Initial Environmental Examination

April 2017

IND: South Asia Subregional Economic Cooperation Road Connectivity Investment Program – Tranche 2

Imphal-Moreh Road (Imphal- Khongkhang section) (Main Report)

Prepared by National Highways and Infrastructure Development Corporation Limited, Government of India for the Asian Development Bank.

CURRENCY EQUIVALENTS

(as of 3 April 2017)

Currency unit		Indian rupee (Rs)
INR1.00	=	$ 0.0154
$1.00	=	INR 64.815

ABBREVIATION

AADT	Annual Average Daily Traffic
AAQ	Ambient air quality
AAQM	Ambient air quality monitoring
ADB	Asian Development Bank
AH	Asian Highway
ASI	Archaeological Survey of India
BDL	Below detectable limit
BGL	Below ground level
BOD	Biochemical oxygen demand
BOQ	Bill of quantity
CCE	Chief Controller of Explosives
CGWA	Central Ground Water Authority
CITES	Convention on International Trade in Endangered Species
CO	Carbon monoxide
COD	Chemical oxygen demand
CPCB	Central Pollution Control Board
DFO	Divisional Forest Officer
DG	Diesel generating set
DO	Dissolved oxygen
DPR	Detailed project report
E&S	Environment and social
EA	Executing agency
EAC	Expert Appraisal Committee
EFP	Environmental Focal Person
EHS	Environment Health and Safety
EIA	Environmental impact assessment
EMOP	Environmental monitoring plan
EMP	Environmental management plan
ESCAP	United Nations Economic and Social Commission for Asia and Pacific
GHG	Greenhouse gas
GIS	Geographical information system
GOI	Government of India
GRC	Grievance redress committee
GRM	Grievance redress mechanism
HFL	Highest flood level
IA	Implementing Agency
IMD	Indian Meteorological Department
IRC	Indian Road Congress
IUCN	International Union for Conservation of Nature
IVI	Important value index
LHS	Left hand side
LPG	Liquefied petroleum gas

Max		Maximum
Min		Minimum
MJB		Major bridge
MNB		Minor bridge
MoEFCC		Ministry of Environment, Forests and Climate Change
MoRSTH/ MoRTH		Ministry of Road Surface Transport and Highways
MPRSD		Master Plan Road Sector Development
N, S, E, W, NE, SW, NW		Wind Directions (North, South, East, West or combination of Two directions like South West, North West)
NGO		Non-governmental organization
NH		National Highway
NHIDCL	-	National Highways and Infrastructure Development Corporation Limited
NOC		No Objection Certificate
NOx		Oxides of nitrogen
PAH		Project Affected Household
PAP		Project Affected Persons
PAS		Protected Areas
PCC		Portland Cement Concrete
PCR		Public Community Resources
PCU		Passenger Car Units
PD		Project Director
PM		Particulate Matter
PIU		Project Implementation Unit
PPE		Personal protective equipment
PPT		Parts per trillion
PPTA		Project Preparedness Technical Assistance
PUC		Pollution Under Control
PWD		Public Works Department
R & R		Rehabilitation and Resettlement
RCC		Reinforced cement concrete
RHS		Right hand side
ROB		Road Over Bridge
ROW		Right of way
RSPM		Respiratory suspended particulate matter
SAARC		South Asian Association for Regional Cooperation
SASEC	-	South Asia Subregional Ecomomic Corridor
SC		Scheduled Cast – Name of a community in India
SEIAA		State Environmental Impact Assessment Authority
SEMU		Social and Environmental Management Unit
SH		State highway
SIA		Social Impact Assessment
SO_2		Sulphur Dioxide
SOI		Survey of India
SPCB		State Pollution Control Board
SPL		Sound Pressure Level
SPM		Suspended Particulate Matter
SPS		ADB Safeguard Policy Statement, 2009
ST		Scheduled Tribes – Name of a community in India

TA	Technical assistance
TDS	Total dissolved solids
TSS	Total Suspended Solids
UA	Urban Agglomeration
UIDSSMT	Urban Infrastructure Development Scheme for Small and Medium Towns
UNESCO	United Nations Educational, Scientific and Cultural Organization
USEPA	United States Environmental Protection Agency
UT	Union Territories
WHC	Water holding capacity
WWF	World Wildlife Fund
ZSI	Zoological survey of India

WEIGHTS AND MEASURES

dB(A)	–	A-weighted decibel
ha	–	hectare
km	–	kilometre
km^2	–	square kilometre
KWA	–	kilowatt ampere
Leq	–	equivalent continuous noise level
µg	–	microgram
m	–	meter
MW (megawatt)	–	megawatt
PM 2.5 or 10	–	Particulate Matter of 2.5 micron or 10 micron size

NOTE

In this report, "$" refers to US dollars.

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EXECUTIVE SUMMARY

A. Introduction

1. This report summarizes the findings and results of the Initial Environmental Examination (IEE) for 65.68 km road section (non-sample subproject) of Imphal-Moreh highway located in Manipur State of India. This subproject is covered under Tranche 2 of ADB's SASEC Regional Road Connectivity Investment Program in India (the Project). The report also briefly describes the Project, existing environmental conditions in the subproject area, anticipated environmental impacts and corresponding mitigation measures, public consultation process, the environmental management plan (EMP) and its monitoring plan.

2. The Initial Environmental Examination for the proposed subproject has been carried out as part of project preparation and in compliance with Environmental Assessment and Review Framework (EARF[1]) for the Project.

B. Description of the Subproject

3. The subproject road section proposed for financing under tranche 2 starts at Lilong (about 10 km from Imphal town at km chainage 330+000) and ends at Khongkhang village (about 35 km before Moreh town km chainage 395+680) covering a total length of 65.68 kms. The subproject road is part of the existing national highway no. 39 (NH-39) and now renamed as Asian Highway 1 (AH1). The subproject road section is proposed for improvement and upgradation to four lane standards (for 20 km length from Lilong to Wanjing i.e. km 330+000 to km 350+000) and rest 45.68 km length of the project road (from Wanjing to Khongkhang village i.e. 350+000 to km 395+680) will be upgraded to 2 lane standards configurations with shoulders and side drains. Table 1 shows information about the subproject road section.

Table 1: Information of the Project Road

Name of the Subproject	Subproject No.	Project Length (km)	Districts	State
Improvement and Upgradation of Imphal-Moreh (AH-1 Priority Section) Road Section from Km 330+000 to Km 395+680 in the State of Manipur	Tranche 2 subproject	65.68	Imphal East, Imphal West, Thoubal and Chandel	Manipur

4. The subproject proposes improvement of part of existing Imphal-Moreh road corridor connecting Myanmar Border (at Moreh) to Imphal (Capital of Manipur). The project corridor traverse through three disctrict of Manipur state in India and mostly pass through rural areas and few urban areas. This corridor will be improved to standard four lane (from Lilong to Wanjing) and two lane carriageway configuration in hilly terrain from Wanjing to Khongkhang village (end point at km chainage 395+680).

5. The present study section, Imphal – Moreh is part of Asian Highway 1 (AH1) in Manipur state in India. The present subproject is aimed to widen and improve about 65.68 km of existing national highway into 2/4 lane configuration between Imphal and Moreh (NH-39) in the state of Manipur. The road stretch is a critical section of the UNESCAP Asian Highway No. 01 (AH01),

[1] Environmental Assessment and Review Framework for proposed IND: SASEC Road Connectivity Investment Program, ADB, December 2013.

paving the way for India and other South Asian countries to Myanmar, and further to ASEAN countries.

6. The subproject corridor starts from Lilong village at its Km 330+000 and ends near Khongkhang village at km 395+680. The subproject road run through plain terrain up to Pallel (36 kms) and remaining road section passes through hilly/rolling terrain (from Pallel to end point). The corridor traverses through agriculturally rich area for first 30 kilometers length but with fair to poor surface condition.

7. The available ROW for the section from Km 330+000 to 330+150 is 60 m and from 330+150 to Km 395+680 is 15 m only. The terrain is plain from Km 330+000 to Km 366+200 and hilly/rolling terrain from 366+200 to 395+680 that is end of project road corridor near Khongkhang village. The major settlements along the project corridor are Lilong, Thoubal, Khangabok, Wangjing, Khongjom and Pallel.

C. Description of the Environment

1. Physical Environment

a. Meteorological Conditions

8. The climate of the subproject area is subtropical temperate. Rainfall is relatively abundant and widespread. The rainy season starts in June with the onset of the south-west monsoon and last upto September. Intermittent rains continue even upto October along with the retreat of the monsoon. The summer months are never oppressive with the average maximum temperature fluctuating from 32°C to 35°C during April-June, the mercury seldom going beyond 37°C.

b. Topography, Geology and Soils

9. ***Topography:*** Topographically, the state is divided according to land elevations (lower hills – altitude ranging from 270 to 1,500 meters; mid hills – 1,500 to 2,000 meters; higher hills – 2,000 to 3,000 meters; alpine zone - above 3,900 meters with vegetation and snow bound land – very high without vegetation up to 8,580 meters). The subproject road is located in lower hills zone with altitude ranging from 500 to 1100m above MSL. It passes through plain terrain (from Imphal to Pallel for 36 km) and through hilly terrain (from Pallel-onwards for about 30 km). Geographically the subproject road lies in the North-Eastern Himalayas between $27^0$00'46" to $28^0$07'48" North latitude and $88^0$00'55" to $88^0$55'25" East longitude.

10. ***Land Use:*** Land use data along the subproject road were obtained with the help of IRS-P3 LISS-III, 2008 Remote Sensing satellite images. The existing land use along the subproject road is mostly agriculture and patches of rural residential areas. About 31% of the project road passes through the think plantation and 31% through thin plantation followed by agrable land (10%) and settlement areas (10%). About 7% land is degraded forest/shrubs whereas about 5.5% land is open /waste land.

11. ***Geology and Soils:*** The subproject road is lies on the foot-hill tectonic belt of Gneissic group. Two forms of Gneiss are usually common i) In South Sikkim – Gneiss is highly micaceous and frequently passes into mica schist. The geological formation is of recent origin resulting by nine repetitive successions of Neocene arnaceous and argillaceous sediments gradually thrown into series of North-South trending longitudinal, plunging anti-clines and synclines. In the higher elevations arnaceous formations occur while the low-lying areas and depressions are represented by argillaceous rocks. The common rocks found are sandstone, shale, silt, stone, clay stones and

slates. The rock system is weak and unstable prone to frequent seismic influence. The state is also seismically active and characterized by frequent landslides. The proposed subproject road fall under the Seismic Zone IV as per the seismic zone map of India (IS 1893 - Part I: 2002).

12. ***Soils:*** The soil in general is loamy sand to silty clay loam with a depth of 30 cm to 100 cm and in some cases even more than 120 cm. It has less water holding capacity and is dry in nature. Chemically acidic soil abound resulting from the washing down of the salts in rain water and also on account of leaching effect. The pH value varies from 4.5 to 7.5. The soils are characterized by low to high organic matter (2-5 percent, in some places even more than 5 percent) with low action exchange capacity and high lime requirement.

c. Water Resources and Hydrology

13. The state has good water resources in the form of lakes, ponds, rivers and streams, some with marshy areas. It has abundant of water potential both ground as well as surface water. Important rivers that flow through the subproject region are the Imphal, Lilong, and Thoubal. The Thoubal river originates in the hill ranges of Ukhrul and is an important tributary of the Imphal river. On its course, it passes through Yairipok and Thoubal before joining the Imphal at Irong near Mayang Imphal. The Imphal river rises in the hills of Senapati district and flows south. During the dry seasons these rivers are lean and thin but, during the rainy monsoon periods these rivers are very wild and frequent flood occur causing widespread damage to the paddy fields, property and life. Other rivers in the region are Wangjing, Arong and Sekmai. These rivers originate in the hills of Ukhrul district.

14. The surface water bodies such as Thoubal River is close to subproject road. The Thoubal River distance from road varies from 5 to 15 m from the subproject road of chainage 339.300 km to chainage 340.000 km. In addition to this, many springs (Jhora) crosses the subproject road.

d. Water Quality

15. In order to represent the true profile of the subproject area, samples from major surface water sources through which the subproject road runs were collected and analysed as per IS-2488 (Part I-V). Ground water (drinking water) samples were analyses as per IS: 10500-1991.

16. Results show that the pH of the drinking water in the region is well within permissible limits (6.5 – 7.5). The samples collected from bore well at Wangjing show highest value of the total dissolved solids of 258mg/l which is well within the permissible standards. Total hardness as $CaCO_3$ in the water sample from Wangjing is found at 209.72mg/l which is highest in all samples but less than the limit (300mg/l) prescribed for drinking water standard limits. BOD level for all analysed ground water samples is higher than the permissible standards. Other parameters analysed like chloride, sulphate, fluorides are found well within standards. Overall the ground water quality in the subproject areas in good.

e. Air Quality

17. Ambient air quality in the state is quite pure compared to other neighbouring states. Except for few urban centres like Imphal and Thoubal and Moreh, the ambient air quality is good. Ambient air quality for particulate matters (PM10 and PM2.5), SO_2, NOx & Pb was monitoring at three locations along the subproject road.

18. It is found from the results that PM10 concentration at one location exceeds permissible limits for residential zone i.e. 100 µg/m^3 prescribed by MoEFCC and World Bank EHS. While

PM10 concentration at AQ1 (MU Gate) Imphal is 115.48 µg/m^3 which is higher than the new permissible limit i.e. 100 µg/m^3 prescribed by MoEFCC and WB EHS guidelines. Other parameters monitored i.e. PM2.5, NOx, SO_2 were found within the permissible limits for all the locations.

f. Noise Levels

19. Noise levels were monitored at three locations along the subproject road. It is found that average day time noise level varies from 64.7 dB(A) to 72.8 dB(A), whereas average night time noise level ranges from 53.8 dB(A) to 62.4 dB(A). The recorded noise level is higher than the permissible limits for residential area of 55 dB(A) and 45 dB(A) for day time and night time, respectively. This noise is mainly from vehicular traffic and local domestic/commercial activities.

2. Biological Environment

20. In spite of its small size, the state's vegetation is rich and varied in character. This is because of its different climatic conditions found in the state and its peculiar physiography. The forest area of the state falls into four distinct zones viz. i) drainage forests, ii) Urkul pine forests, iii) forests overlooking the valley and iv) Barak drainage forests.

21. About 67% of the geographical area of Manipur is hill tract covered forests. Depending on the altitude of hill ranges, the climatic condition varies from tropical to sub-alpine. The wet forests and the pine forests occur between 900-2700 m above MSL and they together sustain a host of rare and endemic plant and animal life.

22. Vegetation along the subproject road sections Imphal to Pallel and Pallel to Khongkhang (end point), are mostly covered by the agriculture, thick grass and secondary Moist Deciduous Forest.

23. Forests along the subproject road sections in plain terrain (Lilong to Pallel) and Hilly terrain (Pallel to Moreh) are mix of agriculture, non-forest areas, open forest.

24. In plain terrain (from starting point at chainage km 330.00 to Pallel at chainage km 365.00) landuse is mixed of built-up (major settlements Wangjing, Thoubal, Pallel) and agriculture. While in hilly terrain (from chainage km 366.00 onwards landuse is mixed of built-up (small settlements), agriculture and forests area (protected, reserve and unclassed) of Thoubal Forest Division and Myanmar Boarder Teak Protected Forest.

25. About 33.28 km length of the subproject road passes through various types of forests. Details of the forest locations along the subproject road section is listed in Table 2.

Table 2: Details of Forest Locations along the Subproject Road section

S. No.	Design Chainage (km)		Length (m)	Side of Road	Forest Name and Type	Remarks
	From	To				
1	334.6	336.2	1600	LHS	Waithou PF	
2	336.3	337.5	1200	RHS	Unclass	
3	355.0	355.3	300	LHS	Proposed Khunadalaiching RF	Proposed CL may be shift towards RHS
4	357.2	357.5	300			
5	358.6	358.9	300			
6	361.9	362.1	200			
7	366.3	384.8	18500	RHS	Proposed Lamdang RF	

S. No.	Design Chainage (km)		Length (m)	Side of Road	Forest Name and Type	Remarks
	From	To				
				LHS	Unclass	Hill section starts
8	384.8	389.0	4200	Both side	Unclass	
9	389.0	391.5	2500	LHS	Myanmar Boarder Teak PF	
				RHS	Unclass	
10	391.5	395.68	4180	Both side	Myanmar Boarder Teak PF	
	Total Length (m)		**33280**			

Source: Field Survey and Data received from Forest Department of Manipur.

26. Local forest department were consulted to know the presence of any endangered species of trees within the formation width. It is confirmed by the forest department officials that there are no endangered species which are likely to be affected by current subproject works.

27. Field surveys have been carried out to identify the number and type of trees to be affected by the proposed improvement work. It is envisaged that about 3691 trees existing within the proposed formation width of the subproject road. Among these trees 1557 are on left side and 2134 tress are on right side of the road while travelling towards Moreh.

28. There are no environmentally sensitive protected area along the subproject road.

3. Socio-economic Environment

a. Demography

29. Manipur is one of the sisters' states in north eastern state a population of 2.38 million with about more than 75 percent of the population living in the rural areas. The human population density is very less (only 107 persons/km^2) compared to 149 persons/km^2 for the north eastern region. Sex ratio is 978 against the 936 in the region. The demographic feature of north eastern states is unique in that there are more than 29 recognized tribes, which inhabit mostly the hill areas and each with distinct culture, ethos, and traditional knowledge systems. The major minority groups in the state namely Aimol, Anal, Angami, Chiru, Chothe, Hmar, Kabui, Kacha Naga, Mizo, Mao, Lusai etc. The majority of the people survive on subsistence economy based mainly on the agriculture, supplemented with limited horticulture, animal husbandry, crafts/handloom, etc.

b. Land Resources

30. The area available for land utilization in the state is about 19052 sq.km out of the total geographical area of 22327 sq.km. This means about 85 percent of the area in the state in available under various land uses. Major portion of the land use is under forest cover covering about 70 percent of the land use area. About 8 percent area is under gross cropped area. Agriculture is the second major land use in area.

31. Agriculture is the mainstay of the people. It contributes major shares in the state domestic product and provides employment to about 63 percent of total working force in state. Total net sown area is 160,000 hectares. Rice is principal food grain followed by maize and millets.

32. Though the state has no marine fishery, it has vast inland fishery resources like ponds, tanks, naturals lakes, marshy areas, swampy areas, rivers, reservoirs, submerged cropped land, paddy field etc. The largest source of fish is the Loktak Lake. The production of fish in Manipur

for the year 2001-02 was estimated to be 16.5 thousands tones as against the 16.05 in thousand tons in the year 2000-01 showing an increase of 2.8 percent over the previous years.

c. Infrastructure

33. Transportation system is a key factor in the socio-economic development of any state. There is practically no railway network in the state. Two rail heads – one at Dimapur in Nagaland (215 km away from Imphal) and the other at Jiribam (225 km away from Imphal) serves the state. The state has one airport at Imphal, which connects up with the rest of the country. Waterways are also not feasible. Roads, therefore, constitute the only means of transport system in the state for movement of men, materials and services within and outside the state. The total road network stands at around 7200 km, of which 2600 km are unsurfaced roads.

34. The state has endowed with mineral resources. The main mineral reserves in the state includes lime stone (14.8 thousand tons), clay (2.5 thousand tons), and chromite (0.1 thousand tons). For exploiting the mineral resources, it is important to provide a good road and rail infrastructure.

35. The north eastern region has the potential to emerge as a strategic base for domestic and foreign investors to tap the potential of the contiguous markets of People's Republic of China, Myanmar, Lao PDR, Nepal, and Bhutan. This calls for converting the unauthorised trade into authorised trade, at the policy level as well as at the ground level. The BIMST-EC (Bangladesh-India-Myanmar-Sri Lanka-Thailand Economic Cooperation) initiative is creating an enabling environment for rapid economic development through identification and implementation of specific cooperation projects in the sectors of trade, investment and industry, technology, human resource development, tourism, agriculture, energy, infrastructure and transportation.

D. Consultation, Disclosure and Grievance Mechanism

36. In accordance with ADB's Safeguard Policy Statement (SPS) 2009 public consultations were held, as part of the IEE study. Consultations were undertaken with project beneficiaries, local/ government officials, community leaders, women groups, NGO's, stakeholders in corridor of impact and people likely to be effected due to the subproject on various issues affecting them and incorporation of various measures pertaining to environmental issues based on the responses from the people.

37. Both formal and informal modes of consultation were used in the public consultation process for the subproject. Consultation with the stakeholders, beneficiaries, and community leaders were carried out using standard structured questionnaires as well as unstructured questionnaires. In addition, focused ground discussions (FGDs) and personal discussions with officials, on-site discussion with project affected stakeholders, and reconnaissance visits have also been made to the project areas. The attempts were made to encourage participation in the consultation process of the Government officials from different departments that have relevance to the subproject. Same way, local people from different socio economic backgrounds in the villages as well as urban areas along the project road alignment and at detours, residents near the existing road, women representatives, local commuters, and other concerned were also consulted.

38. In compliance with ADB's SPS requirements consultation will be continued throughout the subproject process. The consultations were conducted during preparation of the IEE. The official consultation with the key stakeholders was undertaken in the months of June 2013, January 2014 and July 2016 at respective district offices and head quarter in Imphal. Various officials consulted

include PWD Officials, Forest Officers, Wildlife Officials, Environmental Officers from pollution control board, statistical officer, officials from NGOs active in the project areas etc. Besides interview surveys, focused group discussions (FGDs) were organized at key locations along the project roads. In total ten (10) FGDs meetings involving 250 participates from affected people, landowners, and village authorities, were organized. Specific emphasis was given to women participants to ensure that gender concerns are addressed in the project. Out of total participants, 81 participants were from women groups. Most of the people interviewed strongly support the project. The people living in the entire project area expect the different project elements to facilitate transport, employment, boost economic development and thereby provide direct, or indirect, benefits to themselves.

39. The project EA will be responsible for the disclosure of this IEE in compliance to ADB's Communication Policy 2011 and ADB SPS 2009. This draft IEE report will also be made available to all stakeholders as part of the consultation process required under the SPS 2009.

40. A Grievance Redress Mechanism (GRM) has been proposed to address grievances related to the implementation of the subproject, particularly regarding the environmental management plan and to acknowledged, evaluated, and responded to the complainant with corrective action proposed using understandable and transparent processes that are gender responsive, culturally appropriate, and readily accessible to all segments of the affected people. Records of grievances received, corrective actions taken and their outcomes will be properly maintained and form part of the semi-annual environmental monitoring report to ADB. Depending on the nature and significance of the grievances or complaints, the grievance redress mechanism (GRM) will comprise procedures to address grievances i) first at the PIU level and ii) second at the EA level and iv) third at the Grievance Redress Committee (GRC). Most serious complaints which cannot be addressed at the EA level will be forwarded to the GRC. The GRC will comprise members from the EA, IA, Authority's Engineer, contractor, local community and local forestry authority.

E. Anticipated Environmental Impacts and Mitigation Measures

41. The road rehabilitation and upgradation project activities can cause environmental impacts that are short, or long-term, and beneficial, or adverse, in nature. The overall long-term impacts will be largely beneficial in regard to the socio-economic environment and quality-of-life in the region. The key environmental issues associated with various aspects of the proposed subproject and impacts on various environmental components have been assessed for various stages i.e. (a) the project location, (b) design, (c) construction, and (d) operation.

1. Environmental Impacts Associated with Project Location, Preliminary Planning and Design

42. **Location issues**: The environmental impact of subproject road location will not be very significant since widening work will be carried out along the existing road. However since the subproject involved widening of existing carrigenway (4 lane configuration upto Wanjing and 2 lane configuration for rest of the section), this will require acquisition of about 68.1 hectares of land for road right of way. Although land acquisition requirement has been kept to minimum level, it will have impacts on topography and change in land use in the region. Loss of agriculture land and productive soil is also anticipated due to additional land acquisition.

43. Since about 33.28 km length of subproject road passes through forest areas and it requires diversion of about 50.51 hectares of forest land, adverse impacts on flora and fauna are

anticipated. Also land clearing will involve cutting of about 3691 trees. Problem of soil erosion is expected in some locations. Loss of trees will be compensated by planting 11073 trees (1:3 ratio) as compensatory afforestation.

44. The project affected people will be compensated as per the provisions of a Resettlement Plans (prepared as separate report). The widening option, have been devised so as to cause minimise destruction of structures. There are private structures, few small temples, shrines and educational buildings which are coming adjacent to existing carriageway of the subproject road. Care will be taken to avoid such community structures or cause damage in their relocation. There will also be a requirement to establish construction camps and related contractor's facilities, borrow pits and quarries. These will be located in environmentally sound and socially safe areas. It is expected that construction materials for the road works will be mined only from approved quarries.

2. Environmental Impacts Due to Construction

45. **Impacts on Topography, Soil and Vegetation**: During the improvement works of the road section and because of felling of trees, hill cuttings, ground clearing; stone quarrying, and construction of structures etc. the micro-level topography may change.

46. During road improvement works there will be cut and fill activities, cutting of trees, stone quarrying, and construction of structures. Even with reasonable care exercised in the final design, the interaction between proposed road features and existing land features could result in significant land instabilities during construction. Thus, the following mitigating measures should be implemented:

- existing vegetation including shrubs and grasses along the road (except within the strip directly under embankments or cuttings) should be properly maintained and all slopes/soil cutting areas should be revegetated as soon as construction activities are completed,
- excavation and earthworks should be mainly undertaken during the dry season when the risks from erosion and silt run-off are least,
- sites for quarrying, borrowing and disposal of spoils are to be confirmed according to the applicable laws and regulations in the state and the practices followed in recent/ongoing projects of international level,
- controlled and environmentally friendly quarrying techniques should be applied to minimise erosions and landslides,
- cut material should be disposed of in suitable depressions,
- materials that will be used for surface dressing will consist of aggregates and gravel, and must not contain silt, and
- Internationally accepted best practice engineering approaches will be incorporated into contract documents and monitored during construction.

47. **Impacts on Surface and Groundwater Quality, Drainage and Hydrology**: A number of rivers and streams crosses the subproject road. The improvement of the road may result in disruptions to the natural hydrology and water mismanagement that may lead to further problems of soil erosion. Construction activities could also lead to the temporary pollution of rivers from spillage of chemicals and oil at construction sites and waste from construction camps, discharge of sediment-laden water from construction areas and uncontrolled surface water discharge over the road edge creating large–scale erosion on down-slopes. Thus the following mitigating measures are recommended:

- natural courses of water bodies should, as far as possible be maintained and brought back to their natural course,
- all debris and vegetation, clogging culverts should be regularly cleared and disposal of construction debris in streams and rivers should be avoided,
- river-bank slope stabilities should be monitored and appropriate remedial measures applied throughout the construction period,
- if possible, construction work at bridges should also be avoided during the rainy season,
- chemicals and oils should be stored in secure, impermeable containers, and disposed of well away from surface waters,
- no vehicle cleaning activity should be allowed within 300 m of water bodies/ drains,
- construction camps should be equipped with sanitary latrines,
- lined drainage structures should be provided,
- side drain waters must be discharged at every available stream crossing.

48. **Air Quality**: Prediction of the pollutant (CO, NOx and PM10) concentrations has been carried out using CALINE-4, a dispersion model based on Gaussian Equation. It has been observed from the model output that when the traffic volume increases, the concentration of air pollutants also increases correspondingly.

49. During construction, and at the micro-level only, air quality may be degraded by generation of dust (PM) and generation of polluting gases including SO2, NOx and HC for short periods from vehicular movements, site clearance, earth filling and material loading and unloading. The impacts are expected to be localised, temporary and confined to construction areas. Care should, however, be taken at sensitive urban locations so that harmful impacts can be minimised. The following actions should be implemented:

- regular check-up and maintenance of construction equipment,
- mixing plants i.e. asphalt, concrete, and bricks, should be operated within the permissible limits of CPCB and WB EHS, and be located away from settlements,
- the contractor should submit a dust suppression and control programme to the PIU,
- vehicles delivering loose and fine materials should be covered to reduce spills,
- controlled blasting should be carried out and only with the prior approval of the site Engineer and, if required, PIU,
- bitumen emulsion should be used wherever feasible, and
- bitumen heaters should be used and the use of wood for fuel should be discouraged or prohibited.

50. **Noise Level**: With the exception of the Imphal city, the ambient noise level along the road sections is within standards. During the construction period, noise will be generated from the operation of heavy machinery, blasting works, the haulage of construction materials to the construction yard and the general activities at the yard itself.

51. Noise levels were predicted using Federal Highway Administration's Traffic Noise Model (FHWA TNM) which helps for highway traffic noise prediction and analysis. It is observed that the noise levels (Leq) near the receivers are found to be higher than desired levels for the respective categories. The maximum predicted value 67.8 dB(A) is recorded (for the year 2018 when traffic will be induced) at the receiver located close to Thoubal college. The predicted levels show increase in noise levels for future years at all receivers considering an incremental noise level due to current traffic and project traffic is in the range of 5.5 to 7.1 dB(A).

52. Noise and vibration will be unavoidable but the impact will only be temporary and will only affect people living or working near piling locations. Mitigation measures should include (a) provision of noise barriers at sensitive locations, (b) construction machinery should be located away from settlements (c) careful planning of machinery operation and the scheduling of such operations can reduce noise levels, (d) controlled blasting (if any) should only be carried out with prior approval from the Engineer in charge, and (e) contractors should be required to fit noise shields on construction machinery and to provide earplugs to the operators of heavy machines.

53. **Flora and Fauna:** Since about 33.28 km length of the subproject road passes through forest areas, it may cause adverse impacts on flora and fauna of the area. Also acquisition of forest land (50.51 hectares) may add minor impacts on the presence of flora and fauna in the forests. Removal of the existing vegetative cover and the uprooting of about 3691 trees is an unfortunate activity, which may reduce the ecological balance in the areas. This may also enhance soil erosion problem.

54. To minimise adverse impacts on flora such as trees, contract documents should specify that (a) all wood building material for workers' housing should be brought from outside the project area, (b) workers should be supplied with non-wood fuels such as kerosene or liquefied petroleum gas for the duration of the contract, (c) all contract equipment and plants should be cleaned to the satisfaction of the project engineer in charge prior to their relocation to project sites; (d) during site clearance, care should be taken to ensure that the minimum area of vegetation area is affected and (e) the water sprinkling of trucks used as construction vehicles should be properly and regularly undertaken, so that dust deposition problem on vegetation are minimised. Specific measures such as i) construction facilities such as workers camp, construction camp, hot mix plant, batching plant should be located at least 1 km away from the forest area, ii) employment agreements should specify heavy penalties for illegal hunting, trapping and wildlife trading – all other ancillary works should also agree not to participate in such activities, iii) Strict anti-poaching surveillance measures need to be implemented, especially during project construction phase in the forest areas, iv) provisions of signage as a precautionary measure to provide awareness about animal movement will be made to avoid accidents, and v) project staff and work crews should not be allowed to have animal traps etc. There will be strict compliance monitoring by Environmental Specilaist while constructing road through Reserve Forest area.

3. Environmental Effects Related to Operation

55. **Noise and Vibration, Air Pollution, Runoff, Spoils of Hazardous Materials**: The current traffic flows along the project roads is expected to increase because of improved economic activities associated with better access. The larger numbers of vehicles will be an additional source of noise and gaseous emissions. Traffic volumes will, however, remain low and this should not be a significant impact. Repairs to culverts and new drainage work will eliminate/ reduce the soil erosion problems presently caused by poor cross drainage.

56. **Land Use and Settlements**: The likely impacts on land use and settlement patterns are limited. Improved access will inevitably lead to increased in and out migration, but this is likely to occur gradually and over a prolonged period. There will be time for new residential areas to be established. There may, however, be a need to control ribbon development.

4. Potential Environmental Enhancement/ Protection Measures

57. In order to improve the environment, additional measures were also proposed during construction for the following: (a) sanitation and housekeeping at the labour/ construction camps

(b) provision of water supply (c) hygiene and provision of toilet facilities, (d) sewerage and waste disposal (e) first aid, (f) maintenance of buildings and facilities (g) identification of debris disposal sites, and (h) rehabilitation of quarry and borrow pits.

F. Environmental Management Plan

58. A fully budgeted environmental management plan has been prepared for mitigation/management/avoidance of the potential adverse impacts and enhancement of various environmental components along the subproject road. For each mitigation measures to be carried out its location, timeframe, implementation and overseeing/ supervising responsibilities has been identified. Monitoring plan for construction and operation phase has been framed to ensure effective implementation of EMP.

59. The monitoring program included performance indicators for water, air, and noise level monitoring, frequency of monitoring, and institutional arrangements of the project in the construction and operation stages, along with the estimated cost. The reporting system included roles and responsibilities of each party involved in the project implementation i.e. PIU, Authority's Engineer and Contractors and reporting mechanisms during implementation and operation phases.

60. An environmental management budget of INR 8,298,505 (Indian Rupees Eight million two nine eight thousand and five hundred five only) (US$ 0.14 milions) has been estimated for implementation of the environmental management plan. This budget also includes cost of environmental monitoring and associated trainings.

I. INTRODUCTION

A. Project Background and Rational

1. ADB has a regional cooperation program in four South Asian countries: Bangladesh, Bhutan, India and Nepal, called South Asia Subregional Economic Cooperation (SASEC[2]), which has been supporting regional cooperation in the transport sector through SAARC[3] and BIMSTEC[4] over a decade. Major contributions in this regard include assisting the SAARC Regional Multimodal Transport Study (SRMTS)[5] and BIMSTEC Transport Infrastructure and Logistics Study (BTILS).[6] A series of SASEC Trade Facilitation and Transport Working Group meetings have endorsed ADB preparation of a project to improve the most critical corridors connecting regional countries. Further to initiate connectivity between South Asia and South East Asia and as a follow on activity of the BTILS, strategic roads connecting Bangladesh, India and Myanmar are currently being studied.

2. Manipur being landlocked with no rail connectivity presently has to depend on its road network for its transportation requirements. The present study section, Imphal - Moreh is part of Asian Highway (AH-1) in Manipur state in India. AH 1 is the longest route of the Asian Highway Network, running 12,845 miles (20,557 km) from Tokyo, Japan via Korea, People's Republic of China, Southeast Asia, India, Pakistan, Afghanistan and Iran to the border between Turkey and Bulgaria west of Istanbul where it joins end-on with European route E80. In India AH 1 passes through Numaligarh - Golaghat - Garampani - Barpathar - Naojan - Bokajan - Dimapur - Kohima - Tadubi - Senapati - Kangpokpi - Imphal - Thoubal - Tengnoupal – Moreh (Myanmar border).

3. The present subproject aimed to widen and improve about 65.68 km of existing national highway into 4/2 lane configurations between Imphal and Moreh (NH-39 or AH 1) in the state of Manipur. The road stretch is a critical section of the UNESCAP (United Nations Economic and Social Commission for Asia and Pacific) Asian Highway No. 1 (AH-1), paving the way for India and other South Asian countries to Myanmar, and further to ASEAN countries.

4. **Regional Cooperation**: The Project is a critical section of Asian Highway No. 1 (AH-1), which is also the common section of the Indo-Myanmar-Thailand Trilateral Highway[7]. In India, the 4-lanning development is ongoing under the National Highway Development Program (NHDP) upto Imphal via Kohima. In Myanmar AH-1 between Yangon and Mandalay is all 4-lane concrete roads with wide median. For the section of AH-1 in Myanmar between Mandalay and Indian Border, it is narrow two lanes, with good condition upto Kalewa, part of the India-Myanmar Friendship Road. The 30-year plan (2011/12-2030/31) of the Myanmar's Ministry of Construction indicated that all international connecting roads will be 4-lane asphalt concrete roads.

5. The Project will integrate two initiatives of subregional economic and social cooperation: SAARC and ASEAN. The Indo-Myanmar connectivity is the key for integration of South and South East Asia. The Project will provide India with new oil and gas opportunities off the coast of

[2] South Asia Subregional Economic Cooperation (SASEC). Member countries are Bangladesh, Bhutan, India and Nepal

[3] South Asian Association for Regional Cooperation (SAARC). Member countries are Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan and Sri Lanka

[4] Bay of Bengal Initiative for Multi-Sectoral Technical and Economic Cooperation (BIMSTEC). Member countries are Bangladesh, Bhutan, India, Myanmar, Nepal, Sri Lanka and Thailand

[5] SAARC Secretariat. 2007. *Regional Multimodal Transport Study*. Kathmandu.

[6] ADB. 2008. *Final Report of RETA6335: BIMSTEC Transport Infrastructure and Logistics Study*. Manila.

[7] The Indo-Myanmar-Thailand Joint Task Force Meeting on the Trilateral Highway Project held in Delhi on September 2012.

Myanmar as well as easier access to Japanese products made in Thailand. Trade between India, Myanmar and Thailand is currently sea-bound, which not only makes exchanges slow but also prohibitively expensive. The Project will whittle down cost stupendously, ushering in economies of scale and commercial prosperity. Industry estimate suggests that seamless connectivity with the Asian Highway Network through trilateral project would ratchet up India's trade with ASEAN to about US$ 100 billion in the next five years.

6. Cross-border trades via roads between India and Myanmar, via Moreh/Tamu and Reed, comprises only 1.5% of the total road-based cross-border trades of Myanmar ($1.1 billion), against about 70% with People's Republic of China and 26% with Thailand. Some studies indicate that the informal border trade with Myanmar is growing while the official trades have been shrinking. The Project, the biggest official route of border trades, will help increase the cross-border trade. A substantial increase is expected subject to further improvement of border trade systems, including the development of the integrated check post. Moreh is one of the priority border posts under the GoIs Integrated Check Post Program. GoI has also been in discussions with the Government of Myanmar on starting of a bus service between Imphal and Mandalay (about 820km).

7. Myanmar receives various supports for infrastructure development from neighbouring countries for RCI (Regional Cooperation and Integration) Connectivity. The project will add another RCI Initiative to support Myanmar's opening economy. India supports development of a large new terminal at Sittwe and its access from the Indian border in Mizoram at Hmawngbu (Mobu), i.e. Kaladan Multi-Model Transit Transport Project. People's Republic of China supports development of a deep sea port and a special economic zone (SEZ) at Kyaukphyu on the east side of the Bay of Bengal, which includes 12 crude oil tanks. They have been building new oil and gas pipelines starting from Kyaukphyu with Kunming in People's Repubic of China. Thailand supports development of a deep sea port and SEZ at Dawei, together with the support to road development connecting between Thailand and Myanmar, which provides easy access for Thailand and ASEAN countries to Dawei and beyond the Bay of Bengal.

8. **National Economy:** GOI undertakes 4-lanning of the strategic national highway network under NHDP, extending to the India's northeastern region (NER). Currently, it is under development of 4-lanning upto Imphal and Silchar. The Project will complete the 4-lanning for the whole stretch of the national highway to the Myanmar Border (Moreh) via Imphal, or the Indian portion of the Asian Highway No. 1. At a later phase, the road stretch between Imphal and Silchar could be improved into 4-laning, extending the 4-lane East-West Corridor to the Myanmar border, together with the proposed project.

9. The project will also bring new wealth to NER, which have been blighted by local insurgencies and heavy security. The Project road will provide a much shorter route for NER to reach deep seaports in Myanmar, currently under development. The traffic is expected to substantially increase due to the access form other Indian states and also from neighbouring landlocked countries (Bhutan and Nepal) with the result that NER will be transformed into a regional trading hub. The project will also realize the synergy with the 2,000 acre of township development plan of Moreh.

10. Traffic level between 1800 hrs and 0600 hrs were typical 0 and 10% of the daily traffic and the effective road usage hours are less than 12 hours on many roads. In other parts of India traffic levels on road during the night hours are around 30%. Increase to trades and the resultant traffic, the improved road capacity and conditions, will improve the security situation and network utilization.

11. State governments in Assam and Manipur have proposals to provide alternate state roads at state level for improving Myanmar connectivity such as the Leney-Silchar road in Assam and the Jiribhum-Behiang road in Manipur, partly national highways starting from Silchar. These alternate state roads will attract more traffic to the Project road and improve economy of the remote areas in NER.

12. Looking at the benefits of the project, the Government of India requested for a project preparatory technical assistance (TA) from the Asian Development Bank (ADB) to prepare an ensuing investment program for the international trade corridor in Manipur State (the project). The investment program loan will upgrade high priority trade corridors and facilities comprising National Highways (NH) and State Highways (SH) connecting five countries: Bangladesh, Bhutan, India, Myanmar and Nepal in the northeastern part of India. Given the large scale of the program and the need to carefully study priority corridors particularly in the India - Bangladesh - Myanmar region, a sector loan approach is proposed to finance the project.

13. While approximately seven road corridors have been identified for financing under the program, two sample subprojects were prepared as part of the project processing. The options and design for the remaining roads and facilities are still being studied and yet to be clearly defined. Therefore the former are selected as sample subprojects and the later once as non-sample subprojects under the program. The list of ongoing and possible subprojects under theinvestment program are provided below in Table 3.

Table 3: List of Possible Subprojects to be included in the Investment Program

No.	Name of Road/Facility	Length (km)
I	**Tranche I subprojects**	
1.	AH-2: Panitanki (Nepal border) – Fulbari (Bangladesh border)	37.271
2.	AH-48: Jaigaon (Bhutan border) – Changrabandha (Bangladesh border)	90.56
3.	Imphal-Kanchup-Tamenglong-Tousem-Haflong (Manipur**)**	103
	Sub-Total-A	**230.831**
II	**Tranche 2 subprojects**	
1.	**AH-1: Imphal-Moreh Priority section (Imphal to Khongkhang village (km330.000 to 395.680)) in Manipur**	**65.68**
2.	Mechi bridge (West Bengal)	1.50
3.	Additional financing for Imphal-Kanchup-Tamenglong state highway in Manipur	
	Sub-Total-B	**67.28**
III	**Potential subprojects for succeeding tranches**	
1.	Imphal-Moreh AH-1 last mile	30
2.	Imphal-Wangjiang-Heirok-Machi-Khudengthabi (Manipur)	62
3.	Greater Imphal Ring Road	37.72
	Sub-Total-C	**129.72**
	Grand Total (Approximately)	**427.831**

14. This Initial Environmental Examination (IEE) covers a subproject in the State of Manipur i.e. AH-1:Imphal-Moreh Priority Section (Imphal to Khongkhang village road section). All discussions thereafter focused only on this subproject. The environmental assessment report for

this subproject is prepared as part of project preparation in compliance with Environmental Assessment and Review Framework (EARF[8]) for the investment program.

B. Subproject Road

15. The subproject road is a section of the Imphal – Moreh national highway (part of Asian Highway AH1) in Manipur state of India. It passes through the districts of Imphal, Thoubal and Chandel, and it is 65.68 km long. The subproject road section starts from Lilong village at Km chainage 330+000 and ends near Khongkhang village at km chainage 395+680. The road run through plain terrain up to Pallel (36 kms) and remaining road section passes through hilly/rolling terrain (from Pallel to end pont i.e. Khongkhang village). The corridor traverses through agriculturally rich area for first 30 kilometers length but with fair to poor surface condition. Figure 1 shows the index map of the subproject road.

16. The available ROW for the section from Km 330+000 to 330+150 is 60 m and from 330+150 to Km 395+680 is 15 m only. The terrain is plain from Km 330+000 to Km 366+200 and hilly/rolling terrain from 366+200 to 395+680 that is end of project road corridor i.e. Khongkhang village. The major settlements along the project corridor are Lilong, Thoubal, Khangabok, Wangjing, Khongjom and Pallel. The land use along this section is agricultural mixed with roadside development up to Pallel with some of urban and semi urban centers like Lilong, and Thuobal. Clusters of settlement are also noticed in between urban areas. From Pallel to end point, the land use is mix of open/barren land with thin vegetation and patches of agricultural activities on hillocks. These hills are mostly owned by village communities. The vegetation on hilly terrain is mostly mixed bushes and thin forests owned by communities. Table 4 present the salient features of the existing subproject road.

Figure 1: Index Map of the Subproject Road

[8] Environmental Assessment and Review Framework for proposed IND: SASEC Road Connectivity Investment Program, ADB, December 2013.

17. The subproject corridor however passes through some congested urban areas where widening or even minimum improvement of road geometry is not possible. At the same time, the existing constricted condition cannot be allowed to remain if the corridor is to attain a uniform acceptable level of service. Therefore, the project engineering team has studied various alternatives for the alignment including realignment and provision of bypasses.

18. Considering the existing conditions and projected traffic, it is proposed to improve initial 20 kms length (from km 330+000 to km 350+000) to four lane divided carriageway with paved shoulder and service lanes. Remaining 45.68 km section (from km 350+000 to km 395+680) will be improved to 2 lane configuration.

Table 4: Description of Imphal-Moreh Road Section

Subproject Road	Length (km)	Districts	Summary of General Road Condition
AH-1: Imphal-Moreh Priority section (Imphal to Khongkhang village (km330.000 to 395.680)) in Manipur	65.68	Imphal East, Imphal West, Thoubal and Chandel	The subproject road is a section of the Imphal – Moreh national highway (part of Asian Highway AH1) in Manipur state of India. It passes through the districts of Imphal, Thoubal and Pallel and it is 65.68 km long. The subproject road section starts from Lilong village at Km chainage 330+000 and ends near Khongkhang village at km chainage 395+680. The road run through plain terrain up to Pallel (36 kms) and remaining road section passes through hilly/rolling terrain (from Pallel to Khongkhang village). The corridor traverses through agriculturally rich area for first 30 kilometers length but with fair to poor surface condition. The available ROW for the section from Km 330+000 to 330+150 is 60 m and from 330+150 to Km 395+680 is 15 m only. The terrain is plain from Km 330 to Km 366+200 and hilly/rolling terrain from 366+200 to 395+680 that is end of project road corridor. The major settlements along the project corridor are Lilong, Thoubal, Khangabok, Wangjing, Khongjom and Pallel. The land use along this section is agricultural mixed with roadside development up to Pallel with some of urban and semi urban centers like Lilong, and Thuobal. Clusters of settlement are also noticed in between urban areas. From Pallel to end point i.e. Khongkhang village, the land use is mix of open/barren land with thin vegetation and patches of agricultural activities on hillocks. These hills are mostly owned by village communities. The vegetation on hilly terrain is mostly mixed bushes and thin forests owned by communities. Considering the existing conditions and projected traffic, it is proposed to improve initial 20 kms length (from km 330+000 to km 350+000) to four lane

Subproject Road	Length (km)	Districts	Summary of General Road Condition
			divided carriageway with paved shoulder and service lanes. Remaining 45.68 km section (from km 350+000 to km 395+680) will be improved to 2 lane configuration.

C. Objective and Scope of the Study

19. The objective of this IEE study is to identify potential environmental impacts of the proposed road improvement work and formulate strategies to avoid / mitigate the same. The scope of work to accomplish the above objective, comprise the following.

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

20. The environmental studies have been confined to the situation around the deemed areas of direct influence caused by constructional and operational facilities along the proposed road section. The following sections of the report, discusses the methodology adopted by the consultants in conducting the IEE study and presents the results of the same.

D. Methodology Adopted for IEE Study

21. The Initial Environmental Examination has been carried out, in accordance with the requirements of the ADB's Safeguard Policy Statement (SPS 2009) and Environmental Assessment and Review Framework prepared for the overall SASEC Road Connectivity Investment Program. The Government of India guidelines for Rail/Road/Highway project; EIA notification 2006 of MoEFCC, and Highway Sector EIA guidance manual 2010 has also been followed in the process of this environmental assessment. The study methodology has been adopted in such a manner to ensure that environmental concerns are given adequate weightage in the selection of alignment and design of proposed road improvements. The study in this subproject employs an iterative approach in which potential environmental issues have been examined at successive levels in detail and specificity, at each step in the process.

22. The environmental assessment is based on the information collected from secondary as well as primary sources on various environmental attributes. Monitoring of air, water, noise and soil quality was also carried out within the ROW and significant issues were examined during field surveys to determine the magnitude of significant environmental impacts. The major steps in the IEE process for the project were as follows:

1. Collection and Analysis of Data

23. Data was collected on various environmental components such as soil, meteorology, geology, hydrology, water quality, flora and fauna, habitat, demography, land use, cultural properties etc, to establish the baseline environmental setup. Secondary data on environment for the project corridor was collected both from published and other relevant sources e.g., the State Department of Forest, Manipur State Pollution Control Board, State Statistical Department etc. The data collection from the field was completed with the help of field surveyors and

enumerators/investigators. The interviewers/surveyors were trained for taking the samples and filling up the Questionnaires at site. To ensure the accuracy of the data it was collected under the supervision of the consultant.

2. Environmental Monitoring and Analysis

24. In order to assess the situation in particular sections of the road during the screening and site visit of the area, different locations were identified for monitoring and analysis the soil quality, noise level, ambient air and water quality. The monitoring and analysis of soil quality, water quality, air quality and noise level has been done by M/s. Greenvision, a leading environmental research laboratory based in Durgapur, West Bengal in the month of February 2014. Air quality monitoring has been carried out as per MoEFCC notification of November 2009 the revised Air Quality standards (Annex 3) and the on-site monitoring results are incorporated in Chapter- 4 of this IEE report.

3. Vegetation and Wildlife Surveys

25. In order to assess presence of flora and fauna along the proposed alignment field surveys have been carried out with the help of field officers of the state forest department. Findings are incorporated in Chapter- 4 of this IEE report.

4. Stakeholder and Public Consultations

26. Extensive consultations were held during different stages (reconnaissance, detailed design and design review) with key stakeholders that includes local and beneficiary population, government departments/agencies, road users, and project-affected persons. These consultations allowed the interaction between the stakeholders and road designers to identify road features and construction methods that will enhance road upgrading and minimize potential impacts. Information gathered was integrated in the project design and formulating mitigation measures and environmental management plan. Detailed description of public consultation is presented in Chapter-8 of this IEE report.

5. Assessment of Potential Impacts

27. Potential impacts were identified on the basis of: analytical review of baseline data; review of environmental conditions at site; analytical review of the underlying socio-economic conditions with the subproject influence area.

6. Preparation of the Environment Management Plan

28. An EMP for the project is prepared to specify the steps required to ensure that the necessary measures have been taken and the same will be incorporated during construction and operation stage of the project. The EMP includes the monitoring plan giving details of the resources budgeted and the implementation arrangements.

E. Structure of the Report

29. This IEE report has been presented as per requirements of the ADB's Safeguard Policy Statement (SPS) 2009. The report is organised into following eleven chapters, a brief of each chapter is described below:

- ***Chapter 1 - Introduction***: This section describes the background information about the project and EIA study.

- ***Chapter 2 - Policy, Legal, and Administrative Frameworks***: this section summarizing the national and local legal and institutional frameworks that guided the conduct of the assessment.
- ***Chapter 3 - Project Description***: This section presents the key features and components of the proposed project.
- ***Chapter 4 - Description of the Environment***: This section discussing the relevant physical, biological, and socioeconomic features that may be affected by the proposed project.
- ***Chapter 5 - Anticipated Environmental Impacts and Mitigation Measures***: This section presents the environmental assessment of likely positive and adverse impacts attributed to the proposed project and concomitant mitigation measures.
- ***Chapter 6 - Climate Change Risk Assessment***: This section provides an analysis of climate change impacts and risks due to the implementation of proposed project.
- ***Chapter 7 - Information Disclosure, Consultation, and Participation***: This section describes the consultation process undertaken during the environmental examination and its results, their consideration in the project design, and manner of compliance to the ADB's Publication Policy and related national laws.
- ***Chapter 8 - Grievance Redress Mechanism***: This section describing the formal and informal redress procedures for registering, resolving, and reporting complaints.
- ***Chapter 9 - Environmental Management Plan***: This section discussing the lessons from the impact assessment and translated into action plans to avoid, reduce, mitigate or compensate adverse impacts and reinforces beneficial impacts. This plan is divided into three sub-sections; mitigation, monitoring, and implementation arrangements
- ***Chapter 10 - Conclusion and Recommendation***: This section stating whether there is a need for further detailed environmental studies / assessments and highlights key findings and recommendations to be implemented by the borrower.

30. An Executive Summary is also prepared and presented in the beginning of the report.

II. POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORKS

31. India has well defined institutional and legislative framework. The legislation covers all components of environment viz. air, water, soil, terrestrial and aquatic flora and fauna, natural resources, and sensitive habitats. India is also signatory to various international conventions and protocols. The environmental legislations in India are framed to protect the valued environmental components and comply with its commitment to international community under above conventions and protocols. Asian Development Bank has also defined its Environmental and Social Safeguard policies. This assessment is about the applicability of above laws and regulations, conventions, protocols, and safeguards. This section summaries the following:

- National (India) Environmental Legislation and Legal Administrative Framework,
- Social Safeguard Regulatory Requirements,
- ADB safeguard policies and categorisation of the project,
- Summary of international treaties and applicability to the project

1. National (India) Environmental Policy Framework

32. The legal framework of the country consists of several acts, notifications, rules and regulations to protect environment and wildlife. In 1976, the 42nd Constitutional Amendment created Article 48A and 51A, placing an obligation on every citizen of the country to attempt to conserve the environment. The national legislations are broadly divided under following categories:

- Environmental Protection,
- Forests Conservation, and
- Wild Life Protection.

33. The umbrella legislation under each of above category is highlighted below:

- **The Environment (Protection) Act 1986** was enacted with the objective of providing for the protection and improvement of the environment. It empowers the Central Government to establish authorities charged with the mandate of preventing environmental pollution in all its forms and to tackle specific environmental problems that are peculiar to different parts of the country. Various rules are framed under this Act for grant of environmental clearance for any developmental project, resources conservation and waste management.
- **The Forest (Conservation) Act 1980** was enacted to help conserve the country's forests. It strictly restricts and regulates the de-reservation of forests or use of forest land for non-forest purposes without the prior approval of Central Government. To this end the Act lays down the pre-requisites for the diversion of forest land for non-forest purposes.
- **Wild Life (Protection) Act 1972** amended 2003 was enacted with the objective of effectively protecting the wild life of the country and to control poaching, smuggling and illegal trade of wildlife and its derivatives. It defines rules for the protection of wild life and ecologically important protected areas.

34. State Pollution Control Boards (SPCBs) together form the regulatory and administrative core of the part. Other Ministries/ Statutory Bodies/ Departments responsible for ensuring environmental compliance and granting various clearances includes state ministry /dept. of environment, regional offices of MoEFCC and state forests/wildlife departments. Their key roles and responsibilities and interface among them have been concisely depicted through the flow

diagram. The administrative framework defines the roles and responsibility of various ministries and government departments at Central Level and State level. The administrative framework for environmental protection, forests conservation and wildlife protection is given at Figure 2.

35. The environmental impact assessment requirement in India is based on the Environment (Protection) Act, 1986, the Environmental Impact Assessment Notification, 2006 (amended 2009), all its related circulars; MOEFCC's Environmental Impact Assessment Guidance Manual for Highways 2010, and IRC Guidelines for Environmental Impacts Assessment (IRC:104-1988) of highway projects. In addition to road widening and rehabilitation including establishment of temporary workshops, construction camps, hotmix plants, and opening of quarries for road construction work require to comply with provisions of The Forest (Conservation) Act 1980 (Amended 1988) and Rules 1981 (Amended 2003): The Wildlife (Protection) Act, 1972 (Amended 1993); The Water (Prevention and Control of Pollution) Act 1972 (Amended 1988) and Rules 1974; The Air (Prevention and Control of Pollution) Act, 1981 (Amended 1987) and Rules 1982; The Noise Pollution (Regulation and Control) Rules, 2000 (Amended 2002) and Hazardous Waste (Management, Handling and Trans-boundary Movement) Rules 2008 (Amended 2009).

36. A review is undertaken for all the environmental rules and regulation which might be applicable to the proposed Imphal-Moreh road section improvement activities. These legislations with applicability to this subproject are summarised below in Table 5 and approval and monitoring framework is depicted in Figure 2. There is no separate state level legislation. However various acts like Water and Air are enforced through state level authority: State Pollution Control Board.

37. Specifically for the proposed Imphal-Moreh subproject in the state of Manipur, the following (Table 5) environmental laws and regulations are applicable:

Table 5: Applicable Environmental National and State Requirements

Sl. No.	Activity	Statute	Requirement	Competent Authority	Responsible Agency for Obtaining Clearance	Time Required
Planning Stage: Before start of Civil Works Construction (Responsibility: Executing Agency)						
1.	Implementing Project in Forest Area	Environment Protection Act of 1986, Forest Conservation Act	Forest Clearance	Conservator of Forest, Government of Manipur	NHIDCL	6 months
Construction Stage (Responsibility: Contractor)						
2.	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 Environment Protection Act of 1986 and as amended	Consent-for-establishment	State Pollution Control Board	The Contractor	2-3 months
3.	Operating 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 Environment Protection Act of	Consent-for-operation	State Pollution Control Board	The Contractor	2-3 months

Sl. No.	Activity	Statute	Requirement	Competent Authority	Responsible Agency for Obtaining Clearance	Time Required
		1986 and as amended				
4.	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
5.	Storage of fuel oil, lubricants, diesel etc. at construction camp	Manufacture storage and Import of Hazardous Chemical Rules 1989	Permission for storage of hazardous chemical	State Pollution Control Board or Local Authority (DM/DC)	The Contractor	2-3 months
6.	Quarry operation	State Minor Mineral Concession Rules, The Mines Act of 1952, Indian Explosive Act of 1984, Air Act of 1981 and Water Act of 1974	Quarry Lease Deed and Quarry License	State Department of Mines and Geology	The Contractor	2-3 months
7.	Extraction of ground water	Ground Water Rules of 2002	Permission for extraction of ground water for use in road construction activities	State Ground Water Board	The Contractor	2-3 months
8.	Use of surface water for construction	-	Permission for use of water for construction purpose	Irrigation Department	The Contractor	2-3 months
9.	Engagement of labour	Labour Act	Labour license	Labour Commissioner	The Contractor	2-3 months

38. In addition to the acts and regulations listed above the Environmental Impact Assessment Guidance Manual for Highways 2010 issued by MOEFCC and the IRC Guidelines for Environmental Impacts Assessment (IRC:104-1988) of highway projects issued by MORTH, were referred in the process of preparing this IEE. The following requirements are particularly important and need special attention in order to avoid any delays for a project:

i) As per provisions of the EIA Notification 2006 (amended in 2009, 2011 and 2013), all expansion of national highways that are longer than 100km and involve

additional right of way or land acquisition greater than 40m on existing alignment and 60m on realignment or bypass fall under category A and require environmental clearance from the Ministry of Environment, Forests and Climate Change (MoEFCC) at the central level. Since the total length of the proposed subproject road section on Imphal-Moreh National Highway (AH1) is less than 100 km (65.68 km), it does not fall under the purview of EIA notification. Therefore Environmental Clearance from MoEFCC is not required for this subproject.

ii) As per the Forest Conservation Rules (1981, amended 2003) a forestry clearance from Department of Forests is required for diversion of forest land for non-forest purpose. Processing of the forestry clearance entails two stages: stage I and stage II. Amongst other requirements stage I clearance requires the applicant to make payments for compensation of forestry land that will be acquired and trees that will be cut under the project. Accordingly timely allocation of budget for this purpose by the applicant is necessary to expedite the clearance process. Although there are no notified protected areas along the proposed subproject road section on Imphal-Moreh road, about 33.28 km long section passes through various classes of Forests and the subproject does require diversion of about 50.51 hectares of forest land. Therefore forest clearance is required as per Government of India requirements.

iii) Cutting of trees in non forest land require a tree cutting permit from the local forestry department. All trees cut under a subproject must be compensated by compensatory afforestation as required by the State Forest Department.

iv) As per Office Memorandum (OM) issued by MOEFCC on 19 March 2013 the grant of environmental clearance for linear projects including roads has been delinked from the forestry clearance procedure. Hence, after receipt of environmental clearance construction works may commence on sections/parts of a linear project that do not require forestry clearance. Construction works may commence on sections requiring forestry clearance only after receipt of the respective clearance.

v) Placement of hot-mix plants, quarrying and crushers, batch mixing plants, discharge of sewage from construction camps requires No Objection Certificate (Consent to Establish and Consent to Operate) from State Pollution Control Board prior to establishment.

vi) Permission from Central Ground Water Authority is required for extracting ground water for construction purposes, from areas declared as critical or semi critical from ground water potential prospective by them.

39. Before the start of civil works for the any section of the subproject road the project proponent (NHIDCL as subproject IA) must obtain necessary clearances / permits from staturoty authorities. Procedures and steps to be followed to obtain various clearances / permits are presented in Figure 2 and Figure 3 and Table 6 and 7.

2. Social Regulatory Requirements of India and State

40. There are many rules and regulations framed by the Government of India for the protection of workers. Most of these legislations will be applicable to contractors in charge of construction. EA will ensure compliance to these social legislations through contractual obligation and regular checks & penalties. These legislations include The Building and Other Construction Workers (Regulation of Employment and Conditions of Service) Act, 1996; Child Labour (prohibition and Regulation) Act, 1986; Minimum Wages Act, 1948; Workmen Compensation Act, 1923; Payment of Gratuity Act, 1972; Employee State Insurance Act; Employees P.F. and Miscellaneous Provision Act, 1952; Maternity Benefit Act, 1951; Payment of Wages Act, 1936; Equal

Remuneration Act, 1979; Inter-State Migrant Workmen's (Regulation of Employment & Conditions of Service) Act, 1979; Equal Remuneration Act, 1979, Factories Act 1948 (including rules for health and safety of workers) etc.

3. International Treaties and Relevance to the Project

41. Government of India has signed many international treaties. GOI has also framed various laws, regulations and guidelines to meet country's obligations under these treaties. The projects of this magnitude may contribute in meeting country's obligation directly or indirectly. A screening was carried out of these treaties regarding its applicability to this subproject. Outcome of these treaties. The relevant international Treaties are:

- **Kyoto Protocol to the United Nations Framework Convention on Climate Change** (Rectified by India in 1997): The Kyoto Protocol is an international agreement linked to the United Nations Framework Convention on Climate Change. The major feature of the Kyoto Protocol is that it sets binding targets for 37 industrialized countries and the European community for reducing greenhouse gas (GHG) emissions. This amount to an average of five per cent against 1990 levels over the five-year period 2008-2012.
- **Convention Concerning the Protection of the World Cultural and Natural Heritage** (Rectified by India in 1972): The most significant feature of the 1972 World Heritage Convention is that it links together in a single document the concepts of nature conservation and the preservation of cultural properties. The Convention recognizes the way in which people interact with nature, and the fundamental need to preserve the balance between the two.
- World Bank Group (IFCs) Enviornment, Health, and Safety (EHS) Guidelines.

4. ADB Safeguard Policy Statement Requirements

42. The Asian Development Bank has defined its Safeguard requirements under its 'Safeguard Policy Statement 2009 (SPS 2009). The prime objectives of safeguard policy are to: (i) avoid adverse impacts of projects on the environment and affected people, where possible; and (ii) minimize, mitigate, and/or compensate for adverse project impacts on the environment and affected people when avoidance is not possible. This policy requires assessment, mitigation and commitment towards environmental protection. The extent of assessment depends on the category of the project. ADB's SPS 2009 classify a project depending on following three categories.

- **Category A:** A proposed project is classified as category A if it is likely to have significant adverse environmental impacts that are irreversible, diverse, or unprecedented. These impacts may affect an area larger than the sites or facilities subject to physical works. An environmental impact assessment is required.
- **Category B:** A proposed project is classified as category B if its potential adverse environmental impacts are less adverse than those of category A projects. These impacts are site-specific, none or very few of them are irreversible, and in most cases mitigation measures can be designed more readily than for category A projects. An initial environmental examination is required.
- **Category C:** A proposed project is classified as category C if it is likely to have minimal or no adverse environmental impacts. No environmental assessment is required although environmental implications need to be reviewed.

5. Category of the Subproject

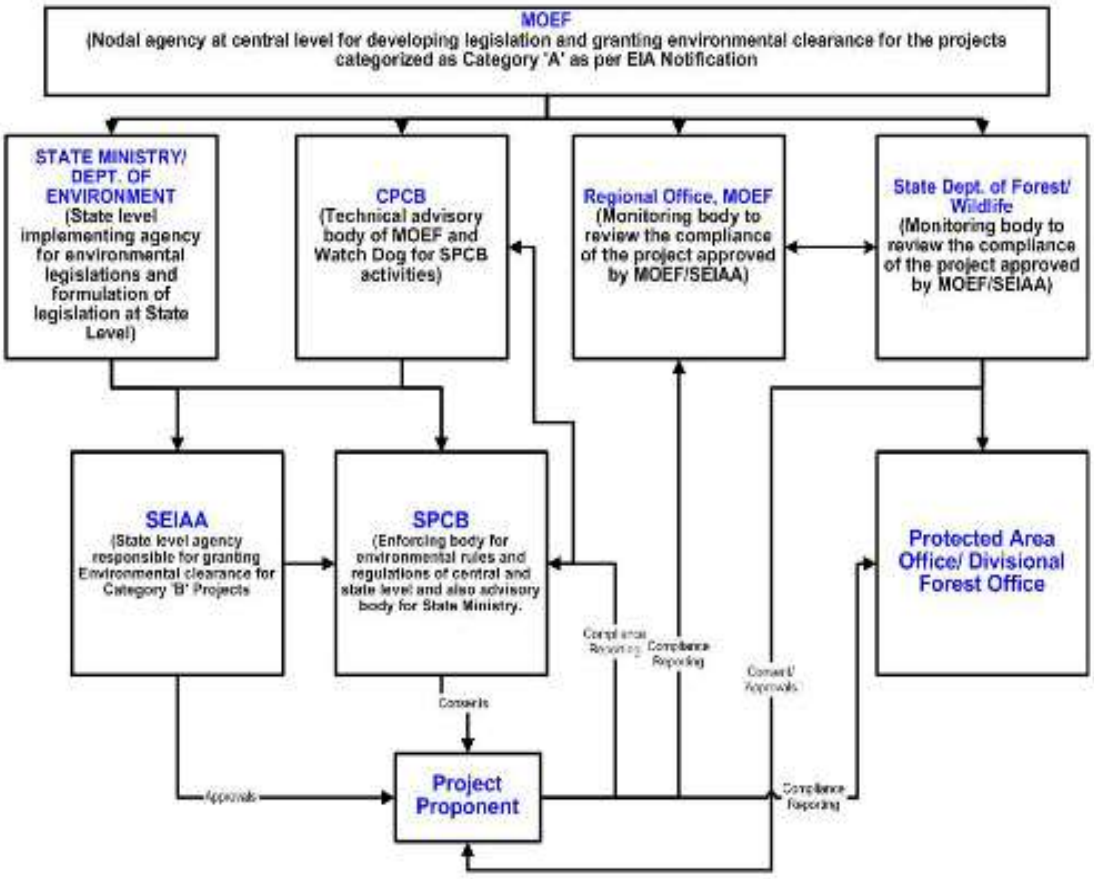
43. The proposed subproject road section on Imphal-Moreh Road has been evaluated considering the outcome of the ADB Rapid Environmental Assessment (REA) checklist and the same is enclosed as Annex 1. All environmentally sensitive areas along the proposed alignment have been critically analyzed to assess the magnitude and extent of likely impacts. The subproject is classified as environmental category 'B'. This categorization was primarily based on the following considerations:

(i) subproject road is an existing road and improvement of this road is proposed along the existing road,

(ii) anticipated impacts from road upgrading on relatively flat terrain along agricultural land are mostly site specific and easily mitigated through proper design and good construction practices, majority of the activities have short-term duration co-terminus with the construction phase, and

(iii) subproject road does not pass through or located within any wildlife sanctuary, national park, or any other environmentally sensitive or protected areas.

Figure 2: Environmental Legal Administrative Framework in India



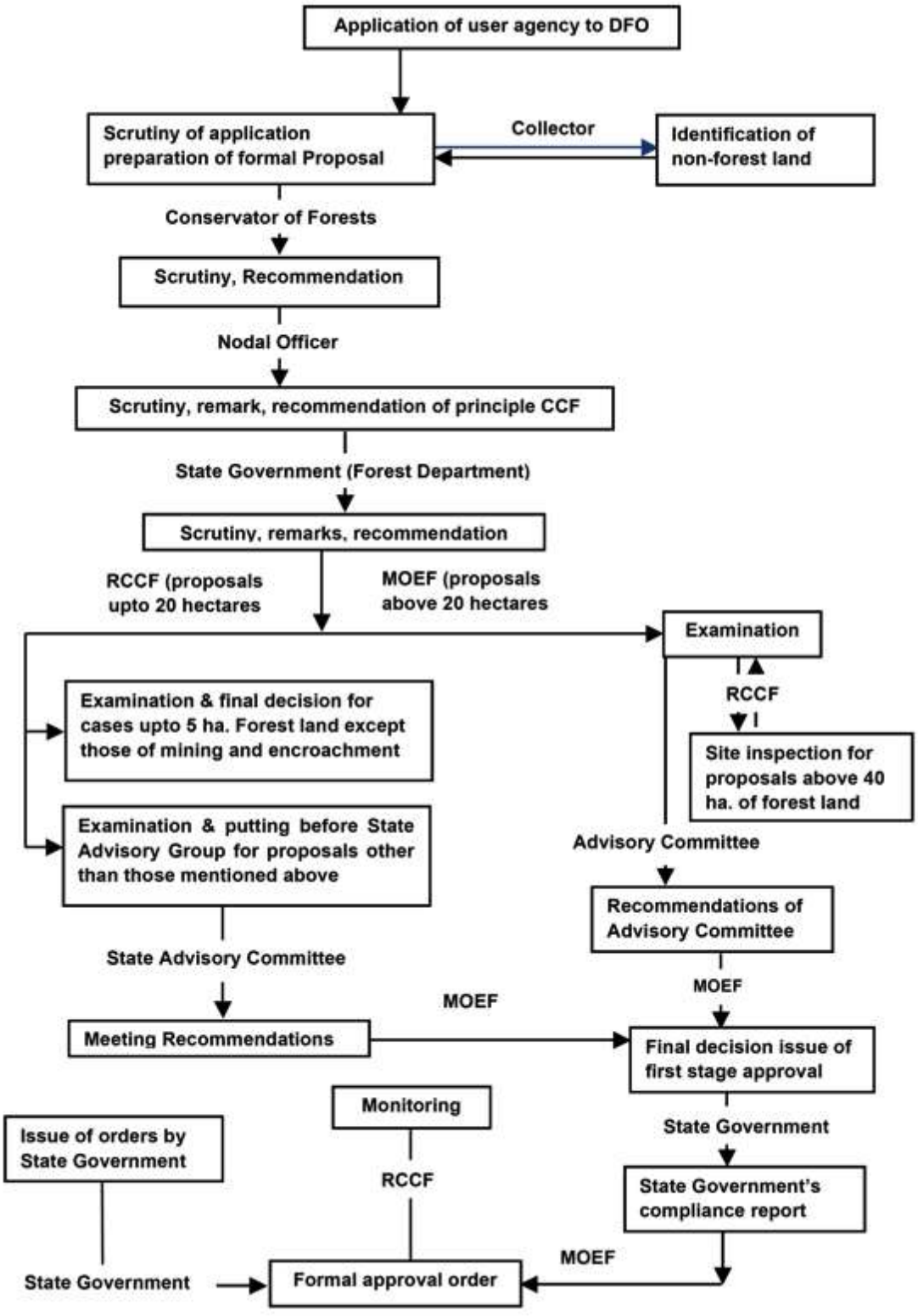


Figure 3: Procedure for Obtaining Forest Clearance

Table 6: Key Steps in Forest Clearance Process

Step No.	Activity	No. of Days
1	Preparation of case / application letter that is submitted to Revenue and Forest Department	7
2	Area calculation to identify land diversion requirement with the help of Revenue Department represented	30
3	Joint visit by Executive Engineer, and District Forest Officer(DFO)	
4	Enumeration of trees by the Forest Department after the visit of Forest Guard and Range Officer	7
5	List is forwarded by the Range Officer to DFO for approval	15
6	Preparation of a combined 'case' papers (documents prepared by Revenue Department, list of trees enumerated by Forest Department and actual area calculation for diversion of forest land are enclosed)	7
7	Case submitted to DFO - DFO Office will examine the case and further send to Conservator of Forests	7
8	Conservator of Forests will examine the papers and further forward the case (subject to the fact that no short-comings/deficiencies are found) to Prin. Chief Conservator of Forests	7
9	Case is further examined by the Prin. Chief Conservator of Forests and forwarded to Additional Secretary (Forests)	4
10	Additional Secretary (Forests) recommends the case for the approval of the Forest Minister.	3
11	Forest Minister approves the case and returns the case file to Additional Secretary (Forests)	8
12	Case file is sent to CF, Shillong (MoEFCC) after the counter signature of Chief Secretary, State Government. (The case file is counter-signed by the Chief Secretary as the case file goes to MoEFCC).	2
13	CF (Shillong) examines the case. May opt for conducting a site inspection or may provide an 'in- principle' clearance without conducting the site visit.	90 (primarily due to work load)
14	If CF, Shillong provides 'in-principle' approval, it is conveyed to DFO. The concerned DFO works out the cost for compensatory afforestation and NPV and the total cost/amount is conveyed to the concerned Executive Engineer.	3
15	Executive Engineer requests PWD for releasing the said amount. The Project Director's Office/PWD directly deposits the specified amount into the bank account of the concerned DFO.	2
16	The DFO communicates the amount deposition to CF, Shillong and requests to provide final/formal approval	2
17	CF, Shillong conveys (in writing) the final/formal approval to the concerned DFO.	30
18	DFO conveys the final/formal sanction to the Executive Engineer	2
19	DFO further directs the concerned Range Officer (Forest Department) to mark (process is formally known as 'hammering') the trees for cutting.	1
20	Range Officer hammers/ marks the trees in presence of Executive Engineer or his field representative	10
21	The Range Officer sends the final list of trees to the concerned DFO for information	1
22	DFO forwards the case to Forest Corporation to call 'tender' for cutting the marked trees	3
23	DM, Forest Corporation calls for bid and fixes date/s to receive the tender documents	30
24	After opening of the tenders and their evaluation, tree cutting work is awarded to the selected contractor	15
25	Contractor mobilizes the required lab our and machinery at site	15

Step No.	Activity	No. of Days
26	Contractor cuts the trees.	30
	Total Number of Days (numbers indicate ideal situations)	**331**

Table 7: Key Steps in Tree Cutting Permission Process:

Step No.	Activity	No. of Days
1	Preparation of case / application letter to the Revenue and Forest Department for felling of trees falling within the Right of Way	7
2	Area to be cleared of trees is verified on the ground with the help of Revenue Department	30
3	Joint visit by Executive Engineer, DFO and Revenue Department staff for the verification of the land and trees falling within the ROW	
4	Enumeration of trees by Forest Department after the visit of Forest Guard and Range Officer (both from Forest Department). The details cover number of trees to be cut along with chainage, species and girth information.	7
5	List of trees to be cut is forwarded by the Range Officer to the concerned DFO for approval	15
6	The combined case paper is prepared by enclosing the documents received from Revenue and Forest Department (as prepared in the steps mentioned above).	7
7	Case is submitted to the concerned DFO – the DFO Office examines the case and if there are no observations, sends it to the Conservator of Forests (CF)	7
8	The CF office will examine the case and if there are no observations, will approve the felling proposal.	7
9	The approval from CF office is conveyed to the concerned DFO, who further conveys the final sanction (in writing) to Executive Engineer.	2
10	DFO further directs the concerned Range Officer (Forest Department) to mark (process is formally known as ‘hammering’) the trees for cutting.	1
11	Range Officer hammers/ marks the trees in presence of Executive Engineer or his field representative.	10
12	The Range Officer sends the final list of trees to the concerned DFO for information.	1
13	DFO forwards the case to Forest Corporation to call ‘tender’ for cutting the marked trees.	3
14	DM Forest Corporation calls for bids and fixes date/s to receive the tenders.	30
15	After opening of the tenders and their evaluation, tree cutting work is awarded to the selected contractor.	15
16	Contractor mobilizes the required labor and machinery at site.	15
17	Contractor cuts the trees	30
	Total Number of Days (numbers indicate ideal situations)	**187**

III. PROJECT DESCRIPTION

A. Type of Project

44. The present report deals with the Initial Environmental Examination of 65.68 km road section of Imphal-Moreh highway located in Manipur State. This section of the road is included in the SASEC Regional Road Connectivity Investment Program in India. The subproject road is part of the existing national highway no. 39 (NH-39) and now renamed as Asian Highway 1 (AH1). The subproject road starts at Lilong (about 10 km from Imphal town at km chainage 330+000) and ends at Khongkhang village (km chainage 395+680) covering a total length of 65.68 kms. The subproject road run through plain terrain up to Pallel (36 kms) and remaining road section passes through hilly/rolling terrain (from Pallel to end point). The corridor traverses through agriculturally rich area for first 30 kms length with fair surface condition. This road section will be improved to standard four lane configuration (from Lilong to Wanjing) and two lane carriageway configuration from Wanjing to end point at km chainage 395+680. Table 8 shows information about the subproject Road.

Table 8: Details of the Subproject Road

Name of the Subproject	Subproject No.	Project Length (km)	Districts	State
Improvement and Upgradation of Imphal-Moreh (AH-1 priority section) Road Section from Km 330+000 to Km 395+680 in the State of Manipur	Tranche 2 Non-sample subproject	65.68	Imphal East, Imphal West, Thoubal and Chandel	Manipur

B. Need for the Project

45. Manipur is one of the eight North Eastern States in India. The geographical area of the state 22.327 sq km constitutes less than 0.70% of the entire country. It lies between latitude of 23°83'N – 25°68'N and longitude of 93°03'E – 94°78'E. The State capital, Imphal is located at an elevation of 790 m above mean sea level. Geographically the state is bounded on all sides by ranges of hills and particularly land blocked.

46. The total population of the state is 2721756 as per 2011 census. Of the total area, only 17 % is in valley and balance in hills and hilly/mountain terrain. The state border totals 854 km of which 352 km is international border with Myanmar to the east and south east. The remaining 502 km separate Manipur to rest of India. The road transport infrastructure in the state of Manipur is far below the all India Standards in terms of road length per sq.km. It is imperative to improve the road transport infrastructure in the state.

47. The national highway corridors namely NH 53, NH 39 and NH 150 are linking the state with the other parts of the country. The NH 39 (recently renamed as NH 102) Imphal Moreh is linking India and Myanmar. Surfaced road in hill districts are mainly limited to National Highways, State Highways and Major District Roads. Majority of the other district roads and village roads are not surfaced. The existing road system suffer from various types of deficiencies such as inadequate crust thickness, inadequate cross drainage works, weak and narrow bridges and pavement failures etc.

48. The present study road section, Imphal – Moreh is part of Asian Highway AH1 in Manipur state in India. AH 1 is the longest route of the Asian Highway Network, running 12,845 miles (20,557 km) from Tokya, Japan via Korea, People's Republic of China, Southeast Asia, India,

Pakistan, Afghanistan and Iran to the border between Turkey and Bulgaria west of Istanbul where it joins end-on with European route E80. In India AH 1 passes through Numaligarh - Golaghat - Garampani - Barpathar - Naojan - Bokajan - Dimapur - Kohima - Tadubi - Senapati - Kangpokpi - Imphal - Thoubal - Tengnoupal – Moreh (Myanmar border).

49. The present subproject aimed to widen and improve about 65.68 km of existing national highway into 2/4 lane configuration between Imphal and Moreh (NH-39) in the state of Manipur. The road stretch is a critical section of the UNESCAP Asian Highway No. 01 (AH01), paving the way for India and other South Asian countries to Myanmar, and further to ASEAN countries.

50. Looking at the benefits of the project, the Government of India requested for a project preparatory technical assistance (TA) from the Asian Development Bank (ADB) to prepare an ensuing loan for the international trade corridor in Manipur State (the project). The Asian Development Bank (ADB) is supporting the preparation of the Sub regional Road Connectivity Project in the state of Manipur, which is programmed for implementation in 2016 with funding support from ADB. In order to facilitate the implementation of the project, the ADB has engaged consultants to prepare detailed feasibility study and preliminary engineering design to define the project scope for implementation through engineering, procurement and construction (EPC) contract. Besides independent consultants have also been fielded by ADB to prepare the requisite safeguards documents in compliance with ADB and Government of India requirements.

C. Location and Features of the Subproject Road

51. The subproject road section is located in three districts of Manipur state namely: Imphal, Thoubal and Chandel. Figure 4 to Figure 5 shows the location map and alignment plotted on Google earth image and topo sheet respectively.

52. The subproject road starts at Imphal (km chainage 330+000) and ends at Khongkhang village (km chainage 395+680) covering a total length of 65.68 kms. The subproject road run through plain terrain up to Pallel (36 kms) and remaining road section passes through hilly/rolling terrain (from Pallel to end point). The corridor traverses through agriculturally rich area for first 30 kilometers length bwith fair surface condition. This road section will be improved to standard four lane configuration (from Lilong to Wanjing) and two lane carriageway configuration from Wanjing to end point at km chainage 395+680.

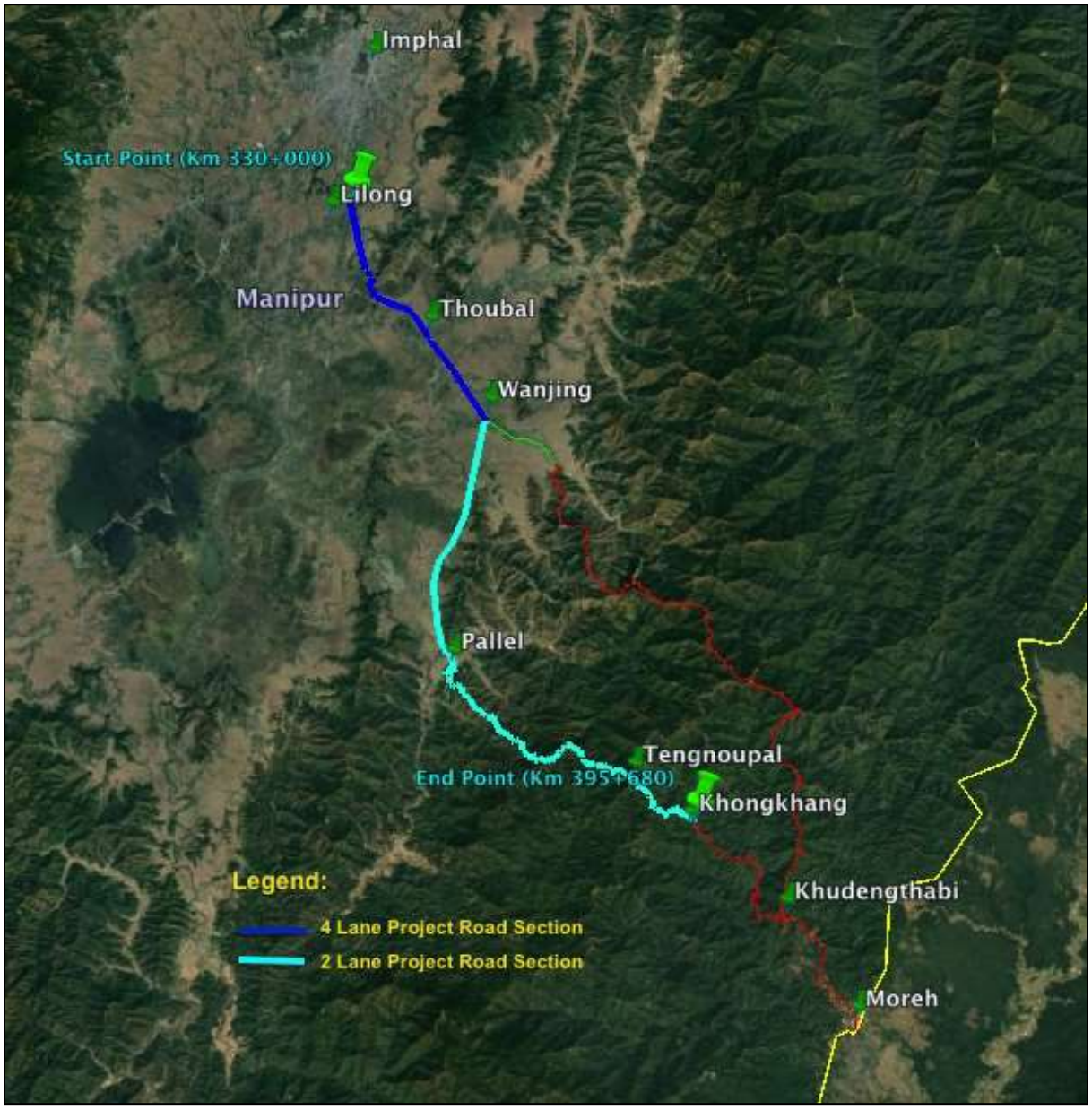
53. The project road running north to south east between Longitudes $24^0$48'8.9" N & $24^0$14'16.46"N and lies between Longitude of $93^0$56'18.44"E & $94^0$18'2.23"E within the state of Manipur.

54. The land use along this section is agricultural mixed with roadside development up to Pallel (km 36) with some of urban and semi urban centers like Lilong and Thuobal. Clusters of settlement are also noticed in between urban areas. From Pallel onwards, the land use is mix of open/barren land with thin vegetation and patches of agricultural activities on hillocks. These hills are mostly owned by village communities and forest authorities. The vegetation on hilly terrain is mostly mixed bushes and thin forests owned by communities.

55. As part of the project feasibility, possible alternative alignments were studied and it is found that there is an alternative alignment existing on western side of the project corridor which starts from Wangjing town and finally merges with the Asian Highway 1 (project corridor road) near Khudengthabi village (Figure 4 and Figure 5).

Figure 4: Map showing Project Alignment

Figure 5: Project Alignment on Google Earth Image



56. The subproject corridor however passes through some congested urban areas where widening or even minimum improvement of road geometry is not possible. At the same time, the existing constricted condition cannot be allowed to remain if the corridor is to attain a uniform acceptable level of service. Therefore, the solution at these locations is to provide realignment or bypass for the major bottle necks near Lilong village, Thoubal town, and Pallel town.

57. The said alternate alignment which will not be included in the current project scope takes off from the project corridor from Wangjing town at its km 350+000 and follows the existing Major District Road (MDR) up to Heirok town. There from the alternative alignment takes right turn and passes adjacent to the Heirok Military camp on a track for a length of 0.5 kilometers to join the

track on hill section. Further the track passes through several villages in hilly terrain and merges with another major district road which connects Tengupoal on NH 39 and Hariyam village where there is a bituminous road observed for its full length. The alternate route again joins the AH-1 at Khudenthabi at km 417.00 (about 22 km away from the end point of the project road).

Lilong Village

Pallel Town

D. Subproject Corridor Sections

58. Considering the nature of traffic, geometric features, a segmental approach is appropriate to describe the subproject road features. Accordingly, the corridor can be divided into three broad sections as given below in Table 9.

Table 9: Subproject Road Section

Subproject	Segment No.	Sections / Segments	Length (km)
Imphal-Moreh NH Section	1.	Lilong Village – Thoubal (From Km 330 to Km 341+900)	11.90
	2.	Thoubal – Pallel (From 341+900 to Km 365+900)	24.00
	3.	Pallel – Khongkhang village (From Km 365+900 to Km 395+680)	29.78
		Total Length	**65.68**

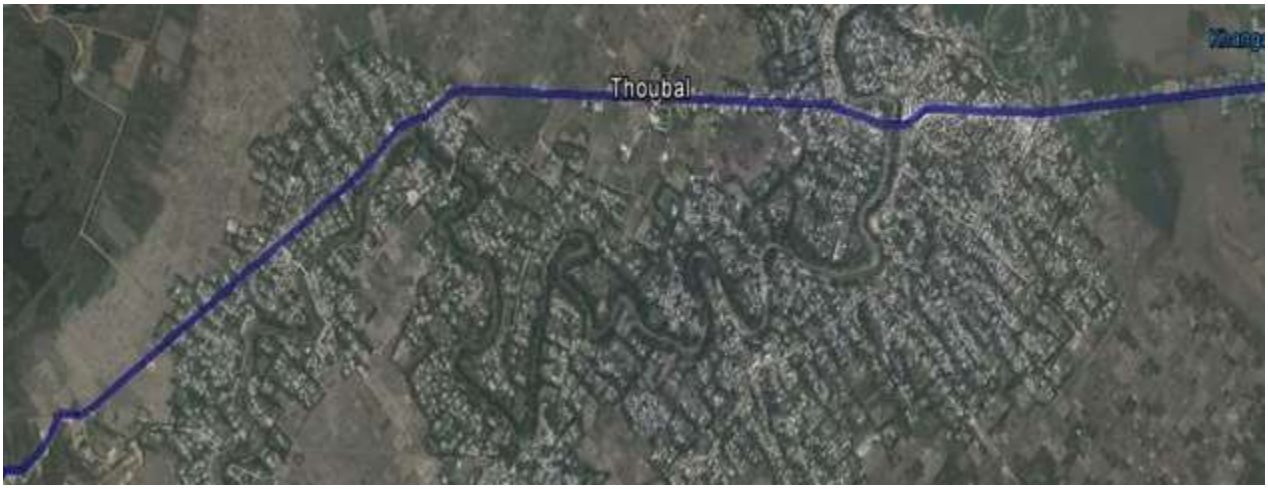
1. Segment 1: Lilong to Thoubal (From Km 330 to Km 341+900)

59. The subproject road starts near Lilong village at Km 330+000 and passes through the Lilong village for a length of 2 kilometers. This segment has two lane carriageway configurations (7 m carriageway) throughout and passes through the plain terrain up to Thoubal connecting several villages namely Lilong Hangamthobi Village at km 333+000, Ushopokpi Village at km 334+100, Sangomsang Village at km 335+000, and Waithou Village at km 336+000. Formation width is 10 m and ROW is 15 m (as per PWD Manipur information) in this section. Existing carrigaway is in fair condtion. There are 2 minor bridges and 2 major bridges situated in this segment.

60. Aerial view for the Built up areas of Lilong village snapshot collected from the google earth is shown below.

2. Segment 2: Thoubal to Pallel (From 341+900 to Km 365+900)

61. This segment of the subproject road has two-lane carriageway that runs through Thoubal, Khangbok, Wangjing and Pallel, out of which Thoubal and Pallel are two major built up areas. The length of urban section through Thoubal town is about 5 kilometers and through Pallel it is 1.5 kilometers. Four lane carriageway is observed in Thoubal town for a length of 900 meters (shown in photo). Entire section of this segment except at the ribbon development areas passes through the paddy fields where embankment heights vary from 1.0 m to 1.5 m. Aerial view for the Built up areas of Thoubal town snapshot collected from the google earth is shown below.



62. The ROW available is 15 m and the formation width is 10 m for the entire segment. There are 6 bridges existing out of which 1 is a major bridge. There is a new bridge under construction near Pallel town on Sekmai River, which will be ready by end of this year. This new bridge is on new alignment which bypasses the entire town portion, therefore further bypass study may not

be required for Pallel town but the study of bypass may be required for Thoubal town. The view of new bridge near Pallel town is shown below.

63. This segment has two lane carriageway configuration throughout and passes through the plain terrain up to Pallel town connecting several village namely Khangabok Village at km 342+200, Wangbai Village at km 346+000, Wangjing Village at km 348+000, Khongjom Village at km 351+500, Sora Village at km 357+300, Kakching Lamkhai at km 360+000 and Bijoypur Village at km 363+000.

Pallel Town

Existing bridge in Pallel

3. Segment 3: Pallel to Khongkhang (From Km 365+900 to Km 395+680)

64. This segment from Pallel runs towards south east through the hilly terrain where the formation width is 10 m only and passes through Thamlapokpi, Bongyang, Sinam and Khongkhang villages. A army check post is at present located near start of ghat section where all the vehicles are being checked. Majority of local passenger/commercial traffic terminates near Pallel town. In hilly terrain isolate slipouts were noticed where the formation widening have been taken up by the department, and the protection works in the form of breast walls will be included in the improvement proposals, in many of the locations of old formation breast walls have been constructed for majority of it length in hill side. There are 1 minor bridge existing in this segment. Pavement condition varies from fair to good. The segment passes on the ridges of the hills for majority of its length. The ROW of is 15 m only. Various villages along this segment is are Bangjing

vilage at km 373+700, Senam village at km 377+500, Salvom village at km 32+200, and Khongkhang village at km 396+680.

E. Design Standards for the Subproject Road

65. The Indian Road Congress (IRC) design standards have been followed in consultation with ToR, while formulating the road design standards. As the subproject road sections pass mainly through plain and hilly terrain, the ruling design speeds considered for the formulation of design standards are 100 km/hr. for plain sections and 50 km/hr. for hilly sections. The purpose of formulation of design standards is to avoid any inconsistency in design during the road construction and operation.

F. Proposed Improvement Works

66. The subproject road corridor has been divided into three homogenous sections (Table 10) based on the traffic flow characteristics. The defined homogeneous sections have been referenced with the existing chainages from km 330+000 to km 395+680. The salient proposals for upgradation and improvement of the existing road sections are classified into the following engineering aspects.

Table 10: Details of Improvement Proposal for Various Sections

Sl.No	Homogenous Section Details	Recommendation on Capacity Augmentation
1	HS 1: Lilong to Wanjing (km 330+000 to km 350+000)	4 Lane with Paved shoulder and service road on built up location.
2	HS 2: Wanjing to Pallel (km 350+000 to km 365+900)	2 Lane with Paved shoulder and service road on built up location.
3	HS 3: Pallel to Khongkhang (365+900 to km 395+680)	2 Lane with Paved shoulder.

G. Engineering Surveys and Investigations

67. Following surveys and investigations had been carried out on the subproject road for collection of data for incorporation in the DPR and evolve the design for improvement and upgradation.

- topographic surveys;
- traffic surveys;
- road and pavement condition survey and inventory;
- culverts and bridges condition survey and inventories;
- material surveys;
- hydrology studies for new bridge structures;
- Geotechnical investigations & subsoil exploration for structures; and
- existing utilities surveys.

68. These surveys had been carried out in accordance with the guidelines in IRC:SP:19 to fulfill requirement in the TOR.

69. **Traffic Surveys:** In order to understand the traffic characteristics and the volume of traffic using the subproject road, primary surveys were carried out to know the existing travel pattern. The traffic on the subproject corridor is a mixture of through and local types because, the land use along the route is both rural and residential.

70. **Annual Average Daily Traffic (AADT):** The traffic plying on any road generally varies over the different periods of the year depending on the cycle of different socio-economic activities in the regions through which it passes. Therefore, in order to have more realistic picture of the traffic on the project road, it is required to assess seasonal variation in traffic to estimate Annual Average Daily Traffic (AADT). In the absence of any reliable data on seasonal variation, no correction was carried out. The traffic survey was carried out for 12 hours from 6 AM to 6 PM and for the remaining time traffic is negligible because international border check post at Moreh closes at 5 PM and there is no traffic movement across border thereafter. In order to account for the daily traffic the ADT observed for 12 hours is increased by 5% to arrive at the AADT (Table 11).

Table 11: Annual Average Daily Traffic (AADT)-Normal Traffic

S. No	Vehicle Type	TVC 1	TVC 2	TVC 3
		HS 1	HS 2	HS 3
1	Motorcycle	6,318	772	1,339
2	Car (New Technology)	7,661	936	1,623
3	Three Wheeler	2,840	347	602
4	Medium Bus	198	24	42
5	Tractor - Trailer	22	3	5
6	Truck Light (2 axles)	1,189	145	252
7	Truck Medium (2 axles)	704	86	149
8	Truck Heavy (3 axles)	66	8	14
9	Truck Articulated (5 axles)	0	0	0
10	Car (Old Technology)	2,928	358	620
11	Mini Bus	88	11	19
Total Motorized Traffic (MT)		22013	2689	4664
Non-Motorized Traffic (NMT)		413	249	89
Total Traffic		22426	2938	4753

Source: Traffic Survey carried out in DPR

71. **Traffic Projections / Growth Rates**: Traffic growth rates established for the study are based on historic traffic data, vehicle registration data, GDP growth and taking into consideration the likelihood of diverted and generated traffic. Based on available evidence and data, the base traffic growth rates as per TA are reasonably in order and adopted are Passenger – 8.6% and Freight – 6.4%. Table 12 and present summary of growth rates for the subproject road section and Table 13 present the project traffic in the additional alignment in the opening year.

Table 12: Summary of Recommended Growth Rates for Project Road

Vehicle Type	2013-18	2018-23	2023-28	2028-33	2033-38
Car/Van/Jeep	7.2	6.4	5.8	5.0	4.0
2 Wheeler	9.0	8.0	6.5	5.6	4.0
3 Wheeler	6.5	5.8	5.2	4.5	3.6
Bus	5.0	4.3	4.0	3.4	3.4
All Trucks	5.5	5.0	4.5	4.0	3.5
LCV	6.1	5.5	5.0	4.4	3.9

72. **Traffic Forecast**: Growth rates are taken from the engineering design report (traffic forecast details). Traffic growth rates adopted over the design life and preconstruction activities are given as under:

Year 2006-2008 : 7.5%.
Year 2009-2011 : 7.5
Year 2012-2031 : Passenger – 8.6%
: Freight – 6.4%

73. Traffic projections for all the homogenous sections were computed with the growth rates given in Table 12 and the traffic from AADT. The yearly projections summary for 30 years from year 2018 for Vehicles and PCU and for each homogenous section of Project Road is given in Table 13.

Table 13: Year wise AADT Projections for Project Road Sections (VEH)

Year	HS 1	HS 2	HS 3
2018	28,095	5,155	8,185
2019	29,500	5,555	8,812
2020	30,975	5,987	9,487
2021	34,149	6,453	10,216
2022	35,857	6,955	11,000
2023	43,319	8,958	13,335
2024	45,051	9,514	14,154
2025	46,853	10,104	15,024
2026	48,728	10,732	15,949
2027	50,677	11,399	16,930
2028	52,197	11,972	17,769
2029	53,763	12,575	18,650
2030	55,376	13,208	19,574
2031	57,037	13,874	20,545
2032	58,748	14,573	21,565
2033	59,923	15,160	22,423
2034	61,122	15,772	23,314
2035	62,344	16,408	24,242
2036	63,591	17,069	25,206
2037	64,863	17,758	26,210
2038	66,160	18,474	27,253
2039	67,483	19,220	28,339
2040	68,833	19,995	29,468

74. **Capacity Analysis and Level of Service**: The projected traffic is compared with the Design Service Volume (DSV) at Level of Service (LOS) -B (for rural roads, IRC: 64- 1990) to examine whether the facility would be able to carry the anticipated traffic or capacity augmentation would be needed. The design service volumes and capacities based on IRC 64-1990 are shown in Table 14.

Table 14: Design Service Volume (PCU/day)

Terrain	Lane Configuration	Design Service Volume (LOS B)	Design Service Volume (LOS C)
As per IRC: 64 –1990 (Guidelines for Capacity of Roads in Rural Areas)			
Plain Terrain with Low Curvature.	2 Lane with earthen shoulder	15,000	22,500
	2 Lane with 1.5m paved shoulder	17,250	25,875
	4 Lane with 1.5m paved shoulder.	40,000	60,000
As per IRC:SP48-1998 (Hill Road Manual)			
Hilly Terrain with Low Curvature.	2 Lane with earthen shoulder	7000	10,500
	2 Lane with 1.5m paved shoulder	8,050	12,075

75. Based on the above design service volume for LOS B and LOS C the capacity augmentation till 2045 is established and the summary is given in Table 15.

Table 15: Level of Service

Homogenous Section	Two lane with Earthen shoulder		Two Lane with Paved Shoulder		Four Lane with Paved Shoulder	
	LOS B	LOS C	LOS B	LOS C	LOS B	LOS C
HS 1	AA	2015	AA	2017	2022	2028
HS 2	2032	NA	2036	NA	NA	NA
HS 3 (Based on Hill roads manual)	2026	2034	2028	2038	NA	NA

AA: Already Achieved & NA: Not Achieving

76. The level of service assessment indicates that HS1 is already exhausted its LOS B for two lane earthen shoulder and two lane paved shoulder configuration and four lane facility is warrants immediately. For HS 2 and HS 3, LOS B is crossed by 2028 to 2036 with a two lane paved shoulder configuration which is within the design period of 20 years from opening year of 2018. Considering difficulty in developing a four lane road on hilly/mountainous terrain through which HS 3 is passing through, it is considered that the NH 39 is providing sufficient capacity for HS 3. On NH 39, HS 1 well exceeds capacity of even 4-lane by 2028, it is recommended that HS 2 also to be developed to four lane facility to ease the pressure of development along HS 1 and extent the development all along the length up to Pallel town (foot of the hill). However the State government is considering improvement of alternate alignment from Wanjing to Khudenthabi via Sita market. Therefore some traffic will be shared by this alternate route. Therefore client has decided to limit expansion of HS 2 to 2 lanes standards, which is sufficient to cater to traffic for the designed life. The summary of recommendation for all the three homogeneous sections is given Table 16.

Table 16: Summary of Homogenous Sections

Homogenous Section Details	Lane Configuration
HS 1: Imphal Junction to Wanjing	Four-Lane paved shoulder
HS 2: Wanjing to Pallel Junction	Two-Lane paved shoulder
HS 3: Pallel Junction to Khongkhang village	Two-Lane paved shoulder

H. The Design

77. The improvement proposal involving design for the subproject road section specifies widening and strengthening of existing road. The design of the subproject road incorporates the following design components:

- analysis of present traffic and future projections,
- analysis of present pavement structure and its strength and design requirements for the new pavement and overlay over the design period for widening and strengthening,
- determination of adequacy of the hydraulic capacity and structural parameters of the existing structures, determination of adequacy of the road's geometry (horizontal as well as vertical); and
- ensuring road safety aspects and safety of local residents are addressed.

I. Design Standards

78. Although the subproject road is composed of National Highway warranty the corresponding set of design standards recommended by IRC, the nature of land use abutting the corridor has made introduction of location specific deviation essential from the point of view of safety and socio economic contribution. The design considerations and the standards adopted to formulate the typical cross sections and for preliminary design are discussed in the following sections.

79. The following codes, inter alia, were used as reference:

IRC: 3-1983	:	Dimensions and Weights of Road Design Vehicles
IRC: 37-2001	:	Guidelines for the Design of Flexible Pavements
IRC: 48-1988	:	Hill Roads Manual
IRC: 58-2002	:	Rigid Pavements for Highways
IRC: 64-1990	:	Guidelines for Capacity of Roads in Rural Areas
IRC: 70-1977	:	Guidelines on Regulation and Control of Mixed Traffic in Urban Areas
IRC: 73-1990&	:	Geometric Design Standards for Rural (Non Urban)
IRC: 86-1983	:	Geometric Design Standards for Urban Roads in plains
IRC SP-73-2007	:	2 Lane manual for PPP project
IRC SP-84-2010	:	4 Lane manual for PPP project
IRC: 81:1997	:	Flexible Road Pavements Using BBD Technique
IRC-SP 13:2004	:	Guidelines for the Design of Small Bridges and Culverts
IRC: 78-2000	:	Code of Practic for Bridges (for Seismic consideration)
IS 1893-4 (2005)	:	Criteria for Earthquake Resistant Design of Structure

80. Besides, AASHTO and the TRL guidelines for pavement and geometric design were appropriately referred to.

J. Geometric Design Standards

81. The salient parameters for the geometric design of roads suggested are given in Table 17.

Table 17: Design Standards

Sl.No.	Design Specification	Unit	Proposed Design Standards			
1.	Design Speed	**Km/hr**	Plain	Rolling	Hilly	Steep
	Desirable		100	80	50	40
	Minimum		80	65	40	30
2.	ROW	**M**	Plain/Rolling			Hilly
	a) Rural (open areas)		30			24
	b) Urban (built-up)		30			20
	c) New Bypasses		30			-
3.	Carriageway width for two lane	**M**	7.0			
	Carriageway width for four lane	**M**	2x7.25			
4.	Shoulder width	**M**	Plain/Rolling	Hilly		
				Hill side	Valley side	
			1.5-2.0m	0.9	0.9	
5.	Camber	**%**				
	Carriageway	2.5				
	Paved Shoulders	2.5				
	Earthen Shoulders	3.0				

Sl.No.	Design Specification	Unit	Proposed Design Standards	
6.	Gradients	%	Ruling	Limiting
	a) Plain and Rolling		3.3	5.0
	b) Mountainous		5.0	6.0
	c) Steep		6.0	7.0
7.	Super elevation Maximum in normal situation	%	5.0	
8.	Minimum Horizontal Curve Radius Desirable Absolute	M	For V=100kmph – 360m For V= 80kmph – 230m For V= 50kmph – 80m For V= 30kmph – 30m	
9.	Sight Distance Stopping Sight Distance Intermediate Sight Distance Overtaking Sight Distance	M	 180 360 640	
10.	Minimum Vertical Curve Length (SSD case) Crest Sag		 73.6A 41.5A	
11.	Widening at curve locations for radii	M		
	Up to 40 m		1.5	
	41-60 m		1.2	
	61-100 m		0.9	
	101-300 m		0.6	

Note: A in the above table is the algebraic difference in grades expressed as percentage

K. Widening Options

82. Capacity augmentation requirement necessitate widening of pavement throughout the section in the form of adding paved shoulder, service road, additional lanes etc. Dual carriage way is proposed where 4 lane sections is required. The dual carriageway ensures improvement of road safety by physically separating the traffic in each direction.

83. Options of eccentric and concentric widening to be chosen judicially as this will impact land acquisition, cost and also traffic movement during construction. The proposed widening options are shown in Table 18.

84. Considering the pro and cons of widening options, by default, eccentric widening is considered for this study. However, concentric widening in semi-urban/urban stretches is definitely preferable to avoid unnecessary rehabilitation and resettlement (R&R) and drainage problems.

85. In additional to all it is not advisable to shift side of widening so frequently as that will leads to serious traffic management issue and also need additional curves to be introduced to transit from one scheme to another. As in the case of addition of paved shoulders, some of the bridges may not be widened if the existing width is more than the requirement given in MORTH circulars on widening of existing structures. In this case concentric widening to be considered invariably. So wherever such constrains like bridge or built up locations exist at very closer interval concentric widening will be preferred. Road safety features including installation of safety measures as well as provision of Padestrian Underpass (PUP)/Vehicular Underpass (VUP) has been inlcuded in the deisgn. The widening scheme proposed for this project is given in Table18.

Table 18: Proposed widening scheme

Sl.No	Design Chainage(m)		Length(m)	TCS Type	Type of Widening
	From	To			
1	330000	330600	600	1	Eccentric
2	330600	332300	1700	4	Concentric
3	332300	332800	500	2	Concentric
4	332800	333200	400	4	Concentric
5	333200	334000	800	2	Concentric
6	334000	334300	300	4	Concentric
7	334300	334700	400	1	Eccentric
8	334700	335060	360	3	New Construction
9	335060	335300	240	2	Concentric
10	335300	335700	400	1	Eccentric
11	335700	336100	400	3	New Construction
12	336100	336600	500	1	Eccentric
13	336600	337560	960	3	New Construction
14	337560	338400	840	2	Concentric
15	338400	339850	1450	4	Concentric
16	339850	340700	850	2	Concentric
17	340700	342240	1540	4	Concentric
18	342240	342930	690	10	Concentric (VUP)
19	342930	343600	670	2	Concentric
20	343600	345100	1500	4	Concentric
21	345100	345600	500	2	Concentric
22	345600	346000	400	4	Concentric
23	346000	348090	2090	2	Concentric
24	348090	349300	1210	10	Concentric (VUP)
25	349300	350100	800	1	Eccentric
26	350100	352300	2200	2	Concentric
27	352300	353300	1000	4	Concentric
28	353300	357600	4300	2	Concentric
29	357600	358100	500	4	Concentric
30	358100	359610	1510	2	Concentric
31	359610	360530	920	10	Concentric (VUP)
32	360530	364600	4070	2	Concentric
33	364600	366200	1600	4	Concentric
34	366200	373730	7530	6	Eccentric(Hill Side)
35	373730	374020	290	8	Concentric
36	374020	395680	21660	6	Eccentric (Hill Side)

86. **Median:** As per IRC recommendations 4.5 m median with raised kerb is provided in a dual carriageway road (4 lane section) to segregate horizontally opposite directional traffic. Its primary objective is to eliminate the possibility of head-on collision.

87. **Paved Shoulders**: 2.0 m wide paved shoulders have been adopted as an improvement option strategy for many upgrading cases. IRC recommends 1.5m wide paved shoulder on either side of carriageway of 2-lane width or more. The usefulness of a paved (or even hard) shoulder is beyond dispute. One of the most important uses of a shoulder is to provide space for movement of slow-moving vehicles and for routine and emergency parking of vehicles.

88. **Service Roads**: Service roads on both sides are envisaged in congested towns / villages locations to segregate the slow moving local traffic from the high speed highway traffic. This will also cater to the need of the local pedestrians and vehicles to travel without hindering the high-

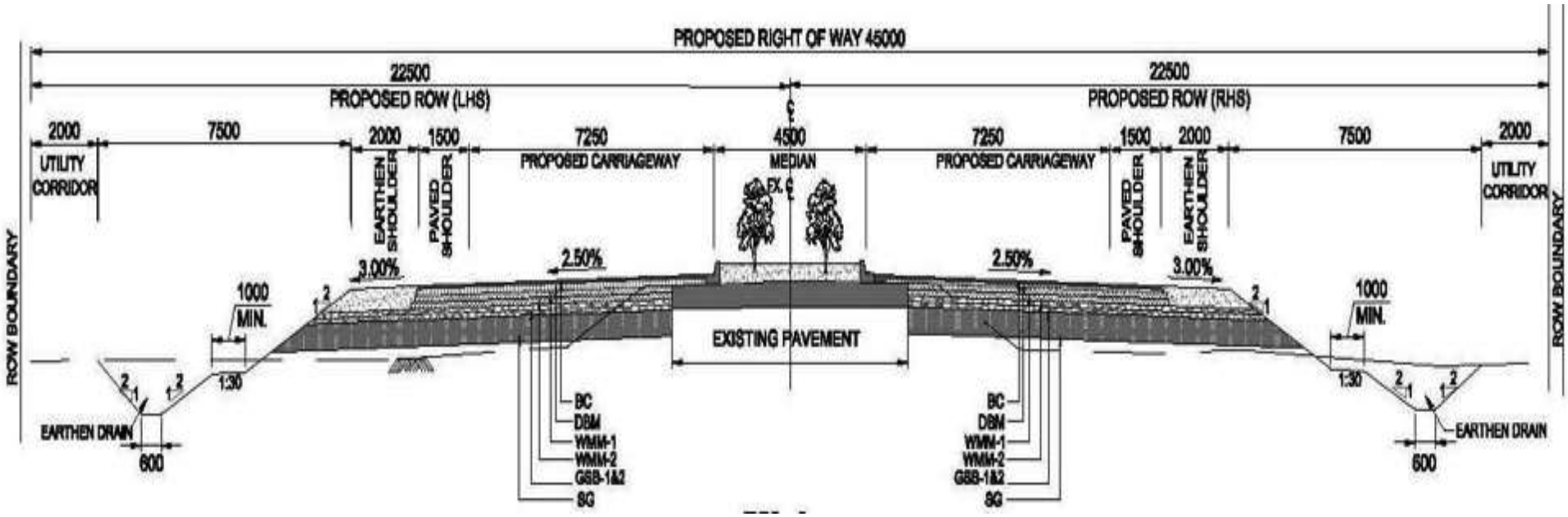
speed highway traffic. In view of social aspects and density of population of Manipur, consultants feel that such built-up locations need to be provided with service road. But when considering the economy of the project, proposal of service roads are restricted at unavoidable locations. However service roads are provided on all built-up areas where raising of embankment is required due to over topping.

89. **Typical Cross-sections**: Based on the standards and the discussions mentioned earlier typical cross-sections for application in different common situations and for assessment of preliminary costs have been developed after considerable deliberations. The types and situations attracting these cross-sections are briefly described as under:

90. Figure 6 shows some of the typical cross-sections considered as strategies in this study. Various cross sections proposed are:

- TCS 1:Eccentric Widening in Rural areas – 4 lane carriageway
- TCS 2 : Concentric Widening in Rural areas – 4 lane carriageway
- TCS 4: Concentric Widening for 4Lane in Urban/Built-up with Service Road
- TCS 3: New/Reconstruction in Rural areas – 4 lane carriageway.
- Type 5:Valley side Widening in Hill Areas- 2 lane carriageway
- Type 6: Hillside widening in Hill Areas- 2 lane carriageway.
- Type 7: Both Hill & Valley side Widening in Hill Areas- 2 lane carriageway
- Type 8: Concentric Widening in Urban Areas- 2 lane carriageway
- Type 9: Concentric Widening in Rural Areas- 2 lane carriageway
- Type 10: Typical Cross section for VUP Approach with Service Road

Figure 6: Typical Cross Sections



TCS 1 and 2- Concentric Widening in Rural areas – 4 Lane Carriageway

IMPHAL

MOREH

TCS - 3

NEW / RECONSTRUCTION IN RURAL AREAS- FOUR LANE CARRIAGEWAY

TCS - 4

CONCENTRIC WIDENING FOR FOUR LANE IN URBAN/ BUILT - UP AREA WITH SERVICE ROAD

DRAFT FOR APPROVAL

NOTES:
1. ALL DIMENSIONS ARE IN METERS UNLESS OTHERWISE SPECIFIED.

OWNER : PWRD/MoRT&H/ SJDA

PROJECT : DETAILED PROJECT FOR INDO MYANMAR ROAD SECTION FROM IMPHAL TO MOREH, ADB TA - 8116 IND

CLIENT : ASIAN DEVELOPMENT BANK

DESIGN CONSULTANT : SHELADIA ASSOCIATES INC., USA

JOB No. : SAI 3446

TITLE : TYPICAL CROSS SECTION

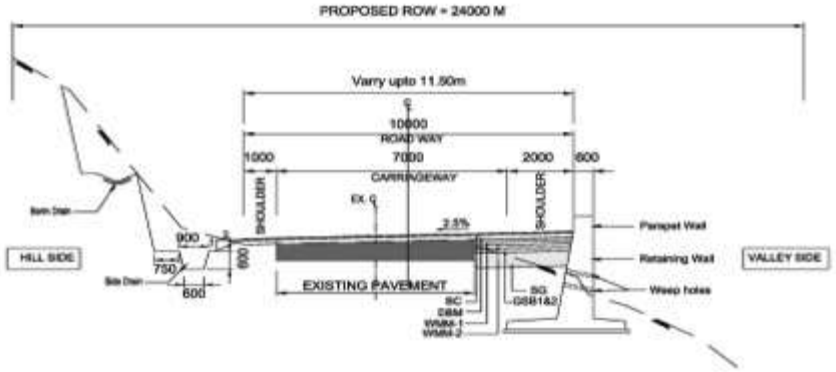
REV. 0

SIZE A2

DRAWING NO : A D B - 8 1 1 6 - D P R - Y C S

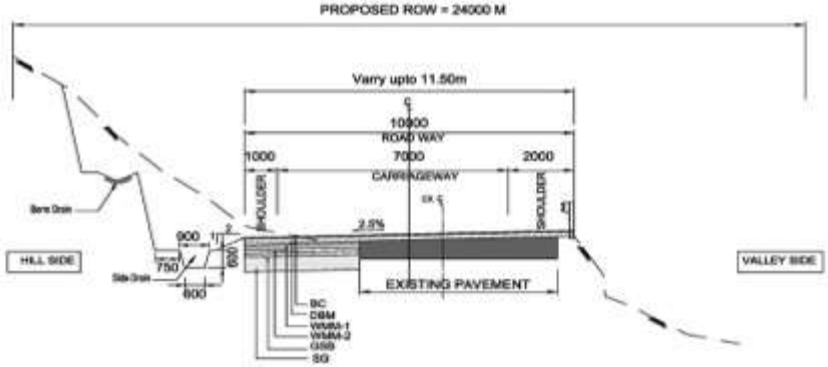
IMPHAL

MOREH



TCS - 5

VALLEY SIDE WIDENING IN HILL AREAS - TWO LANE CARRIAGEWAY



TCS - 6

HILL SIDE WIDENING IN HILL AREAS - TWO LANE CARRIAGEWAY

*Note :- Extra Widening as per Cuvature

DRAFT FOR APPROVAL

NOTES:
1. ALL DIMENSIONS ARE IN METERS UNLESS OTHERWISE SPECIFIED.

OWNER : PWRD/MoRT&H/ SJDA

PROJECT : DETAILED PROJECT FOR INDO MYANMAR ROAD SECTION FROM IMPHAL TO MOREH, ADB TA - 6116 IND

CLIENT : ASIAN DEVELOPMENT BANK

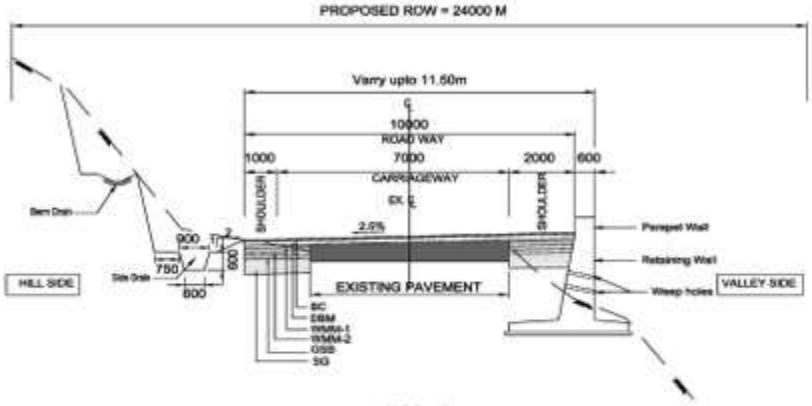
DESIGN CONSULTANT : SHELADIA ASSOCIATES INC., USA

TITLE : TYPICAL CROSS SECTION

DRAWING NO : A D B - 6 1 1 6 - D P R - T C S

IMPHAL

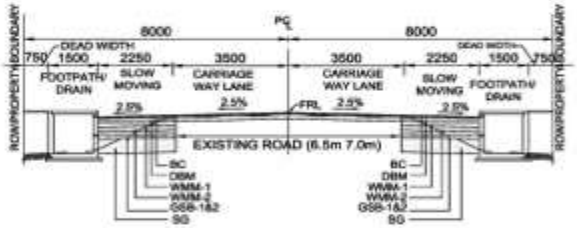
MOREH



TCS - 7

BOTH HILL & VALLEY SIDE WIDENING IN HILL AREAS - TWO LANE CARRIAGEWAY

*Note :- Extra Widening as per Cuvature



TCS - 8

CONCENTRIC WIDENING IN URBAN AREAS - TWO LANE CARRIAGEWAY

DRAFT FOR APPROVAL

NOTES:
1. ALL DIMENSIONS ARE IN METERS UNLESS OTHERWISE SPECIFIED.

OWNER : PWRD/NAIRT&H/ SJDA

PROJECT : DETAILED PROJECT FOR INDO MYANMAR ROAD SECTION FROM IMPHAL TO MOREH, ADB TA - 8116 IND

CLIENT : ASIAN DEVELOPMENT BANK

DESIGN CONSULTANT : SHILADITYA [illegible] PVT. LTD.

TITLE : TYPICAL CROSS SECTION

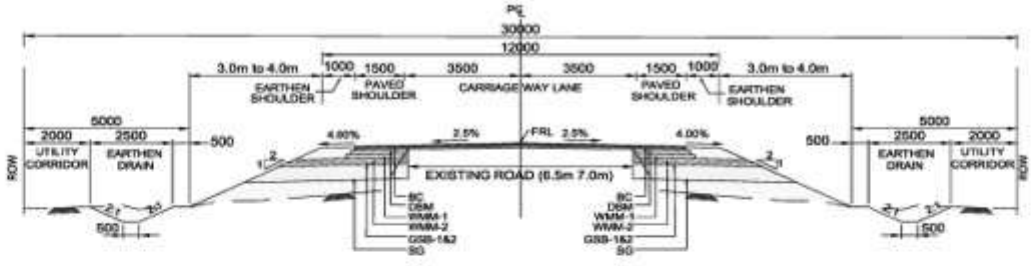
DRAWING NO : ADB-8116-DPR-TCS

REV. 0

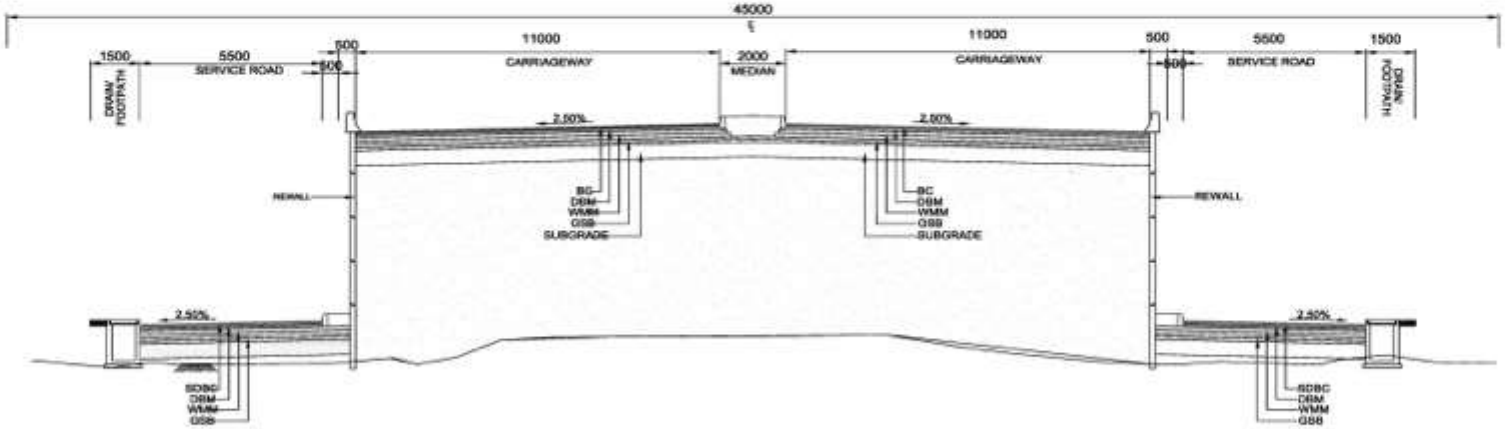
SIZE A2

IMPHAL

MOREH



TCS - 9
CONCENTRIC WIDENING IN RURAL AREAS - TWO LANE CARRIAGEWAY



TCS-10 TYPICAL CROSS SECTION FOR VUP APPROACH WITH SERVICE ROAD

DRAFT FOR APPROVAL

NOTES:
1. ALL DIMENSIONS ARE IN METERS UNLESS OTHERWISE SPECIFIED.

OWNER : PWRD/MoRT&H/ SJDA

PROJECT : DETAILED PROJECT FOR INDO MYANMAR ROAD SECTION FROM IMPHAL TO MOREH, ADB TA - 8116 IND

CLIENT : ASIAN DEVELOPMENT BANK

DESIGN CONSULTANT : SHELADIA ASSOCIATES INC., USA

TITLE : TYPICAL CROSS SECTION

DRAWING NO : A D B - 8 1 1 6 - D P R - T C S

91. **Embankment Height**: From the inventory analysis, it is observed that the subproject road has embankment height varying from zero to 1.0 m only and HFL during monsoon season will be above natural ground level in many places. Raising of the embankment is proposed for total section in Plain Area in between Imphal and Pallel. Section wise length for requirement of rising of embankment on account of in adequate height is given in Table 19.

Table 19: Requirement of Raising of Embankments

Sl. No.	Design Chainage	Section	Length of Raising (km)	Average Raising (m)
1.	330+000 to 334+300	Lilong to Thoubal	4300	1
2.	343+300 to 344+300	Thoubal to Pallel	1000	1
3.	345+500 to 347+500	Thoubal to Pallel	2000	1
4.	349+000 to 350+000	Thoubal to Pallel	1000	1

92. **Pavement Design**: The general design procedure is based on the prevalent practices in the country. The design of pavement structure has been carried out as per IRC Guide lines and TOR. The detailed design of new pavement and overlays on existing pavement shall be based primarily on IRC-37:2012 and IRC-81: 1997 for flexible pavement and IRC-58: 2011 for rigid pavement.

93. Design CBR will be based on the results of borrow area sample testing as the borrow area sampling is not carried out a minimum CBR of 7% and 10% for Lilong to Pallel (HS 1& HS 2) and from Pallel to end of subproject road section recommended respectively.

94. Minimum design traffic of 25 CMSA and 20 CMSA for Lilong to Pallel (HS 1& HS 2) and from Pallel to end of subproject road recommended respectively. Based on the pavement condition and keeping the embankment heights and overtopping situation the total subproject road section from km 330+000 to km 395+680 has recommended for reconstruction.

95. **Junction Improvement**: The widening of the subproject road would involve improvement of junctions, with other roads, in order to carry through the standard features of the subproject road. As a policy, improvement of the cross roads over a suitable length from the junction has been proposed. The existing junctions requiring improvement have been classified into two categories, major and minor.

- **Major Junction:** Intersection of the project road with another highway or a major district road is treated as a major junction.
- **Minor Junction:** Intersection of the project road with a minor road such as ODR or village road has been termed as a minor junction. The minor road approaches, however, are proposed to be widened to facilitate easy movement of turning traffic.

96. **Road Furniture and Markings**: The road furniture proposed to be provided include routine and special road signs; hectometer, kilometer and 200 m stones, guard posts on high embankment stretches (3m and above) e.g. bridge approaches and also at sharp curves. The existing furniture, which are in a reasonably good state of repair, are proposed to be recycled to the extent possible. Road markings would be generally standard centerline and yellow edge markings using thermoplastic paints. Lane markings, kerb/object markings, etc. as required under different options and stretches have been considered. Street illumination for urban road sections has been considered and included in design as appropriate.

97. **Safety Features**: The typical provisions that have been considered in design to prevent or minimize accidents are:

- Reflective studs (cats' eyes) on road markings.
- Double Beam Crash barriers in high embankment greater than 3 m and on approaches of bridges and also on valley side.
- Pedestrian crossings with road markings and reflective studs.
- Pedestrian guardrails (in Palin built-up area).
- Padestrian Underpass (PUP)/Vehicular Underpass (VUP) as selected location. This was one of the demands raised by people during consultation process particularly at Thoubal.
- Service roads to segregate local traffic at congested places.

98. **Truck Terminal, Truck Lay bays and Rest Area**: Based on the inventory data collected it is observed that way side amenities like truck lay bays and rest area is not available along the project. Since the project road improvement envisages induced truck traffic into the project, adequate number of truck lay byes to be provided. Appropriately designed rest areas are not available on the project alignment. However some facilities are available in Thoubal and Pallel towns. Rest area facilities are proposed on two locations i.e. i) Near Thoubal, and ii) Near Pallel.

99. **Bus Bays / Way side Bus Stops**: Considering the overall safety of traffic and minimum hindrance to through traffic, bus bays with pick-up bus stops have been proposed at following major town and villages along the project road . Bus stop locations will be finalized such that,

- It shall not be located at horizontal curves.
- It shall not be located on top of summit vertical curves.
- It shall be located away from intersection as specified in IRC: 80-1981
- It shall be located preferably at straight road at flat gradient with good visibility.
- The location should not be prone to land slide for the safety of passengers.

100. The shelter shed for passenger shall be structurally safe and aesthetically pleasing in appearance, while also being functional so as to protect the waiting passenger adequately from the sun, wind, and rain. Bus-lay byes shall also be designed with proper drainage (Cross and Longitudinal) along with proper signage and markings.

101. **Toll Plaza**: At prasent toll plazas have not been proposed in the design. The requirement and decision on toll plaza will be reviewed and decided by EA based on the tolling policy of the execution agency. If decided the exact location of the Toll plaza will be identified based on the availability of land and the suitability.

102. **Retaining Wall:** Upgrading options involving widening of the roadway in hilly terrain on valley side up to 9 m heights. Retaining walls are provided at key spots.

103. **Roadside Drain and Footpath**: In rural sections of the road, unlined toe drains are invariably proposed unless, the embankment height exceeds 1 m. The toe drain literally starts from the embankment toe with a generally acceptable slope of 1:1. The depth of this drain would have to be sufficient to allow at least the drainage layer in the pavement to be exposed to daylight. As a rule, the minimum depth should be 60 cm.

104. In urban and semi-urban areas, to facilitate proper drainage of surface run-off, roadside drains have been proposed. The three common types of drains envisaged are:

- Lined rectangle open drain in semi-urban area

- Lined trapezoidal type open drain in semi-urban areas
- PCC box-type covered drain with footpath in urban areas
- RCC pipe drain under footpath/shoulder in urban areas
- Chute drains in high embankment would also be required.

105. **Paver Blocks in Urban Area**: i) **In Service Roads:** The service roads in urban areas where the right of way is a constraint to have exclusive utility corridor (refer typical cross-sections), are proposed to be constructed with vibro-pressed interlocking concrete paver blocks. Laid on a sand-bed of 50 mm over granular base and sub-base courses, these paver blocks function very well in urban situations because these:

a. are not affected by poor drainage conditions
b. can be easily removed and re-laid in connection with maintenance of utility services housed below.
c. present a clear distinction between the main carriageway and the slow-lane.

106. **In Footpath**: Paver blocks have also been proposed in footpath albeit of lower thickness 50 mm. Paver block construction would generally conform to IRC 63-2004.

107. **Median Opening**: In dual carriageway roads, median opening at important junctions, and at regular interval of 2 km in straight stretches have to be provided.

108. **Drainage Design Standards**: The design of drainage structures is carried out in accordance with the following codes:

- IRC: SP: 13 - 2004, “Guidelines for the design of small bridges and Culverts”.
- IRC: 5 – 1998 “Standard specifications and code of practice for Road bridges”.
- IRC: SP: 84 - 2009, “Manual of Specifications & Standards for Four laning of Highways through Public Private Partnership”.
- IRC: SP: 42 – 1994, “Guidelines on Road Drainage”.
- IRC: SP: 50 – 1999/IRC: SP: 50 – 2013, “Guidelines on Urban Drainage”.
- IRC: SP: 48– 1998, “Hill Road Manual”.

L. Recommendation for Bridges

109. As a safety consideration, width of the bridges was proposed to match with the width of the road at approaches. That is 14.8m in urban and 12.9m in rural for the 2-lane and 27.5m (12+3.5+12) for 4-lane road improvement. Bridge constrcution work will also involve piling activities only at bridge sites.

110. **Major Bridges**: The important major bridges that would be covered in this study are being addressed as described below.

- **Lilong Bridge** at chainage 330+150 is PSC I-girder type superstructure with well foundations. Condition survey shows that this bridge is of structurally sound and hydraulically functioning good. The bridge is also met the carriageway requirement of 2lane improvement even though the total width of the bridge is less than that required. Considering these parameters, this bridge is proposed to be retained with minor repair and rehabilitation.
- **Thoubal bridge**, at chainage 341+780, is PSC I-girder type superstructure with well foundations. Condition survey shows that this bridge is of structurally sound and hydraulically functioning good. The bridge is also met the carriageway requirement of 2lane improvement even though the total width of the bridge is less

than that required. Considering these parameters, this bridge is proposed to be retained with minor repair and rehabilitation

- **Pallel Bridge** at chainage 365+500 a new 2 lane bridge has been recently constructued at Pallel and it is already in operation therefore no realignment is required and the use of existing bridge is proposed at Pallel. A new 2 lane bridge under 4 lane section is proposed adjacent to the existing bridge.

111. **Minor Bridges:** Minor bridges at chainage 334+330, 347+600, 348+150, 349+900, 352+800 are the RCC solid slab type,, 336+100, 344+240 are RCC T girder bridges. These bridges fall in 4 lane improvement stretch of the subproject corridor. Condition survey shows that these bridges are of structurally sound and hydraulically functioning well except the bridges at 336+100 and 348+150 are structurally distressed hence these can be reconstructed. Remaining bridges are structurally sound, hence these can be widened to 12.0m and a new 2 lane bridge is proposed parallel to the existing bridge. Details of bridges and proposed improvements are given in Table 20.

Table 20: Details of Bridges and Proposed Improvements on the Project Road

Sl. No.	Design Chainage	River/ Bridge name	Superstructure Type	Span Arrangment	Improvement Proposal
Major Bridges					
1.	330+150	Lilong	PSC I girder	1x48.5+1x 48.5	Existing bridge retained. New 2lane bridge is next to the existing bridge
2.	341+780	Thoubal	PSC I girder	2x34.5	Existing bridge to be widened to 12.0m width and New 2lane bridge is next to the existing bridge
3.	365+550	Pallel Bridge	RCC Solid slab	3x24	Existing bridge retained. New 2lane bridge is next to the existing bridge
Minor Bridges					
1.	334+330	Ushoipokpi	RCC Solid slab	5.6+6+5.6	Existing bridge to be widened to 12.0m width and New 2lane bridge is next to the existing bridge
2.	336+100	Waithou	RCC girder	3X13.2	Reconstruction of existing bridge. New 4-lane bridge at same location of existing bridge
3.	344+150	Arong Bridge	RCC T girder	3X11.0	Existing bridge to be widened to 12.0m width and New 2lane bridge is next to the existing bridge
4	347+600	Khangabhok	RCC Solid slab	2x7.0	Existing bridge to be widened to 12.0m width and New 2lane bridge is next to the existing bridge
5.	348+150	Wangjing	RCC Solid slab	8.8+8+8.8	Reconstruction of existing bridge. New 4-lane bridge at same location of existing bridge

Sl. No.	Design Chainage	River/ Bridge name	Superstructure Type	Span Arrangment	Improvement Proposal
6.	349+900	Uningkhom	RCC Solid slab	2X5.8	Existing bridge to be widened to 12.0m width and New 2lane bridge is next to the existing bridge
7.	352+800	Khongjom	RCC Solid slab	2X5.8	Existing bridge to be widened to 12.B5m width and New 2lane bridge is next to the existing bridge

112. **VUP/ PUP:** There is one Padestrial Under Pass (PUP) in the approach of Thoubal Bridge (Chainage Km 341+825), which is structurally sound and is proposed to be widened to meet the requirement for the improvement to 4 lanes. Addtionally one new Vehicular Under Pass (VUP) is proposed along the subproject road. Details are given in Table 21 below.

Table 21: Details of PUP / VUP Proposed on Project Road

Sl. No.	Design Chainage	Proposed Span (m)	Type of Strcuutre	Road Crossing	Structure Type
1.	341+825	1x20.0 x 5.5	**RCC Box**	**4 Lane**	**PUP**
2.	342+535	1x20.0 x 5.5	**RCC I Girder**	**4 Lane**	**VUP**

113. **Culverts:** Referring to the standards highlighted in the previous sections, improvement proposal for culverts are prepared. There are 191 pipe culverts and 117 Slab/Box/Arch culverts proposed for reconstruction along the subproject road.

M. Shifting of Utilities

114. Utilities like telephone cable, electrical lines along with water supply lines may be required to shift during widening. A proper scheme of relocating these shall be worked out once the widening schemes are approved. Details of the utilities along the project road are given in the inventory in DPR. Strip plan showing existing utilities and relocation plan for the affected utilities due to the widening shall be submitted separately.

N. Road Construction Materials

115. Material Survey for road construction materials for the subproject road, i.e. earth, aggregates, water, bitumen etc. has been carried out in the subproject road corridor and the indicative lead charts have been prepared.

116. Besides, the field in-situ investigations were conducted. The materials samples collected were tested in the laboratory and results data compiled in Material Report of the DPR.

117. The lead involved for the subproject road and the investigations are quite representative, but more extensive investigation shall need to be conducted by the contractors at the time of construction, for earth and aggregates available from such sources.

118. Adequate earth material is available from barren land in the vicinity. Estimated quantity is 1,45,500 cum Aggregates (320000 MT) will be mostly sourced from licensed quarries available locally and also from sufficient quantity of river boulders is available in the Imphal River at Km.

309+000 RHS and lead is 1.0 km. About 80,000 cum of sand will be required which will be taken from river beds after prior permission from competent authority. Also there is another source for fine aggregate has been identified which is near Yaripok village at km 342+200 on LHS and lead is about 18 km in length. Cement will be sources from factories whereas bitumen will be taken from the refineries. It is proposed to use river water as well as ground water for construction and domestic uses. Since the rivers are seasonal the impacts of aquatic ecosystem of the river will be very limited. Prior to commencement of sand extraction from the river, water sample will be collected to check aquatic paramters of the river water. Enviornment Specialist of the Authority's Engineerwill ensure that contractor undertake sampling and if required appropriate site specialist mitigation measures will be implemented.

O. Project Cost

119. The cost of civil works including maintenance amounts to Rs. 1,046.44 crore (US$ 158.55 million) for 65.68 km length road from Imphal to Khongkhang on Imphal-Moreh NH section. These costs are based on 2016 rates as per analytical rates. The cost has been indexed for escalation till mid-2015 @ 5% per annum.

P. Construction Packaging and Implementation Schedule

120. It is proposed to carry out construction of the road sections under two packages with a time period of 36 months under the each contract. The subproject roads are proposed to be undertaken through International Competitive Bidding (ICB). Currently the project is at bidding stage and scheduled to award contract in 2017. The project is expected to complete in 2020.

121. The proposed Contract Packages, along with final design length of sections included in the project, are presented in Table 22. The mode of contract is indicated as EPC model. The contract packaging and mode of contracting and implementation arrangements are as EPC Model.

Table 22: Summary of the Contract Packages

Package No.	Section	Sub-section Length (Km)	Package Length (KM)	Estimated Civil Works Cost (INR Crores)	Proposed Duration (Months)
1	Imphal-Wanjing	Km 330 to Km 350+000	20.0	352.29	36
2	Wanjing-Khongkhang village	Km 350+000 to Km 395+680	45.68	517.58	36

Q. Project Benefits

122. The implementation of various project items is envisaged to have the following direct benefits:

- improved quality of life for the rural population in the project influence: this as a result of better access to markets, health, education and other facilities; and the derived stimulus for local economic activity;
- a more efficient and safe road transport system: through reduced travel times, reduced road accidents, reduced vehicle operating and maintenance costs and reduced transportation costs for goods;

- the facilitation of tourism; and
- Interstate connectivity to Imphal, Thoubal and Chandel Districts.

IV. DESCRIPTION OF THE ENVIRONMENT

123. In order to assess the impacts of the proposed improvement to the subproject road, field visits were undertaken by the Consultants to understand environmental profile of the project influence area. This involved field inspections at all the sensitive locations, collection of secondary information for all the environmental components and discussions with the officials, NGO's and local populace. The profile presented below comprises of the following:

- Physical environmental components such as meteorology, geology, topography, soil characteristics, air quality, surface and sub-surface water quality;
- Biological environmental components such as aquatic, biotic and marine flora, fauna and mammals, and
- Land environment in terms of land use, soil composition.

A. Physical Environment

124. Information of various physical parameters was collected from the Guwahati Centre of Indian Meteorological Department, Statistical Department, Gazetteer of Manipur, Forest Department, Department of Environment and other concern Government Departments and discussions with the officials from these agencies.

1. Meteorological Conditions

125. The state has a subtropical monsoon to temperate climate depending on elevation. Rainfall is relatively abundant and widespread. The rainy season starts in June with the onset of the south-west monsoon and last upto September. Intermittent rains continue even upto October along with the retreat of the monsoon. During the rainy season the rainwater in the hills quickly flow down to the valley and all the rivers and small streams rises to the full brim, frequently flooding its embankments. The cold season last from the month of December to February. During the winter months light rainfall occurs under the influence of the north-east monsoon, March and October are by far the most pleasant months in the year. April and May are not hot season followed by occasional thunder storms.

126. The annual rainfall of Manipur in 2001 was to be 1769 mm as against the normal rainfall of 2000mm. The state has a salubrious climate. The summer months are never oppressive with the average maximum temperature fluctuating from 32°C to 35°C during April-June, the mercury seldom going beyond 37°C. In December-February with the start of the cold winter months the average minimum temperature fall to 6°C to 4°C.

127. The salient climatic features of the state are as fallow:

- Average Annual Rainfall - 1769 mm
- Concentration of precipitation - June to October
- Humidity - 79 to 96%
- Cloudiness - Heavily clouded
- Wind - Generally light except rainy season
- Temperature - Summer 32°C to 35°C
  Winter 6°C to 4°C

128. Based on temperature, rainfall attributes and wind directions, three main seasons are clearly be recognised, these are: (i) winter extending from November to February, (ii) summer

from March to May, and (iii) rainy season from May to October. The climatic conditions of the subproject area (districts wise) is summarised in subsequent paragraphs.

129. **Imphal (West and East) Districts:** The climate is warm and temperate in Imphal. In winter there is much less rainfall than in summer. The Köppen-Geiger climate classification is Cwa. The average annual temperature in Imphal is 21.1°C. The average annual rainfall is 1589 mm. The driest month is December with 3 mm rainfall. Most precipitation falls in June, with an average of 359 mm. The warmest month of the year is June with an average temperature of 24.6 °C. In January, the average temperature is 14.5°C. It is the lowest average temperature of the whole year in Imphal. The difference in precipitation between the driest month and the wettest month is 356 mm. The average temperatures vary during the year by 10.1°C.

130. **Thoubal District:** In Thoubal, the climate is warm and temperate. In winter there is much less rainfall than in summer. According to Köppen and Geiger climate is classified as Cwa. The average annual temperature in Thoubal is 21.1 °C. The average annual rainfall is 1725 mm. The driest month is December with 5 mm. Most precipitation falls in June, with an average of 395 mm. The warmest month of the year is June with an average temperature of 24.6 °C. In January, the average temperature is 14.8 °C. It is the lowest average temperature of the whole year. The difference in precipitation between the driest month and the wettest month is 390 mm. The average temperatures vary during the year by 9.8 °C.

131. **Chandel District:** In Chandel, the climate is warm and temperate. Throughout the year, there is virtually no rainfall in Chandel. According to Köppen and Geiger climate is classified as Cwb. The average annual temperature in Chandel is 20.6°C. About 1877 mm of precipitation falls annually. The driest month is December with 8 mm rainfall. Most precipitation falls in June, with an average of 432 mm. The warmest month of the year is May with an average temperature of 23.8°C. In January, the average temperature is 14.4°C. It is the lowest average temperature of the whole year. The difference in precipitation between the driest month and the wettest month is 424 mm. The average temperatures vary during the year by 9.4°C.

a. Rainfall

132. The climate of Manipur State is sub-tropical monsoon type. The rainy season of the area is quite long starting sometimes in the early part of May and continues up to the middle of October. The annual rainfall varies from 895 mm to 2135 mm in the valley and up to 3148 mm in the hilly area.

133. The average rainfall in the state is around 1435 mm (Image 1). Monsoon confers upon Manipur a very good rain as seen below.

Image 1: Average Monthly Rainfall in Manipur

- South-West monsoon (June-Sept.) - 825 mm
- Post monsoon period (Oct. to Dec.) - 151 mm

- Winter monsoon (Jan. to Feb.) - 52 mm
- Pre monsoon (March – May) - 407 mm

Total **- 1435 mm**

134. Table 23 and Figure 7 present the month-wise normal rainfall data in Manipur.

Table 23: Monthly Normal Rainfall in Manipur as a whole and Subproject Districts

Month	Monthly Rainfall (mm)			
	Manipur	**Imphal**	**Thoubal**	**Chandel**
January	6.9	20.0	16.0	13.0
February	0.3	30.0	29.0	27.0
March	128.1	79.0	65.0	58.0
April	229.5	86.0	77.0	73.0
May	193.7	163.0	155.0	150.0
June	238.4	359.0	395.0	432.0
July	296.1	268.0	301.0	334.0
August	103.6	251.0	296.0	336.0
September	262.3	149.0	188.0	225.0
October	195.0	159.0	175.0	196.0
November	12.6	22.0	23.0	15.0
December	59.2	3	5.0	8.0
Annual	**1725.7**	1589.0	1725.0	1867.0

Source: i) Economic Survey Manipur 2010-11, ii) www.en.climate-data.org

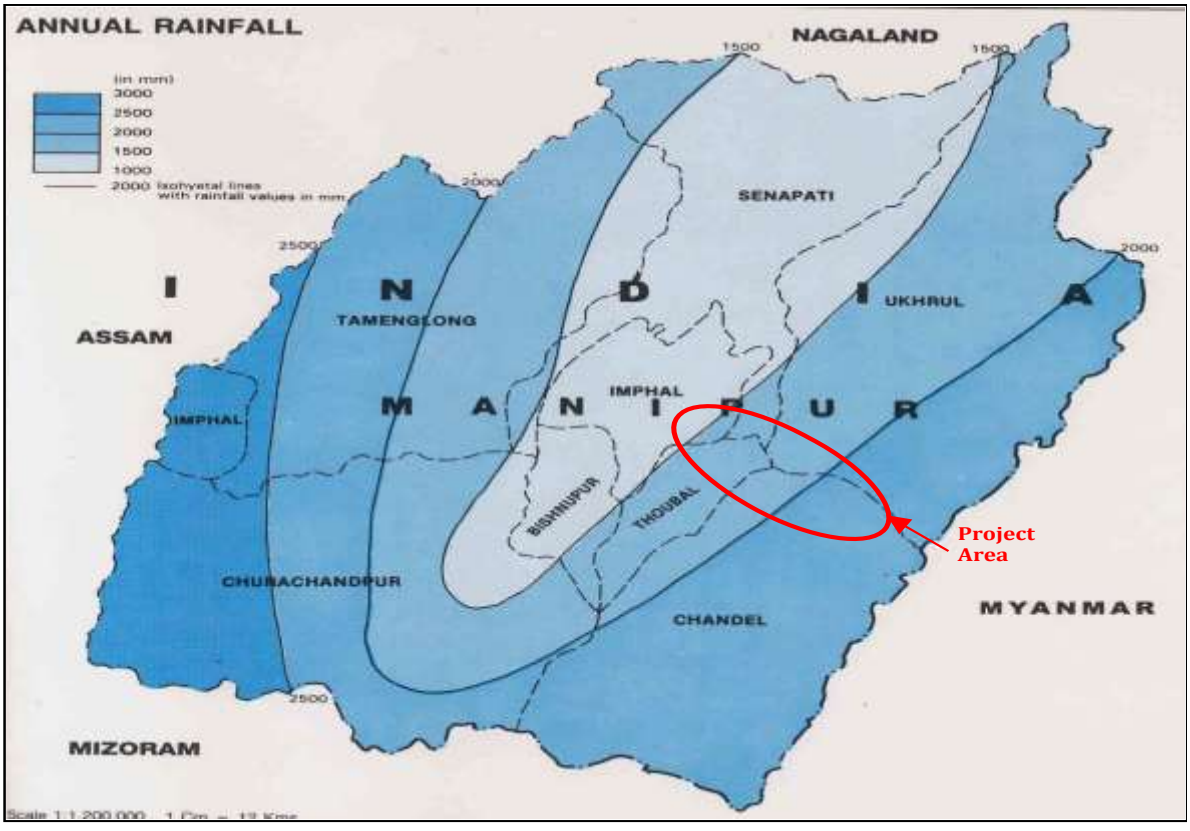


Figure 7: Average Annual Rainfall Map of Project Area

b. Temperature

135. The mean annual temperature of the state ranges from 15.4^{0}C to 25.3^{0}C. The mean monthly temperature rises abruptly with the onset of southwest monsoon in May (23.1^{0}C) from April (20.8^{0}C), and it continues high upto October (24.0^{0}C), until the southwest monsoons have started to retreats. December (17.1^{0}C) and January (15.4^{0}C) are the coldest months. August temperature (25.0^{0}C) is the hottest in a year.

136. The average minimum temperature of the coldest month of January is 4.3^{0}C; and the average maximum temperature is 26.4^{0}C with the mean temperature 15.4^{0}C. The minimum temperature of the hottest month August is 19.8^{0}C and the maximum temperature is 30.7^{0}C with the mean temperature of 25.3^{0}C. The annual average mean maximum temperature of the state is 36.6^{0}C and minimum mean temperature is 4.2^{0}C with mean temperature of 20.4^{0}C.

c. Relative Humidity

137. The relative humidity curve of the state has little downwards from January (74 %) to March (71 %). It rises abruptly with the increasing atmospheric moisture from April (77 %) to October (84 %) during the monsoon season and it becomes a downward from November (78 %) to December (77 %) with the onset of dry winter season, due to increasing atmospheric moisture. The drier months, November to march have great range between the morning and evening relative humidity than that of the wet months (April- October).

138. Table 24 shows the district-wise monthly mean temperature and monthly mean daily relative humidity in Manipur and subproject districts.

Table 24: District-wise Monthly Mean Temperature and Relative Humidity

Month	District / Mean Monthly Temperature (^{0}C) and Relative Humidity (%)											
	Manipur			Imphal			Thoubal			Chandel		
	Max	Min	RH	Max	Min	RH	Max	Min	RH	Max	Min	RH
January	25.1	9.9	-	21.3	7.8	-	21.5	8.1	88	20.8	8.0	-
February	27.6	11.6	-	23.2	9.5	-	23.4	9.6	88	22.9	9.5	-
March	31.3	14.9	-	27.1	12.9	-	27.2	12.9	86	26.8	12.8	-
April	33.2	19.1	-	29.1	16.4	-	29.5	16.5	79	29.1	16.2	-
May	33.9	22.2	-	29.3	19.0	-	29.5	19.0	81	29.0	18.6	-
June	31.8	24.1	-	28.3	20.9	-	28.3	20.9	89	27.5	20.2	-
July	30.8	24.3	-	27.9	21.2	-	27.8	21.2	89	27.0	20.5	-
August	31.0	24.3	-	28.0	21.2	-	27.8	21.2	80	26.9	20.4	-
September	31.4	23.6	-	27.8	20.5	-	27.7	20.4	83	26.9	19.8	-
October	31.6	21.8	-	27.2	18.4	-	27.1	18.4	85	26.3	17.8	-
November	28.4	16.7	-	24.4	13.6	-	24.4	13.8	87	23.6	13.5	-
December	25.6	11.4	-	21.9	9.3	-	21.9	9.5	86	21.2	9.4	-

Source: i) Economic Survey Manipur 2010-11, ii) www.en.climate-data.org

d. Wind Speed

139. The average annual wind speed in project area is 5.55 km/hrs. The mean monthly wind speed varies from as low as 5.55 km/hrs from July to September to high of 7.4 km/day in the month of April. Table 25 and Figure 8 present the monthly mean wind speed in Manipur.

Table 25: Monthly Mean Wind Speed in Manipur as a whole

Month	Wind Speed (km/hrs)
January	5.55
February	7.41
March	7.41
April	7.41
May	7.41
June	7.41
July	7.41
August	7.41
September	5.55
October	5.55
November	7.41
December	5.55

Source: www.windfinder.com

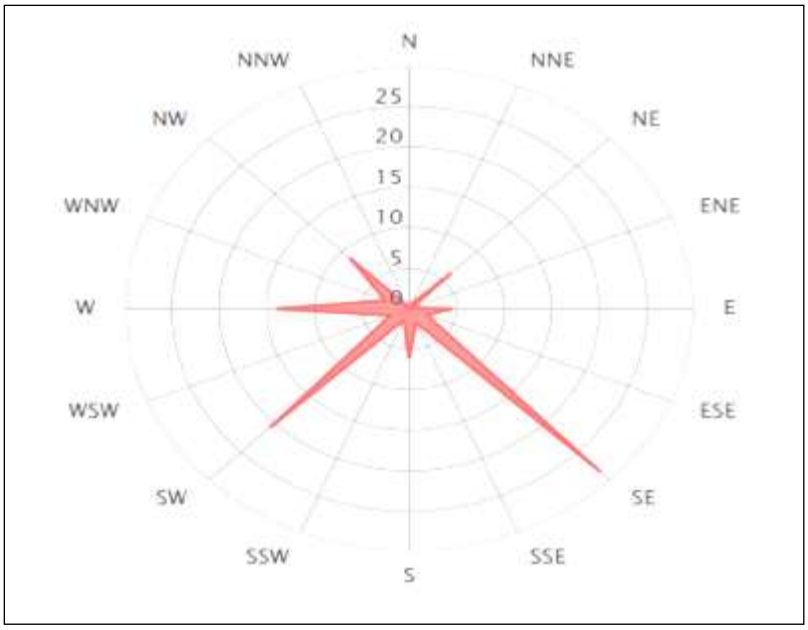


Figure 8: Annual Wind Direction and Distribution (%) in Manipur

2. Topography, Land Use, Geology and Soils

a. Physiography

140. Manipur, one of the eight sisters of the north eastern region in India, is an isolated hill-grit state located between $90^0$03'E and $94^0$42'E longitude and $23^0$50' and $25^0$42'N latitude. The state IS encircled by nine hill ranges on all sides with a small oval valley at the centre. The state has 352 km long international border with Myanmar to the south-east and 502 km border with the adjacent states of Nagaland on the north, Cachar district of Assam in the on the west and Mizoram on the south and the south west. The altitude of the state above the mean seal level varies from 790 meters to 2020 meters.

141. The state has a total geographical area of about 22327 sq km. which constitutes 0.7 percent of the total land surface of the country. Ninety percent of the total area of state is covered by hills; remaining area is a small valley. About 68 percent of the area is recorded as under forest. The population of the state stood at 2.39 million in 2001 of which 76 percent is rural.

142. The topography of the project area is mixed type. Imphal to Pallel section (about 36 km) passes through plain terrain and whereas remaining Pallel to Moreh portion passes though hilly terrain. Pockets of reserve forests where exists on the hillocks. Land use is mainly agricultural followed by residential and forest type. Image 1 and Image 2 shows the typical terrain along the project road, whereas Figure 9 and Table 26 shows that topography and land use along the project road marked on the Google-earth image.

Table 26: Details of the Existing Road Section Terrain

Sl. No.	Road	Length (km)	Terrain	Land Use	Average Elevation above MSL (m)
1.	Lilong (Imphal) – Pallel	35.90	Plain	Agricultural / Residential	450 - 1225
2.	Pallel to Khongkhang	29.78	Rolling to Hilly	Agricultural / Forest	1060 - 1225

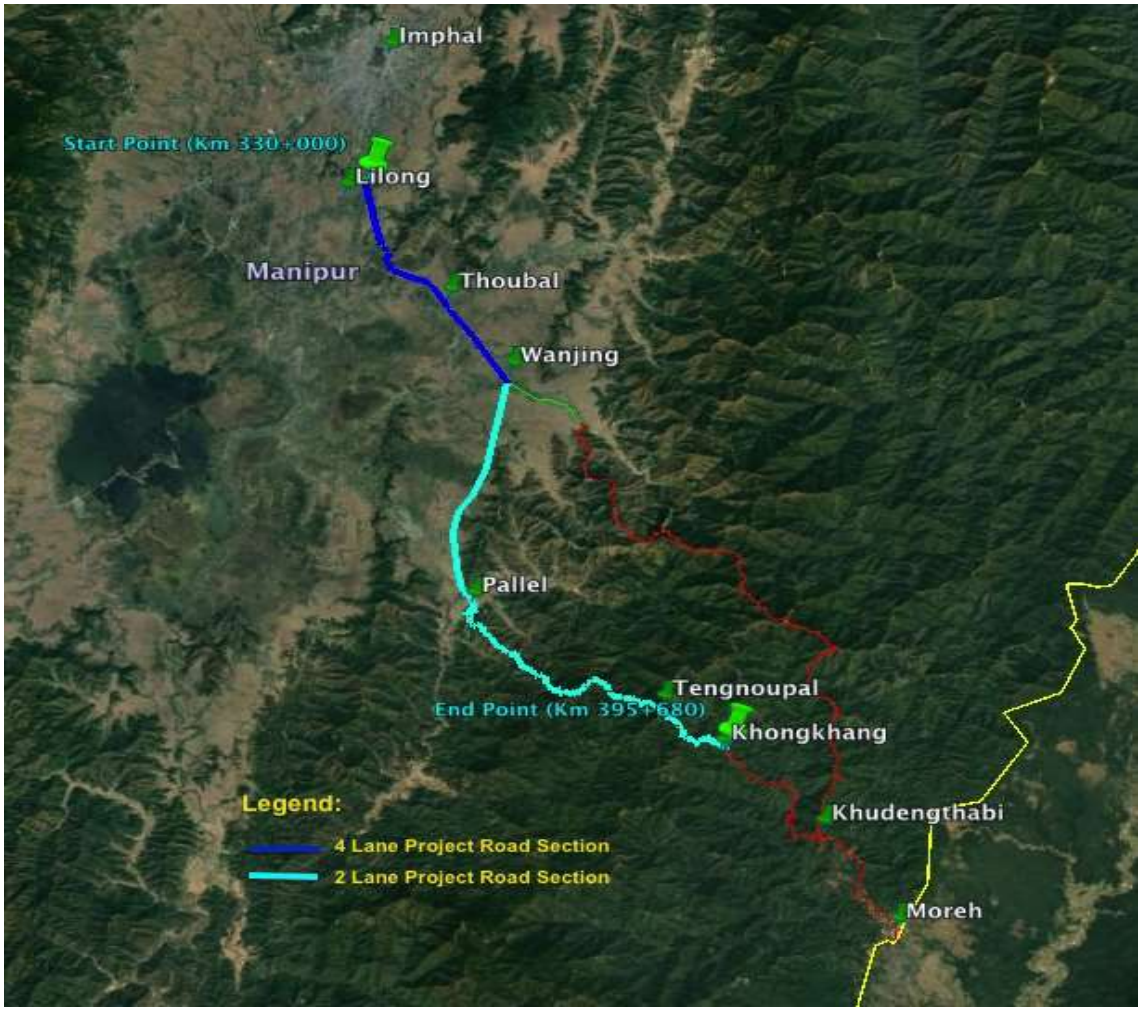


Figure 9: Google earth image showing terrain and land use along the Project road

Image 2: Typical Terrain along the Pallel-Moreh Section of Project Road

Image 3: Typical Terrain along the Lilong-Pallel Section of Project Road

143. The project road running north to south east between Longitudes 24°48'8.9" N & 24°14'16.46"N and lies between Longitude of 93°56'18.44"E & 94°18'2.23"E within the state of Manipur. The Indo-Myanmar road project in Manipur state transverses through three districts Imphal, Thoubal and Chandel. With an area of 120.100 ha., the district Imphal mainly falls in the valley area. Thoubal and Chandel with an area of 50.7 & 331.3 ha., respectively have mixed type of terrain valley and hilly.

144. Map showing physical features of the state is presented in Figure 10 and Figure 11 show the altitudinal zone in the project areas. It can be seen from the map that physiographically the project road sections i.e. Imphal to Pallel are laying in valley area with marshy land surrounded by inner hill basins. The area in between Pallel to Moreh is mostly on the low and high hill slopes along with piedmont.

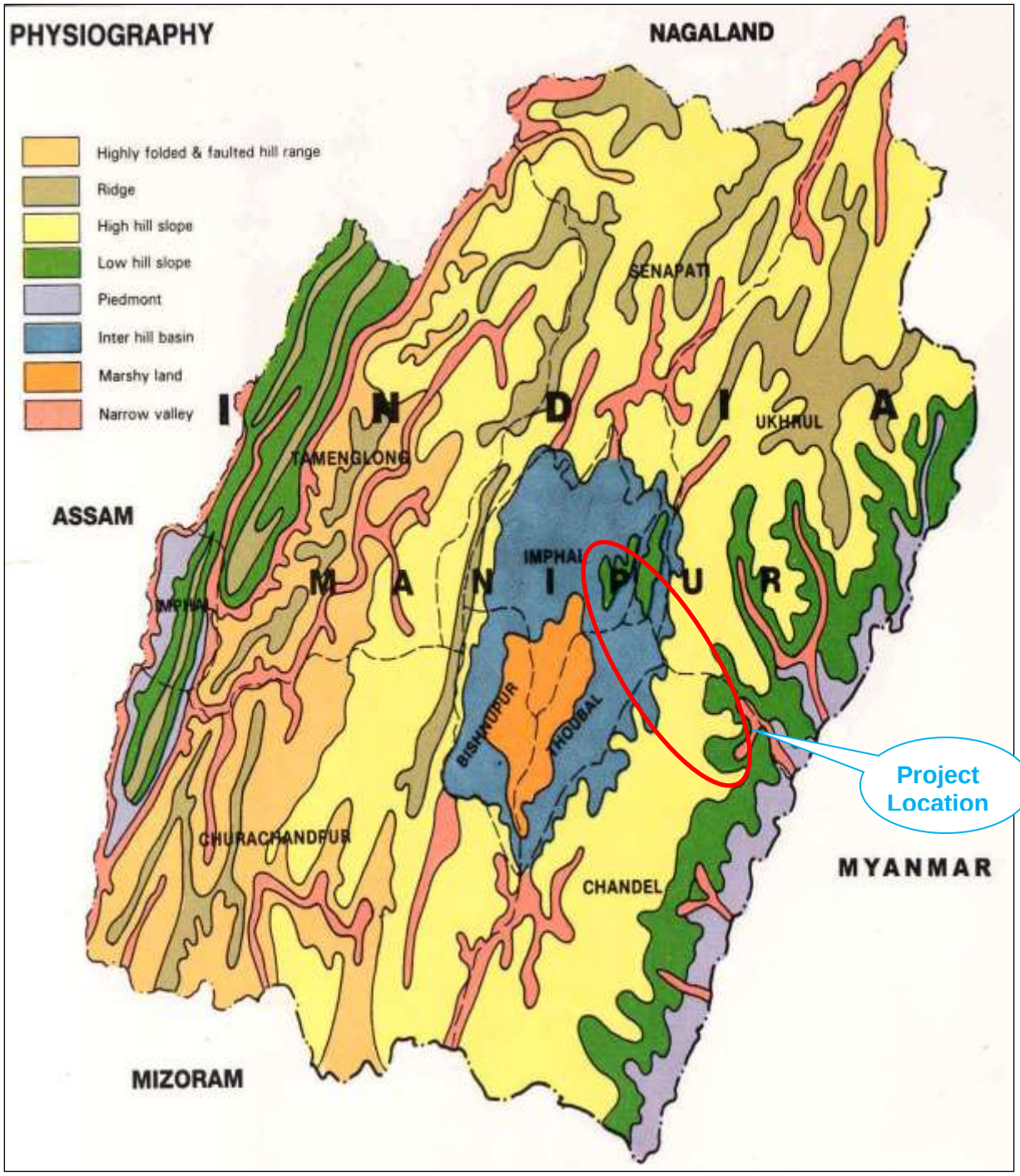


Figure 10: Physiological map showing in the Project Area (Source: Manipur Science & Technology Council (MASTEC), Imphal)

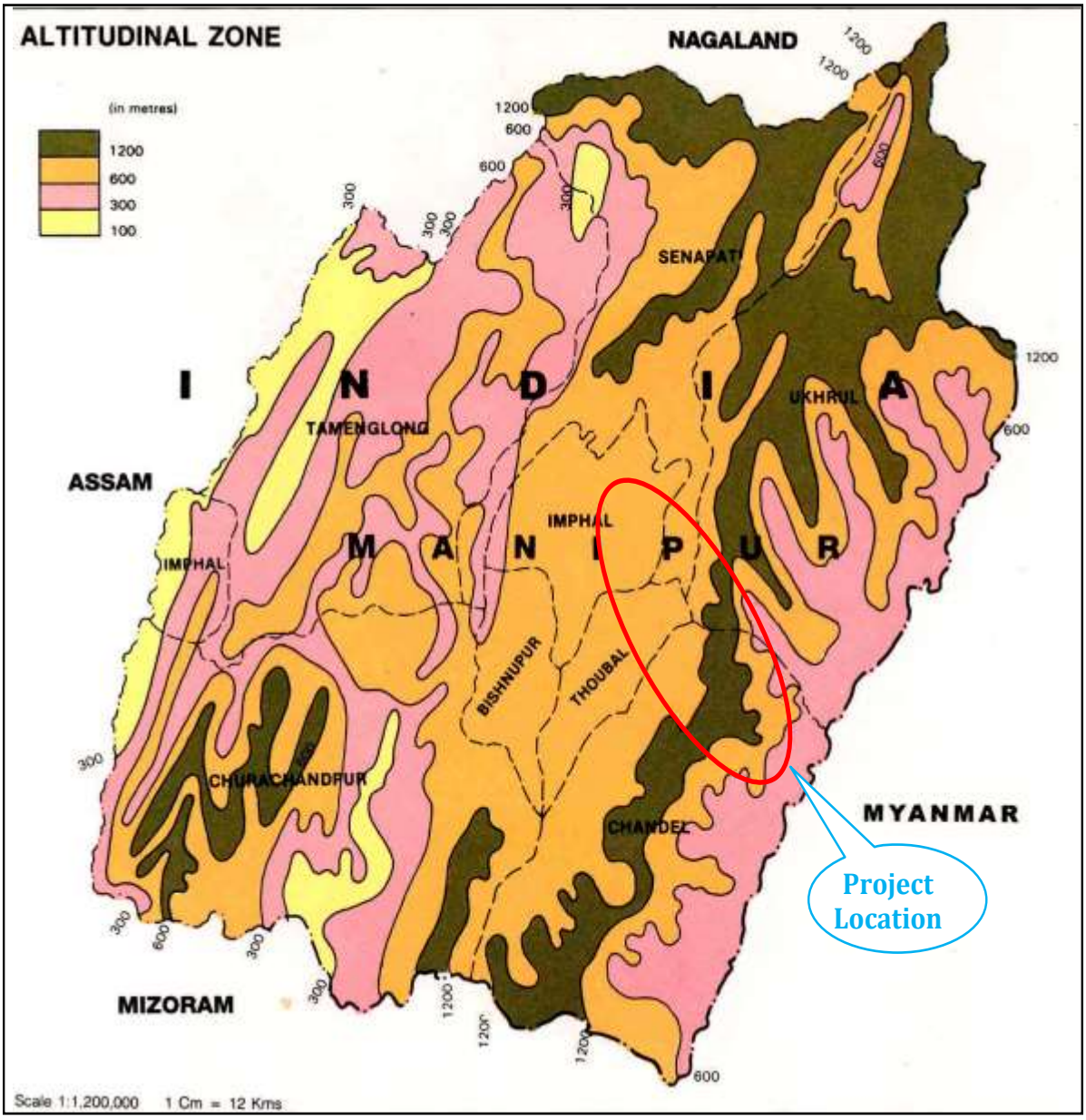


Figure 11: Altitudinal Zone Map of Manipur and Project Area

b. Land Use

145. The existing land use along the subproject road is mostly agricultural mixed with roadside development in plain terrain and vegetative and forested on hilly terrain. Land use in Lilong-Pallel section is primarily agricultural followed by residential areas with settlements along the project road. Whereas in Pallel-end of project road section (30 km) the land use dominated by forests and vegetative. Patches of agricultural activities are also noticed on hills in this section.

146. Data obtained from IRS-P6 LISS-IV 2011 satellite image of the project area shows that about 21% of the project area is covered by thick plantation and 31.5% by thin plantation followed

by agricultural land (23.9%), forest land (10.9%), and settlement areas (8.6%). Water bodies and rivers cover about 4.3% land area in the project road.

147. Figure 12 and Table 27 show the detailed of the land use distribution along the project road section.

148. Detailed landuse map with the help of IRS-P6 LISS-IV, 2011 Remote Sensing satellite data has been prepared for within 10 km radius on either side of the project road and the breakup of land use is given in Table 27 and shown in Figure 13. This shows that vegetation cover, forest land, and agrable land are the major land use followed by habitation and water bodies. False Colour Composite (FCC) scenes generated from IRS-P6 LISS-IV 2011 for 10 km radius of proposed alignment is shown in Figure 14.

Table 27: Land Use Pattern along the Project Road

Land Use Type	%
Thick Vegetation	20.9
Thin Vegetation	31.5
Degraded Forest/ Scrub	10.9
Agrable Land	23.8
Human Settlements	8.6
River/ Water bodies	4.3
Total	**100**

Source: Data obtained with the help of IRS-P3 LISS-III, 2008 remote sensing setellite

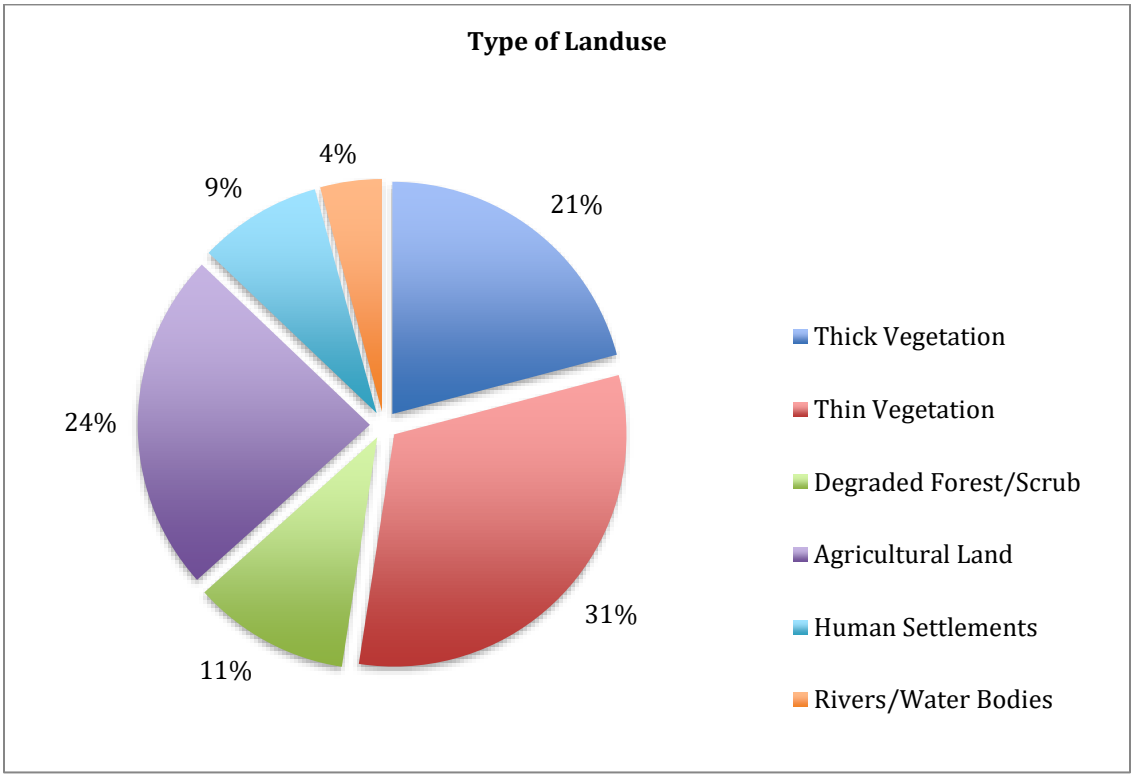


Figure 12: Land Use Distribution along the Project Road

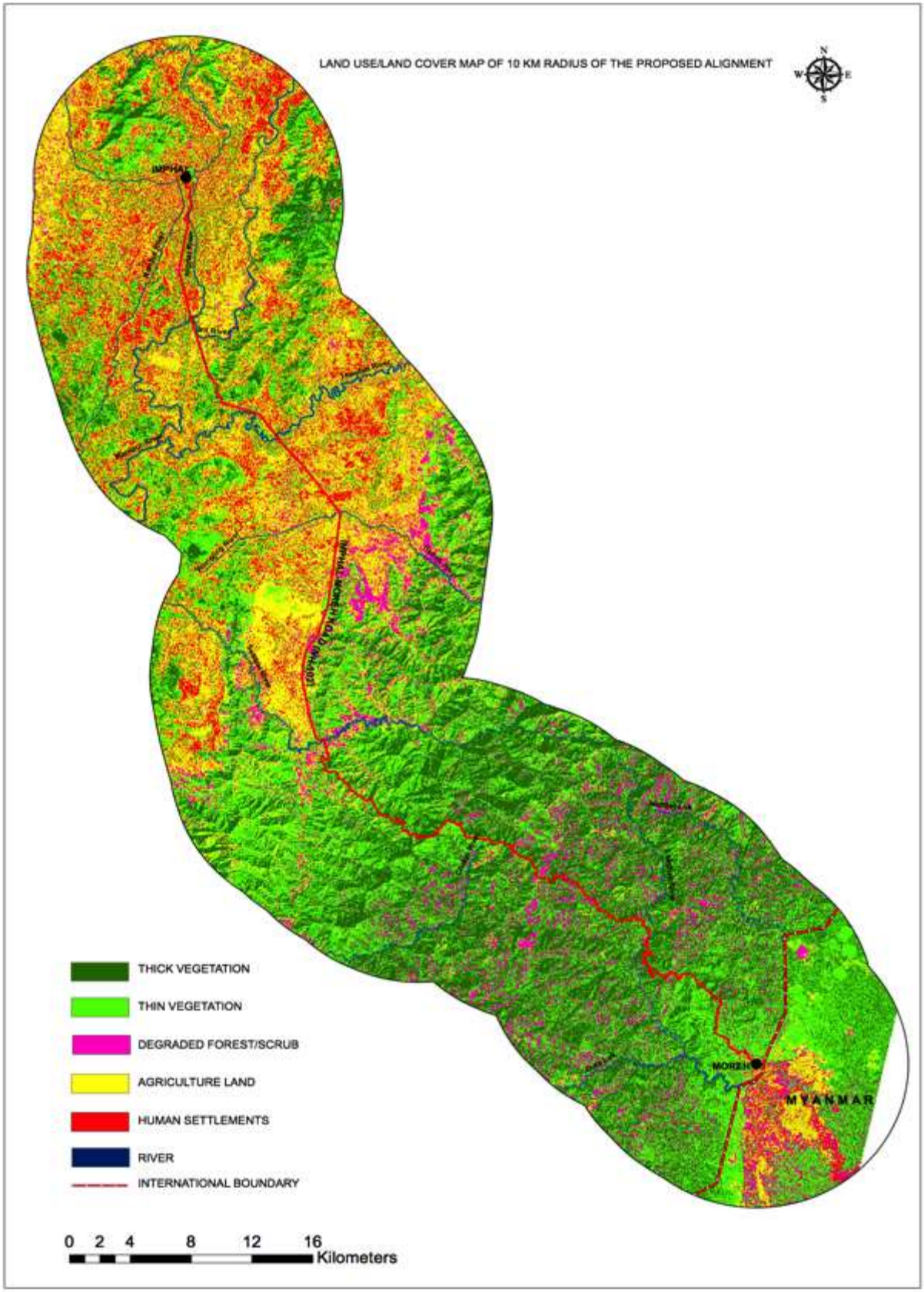


Figure 13: Land Use Cover of the Project Area

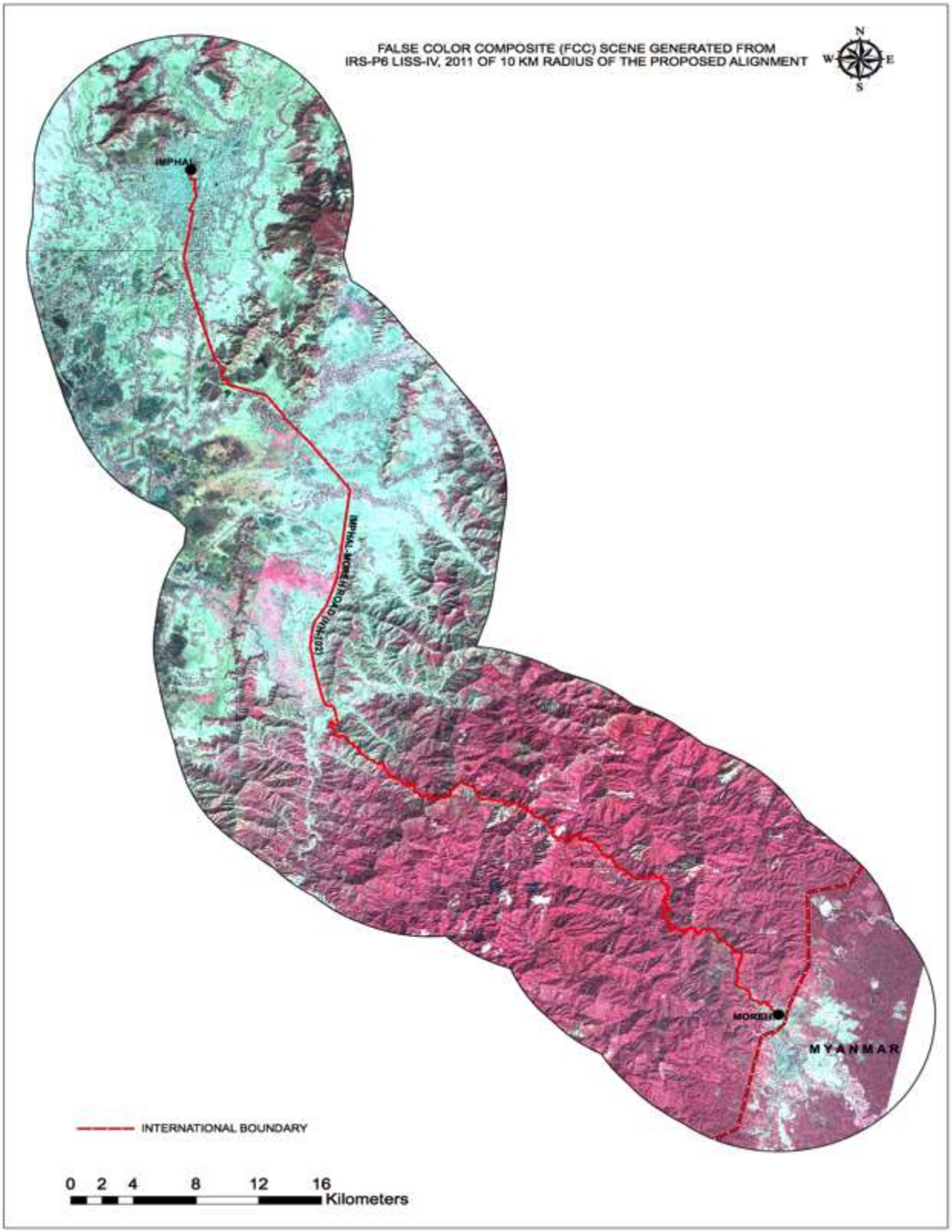


Figure 14: False Colour Composite (FCC) Scene Generated from Satellite Image for Project Area

c. Geology

149. Geologically, Manipur state belongs to the young folded mountains of the Himalayan system. The rocks in the state vary from upper cretaceous to the present Alluvium. The oldest rocks found in Manipur are mainly confined in the eastern part of the State close to Indo-Myanmar border and the rocks are grouped as cretaceous rocks consisting chromite, serpentine etc. availability of Asbestos, Chromite, Copper ore, Coal, Big iron, Lignite, Lime stone, Nickel ore and petroleum is reported in some parts of the state. The limestone deposits found in the Ukhrul district belong to the upper cretaceous period. The sandstone, shale of the Disang group found over the eastern half of the Manipur belong to the Eocene period. The rocks consisting of sandstone, shale, clay, etc. of the Brail Group are confined over the rocks of Disang group and extending along the mid-western portion of the state and they belong to the upper Eocene and Oligocene periods. The shales and sandstone of the Tipam and Surma groups cover the western banks of Manipur and they belong to the Miocene period. Rocks of alluvial deposits found in the Manipur valley portion are of recent origin and further they can be grouped as older and younger alluvium. The state is mainly composed of tertiary rocks. In the Ukhrul area there are igneous rocks which contain quartz, sandstone, limestone, etc. Figure 15 present the map showing geology and stratigraphy of the Project area.

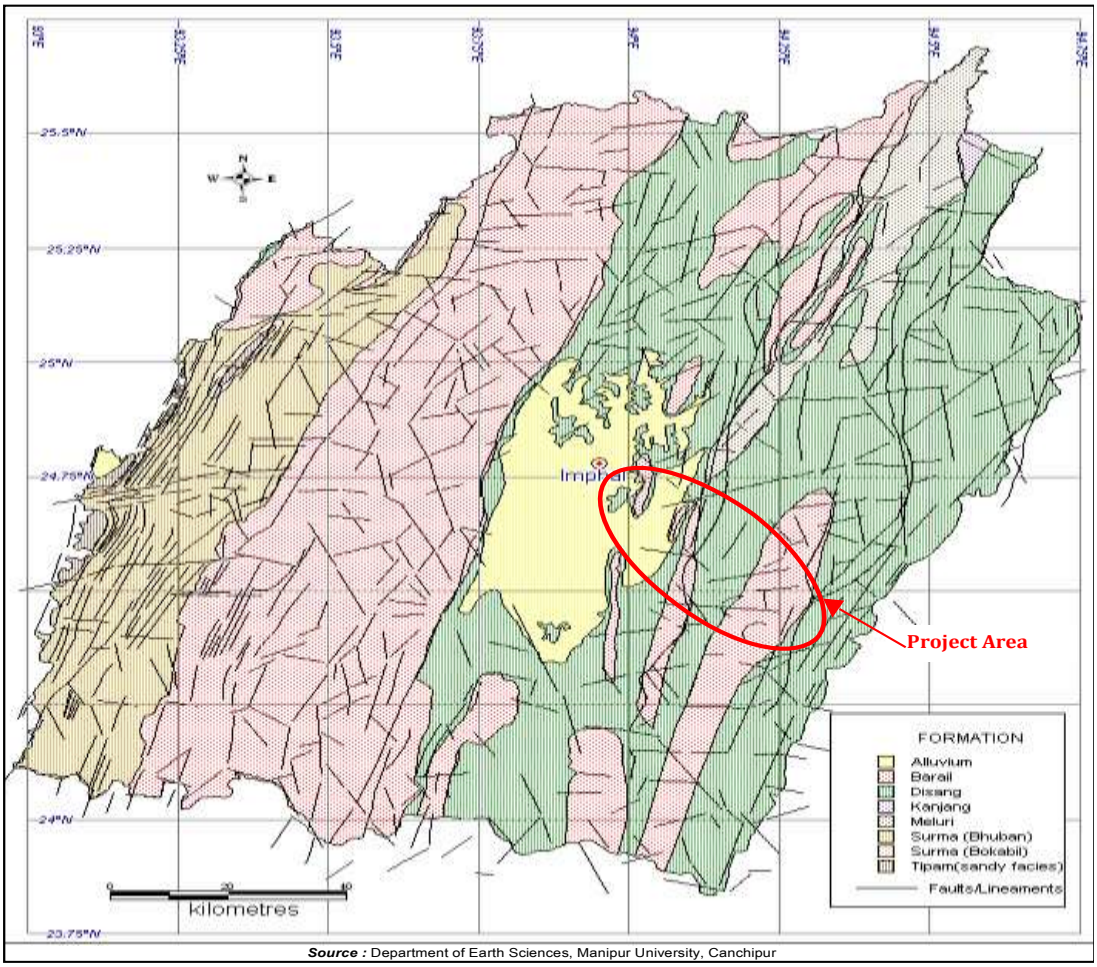


Figure 15: Geology and Stratigraphy of the Project Area

d. Seismicity

150. The proposed project road falls under the Seismic Zone V, which is susceptible to major earthquakes as per the seismic zone map of India (IS 1893 - Part I: 2002), shown below in Figure 16. The road and bridges design have been carried out with due considerations to the seiemicity. IRC IRC 78 (2000) and IS (IS 1893 (1998 and 2005) codes are followed for the design.

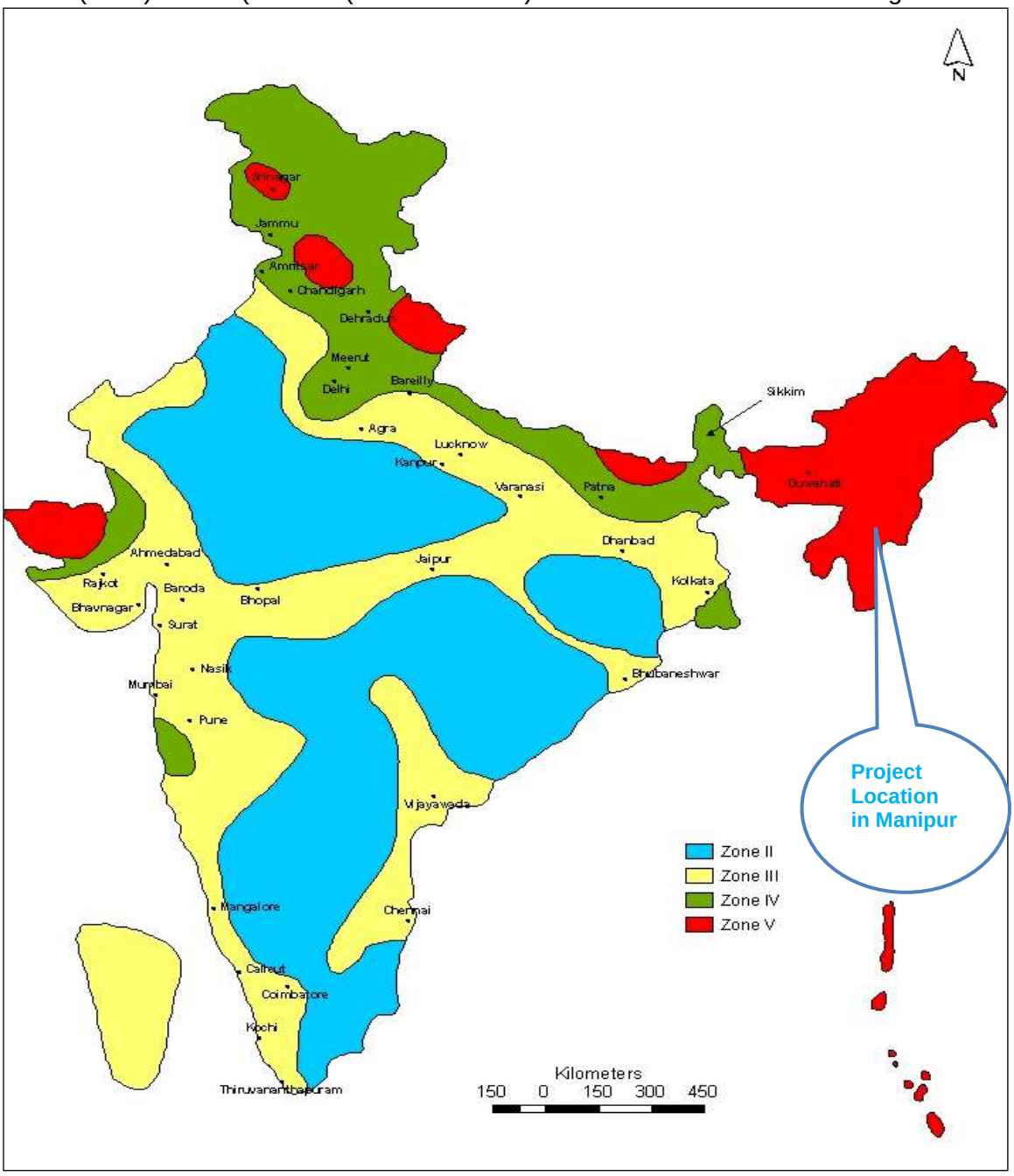


Figure 16: Seismic Zoning Map of India showing Project Location (Source: Envis, Government of Manipur)

151. Earthquakes of low to moderate intensity are recorded here regularly. The state of Manipur, has weathered dozens of large earthquakes the biggest in recent times being the 1988

M7.2 earthquake. Most earthquakes in western Manipur are shallow. But some, especially those recorded in the eastern parts and along and across the Myanmar border have greater depths. Areas in central Manipur are especially vulnerable to damage during earthquakes as they lie in the Imphal Valley, the lowest point of which lies the Loktak Lake. Much of the valley floor provides for strong shaking from even far off quakes as its soft soil amplifies the wave motions. Tectonically, the project area lies on the tertiary sediments on the western side.

e. Soils

152. The soil in the project area is mostly clay to sandy loam. Near Myanmar border the soil is sandy loam. The soil of the state is of two major types – residual and transported, which cover both the hill and plain of the State. The residual soils are either laterized or non-laterized. The laterized red soils covering an area of 2,500 sq. km. in the Barak drainage on the Western slope of Manipur. It contains rich portion of nitrogen and phosphate, a medium acidity and lesser amount of Potash. The old alluvial is brought down by river Barak basin and Jiri river and their tributaries from their lateritic water ship hills. The compact and less permeable soils contain higher quantity of potash, fair amount of nitrogen and phosphorus with medium acidity.

153. The transported soils are of two types – alluvial and organic. The alluvial soils cover 1600 sq. km. in the valley. These soils have general clayey warm texture and grey to pale brown colour. They contain a good proportion of potash and phosphate, a fair quantity of nitrogen and organic matter and are less acidic. The organic soils cover the low lying areas of the valley. With dark grey colour and clayey loam texture, these peaty soils have high acidity, abundance of organic matter, a good amount of nitrogen and phosphorus but are poor in potash. The hill soils are more or less rich in organic carbon (1 to 3%) in the top soil, but poor in available phosphorus and potash. They are acidic in nature.

154. The soil of Manipur belongs to 4 orders, 8 suborders, 13 greatgroups and 23 subgroups. It is observed that the Inceptisols are the dominant soils followed by Ultisols, Entisols and Alfisols and occupy 38.4%, 36.4%, 23.1% of the total geographical area of the State, respectively. Lakes and marshy lands occupy 1.9 percent. The area- wise distribution of soil at order and suborder levels of Taxonomy are given below.

155. Hill soils (mostly in Moreh region which is outside project influence area) being acidic are not suitable for much plant growth and traditional shifting cultivation together with indiscriminate cutting and burning of forest (jhum) over the years have seriously affected the ecological balance leaving the soil barren. In the valley region the deep soils are poorly drained and low in available phosphorus content. They are also susceptible to flood hazards.

156. The characteristics of soil of the subproject area (Imphal-Moreh Road corridor in plain areas) vary from place to place due to topographical variations. The soil in general is loamy sand to silty clay loam with a depth of 30 cm to 100 cm and in some cases even more than 120 cm. It has less water holding capacity and is dry in nature. Chemically soils along the project road are alkaline with pH value varies from 8.29 to 9.58. The soils are characterized by low to high organic matter (2.5-4 percent, in some places even more than 5 percent) with low action exchange capacity and high lime requirement. Notwithstanding the relatively high organic matter content, the nitrogen content in the soil is low.

157. Some of the plant nutrient like phosphate gets fixed in soils due to the high acidity and thus does not become available to the growing plants even on application. As such there is

remarkable deficiency of micronutrients viz. zinc, boron, copper, calcium, magnesium, manganese etc. in the soils. Figure 17 shows the soil map of the project area.

158. Chemical tests were carried out on soil at selected locations along the subproject road and the test results are given Table 28.

Table 28: Soil Quality along the Project Road Imphal-Moreh

Location / Chainage	Ph	Sulphates as SO_4(mg/g)	Chlorides (mg/g)	Organic Matter (%)	Total Soluble Solids (mg/g)
Main Alignment					
Wangjing (SQ-1)	8.29	16.97	4.86	3.78	811.8
Pallel (SQ-2)	9.58	17.04	5.12	2.45	615.0

Source: Soil Testing Carried Our by EIA Team, May 2014

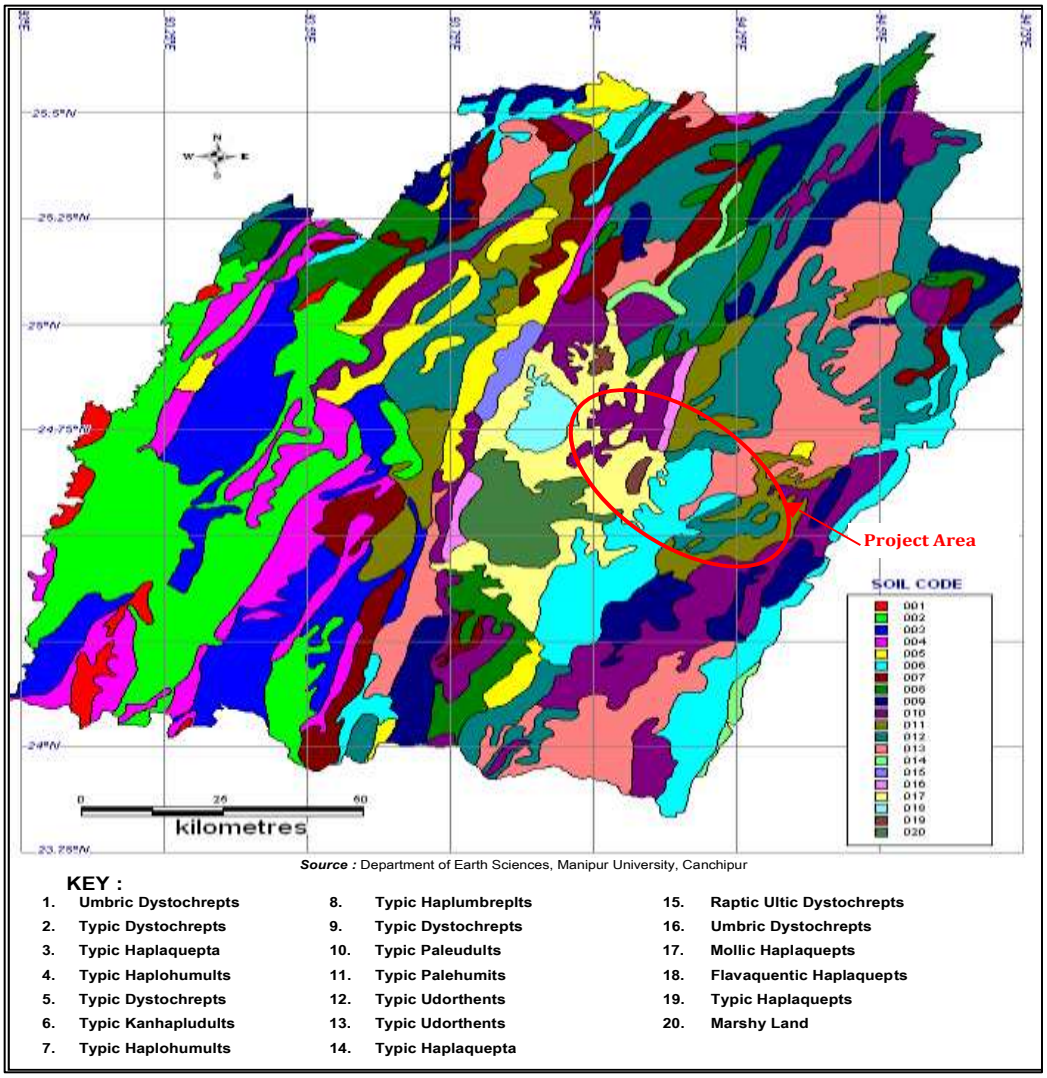


Figure 17: Map showing Soils and Surface Texture Class in the Project Area (Source: SOE Report, Government of Manipur)

3. Water Resources and Hydrology

159. The state has vast water resources in the form of lakes, ponds, rivers and streams, some with marshy areas. It has good water potential both ground as well as surface water. Important rivers that flows through the project region are the Lilong, the Thoubal and the Lokchao. The Thoubal river originates in the hill ranges of Ukhrul and is an important tributary of the Imphal river. On its course, it passes through Yairipok and Thoubal before joining the Imphal at Irong near Mayang Imphal. The Imphal river rises in the hills of Senapati district and flows south. During the dry seasons these rivers are lean and thin but, during the rainy monsoon periods these rivers are very wild and frequent flood occur causing widespread damage to the paddy fields, property and life. Other rivers in the region are the Wangjing, the Arong and the Sekmai. These rivers originate in the hills of Ukhrul district. Table 29 list out the major rivers which cross the subproject road. Besides these rivers there are several small streams and small ponds exist along the subproject road.

Table 29: Major Rivers crossing the subproject road

Sl. No.	River Name	Chainage (Km)	Category of Bridge	Width of the River Crossings (m)
1.	Lilong River (Bridge)	330+100	Major	97
2.	Waithau River (Bridge)	336+000	Minor	39.6
3.	Thoubal River	339+300	Parallel on RHS	Parallel on RHS
4.	Thoubal River (Bridge)	341+700	Major	69
5.	Arong River	344+100	Minor	33
6.	Wangjing River (Bridge)	348+100	Minor	25.6
7.	Pallel River (Bridge)	365+400	Minor	60

160. These rivers and ponds are being used for domestic purposes (bathing, wasing clothes etc.) by local communities whereas tubewells and water supplied by local administration is used for drinking purposes. Ponds are used for local fishing purpose. The water in the rivers are seasonal therefore fishing activities are not taking place in the rivers.

161. The ground water aquifers in the region occur in sediments and fractured rocks. Springs are either seasonal or perennial and are often used for irrigation and drinking purposes. There are number of hot springs in the region which are being used by the local communities for domestic and agricultural purposes and also being used by the visiting tourists. There are no hot springs within project road corridor which are used for tourism purpose. There are no wells within 100m of the project road corridor.

162. The surface water quality in the region is reported to be well within the permissible limits and also found by visual identifications. There are no reports of any water born decease in the region.

Image 4: Ground Water sample collection at Wangjing

163. The surface water bodies such as Thoubal River is close to subproject road. The Thoubal River distance from road varies from 5 to 15 m at chainage 339.300 km to chainage 340.000 km. In addition to this, large numbers of springs (Jhora) are

crossing the subproject road. These rivers and Jhoras are mostly used for domestic purpose (bathing and washing) by local communities. Fishing activities are negligible along the project road.

4. Water Quality

164. In order to establish baseline conditions, surface and groundwater samples were collected. The sampling locations were selected after the field reconnaissance and a review of all the water bodies/ resources in the project influence area. Samples were collected as per IS- 2488 (Part I-V).

165. In order to represent the true profile of the project area, samples of ground (one) and surface water (two) of the area through which the project road runs were collected on 23 and 25 January 2014. Monitoring locations are shown in Figure 18 and Table 30. Samples were analyses as per IS: 10500-1991. Grab sample were collected from water source and were analysed for various parameters as per the procedures laid down in the APHA and BIS. Atomic Absorption Spectrophotometer and UV/VIS Spectrophotometer were used for analysis of water samples according to the necessity.

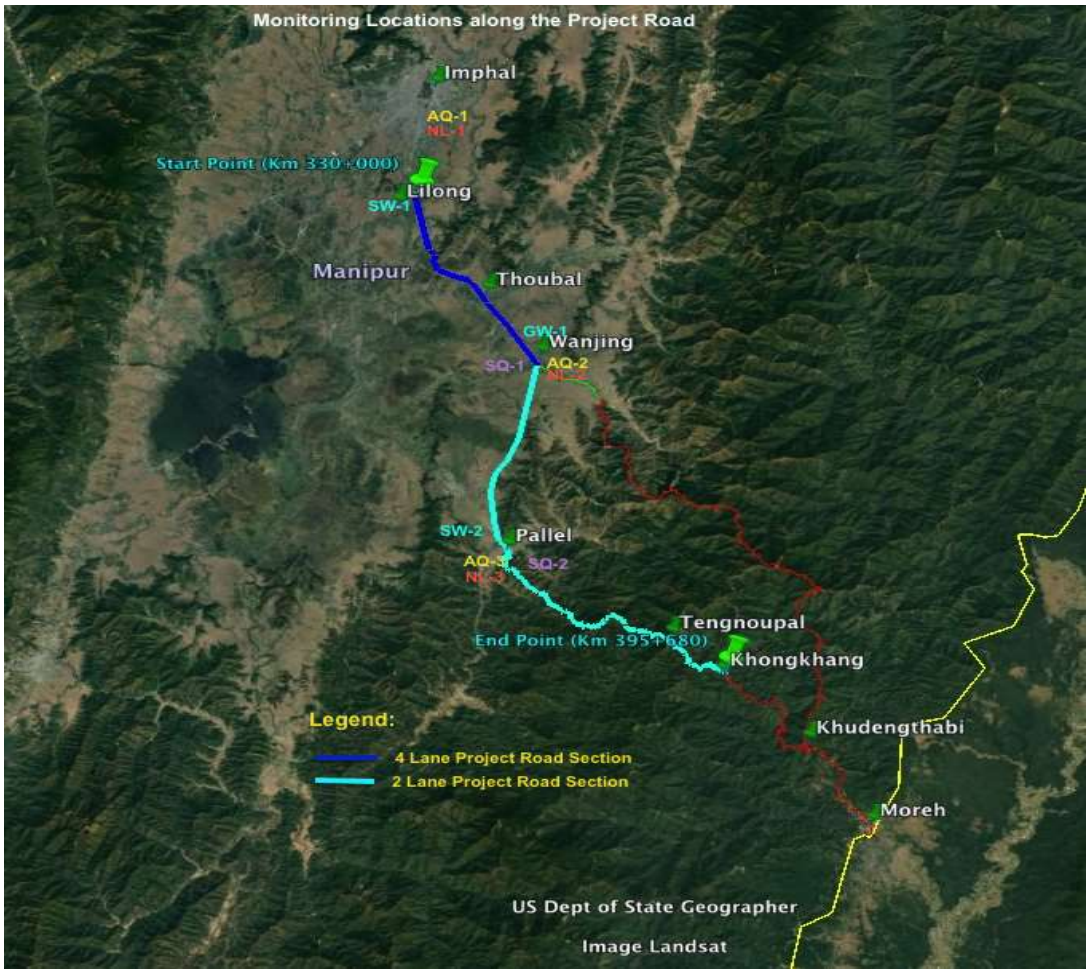


Figure 18: Map showing monitoring locations along the Project Road

166. The results of the analysed of these samples are presented in Table 30 for Surface Water (SW) and Ground Water (GW). The results were compared with standards for drinking water quality (Annex 2).

167. It can be seen from Table 30 that, the pH of the drinking water in the region is well within permissible limits (6.5 – 7.5). The samples collected from bore well at Wangjing show highest value of the total dissolved solids of 258mg/l which is well within the permissible standards. Total hardness as $CaCO_3$ in the water sample from Wangjing is found at 209.72mg/l which is less than the limit (300mg/l) prescribed for drinking water standard limits. BOD level for all analysed ground water samples is higher than the permissible standards which is an indicator of pollution but insufficient suite of testing means source unclear.. Other parameters analysed like chloride, sulphate, fluorides are found well within standards. It can bee seen from the results that that both the surface and ground water quality meets the standards of IS:10500 standards for drinking water and CPCB standards for ground water, except for the presence of fecal coliform and total coliform in the surface water samples. The source of the coliform is open defaecation by the local people along the river edge.

Table 30: Water Quality Characteristics along the Project Road

Sl. No.	Parameter	Unit	Prescribed Limit as per IS:10500 & IS:2296	Monitored Value		
				Imphal River (SW1)	Wangjing Handpump (GW1)	Pallel River (SW2)
1.	pH	-	6.5 – 7.5	7.04	7.41	6.85
2.	Total Dissolved Solids (TDS)	mg/l	500 max	104.0	258.0	92.0
3.	Chloride as Cl-	mg/l	250 max	3.88	1.7	3.4
4.	Sulphate as SO_4	mg/l	200 max	10.86	10.17	11.12
5.	Total hardness as $CaCO_3$	mg/l	300 max	66.0	209.72	51.36
6.	COD	mg/l	200 max	50.2	77.44	38.72
7.	BOD 5 day	mg/l	<5	9.16	11.76	7.05
8.	Fluoride as F	mg/l	1 max	<1.0	<1.0	<1.0
9.	Fecal Coliform	MPN/100ml		4580	Absent	2894
10.	Total Coliform	MPN/100ml	10/100ml	16890	Absent	8870

Source: Water Quality Monitoring carried out by EIA Team, 2014

5. Air Quality

168. Ambient air quality in the state is quite pure compared to other neighbouring states. Except for few urban centres like Imphal and Thoubal, the ambient air quality is good. There are no major industrial activities in the State. Dust arising from unpaved surfaces, forest fire, smoke charcoal production and domestic heating, and vehicular pollution are sources of pollution in the region. Firewood burning is the major contributor in the ambient pollution load. Industrial and vehicular pollution is mainly concentrated in the major commercial areas in State capital.

169. Vehicular pollution is a secondary source of pollution in the state as the traffic density is low. Pollution from vehicles is mainly due to use of low-grade fuel, and poor maintenance of vehicles. The level of pollution in rural areas is much lower than that of the urban areas due to lower volume of traffic. The traffic density in the state is very low. There is sudden increase in the number of vehicles in the town area during the last one decade producing a lot of smoke. The use of a large number of second-hand diesel jeeps as transport is another cause of air pollution.

170. Secondary information is not available on ambient air quality of the subproject road area. The major transport on the project section is the traffic flowing on National highway connecting Imphal to rest of the country as well as traffic flow towards Moreh from Imphal and from Assam. This might also add to the air pollution load on the project section.

171. The baseline status of the ambient air quality was assessed using a scientifically designed ambient air-quality monitoring network. The design of this network was based on the following:

- meteorological conditions;
- the assumed regional influences on background air quality;
- the areas where impact would most likely be greatest;
- present land use along the proposed alignment; and
- traffic congestion points.

172. To establish the baseline ambient air quality, Ambient Air Quality Monitoring (AAQM) stations were set up at three locations as indicated in Table 31. Monitoring locations are shown in Figure 19.

Table 31: Details of Ambient Air Quality Monitoring Locations

Sl. No.	Location Code	Name of the Location	Source
1.	AQ1	Imphal: Opposite of Manipur University Gate: Chainage Km 326.500 i.e. near starting point of project road	Urban/Sensitive
2.	AQ2	At Junction point of Wangjing - Heirok and National Highway at Chainage Km 348.200: Right hand side of the road	Commercial /Residential
3.	AQ3	Market area at Pallel: Chainage Km 365.100 Left hand side of the road	Commercial / Residential

173. At each of the three locations monitoring was undertaken as per new notification issued by MoEFCC on 16th November 2009, between 23-29 January 2014. Data for the following parameters was collected.

- Suspended Particulate Matter (SPM)
- PM 10
- PM 2.5
- Sulphur Dioxide (SO_2)
- Oxides of Nitrogen (NOx)
- Carbon monoxide (CO)
- Hydrocarbons (HC); and
- Lead (Pb)

Image 5: Air Quality Monitoring Station Setup at Wanjing (AQ2)

174. The sampling of SPM, PM10, PM2.5, SO_2, NOx & Pb was undertaken on a 24-hourly basis while 8- hourly samples were collected for CO and HC. SPM, RPM, SO_2, NOx, & Pb were monitored using M/s Envirotech Instruments Private Ltd; make Respirable Dust Sampler (APM 460) (Image 5) along with gaseous attachment (Model APM 415 & 411). Whatman GF/A filter papers were used for SPM, whereas, Whatman EPM 2000 filter papers were used for monitoring Pb. Carbon monoxide (CO) & Hydrocarbon samples were

monitored by using M/s Endee Engineers Pvt. Ltd. make gas detector model No. CO96 & GP - 200P respectively.

175. Methodology adopted for sampling and analysis and instrument used for analysis in laboratory are presented in Table 32.

Table 32: Techniques Used for Ambient Air Quality Monitoring

Sl. No.	Parameter	Technique	Instrument Used	Minimum Detectable Limit (µg/m^3)
1.	Suspended Particulate Matter	Respirable Dust Sampler (Gravimetric method)	Electrical Balance	1.0
2.	PM 10 and PM2.5	Respirable Dust Sampler (Gravimetric method)	Electrical Balance	1.0
3.	Sulphur Dioxide	Improved West & Gaeke Method	Colorimeter	5.0
4.	Nitrogen Oxide	Jacob & Hochheiser modified (Na-Arsenite) Method	Colorimeter	5.0
5.	Carbon Monoxide	Gas Chromatograph		0.01
6.	Hydrocarbons	Gas Chromatograph		0.01
7.	Lead	AAS Method after sampling using EPM 2000 filter paper	Atomic Absorption Spectrophotometer	0.01

176. A summary of results for each location is presented in Table 33. Figure 19 shows the graphically presentation of the existing air quality along the project road at monitored locations. These results are compared with the new National Ambient Air Quality Standards prescribed by the MoEFCC for respective zones.

Table 33: Summary of AAQM Results (Average Values)

Location	Parameter and Values (µg/m^3)							
	SPM	PM10	PM2.5	NOx	SO_2	Pb	CO	HC
GOI Standard for Sensitive	100	100	60	80	80	1.0	4000	1000
GOI Standard for Residential	200	100	60	80	80	1.0	4000	2000
WB-EHS Standards	None	50 – 250[9]	25 - 75[10]	200 (1hr)	20 – 125 (24 hr)[11]	None	None	None
AQ1- Imphal: Opposite of MU Gate	388.69	115.48	52.93	35.49	9.15	0.023	1.316	BDL*
AQ2 - Junction point of Wangjing - Heirok and NH 102	305.12	94.48	47.17	32.43	8.41	BDL	0.946	BDL
AQ3 -Market area at Pallel	269.54	83.96	41.37	30.79	7.76	BDL	0.706	BDL

Note: BDL-Below Detectable Limit
Source: Ambient Air Quality Monitoring carried out by EIA Team, 2014

177. It can be seen from the Table 33 that concentration of most of the parameters monitored is well within the prescribed limits of CPCB as well as World Bank EHS standards except SPM and PM10 level at MU Gate (Imphal). However, for health impacts it is mainly the PM10 and PM2.5 levels which are more important as it is these smaller particulate matters which can enter the respiratory system and cause health problems. PM10 exceeds the permissible limit marginally

[9] Interim target values are 75 – 150 µg/m^3 arnd guideline value is 50 µg/m^3
[10] Interim target values are 37.5 - 75 µg/m^3 arnd guideline value is 25 µg/m^3
[11] Interim target values are 50 - 125 µg/m^3 arnd guideline value is 20 µg/m^3

i.e. 115.48 µg/m^3 against the permissible limit i.e. 100 µg/m^3 prescribed by CPCB as well as WB EHS Guidelines. Other parameters monitored i.e. PM2.5, NOx. SO_2 were found within the permissible limits for all the locations. Overall the air quality in the project area in not an issue. The National Ambient Air Quality Standards (NAAQS) prescribed by MoEFCC are given in Annex 3.

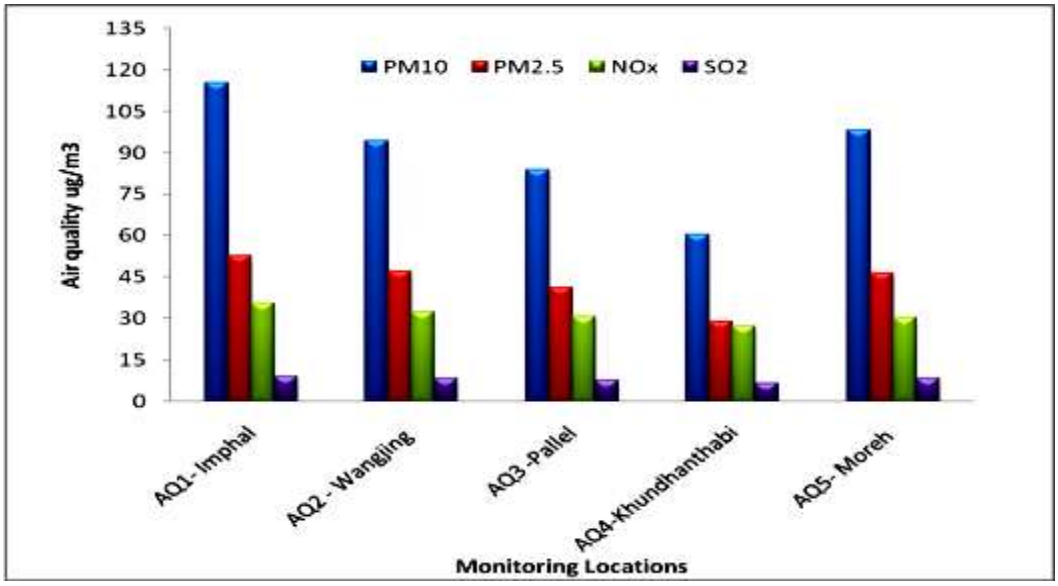


Figure 19: Air Pollutant Concentration in Ambient Air along the Project Area

6. Noise Quality

178. Noise pollution is not a current problem in the region except in commercial location in urban areas where major settlements are along the road, and high traffic flow. However, few commercial locations in Imphal and Thoubal will experience increase in noise levels but still the ambient noise quality is expected to be higher than the permissible limits.

179. During construction period, temporary increase in the noise levels are expected from the movement of construction machineries and construction activities. Suitable barriers and timely scheduling of construction activities will minimize these impacts.

180. No secondary information was available on noise level in the project area. In order to establish the baseline noise quality in the project area, a reconnaissance survey was therefore undertaken to identify noise generating sources and sensitive receptor such as school, hospitals, temples, built-up areas. Three locations listed in Table 34 were selected for monitoring the noise level.

Table 34: Details of Noise Level Monitoring Locations

Sl. No.	Location Code	Name of the Location	Source
1.	NL1	Imphal: Opposite of Manipur University Gate: Chainage Km 326.500 i.e. near starting point of project road	Sensitive Area
2.	NL2	At Junction point of Wangjing - Heirok and National Highway at Chainage Km 348.200: Right hand side of the road	Commercial/ Residential

3.	NL3	Market area at Pallel: Chainage Km 365.100 Left hand side of the road	Commercial / Residential

181. **Methodology:** At each of the three locations, Sound Pressure Level (SPL) measurements were taken at an interval of 1 minute using a sound level meter of Lutron make Digital Sound Level Meter. At all these locations, daytime noise levels were monitored during the period 6 am to 9 pm and night-time noise levels during the period 9 pm to 10 pm. Noise readings, with setting at 'A' response - slow mode, were recorded. The readings were tabulated and a frequency distribution table prepared from which 24 hourly, hourly, and Average Leq noise levels were calculated.

182. **Presentation of Results:** Table 35 show the noise level at the monitored locations. It can be seen from the table that at all the locations (NL1, 2, 3,) along the subproject road, the average day time noise level varies from 65.3 dB(A) to 72.8 dB(A), whereas average night time noise level ranges from 53.8 dB(A) to 62.4 dB(A).

183. It is found that the recorded noise level is higher than the permissible limits for residential area prescribed by CPCB and also by World Bank EHS standards of 55 dB(A) and 45 dB(A) for day time and night time respectively. Night time noise level readings were taken upto 10 pm only as after 10 pm no traffic movements were observed. This noise is mainly from vehicular traffic and local domestic/commercial activities.

Table 35: Ambient Noise Level in decibel (A) along the Project Road

Location	Date of Sampling	Noise Level dB (A)						CPCB / World Bank Standard dB(A)
		Day Time			Night Time			
		L_{min}	L_{max}	L_{eq}	L_{min}	L_{max}	L_{eq}	
NL1	23.01.2014 to 24.01.2014	65.4	76.4	71.5	57.8	66.3	61.2	55 for day time and 45 for night time
	26.01.2014 to 27.01.2014	67.0	77.4	72.8	58.5	67.4	62.4	
	29.01.2014 to 30.01.2014	64.7	75.8	71.0	57.0	68.2	61.9	
NL2	23.01.2014 to 24.01.2014	62.3	70.6	67.7	53.9	62.1	57.4	
	26.01.2014 to 27.01.2014	61.8	71.0	67.0	54.5	63.2	58.1	
	29.01.2014 to 30.01.2014	61.2	69.8	66.2	53.0	62.5	57.2	
NL3	23.01.2014 to 24.01.2014	60.8	70.0	66.2	53.2	60.4	56.2	
	26.01.2014 to 27.01.2014	61.4	69.5	65.9	52.8	59.7	55.6	
	29.01.2014 to 30.01.2014	60.3	69.0	65.3	50.6	58.5	53.8	

Source: Noise Monitoring carried out by EIA Team, 2014

B. Biological Environment

1. Forests and Vegetation

184. In spite of its small size, the state's vegetation is rich and varied in character. This is because of its different climatic conditions found in the state and its peculiar physiography. The forest area of the state falls into four distinct zones viz. i) Myanmar drainage forests, ii) Urkul pine forests, iii) forests overlooking the valley and iv) Barak drainage forests.

185. In Manipur, the forest area covers about 17219 sq.km land area which is about 78 percent of total geographical area of the state and 2.54 percent of country's forest cover. The areas under reserve forests and protected forests stood at 1467 sq.km and 4171 sq.km respectively. The remaining forest area is unclassed forests.

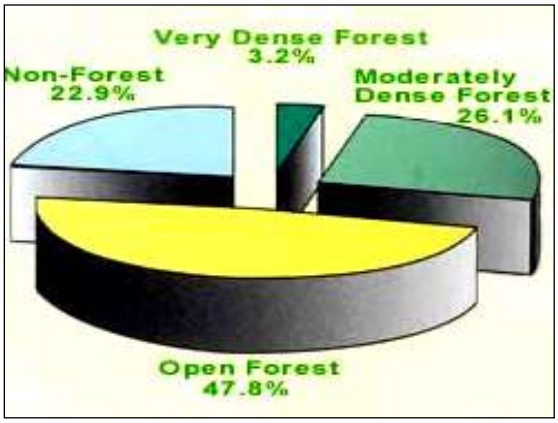


Image 6: Distribution of Forests in the State

186. According State of Forest report, 2009 by Forest Survey of India the forest cover of Manipur is 17,280 sq.km which is 77.40% of the total geographical area of the State. Out of the total forest area in the State, the area under Reserved Forests including Wildlife Protected Area Network is 1,467 sq. km. i.e. 8.4 % of the total forest area. An area of 4,171 sq. kms. or 24 % of the total forest area is recorded as Protected Forests and the rest 11,780 sq. kms.(67.6%) belong to the category of Unclassed forests. During the year 2010-11 there is no reservation and de-reservation of forest areas within RF. Table 36 shows area under legal type of forest in the state of Manipur.

Table 36: Area under Forest type in the State of Manipur

S. No.	Forest Type	Area (Sq.km.)	% of Total Forest Area
1	Reserved Forest	1,467	8.40
2	Protected Forest	4,171	24.00
3	Other Forest	11,780	67.60
4	Total	17,418	100.00

Source: State of Forest report, 2009

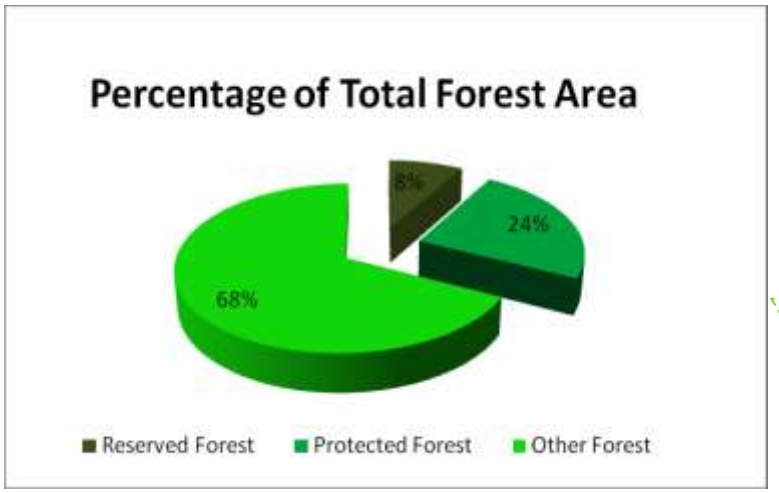


Image 7: Recorded Forest Land of State
Source: Forest Department, Manipur, Annual Administrative Report, 2010-11

187. Blessed with an amazing variety of flora and fauna, 67% of the geographical area of Manipur is hill tract covered forests. Depending on the altitude of hill ranges, the climatic condition varies from tropical to sub-alpine. The wet forests and the pine forests occur between 900-2700 m above MSL and they together sustain a host of rare and endemic plant and animal life. Coveted the world over as some of the most beautiful and precious blooms, orchids have an aura of exotic, mysteries about them.

188. In Manipur, they are abound in their natural habitat growing in soil or on trees and shrubs speaking their beauty and colour, stunning the eye that is not used to seeing them in such profusion. There are 500 varieties of orchids which grow in Manipur of which 472 have been identified.

189. The major species of vegetation available in the state include Teak, Uninthou, Khasi-pine, Dipterecarpes species, Michelia, Champa, Terminalia, species, Cedrela Toona, Schima Wallichii etc.

190. Classification of forests with the dominant and associated plant species in each zone was given by Deb (1960). According to him the state was divided into four climatic Zones, Tropical climate (valley and hill upto 900m), Mountain subtropical climate (area lying between 900-1800m).Mountain temperate climate (area ranging from 1800-2400m), Sub-alpine (hills ranges above 2400m). Forest Types in Manipur Eastern Himalaya are presented in Table 37.

Table 37: Details of Forest Types in Manipur Eastern Himalaya, India, adapted from Champion and Seth (1968)

Sl. No.	Characteristic species	Altitude Range (m)	Classification code	Forest Types adapted from Champion and Seth (1968)
1.	*Laurus-Melia- Bauhinia association and Michelia champaca, Schima wallichi, Gmelina arborea, Podocarpus nerifolium, Dillenia spp.*	300–900	2B/C2	Tropical Semi-evergreen forests
2.	*Tectona grandis, Dipterocarpus turbinatus, Melanorrhoea usitata, Dillenia, Xylia, Lagerstroemia, Terminalia, Gmelina, Bombax spp*	300–900		Moist deciduous forests

Sl. No.	Characteristic species	Altitude Range (m)	Classification code	Forest Types adapted from Champion and Seth (1968)
3.	*Quercus-Magnolia-Acer and conifers association*	1700-2700	11B/C1	East Himalayan Wet temperate forests
4.	*Prunus, Pyrus, Ligustrum, Taxus, Bucklandia populnea, Acer campbelli, Magnolia campbelli, Castanopsis tribuloides*	Above 2700	-	Sub-Alpine Forests
5.	*Sub-climax state of grassland due to heavy biotic*	-	-	Grassy blanks
6.	*Bambusa manipureana and Dendrocalamus manipureanus*	1,700–2,800	12/DS1	Bamboo brakes
7.	*Calamus tenius, C. leptospadix, C. floribundus and C. erectus*	-	-	Cane brakes

Source: Forest Department, Manipur, Annual Administrative Report, 2010-11

191. Vegetation along the subproject road sections Imphal to Pallel and Pallel to end point, are mostly covered by the agriculture, think grass and secondary Moist Deciduous Forest as shown in the Vegetation map and Forest map of the Manipur state in Figure 20 and Figure 21, respectively.

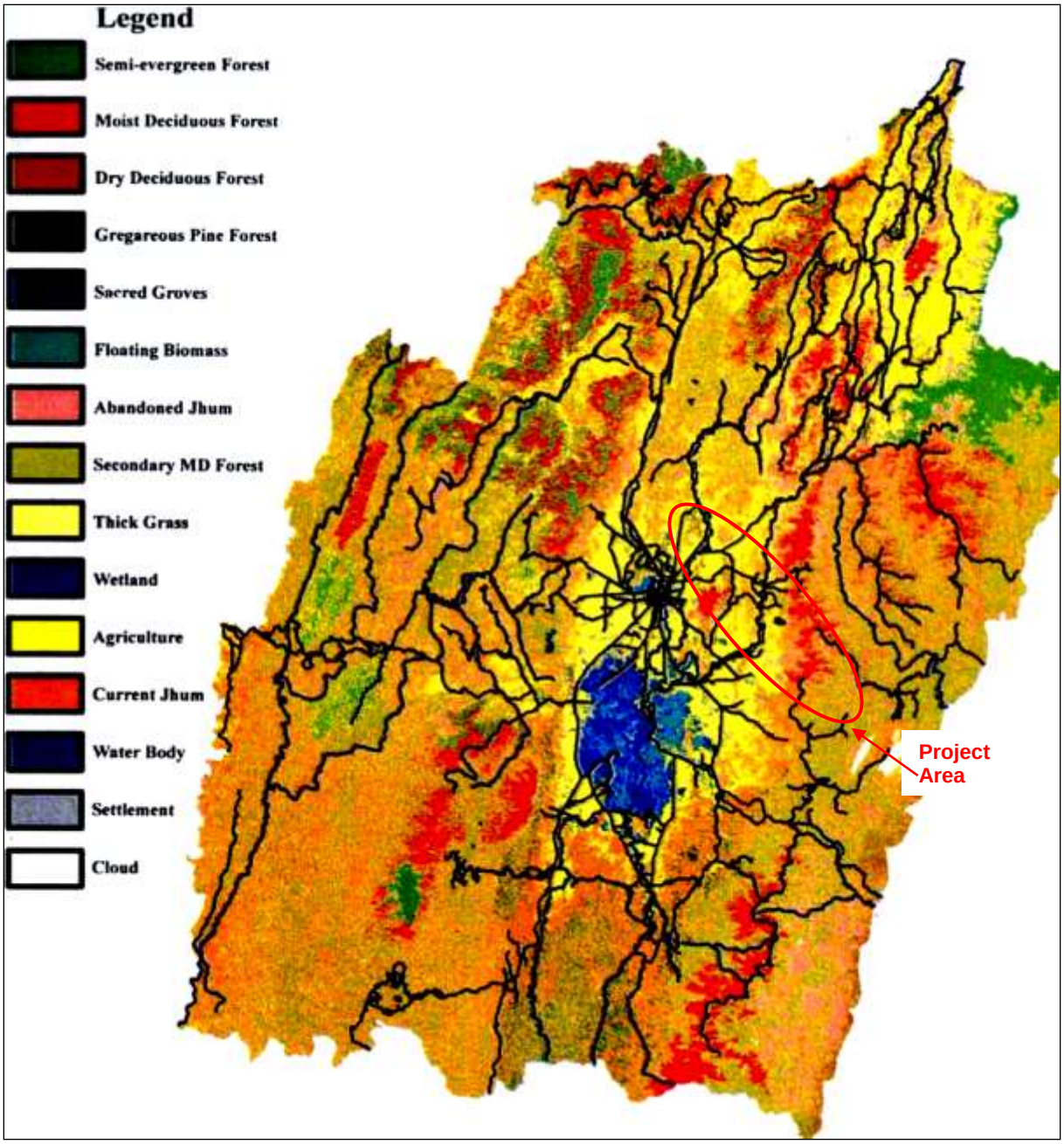


Figure 20: Vegetation Map of Manipur State (Source: MRSAC, Imphal)

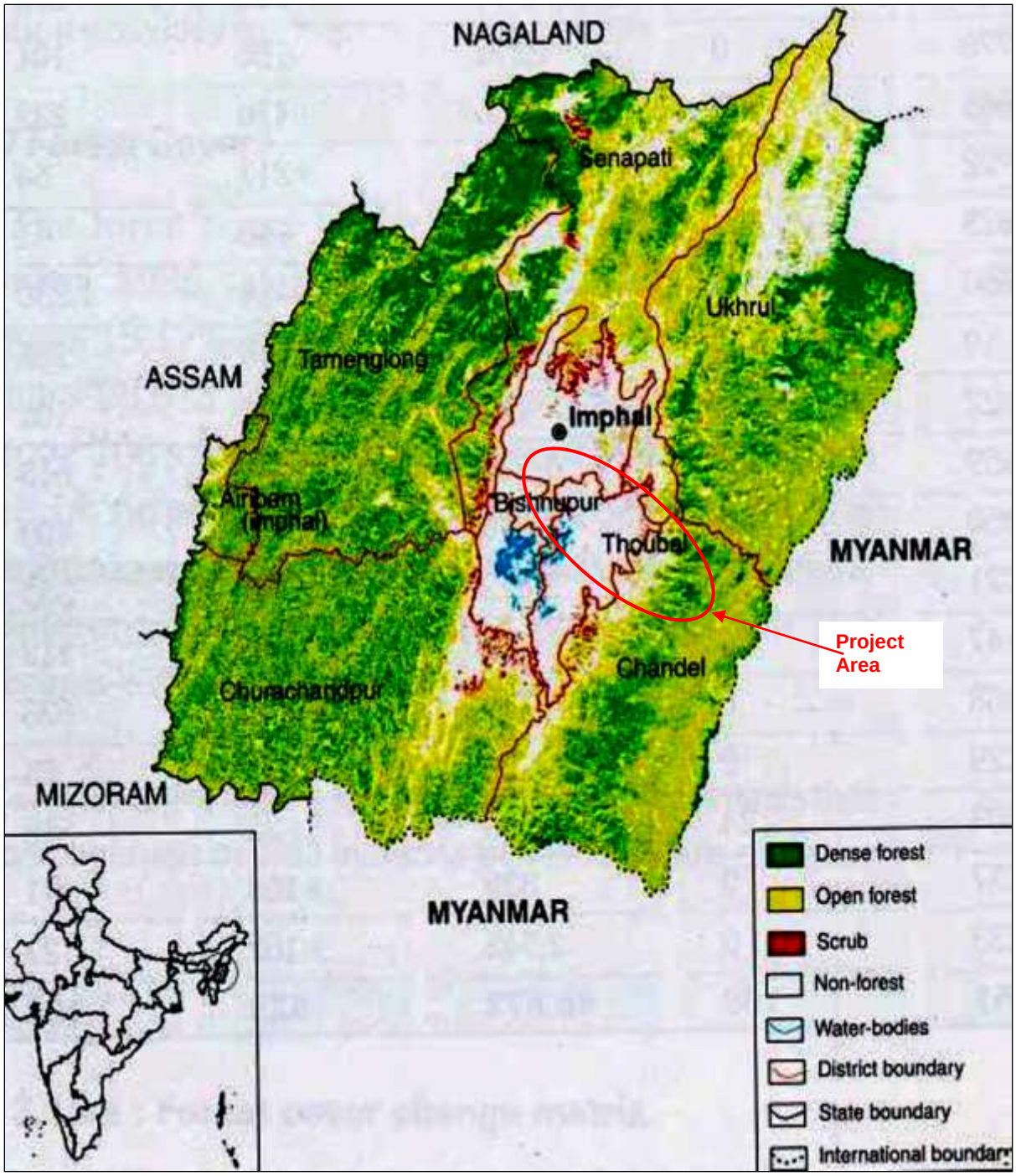


Figure 21: Forest Map of Manipur State *(Source: State of Environment Report, Manipur)*

192. Forests along the subproject road sections in plain terrain (Lilong to Pallel) and Hilly terrain (Pallel to end point) are mix of agriculture, non-forest areas, open forest as shown in the map (Figure 20 and Figure 21).

193. In plain terrain from starting point at chainage km 330.0 to Pallel at chainage km 365.00 landuse is mixed of built-up (major settlements Wangjing, Thoubal, Pallel) and agriculture. While

in hilly terrain at chainage km 366.00 onwards landuse is mixed of built-up (small settlements), agriculture and forests area (protected, reserve and unclassed) of Thoubal Forest Division and Myanmar Boarder Teak Protected Forest.

194. About 33.28 km length of the subproject road passes through various trype of forests. Details of the forest locations along the sun-project road section is listed in Table 38 and shown in Figure 22.

Table 38: Details of Forest Locations along the Subproject Road section

S. No.	Design Chainage (km)		Length (m)	Side of Road	Forest Name and Type	Remarks
	From	To				
1	334.6	336.2	1600	LHS	Waithou PF	
2	336.3	337.5	1200	RHS	Unclass	
3	355.0	355.3	300	LHS	Proposed Khunadalaiching RF	Proposed CL may be shift towards RHS
4	357.2	357.5	300			
5	358.6	358.9	300			
6	361.9	362.1	200			
7	366.3	384.8	18500	RHS	Proposed Lamdang RF	Hill section starts
				LHS	Unclass	
8	384.8	389.0	4200	Both side	Unclass	
9	389.0	391.5	2500	LHS	Myanmar Boarder Teak PF	
				RHS	Unclass	
10	391.5	395.68	4180	Both side	Myanmar Boarder Teak PF	
	Total Length (m)		**33280**			

Source: Field Survey and Data received from Forest Department of Manipur.

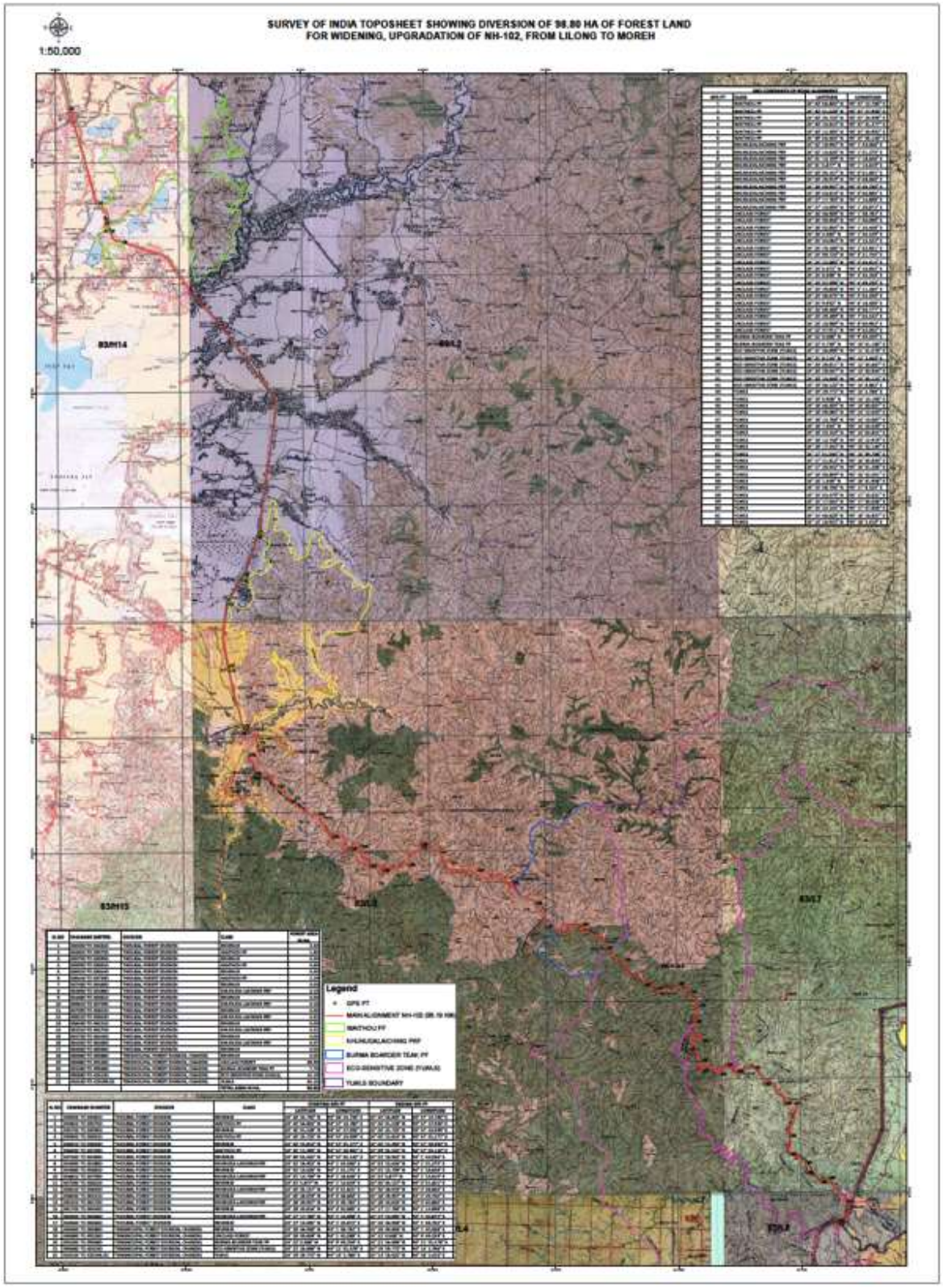


Figure 22: Map showing sections of Forest Areas along the proposed alignment on toposheet *(Source: GIS Division, Forest Department, Manipur)*

195. Local forest department were consulted to know the presence of any endangered species of trees within the formation width. It is confirmed by the forest department officials that there are no endangered species which are likely to be affected by current project.

196. Field survey has been carried out to identify the number and type of trees to be affected by the proposed improvement work. It is envisaged that about 3691 trees existing within the proposed formation width of the subproject road. Among these trees 1557 are on left side and 2134 tress are on right side of the road while travelling towards Moreh. These trees are likely to cut for widening of the road. Table 39 show details of the trees to be cut.

Table 39: Detail of trees within formation width of the Main alignment (Indo-Myanmar)

Section	Chainage (km)		Left Hand Side (LHS)	Right hand Side (RHS)	Type of Trees[12] (local name)
	From	To			
Lilong to End point	330+000	395+680	1577	2134	Nasik, Gulmohor, Boroi, Jam, Baraphi, Heibong, Tairm, Mango, Heikha, Neem, Sorokhi, Tumitla, Khongnang, Konbla, Uyumg, Pungton, Jamun, Yongchak, Theibong, Heirik, Teak, Sayee, Kaygay, Kwa, Tera, Thibong, Qurei, Lairik Heibi, Kongong Thopki, Bhushlei
Total trees to be cut (Nos)			**3691**		

Source: Field Survey carried out by the Consultant Team, 2014

197. Table 40 present the girthwise distribution of trees along the subproject road. It can be seen from the table that most of the trees (67%) to be affected by subproject development are within the girth size of 300 mm.

Table 40: Detail of trees within formation width of the Main alignment (Indo-Myanmar)

Girthsize	LHS	RHS
G1 (30 cm)	1129	1340
G2 (30-60cm)	220	524
G3 (60-90 cm)	165	212
G4 (90-120 cm)	31	53
G5 (120-150 cm)	6	2
G6 (150-210 cm)	3	1
G7 (>210 cm)	3	2
Total	**1557**	**2134**
	3691	

Source: Field Survey carried out by the Consultant Team, 2014

198. Table 41 present the floral species found in the forest areas along the subproject road (with their family and its IUCN status.

Table 41: Floral Species Recorded in the Project Area

Botanical Name	Local Name (Common Name)	Family	IUCN Status
Pinus kesiya Royle	*Uchan*	Pinaceae	Not Assessed
Gnetum montanum		Gnetaceae	Not Assessed

[12] None of these specific are recorded in the IUCN red data list of endangered / protected species. Local forest department were consulted and they also confirmed that none of these species are classified as rare or endangered and also they are not notified by government schedule.

Botanical Name	Local Name (Common Name)	Family	IUCN Status
Persea villosa (Roxb) Koster		Lauraceae	Not Assessed
Fragaria dattondama S. Gay		Rosaceae	Not Assessed
Potentilla griftihii Hookf		Rosaceae	Not Assessed
Prunus persica (Linn) Stokes		Rosaceae	Not Assessed
Roja multiflora Thunb		Rosaceae	Not Assessed
Rubus calycinus Wall		Rosaceae	Not Assessed
Rubus niveus Thanb		Rosaceae	Not Assessed
Chailleta gelonioides Hool f.		Chailletiaceae	Not Assessed
Bauhinia variegate L.		Caesalpiniaceae	Not Assessed
Cassia fistula Linn.	*Chaohui*	Caesalpiniaceae	Not Assessed
C. leschenaultainae DC		Caesalpiniaceae	Not Assessed
C. mimosoides Linn		Caesalpiniaceae	Not Assessed
C. sophera Linn		Caesalpiniaceae	Not Assessed
Acacia pennata (Linn) Willd		Caesalpiniaceae	Not Assessed
Acacia myriophylla Benth		Caesalpiniaceae	Not Assessed
Phaneria glabifolia Benth		Mimosordeae	Not Assessed
Calliandra grithhii Benth		Mimosordeae	Not Assessed
Mimosa pudica Linn		Mimosordeae	Least Concern
Butea minor Ham		Mimosordeae	Not Assessed
Crotolaria juncea Linn		Papilionaceae	Not Assessed
Crotolaria pallid Ait		Papilionaceae	Not Assessed
Crotolaria sessiliflora Linn		Papilionaceae	Not Assessed
Dalbergia sissoo Roxb		Papilionaceae	Not Assessed
Desmodilum confertum DC		Papilionaceae	Not Assessed
Desmodium diocium DC		Papilionaceae	Not Assessed
D. laxiflorum DC		Papilionaceae	Not Assessed
D. parvifloum DC		Papilionaceae	Not Assessed
D. sequax Wall		Papilionaceae	Not Assessed
D. triquetrum (Line) DC		Papilionaceae	Not Assessed
Indigofera atropurpurea		Papilionaceae	Not Assessed
I. cassioides Ronl		Papilionaceae	Not Assessed
I. wightii Graen		Papilionaceae	Not Assessed
Smithia sensitive Ail		Papilionaceae	Not Assessed
Spatholobus roxburghi Benth		Papilionaceae	Not Assessed
Dipterocarpus turbinatus Gaerin		Dipterocarpaceae	Not Assessed
Dillenia pentagyna		Dilleniaceae	Not Assessed
Juglans regia Linn		Jaglandaceae	Not Assessed
Cannabis sativa Linn		Cannabaceae	Not Assessed
Ficus benghalensis Linn	*Khonang*	Moraceae	Not Assessed
F. elastica Roxb.	*Rubberpambi*	Moraceae	Not Assessed
F. geniculata Kurj	*Ksiherbong*	Moraceae	Not Assessed
F. racemosa Linn	*Heibong*	Moraceae	Not Assessed
F. religiosa Linn	*Kanakhsangnang*	Moraceae	Not Assessed
F. semicordata Buch-Hem		Moraceae	Not Assessed
F. squamosa		Moraceae	Not Assessed
Morus australis Poir		Moraceae	Not Assessed
Strobilanthus zeylanicus Kerr		Moraceae	Not Assessed
Diplolyclos palmatus C. Jeffery		Cucurbtaceae	Not Assessed
Epiphylum, phyllanthus (Linn) Hew		Cactaceae	Not Assessed
Opuntia vulgaris Mill		Cactaceae	Not Assessed
Boehmeria platyphylla D. Don		Urticaceae	Not Assessed
Broussonetia papyrifera		Urticaceae	Not Assessed

Botanical Name	Local Name (Common Name)	Family	IUCN Status
Poikilospermum suaveolens BI		Urticaceae	Not Assessed
Bixa orellana		Bisaceae	Not Assessed
Capparis multiflora Hook F		Capparaceae	Not Assessed
Crateva religiosa Forst F		Capparaceae	Not Assessed
Begonia roxbunghii A DC		Begomaceae	Not Assessed
Hibiscus cannabinus Linn		Malvaceae	Not Assessed
H. surattensis Linn		Malvaceae	Not Assessed
Grewia microcos Linn	*Heitup*	Tiliaceae	Not Assessed
Triumfetta pilosa Boj		Tiliaceae	Not Assessed
Byttneria pilosa Roxb.		Sterculiaceae	Not Assessed
Sterculia indicca Merr.		Sterculiaceae	Not Assessed
Bombax ceiba Linn		Bombacaceae	Not Assessed
Bombax insigne Wall		Bombacaceae	Not Assessed
Actephila excels (Dalz.) Muel		Euphorbiaceae	Not Assessed
Baliospermum calycinum Muell		Euphorbiaceae	Not Assessed
Breynia retusa (Dennst) Alston		Euphorbiaceae	Not Assessed
Bridelia pubescens Kurz		Euphorbiaceae	Not Assessed
Croto roxburghii Balakrishnan		Euphorbiaceae	Not Assessed
Euphorbia hypervifolia Linn.		Euphorbiaceae	Not Assessed
Homonoia riparia Lour.		Euphorbiaceae	Not Assessed
Phyllanthus emblica Linn		Euphorbiaceae	Not Assessed
P. virgatus G. Furst		Euphorbiaceae	Not Assessed
Ricinus communis Linn	*Kege*	Euphorbiaceae	Not Assessed
Securinega virosa (Roxb & Willd) Bail		Euphorbiaceae	Not Assessed
Garcina cowa Roxb	*Heibung*	Guttiferae	Not Assessed
Combretem ovalofoium Roxb		Combretaceae	Not Assessed
Vaccinium graiffithianum Wight		Vacciniaceae	Not Assessed
Callistemon linearis DC		Myrtaceae	Not Assessed
Osbeckia nutans Wall		Melastomaceae	Not Assessed
Sonerila stricta Hook		Melastomaceae	Not Assessed
Daubanga grandiflora (Roxb. ex DC) Walp		Lythraceae	Not Assessed
Celastrus stylosus		Calastraceae	Not Assessed
Rhamnus nepalensis (Wall) Lawson		Rhamineceae	Not Assessed
Cissus javanica DC		Vitaceae	Not Assessed
Tetrastigma bracteolatum (Wall) Plench		Vitaceae	Not Assessed
Vitis vinifera Linn.		Vitaceae	Not Assessed
Leea edgeworthii Santapou		Leeaceae	Not Assessed
Boenninghausenia albiflora (Hook) Reichneb		Rutaceae	Not Assessed
Citrus maxima (Burm) Merr	*Nowab*	Rutaceae	Not Assessed
C. media Linn.	*Heizang*	Rutaceae	Not Assessed
Paramigynna armata oliv		Rutaceae	Not Assessed
Zanthoxylum acanthospodium DC		Rutaceae	Not Assessed
Z. armatum DC		Rutaceae	Not Assessed
Rhus semilata Murrey		Anacardiaceae	Not Assessed
Spondias pinnata (L.f.) Kruz		Anacardiaceae	Not Assessed
Catharanthus roseus (Linn.) G. Don		Apocynaceae	Not Assessed
Nerium indicum Mill		Apocynaceae	Not Assessed
Thevetia peruviana (Pers) K Schum		Apocynaceae	Not Assessed
Calotropis giganties (Wild). Aitf		Ascelecediaceae	Not Assessed
Agrostemma sarmentosum Wall		Rubiaceae	Not Assessed
Coffea Arabica Linn.		Rubiaceae	Not Assessed
Gardenia jasminoides Ellis.		Rubiaceae	Not Assessed

Botanical Name	Local Name (Common Name)	Family	IUCN Status
Hedyotis biflora (Linn.)		Rubiaceae	Not Assessed
Hedyotis lineate Roxb		Rubiaceae	Not Assessed
Meyna spinosa Roxb	*Heibi*	Rubiaceae	Not Assessed
Mussaenda incana Wall.		Rubiaceae	Not Assessed
Ophiorrhiza mungos Linn.		Rubiaceae	Not Assessed
Paveta brunmsis Linn.		Rubiaceae	Not Assessed
Pavetta subapitata Hook		Rubiaceae	Not Assessed
Spirendiclis cylindrical Wall.		Rubiaceae	Not Assessed
Wendlandia glabra DC		Rubiaceae	Not Assessed
Holmskioidea sanguine Retz		Verbenaceae	Not Assessed
Lantana camara Linn		Verbenaceae	Not Assessed
Premna coriacea (B. Clarke)		Verbenaceae	Not Assessed
Pygmaeopremna berbaceae (Roxb) Moldenka		Verbenaceae	Not Assessed
Stachytarpheta jamaicensis (Linn.) Vahl		Verbenaceae	Not Assessed
Tectona grandis Linn.		Verbenaceae	Not Assessed
Clematis gouriana Roxb		Ranuculaceae	Not Assessed
Stephania japonica (Thunb.) Meir		Menispermeae	Not Assessed
Papaver orientale Linn.		Papaveraceae	Not Assessed
Capsella bursa pastoris (Linn) Medikus		Brassicaceae	Not Assessed
Cardamine hirsute Linn		Brassicaceae	Not Assessed
Rorippa indica (L.) Hochreut		Brassicaceae	Not Assessed
Stellaria aquatica (Linn.) Scop		Caryophyllaceae	Not Assessed
Fagopyrum eslentum Moench		Polygonaceae	Not Assessed
Muchlenbeckia platyclades (Muell) Meissn		Polygonaceae	Not Assessed
Polygonum capitatum Auch Hum.		Polygonaceae	Not Assessed
Polygonum chinense Linn.		Polygonaceae	Not Assessed
P. orientale Linn		Polygonaceae	Not Assessed
P. tubulosum Boiss		Polygonaceae	Not Assessed
Rumex nepalensis Spreng		Polygonaceae	Not Assessed
Chenopodium album Linn.		Chenopodiaceae	Not Assessed
Altenenthera sessilis (Linn) R. Br.		Chenopodiaceae	Not Assessed
Amaranthus viridis Linn.		Amaranthaceae	Not Assessed
Celosia argentea Linn.		Amaranthaceae	Not Assessed
C. polygonoides Reitz.		Amaranthaceae	Not Assessed
Cyathula capitata DC		Amaranthaceae	Not Assessed
Gompherena globosa Linn.		Amaranthaceae	Not Assessed
Ludwigia adscendens (Linn.) Hore		Onagraceae	Not Assessed
Plantago erosa Wall.		Plantaginaceae	Not Assessed
Eryngium foetidum Linn.		Apiaceae	Not Assessed
Hydrocotyle himalaica P.K. Mukherjee		Apiaceae	Not Assessed
H. sibthorpiodes Lam		Apiaceae	Not Assessed
Peucedenum dhana Wall		Apiaceae	Not Assessed
Agerratum coyzoides Linn.		Asteraceae	Not Assessed
Ambrosia artemsifolia Linn.		Asteraceae	Not Assessed
Artemisia indica Willd.		Asteraceae	Not Assessed
Bidens pilosa Linn.		Asteraceae	Not Assessed
Blumea aromatic DC		Asteraceae	Not Assessed
B. balsamifera (Linn) DC		Asteraceae	Not Assessed
Blepharis boerhaaviaefolia Pers.		Acanthaceae	Not Assessed
Eranthemum pulchellum Andrews		Acanthaceae	Not Assessed
Gymnostachyum glabrum T. Anders		Acanthaceae	Not Assessed

Botanical Name	Local Name (Common Name)	Family	IUCN Status
Justicia diffusa Wild		Acanthaceae	Not Assessed
Nelsonia canescens Datz.		Acanthaceae	Not Assessed
Thunbergia alata Bujer		Acanthaceae	Not Assessed
T. grandiflora (Roxb ex. Rottl) Roxb.		Acanthaceae	Not Assessed
Impatiens balsamifera Linn.		Balsaminaceae	Not Assessed
I. Tomentosa Heyne		Balsaminaceae	Not Assessed
Heliotropium indicum Linn.		Boraginaceae	Not Assessed
Rhabdia lycioides Mart		Boraginaceae	Not Assessed
Clinopodium umbrosum (M. Bieb) C. Kah		Labiatae	Not Assessed
Eusterelis cruciata (Benth) Panigrahi		Labiatae	Not Assessed
Epimeedi indicus (Linn) Rotham		Labiatae	Not Assessed
Gomphostema niveum Hook f.		Labiatae	Not Assessed
G. wallichi Prain		Labiatae	Not Assessed
Leonurus japonicas Houtt.		Labiatae	Not Assessed
Nepeta leucophylla Benth.		Labiatae	Not Assessed
Rhabdosia scrophularioides (Wall ex. Benth)		Labiatae	Not Assessed
Salvia plebeja R. Br.		Labiatae	Not Assessed
S. saxicola Wall.		Labiatae	Not Assessed
Scutellaria assamica Mukherjee		Labiatae	Not Assessed
S. rivularis Wall		Labiatae	Not Assessed
Cyanotis vaga(Lour) J.A. & J.H Schultes		Commelinaceae	Not Assessed
Hedychium marginatum Clarke		Zingiberaceae	Not Assessed
Hedychium coronarium koeing		Zingiberaceae	Not Assessed
H. thyrsiforme Buch		Zingiberaceae	Not Assessed
Zingber officinale Losc		Zingiberaceae	Not Assessed
Alpinia calcarata Rose		Zingiberaceae	Not Assessed
A. nigra (Gaertn) B.L. Burtt		Zingiberaceae	Not Assessed
Curcuma angustifolia Roxb		Zingiberaceae	Not Assessed
C. caesa Roxb		Zingiberaceae	Not Assessed
B. fistulosa (Roxb) Kurz		Asteraceae	Not Assessed
B. hieraciifolia (D. Don) DC		Asteraceae	Not Assessed
B. lacera (Burmt.) Mar		Asteraceae	Not Assessed
Carthamus tinctorius Linn.		Asteraceae	Not Assessed
Cetipeda minima (Linn) A. Br. and Aschers		Asteraceae	Not Assessed
Chrysanthemum indicum Linn.		Asteraceae	Not Assessed
Conyza angustifolia Roxb.		Asteraceae	Not Assessed
C. striata Willd		Asteraceae	Not Assessed
Cyathocline purpurea (Buch-Ham ex. D. Don)		Asteraceae	Not Assessed
Dicrocephala integrifolia (L.f.) O. Kuntze		Asteraceae	Not Assessed
Emilia sonchifolia DC Var. Scabra Hooker		Asteraceae	Not Assessed
Eupatorium adenophorum Spreng		Asteraceae	Not Assessed
E. odoratum Linn.		Asteraceae	Not Assessed
Gallinsoga parviflora Cav.		Asteraceae	Not Assessed
Inula barbata Wall. Ex. DC		Asteraceae	Not Assessed
I. eupatoriodes DC		Asteraceae	Not Assessed
Lactuca sativa		Asteraceae	Not Assessed
Laggera alata (D. Don)		Asteraceae	Not Assessed
Sclerocarpus africanus Jacq		Asteraceae	Not Assessed
Senecio scendens Buch Ham.		Asteraceae	Not Assessed
Sieges beckia orientalis Linn		Asteraceae	Not Assessed
Sochus oleraceus Linn.		Asteraceae	Not Assessed
Synedrella nodiflora (Linn) Gaertn.		Asteraceae	Not Assessed

Botanical Name	Local Name (Common Name)	Family	IUCN Status
Tagetes patuna Linn.		Asteraceae	Not Assessed
Veronia aspera Buch-Ham		Asteraceae	Not Assessed
V. cinerea (Linn.) Less		Asteraceae	Not Assessed
Zinnia elegans Jacq		Asteraceae	Not Assessed
Nicotiana tobacum Linn.		Solanaceae	Not Assessed
Physalis minima Linn		Solanaceae	Not Assessed
Solanum nigrum Linn.		Solanaceae	Not Assessed
Lindernia allioni		Scrophulariaceae	Not Assessed
Stemodia viscose Roxb.		Scrophulariaceae	Not Assessed
Acanthus leucostachys Wall. ex. Nees		Acanthaceae	Not Assessed
C. domestica Valeton		Zingiberaceae	Not Assessed
C. reclinata Roxb		Zingiberaceae	Not Assessed
C. flaccid Sal.		Cannaceae	Not Assessed
C. indica Linn		Cannaceae	Not Assessed
Dianelia nemorosa Lamk		Liliaceae	Not Assessed
Streptopus simplex		Liliaceae	Not Assessed
Smilax roxburghiana Wall		Smilacaceae	Not Assessed
Colocasia esculenta (Linn) Schott		Araeae	Not Assessed
Lasia spinosa (Linn) Thw		Araeae	Not Assessed
Pothos cathcartii Schott		Araeae	Not Assessed
Dioscorea kamoonesis Kunth		Dioscoreaceae	Not Assessed
Areca catechu Linn.		Palmae	Not Assessed
Caryota sp.		Palmae	Not Assessed
Phoenix sylvestris (Linn)		Palmae	Not Assessed
Pandanus furcatus Roxb		Pandanaceae	Not Assessed
Dendrobium chrysotoxum Lindl.		Orchidaceae	Not Assessed
D. densiflorum Lindl.		Orchidaceae	Not Assessed
Habenaria prainii Hook f.		Orchidaceae	Not Assessed
H. suaveolens Dalz		Orchidaceae	Not Assessed
Carex indica Linn.		Cyperaceae	Not Assessed
Cyperus diffuses Vahl		Cyperaceae	Not Assessed
Fimbrostyllus diphylla (Retz) Vahl		Cyperaceae	Not Assessed
Bambusa balcooa Roxb		Poaceae	Not Assessed
B. burmanica Gamble		Poaceae	Not Assessed
B. pallid Roxb		Poaceae	Not Assessed
Cynodon dactylon (L) Pers		Poaceae	Not Assessed
Dinochloa compactiflora (Kurz) McClore		Poaceae	Not Assessed
Pogonatherum crinitum (Thunb.) Kunth.		Poaceae	Not Assessed
Thysanolaema maxima (Roxb) Kuntze		Poaceae	Not Assessed

2. Endangered and Protected Flora

199. Some of the important rare and endangered floral species in the protected areas[13] along the project road are *Tectona grandis, Dipterocarpus turbinatus, Dipterocarpus tuberculaus,* Melonarrhoea usitata, Duabanga Sonnoroedes, Dillenia pentagyna, Terminallia tomentosa, Gmelina arborea, Bauhinia spps., some species of bamboos, orchids, etc.

[13] Source: Management Plan of the Yangoupokpi Lokchao Wildlife Sanctuary prepared by Wildlife Division of Manipur.

200. Local forest department were consulted to know the presence of any endangered and protected species of flora within the formation width. It is confirmed by the forest department officials that there are no endangered species which are likely to be affected by current project.

201. Joint inspection is being carried out with field officials from the local forest department to prepare the detailed inventory and marking of the trees to be cut. During the joint inspection, if any endangered and or protected species of flora found within the formation width of the subproject road, necessary mitigation measures will be adapted to protect such species.

202. Also based on the joint inspection, a suitable compensatory afforestation plan will be prepared to mitigate loss of vegetative cover due to the subproject activities.

3. Wildlife and Protected Area Network

203. The State has rich wildlife and has long network of protected areas. In order to protect the rich flora and fauna of Manipur from the poacher, the Government has established parks and sanctuaries. The state's protected area network comprises of five wildlife sanctuaries and two national parks. Recognizing the importance of this region as one of the hot spots, majority of the biodiversity rich areas of the state has been placed inside the protected area network system comprising mainly of the National Park and Sanctuary.

204. In the State, conservation of wildlife is carried out in two categories as ex-situ conservation and in-situ conservation.

205. **Ex-Situ Conservation**: The wildlife is located/ transported from their natural habitat to an area well protected from outside elements and preserved there. An example of this category is the Manipur Zoological Garden at Iroishemba, Orchid Preservation Centre at Khonghampat, Arboretum etc.

206. **In-Situ Conservation**: Areas having adequate natural flora and fauna are declared as National Parks and Wildlife Sanctuaries. They are known as the Protected Areas Networks (PAN). The entry of human and cattle inside the area is strictly under control. No dead, dying or diseased plants can be removed from such areas. The examples of this category are the Keibul Lamjao National Park and Yangoupokpi Lokchao Wildlife Sanctuary.

207. The details of sites are given in Table 42. Figure 23 show the protected area map of the Manipur. The total area under the protected area network is 1 percent of total geographical area of state and that of under national parks is 0.2 percent.

Table 42: Protected Area Network in the State of Manipur

Sl.	Protected Area	Location (District)	Area in sq.km
A.	**In-situ Conservation Sites**		
1	Keibul Lamjao National Park	Keibul Lamjao (Bishnupur Dist.)	40.00
2	Yangoupokpi Lokchao Wildlife Sanctuary	Lokchao (Chandel Dist.)	184.80
3	Shiroi Hill National Park	Ukhrul (Ukhrul Dist.)	41.00
4	Kailam Wildlife Sanctuary	Churachandpur Dist.	187.50
5	Jiri-Makru Wildlife Sanctuary	Tamenglong Dist.	198.00
6.	Bunning Wildlife Sanctuary	Tamenglong Dist.	115.80
7.	Zeliad Wildlife Sanctuary	Tamenglong	21.00
B.	**Ex-site Conservation Sites**		
1	Manipur Zoological Garden	Iroisemba, Imphal West	0.08
2	2nd Home SANGAI	Iroisemba, Imphal West	0.60

Sl.	Protected Area	Location (District)	Area in sq.km
3	Orchid Preservation Centre	Khonghampat, Imphal West	0.50

Source: Statistical Booklet of Manipur Forest (2008-2009), Wildlife Wing, Forest Department, Government of Manipur

208. In the state, in spite of its rich vegetation, due to the absence of any forest worth the name within the district wild animals are not found abundantly, Deer and Jungle fowl are some of the varieties found at present occasionally along the slope of eastern hills adjoining the district. But the lakes support a variety of wild birds such as partridge, snipe, duck, geese, etc. particularly in winter months. These birds are mostly migratory in character. Some of them are seen coming from far off Siberia. With the gradual conversation of the lakes into agricultural lands these migratory birds are seen in increasingly fewer members in recent times.

209. There are no protected areas along the project road. Nearest protected area is Yangoupokpi Lokchao Wildlife Sanctuary, which is 8.45 km away from the end point of the subproject road (i.e. km chainage 395.68).

210. The Yangoupokpi Lokchao Wildlife Sanctuary has a diverse assemblage of wildlife harbouring many species of mammals, birds, reptiles & amphibian, fishes and insects. The main Carnivores are Leopard, Jungle cat, Jackal, Mongoose, Civet cat, Fox, etc. The main Herbivores are Sambar, Deer, Wild boar, Monkey, etc. Among the small Mammals, Langur, Porcupine, Pangolins are to be mentioned. Hoolock gibbon and Serrow are rare and endangered ones. The Reptilian fauna is represented by Cobra, Krait, Tree-boa, Python, Lizards, Water monitor lizards, Tortoise, Tokke gekko, etc. Avian fauna is represented by Burmese peafowl, Moorhen, Blyth‟s tragopan, Mrs. Hume‟s bar-backed pheasant, Red Jungle fowl and 3 species of Hornbills viz. Great Indian Hornbill, Rufous-necked hornbill, Wreathed hornbill, etc. The stamp-tailed Macaques are also found. Many seasonal colourful birds also visit the sanctuary. And there is the seasonal migration of elephants from Myanmar plains to the sanctuary during paddy harvesting season i.e. August to September every year. Many of the above species of wildlife are becoming rarer and rarer due to substantial increase in human and domestic cattle population, large scale de-forestation, shifting cultivation and poaching including illegal trading of wildlife parts. It has been observed that various factors like vegetation, terrain, water and biotic pressure, etc. greatly influence the habitat preference of wild animals inhabiting in the Protected Area of YLWLS.

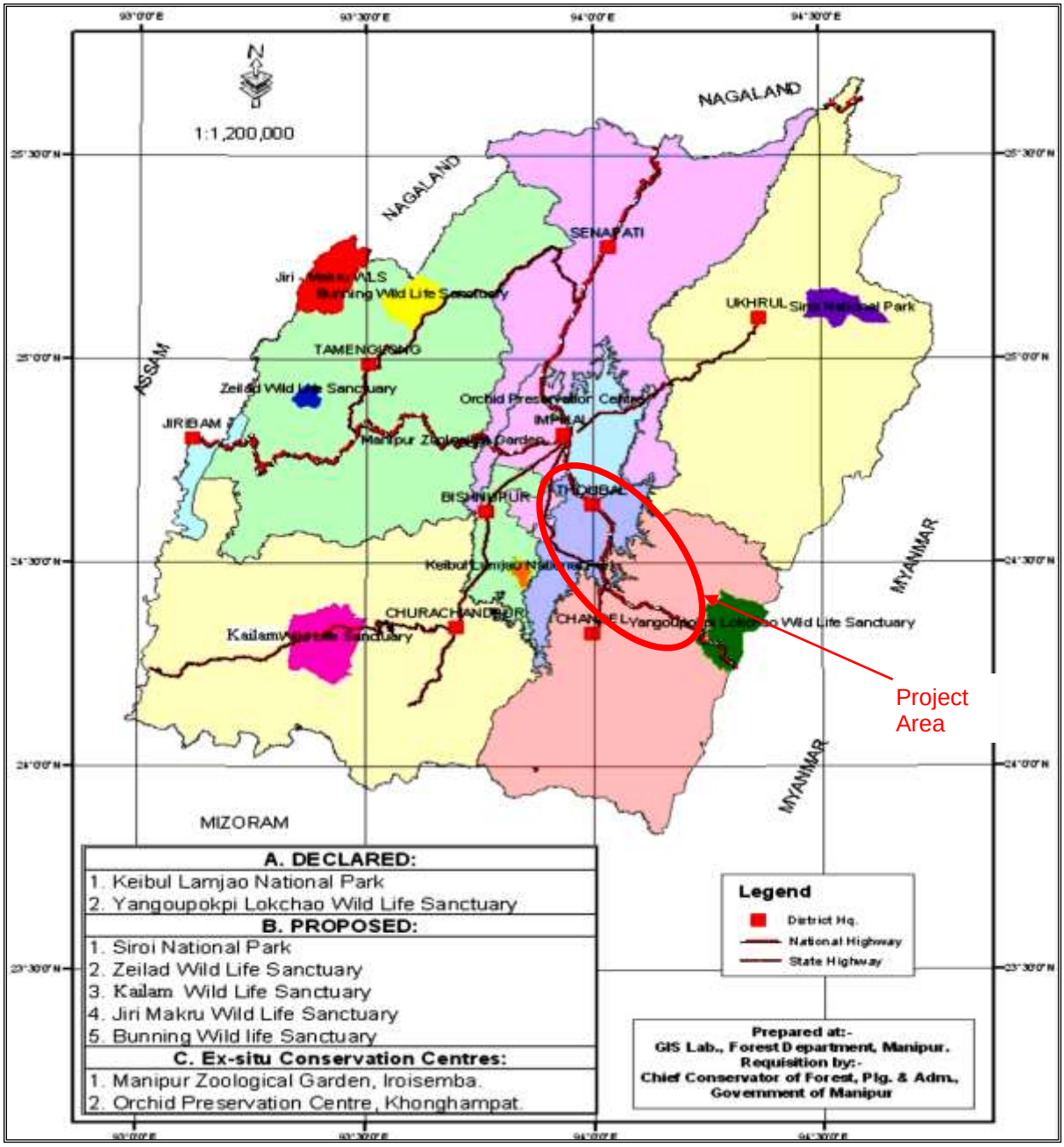
211. The habitat quality is reflected by the abundance of the prey species. The prey base is the most crucial requirement for the survival of a thriving population of predators. Habitat use in the YLWLS is presented in Table 43.

Table 43: Habitat use in the YLWLS

S. No.	Kind of animal	Shelter	Loafing ground	Travel lane
1	Sambar	Dense wet deciduous riverine forests on hill slopes	Denser patches close to water	Mixed deciduous areas along upper hill slopes
2	Leopard	Wet and mixed deciduous forest areas	As above	Hilly slopes of open scrub forests
3	Fox	Open deciduous Scrub forest	Bushy areas	Barren scrub areas
4	Jackal	-do-	Bushy areas and waterholes	Flat tracts and open scrubs
5	Jungle Cat	Wet deciduous and mixed forest	Flat area and water holes	Scrubby, grassy trails

6	Wild Boar	Wet deciduous scrub and teak forest	Flat and gentle undulating areas	Deciduous forest areas
7	Monkey	Deciduous forest mixed forests	Deciduous forests	Upper & middle storey trees
8	Porcupine	Rocky lower hill sides	Deciduous forest areas	Uses rough roads & trails
9	Pangolin	Open deciduous scrubs over grazed areas	Areas with ant hills	In dry nalahas & scrubby open forest

Source: YLWLS Management Plan (2012-13 to 2021-22)



Source: Wildlife Wing, Forest Department, Government of Manipur

Figure 23: Protected Area Map of Manipur State

212. A transact walk field survey on mammals was conducted along the proposed subproject road alignment particularly on the 22.9 km section of the AH-1 (not a part of subproject road) within YLWLS with critical wildlife habitat area during the field surveys in the second quarter of 2014 and also in 2016. Information and evidences on mammals were collected. Also data from wildlife census conducted by Forest Department in YLWLS were used to assess the status of wildlife habitat in the project areas.

213. Informal interviews were held with the local villagers, livestock herders to gather information on the status of wildlife and their habitats. Information on cattle depredation, crop damage by wild animals, incidences of road accidents involving wild animals was also collected during informal interviews.

214. Officials from Wildlife division including Chief Wildlife Warder, Chief Conservator of Forests and Field officers of YLWLS were also consulted in the process.

215. As a result of surveys and consultations, it was found that the project area (mainly section of AH-1 in YLWLS) has faunal species of Samber, leopard, fox, jackle, jungle cat, wild boar, monkey (langur), parpupine, pangolin.

216. Besides these species, it is reported that the protected area of YLWLS (core zone) has rare and endangered faunal species which include Mammals: Hoolock gibbon, Malayan Sun Bears, Serow, Pangolins, and Macaques; Birds: Hornbills, Mrs Hume's bar-backed pheasant, Blyth's tragopan, Burmese peafowl; Reptiles & Amphibians: King cobra, Monocle cobra, krait, Rock pythons, Monitor lizards, Tokke gokko, Leaf Turtle, a number of frogs which includes species of genus Cylemys Polypedates, Fajerverya and Hoplobatrachus,etc.

217. Office of the Wildlife Warden (Manipur) informed that there is no specific information available about wildlife movement corridors and wildlife migratory routes along national highway section (AH-1). Wildlife movement is mostly limited to the core zone of the sanctuary and along the rivers/streams within sanctuary. The sanctuary has an existing natural wildlife corridor between eastern part of sanctuary and adjoining Myanmar border. Seasonal migration of wildlife including Asian Elephant were reported through this corridor. However there is no record of wildlife movement across project road. Local communities also informed that they rarely noticed movement of animals across the national highway. Some of the people consulted indicated that they occasionally (once in a week or less) spot small animals such as langur crossing the national highway. Also there is no history of road accident involving wild animals on national highway section.

218. Table 44 present the faunal species in the protected areas of YLWLS and its IUCN status. It is found that none of the endangered or rare specific of wildlife will be impacted from the proposed project activities since movement of endangered species are mostly limited to core zones of the sanctuary.

Table 44: Faunal Species Recorded in the Project Area

Scientific Name	*Local Name (Common Name)*	IUCN Status
FISHES		
Acantopsis choirorhynchus (Blecker)	*Chingngakrichou*	Not assessed
Catla catla (Ham.)	*Catla*	Not assessed
Silurus morehensis Arun Kr & Tombi Singh	*Ching-Ngaten*	Not assessed
Tetraodon cucutla. (Ham)	*Hnagoi-nga*	Not assessed

Scientific Name	*Local Name (Common Name)*	IUCN Status
Anguilla bengalensis bengalensis Gr. & Harol	*Ngaril leina*	Not assessed
Amblycep mangois Ham	*Ngaril leina*	Not assessed
Chanda nama Ham.	*Ngamhai*	Not assessed
Aorichthys aor (Ham)	*Ngachou*	Not assessed
A. scenghala (Syke)	*Ngachou*	Not assessed
Mystus bleckeri (Day)	*Ngasep*	Not assessed
M. menoda (Ham.)	*Ngasep*	Not assessed
M. microphthalmus (Day)	*Nganan*	Not assessed
Rita rita (Ham.)	*Nganan*	Not assessed
Xenontodon cancilla (Ham.)	*Ngacheklaobi*	Not assessed
Colisa fasciatus (Schn.)	*Ngapemma*	Not assessed
Channa marulius Bloch & Schn	*Ngamu gojar (Snake head)*	Not assessed
Aspidoparia morar (Ham)	*Ngarang*	Not assessed
Barilius dogarsinghi (Hora)	*Ngawa*	Not assessed
B. barnoides Vinciguerra	*Ngawa*	Least Concern
Chela laubuca (Ham)	*Ngasang*	Not assessed
Cirrhinus reba (Ham)	*Ngaton*	Not assessed
Chagunius nicholsi (Myers)	*Ngawameingbi*	Not assessed
Danio naganensis (Chandhuri)	*Ngasang*	Not assessed
D. yunsis Arun Kr & Tombi Singh	*Ngasang*	Not assessed
Exomus danricus (Ham)	*Ngasengum*	Not assessed
Garra gavelvi (Annandelei)	*Ngasengum*	Not assessed
G. gotyla gotyla (Gray)	*Ngasengum (Pattar Chat)*	Not assessed
Labeo calbarasu (Ham)	*Ngathi*	Not assessed
L. pangusia (Ham.)	*Ngathi*	Not assessed
Neollissochilus hexagonolepsis (Mecl.)	*Ngara*	Not assessed
Oxteobrama Cotio cunma (Day)	*Ngaseksa*	Not assessed
Poro sarana Orphoides (Ham.)	*Ngahou*	Not assessed
P. meinganbi Arunkr. & Tombi Singh	*Ngakhameingabi*	Not assessed
P. yuensie Arunkr. & Tombi Singh	*Ngakhahangampal*	Not assessed
Parluciosoma daniconius (Ham.)	*Ngasanpokchaobi*	Not assessed
Tor putitora (Ham.)	*Nunga (Golden Mahsheer)*	Not assessed
T. tor (Ham.)	*Nunga*	Not assessed
Glossogobius giuris (Ham.)	*Nailon-ngamu*	Not assessed
Aeanthocabitis botia (Ham.)	*Ngatup*	Not assessed
Schistura manipurensis Chandhuri	*Ngatup*	Not assessed
S. praschadi Hora	*Ngatup*	Not assessed
S. vinciguerrae Hora	*Ngatup*	Not assessed
Mastacembelus armatus Lacepede	*Ngaril*	Not assessed
M. alboguttatus Boulenger	*Ngaril*	Not assessed
Macrognathus pancalus Ham.	*Ngaril macha*	Not assessed
M. moreehensis Arunkr. & Tombi Singh	*Ngamoitup*	Not assessed
Badis badis (Ham.)	*Nga-Sakthibi*	Least Concern
Psilorphynhus manipurensis Vishwanath	*Nga-Sakthibi*	Not assessed
Bagarius bagarius (Ham.)	*Ngarel*	Not assessed
Gagata cenia. Cenia (Ham.)	*Ngarang*	Not assessed
Gluptothorax cavia Ham.	*Ngapang*	Not assessed
G. pectinopterus (Mccl.)	*Ngapang*	Not assessed
G. sinense Regan	*Ngapang*	Not assessed
G. trilineatus Blyth	*Ngapang*	Not assessed
Channa orientalis (Ham.)	*Meitei-ngamu*	Not assessed
Amblypharyngodon mola (Ham.)	*Muka-nga*	Not assessed

Scientific Name	*Local Name (Common Name)*	IUCN Status
Cirrhinus mrigala. (Ham.)	*Mrigal*	Not assessed
Cyprinion semplotum (Mccl.)	*Maku-nga*	Not assessed
Labeo bata (Ham.)	*Khabak*	Not assessed
Labeo rohita (Ham.)	*Rou*	Not assessed
Botia berdmorei (Blyth)	*Sarengkhoibi*	Not assessed
B. histronica (Blyth)	*Sarengkhoibi*	Not assessed
Wallago attu (Schneider)	*Sareng*	Not assessed
Osteobrama belangeri (Val.)	*Pengba*	Not assessed
Poro sophore (Ham.)	*Phabounga*	Not assessed
AMPHIBIANS		
Polypedates leucomystax Gavenhorst	*Hangoi tangsang*	Not assessed
Bufo melasnotictus Schneider	*Hangoi borbi*	Not assessed
Hyla annectan Jerdon	*Laphu-hanoi*	Not assessed
R. breviceps Schneider	*Labuk-hangoi*	Not assessed
Rana tigerina Daudin	*Moreh-hangoi*	Not assessed
Rana limnocharis Boie	*Narak-hangoi*	Not assessed
REPTILES		
Rhabdop bicolar Schiegel	*Ching-Kharou*	Not assessed
Hemidactylus bowringi Gray	*Chum*	Not assessed
Varanus bengalensis Daudin	*Hang-kok*	Not assessed
V. Salvator Laurenti	*Hang-kok*	Not assessed
Ophiophagus Hannah	*Ishing-kharou*	Not assessed
Naja naja Kauthia Linnaeus	*Kharou (Monocled Cobra)*	Least Concern
Amphiesma stolata Linn	*Linha*	Not assessed
Natrix himalayana Gunther	*Linha*	Not assessed
N. Punetulata Gunther	*Linha*	Not assessed
Oligodon albocinctus Cantor	*Linkhak*	Not assessed
Xenochrophis piscator Schineider	*Lilabob*	Not assessed
Bungarus fasciatus Schineider	*Linkhak*	Not assessed
Python molurus bivittatus Schlegel	*Lairen (Indian Python)*	Lower Risk/ Near threatened
P. reticulates Schneider	*Lairen (Oriental Rat snake)*	Not Assessed
Ophisaurus gracilis Boulenger	*Lin-makhongpanbi*	Not assessed
Boiga ochracea Walli Smith	*Naril-asangba*	Not assessed
Opheodrys doriae Boulenger	*Naril*	Not assessed
Calotes versicolor Daudin	*Numit yungbi (Changeable Lizard)*	Not assessed
C. jerdoni Gray	*Numit yungbi*	Not assessed
C. microlepsis Boulenger	*Numit yungbi*	Not assessed
C. mystaceus Dumeril & Bibon	*Numit yungbi*	Not assessed
Mabuya novemcarinata (Anderson)	*Sharit*	Not assessed
M. multifasciata (Schneider)	*Sharit*	Not assessed
Ptyas korros Schlegel	*Tanlei (Oriental Rat snake)*	Not assessed
Trionyx hurum. Gray (Lokchao river)	*Thengu-arangbi*	Not assessed
Typhlos braminus Cuv.	*Timul-napun*	Not assessed
AVES		
Acridotheres tristis tristis (Lin.)	*Chong-nga*	Not assessed
A. albocinctus Godwin A. & Walden	*Chong-nga*	Not assessed
A. focus (Wagler)	*Chong-nga*	Not assessed
Sturnus centra Superciliaris (Blyth)	*Chonga-thijabi*	Not assessed
S. malabaricus (Gmelin)	*Chonga-thijabi*	Not assessed
Dicrurus adsmiles albrictus (Hodgson)	*Charoi*	Not assessed
Upupa epops longirostris Jerdon	*Chongaraba*	Least Concern
Aecipitter badius (Gmelin)	*Khunukharang*	Not assessed

Scientific Name	*Local Name (Common Name)*	IUCN Status
Pandion hallactus hallactus (Linnaeus)	*Khunukharang*	Not assessed
Treron phoenicaptera (Lathani)	*Khunu asangba*	Not assessed
Corvus macrorhynchus levaillantii Lesson	*Kwak*	Least Concern
Eudynamis scolopaceus (Linnaeus)	*Kokil*	Not assessed
Motacilla alba (Lin)	*Khambrangehak*	Least Concern
M. caspica (Gmelin)	*Khambrangehak*	Least Concern
Pcynonotus jocosus monticola (Mccl)	*Khoining*	Not assessed
P. cafer cafer (Lin.)	*Khoining*	Not assessed
Francolinus pintadaenus phayrei	*Kabo-urenbi*	Not assessed
Streptopelia chinensis (Scopoli)	*Lam-Khunu*	Least Concern
S. tranquebarica (Hermann)	*Lam-Khunu*	Not assessed
S. decaoto (Frivaldszky)	*Lam-Khunu*	Not assessed
S. senegalensis (Linnaeus)	*Lam-Khunu*	Not assessed
Treron pompadora phayarei (Blyth)	*Lam-Khunu*	Not assessed
T. bicineta (Jerdon)	*Lam-Khunu*	Not assessed
Gallus gallus spadiceus (Bonnaterre)	*Lam-Khunu*	Least Concern
Polypectron bicalcaratum bakeri Lowe	*Lamyel*	Least Concern
Otus bakkamoena maniprensis Roonwal & Nath	*Layel*	Least Concern
Tyto capensis longimembris (Jerdon)	*Maku*	Not assessed
Corcacias benghalensis (Linnaeus)	*Maku*	Not assessed
Prinia socialis Sykes	*Mayang kwak*	Not assessed
Lonchura malacca (Linnaeus)	*Mongtit*	Not assessed
L. maiabarica (Linnaeus)	*Mongba*	Not assessed
L. punetulata (Linnaeus)	*Mongba*	Not assessed
L. striata (Linnaeus)	*Mongba*	Not assessed
Centropus sinesis intermedius (Hume)	*Nong-guo-bi*	Not assessed
Halcyon smyronnsis perpul chra Madarasz	*Ngarakpi*	Not assessed
Ceryle rudis leucomclanura Reichenbach	*Orit achouba (Pied Kingfisher)*	Least Concern
Turdoides caudatus (Dumont)	*Orit achouba*	Not assessed
T. strintus (Dumont)	*Orit achouba*	Not assessed
Pellorneum ruficeps Swnisson	*Orit achouba*	Not assessed
Monticola solitarius (Linnaeus)	*Orit achouba*	Least Concern
Picoides cathpharius pyrrothorax (Hume)	*O-tubi*	Not assessed
Jynx torquilla Linnaeus	*Oophak-ohabi*	Not assessed
Buho nipalensis nipalensis Holgsin	*Oorak-maku*	Not assessed
Zosterops palpebrosa (Temminek)	*Oorit Mtlaobi*	Not assessed
Lanius excubiator (Linneaus)	*Oori Mitlaobi*	Not assessed
Saxicoloides fulicata (Linneaus)	*Robin*	Not assessed
Copsychus saularis (Linneaus)	*Robin achouba (Oriental Magpie Robin)*	Least Concern
Aegithina tiphia (Linneaus)	*Shoubeega*	Not assessed
Hirundo dauria (Lin)	*Sembrang*	Not assessed
H. concolar sykes	*Sembrang*	Not assessed
Apus affinis (J.E. Gray)	*Sembrang (House Swift)*	Least Concern
Coturnix coturnix (Lin)	*Sorbol*	Not assessed
Passer montanus (Lin)	*Sendrang*	Not assessed
Alausda gulgula (Franklin)	*Tinkhaklen*	Not assessed
Psittacula eupatria avensis (Kloss)	*Tenawa*	Not assessed
P. krameri borealis (Neumann)	*Tenawa*	Not assessed
P.K. manillensis (Bechstein)	*Tenawa*	Not assessed
Emcurus schistaceus (Hodgson)	*Uchinao*	Not assessed
Francolinus francolinus (Lin)	*Urel*	Not assessed

Scientific Name	*Local Name (Common Name)*	IUCN Status
Amaurornis phoenicurus phoenicurus(Penant)	*Uren-konthou*	Not assessed
Milvus migrans govinda . Sykes	*Umaibi*	Not assessed
Spilornis chela chela (Latham)	*Umaibi-limphabi (Crested Serpent Eagle)*	Least Concern
Saxicola caprata. (Linneaus)	*Warak Sendrang*	Not assessed
Bambusicola fytechii hopkinsonii Godwon-Austen	*Wakhrek*	Not assessed
Lophura leucomelana lathami (J.E Gray)	*Waba (Kalij Pheasant)*	Least Concern
Pavo muticus specife Shaw & Nodder	*Wahong asangba*	Not assessed
MAMMALS		
Paradoxurus hermaphrodites (Pallas)	*Chahelo manam nimbi (Common Palm Civet)*	Lower Risk
Vulpes bengalensis (Shaw)	*Keishal (Bengal Fox)*	Lower Risk
Felis bengalensis. Kerr	*Keijenlang (Leopard Cat)*	Lower Risk
Felis marmorata charl toni Gray	*Keijeng (Marbled Cat)*	Vulnerable (VU)
F. temmineki Vigros & Horsefield	*Keimu*	Not assessed
Funambulus pennati (Wroughton)	*Kheiroi-achouba*	Not assessed
Petaurista petaurista (Paslas)	*Kheiroi-apaibi*	Not assessed
Bos gaurs H. Smith	*Lamsan (Gaur)*	Vulnerable (VU)
Canis aureus Lin.	*Lamhui*	Not assessed
Felis chaus Guldenstaedt	*Lamhoudong (Jungle Cat)*	Lower Risk
Arctictis binturong (Raffles)	*Lam-ok-macha*	Not assessed
Sus scorfa Lin	*Lam-ok (Wild Pig)*	Lower Risk
Prionodon perdicolor Hodgson	*Linsang*	Not assessed
Arctictis binturong (Raffles)	*Linsang*	Not assessed
Petaurista alborufus candidulus wroughton	*Kheiroi-apaibi*	Not assessed
Panthera pardus Linn.	*Kabokei (Leopard)*	Lower Risk
Hylopetes alboniger alboniger (Hodgson)	*Kheiroi-apaibi*	Not assessed
Manis crassicaudata Gray	*Kakchenchabi*	Not assessed
Viverricula indica. (Desmarest)	*Moirang Sathibi macha (Small Indian Civet)*	Vulnerable (VU)
Paguma larvata (Ham & Smith)	*Moirang Sathibi (Gem-faced Civet)*	Least Concern (LC)
Arctonyx collaris Cuvier	*Nung-ok (Hog Badger)*	Near Threatened (NT)
Neofelis nebulosa macrosceloides Hodgson	*Oothak-Keijeng*	Not assessed
Golunda ellioti. Gray	*Oochi (Indian Bush Rat)*	Least Concern (LC)
Mus booduga. Gray	*Oochi*	Not assessed
Rattus manipulus kekrimus Roonwal	*Oochi*	Not assessed
Capricornis sumatraensis (Bechstein)	*Sabeng (Himalayan Serow)*	Vulnerable (VU)
Cervus unicolor equines. Guvier	*Shajal*	Not assessed
Manis pentadactyla aurita (Hodgson)	*Shaphu*	Not assessed
Herpestes urva. (Hodgson)	*Sandung*	Not assessed
Marte-flavigula. (Boddaert)	*Shaji-kurangyai*	Not assessed
Ursus malayanus Raffles	*Sawom*	Not assessed
U. thibetanus Guvier	*Sawom*	Not assessed
Pteropus giganticus (Brunnich)	*Sekpi-achouba*	Not assessed
Pipistrellus coromandra. (Gray)	*Sekpi-macha*	Not assessed
P. paterculus Thomas	*Sekpi-macha*	Not assessed
Eptesicus serotinus. (Schreber)	*Sekpi-macha*	Not assessed

Scientific Name	*Local Name (Common Name)*	IUCN Status
Elephas maximums. Linn.	*Shamu (Asian Elephant)*	Endangered
Muntiocus muntijak (Zimmermann)	*Shaji*	Not assessed
Macaca mulata (Zim.)	*Yong*	Not assessed
Hylobates hoolock (Harlan)	*Yong mu*	Not assessed

C. Socio-economic Environment

1. Demography

219. Manipur is one of the sisters' states in north eastern state a population of 2.38 million with about more than 75 percent of the population living in the rural areas. The human population density is very less (only 107 persons/km^2) compared to 149 persons/km^2 for the north eastern region. Sex ratio is 978 against the 936 in the region. The demographic feature of north eastern states is unique in that there are more than 29 recognized tribes, which inhabit mostly the hill areas and each with distinct culture, ethos, and traditional knowledge systems. The major minority groups in the state namely Aimol, Anal, Angami, Chiru, Chothe, Hmar, Kabui, Kacha Naga, Mizo, Mao, Lusai etc. The majority of the people survive on subsistence economy based mainly on the agriculture, supplemented with limited horticulture, animal husbandry, crafts/handloom, etc. Table 45 presents the demographic features of the state and the North eastern region.

Table 45: Demographic Features of Manipur and North Eastern Region as per 2001 census (p)

State	Area (sq. km)	Population			Density	Sex Ratio
		Rural	Urban	Total		
Manipur	22327	1818224	570410	2388634	107	978
NE Region	262179	33008703	5809395	39041167	149	936
All India	3287263	741660293	285354954	1027015247	312	933

Source: 1) Census of India, 2001 (Provisional), 2) Statistical Abstract of State Governments, Directorate of Economics and Statistics, 3) Where do we stand in 2003, Meghalaya & North East and India & The World, Directorate of Economics & Statistics, Government of Meghalaya

220. The Net State Domestic Product at constant (1993-94) prices in the year 2001-02 was Rs.19350 million, with annual growth of around 6 per cent. Per capita income at constant prices in 2001-02 was Rs.7976 (against Rs.10754 for the country as a whole). Agriculture continues to be a major contributor for the economy. The progress on industrial front has been constrained by many factors particularly the lack of appropriate infrastructure, lack of raw materials and trained manpower.

2. Land Resources

221. The area available for land utilization in the state is about 19052 sq.km out of the total geographical area of 22327 sq.km. This means about 85 percent of the area in the state in available under various land uses. Major portion of the land use is under forest cover covering about 70 percent of the land use area. About 8 percent area is under gross cropped area. Agriculture is the second major land use in area. The area under various land uses in the region is presented in the Table 46.

Table 46: Land use pattern in North East Region (in thousand hectare)

State	Reporting area for land utilization	Forest area	Not available for cultivation	Other uncultivated land excluding fallow land	Fallow land	Gross cropped area	Net area sown	Area sown more than once	Total
Manipur	1905.2	1741.8	269.5	82.6	3.3	182	140	42	2461.2
NE Region	21754.5	13379	3296.8	1624	913.6	5448.6	3891.1	1557.5	30110.6

Source: www.neportal.org (Directorate of Economics and Statistics, NE states and NEC, Shillong). Statistical Abstract (2001-02), Sikkim, Directorate of Economics and Statistics, NE States.

3. Agriculture and Forestry

222. Agriculture is the mainstay of the people. It contributes major shares in the state domestic product and provides employment to about 63 percent of total working force in state. Total net sown area is 160,000 hectares. Rice is principal food grain followed by maize and millets. An annual production of 366,000 tons of rice was registered in 2000-01. Sugarcane is another cash crop.

223. The socio-economic life of people centres on the forests. As mentioned earlier they cover about 70 per cent of the total geographic area of the state. Wide varieties of bamboos, orchids, aromatic and medicinal plants are found in the State.

4. Fisheries

224. Though the state has no marine fishery, it has vast inland fishery resources like ponds, tanks, naturals lakes, marshy areas, swampy areas, rivers, reservoirs, submerged cropped land, paddy field etc. The largest source of fish is the Loktak Lake. The production of fish in Manipur for the year 2001-02 was estimated to be 16.5 thousands tones as against the 16.05 in thousand tons in the year 2000-01 showing an increase of 2.8 percent over the previous years.

225. The important fishes commonly found in the region's plain and river basins are *Catla catla, Labeo rohita, Labeio calbase, Cirrihinus mirigale, Clarius, batrachus, Rita rita, Heteropneuptus fonilis, Notopterus nontopterus, N. Chitala, Macrobrachum rosenbergii, M. malconsoni, M. Chapral, Channa punetatus C. gaehua, C. striatus*.

226. Although state has potential for fisheries, the rivers and ponds along the project road are mostly seasonal ones therefore there are no commercial fishing activities being done in the rivers along the project roads. During the consutlations local people infomred that during rainy seasons local people catch some fish for their domestic use.

5. Transportation

227. Transportation system is a key factor in the socio-economic development of any state. There is practically no railway network in the state. Two rail heads – one at Dimapur in Nagaland (215 km away from Imphal) and the other at Jiribam (225 km away from Imphal) serves the state. The state has one airport at Imphal, which connects up with the rest of the country. Waterways are also not feasible. Roads, therefore, constitute the only means of transport system in the state for movement of men, materials and services within and outside the state. The total road network stands at around 7200 km, of which 2600 km are unsurfaced roads.

6. Mineral Resources

228. The state has endowed with mineral resources. The main mineral reserves in the state includes lime stone (14.8 thousand tons), clay (2.5 thousand tons), and chromite (0.1 thousand tons). For exploiting the mineral resources, it is important to provide a good road and rail infrastructure. There are no quarries or mines for extracting minerals along the project road.

7. Industrial Situation

229. The State is industrially backward compared to the rest of the country. There is no large scale industry. It has 1 industrial estate, 12 medium scale and 8771 small scale units (2001) giving employment to about 2 lacs people. Lack of roads, power and transport are the major constraints impeding the industrial growth. There are no industries along the project road.

8. Aesthetic and Tourism

230. The state has immense scope for promotion of tourism. It has a salubrious climate, exotic greenery and rich flora and fauna besides the rich culture. Keibul Lamjo National Park, the only habitat of Brow Antlered Deer, on the bank of Loktak Lake (the biggest fresh water lake in north eastern India), Khongjom War Memorial are few major tourist spots in the region. During the year 2001, 409 foreign tourists and 10385 thousands of domestic tourists came to the state. The state offers unique opportunity for eco-tourism development. There as no tourism sites along the project road.

9. Cultural Resources

231. The state has great cultural value. Festivals and cultural activities are being celebrated throughout the year in the state. The department of arts and cultural has taken various activities like promotion of art and culture, preservation of old and historical monuments. The state has great cultural value for Buddhism. To promote and preserve the rich cultural heritage of the state, the department has been organising a number of programmes annually. Based on the inventory conducted as part of IEE, it is found that there are no cultural or historial sites along the project road except small shrines and temples as listed in Section 12 below.

10. Energy and Electric Power Potential

232. The state has an installed capacity of 117 MW of power including the power from central sector. It is just able to meet the current demand. With increase in socio-economic development, more power will be required. It is, therefore, necessary to increase power availability in the state.

11. International Trade & Commerce

233. The north eastern region has the potential to emerge as a strategic base for domestic and foreign investors to tap the potential of the contiguous markets of People's Republic of China, Myanmar, Lao PDR, Nepal, and Bhutan. This calls for converting the unauthorised trade into authorised trade, at the policy level as well as at the ground level. The BIMST-EC (Bangladesh-India-Myanmar-Sri Lanka-Thailand Economic Cooperation) initiative is creating an enabling environment for rapid economic development through identification and implementation of specific cooperation projects in the sectors of trade, investment and industry, technology, human resource development, tourism, agriculture, energy, infrastructure and transportation.

12. Hotspots along the Project Road

234. Inventory of various physical features including Public Community Resources (PCRs) existing along the subproject road has been carried out as presented in Table 47. This also includes information about physical features, sensitive zones, sinking areas etc.

235. The various physical features including PCRs, settlements and senstive areas along the project road are described in Tables 48 and 49.

Table 47: Physical /Sensitive Features along the project road

Location / Chainage (Km)	Features
330 -331	Starting point, Lilong settlement, schools & market, plain terrain, Lilong River Bridge
331-334	Plain terrain with Agriculture Fields
334-336	Village area mixed thin settlement & agriculture Fields, Hilly Terrain
336-338	Plain terrain with Agriculture Fields
338-340	Semi-urban area settlement mixed with agriculture field
340-346	Urban settlement at Thoubal and Khanback commercial area, Plain Terrain, Thoubal River Bridge
346-348	Plain terrain with agriculture field
348-349	Semi-urban area settlement at Wangjing
349-360	Plain terrain with agriculture field and thin settlement in between at Khongjom and Sora Village
360-361	Village area with settlement at Kakching market
361-365	Plain terrain with agriculture field and thin settlement in between at Bijoypur and Kanemrom Village
365-366	Village area with settlement at Pallel market
366-395.68	Hilly Terrain with pockets of open non-forest and forests on hillocks mixed with thin settlements at Bongyang, Sinam, Tengoupal, Chamol, Khongkhang Chote

Table 48: List of Settlement Areas along the Project Road

Sl. No.	Chainage (KM)		Settlement Name
	To	From	
1	330+000	334+610	Lilong
2	334+610	336+310	Chaobok
3	336+310	339+440	Kiyam Shipai
4	339+440	340+300	Haokha Maning
5	340+300	341+210	Okram Wangmataba
6	341+210	343+610	Thoubal
7	343+610	344+200	Athokpam
8	344+200	347+300	Khangbok
9	347+300	347+900	Wangbal
10	347+900	352+100	Wangjing
11	352+100	353+000	Khongjom
12	353+000	354+000	Sapam Solai
13	354+000	355+600	Sapam Papal
14	355+600	357+300	Yaithibi Khunou
15	357+300	356+800	Loushipat
16	356+800	358+700	Irengband
17	358+700	360+150	Kacking Wairi
18	360+150	364+700	Kacking Khullen
19	364+700	366+800	Pallel
20	366+800	371+175	Thamlapopki

Sl. No.	Chainage (KM)		Settlement Name
	To	From	
21	366+940	367+620	Thamla Khuren
22	371+175	375+550	Lamkang Khunou
23	373+000	373+340	Bongyang
24	375+550	380+335	Sinam
25	380+335	381+365	Aigejang
26	381+365	383+155	Saivom
27	383+155	393+300	Tengnoupal
28	390+910	391+808	Chahmol
29	393+300	395+680	Khongkhang

Table 49: Location of Sensitive area along alignment

Chainage		Sensitive Features (Left Side of Road)	Distance from the edge of existing road (m)
Start	End		
330+400	330+500	Abdul Ali Govt. High School	6
331+100	331+200	Lillong Higher Secondary Madrassa	18
331+200	331+300	Galaxy Institute of School	18
339+300	339+400	Temple	6
339+400	339+500	Temple	2
340+600	340+700	Nimaichand High School	5
341+200	341+300	The Fancier Abhiram Sec. School	5
344+800	344+900	The Khangabok Govt High School	22
345+300	345+400	KM Blooming Higher Secondary School	19
346+200	346+300	Wangbal Jr. High School	10
348+900	349+100	The Y.K College	12
352+400	352+500	Khongjom Standard School	18
357+700	357+800	Sora High School, Mosque	8
391+200	391+300	Chamol Baptist Church	19
330+000	330+100	Lilong Higher Secondary School	30
330+900	331+000	Mosque (Jama Masjid)	5
331+500	331+600	The Lilong Girls High School	14
331+700	331+800	Mosque	14
332+700	332+800	Mosque	7
333+500	333+600	Mosque	16
333+600	333+700	Mosque	15
337+000	337+100	Small temple	10
337+900	338+000	Temple	10 m
340+700	340+800	Waikhom Mani Girls College	7
342+800	342+900	RK Muktasana Educational Institute	5
343+900	344+000	Athokpam Jr. High School	13
344+400	344+500	Thoubal District Hospital	4
347+800	347+900	Royal Academy School	8
352+700	352+800	Small Temple	15
363+000	363+100	Temple	15
364+800	364+900	Temple(Ibhidhou Pakhangba)	2
365+700	365+800	Ideal High School	6

V. ANTICIPATED ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

A. Introduction

236. This chapter presents key environmental issues associated with various aspects of the proposed subproject. The environmental impacts caused due to the development of the subproject road sections can be categorised as primary (direct) and secondary (indirect) impacts. Primary impacts are those which are induced directly by the subproject where as the secondary impacts are those which are indirectly induced and typically include the associated investment and changing patterns of social and economic activities due to the proposed action. Interaction of the subproject activities with environmental attributes is presented as Activity-Impact matrix in Table 50.

Table 50: Activity-Impact Identification Matrix

Sl. No.	Activities	Type of Impact							
		Air	**Water**	**Noise**	**Flora**	**Fauna**	**Drainage**	**Soil**	**Topography**
1.	Labour camp activities		- ve/t						
2.	Quarrying	-ve/t		- ve/t	- ve/t		- ve/t		- ve/p
3.	Material transport and storage	- ve/t		- ve/t					
4.	Drilling, blasting and hill cutting	- ve/t		- ve/t	- ve/t	- ve/t			
5.	Earthwork						- ve/p	- ve/t	- ve/t
6.	Payment works	- ve/t	- ve/t	- ve/t	- ve/t			- ve/t	- ve/p
7.	Use of construction equipments	- ve/t	- ve/t	- ve/t		- ve/t			
8.	Plantation	- ve/p		- ve/p	- ve/p				
9.	Drainage work						- ve/p		
10.	Culvert and bridge construction		- ve/t	- ve/t			- ve/p		
11.	Stripping of top soil							- ve/p	
12.	Debris generation						- ve/t	- ve/t	
13.	Oil and grease							- ve/t	
14.	Construction in forest and sensitive areas	- ve/t	- ve/t	- ve/t	- ve/t	- ve/t	- ve/p	- ve/p	- ve/p

Notes: t – temporary, p – permanent. Impact indicated in bold letters indicates significant impacts.

237. Identification and assessment of the potential environmental impacts are based on secondary information supplemented by field visits. Impacts on various environmental components have been assessed at four different stages, namely:

- the project location;
- design and pre-construction;
- construction; and
- operation stages.

238. A few permanent as well as short-term and long-term adverse effects, mainly at the construction and operation stages, are, nonetheless, anticipated. Temporarty short-term impacts can be kept in check through proper planning and adopting environment friendly road construction methods and the appropriate regulatory measures.

B. Positive Environmental Impacts due to improvement of subproject road sections

239. The positive impacts expected from the improvement of the Imphal-Moreh (AH1) road section includes:

- reduction in travel time and lower vehicle operating cost will reduce fuel consumption and emissions of pollutants,
- enhance the trade and commerce between India and Myanmar and other ASEAN regional countries, and
- provide better access to other parts of the state and Myanmar by connecting National Highway 39 (Asian Highway 1) which is major routes connecting these districts with other parts of State and also international border to Myanmar at Moreh.

C. Adverse Environmental Impacts due to improvement of subproject road sections

240. The adverse environmental impacts anticipated from the improvement of the project road section are:

- Cutting of road side trees that falls within formation width i.e. 10-30 m may reduce the ecological balance of the area and also increase soil erosion problem.
- Noise, air and water pollution and disposal of construction waste, during construction, will adversely impact both local residents. These latter effects should, however, only be temporary/reversible.
- A number of quarries and other sources will be established which will change the landscape. However, the operation of quarries is an independent and already regulated activity. Adverse impacts on water quality of rivers (Imphal, and Thoubal) in the form of silt deposition and runoff during construction are expected. However, this is short term and will be taken care of by controlled construction activities.
- improvement on existing road and construction of bridges, although limited, may enhance soil erosion, landslips and reduce the micro-level ecological balance of the area. Construction may also disturb the habitation of fauna living in this area. These should, however, be only temporary/reversible effects. The improvement will also require the cutting of about 3691 trees.
- Minor impacts of noise and air quality for those now living and workings close to the project road (mainly at Imphal, Thoubal, and Pallel) will deteriorate during the construction period and afterwards during operation.

D. Impacts Related to Project Location, Preliminary Planning and Design

1. Land Acquisition and Loss of Productive Land

241. Since the subproject involves widening of existing road to 4/2-lane carriegeway configuration this will require acquisition of about 68.1 hectare of land for road right of way (24-37 m in plain areas and 20 m hilly terrain). Although land acquisition requirement has been kept to minimum level, it will have impacts on topography and change in land use in the region. Loss of agriculture land and productive soil is also anticipated due to additional land acqusition. To minimize land acquisition and soil productivity, the following mitigation measures have been /will be adopted during the detailed design and construction stage of the project:

- Alignment will be adjusted to avoid and minimize acquisition
- Topsoil management during construction.

2. Forest Clearing and Tree Felling

242. Since the project road passes through plain as well as hilly terrain with about 33.28 km length of the subproject road passes through various categories of forest areas. Adverse impacts due to diversion of about 51.5 hectares of forest land are anticipated. Also land clearing will involve cutting of about 3691 trees. Problem of soil erosion is expected in some locations. To minimize loss of trees, the following mitigation measures have been /will be adopted during the detailed design and construction stage of the project:

- Widening proposal considered option with minimal tree cutting.
- Widening is restricted to minimum width in the length passing through forest areas.
- Adequate measures are included in the design to minimize any unforeseen impacts on flora and fauna in the forest areas.
- Land stabilization measures were included in identified areas prone to erosion.
- strictly enforce the environmental conditions put as part of the environmental clearance by the MoEFCC and SPCB.
- adopting Environmental Friendly Road Construction (EFRC) methods.

243. The improvement of the proposed road is largely confined on the existing alignment. At some locations, improvements to the geometry may involve cutting, filling, and the need to cut vegetation along most of the project road length. This will have more significant impact and this matter is discussed in the sections which follow.

244. In forests areas (particulary about 33.28 km section on Imphal-Moreh road - Table 51), it is particularly important that the road improvement works should minimise environmental impacts from inadequate drainage and/or slope failures and should assist in maintaining, or repairing, forest cover. Table 51 list out the locations of the forest area along the project road.

Table 51: Sections of Subproject Road Passing through Forest Areas

S. No.	Design Chainage (km)		Length (m)	Side of Road	Forest Name and Type	Remarks
	From	To				
1	334.6	336.2	1600	LHS	Waithou PF	
2	336.3	337.5	1200	RHS	Unclass	
3	355.0	355.3	300	LHS	Proposed Khunadalaiching RF	Proposed CL may be shift towards RHS
4	357.2	357.5	300			
5	358.6	358.9	300			
6	361.9	362.1	200			
7	366.3	384.8	18500	RHS	Proposed Lamdang RF	Hill section starts
				LHS	Unclass	
8	384.8	389.0	4200	Both side	Unclass	
9	389.0	391.5	2500	LHS	Myanmar Boarder Teak PF	
				RHS	Unclass	
10	391.5	395.68	4180	Both side	Myanmar Boarder Teak PF	
	Total Length (m)		**33280**			

245. Based on the tree inventory carried out during the field surveys in May-June 2016, the total number of trees to be cleared along Imphal-Moreh section is 3691. Table 52 present details

of the trees to be cut due to proposed road improvement. As per compensatory afforestation requirement, the tree plantation will be done three times of tree cutting (1:3 of tree cutting). At sensitive locations such as schools, colleges and hospitals along the project road noise barrier shall need to be provided.

Table 52: Detail of trees within formation width of the proposed alignment

Section	Chainage (km)		Left Hand Side (LHS)	Right hand Side (RHS)	Type of Trees[14] (local name)
	From	To			
Lilong to End point	330+000	395+680	1577	2134	Nasik, Gulmohor, Boroi, Jam, Baraphi, Heibong, Tairm, Mango, Heikha, Neem, Sorokhi, Tumitla, Khongnang, Konbla, Uyumg, Pungton, Jamun, Yongchak, Theibong, Heirik, Teak, Sayee, Kaygay, Kwa, Tera, Thibong, Qurei, Lairik Heibi, Kongong Thopki, Bhushlei
Total trees to be cut (Nos)			**3691**		

Source: Field Survey carried out by the Consultant Team, 2016
Note: The exact number of trees to be cut might vary from these figures. Joint inspection with forest range officers shall be carried out to estimate the number and type of trees to be cut by improvement proposals. In case of any change, numbers will be updated and accordingly compensatory plan be updated.

246. The compensatory plan is being developed in consultation with local forest department. As per compensatory afforestation, the tree plantation will be done three times of tree cutting (1:3 of tree cutting) as detailed in Table 53. The compensatory plan will be monitored by the Authority's Engineer and PIU in consultation with Forest Department Officials.

Table 53: Details of Trees to be Cut and Planted

Road Section (From / To)	Length (km)	Tree to be cut in the project road	Proposed tree to be planted in the project area in consultation with Forest Dept. (1:3 of tree cutting)
Imphal-Moreh	65.68	3691	11073

3. Borrow Pits and Quarries Operation

247. There is a need to establish construction camps and related facilities, such as borrow pits and quarries. These must be located in environmentally sound and socially safe areas. It is expected that construction materials for the road works will be mined mostly from approved quarries. Aggregates will be sources from Santosh Stone Crusher (existing) at km 307 on left and river boulders from the Imphal River at Km. 309+000 RHS side. Borrow areas are yet to be finalized. The following criteria is applied for locating the borrow areas:

- Borrow areas are not established in ecologically sensitive areas;
- Villagers are consulted in regard to the design and location of all borrow areas – these should ensure the safety of local communities and, if possible, should incorporate beneficial post construction features for the villages;

[14] None of these specific are recorded in the IUCN red data list of endangered / protected species. Local forest department were consulted and they also confirmed that none of these species are classified as rare or endangered.

- Located away from the road and hill slopes as well as settlements facing the road, so as to minimise visual impacts;
- In case of protected areas/ reserve forest areas, construction facilities such as temporary workers camp, hot mix plants, and concrete batching plant and stone crushers should not be established in stretches that passes through reserve / protected forests and also away from degraded airshed. Local forest department / village forest management committees should be consulted before locating these temporary project facilities;
- Construction camps for labourers should be located at least 500 m away from settlements and 1 km away from forest/protected areas;
- Living accommodation and ancillary facilities should be erected and maintained to standards and scales approved by the Engineer-in-Charge; and
- Toilets and urinals should be provided in accessible places away from the asphalt plant and mixing yard.

4. Cultural Heritage

248. There are no adverse impacts anticipated on historical places/monuments. However, there are few small shrines along the road (listed in Table 49). Care must be taken to avoid any damage to these structures. Earthworks, as associated with the road construction/improvement works, or deriving from secondary sites such as quarries or borrow pits, may reveal sites or artifacts of cultural/archaeological significance. In the event of such discovery, the concerned authorities should be informed and the requirement to take such action should be incorporated in contract documents.

5. Other Impacts deriving from the Project Planning and Design Process

249. During preliminary planning and design of this project, the Consultant has taken into account the need for:

- optimum sitting and control of borrow areas;
- reduced incidence of slope failures due to inadequate drainage;
- providing adequate culverts/drains;
- providing side-drainage structures;
- mechanised construction methods and thereby, for example, reduced use of firewood for heating bitumen;
- maximising safety and thereby reducing traffic accidents;
- reducing travel times and, thereby, fuel consumption and emissions;
- adequate signages for wildlife protections,
- increased accessibility for residents to education and health facilities, markets etc., and for others who might come for tourist or other purposes; and
- improving the socio-economic conditions of residents in the project areas of influence.

250. As part of the engineering works for this work, the following guiding principles have been used in determining the alignments:

Environmental Issue	Measures taken
Alignment	Final alignment has been determined so as to minimise land take, tree removal, air pollution and the impact on people and

Environmental Issue	Measures taken
	animals and to avoid unfavourable geological condition and cultural relics.
Balancing cut and fill	The design attempted to equalise cut and fill. The centreline has been aligned so that on all slopes below 60 degrees, half cut and half fill is achieved.
Soil erosion	Temporary and permanent drainage systems have been designed to minimise the soil erosion.
Dust and air pollution	Borrow sites, waste disposal sites and asphalt mixing sites will be identified – keeping in mind environmental issues such as dust.
Cultural heritage	Any archaeological sites identified along the alignment should be excavated prior to construction.
Wildlife Habitat	Care has been taken in preservation of wildlife and construction workers should be educated on wildlife protection.

E. Environmental Impacts - Construction Stage

1. Permits and Clearances

251. As a requirement of Environmental Impact Assessment Notification, 2006, by Government of India, any development activities should not be taken in any part of the Country unless it has granted environmental clearance by the Ministry of Environment, Forests and Climate Change, Government of India.

252. Highways are classified as one of the project, listed in said notification, which require prior clearance. However, an amendment to this notification clarifies, that the highway improvement projects are excluded from purview of this notification. Some of the relevant applicable sections are:

i) As per provisions of the EIA Notification 2006 (amended in 2009, 2011 and 2013), all national highway expansion projects that are longer than 100km and involve additional right of way or land acquisition greater than 40m on existing alignment and 60m on realignment or bypass fall under category A and require environmental clearance from MoEFCC at the central level. Since the total length of the subproject road section on Imphal-Moreh National Highway (AH1) is less than 100 km (65.8km), it does not fall under the purview of EIA notification. Therefore Environmental Clearance from MoEFCC is not required for this subproject.

ii) As per the Forest Conservation Rules (1981, amended 2003) a forestry clearance from Department of Forests is required for diversion of forest land for non-forest purpose. Processing of the forestry clearance entails two stages: stage I and stage II. Amongst other requirements stage I clearance requires the applicant to make payments for compensation of forestry land that will be acquired and trees that will be cut under the project. Accordingly timely allocation of budget for this purpose by the applicant is necessary to expedite the clearance process. Although there are no notified protected areas along the proposed subproject road section, about 33.28 km long section passes through various categories of forest areas. Also some areas along the subproject road are declared as proposed reserve forest areas and it does require diversion of forest land. Therefore forest clearance is required as per Government of India requirements.

iii) Cutting of trees in non forest land require a tree cutting permit from the local forestry department. All trees cut under a project must be compensated by compensatory afforestation as required by the State Forest Department.

iv) As per Office Memorandum (OM) issued by MoEFCC on 19 March 2013 the grant of environmental clearance for linear projects including roads has been delinked from the forestry clearance procedure. Hence, after receipt of environmental clearance construction works may commence on sections/parts of a linear project that do not require forestry clearance. Construction works may commence on sections requiring forestry clearance only after receipt of the respective clearance.

v) Placement of hot-mix plants, quarrying and crushers, batch mixing plants, discharge of sewage from construction camps requires No Objection Certificate (Consent to Establish and Consent to Operate) from State Pollution Control Board prior to establishment.

vi) Permission from Central Ground Water Authority is required for extracting ground water for construction purposes, from areas declared as critical or semi critical from ground water potential prospective by them.

253. Before the start of civil works for any section of subproject the project proponent (NHIDCL) must obtain necessary clearances / permits from the regional office of the Ministry of Environment, Forests and Climate Change, and State Pollution Control Board. Table 54 outlines the applicable clearances and permits and the authorised bodies that issue them along with the procedures involved. The status of the permits / clearances has also been presented in this Table 54.

Table 54: Clearances and Permits Required for the Subprojects

Sl. No.	Clearance/ Permit	Authorised body	Procedures involved	Time involved	Responsibility
1.	Forest Clearance	Regional Office of MoEFCC, Shillong	Detailed proposal in appendix specified in Forest (Conservation) Act, 1980 along with project report and necessary details of tree felling. Local division office will forward after joint verification of site and preliminary scrutiny of proposal to PCCF office for approval. Joint verification and enumeration of trees to be cut shall be done by division office and after approval shall be allowed to cut.	Approx. 6 months or more	NHIDCL
2	Clearance for quarry sites	Department of Geology and Mines, Govt. of Manipur, Imphal	Submission of application for quarry site to mining department. Department of mines and geology after scrutiny of application and consultation with forest department and revenue department together with site verifications will give approval with specific conditions.	Takes between 3 months and six months.	Contractors

Sl. No.	Clearance/ Permit	Authorised body	Procedures involved	Time involved	Responsibility
3	Clearance for blasting	State Mining Department, Imphal	Detailed application with blasting locations and amount of blasting shall be submitted to DoM. Mining department may issue the conditional approval.	2 to 6 months	Contractors

254. Any felling of trees requires forestry clearance and appropriate permits. The procedures necessary to obtain such permits will require liaison with local territorial forestry offices and their head office in Imphal. Joint verification and making of trees to be cut is being carried out jointly with divisional forest departments of districts involved. No clearance is required for the use of surface sand and stone from the river banks as for commercial purposes they can only be purchased in an open auction carried out by the forestry office. It is imperative that all necessary clearances and permits be obtained before commencement of work. Blasting will be required only in hilly sections.

2. Physical Environment

a. Topography, Geology and Soil

255. During the improvement works for the road section, the cutting of hill slope, filling, the cutting of trees, stone quarrying, and construction of structures, the micro-level topography may change. With proper planning, these topographical impacts can be kept within acceptable limits and sometimes even used to enhance local aesthetics. Any negative impacts on topography (existing or new), particularly soil erosion due to a lack of drainage facilities, will be minimised with the provision of proper drainage facilities such as culverts, causeways etc.

256. The terrain and geological conditions of area are such that, even with reasonable care exercised during final design, during construction the interaction between proposed road features and existing land features may reveal/result in significant land instabilities.

257. During the construction phase following restrictions should be imposed:

- existing vegetation including shrubs and grasses along the road (except within the strip directly under embankments or cuttings) should be properly maintained;
- sites for quarrying, borrowing and disposal of spoils are to be confirmed according to the applicable laws and regulations in the state and the practices followed in recent/ongoing internationally funded road projects should be continued;
- controlled and environmentally friendly quarrying techniques should be applied to minimise erosions and landslides;
- provide adequate safety measures (personal protctive equipments such as eye protectors, ear plugs, safety helmets) for workers as well as safety installations at work sites for local public;
- blasting should not be carried out during busy periods; and
- cut material should be disposed of in suitable depressions.

258. It is also important to:

- maintain adequate vegetative cover above and below the road;
- maintain the natural course of water bodies (that is as far as possible) and avoid throwing debris into stream courses;

- construct proper drainage structures to avoid erosion; and
- minimise the construction of hair-pin bends that are close to each other: as this often adds to instability.

259. Given the existence of high slope and high rainfall in almost entire project area and weak geology in some areas, it is inevitable that some sites will face problems of erosion, mostly debris slides.

b. Erosion, Silt Run-Off and Landslides

260. Contraction work in Pallel to end section of the project road will be virtually through mountainous terrain with steep and unstable slopes. Much of areas in this section are geologically young, resulting in soft/fragile substrates. Another complicating factor is the high monsoon rainfall throughout most parts of the subproject road. These factors mean that project area conditions are amongst the most difficult in the region for road construction. Landslides frequently caused by inappropriate construction techniques, slope instability, and inadequate drainage are major problems and are associated with all types of road construction. It should be noted that a significant number of landslides that occur in the vicinity of road are caused by factors/features only indirectly linked to the road itself – frequently, irrigation channels, logging, quarrying and cultivation practices. To control these, following measures are suggested by local environmental authorities:

- logging immediately above road should be restricted to reduce erosion/landslide potential;
- quarrying along road ROW should be restricted;
- excavated material should be properly disposed of and not simply dumped downhill;
- adequate reclamation (e.g. fertilisation and reseeding) along denuded ROW should be implemented;
- particular care should be given to providing adequate drainage;
- careful supervision/training of blasting technicians is required;
- provide adequate health and safety measures for workers working in landslide prone zones, and
- to the largest extent possible, care should be taken to avoid sacred and religious sites.

261. Previous studies by the Border Road Organisation and CRRI indicate the need to incorporate the following measures:

- balance cut and fill: with a prohibition on the dumping of spoil over the road edge – thus minimising erosion;
- more frequent use of retaining walls - to control landslips;
- improved drainage - again so that erosion is minimised;
- controlled blasting in rock-cut areas - to minimise erosion; and
- use of bioengineering technique for slope protection: use of native species of plants and shrubs for slope stabilisation.

262. Unstable, uncompacted road embankment materials and exposed material can result to soil erosion, clogging of side drains and the spill-over of rainwater runoff onto the road surface and down slopes. These cause landslides and hinder traffic movement. These problems can be mitigated by maintaining the batter gradients as specified in the MoRTH guidelines. The existing vegetation on slopes outside the immediate area of construction must remain undisturbed during construction and/or upgrading. Bioengineering techniques will be used to prevent barren slopes and to stop soil erosion and to protect the animals from grazing animals. Support structures will be installed where slope failures are anticipated or may have occurred previously. Slope failures should be monitored and remedial actions initiated at the earliest possible time.

Image 8: Landslide Prone Location along Imphal-Moreh road

263. Construction involving rock/soil cutting of hillsides may render hill slopes unstable and increase vulnerability to landslides. Blasting of rocks may also result in landslides.

264. All hill/soil cutting areas should be revegetated as soon as construction activities are completed. At more vulnerable locations, selected bioengineering techniques should be adopted - a combination of bioengineering techniques and engineering solutions such as rock bolting and the provision of bank drains may be required. Solutions will, however, need to be individually tailored by the geo-technical/ environmental experts of the Authority's Engineer. Image 8 below shows the typical geologically weak zone along the project road.

265. Excavation and earthworks should be undertaken during the dry season when the risks from erosion and silt run-off are least. The materials used for surface dressing will consist of aggregates and gravel which do not contain silt. Internationally accepted best practice engineering approaches to minimise landslide and erosion risks and silt run-off will be incorporated into contract documents and monitored during construction.

266. In order to minimise erosion, silt run off and landslides, it will also be important to:

- ensure all embankment grades are not too steep and prone to erosion;
- waste material is not thrown into nearby rivers (Imphal, Thoubal) and cross cutting water bodies;
- temporary retention ponds, interception drains, and silt traps are installed to prevent silt laden water from entering adjacent water bodies;
- topsoil of borrow areas is preserved and used for re-vegetation;
- borrow areas are provided with gentle side slope that are re-vegetated and connected to the nearest drainage channel to avoid the formation of cess pools during the rainy season; and
- control the disposal and ensure the vegetative stabilisation of spoil.

c. Climate

267. The proposed improvement/construction works will be localised activities and the Project will not have significant impact on climatic conditions, such as rainfall, temperature and humidity in the project area. A climate change impact and risk analysis has been carried out using TEEMP

model (Chapter 6: Climate Change Impact and Risks) and appropriate adaptation measures are incorporated in the subproject design.

d. Surface and Ground Water, Drainage and Hydrology

268. Given the presence of rivers and streams in the project area and some of them crossing and /or running parallel to project road; improvement of road may result in disruptions to the natural hydrology and water mismanagement and lead to further problems of soil erosion.

269. The natural courses of rivers/streams will be maintained. Appropriate temporary diversions of streams will be made and brought back to their natural course as soon works are completed in that section. No disposal of construction debris in streams and rivers is allowed. Specific measures will be taken by contractor during constrcution along Thoubal river since the river is running parallel to the project road at 5-15 m. Quality of the river water quality will be monitored prior to start of the construction work to establish baseline in rivers/streams along the project road. Streams/Jhoras along the project roads will also be protected during constrcution period.

270. Minor impacts on water resources are expected during the construction phase. The rehabilitation of existing bridges may also cause soil erosion and turbidity in downstream water bodies. To mitigate this, river-bank slope stabilities will be monitored and, if necessary, appropriate remedial measures applied throughout the construction period. Construction work at bridges during rainy season will be minimized to avoid erosion and sedimentation.

271. The likely impacts of surface water movements are changes in the natural drainage systems, downstream scour, and erosion due to constriction in flows. If suspended solid concentrations in the water are affected, this could also affect aquatic river ecology.

272. To mitigate these impacts the following measures should be implemented:

- chemicals and oils are stored in secure, impermeable containers, and disposed of well away from surface waters;
- follow World Bank Group EHS Guidelines including 110% bund capacity for storage of fuel, oil, chemical etc.;
- no vehicle cleaning activity is allowed within 300 m of water bodies/ drains;
- construction camps are equipped with sanitary latrines that do not pollute surface waters;
- the work on bridges and culverts is limited to dry seasons, when many of the smaller streams will have low water - water diversion works can be minimised and the original course restored immediately after the work has been completed;
- drivers are made aware of diversions and other works at bridge construction site to avoid accidents;
- drainage structures are properly designed to accommodate forecast discharges;
- side drain waters must be discharged at every available stream crossing to minimize volume and prevent erosion at discharge point;
- provide lined drainage structures;
- where an increased discharge of surface water endangers the stability of the water outlet, erosion protection measures such as bioengineering measures, ripraps, and check dams are incorporated;
- in areas with high water tables, seepage may occur and side drains and up-slope catch drains must always been lined to avoid percolation; and
- all debris and vegetation, clogging culverts are regularly cleared.

273. Ground water pollution is not envisaged in this subproject. However ground water must not be used for drinking purpose given the high level of BOD in the water quality.

e. Air Quality

274. During construction air quality may be degraded for short periods due to (i) the exhaust emissions from the operation of construction machinery; (ii) fugitive emissions from brick, concrete, and asphalt plants; (iii) the dust generated from the haulage of materials, exposed soils and material stockpiles; (iv) cutting and filling of hill slope; (v) cleaning of the road; (vi) material loading; (vii) unloading; and (viii) blasting activities. The impact is expected to be localised, temporary and confined to construction areas.

275. Adverse air quality impacts during construction are likely to result from three main sources; (i) emissions from construction equipment, including delivery trucks; (ii) fugitive dust from earth-moving operations and demolition; and (iii) localised increased traffic congestion in construction areas.

276. The adverse impacts on air quality during construction stage were classified and presented in Table 55. There are two types of pollution i.e. dust pollution and pollution from harmful gases.

Table 55: Impact on Air Quality during Construction Stage

Sl. No.	Impact	Source
1.	Generation of Dust (SPM)	• Cutting of slopes towards hillsides • Transportation and tipping of cut material - while the former will occur over the entire stretch between the cutting location and disposal site, the latter is more location specific and more intense; • Blasting operations; • Activation of landslides and rock falls etc.; • Transportation of raw materials from quarries and borrow sites; • Stone crushing, handling and storage of aggregates in asphalt plants; • Site levelling, clearing of trees, laying of asphalt, construction of bridges; • Concrete batching plants; • Asphalt mix plants – due to the mixing of aggregates with bitumen; and • Construction of structures and allied activities
2.	Generation of polluting gases including SO_2, NOx and HC	• Hot mix plants; • Large construction equipment, trucks and asphalt producing and paving equipment; • The movement of heavy machinery, oil tankers etc. on steep slopes will cause much higher emissions of gases; • Toxic gases released through the heating process during bitumen production; and • Inadequate vehicle maintenance and the use of adulterated fuel in vehicles.

277. On the 65.68 km subproject road section of Imphal-Moreh highway, it is expected that air quality will be affected to some minor extent by dust and particulate matters generated by construction, vehicular movements, site clearance, earth filling and material loading and unloading. The impacts are expected to be localised, temporary and confined to construction areas. Care should, however, be taken at sensitive urban locations so that harmful impacts can be minimised. No hot mix plant or other source of air pollution (especially dust pollution) must be located within the degraded airshed for particulate matter (SPM/PM10). Specific measures such as watering of roads etc. shall be adopted for upgrading works in degraded airshed to avoid generation of additional SPM to add to the already poor quality air.

f. Noise Levels

278. With the exception of the urban centres such as Imphal, Thoubal and Pallel, the ambient noise level along the road sections is within standards. During the construction period, noise will be generated from the operation of heavy machinery, blasting works, the haulage of construction materials to the construction yard and the general activities at the yard itself. Concrete mixing and material movements will be the primary noise generating activities and will be uniformly distributed over the entire construction period. These construction activities are expected to produce noise levels in the range of 80-95 dB(A) at a distance of about 5 m from the source.

279. Construction noise is not normally regulated, though still may cause concern among local villagers. The range of typical noise levels in relation to distance from a construction site is shown in Table 56.

Table 56: Construction Noise / Distance Relationship

Distance from construction site (m)	Range of Typical Noise Level dB(A)
8	82 – 102
15	75 – 95
30	69 – 89
61	63 – 83
91	59 – 79
122	57 – 77
152	55 – 75
305	49 - 69

Source: Department of Transportation, State of Wisconsin (USA)

280. Piling, if necessary, will also cause vibration. In this project piling will be required only at bridge locations. Bridges are away from the residential areas therefore impacts on structures due to piling is negligible. Noise and vibration from this source will be unavoidable but the impact will only be temporary and affect people living or working near piling locations. In construction sites within 500 metres of a settlement, noisy operations should cease between 14:00 and 10:00 hrs. Regular maintenance of construction vehicles and machinery must also be undertaken to reduce noise. The impact and sources of noise and vibration are summarised in Table 57.

Table 57: Likely Impact on Noise Quality in the Vicinity of Project Area

Impact	Source
Increased noise levels causing discomfort to local residents, workers and local fauna	• Mobilisation of heavy construction machinery; • Accelerations/ decelerations/ gear changes – though the extent of impact will depend on the level of congestion and smoothness of the road surface; • Use of blasting to cut into hill sides;

Impact	Source
	• Excavation work for foundations and grading; • Construction of structures and other facilities; • Crushing plants, asphalt production plants; and loading, transportation and unloading of construction materials.

281. Typical noise levels associated with various construction activities and equipment are presented in Table 58.

Table 58: Typical noise levels of principal construction equipments (Noise Level in dB (A) at 50 Feet)

Clearing		**Structure Construction**	
Bulldozer	80	Crane	75-77
Front end loader	72-84	Welding generator	71-82
Jack hammer	81-98	Concrete mixer	74-88
Crane with ball	75-87	Concrete pump	81-84
		Concrete vibrator	76
Excavation and Earth Moving		Air compressor	74-87
Bulldozer	80	Pneumatic tools	81-98
Backhoe	72-93	Bulldozer	80
Front end loader	72-84	Cement and dump trucks	83-94
Dump truck	83-94	Front end loader	72-84
Jack hammer	81-98	Dump truck	83-94
Scraper	80-93	Paver	86-88
Grading and Compaction		**Landscaping and clean-up**	
Grader	80-93	Bulldozer	80
Roller	73-75	Backhoe	72-93
		Truck	83-94
Paving		Front and end loader	72-84
Paver	86-88	Dump truck	83-94
Truck	83-94	Paver	86-88
Tamper	74-77	Dump truck	83-94

Source: U.S. Environmental Protection Agency, noise from Construction Equipment and Operations. Building Equipment and Home Appliance. NJID. 300.1.December 31, 1971

282. The noise levels indicated for various construction activities/equipment, while far exceeding permissible standards of CPCB and WB EHS for residential areas and occuptional areas, it will occur only intermittently. Still, these extremely high sound levels present real risk to the health of workers on- site. Timely scheduling of construction activities, proper maintenance of construction machineries, provision of noise barriers, use of personnel protective equipments etc. will minimize these impacts.

283. A preliminary estimate suggested that about 1332 families/residences from 29 villages/settlements, and 31 sensitive receptors (schools, shrines, health clinics, and other noise sensitive areas) within 100 m the roadways will be affected temporarily during construction.

284. During construction, varying degree of noise impacts are likely to be felt by the communities of main settlements i.e. Imphal, Thoubal, and Pallel and other small settlements along the project road. Although temporary in nature, the construction noise will affect the most communities living close to the construction zone.

285. Noise impacts are an unavoidable consequence of construction that should be mitigated by providing noise barriers and limiting the times of construction to daylight hours (10am-4pm) in the vicinity of sensitive receptors. Further to minimize noise impacts near sensitive receptors (particularly schools), operation of excavator and other heavy machineries will be carried out mostly during off-hours (7 am to 9 am and 3.30 pm to 7 pm) and on holidays (Saturday and Sundays). Baseline noise will be established for all sensitive locations (listed in Table 49) prior to construction and follow up noise monitoring will be carried out during the construction. Details of the follow up monitoring is provided in EMoP (Table 79).

286. Although estimated noise over the project duration shows higher noise levels at various receptor locations; implementation of suitable mitigation measures will reduce the construction noise to acceptable limits. Mitigation measures should include:

- Installations of noise barriers;
- construction machinery should be located away from settlements;
- careful planning of machinery operation and the scheduling of such operations;
- controlled blasting should only be carried out with prior approval from the Engineer in charge;
- Construction workers in high noise level zone must be provided with ear protection equipments. Site specific mitigation measures will provided by contractor particularly in sentitive and urban locations.
- contractors should be required to fit noise shields on construction machinery and to provide earplugs to the operators of heavy machines;
- blasting should be conducted only during day-light hours; and
- only controlled blasting should be conducted.

g. Topography and Appearance

287. Construction activities of the project road will bring permanent changes in the local-level topography and appearance of the project site. There will be loss in aesthetic beauty of the project area mainly due to the earthwork. Table 59 elaborates potential effects on the topography and appearance and appropriate mitigation measures.

Table 59: Potential Effects on Topography by the Proposed Road Section Upgrading

Sl. No.	Construction activity	Potential effect on topography and appearance	Mitigation
1.	Clearing of vegetation and cutting of hillside for widening of the road	Scarring of landscape from cutting and potential landslides (short term and long term) may be caused. There may be minor permanent changes in the landscape.	Cut material should be used to widen the road or disposed off at proper disposal sites. Cut slopes should be re-vegetated immediately after widening activities.
2.	Stone quarrying	Scarring of landscape and potential landslides (rock slides/falls). There may be permanent changes in the landscape.	Stone quarrying should only be undertaken in legally approved areas. Controlled and environmental friendly quarrying should be carried out to minimise landslides and erosion.

Sl. No.	Construction activity	Potential effect on topography and appearance	Mitigation
3.	Earthwork from borrow areas	Scarring of landscape due to unearthing activities. Minor but permanent changes in landscape.	Borrow areas should be in legally approved locations. As soon as construction activities are complete, they should be re-vegetated and brought back as far as possible to their previous appearance.
4	Waste disposal	Disposal of cut soils and debris at improper locations such as hillside below the road will make the area look untidy and unattractive.	Cut off material should be used to widen the road or disposed of at proper disposal sites.
5	Establishment of labour camps	Disposal of waste and litter at improper locations and deforestation for firewood will make the area look dirty and unattractive.	Provision and allocation of proper waste disposal bins and sites are required. A supply of cooking gas should be provided by the contractor to eliminate the use of firewood.

3. Ecological Resources

a. Wildlife

288. The proposed road alignment is not located inside any legally protected or key biodiversity area which was identified as the corridor of impact.

289. The impacts of road building to wildlife includes direct and indirect mortality; destroying, degrading, and fragmenting habitat; serves as barriers to movement; and spurs domino effect brought by a change in land-use. Small animals that often disperse, large animals like ungulates and carnivores are at risk to road kills during project operation. Since the project activities involve widening of exisitng road wildlife habitat fragmentation, and disruption of wildlife movement corridor are not anticipated. However with increase in traffic and widened road will increase the magnitude of the existing impact. Additional measures such as controlled monitoring, speed limit and no horn restrictions etc. are included in the EMP.

290. Forests and Widlife Officials including the Chief Wildlife Warden, the Chief Conservator of Forests (Wildlife), Field Staff of forest department, NGOs (IBCN/WWF), representative of local communities and villagers, were consultant to identify possible impacts of proposed road improvement project on wildlife of forest areas.

291. Office of the Wildlife Warden (Manipur) informed that there is no specific information available about wildlife movement corridors and wildlife migratory routes along national highway section (project road). Wildlife movement is mostly limited to the core zone of the YLWLS, which is about 8.45 km away from the project road. However there is no record of wildlife movement across project road. Local communities also informed that they rarely noticed movement of animals across the national highway. Some of the people consulted indicated that they occasionally (once in a week or less) spot small animals such as langur crossing the national

highway. Also there is no history of road accident involving wild animals on national highway section.

292. The road construction through forest areas in hilly terrain (from Pallel to end point) will require new hill cutting and steep slopes. Although improvement work will be taken up eccentrically (on one side of existing road -not towards boundary of the sanctuary), it will affect the habitats of the area. The main predicted impact is the damage and disruption of wildlife movement routes (although no specific route exist); and loss of food sources and the nesting sites for birds.

293. Regarding the six definitions of critical habitat (ADB SPS) and the IFC Tier 1 and 2 definitions, none of these definitions has been found to apply to the project area. Since there are no legally defined critical habitats (the ADB SPS notes that critical habitats include legally protected areas such as the national parks, wildlife sanctuaries, biological corridors), the project area does not impinge on any specific areas that is critically important to the populations of threatened species in India. Regardless of this conclusion, the project is still taking a precautionary approach and will be implementing a biodiversity conservation plan that includes monitoring and development of a wildlife database, as well as field conservation measures to protect wildlife. Furthermore, at night time, all construction activities will be disallowed, to avoid disrupting wildlife movements particularly in sections of project road with forest areas.

294. The road construction through forest in 33.28 km length and hilly terrain (from Pallel onwards will require new hill cutting and steep slopes. The road constrcution work in this area will affect the habitats of the area.. The main predicted impact is the damage and disruption of wildlife movement routes (although no specific route exist); and loss of food sources and the nesting sites for birds.

295. Steep road cuts will form a barrier to wildlife movements and disrupt the wildlife migration. It is generally known that wildlife generally migrates seasonally. Environmental Specilaist of Authority's Engineer in consultation with the wildlife conservators of forest divisions will reconfirm the exact migratory routes and the timing of their migration for planning and execution of road construction. Road construction works will be allowed only during dry season and between 1 hour after dawn and 1 hour before dusk and to minimize the disturbance to wildlife. Gentle side slope (more slope) will be maintained wherever there are known wildlife crossings (as per the recommendations of Environmental Specialist of the Authority's Engineer). The gentle slopes (slopes with lesser gradient) will be maintained in all known movement/migratory paths. Spoil will be disposed to the pre-identified dump-sites. Wildlife crossing and speed limit signages will be posted on both sides of road in Reserve Forest area to caution travelers of possible dangers of collision with wildlife. Exact location of signage posting will be determined by Environmental Specilaist in consultation with the Wildlife conservator. Further as long-term mitigation measures, the habitat enrichment activities such as planting of native bamboos, fruiting and fodders trees will be carried out. Environment Specialist in collaboration with Wildlife Conservator will determine the suitable plant species for wildlife habitat enrichment. There will be strict compliance monitoring by Environmental Specilaist while constructing road through Reserve Forest areas.

296. Construction workers may not hunt, fish or carry out other activities that will negatively impact wildlife. Strict rule must be adopted by contractor then any breach equals immediate dismissal. No construction or labour camps, batching plants, hot mix plant, stone crushing plants, and quarrying activities will be allowed within or 1 km radius Reserve Forest area and potential biological Corridor. The contractor will clearly brief the construction workers on strict forestry rules on illegal harvesting of forest products, poaching of wildlife and illegal fishing. Contractor will

ensure supply of all necessary food items, cooking gas and proper housing is provided to prevent illegal hunting and tree felling.

297. The operation of various construction equipment is likely to generate significant noise. Noise disturbance may cause migration of the animals to other areas which may increase the probability of human-animal conflicts. Setting of construction camp near forests or protected area may generally disturb surrounding fauna.

298. Limited indirect ecological degradation may also occur from wildlife poaching, by construction workers and outsiders due to greater accessibility and as a result of increased local demand for food. In order to avoid such impacts the contract document should include the following:

- Improvement proposals are restricted to minimum width in the length passing through Reserve Forest Area. Aligment has been selected to avoid areas with dense forests.
- Adequate measure are included in the design to minimize impacts on widlife.
- Signage for no-noise zones, wildlife conservation boards should be installed at the required project sites.
- Noise generating equipment like DG set, compressors will have acoustic enclosures. These will not be installed at least in one km area of Reserved forests. Noise generating activities should not be permitted during night.
- Drivers should be warned to move slowly in the wild life movement areas.
- If any wild animal come within the vicinity of 100m from the construction site, construction works must immediately stop and resume only after the wild animlas have moved away
- Provisions of signage as a precautionary measure to provide awareness about animal movement will be made to avoid accidents
- project staff and work crews should not be allowed to have fire-arms and animal traps etc. in the work zone within Reserved Forest;
- construction facilities such as workers camp, construction camp, hot mix plant, batching plant should be located at least 1 km away from the forest stretches.
- employment agreements should specify heavy penalties for illegal hunting, trapping and wildlife trading – all other ancillary works should also agree not to participate in such activities.
- Strict anti-poaching surveillance measures need to be implemented, especially during project construction phase in the reserved forests.

299. The forests along the project road also faces many problems and issues including hunting, poaching, etc.; and additionally the illegal trade on wildlife parts and articles at the International Cross Border (with Myanmar). Environment Specialist of the Authority's Engineer will coordinate with forest authorities to support its programmes on regular checking and monitoring of illegal contraband wildlife, their parts and other wildlife articles.

b. Vegetation

300. About 33.28 km length of the subproject road passes though the forest area. The density of vegetation in forest is 0.4 to 0.5. Removal of the existing vegetative cover and the uprooting of 3691 trees is an unfortunate activity, which will reduce the ecological balance in the areas. This will also enhance soil erosion. About 656,800 sq m (10 m strip for entire length 65.68 km) of scrub forests and vegetation will probably be removed for improvement of road section between Imphal and Moreh. The loss of vegetative cover will mostly be permanent and only some might be revived

through mitigation efforts. Another impact from road construction activities and deriving from the cutting of hillsides, quarrying, preparation and transfer of stone chips and other earthwork; is the accumulation of dust on the surrounding vegetation. This leads to deterioration of the vegetative health, which in turn will affect the ecology as well as the aesthetic beauty of the area. Induced impacts may result from the following:

- increased forest harvesting for fire-wood, construction timber, forage, medicinal plants and other products;
- increased earth and rock extraction;
- construction crew demands for wood as a fuel and for building materials;
- construction crew demands for food and recreational hunting and fishing;

301. To minimise negative impacts on the vegetative cover the contract documents should specify that:

- all wood building material for workers' housing should be brought from outside the project area;
- workers should be supplied with non-wood fuels such as kerosene or liquefied petroleum gas for the duration of the contract;
- all contract equipment and plants should be cleaned to the satisfaction of the project engineer in charge prior to their relocation to project sites;
- during site clearance, care should be taken to ensure that the minimum area of vegetation area is affected; and
- water sprinkling of trucks used as construction vehicles should be properly and regularly undertaken, so that dust deposition problem on vegetation are minimised.
- preservation of archid and other threatened plant species during construction by transplanation of archids found within proposed alignment and if transplantation is not possible, compensatory afforestation will be done in coordination with forest and horticulture departments of Manipur.

4. Human Use Values

302. Field reconnaissance surveys of the project road were conducted to assess the environmental and social conditions. It was noted that the relocation of structures will be required at congested locations along the subproject road mainly Imphal, Thoubal and Pallel. The widening options have been devised to minimise impacts of structures.

303. The survey also found that there are 1332 affected families and few shrines likely to be affected due to widening of road section. A resettlement plan is prepared to address this issue. The affected people will be compensated and rehabilitated as per the provisions of the Resettlement Plan.

304. The project will also required acqusition of about 68.6 Hactare of land to accommodate proposed widening of the subproject road section.

305. At certain locations on the road, particularly at bridge /culvert sites, traffic will be temporarily diverted from the existing carriageway while construction is in progress and temporary traffic diversions will be managed within the ROW. In other instances, traffic may have to be diverted across adjacent private land, in which case compensation will be paid for any loss of crops or the replacement of damaged structures. In other situations, most frequently not at bridge sites, for example when bitumen surfacing is in progress, it may be required to close the road temporarily. In these circumstances, adequate radio and press releases should be made beforehand and a date/time given for the re-opening.

306. Most construction will be undertaken during the dry season when few crops are planted. Losses should be minimised during construction.

5. Sensitive Location Such as School, Temples, Hospital along the Project Road

307. The sensitive location such as school, college and hospital along subproject road within 100 meter from the edge of the existing road has been identified as given Table 61.

Table 60: Sensitive Locations along the Project Road

Chainage		Sensitive Features (Left Side of Road)	Distance from the edge of existing road (m)
Start	End		
330+400	330+500	Abdul Ali Govt. High School	6
331+100	331+200	Lillong Higher Secondary Madrassa	18
331+200	331+300	Galaxy Institute of School	18
339+300	339+400	Temple	6
339+400	339+500	Temple	2
340+600	340+700	Nimaichand High School	5
341+200	341+300	The Fancier Abhiram Higher Secondary School	5
344+800	344+900	The Khangabok Govt High School	22
345+300	345+400	KM Blooming Higher Secondary School	19
346+200	346+300	Wangbal Jr. High School	10
348+900	349+100	The Y.K College	12
352+400	352+500	Khongjom Standard School	18
357+700	357+800	Sora High School, Mosque	8
391+200	391+300	Chamol Baptist Church	19
330+000	330+100	Lilong Higher Secondary School	30
330+900	331+000	Mosque (Jama Masjid)	5
331+500	331+600	The Lilong Girls High School	14
331+700	331+800	Mosque	14
332+700	332+800	Mosque	7
333+500	333+600	Mosque	16
333+600	333+700	Mosque	15
337+000	337+100	Small temple	10
337+900	338+000	Temple	10 m
340+700	340+800	Waikhom Mani Girls College	7
342+800	342+900	RK Muktasana Educational Institute	5
343+900	344+000	Athokpam Jr. High School	13
344+400	344+500	Thoubal District Hospital	4
347+800	347+900	Royal Academy School	8
352+700	352+800	Small Temple	15
363+000	363+100	Temple	15
364+800	364+900	Temple(Ibhidhou Pakhangba)	2
365+700	365+800	Ideal High School	6

308. In the 4 lane widening section (20 km length) only Thoubal is the congested area which already has 4 lane divided carriageway width. Therefore disturbance to the residences and sensitive receptors will be less compared to existing two lane road sections proposed for 4 laning.

These structures will be kept unaffected by the proposed improvement proposal. Short term impacts during the construction stage are expected. Measures such as timely scheduling of construction activities in these areas, provision of sign boards, appropriate noise barriers or raised boundary walls are adopted to minimize impacts.

6. Health, Safety and Hygiene for Construction Workers

309. Construction of the road will result in the generation of waste. In isolated places, the amount of waste generated may be greater than normal because of substandard subsoil materials, which will need to the replaced. The Contractor will strictly follow the World Bank EHS guidelines with respect to H&S, sanitation and welfare facilities to be provided. Specific measures will be taken while working in hilly terrain.

310. The Contractor will be required to control the construction site, keep it clean and provide facilities such as dust bins and collectors for the temporary storage of all waste. This waste should be adequately stored to avoid pollution of water supplies and water sources and to avoid dust formation. The Contractor will be responsible for the safe removal and/or storage of all waste in order to prevent environmental pollution of any type that may be harmful to people or animals.

311. All necessary safeguards should be taken to ensure the safety, welfare and good health of all persons entitled to be on the sites and to ensure that works are carried out in a safe and efficient manner. All personnel working at vulnerable site locations will wear safety helmets and strong footwear. It should be ensured that all workmen and staff employed on site use proper safety equipment – for example, eye protectors, ear plugs, safety helmets, the designated safety equipment when working over water - and that proper rescue equipment is available. Fire extinguishers and first-aid equipment will be kept at all sites.

312. The construction camps are anticipated to house up to 200 people for about three years. With this concentration of people, the potential for the transmission of diseases and illnesses will increase. The main health and safety risks during construction will arise from:

- inadequate sanitation facilities in worker camps;
- introduction of sexually transmitted, and other diseases, by immigrant workers; and
- outbreaks of malaria, typhoid, cholera etc. amongst the labour force.

313. The following actions will be undertaken at construction camps and stipulated in construction contracts:

- submit and obtain approval for a health and safety plan prior to the commencement of work;
- provision of adequate health care facilities; and
- workers will be required to undergo pre-employment medical screening and treatment (if required) and periodic health checks thereafter.

314. The subproject will support a public health education programme for workers and villagers covering road safety, malaria, hygiene, and sexually transmitted diseases. The district health departments will also be invited to participate in monitoring and educating communities and workers affected by the project.

7. Nuisance to Nearby Properties

315. Nuisance to nearby properties is likely to result from:

- noise and vibration from mechanical devices and construction plant;

- dust during quarrying, construction and the trafficking of new surfaces prior to sealing;
- gaseous emissions from heavy equipment; and
- fumes from asphalt boiling sites.

316. About 30 km length of the subproject road (from Pallel onwards) passes through hilly terrain and except for SPM and PM10 at congested locations, presently air/dust pollution is not a major issue. There will be regular watering of the road surfaces or the application of emulsion coats near villages, where dust is a nuisance. Noise generating equipment such as power generators and concrete mixers will be kept away from populated/commercial areas. Provisions will be incorporated into the contractor's contract to require the use of dust suppression measures.

8. Interference with Utilities and Traffic

317. On the project road, utilities interfere with the ROW at few locations that will have to be shifted / removed prior to construction. This should not be a major problem.

318. Traffic may experience minor delays when diverted around active construction areas, but will be more severely hampered at the locations where temporary road closures are necessary. Such hazard points will have proper signs indicating the nature of the problem envisaged. In hilly terrain specific measures such as prior intimation about road closure, timing of work, safety equipments for workers etc. will be impemented. Site specific measures will be implemented by contractor in such locations in consultation with the Environment Speicalist of the Authority's Engineer's environment specialist.

319. Contractor will ensure that information on the timing of construction works and notifications of road closure (if any) is provided via the local media (radio, TV, newspaper etc.) or through the local community heads.

9. Community Impacts

320. Community impacts are mostly due to the resettlement of people due to widening of the project road to 4/2 lanes.

321. Construction camps may put stress on local resources and the infrastructure in nearby communities resulting to people raising grievances. This sometimes leads to aggression between residents and migrant workers. To prevent such problems, the contractor should provide the construction camps with facilities such as health care clinics, places of worship, and occasional entertainment. The use of local labourers during the construction will be promoted to minimise these problems.

10. Quality of Life

322. The impact of the improvements of project road on the socio-economic environment will be significantly beneficial. Improved access and reduced travel time and cost will be major stimuli to economic growth, particularly in rural areas. Better access of agricultural goods to market will be important and a major contributor to poverty reduction.

323. Increased labour mobility will occur. This has both positive and negative impacts. Increased access is a two-way phenomenon, and the corollary to increased access to the project areas is increased access for the residents of these areas to more urban life-styles. Out-migration

may result. There is also the likelihood of the relocation of homes and businesses to new road-side locations.

324. During construction, benefits to local people can be maximised if the contractor recruits construction workers locally regardless of gender. Where possible, he/she should also not discriminate in the employment of women.

11. Construction Materials

325. The use of proper sources for stone and aggregates has become a major issue in most of the north-eastern states. Historically, stone has been collected from the roadside or from shallow surface workings. Small quarries on steep slopes are often enlarged by blasting or excavation at the base. This is dangerous and can cause slope failures. Roadside stone collection continues in some districts despite its proven negative impacts on road safety and stability. Sand and gravel are often obtained from river deposits. Jurisdiction over stone and aggregates is shared between the Geological Survey of India and the State Forest Department. The Geological Survey of India issues licences for major mineral developments while the Forest Department issues permits for stone quarrying and for sand and gravel extraction. This is largely because these are mostly found on forest lands. Roadside quarrying is officially discouraged, but unofficially continues, invariably by petty contractors.

326. Adequate earth material is available from barren land in the vicinity. Estimated quantity is 1,45,500 cum Aggregates (320000 MT) will be mostly sourced from licensed quarries available locally. Sand 80,000 cum will be taken from river beds after prior permission from competent authority. Sicne the rivers are seasonal the impacts of aquatic ecosystem of the river will be very limited. Prior to commencement of sand extraction from the river, water sample will be collected to check aquatic paramters of the river water. The Authority's Engineer's Environment Specialist will esnure that contractor undertake sampling and if required appropriate site specialist mitigation measures will be implemented.

327. Construction water requirement (avg. 300KLD and peak 400 KLD) will be met through local rivers and other local streams. Domestic water requirement (50 KLD) for workers will also be met mainly through local streams after adequate treatment and testing. Ground water must not be used for drinking purpose given the high level of BOD. If needed, in extreame cases groundwater may also be abstracted and treated prior to using it for drinking purposes. Water testing shall be done weekly to confirm it is acceptable for human consumption (regular tests required since baseline tests indicate pollution).

328. Road maintenance, repair and new construction will continue to cause large demands for construction materials. There is a clear need for a better materials supply policy in each district to minimise environmental impacts of small-scale, poorly managed operations and improve the quality and reliability of supply. In some districts, it may be appropriate to develop centralised quarries, if an operator can be attracted. In any case, pre-designation of sources would give contractors a level playing field for bidding and minimise incentives for environmentally damaging cost cutting.

329. The engineering team as part of material survey has identified and recommended sources of the construction materials. Details are these sources are provided in Section 3, N (para 117). As a prior requirement of project, every new quarry and borrow area should also be subjected to a site specific environmental investigation work according to an approved plan; and should be left

in a safe condition or restored to a productive land use. Subject to these conditions, obtaining construction materials for projects will not cause unacceptable impacts.

330. Quarry and borrow pits may be filled with rejected construction waste and afterwards should be given a vegetative cover. If this is not possible, then the excavated slopes will be filled in such a way that they resemble an original ground surface.

331. Mitigation for Quarries

- aggregates will be first sourced from licensed quarry sites (which are in operation) that comply with environmental and other applicable regulations;
- occupational safety procedures/practices for the work force will be adhered to in all quarries;
- quarry and crushing units will be provided with adequate dust suppression measures; and
- regular monitoring of the quarries by concerned authorities to ensure compliance with environmental management and monitoring measures.

332. Mitigation of Borrow Areas

- prior approval will be obtained from concerned authorities and all local environmental regulations be complied with;
- within all identified borrow areas, the actual extent of area to be excavated will be demarcated with signs and access to the operational area controlled;
- borrow pit plant and machinery will conform to CPCB and World Bank EHS noise leven guidelines;
- protective gear (ear plugs, helmets, gloves, shoes etc) will be provided to the workforce exposed to noise levels beyond threshold limits of 85dB(A) and there should be proper rotation of such personnel; and
- all operation areas will be water sprinkled to control dust levels to national ambient air quality standards (Annex 3).

333. The project will require large amounts of bitumen or bitumen emulsion usually stored in drums. The empty bitumen drums should be properly stored and recycled for suitable purposes. The empty bitumen drums must not be used for parapets or river bank stabilization.

334. The project will require the import, transport and use of fuel and oils. Minor diesel spills are common in region, especially around fuel stations. To mitigate these impacts following measures will be applied.

- Secondary containment around fuel tanks and at fuelling stations will be built;
- Follow World Bank EHS guidelines including 110% bund for fuel, oil, chemical, hazardous waste storage area etc.
- Oil and fuel spills, and other runoff from contaminated areas will be controlled; and
- Equipment and fuel depots will be placed in safe zones away from drinking water sources and along river banks.

335. The project provides an opportunity to assist the PIU and contractors in improving fuel handling practices so as to minimise future fuel spillage.

F. Environmental Impacts - Operation Phase

1. Runoff, Spoils of Hazardous Materials

336. The current low traffic flows along the project road is expected to increase because of improved economic activities associated with better access. The larger numbers of vehicles will be an additional source of noise and gaseous emissions.

337. Repairs to culverts and new drainage work will eliminate/reduce the soil erosion problems presently caused by poor cross drainage. Also, the situation will remain good because this road pass through area that are largely forested and trees and plants have the capacity to absorb gaseous pollutants. Bioengineering techniques may also help to absorb pollution.

338. As the subproject work will include blasting of rocks in hilly, there are possibilities of Acid Rock Drainage (ARD) due to leaching of sulphur containing materials from rocks that become exposed to atmospheric oxygen by blasting work. This may lead to degradation of water quality in the area. To avoid ARD issue, it is recommended that during the details design the Authority's Engineer geologist should confirm that the local geology does not provide for any ARD issues. In case, there are indications of ARD issue, site specific measures will be impelemented to control the ARD.

2. Air Quality Modelling and Prediction of Impacts

339. To assess the likely concentrations at the various locations along the subproject road corridor, the prediction of the pollutant concentrations has been carried out using CALINE-4, a dispersion model based on Gaussian Equation. The modelling has been done seperately for each package i.e. Package 1 (Lilong-Wanjing) and Package 2 (Wanjing-Khudenthabi) road corridors. The input parameters for the prediction are detailed in subsequent paragraphs.

340. CALINE-4 is a dispersion model based on Gaussian equation. It is developed by the California Department of Transportation for the prediction of concentrations of critical atmospheric pollutants (CO, NOx and PM10) along the highways. This model employs a mixing zone concept to characterize pollutant dispersion over the highway and can be used to predict the pollutant concentrations for receptors upto 500 m of the corridor. The model uses the baseline data on existing concentration of pollutants and estimates the incremental emissions due to the project.

341. Various input parameters for the prediction of pollutant concentrations are discussed below:

- **Traffic Data:** The fleet wise traffic volumes for the present study have been taken from the detailed project report of the project. The annual average daily traffic (AADT) data is available for the proposed highway corridor through traffic survey. CALINE 4 model needs hourly average traffic volume. However, model has been setup for peak traffic hours assuming 3 times of average hourly traffic volume. The total traffic hour volume is further categorized in to two wheeler, four wheeler, Light commercial vehicles (LCVs), Bus and high commercial vehicles (HCVs), based on the traffic survey at existing highway corridor. The annual average daily motorized traffic data are given in Table 61 and Table 62 on Package 1 (Lilong-Wanjing) and Package 2 (Wanjing-Khudenthabi) road corridors respectively.

Table 61: Annual average daily motorized traffic data Lilong to Wanjing (Package 1)

Types of Vehicles	2016	2020	2025	2030	2035	2040
Motorcycle	7314	8890	14470	17102	19254	21258
Car (New Technology)	8868	10779	15521	18344	20652	22802
Three Wheeler	3287	3996	5503	6504	7323	8085
Medium Bus	229	279	401	474	534	590

Tractor - Trailor	25	31	43	50	57	63
Truck Light (2 axles)	1376	1673	2723	3218	3623	4000
Truck Medium (2 axles)	815	991	1862	2200	2477	2735
Truck Heavy (3 axles)	76	93	221	261	294	325
Truck Articulated (5 axles)	0	0	0	0	0	0
Car (Old Technology)	3389	4120	5932	7011	7893	8715
Mini Bus	102	124	178	211	237	262

Table 62: Annual average daily motorized traffic data Wanjing-Khudanthabi Section (Package 2)

Types of Vehicles	2016	2020	2025	2030	2035	2040
Motorcycle	999	1,588	2,324	3,119	3,950	4,899
Car (New Technology)	1,153	2,990	4,993	6,519	8,085	9,836
Three Wheeler	419	694	933	1,170	1,404	1,660
Medium Bus	28	81	100	122	144	167
Tractor - Trailor	3	4	5	7	8	9
Truck Light (2 axles)	173	294	817	1,088	1,362	1,657
Truck Medium (2 axles)	101	272	764	972	1,196	1,455
Truck Heavy (3 axles)	9	37	130	165	203	247
Truck Articulated (5 axles)	0	1	2	3	3	4
Car (Old Technology)	441	0	0	0	0	0
Mini Bus	12	25	36	44	52	61

- **Road Geometry:** In the CALINE-4 model the entire length of the selected road section is divided into various road links. The division of sections into links has been done in such way, so that the link can be fairly considered as straight stretch of road having homogenous geometry with uniform road width, height and alignment. The coordinates of end points of links specify the location of the links in the model. The maximum numbers of link in each road section can be 20. The mixing zone width calculated for selected highway corridor is 21 m (1m+ 3 m + 3 m + 14 m) as per guideline provided in CALINE4 model.

- **Emission Factors:** Emission factor is one of the important input parameter in Caline-4 model. In the present study, the emission factors specified by the Automotive Research Association of India (ARAI, 2007) have been used for calculation of weighted emission factors. These emission factors have been expressed in terms of type of vehicles and type of fuel used (for petrol and diesel driven passenger cars). Since, there is only one input requirement for total no. of vehicles in the CALINE 4 model, whereas, there are different categories of vehicles (viz., Two wheelers, Cars, Bus and trucks) with different year of manufacture and fuel used, it is essential that a single value representing the equivalent or weighted emission factors for all the vehicles is input into the model. The emission factor used to estimate WEF are given below in table 3. The traffic data are not available for fuel types, therefore average emission factor are used in this study. Thus, WEF expressed in g/mile (converted from gm/km) has been calculated for the present study using methodology given by Sharma et al., 2013. For PM_{10}, emission from re-suspension of road dust of paved road have been estimated using following empirical equation (USEPA 2011).

  $E = k\,(sL)^{0.91} \times (W)^{1.02}$

Where:
E= particulate emission factor (g/VKT)
K =particle size multiplier (g/VKT), default value of "k" for $PM_{2.5}$ is 0.15 g/VKT
sL = road surface silt loading (g/m^2) = 0.531 g/m^2 (Sahu et al., 2011)
W = Average weight of vehicles (in tons) on road = 1.41 Ton (Sahu et al., 2011)

The emission factor for CO, $PM_{2.5}$ and NOx used in the present study for different vehicles type are given in table 2. The calculated WEF for CO, $PM_{2.5}$ and PM_{10} for peak traffic hours is given in table 3. The calculation of SO_2 emission factor for different categorized of vehicles are described in table 4.

Table 63: Emission factors for different types of Vehicle (ARAI, 2007)

Vehicle type	CO Emission factor (gm/km)	$PM_{2.5}$ Emission factor (gm/km)	Nox Emission factor (gm/km)
Two wheeler	3.08	0.20	0.412
Three Wheeler	2.50	0.24	0.532
Cars/Jeep	1.53	0.06	0.424
LCV	2.02	0.49	1.723
BUS	8.40	1.08	6.53
HCV	12.65	1.60	6.53

Table 64: Weighted Emission Factor for proposed traffic

Weighted Emission factor for CO (g/mile)	Weighted Emission factor for $PM_{2.5}$ (g/mile)	Weighted Emission factor for PM_{10} (g/mile)	Weighted Emission factor for NOx (g/mile)
4.78	0.41	0.67	1.28

Table 65: Emission Factor of SO_2 for proposed traffic

Vehicle Category	Vehicle mileage(km l^{-1})	Fuel consumed per km (ltrs)	Sulphur content (%)	Density (kg/m^3)	SO_2 (g/km)
2Ws	45.1	0.022	0.015	750	0.004989
LMVs-passenger	20.5	0.049	0.015	750	0.010976
4Ws-Petrol	12.6	0.079	0.015	750	0.017857
4Ws-Diesel	13.8	0.072	0.035	876	0.044435
LMV-goods	10	0.100	0.035	876	0.06132
HDVs-truck	4.6	0.217	0.035	876	0.133304
Buses	4.6	0.217	0.035	876	0.133304

- **Meteorological data:** The study was conducted to predict pollutant concentration for worst meteorological conditions. The meteorological parameters such as wind speed, wind direction standard deviation, temperature, mixing height and stability condition are used in model. The wind direction standard deviation was calculated to know the flexibility of wind direction and used as input parameters in worst case

run condition. The model has been run with worst case, in which models predicted maximum pollutant concentration.

- **Receptors:** A set of link receptors were taken at various receptor locations within each section at a distance of 5 m, 10 m, 20 m, 40 m, 70 m, 100m and 200 m both sides from edge of the carriageway to know the dispersion of pollutant from the road. The monitoring station are marked as receptor points to compare the monitoring and predicted pollutant concentrations.

342. A worst-case scenario[15] has been considered to predict the pollutant concentration levels. The incremental pollutant concentration levels predicted along the road corridors for the years 2016, 2020, 2025, 2030, 2035, and 2040 are presented in the Table 66 and Table 67 respectivley for Package 1 and Package 2. The predictions for pollutant concentration PM10, CO and NOx have been made taking into consideration the existing pollutant levels as established by the ambient air quality monitoring. The predicted concentrations are also presented graphically on Figure 1-3 (Package 1) and Figure 4-6 (Package 2).

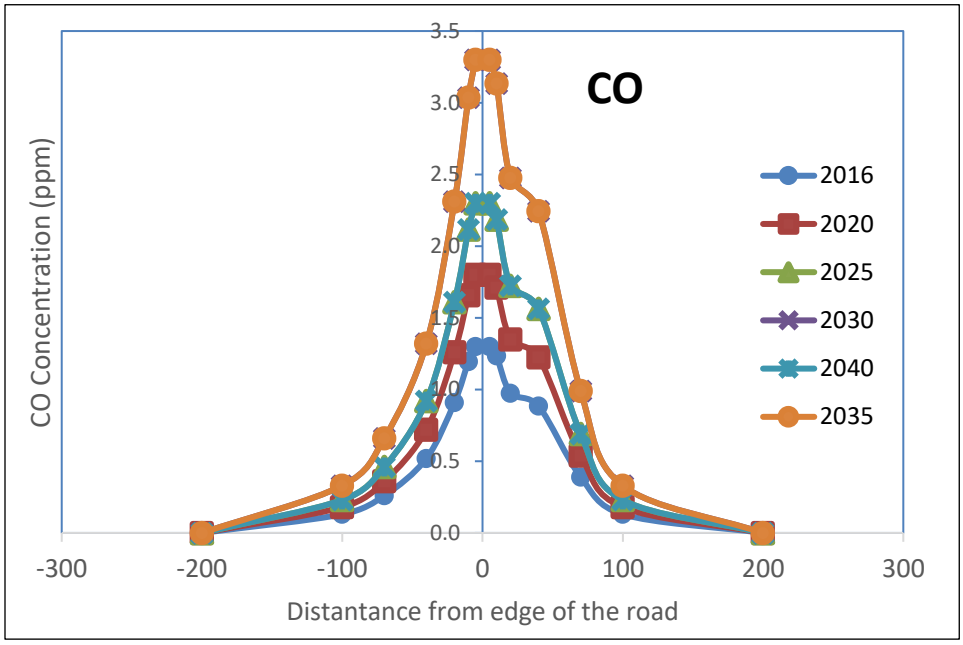
[15] Worst-case scenario considers worst-case wind angle and worst-case meteorological conditions. In worst-case scenario, the model takes the given wind speed and selects wind direction which gives maximum CO concentration at pre-defined receptor locations. The background CO concentration was assumed to be zero, so the predicted CO concentration reflected the incremental increase in CO concentrations due to vehicle the vehicle activities only.

Table 66: Pollutant predicted concentrations along the Package 1 (Lilong-Wanjing Road Corridor) for peak traffic hour

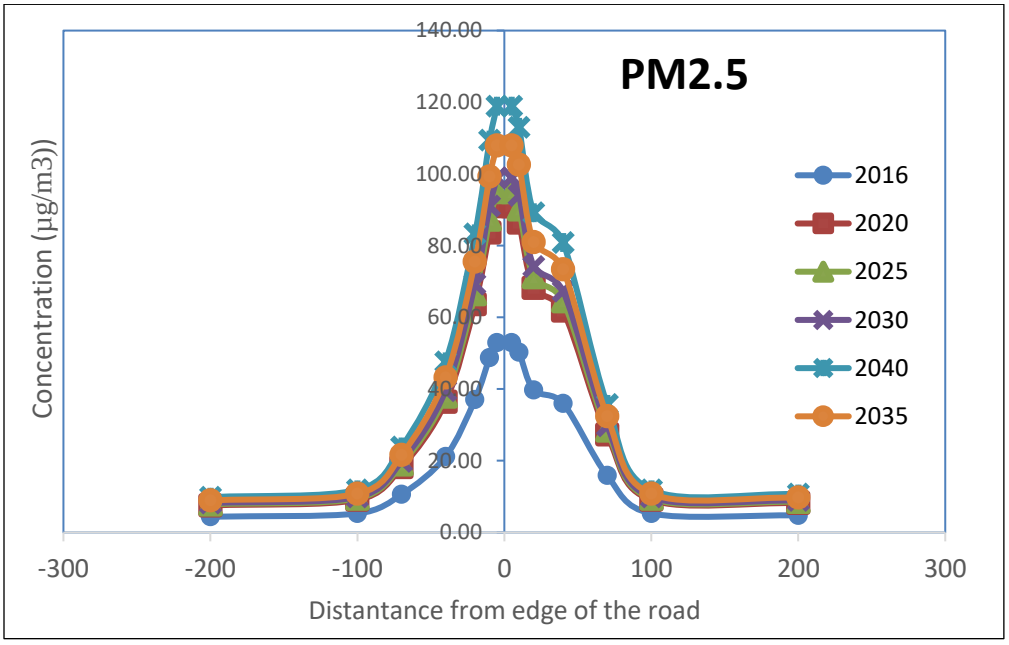
Road Stretch		Pollutant concentration														
	Year	Distance from the edge of the road, m. (Left side)								Distance from the edge of the road, m. (Right side)						
		-200	-100	-70	-40	-20	-10	-5		5	10	20	40	70	100	200
CO	2016	0.0	0.1	0.3	0.5	0.9	1.2	1.3		1.3	1.2	1.0	0.9	0.4	0.1	0.0
	2020	0.0	0.2	0.4	0.7	1.3	1.7	1.8		1.8	1.7	1.4	1.2	0.5	0.2	0.0
	2025	0.0	0.2	0.5	0.9	1.6	2.1	2.3		2.3	2.2	1.7	1.6	0.7	0.2	0.0
	2030	0.0	0.2	0.4	0.8	1.5	1.9	2.1		2.1	2.0	1.6	1.4	0.6	0.2	0.0
	2035	0.0	0.3	0.7	1.3	2.3	3.0	3.3		3.3	3.1	2.5	2.2	1.0	0.3	0.0
	2040	0.0	0.2	0.5	0.9	1.6	2.1	2.3		2.3	2.2	1.7	1.6	0.7	0.2	0.0
$PM_{2.5}$	2016	4.38	5.29	10.59	21.17	37.05	48.70	52.93		52.93	50.28	39.70	35.99	15.88	5.29	4.76
	2020	7.53	9.09	18.19	36.37	63.65	83.66	90.93		90.93	86.38	68.20	61.83	27.28	9.09	8.18
	2025	7.86	9.49	18.99	37.97	66.45	87.34	94.93		94.93	90.18	71.20	64.55	28.48	9.49	8.54
	2030	8.19	9.89	19.79	39.57	69.25	91.02	98.93		98.93	93.98	74.20	67.27	29.68	9.89	8.90
	2035	8.94	10.79	21.59	43.17	75.55	99.30	107.93		107.93	102.53	80.95	73.39	32.38	10.79	9.71
	2040	9.85	11.89	23.79	47.57	83.25	109.42	118.93		118.93	112.98	89.20	80.87	35.68	11.89	10.70
PM_{10}	2016	9.56	11.55	23.10	46.19	80.84	106.24	115.48		115.48	109.71	86.61	78.53	34.64	11.55	10.39
	2020	15.04	18.17	36.34	72.67	127.18	167.15	181.68		181.68	172.60	136.26	123.54	54.50	18.17	16.35
	2025	15.61	18.85	37.70	75.39	131.94	173.40	188.48		188.48	179.06	141.36	128.17	56.54	18.85	16.96
	2030	16.52	19.95	39.90	79.79	139.64	183.52	199.48		199.48	189.51	149.61	135.65	59.84	19.95	17.95
	2035	16.85	20.35	40.70	81.39	142.44	187.20	203.48		203.48	193.31	152.61	138.37	61.04	20.35	18.31
	2040	17.51	21.15	42.30	84.59	148.04	194.56	211.48		211.48	200.91	158.61	143.81	63.44	21.15	19.03
SO_2*#	2016	0.00	0.92	1.83	3.66	6.41	8.42	9.15		9.15	8.69	6.86	6.22	2.75	0.92	0.00
	2020	0.00	0.92	1.83	3.66	6.41	8.42	9.15		9.15	8.69	6.86	6.22	2.75	0.92	0.00
	2025	0.00	0.92	1.83	3.66	6.41	8.42	9.15		9.15	8.69	6.86	6.22	2.75	0.92	0.00
	2030	0.00	0.92	1.83	3.66	6.41	8.42	9.15		9.15	8.69	6.86	6.22	2.75	0.92	0.00
	2035	0.00	0.92	1.83	3.66	6.41	8.42	9.15		9.15	8.69	6.86	6.22	2.75	0.92	0.00
	2040	0.00	0.92	1.83	3.66	6.41	8.42	9.15		9.15	8.69	6.86	6.22	2.75	0.92	0.00
NOx*	2016	0.00	3.55	7.10	14.20	24.84	32.65	35.49		35.49	33.72	26.62	24.13	10.65	3.55	0.00
	2020	0.00	3.55	7.10	14.20	24.84	32.65	35.49		35.49	33.72	26.62	24.13	10.65	3.55	0.00
	2025	0.00	3.55	7.10	14.20	24.84	32.65	35.49		35.49	33.72	26.62	24.13	10.65	3.55	0.00
	2030	0.00	3.55	7.10	14.20	24.84	32.65	35.49		35.49	33.72	26.62	24.13	10.65	3.55	0.00
	2035	0.00	3.55	7.10	14.20	24.84	32.65	35.49		35.49	33.72	26.62	24.13	10.65	3.55	0.00
	2040	0.00	3.55	7.10	14.20	24.84	32.65	35.49		35.49	33.72	26.62	24.13	10.65	3.55	0.00

Table 67: Pollutant predicted concentrations along the Package 2 (Wanjing-Khudenthabi Road Corridor) for peak traffic hour

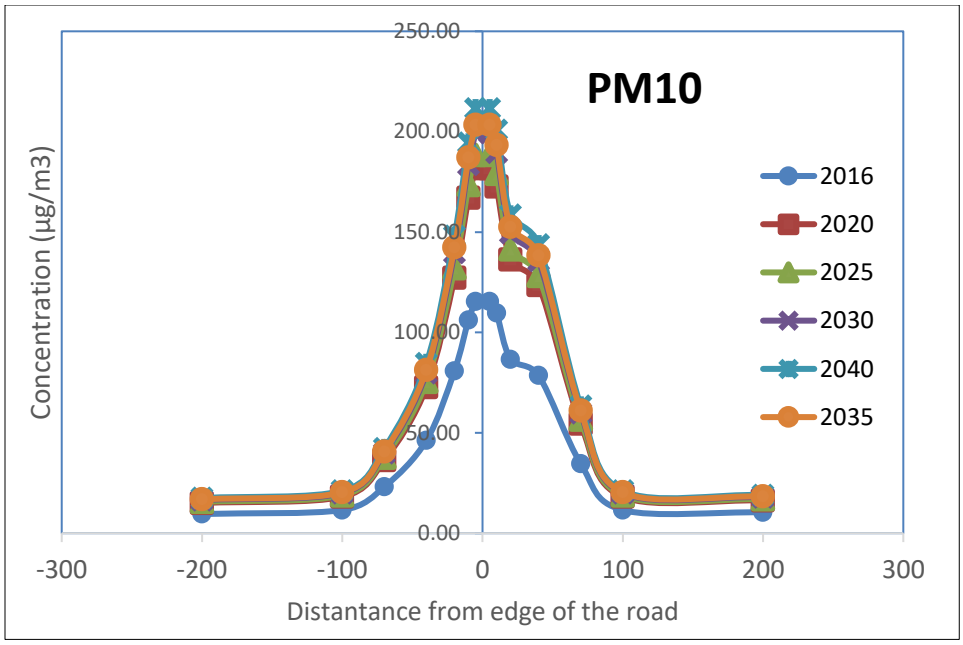
Road Stretch		Pollutant concentration														
	Year	Distance from the edge of the road, m. (Left side)								Distance from the edge of the road, m. (Right side)						
		-200	-100	-70	-40	-20	-10	-5		5	10	20	40	70	100	200
CO	2016	0.0	0.1	0.1	0.3	0.5	0.6	0.7		0.706	0.7	0.5	0.5	0.2	0.1	0.0
	2020	0.0	0.1	0.2	0.4	0.6	0.8	0.9		0.9	0.9	0.7	0.6	0.3	0.1	0.0
	2025	0.0	0.2	0.5	0.9	1.6	2.1	2.3		2.3	2.2	1.7	1.6	0.7	0.2	0.0
	2030	0.0	0.1	0.2	0.4	0.8	1.0	1.1		1.1	1.1	0.8	0.8	0.3	0.1	0.0
	2035	0.0	0.3	0.7	1.3	2.3	3.0	3.3		3.3	3.1	2.5	2.2	1.0	0.3	0.0
	2040	0.0	0.1	0.2	0.5	0.8	1.1	1.2		1.2	1.1	0.9	0.8	0.4	0.1	0.0
$PM_{2.5}$	2016	3.43	4.14	8.27	16.55	28.96	38.06	41.37		41.37	39.30	31.03	28.13	12.41	4.14	3.72
	2020	4.64	5.61	11.21	22.43	39.25	51.58	56.07		56.07	53.27	42.05	38.13	16.82	5.61	5.05
	2025	5.36	6.48	12.95	25.91	45.34	59.59	64.77		64.77	61.53	48.58	44.04	19.43	6.48	5.83
	2030	5.91	7.14	14.27	28.55	49.96	65.66	71.37		71.37	67.80	53.53	48.53	21.41	7.14	6.42
	2035	6.41	7.74	15.47	30.95	54.16	71.18	77.37		77.37	73.50	58.03	52.61	23.21	7.74	6.96
	2040	7.00	8.46	16.91	33.83	59.20	77.80	84.57		84.57	80.34	63.43	57.51	25.37	8.46	7.61
PM_{10}	2016	6.95	8.40	16.79	33.58	58.77	77.24	83.96		83.96	79.76	62.97	57.09	25.19	8.40	7.56
	2020	8.91	10.77	21.53	43.06	75.36	99.05	107.66		107.66	102.28	80.75	73.21	32.30	10.77	9.69
	2025	10.11	12.21	24.41	48.82	85.44	112.30	122.06		122.06	115.96	91.55	83.00	36.62	12.21	10.99
	2030	10.98	13.26	26.51	53.02	92.79	121.96	132.56		132.56	125.93	99.42	90.14	39.77	13.26	11.93
	2035	11.85	14.31	28.61	57.22	100.14	131.62	143.06		143.06	135.91	107.30	97.28	42.92	14.31	12.88
	2040	12.78	15.44	30.87	61.74	108.05	142.01	154.36		154.36	146.64	115.77	104.96	46.31	15.44	13.89
SO_2*#	2016	0.00	0.38	0.76	1.52	2.65	3.49	3.79		3.79	3.60	2.84	2.58	1.14	0.38	0.00
	2020	0.00	0.38	0.76	1.52	2.65	3.49	3.79		3.79	3.60	2.84	2.58	1.14	0.38	0.00
	2025	0.00	0.38	0.76	1.52	2.65	3.49	3.79		3.79	3.60	2.84	2.58	1.14	0.38	0.00
	2030	0.00	0.38	0.76	1.52	2.65	3.49	3.79		3.79	3.60	2.84	2.58	1.14	0.38	0.00
	2035	0.00	0.38	0.76	1.52	2.65	3.49	3.79		3.79	3.60	2.84	2.58	1.14	0.38	0.00
	2040	0.00	0.38	0.76	1.52	2.65	3.49	3.79		3.79	3.60	2.84	2.58	1.14	0.38	0.00
NOx*	2016	0.00	0.78	1.55	3.10	5.43	7.14	7.76		7.76	7.37	5.82	5.28	2.33	0.78	0.00
	2020	0.00	0.78	1.55	3.10	5.43	7.14	7.76		7.76	7.37	5.82	5.28	2.33	0.78	0.00
	2025	0.00	0.78	1.55	3.10	5.43	7.14	7.76		7.76	7.37	5.82	5.28	2.33	0.78	0.00
	2030	0.00	0.78	1.55	3.10	5.43	7.14	7.76		7.76	7.37	5.82	5.28	2.33	0.78	0.00
	2035	0.00	0.78	1.55	3.10	5.43	7.14	7.76		7.76	7.37	5.82	5.28	2.33	0.78	0.00
	2040	0.00	0.78	1.55	3.10	5.43	7.14	7.76		7.76	7.37	5.82	5.28	2.33	0.78	0.00



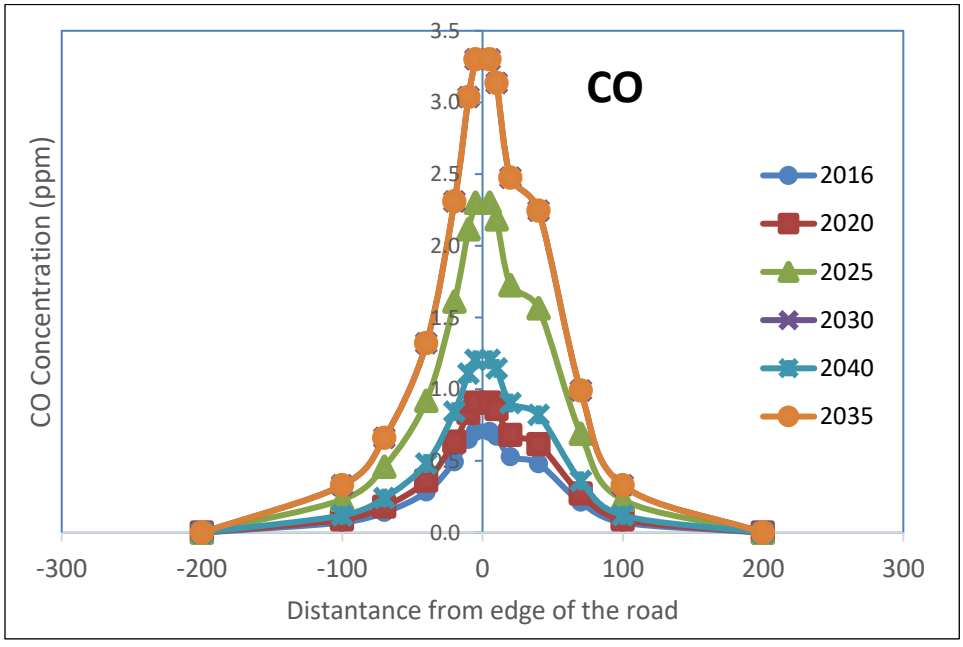
Graph 1: CO predicted concentrations (ppm) along the Package 1 road corridor



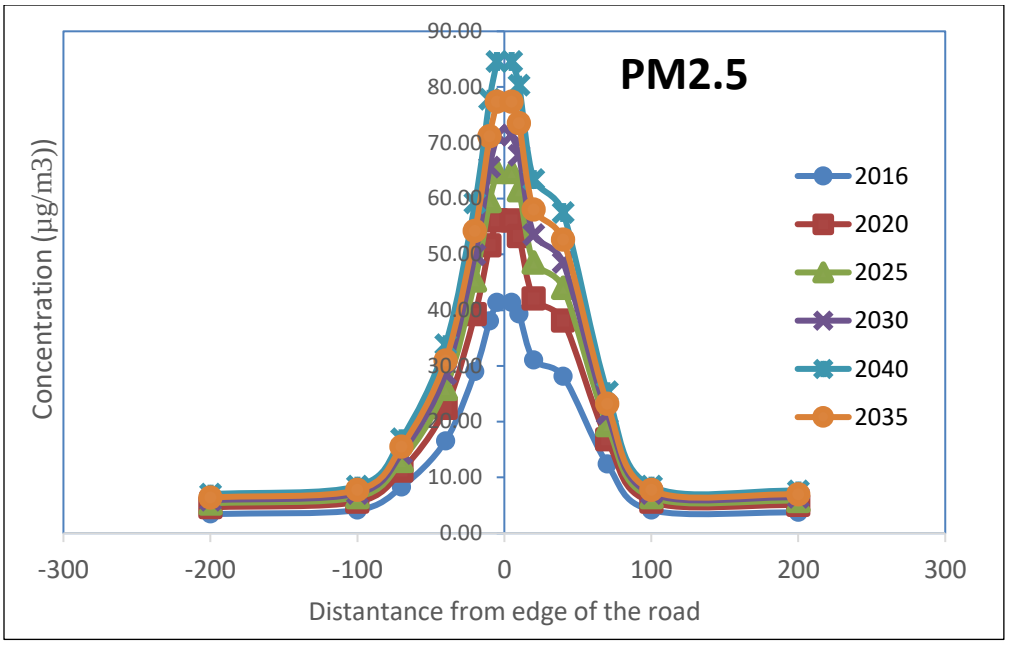
Graph 2: PM2.5 predicted concentrations (µg/m3) along the Package 1 road corridor



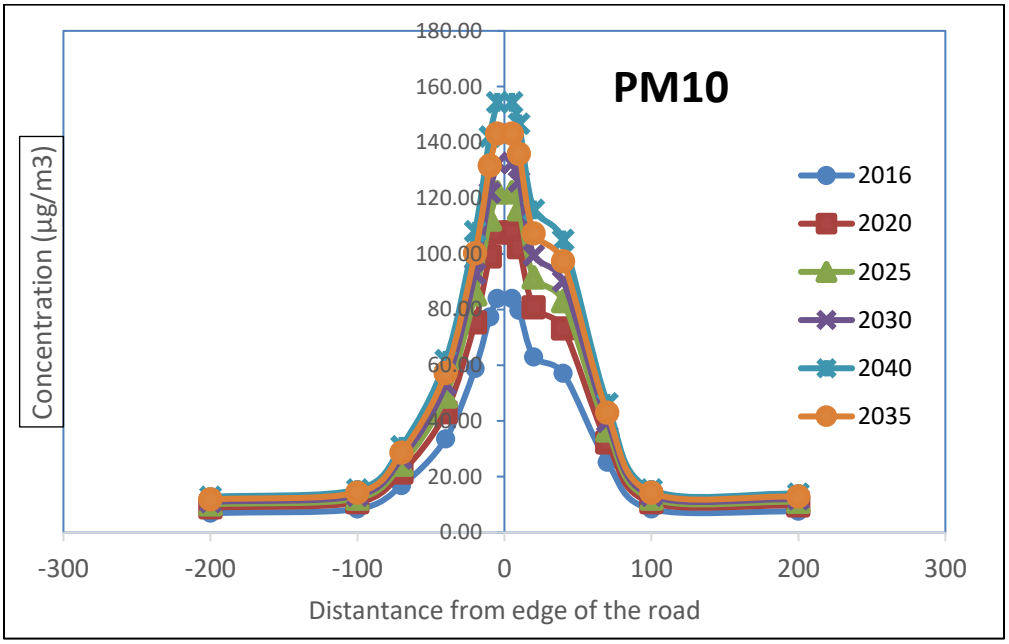
Graph 3: PM10 predicted concentrations (µg/m3) along the Package 1 road corridor



Graph 4: CO predicted concentrations (ppm) along the Package 2 road corridor



Graph 5: PM2.5 predicted concentrations (µg/m3) along the Package 2 road corridor



Graph 6: PM10 predicted concentrations (µg/m3) along the Package 2 road corridor

343. In addition, the spatial distribution of hourly average predicted CO, $PM_{2.5}$, PM_{10}, SO_2 and NOx concentrations have been plotted respectively for peak traffic hour which shows that pollutant concentrations is decreasing when goes away from the highway corridor. From the CALINE4 modelling results, it is observed that maximum dispersion of pollutants concentration emitted from traffic volume at proposed road corridors is up to 70m. Therefore, the impacts of traffic movement at proposed road project will not impact the surrounding atmosphere significantly. The complete report on CALINE model run is including spatical distribution of hourly average predicted CO CO, $PM_{2.5}$, PM_{10}, SO_2 and NOx concentrations is provided in Annex 12

and Annex 13 for Package 1 (Lilong-Wanjing section) and Package 2 (Wanjing-Khudenthabi section) respectively.

344. **Observations:** It has been observed from the model output that when the traffic volume increases, the concentration of air pollutants also increases correspondingly. The particulate matter (PM2.5) concentration is high at all sensitive receptors. This shows the degraded air shed for particulate matter. However, the annual incremental PM10 level over the period of next 30 years is in the range of 2-2.5 µg/m3. Also the PM concentration exceeding only within a corridor of 10 m from the edge of road. Beyond 10m, the concentration is well within the permissible limits. Predicted pollutant concentrations of CO and NOx over the existing ambient air quality are found to be within the National Ambient Air Quality Standards (Annex 3) as well as IFC (World Bank EHS Guidelines). For SPM management, the SPS requirements and EHS guidelines for degraded airshed will be followed during constuction as well as operation phases to control the air pollution. Relevant rcommended mitigation measures for controlling PM concerntration as per the WB-EHS guidelines are:

- Speed reduction of traffic
- paving (asphalt - concrete)

3. Noise Level Modeling and Predictions

345. Federal Highway Administration's Traffic Noise Model (FHWA TNM) helps for highway traffic noise prediction and analysis. TNM computes incremental highway traffic noise at nearby receivers. As sources of noise, it includes noise emission levels for the following vehicle types:

- Automobiles: all vehicles with two axles and four tires -- primarily designed to carry nine or fewer people (passenger cars, vans) or cargo (vans, light trucks) -- generally with gross vehicle weight less than 4,500 kg (9,900 lb);
- Medium trucks: all cargo vehicles with two axles and six tires -- generally with gross vehicle weight between 4,500 kg (9,900 lb) and 12,000 kg (26,400 lb);
- Heavy trucks: all cargo vehicles with three or more axles -- generally with gross vehicle weight more than 12,000 kg (26,400 lb);
- Buses: all vehicles designed to carry more than nine passengers; and
- Motorcycles: all vehicles with two or three tires and an open-air driver / passenger compartment.

346. The procedure for prediction of noise levels involves the following steps:

- Identification of various receivers,
- Determination of land uses and activities which may be affected by the noise generated,
- Assemble input parameters, and
- Application of the model.

347. The description of the components to predict noise level are as follows:

- **Receivers:** TNM calculates the sound levels at the input receivers.
- **Land Uses:** Land use along the road is obtained from the topographic drawings. This information provides the range of shielding and absorption factors to be applied at the various receivers.
- **Input Parameters:** Traffic volume for the projected period is obtained from the traffic projections. The total number of vehicles passing per hour by type - light, medium and heavy along with their average speed is used for predictions.

- **Average Noise Level:** All vehicles produce noise, which is taken as the base, and the cumulative noise at the receiver distance due to the whole traffic is estimated. The average noise level varies depending on the type of vehicle.
- **Application of Model:** Equivalent noise levels due to traffic at the receivers are estimated using Federal Highway Noise model. Equivalent Sound Level (TEQ, denoted by the symbol, LAeqT): Ten times the base-10 logarithm of the square of the ratio of time-average, mean-square, instantaneous A-weighted sound pressure, during a stated time interval, T (where T=t2-t1), and the reference mean-square sound pressure of 20: Pa, the threshold of human hearing, e.g., 1HEQ, denoted by the symbol, LAeq1H, represents the hourly equivalent sound level. LAeqT is related to LAE by the following equation:

$$L_{AeqT} = L_{AE} - 10*\log10(t_2-t_1)$$

where L_{AE} = Sound exposure level in dB

348. **Sound Exposure Level (SEL, denoted by the symbol, LAE):** Over a stated time interval, T (where T=t2-t1), ten times the base-10 logarithm of the ratio of a given time integral of squared instantaneous A-weighted sound pressure, and the product of the reference sound pressure of 20:Pa, the threshold of human hearing, and the reference duration of 1 sec. The time interval, T, must be long enough to include a majority of the sound source's acoustic energy. As a minimum, this interval should encompass the 10 dB down points. Table 66 present the predicted day time noise levels over the existing baseline data at selected receptors.

Table 68: Predicted Noise Levels along the Project Road

Sl. No.	Receiver Name	Predicted LAeq 1hr in dB(A)							Incremental Increase in noise level over the project period of 20 years
			2017	2018	2019	2020	2025	2030	2035	
1	Govt. School Lilong		64.0	65.2	65.5	65.9	67.4	68.5	69.1	6.2
2	Lilong Hg. School		66.1	67.2	67.5	68.0	69.5	70.6	71.2	6.1
3	School @ 11.2 m		65.2	66.4	66.8	67.2	68.7	69.7	70.4	6.2
4	Waithau Primary School		65.5	66.7	67.0	67.5	69.0	70.1	70.7	6.3
5	Houkha Primary School		64.6	66.0	66.3	66.8	68.3	69.3	70.0	6.4
6	Thoubal College		66.2	67.4	67.7	68.2	69.8	70.8	71.4	6.4
7	Fancier Abhiram School		65.1	66.5	66.8	67.3	68.7	69.8	70.4	6.4
8	Girls Hostel		65.3	66.7	67.0	67.5	69.0	70.0	70.7	6.4
9	Zonal Education Office		65.7	67.1	67.4	67.9	69.4	70.4	71.1	6.4
10	Khangabock Hg School		64.6	66.0	66.3	66.8	68.4	69.5	70.1	6.7
11	God Father Boys Career Hostel		64.1	65.4	65.8	66.3	67.9	68.9	69.6	6.7
12	The KM Blooming Eng School		64.3	65.7	66.0	66.5	68.1	69.2	69.8	6.7
13	The KM School		64.8	66.2	66.5	67.0	68.6	69.7	70.3	6.7
14	Y.K. College		64.9	66.4	66.7	67.2	68.8	69.9	70.5	6.7
15	S P school		63.9	65.8	66.1	66.6	68.2	69.3	70.0	7.1
16	Lilong Girls High School		60.8	61.8	62.2	62.6	64.1	65.1	65.7	5.9

Sl. No.	Receiver Name	Predicted LAeq 1hr in dB(A)							Incremental Increase in noise level over the project period of 20 years
			2017	2018	2019	2020	2025	2030	2035	
17	Islamic English School		64.5	65.4	65.7	66.1	67.6	68.6	69.2	5.7
18	Peace & Freedom Academy		65.6	66.5	66.8	67.2	68.8	69.8	70.4	5.9
19	Girls College		65.0	65.9	66.2	66.6	68.1	69.1	69.7	5.7
20	Best Academy School		65.3	66.2	66.5	67.0	68.5	69.5	70.1	5.8
21	R.K.M. Hg. Sec. School		66.3	67.3	67.6	68.0	69.5	70.5	71.2	5.9
22	Athokpam Junior Hg. School		64.7	65.7	66.0	66.4	67.9	69.0	69.6	5.9
23	Manipur Nursing Institute		66.1	67.1	67.4	67.8	69.3	70.3	70.9	5.8
24	Brighter Angel School		64.0	65.0	65.3	65.7	67.3	68.3	68.9	5.9
25	Urban Health Center		59.6	60.5	60.8	61.3	62.8	63.8	64.5	6
26	District Hospital		60.9	61.9	62.3	62.7	64.2	65.3	65.9	6
27	Veterinary Hospital		64.1	65.6	65.9	66.4	68.0	69.0	69.7	6.7
28	Lorrain Eng. Junior School		60.7	62.0	62.4	62.9	64.6	65.7	66.3	6.7

h. Observations

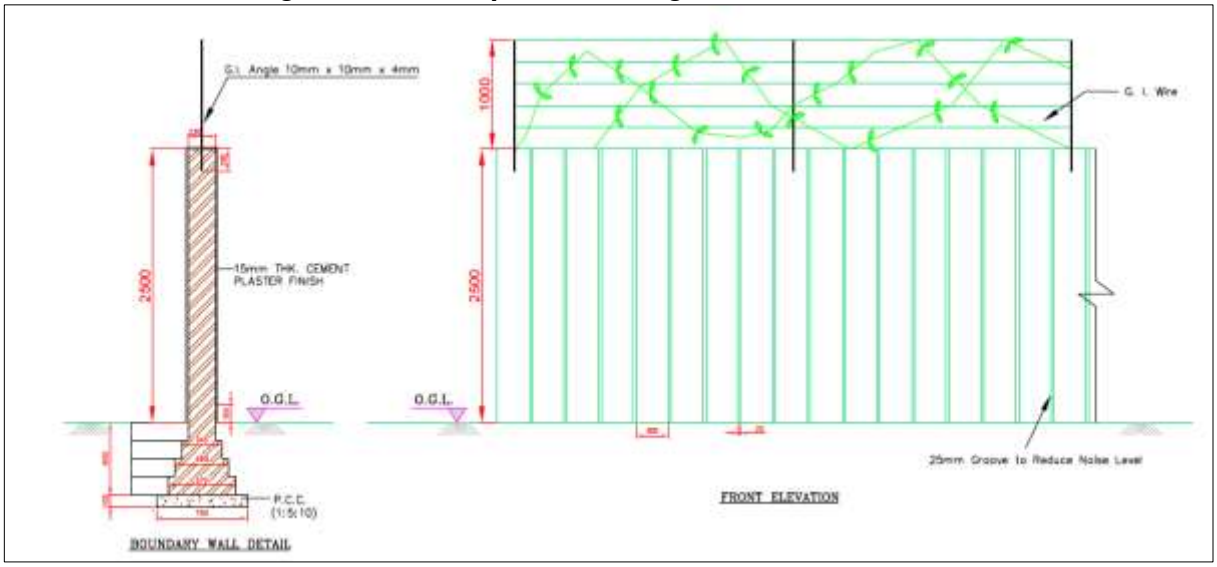
349. It can be seen from the Table 66 that noise levels (Leq) near the receivers are found to be higher than desired levels for the respective categories when compared with prescribed standards of CPCB (Government of India) as well as IFC (World Bank EHS Guidelines). The maximum predicted value 67.8 dB(A) is recorded (for the year 2018 when traffic will be induced) at the receiver located close to Thoubal college RKM School. The predicted levels show increase in noise levels for future years at all receivers considering an incremental noise level due to current traffic and project traffic is in the range of 5.5 to 7.1 dB(A). Installations of physical noise barriers are proposed at sensitive locations close to the edge of the road to keep the projected noise levels at these locations within CPCB/WB EHS standards i.e. 55 dB(A). Effective noise barriers can reduce noise levels by approximately 6db(A)[16]. Hence , the noise barriers should be able to maintain the noise at around baseline levels.

350. The Noise barriers can be constructed from earth, concrete, masonry, wood, metal, and other materials. To effectively reduce sound transmission through the barrier, the material chosen must be rigid and sufficiently dense (at least 20 kilograms/square meter). All noise barrier material types are equally effective, acoustically, if they have this density. To effectively reduce the noise coming around its ends, a barrier should be at least eight times as long as the distance from the home or receiver to the barrier. A provision of five Noise barrier locations in each corridor is made which should be provided based on the willingness of the school/temple or religious structures authorities and technical feasibility. Conceptual drawing of the noise barried is provided in 26.

[16] https://www.in.gov/indot/files/Noise%20Barriers%20Brochure.pdf

Environmental Specialist of Authority's Engineer will prepare site specific design of the noise barries and will provide it to the Contractor.

Figure 24: Conceptual Drawing of the Noise Barrier



351. At sensitive receptor locations where noise level is a major issues, physical noise barriers have been provided in the subproject design. These physical noise barriers can be constructed from earth, concrete, masonry, wood, metal, and other materials. To effectively reduce sound transmission through the barrier, the material chosen must be rigid and sufficiently dense (at least 20 kilograms/square meter). To effectively reduce the noise coming around its ends, a barrier should be at least eight times as long as the distance from the home or receiver to the barrier.

4. Land Use and Settlements

352. The likely impacts on land use and settlement patterns are limited. Improved access will lead to increased migration, but this will occur gradually and over a prolonged period. There will be time for new residential areas to be established. There will be a need to control ribbon development.

5. Social Impacts

353. Specific benefits to local people will include:

- easier communication;
- easier access to markets (both internally and regionally) with savings in travel times and costs;
- enhanced market efficiency through better distribution and accelerated deliveries etc.;
- improved access to health, education and other social services;
- employment generation;
- improved technical skills; and
- enhanced economic activity.

354. Likely adverse social impacts will include:

- increased chances of exposure to communicable diseases, particularly during construction;
- influxes of new settlers leading to increased pressure on natural resources causing hardship to local communities relying on local/forest resources; and
- rural-to-urban migration causing labour shortages in the depleted rural areas and other negative impacts in the urban areas.

G. Cumulative and Induced Environmental Impacts

355. According to the ADB Environment Safeguards Sourcebook17 Cumulative Impacts is described as: "The combination of multiple impacts from existing projects, the proposed project, and anticipated future projects that may result in significant adverse and/or beneficial impacts that cannot be expected in the case of a stand-alone project." The sourcebook also describes Induced Impacts as: "Adverse and/or beneficial impacts on areas and communities from unintended but predictable developments caused by a project, which may occur at later or at a different location.

1. Cumulative Impacts

356. The existing projects with significant environmental implications in the project areas are cross border trade through Asian Highways, quarry development in Chancel district, and new township development at Moreh. Project road may act as one of the access routes to mineral resources in future.

357. Induced Traffic: Based on the experience of the Consultants for similar NH projects, induced traffic has been considered based on the potential for existing land uses to release extra demand which might have been suppressed prior to the improvement of the project road. It is logical to assume that such induced traffic would be released from the zones in the influence area of the project road and not from the zones very far from Imphal-Moreh road. The induced traffic has been taken as 5% of the traffic on the project road.

358. Generated Traffic: After improvement of the project road some generated traffic would also be added to the normal traffic due to land use developments, which will be triggered by the increased accessibility along the project road. The generated traffic on the project road may be on account of the increased cross-border trade between India and Myanmar, existing quarries and minieral resources in the Chandel district, or due to the proposed petroleum refinery and the mineral reserve that is available along the project road also proposed township development in Moreh. Presently these resources are not being used fully. Once the project road is improved and the accessibility is improved the generated traffic will be released on the project road. Thus the share of generated traffic has been taken as 15% for the project road. Besides vehicular emission, other impacts associated with operation of new industries are soil erosion, noise and dust and ecological impacts particulary on wildlife section of the Imphal-Moreh road which will also have increased traffic due to improvement of the Project road.

359. Regional Trade: Since the project road is part of the ASEAN highway netwrok, the project will also contribute to the regional trade and commerce actvities.

360. The establishment of civilian government in Myanmar and the intensification of engagement with other countries and relaxation of trade sanctions are opening up trade opportunities with Myanmar. India is engaged in Myanmar with several projects and is actively

[17] Environment Safeguards, A Good Practice Sourcebook, Draft Working Document, December 2012

taking steps to upgrade border trade infrastructure and other trade facilitation measures. All these are expected to significantly increase the border trade. The India-ASEAN FTA in goods has seen increasing India's trade with ASEAN has seen large increase reaching USD 80 billion last year. The FTA is expected to abolish tariff restrictions on 3200 items by end of 2013 and will facilitate large growth in trade. Myanmar with its strategic location is the only land bridge to the ASEAN nations. With the opening up of Myanmar and the large potential in India-ASEAN trade growth, there is vast scope for generating traffic from adjacent country Myanmar for the various tradable goods. The trade potential at the Indo-Myanmar border through Moreh was estimated based on available assessments from various sources[18,19] and volume of trade estimated through Moreh Integrated Check post within 5 years of its operationalization. It is expected that a large portion of North East India's need will come through these border points in future. Based on the details collected from the Manipur PWD, the estimated goods vehicle traffic are given below for each type of tradable item:

- **Pulses, beans and lentils**: 150 truckloads daily @ 10 tons capacity (Background of the forecast: Estimated at two-third of the North East India pulses Consumption @ 58.1gm/capita/daily currently brought from rest of India).
- **Timber and timber products** (teak, hardwood & C class) - for use in 'Timber Park' at Moreh and for domestic demands: 50-60 truck loads daily (Background of the forecast: Estimated volume 200,000 cubic meters, (100,000 cum from Myanmar and 100,000 cum import from ASEAN Countries)).
- **Minerals** (coal, limestone, granite, iron ore, gypsum, silica sand, dolomite, rock phosphate etc.)= 75 to 200 truck loads daily. (Background of the forecast: Estimated at the installed manufacturing capacity of the factories in North East and local market). [India is importing about 5 million tons of rock phosphate for manufacture of fertilizer; of this about 2 million tons are imported from Kunming People's Republic of China. In return People's Republic of China imports 1.5 to 2 million tons of iron ore from India. Kunming to Kolkata via Moreh-Manipur route is less than 2000 Kms. There are huge coal mines in Myanmar, coal is cheaper and better. Other minerals command the same advantage from commercial points of view.
- **Items of general trade & commerce**: 40 to 60 truck loads daily. Items: Industrial goods & FMCG products, steel bars, cement, hardwares, petroleum products, tyres, automobile parts, machinery, equipments, fabric, yarn, essential commodity products, tea, marine fish, crafts & handlooms products, minor forest products etc.

361. Assuming about one-third of the export-import through land routes and Moreh being the main gateway from Myanmar, the potential of trade through Moreh is of the order of UD$ 600 million and this in terms of truck traffic based on broad assumptions is equivalent to about 750 trucks per day. With an annual growth of 14% in trade between India and Myanmar3 and the potential for trade with other ASEAN countries also through this corridor, it is safe to assume the potential will realize in the next 10 years and the potential for truck traffic is of the order of 1000 trucks per day along this corridor including empty trucks by 2022. This is also in line with the above estimate of about 400 trucks for import alone from Myanmar (almost 600 trucks including empty trucks).

[18] Kimura, F., T. Kudo and S. Umezaki (2011), 'ASEAN-India Connectivity: A Regional Framework and Key Infrastructure Projects' in Kimura, F. and S. Umezaki (eds.), ASEAN-India Connectivity: The Comprehensive Asia Development Plan, Phase II, ERIA Research Project Report 2010-7, Jakarta: ERIA, pp.1-56.

[19] Augmenting Bilateral Trade Between India &Myanmar, Country Report, Indian Chamber of Commerce, 2012

362. The road upgrading will also improve the travel speed and travel condition along the Imphal-Moreh corridor and is expected to generate a road user cost saving of over 20% and this will result in additional traffic generation along the corridor which is taken at 10% of the traffic

363. In addition, there is potential for large scale quarry development along project corridor (mainly Khudumbthabi area) this corridor with abundant quantity of good quality aggregate availability. Based on consultation with state PWD and others involved in the construction industry, it is estimated that about 200 trucks per day will be generated by developing the quarries. This is expected to happen within 5 years of opening of the road. Besides vehicular emission, other impacts associated with operation of quarries are soil erosion, noise and dust.

364. Development of proposed new township[20] at Moreh is also expected to contribute to traffic. The township is planned for next ten years. It is expected that about 80-100 vehicles will be added to the project road due to this proposed township. The environmental issues associated with township would be vehicle pollution, waste management etc.

365. Appropriate mitigation measures have been included in the EMP for possible short-term and long-term impacts which may arise particularly in the quarry development and Moreh areas where new township is planned.

a. Cumulative Impacts of Extension of Project Road to Moreh

366. An assessment is made of likely cumulative impacts due to extension of project road further to international border at Moreh which further connects to ASEAN Highway network. The expansion of NH-39 (AH-1) upto Moreh is proposed for improvement under Tranche 3 of this SASEC investment program. The road stretch is a critical section of the UNESCAP Asian Highway No. 01 (AH01), paving the way for India and other South Asian countries to Myanmar, and further to ASEAN countries.

367. This assessment is based on the review of the secondary data and maps on location, topography, terrain, land use and assciated construction activities.

368. This section of road starts at Km 395+680 (end point of subproject road) and ends at Moreh border (km 425+411) covering a total length of about 30 kms. The terrain is mostly hilly (except Moreh town area) with steep slopes for most part of the road and land use to forested. About 20 km length of the this road passes through Yangoupokpi Lokchao Wildlife Sanctuary (YLWLS - a protected area under GOI regulations). Elevation ranges from 2100 m above msl to 1120 m. It crossed one Lokchao rivers. Figure 25 show the location map of the Imphal-Moreh Extension Road. The road work will include expansion of existing road to 2 lane carriageway standards.

[20] Master Plan for new township at Moreh, Manipur (2013-2032) prepared by Town and Country Planning Organization, MoUD, Government of India.

Figure 25: Location map of the Tamenglong-Haflong Extension Road

369. Owing to the lack of exact information on improvement proposals, location, extent and timeframe of development of this extension road, it is not currently possible to assess cumulative impacts that may occur. Should these development projects take place in proximity of and concurrent to works on the proposed project road section, possible cumulative impacts may include:

- Land Acquisition: impacts due to acquisition of fresh land for construction of new road paticualry from the YLWLS and forest areas.
- Loss of Flora and Fauna: Due to diversion of forest and YLWLS sanctuary land and also construction of road through protected areas. Areas of protected flora and fauna sensitive to disturbance.
- Wildlife movement: due to increased traffic on the this road section since it will be upgraded and linked to international ASEAN highway network.
- Landslides: due to steep slope and soil erosion.
- Natural resources: road development projects are likely to require large amounts of aggregates during construction. There may be significant cumulative impacts from transportation of aggregates from the borrow pits and quarries to the construction sites, and from the operation of concrete batching plants.
- Water resources: There is the potential for pollution of sensitive water resources during construction in the same way as for the proposed subproject road Project. The cumulative impact is considered to be potentially negative; however, large volumes of fuel, oil or chemicals are unlikely to be used during construction.
- Ecology: Cumulative impacts from the road extension project may include permanent removal of habitat particularly in forest areas and YLWLS area This is considered as significant impact since entire section passes through forest/sanctuary area. However since there is an existing road and project will involve widening and will be in general an extension to the existing footprints rather than completely new ones in areas of undisturbed habitat.
- Air quality: At locations where construction of the proposed extension road passes in close proximity to dwellings, construction dust may cause a temporary nuisance to local residents. This is important particularly for Khudengthabi and Moreh town

areas. There could be some additional dust in the atmosphere or the duration of increased dust concentrations could be longer.

- Noise and vibration: At locations where construction of the proposed road extension work is carried our, noise may cause a temporary disturbance to local residents as well as vibration may cause damage to the most vulnerable properties.
- Community health and safety: during road construction impacts in community health and safety due to exposed to noise, dust and vibration disturbance and the risk of road traffic accidents.
- Traffic: The proposed Project will involve a large number of vehicle movements on public roads that are also used by other developments and construction projects, as well as the public. This could have a cumulative impact in terms of temporary congestion or an increased risk of accidents, and is considered to be a potentially negative. There may be significant cumulative impacts from general construction traffic movements, including transportation of aggregates from the borrow pits and quarries to concrete batch plants and construction sites.
- Unplanned events: New developments will not be permitted within a defined distance from the proposed project facilities in accordance with Indian law, and any development planned within 500m will be subject to risk assessment. Keeping third-party developments at safe distance from the project facilities means that third-party incidents are extremely unlikely to escalate to include the project or vice versa.

370. Since the topography, terrain, land use and improvement proposals of the road upto Moreh is expected to be similar to those of subproject road but will be significant in terms of impacts on flora and fauna and biodiversity values. Specific mitigation measures will be proposed including an detailed biodiversity assessment study as well as conservation programs in collaboration with YLWLS management plan. Mitigation measures proposed in the EMP for project road would minimize some of the impacts associated with extension of project road to Moreh. Therefore it is recommended to follow the proposed EMP for extension road section as well.

2. Induced Impacts

371. An assessment is made of likely induced impacts due to improved project activities.

372. The trade level between border countries is on rise since a very long period. The damaged road condition have little deterrent on trade in the past through, it has posed substantial inconvenience to people and trading community. The region to which the road traverse is already developed in terms of industry and trade aspects for supply of commodities required by neighbouring countries. The improved road is expected to increase transport through this region but is unlikely to trigger exponential development in this region. Setting up few new industries and increase in trade volume though cannot be ruled out. As such no significant induced environmental impact is anticipated due to proposed project activity. Few of the probable positive and negative induced impact are indicated below:

a. Positive Induced Impact

- Increased Trade Opportunities among ASEAN countries
- Increase in Per Capita Income in Manipur and country as a whole
- Easy access to cross country education and employment opportunities

- Increased competition requiring better products at least costs, forcing entrepreneur adoption of technologically advanced systems and process resulting in efficient resource utilisation,
- Link infrastructural development.

b. Negative Induced Impacts

- May stress the available limited resources
- May lead to conversion of more and more agricultural areas to non-agricultural uses
- May have cultural changes due to movement of people from different caste and culture
- May lead to faster growth of urban population putting larger pressure on municipal infrastructure.
- May result in deterioration of air, water and soil quality due to inappropriate disposal of municipal waste and increase of vehicle population in satellite town areas.
- There are mineral resources within Moreh district. Though they are not located within the project area, the project road may act as one of the access routes to mineral resources in future.

373. For addressing the impacts of air pollution, noise and safety, measures on regular maintenance of the road including the road furniture, monitoring of vehicle emissions and enforcement of Euro 3 standards, construction of noise barriers and others have been included in the EMP during operation stage.

H. Potential Environmental Enhancement/ Protection Measures

374. Annex 5 to Annex 9 of this IEE Report presents good environmental management practices and guide documents in the following aspects of road construction:

- Plant Management – Annex 5
- Camp Site Management – Annex 6
- Debris Disposal Management – Annex 7
- Borrow Area Management – Annex 8
- Quarry Area Management – Annex 9

VI. CLIMATE CHANGE IMPACTS AND RISKS

A. Climate Change Mitigation

375. The Transport Emissions Evaluation Model for Projects (TEEMP)[21] developed by Clean Air Asia[22] was utilized to assess the CO2 gross emissions 'with' and 'without' the subproject improvements which is mainly surface roughness and directly impacts of vehicle speed and fuel consumptions. It also allows the assessment of future congestion, if they will occur in the future given the projected increase in traffic and road capacity 'with' and 'without' the subproject improvements like lane configuration and road roughness.

376. Information that was fed into the model for projecting the CO2 emissions were:

- Tranche 2 subproject road between Imphal-Moreh will improve 65.8 km road section (national highway) located in three districts i.e. Imphal, Thoubal and Chandel; of Manipur state in northeastern part of India;
- Road section between Lilong-Wanjing (20.0 km) will be widened and improved to 4-lane carriagway configuration (with 26 m carriageway width) whereas section between Wanjing - Khongkhang village (45.8 km) will be improved to 2-lane configuration (with 7 m carriageway width);
- Road surface roughness will decrease from the general condition of 7.0 m/km to 3.0 m/km;
- Other improvements include the repair or reconstruct damaged culverts, introduction of paved drains for all road section and built up drains where necessary, removal of any irregularities that are on the existing vertical profile, and road safety appurtenances.

377. Traffic forecasts were taken from the economic analysis / engineering report (Chapter 4 of Main Volume of Detailed Project Report) for two homogeneous road sections disaggregated into vehicle types and share to the annual average daily traffic as presented in Table 67.

Table 69: Vehicle Composition on subproject road

Vehicle Type	Traffic Composition (%)	
	Section 1	Section 2
Car/Jeep/Van	23.2	5.3
Taxi	16.1	0.0
2- Wheeler	29.1	7.1
3- Wheeler	24.8	7.6
Mini Bus	0.0	0.0
Std Bus	0.9	0.0
Ambulance,Firetender,Funeralvans	0.1	0.0
Trucks	0.2	0.1
Cycle	1.7	0.4
CRK	0.2	0.0
AC	0.0	0.0
HC	0.0	0.0

[21] TEEMP is a Microsoft excel-based, free-of-charge spreadsheet models to evaluate emissions impacts of transport projects.

[22] A network of 250 organizations in 31 countries established by the Asian Development Bank, World Bank, and USAID to promote better air quality and livable cities by translating knowledge to policies and actions that reduce air pollution and greenhouse gas emissions from transport, energy and other sectors.

Vehicle Type	Traffic Composition (%)	
	Section 1	Section 2
Others	0.0	0.0
3- Tyre	0.5	0.1
Mini LCV (Ace)	0.8	0.0
4-Tyre	1.0	0.3
6-Tyre	0.8	0.2
2-Axle	0.5	0.1
3-Axle	0.2	0.0
MAV	0.0	0.0
7 Axle or more Axle/HCM/EME	0.0	0.0
Trailers	0.0	0.0
Tractor	0.0	0.0

378. Road capacity of 7,200 PCU/lane/day for rural roads was adopted for the project. Emission factors were mostly taken from the CBCP/MoEFCC (2007) Draft Report on Emission Factor Development for Indian Vehicles, the Automotive Research Association of India, and C. Reynolds et.al (2011) Climate and Health Relevant Emissions from in-Use Indian for three-wheelers rickshaw as presented in Table 68.

Table 70: CO2 Emission Factors used in the TEEMP Model

Vehicle Type	Petrol	Diesel	LPG/CNG
2-Wheel	1.37 kg/l		
3-Wheel	2.12 kg/l	2.58kg/l	3 kg/l
Cars/bus/bus	2.24 kg/l	2.58 kg/l	

379. Finally, emission from 1 kilomerte rural road construction were taken from the ADB reference (ADB - Carbon footprint 4, http://www.adb.org/documents/reports/estimating-carbon-footprints-road-projects/default.asp). In present case 2115200 kg CO2/km of road constrcution were taken as referecne value. This value if based on estimation of unit bill of materials required to upgrade /construct 1 kilometer of rural highway which include cement, steel, gasoline, diesel, and bitumen etc.

380. **Estimated carbon emissions**. For each kilometer of rural highway upgrading, CO_2 emission from construction is estimated at 3.8 tons. The design life of the project road range from 15 to 20 years. Total annual emission without the project at the middle of the design life at year 10 is estimated at 55,434 tons and with project including induced traffic is estimated at 64,960 tons. A summary of the expected annual CO_2 emissions is provided in Table 69.

Table 71: Estimated Annual Gross CO2 Emissions Intensity for subproject road

Road Section	Business-As-Usual	Project (without Induced Traffic)	Project (with Induced Traffic)
Imphal-Moreh	55434	24932	64960

381. While there is an increase in the CO2 emissions due to increase in traffic the levels are still far below the 100,000 tons per year threshold set in the ADB SPS 2009 and therefore not required to implement options to reduce or offset CO2 emissions.

B. Climate Risks and Adaptation Needs

1. Introduction

382. In general, transport can be vulnerable to many different types of weather conditions, of which, some of them could be exacerbated with climate change. Many of them relate to extreme weather conditions (e.g. storms, extreme precipitations, extreme temperatures) which on their turn may result in severe consequences for the physical environment (e.g. floods, landslides, etc.) and represent risks for transport infrastructures and operations.

383. Depending on future global warming and the region of Manipur in India, transport modes and system components could be affected by one or several simultaneous changes in climate conditions, including hotter summers, extreme precipitation events and increased storminess. If such impacts are not anticipated in future transport infrastructure design and maintenance, those changing weather conditions could, in some regions, accelerate their deterioration, increase severe damages risks, traffic interruption and accidents which could, on their turn, affect economic activities.

384. A recent development in the state of Manipur is the establishment of a dedicated Climate Change Cell under the Directorate of Environment, Government of Manipur. The establishment of the Climate Change Cell in 2015 aims to address the existing as well as future challenges of climate change and take actions to reduce the associated risks and vulnerabilities. The Cell is the nodal agency, which in collaboration with 20 line government departments / agencies of Manipur Government, is responsible for the preparation of the Manipur State Action Plan on Climate Change (SAPCC). This cell has a research, advisory and coordinating role on climate change issues and is a single-window contact for dealing with the state government and other external funding agencies in issues pertaining to uptake of climate change related proposed actions.

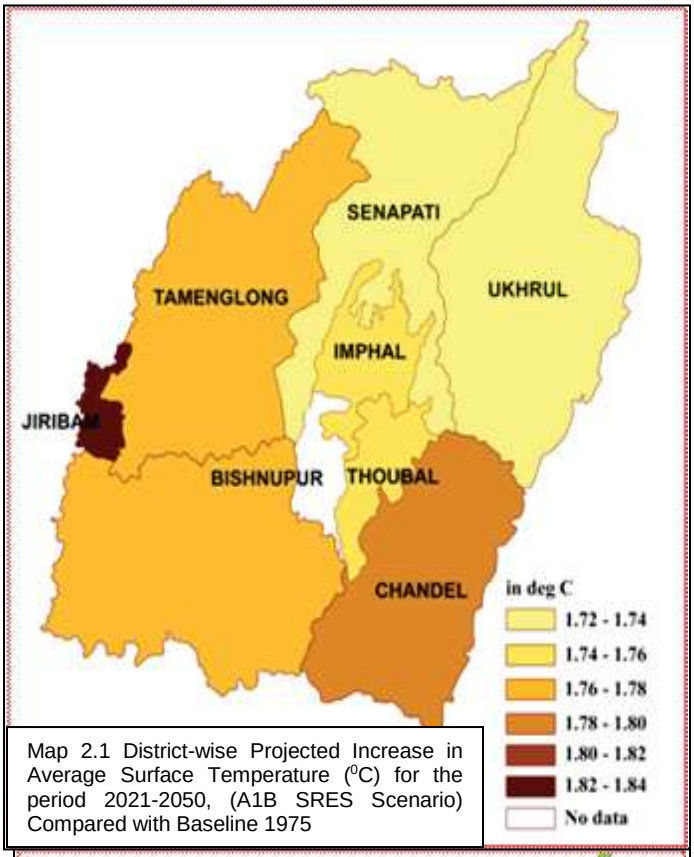
2. Literature Review of Climate Change in the State of Manipur

a. Manipur State Action Plan on Climate Change (SAPCC Draft Report), 2013

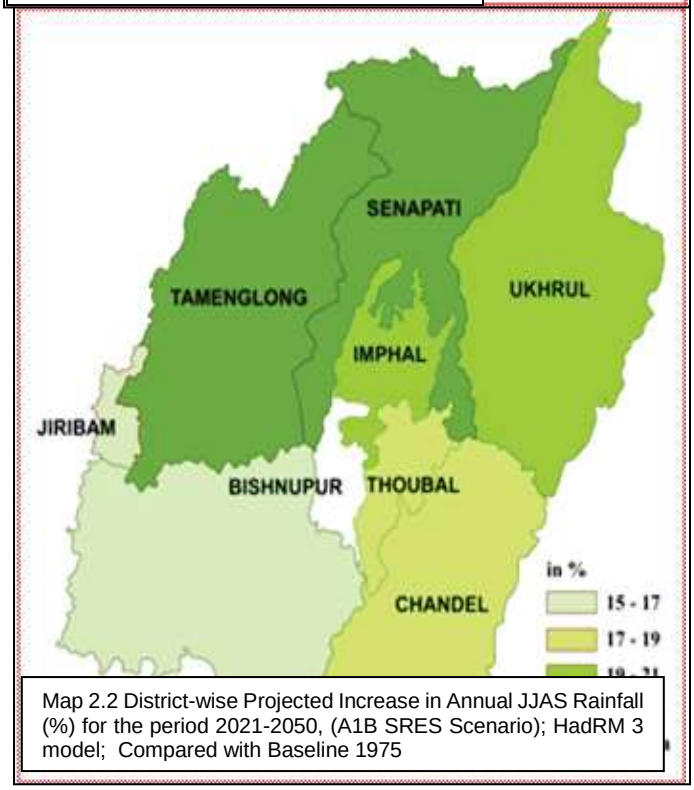
385. The State Action Plan on Climate Change (SAPCC) - Manipur focuses on understanding the climate change, adaptation practices, mitigation of climate variability and natural resource conservation through eight missions viz. (1) State mission for Ecosystem, Biodiversity and Livelihood sustainability (2) State mission for Water Resources (3) State mission for Sustainable Agriculture Practices (4) State mission for Health (5) State mission for Forests Resources Conservation, (6) State mission for Enhanced Energy Efficiency & Conservation, (7) State mission for Urban Planning and (8) State mission for climate change Strategic Knowledge & Information. It provides a multi-pronged and integrated framework for addressing the climate change in the state.

386. The SAPCC presents Climate change projections made for the following for the time slice 2021-2050: (a) daily values of temperature (average), and (b) daily values of precipitation. Data from the HadCM3 global climate model downscaled with HadRM3 (PRECIS) model and a regional climate model for downscaling global climate projections (Kumar et al., 2006), has been used for the projections. Daily weather dataset of Manipur for the last 57 years (January 1954-December 2011) was developed by Environment Monitoring, Research & Development Laboratory, Directorate of Environment, Govt. of Manipur & integrated in the study. District-wise

data was obtained by re-gridding the dataset to 0.1 X 0.1 degrees, and re-aggregating by districts to study the climate variability at district level.



Map 2.1 District-wise Projected Increase in Average Surface Temperature (^{0}C) for the period 2021-2050, (A1B SRES Scenario) Compared with Baseline 1975



Map 2.2 District-wise Projected Increase in Annual JJAS Rainfall (%) for the period 2021-2050, (A1B SRES Scenario); HadRM 3 model; Compared with Baseline 1975

387. ***Projected Changes in Surface Temperature.*** The dataset of surface temperature variation observed during 1954 – 2011 shows an increasing trend in the mean maximum temperatures. With the mean maximum temperature increased from 26.50C to 27.30C, equally the mean minimum temperature has increased from 13.80C to 15.30C.

388. The projected change in average surface temperature in the state of Manipur by the mid 2030's as developed by IIS Bangalore is reproduced as follows: (Refer Map 2.1 for district-wise projections)

- the state is projected to experience an increase in temperature above 1.7°C
- the projected increase in annual average temperatures for the southern districts are higher than the northern districts of Manipur
- the western-most district and Imphal west is projected to experience the highest increase in temperature, 1.8°C and ° the northern part of the state is projected to have lower increase in average temperature compared to the southern part of the state.

389. ***Projected Changes in Annual Precipitation:*** By the same report, the following are indicated.

390. Map 2.2 shows the district-wise projected change in total annual rainfall for the southwest monsoon season (June, July, August and September). Precipitation events by 2030's in Manipur are:

- The entire state of Manipur is projected to receive increased precipitation

- The northern parts of the state are projected to experience an increase of ≥ 19% of rainfall
- The southern parts also experience an increase in precipitation of ≥ 15%.
- Further, an increase in the number of extreme rainfall (> 100 mm/day) conditions is projected for the state.

b. Climate change vulnerability profiles for North East India[23].

391. The North East region of India, consisting of eight states covering a geographic area of 26.2 mha and a population of 40 million, is characterized by large rural population (82%), low population density, large percentage of indigenous tribal communities (34–91%) and large area under forests (60%). The region has two main river basins (the Brahmaputra and Barak), a large dependence of the population on natural resources, and poor infrastructure development. The region is also characterized by diverse climate regimes which are highly dependent on the southwest monsoon (June–September). Over 60% of the crop area is under rain-fed agriculture, and so is in areas highly vulnerable to climate variability and climate change.

392. This study has carried out an assessment of the overall implications of climate change and vulnerability in the North East in three major sectors, viz. agriculture, water and forest. The objective was to understand the sector-wise vulnerabilities at the district level so that the targeted policies by development agencies can be designed to improve the most vulnerable sectors. In the case of the North East, district-wise vulnerability profiles are developed in all the eight states, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim and Tripura. This is a first of its kind study conducted in North East India whereby a local scale of vulnerability assessment is utilized. The coverage of all the 79 districts of all the 8 states is also unique to this study. The quantitative approach for assessing the vulnerability of the three key sectors of agriculture, water and forest is done by developing vulnerability indices (ranging from 0 to 5) for each of these sectors. Further, this index developed for the current climatic conditions and has been extended for future projected climatic conditions.

393. By the study, both intensity of floods and drought severity are likely to increase in many parts of the North East region. There is a general increase in flood magnitude of the Barak basin compared to Brahmaputra basin in future. For Manipur, the flood magnitude is likely to increase by about 25% in the future compared to the present due to increased intensity of precipitation.

c. State Level Climate Change Trends in India[24]

394. Long-term changes in surface temperature and precipitation in India were analyzed using observational records of IMD from 1951 to 2010. In this study, 282 stations free from highly influence of urbanization and having continuous temperature records from 1951 onwards were selected to estimate long term temperature trends and for precipitation trends, 1451 stations having continuous records from 1951 onwards were selected.

395. **Annual Mean Maximum Temperature Trends.** State wise averaged annual mean maximum temperature time series has shown increasing trends over many states of India except Bihar, Chhattisgarh, Delhi, Haryana, Meghalaya, Punjab, Tripura and Uttar Pradesh. The increasing trends were significant over Andaman and Nicobar, Andhra Pradesh, Assam, Goa,

[23] Climate change vulnerability profiles for North East India; Centre for Sustainable Technologies, and Divecha Center for Climate Change, Indian Institute of Science, Bangalore 560 012, India, Department of Civil Engineering, Indian Institute of Technology Delhi, New Delhi 110 016, India; (CURRENT SCIENCE, VOL. 101, NO. 3, 10 AUGUST 2011)

[24] Meteorological Monogram No: ESSO/IMD/EMRC/02/2103, Indian Meteorological Department, 2013

Gujarat, Himachal Pradesh, Jharkhand, Karnataka, Kerala, Lakshadweep, Madhya Pradesh, Maharashtra, Manipur, Mizoram, Orissa, Rajasthan, Sikkim, Tamil Nadu and Uttarakhand. The highest increase in annual mean maximum temperatures was observed over Himachal Pradesh (+0.060 C/year) followed by Goa (+0.040 C/year), Manipur, Mizoram and Tamil Nadu (+0.030 C/year each).

396. **Monsoon Season Rainfall Trends**. State averaged monsoon season rainfall has increased over Bihar, Gujarat, Jharkhand, Karnataka, Lakshadweep, Meghalaya, Mizoram and West Bengal during 1951-2010. The highest increase (non-significant) in rainfall was found over Meghalaya and Mizoram. Decreasing trend in monsoon rainfall have been observed over Andaman and Nicobar, Andhra Pradesh, Assam, Chhattisgarh, Delhi, Goa, Haryana, Himachal Pradesh, Kerala, Madhya Pradesh, Maharashtra, Manipur, Nagaland, Orissa, Punjab, Rajasthan, Sikkim, Tamil Nadu, Tripura, Uttar Pradesh and Uttarakhand. Andaman and Nicobar and Himachal Pradesh have shown highest decline trends (non-significant) in monsoon season rainfall, while significantly decrease has been observed over Tamil Nadu (-1.35 mm/year) and Uttar Pradesh (-3.52 mm/year).

3. Climate Risks and Adaptation

a. Disaster Risk Profile – Manipur State

397. A report on disaster risk profile of Manipur State[25] outlines the major disaster risks afflicting Manipur as arising from:

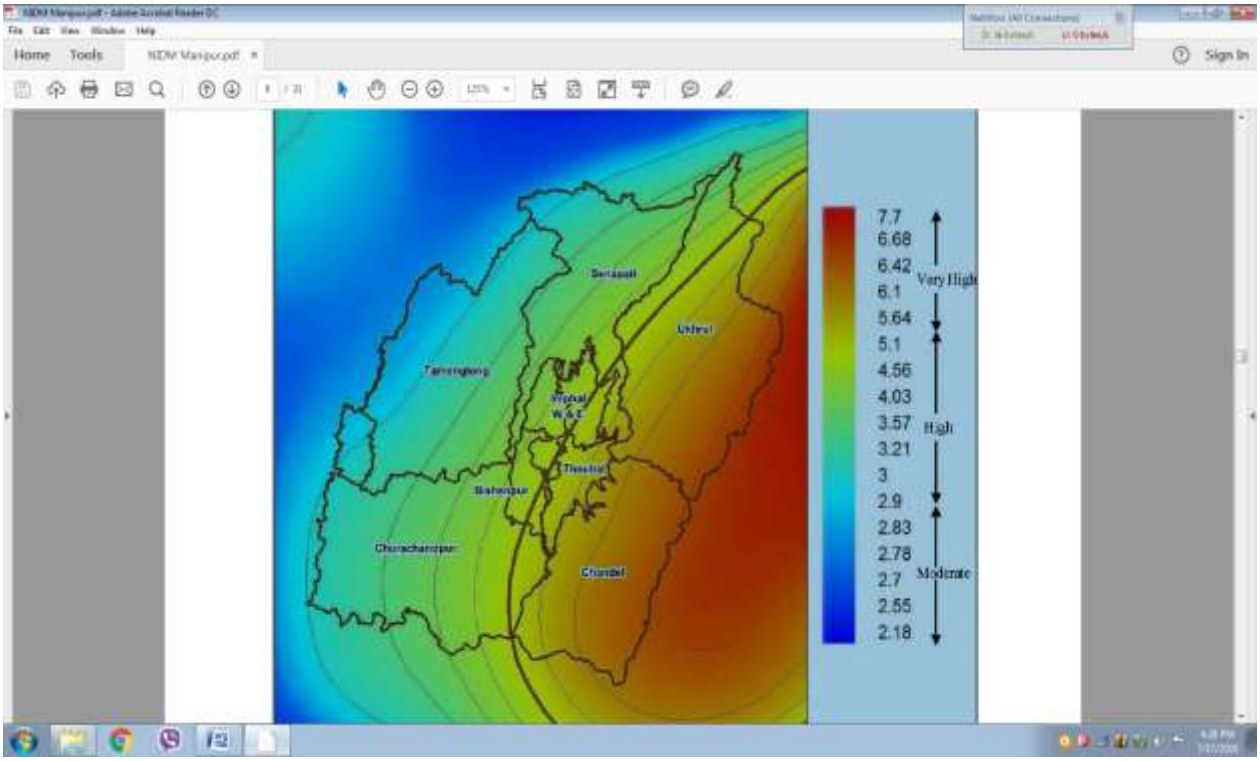
a. earthquakes
b. landslides
c. floods
d. wild fires
e. hailstorms
f. lightning
g. pest attacks
h. drought
i. highway accidents
j. and epidemics.

398. Major disaster events from 1992 to 2002, (Table 2.11 of the cited report) include three incidences of earthquakes and seven flooding events. The floods have been attributed to incessant rains lasting quite several days; a flood of September 2009 recounts incessant rain starting 24th August till 3rd September.

399. Related to climate change and effects on highway transport, one can recognize landslides and floods as a result of increasing frequency and intensity of precipitation under a changed climate. Other risks although unrelated to climate change which the highway design engineers have to be vary about are damages to infrastructure by earthquakes, which is reported as quite rampant as Manipur is situated in seismic zone V, which is the most earthquake prone zone in the country (Seismic Zones -India 2001). It keeps on experiencing minor tremors off and on. The seismologists, on the basis of past pattern have predicted that a major earthquake is almost overdue in the north east region of India (Tiwari 2002).

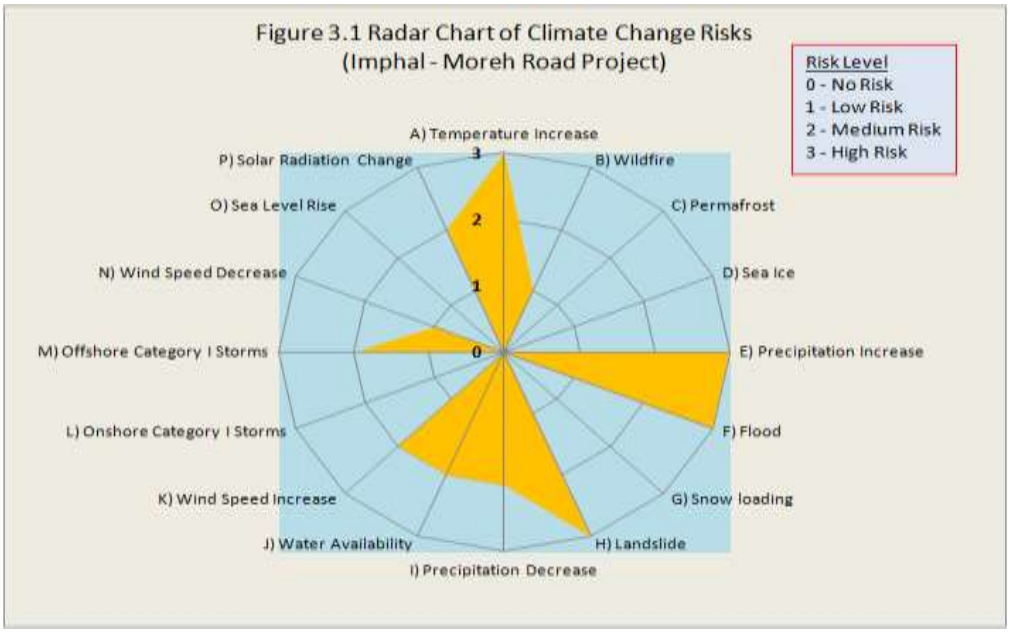
[25] NIDM, National Disaster Risk Reduction Portal, Manipur State, 2014

400. A screenshot of the estimated spectral ground acceleration (m/s2) due to earthquakes in the State of Manipur is reproduced Map below. It would be worth to note that the proposed highway improvement project from Imphal to Moreh on NH39 passes through high to very high seismic activity zones.



b. Climate Change Vulnerability Assessment

401. Based on the limited number of reviewed literature cited in Section 2 above, and starting with an exhaustive list of potential future impacts for transport (infrastructures / activities), linked to key weather stressors, (Courtesy: AwareTM geographic data set), a radar diagram of climate change risks that Manipur would need to brace is shown in Map 3.1. It must be noted that few accessible literature seems to indicate that effects of climate change on road transport infrastructure have received very little attention. No exclusive climate change studies on transport sector could be traced in the NE Indian context.



402. By the above figure, high risks remain in dealing with increased surface summer temperature, increased frequency and intensity of monsoon precipitation, and as a result high risk floods and landslides. A road infrastructure vulnerability matrix under the potential impacts on road transport infrastructure and operation due to climate extremes in the State of Manipur can be visualized as follows:

Vulnerable Infrastructure →	**Pavement**	**Drains**	**Culverts**	**Side Slopes**	**Bridge**	**Road Signs**
Temperature (Summer) → surface cracking, rutting, heat stresses, expansion joints, etc.	√				√	
Precipitation (Monsoon) → Floods, Landslides	√	√	√	√	√	√

403. Extreme weather conditions can be exacerbated under future climate change, thus increasing risks for transport and negatively affecting transport performance in terms of safety, reliability, and cost efficiency. Sadly today's growing number of global, national, and regional studies on climate change outline future changes in terms of climatic averages eg. mean sea level rise, mean maximum temperature, mean maximum precipitation, etc. through time slices. However, many practical problems require knowledge of the behavior of extreme values. In particular, the infrastructures we depend upon for food, water, energy, shelter and transportation are sensitive to changes in climate extremes rather than averages.

404. Construction design and maintenance of transport infrastructures are essential to maintain their integrity and serviceability. Nevertheless, complete avoidance of weather-induced infrastructure deterioration and failures is not exactly full-proof. Infrastructures are traditionally designed to cope with various stresses along their life, including extreme weather events as historically and currently experienced. Regular maintenance is normally performed to maintain sufficient resilience to the weather conditions. Although design codes are usually defined to achieve a high level of resilience to extreme events for which the occurrences (return period) is set in accordance to the typical design life spans, there is usually a gap between the need for

considering climate change impacts and the actual published guidelines that do not reflect climate change influences in extreme precipitation and flood frequency.

405. Under climate change scenario, heat extremes and heat waves are likely to become more intense, longer lasting, and more frequent during this century. It's known that increasing periods of extreme heat will place additional stress on infrastructure, reducing service life and increasing maintenance needs. Extreme maximum temperature and prolonged duration heat waves are expected to stress the steel in bridges through thermal expansion and movement of bridge joints and reduce the life of asphalt road pavements through softening and traffic-related rutting.

406. The design report considers a temperature gradient for stress calculations based on IRC recommendations. For the Manipur region, the highest maximum and lowest minimum temperatures taken are 400C and -2.50C respectively.

407. For record, the highest maximum temperature recorded by Imphal Met station between 1952 and 1990 was 35.60C. This was surpassed on April 28, 1999, where the maximum reached 36.10C. By the "Meteorological Monogram No: ESSO/IMD/EMRC/02/2103, Indian Meteorological Department, 2013", the highest increase in mean maximum temperature for Manipur is estimated to be around +0.030C/year. The design's maximum temperature of 400C can be considered as reasonable, and also further considering that engineering designs usually include a factor of safety to compensate for any uncertainties.

408. As to the lowest minimum temperature recorded at Imphal, it was -2.70C on Jan 10, 1970. (Times of India, Jan 12, 2013). However, as warmer winters are projected under future climate, the IRC's recommendation of -2.50C can be fairly reasonable.

c. Concerns That Need Addressing

409. **Design Return Period.** A 2014 ADB study[26] states that while there are obviously many challenges to projecting future climate, even a seemingly small increase in any of the climate parameters can have significant impacts on human lives and infrastructures. An early investment in adaptation can help mitigate large damages to economies in later decades and this calls for proactive actions that aim to reduce future risks.

410. Climate projections at a local level are highly uncertain. Given that uncertainty, the alternative is to look at several plausible future scenarios of climate change risks based loosely on findings in the literature to provide some bounds on how potential changes in risks could translate into economic damages.

411. Owing to paucity of published guidelines on incorporation of climate change effects, some few countries around the world have adopted policy design guidelines on climate change adjustment factors to be applied to current design estimates and may depend on design return period and projection horizon. Literature search could not identify the existence of such policy guidelines for India and in particular for the state of Manipur. In table 70, a review of applied methods in some European countries is presented here as "food for thought".

[26] Assessing the Costs of Climate Change and Adaptation in South Asia, (Mahfuz Ahmed, Suphachol Suphachalasai), June 2014, ADB and UKaid

Table 72: Existing European Guidelines on Climate Change Adjustment Factors on Design Flood

Country	Region	Variable	Guideline	Reference
Belgium	Flanders	Design Floods	30% increase	Boukris and Willems (2008)
Germany	Bavaria	Design flood with 100-year return period	15% increase	Hennegriff *et al.* (2006)
Germany	Baden – Wurrtemberg	Design floods	Increase between 0% and 75% depending on location and return period	Hennegriff *et al.* (2006)
Norway	National	Design floods	0%, 20% and 40% increase based on region, prevailing flood season and catchment size	Lawrence and Hisdal (2011)
United Kingdom	National	Design floods	20% increase for 2085	Defra (2006)

412. Many studies strongly recommend that any design based on a 100-year design flood flow may need to be changed to a design flood flow for a return period higher than 100-year, say 200 or 500, in order to account for the impact of climate change. All studies admit that amidst the uncertainties, these projections provide reasonable insight in support of alterations or re-consideration of design standards or design values of hydraulic structures if impact of climate change is to be taken into consideration during hydraulic design of infrastructure such as bridges.

413. **Design Adaptation Measures Considered in the Design of Imphal – Moreh Road**[27] **.** Key design parameters in relation to road infrastructure vulnerable to extreme weather events and some adaptation measures requiring a total cost of about US$ 42.77 million is provided in Table 71 below. The study observes that a one-off adaptation measure undertaken just once for structure design to deal with long-term (which is uncertain) is probably not sensible. An adaptive maintenance management that calls for incremental adaptation to be decided and implemented over successive short timescales every 5 years has been envisaged to provide advantage to manage climate change uncertainty iteratively, based on gradually increasingly reliable climate change data whilst reducing the risk to commit to highly expensive investment which could tune out inadequate.

Table 73: Adaptation Measures considered and Cost Estimates

Infrastructure Component	Design Parameters needing Consideration	Adaptation Measures Considered and cost estimates
(1) Earthwork Design	*Embankment Height* Observed from inventory analysis that the project road embankment height is inadequate as varying from zero to 1.0 m only and HFL during monsoon season is above natural ground level in many places in plain areas	- Project design team considers raising of the embankment to at least 1 m in height all along the total road section in plain area $ 0.38 million
(2) Pavement	*Design Life* Per ToR, design life for flexible pavement specified as 10 years	- Flexible pavement design loading computed for both 15 years and 20 years. - Camber of 2.5% maintained to quickly remove surface water

[27] ADB TA No. 8116-IND, Indo Myanmar Road Section from Imphal to Moreh on NH 39, Detailed Project Report, Vol I, Sheladia Associates Inc. USA, 2014

Infrastructure Component	Design Parameters needing Consideration	Adaptation Measures Considered and cost estimates
		- Periodic maintenance after every 5 years and regular routine preventive maintenance checks are proposed
(3) Drainages	*Discharge Estimation (return period)* IRC considers a 50-year return period for hydraulic design	- Project design team considers a 320 mm/24 hour rainfall of 100-year return period (by CWC projection) that yields 166.7 mm/hour rainfall intensity. - New sideway drains and retaining walls will be constructed $19.5 million
(4) Culverts	*Hydraulic Adequacy* Inspection of existing culverts (900 mm Ø) along project road showed inadequate hydraulic functionality	- Design team proposes new pipes of 1.2 m Ø, or box culverts with equivalent vent size - To discharge runoff, approximately 5 culverts per km of road has been proposed based on site investigations $7.26 million
(5) Bridges	*Flood Estimation (return period and design discharge)* - Several methods of flood estimation depending on catchment area in accordance with IRC: 5- 1998 *Temperature Stresses* - Based on IRC recommendation - *Hydraulic Structure Design Method*	- 100-year return period adopted for rainfall intensity derivation from the higher CWC data, 320 mm/day - The design discharge adopted is the maximum discharge of all methods. - Highest maximum 40^0C - Lowest minimum -2.5^0C - Limit state method (plastic design) has been adopted rather than the old working stress method (elastic design) $15.62 million

414. Provisions have also been made in the bidding documents for the contractor to prepare contract package specific EMP's based on the final detailed design to address a range of issues including climate related risks and vulnerabilities such as flooding, coastal erosion, landslide and accordingly incorporate required costs in the BOQ.

VII. PUBLIC CONSULTATION AND INFORMATION DISCLOSURE

415. In accordance with ADB's Safeguard Policy Statement (SPS) 2009 and Environment Impact Assessment Notification of GoI (2006), public consultations were held, as part of environment assessment study. The consultation undertaken with project beneficiaries, local/ government officials, community leaders, non-government organizations (NGO's), stakeholders in the corridor of impact and people likely to be effected due to the project on various issues affecting them and incorporation of various measures pertaining to environmental issues based on the responses from the people.

A. Objectives of Consultations

416. The process of public participation/ consultations was taken up as an integral part of the subproject in accordance with environmental assessment requirements. The objectives of these consultations are:

- To inform and educate the general public, specially potentially impacted communities/ individuals and stakeholders about the proposed project activities;
- To familiarize the people with technical, environmental, social and economic issues of the project for better understanding;
- To solicit the opinion of the affected communities/ individuals on environmental issues and assess the significance of impacts due to the proposed development;
- To foster co-operation among officers of NHIDCL, the communities and the stakeholders to achieve a cordial working relationship for smooth implementation of the project;
- To identify the environmental issues relating to the road improvement work;
- Assess the views of the beneficiary communities and their willingness to participate in the project in a bottom up planning and decision making process;
- To secure people's inputs in respect of project planning, selection of mitigation measures and monitoring strategies;
- To ensure lessening of public resistance to change by providing them a platform in the decision making process;
- To inculcate the sense of belongingness among the public about the project.

B. Methodology used for Consultations

417. Both formal and informal modes of consultation were used in the public consultation process for the project. Consultation with the stakeholders, beneficiaries, and community leaders were carried out using standard structured questionnaires as well as unstructured questionnaires. In addition, focused ground discussions (FGDs) and personal discussions with officials, on-site discussion with project affected stakeholders, and reconnaissance visits have also been made to the project area. The attempts were made to encourage participation in the consultation process of the government officials from different departments that have relevance to the project. Same way, local people from different socio economic backgrounds in the villages as well as urban areas along the road alignment and at detours, women, residents near the existing road, local commuters, and other concerned were also consulted.

C. Identification of Stakeholders

418. Stakeholders were identified to ensure as wide coverage as possible of the project area as follows:

- Households in the project area including potential Project Affected Persons,
- Women groups,
- Local, regional and international voluntary organisations / non-government organizations (NGOs),
- Government agencies, and
- Community leaders.

419. Questionnaire survey/ discussions were designed to obtain background information and details of general environmental issues that concern people in the project area. In addition, environmental issues were discussed with relevant organizations, government officials, beneficiaries, community leaders, women groups and experts.

420. In compliance with ADB's SPS requirements consultations will be continued throughout the project planning, design and implementation phase. The consultation process initiated during preparation of the IEE study. The official consultation with the key stakeholders was undertaken in the months of August 2013-February 2014 and again in April-July 2016 at respective district offices and head quarter in Imphal. Various officials consulted include NHIDCL and PWD (Manipur) Officials, Officials from Department of Environment (Manipur), Forest Officers, Wildlife Officials, Environmental Officers from pollution control board, statistical officer, officials from NGOs active in the project areas etc. Various issues discussed are:

- Statistics of forests cover in the State and its legal status i.e. Reserved, Protected, Unclassed;
- Protected area network of Manipur,
- Applicability of various laws and regulations to the present road development project;
- Requirements of Forest Department to carryout project activities within forest /protected areas;
- Flora and Fauna and endangered species in the State and project area in particular;
- Scope of the proposed road development, IEE and likely impacts on flora & fauna;
- Major threats to flora & fauna in the state;
- Applicability of GoI EIA Notification 2006 to the proposed project;
- Procedure to get clearance from forest department and NOC from pollution control board;
- Environmental quality parameters i.e. air, water, noise quality in the State and major sources of pollution;
- Institutional capacity of state authorities in pollution control and environmental management;
- Socio-economic conditions and likely impacts on due to proposed road improvement;

421. The list of officials/ people contacted along with the venue, issues raised, date of consultation is presented on Table 72.

Table 74: List of Officials Consulted & Issues Discussed During Field Visit

Sl. No.	Name of Official Consulted	Department	Issue discussed
1.	Mr. Neeraj Verma	Joint Secretary, Ministry of Road Transport and Highway, Government of India, New Delhi	Scope of the work, implementation arrangement, policy and regulatory requirements from environmental point of view.
2.	Mr. Kh. Temba Singh	Addl. Chief Engineer-II PWD, Manipur, Imphal	Overall scope of the Project, existing conditions of road section in Manipur, Major problems on NH, treatment to landslides
3.	Mr. Y. Joykumar Singh	Project Director, NESRIP, PWD Manipur, Imphal	Existing conditions of state road, Major problems of state roads, clearances /permits requirements, Treatment to landslides
4.	Th. Ibobi Singh, IFS	Additional PCCF (Wild Life) and Chief Wildlife Warden, Forest Department, Govt. of Manipur, Imphal	Scope of IEE, Impacts on wildlife and forest, Wildlife status in state, flora & fauna species, environmental aspects of hilly roads, regulatory requirements of Manipur and GOI for the implementation of the Project.
5.	Mr. A.K. Rana	PCCF, Forest Department, Govt. of Manipur, Imphal	Scope of IEE, Impacts on wildlife and forest, Wildlife status in state, flora & fauna species, environmental aspects of hilly roads, regulatory requirements of Manipur and GOI for the implementation of the Project.
6.	Mr. L. Joykumar Singh, IFS	Dy. Conservator of Forests (Wildlife), National Parks and Sanctuaries Division, Forest Department, Government of Manipur, Imphal	Scope of IEE, Impacts on Wildlife and forest, Wildlife status in state, flora & fauna species, Environmental aspects of hilly roads
7.	Mr. Dhananjay, IFS	Chief Conservator of Forests, Forest Department, Manipur, Imphal	Details of Flora & Fauna, Forest Resources, Scope of IEE, potential impacts due to proposed project
8.	Mr. Mahendra Pratap, IFS	Conservator of Forests, Forest Department, Manipur, Imphal	Details of Flora & Fauna, Forest Resources, Scope of IEE, potential impacts due to proposed project
9.	Mr. K. Jagadishwar Singh, IFS	Member Secretary, Manipur Pollution Control Board (MPCB), Lamphalpat, Imphal	Applicability of SPCB requirements for the currently road development project. Ambient air quality monitoring network in Manipur and existing environmental quality in Manipur.

Sl. No.	Name of Official Consulted	Department	Issue discussed
10.	Mr. W. Roshan Singh	Assistant Environmental Engineer, MPCB, Lamphalpat, Imphal	Ambient air quality monitoring network in Manipur and existing environmental quality in Manipur.
11.	Mr. Khumanthem Tomba Singh	Scientist C, MPCB, Lamphalpat, Imphal	Environmental quality monitoring for along project road section. Existing environmental quality in Manipur.
12.	Dr. T. Brijakumar Singh	Research Officer, Directorate of Environment, Government of Manipur, Imphal	Environmental issues in the project areas. Biodiversity studies in the project areas. Flora and fauna species.
13.	Dr. N. Sana Macha	Investigator, Directorate of Environment, Government of Manipur, Imphal	Environmental issues in the project areas. Biodiversity studies in the project areas. Flora and fauna species.
14.	Dr. H. Nandiram Sharma	Rtd. HOD, PG Dean College, President Science Teacher forum, Manipur	Environmental issues in the project areas. Research projects on biodiversity.
15.	Dr. Vinay Kumar	Associate Professor, Deptt. Of Life Sciences, Manipur University, Imphal	Environmental quality and issues in the project areas. Research projects on biodiversity.
16.	Dr. Sharma	Professor, Deptt. Of Life Sciences, Manipur University, Imphal	Environmental quality and issues in the project areas. Research projects on biodiversity.
17.	Mr. Raj Kumar Birjit Singh	State coordinator, Indian Bird Conservation Network (IBCN), Ningthoukhong, Bishnupur, Manipur	IBCN activities in Manipur, biodiversity issued in Manipur, bird conservations programs in Yangoupokpoi Lokchao Wildlife Sanctuary, presence of threaten/endangered/vulnerable species of birds and wild animals in forest areas along the project road..
18.	Mr.Wahengbam Rajesj Singh	Nodal Person, Indian Bird Area (IBA) Program for Yangoupokpoi Lokchao Wildlife Sanctuary, IBCN, Imphal, Manipur	Bird conservations programs in Manipur, presence of threaten/endangered/vulnerable species of birds and wild animals in forest areas along the project road.
19.	Ms. Archita B. Bhattacharyya	Program Officer, WWF India, Uzan Bazar, Guwahati	WWF activities in Manipur and north-eastern region, biodiversity issues in Manipur, conservations programs in the State, presence of

Sl. No.	Name of Official Consulted	Department	Issue discussed
			threaten/endangered/vulnerable species of flora and fauna in Manipur.
20.	Mr. Jaydish Bose	Officer In charge, WWW Program in North-eastern States, WWF India, New Delhi	WWF activities in Manipur and north-eastern region, biodiversity issues in Manipur, conservations programs in the State, presence of threaten/endangered/vulnerable species of flora and fauna in Manipur.

422. In order to document likely impacts on affected persons, an interview survey has been carried out. A sample of PAPs was selected and interviewed through a designed questionnaire. Precaution has been exercised during the survey to ensure that the sample interviewed is truly representative of the affected groups and the questions are worded so as not to generate a bias response. Image 9 below shows one such interview survey. The consultation is focussed on:

- General awareness in local communities about environmental quality in terms of quality of water in rivers, ponds, lakes, ground water, ambient air and noise quality and its sources.
- Presence of archaeological / historical sites, monuments in the project region and likely impacts
- Presence of endangered /rare species of flora and fauna and its locations in the project region
- Frequency of natural calamities / disasters in the region
- Cultural places along the project roads and likely impacts of proposed road development, etc.

Image 9: View of Community Consultation

423. Besides interview surveys, focused group discussions (FGDs) were organized at key locations along the project roads. In total ten (10) FGDs meetings involving 250 participates from affected people, landowners, and village authorities, were organized. Specific emphasis was given to women participants to ensure that gender concerns are addressed in the project. Out of total participants, 81 participants were from women group.

424. Summary of public consultations through focused ground discussions (FGDs) meeting organized is presented in Table 73. Details of these consultations are presented in Annex 10.

Table 75: Summary of Public Consultations

Date	Venue / Place	Participants	Remarks
27 August 2013	Village: Lailong Bazar Block: Thoubal District: Thoubal	27 Participants (22 man and 5 women) from village community including village heads, teachers, housewife, business owners, labours, farmers and students	All participants supported the project.

Date	Venue / Place	Participants	Remarks
27 August 2013	Village: Thoubal Block: Thoubal District: Thoubal	22 Participants (12 man and 10 women) from village community including village housewife, business owners, labours, and farmers.	All participants supported the project.
26 August 2013	Village: Wangjing, Block: Thoubal District: Thoubal	26 Participants (18 man and 8 women) from village community including villages heads, councillors, housewife, business owners, labours, farmers and students.	All participants supported the project.
26 August 2013	Village: Khongjom Block: Thoubal, District: Thoubal	21 Participants (14 man and 7 women) from village community including villages heads, ward members, housewife, business owners, labours, farmers and students.	All participants supported the project.
31 July 2016	Village: Lilong Bazar Block: Thoubal District: Thoubal	27 Participants (22 man and 5 women) from village community including villages heads, housewife, business owners, labours, farmers.	All participants supported the project.
27 July 2016	Village : Kiyam Siphai Block : Thoubal District: Thoubal	18 Participants (15 man and 03 women) from village community including villages heads, housewife, business owners, labours, farmers and students.	All participants supported the project.
26 July 2016	Village: Khangabok Block: Thoubal District: Thoubal	24 Participants (19 man and 05 women) from village community including villages heads, housewife, business owners, labours, farmers and students.	All participants supported the project.
26 July 2016	Village: Khongjom Block: Khongjom District: Thoubal	34 Participants (16 man and 18 women) from village community including villages heads, housewife, business owners, labours, farmers and students.	All participants supported the project.
25 July 2016	Village: Irengband Block: Kakching District: Thoubal	19 Participants (15 man and 4 women) from village community including villages heads, housewife, business owners, labours, farmers and students.	All participants supported the project.
11 September 2013	Village: Kakching Khullen Block: Kakching District: Thoubal	32 Participants (16 man and 16 women) from village community including villages heads, housewife, business owners, labours, farmers and students.	All participants supported the project.

D. Results of Consultations

425. Most of the people interviewed strongly support the project. The people living in the entire project area expect the different project elements to facilitate transport, employment, boost economic development and thereby provide direct, or indirect, benefits to themselves.

426. Construction camps may, however, put stress on local resources and the infrastructure in nearby communities. In addition, local people raised construction-process related grievances with the workers. This sometimes leads to aggression between residents and migrant workers. To prevent such problems, the contractor should provide the construction camps with facilities such as proper housing, health care clinics, proper drinking water and timely payment. The use of local labourers during the construction will, of course, increase benefits to local peoples and minimise these problems. Project design will ensure that wherever possible, such people should be employed. Local people also raised safety related issues and requested to provide underpasses/footover bridge and safety measures at congested places. Project considered safety aspects and proposed design incorporated constrcution of one padestrian underpass at Thoubal and two vehicular underpasses. Adequate safety installations have been proposed as part of the design (detailed in Section 3). Compensation related issues are addressed in involuntary resettlement framewrok.

427. In order to access the existing environment and likely impacts on PAPs, an interview survey has been carried out. A sample of PAPs has been interviewed through a designed questionnaire. Precaution has been exercised during the survey to ensure that the sample interviewed is truly representative of the affected groups and the questions are worded so as not to generate a bias response.

428. It is envisaged from the interview survey that there is increased environmental awareness among the people. It can also be seen from the table 73 that more than 70% of the persons believes the existing environmental conditions of the area is good. Over 90% of the people agreed that the quality of air, water and noise in the area is good; whereas, about 6% respondent feel that the environmental quality is being deteriorated. Poor road condition and vehicular emissions are the major sources they feel responsible for this. In case of presence of archaeological / historical the responses are very few. In case of cultural and historial sites, the response of the people is mizxed. The area experiences natural disasters i.e. floods, earthquake etc. as it also envisaged that 73% of respondent reported history of natural disaster. Only 30% people indicated that there are rare and endangered species of fauna in the forests of the region. Overall, the general environmental conditions in the region are good and people have increased environmental awareness. Table 74 shows the result of public opinion survey carried out in the region.

Table 76: Peoples' Perception about Environment Degradation

Sl. No.	Question asked about	No. of people interviewed	Positive response (%)	Negative response (%)	No response (%)
1.	Water quality of rivers, ponds, wells, and canals	46	94	6	0
2.	Noise quality of the area	46	87	13	0
3.	Air quality of the area	46	94	6	0
4.	Archaeological sites	46	82	6	12
5.	Natural disaster	46	73	27	0

Sl. No.	Question asked about	No. of people interviewed	Positive response (%)	Negative response (%)	No response (%)
6.	Rare species of animals and birds	46	70	30	0
7.	Cultural sites i.e. market, melas	46	88	6	6

Note: Positive response shows that the overall environmental scenario in the area is good and wise versa.

429. During FGDs, local people extended their support to the project as they expect better connectivity and improved livelihood opportunities from the development of proposed road sections. Details of issues discussed during FGDs and mitigation measures incorporated in the project design are presented in Annex 10.

E. Interaction with Local/National and International NGOs

430. In order to get independent views on the likely impacts of the projects, non-government organizations at local as well as international level were consulted during the IEE process. This includes Indian Bird Conservation Network (IBCN); World Wide Fund (WWF) for Nature Office; and local self-help groups. The IBCN is active in protected areas if Manipur whereas the WWF do not have direct activities along the project road. Local NGOs consulted included i) Social Education and Economic Development Society (SEEDS)- Wangjing; ii) Social and Health Development Organization, Moreh; and iii) Socio-Economic Development Association (SEDA), Thoubal.

431. Aspects such as conservation activities, presence of flora and fauna, likely project impacts and possible mitigation measures were discussed and views and suggestions from these NGO's were incorporated in the EMP. Consultation will continue with these NGO's during finalization of IEE, and project implementation and operation.

F. Public Disclosure

432. The project EA will be responsible for the disclosure of this IEE in compliance to ADB's Communication Policy 2011 and ADB SPS 2009. The draft IEE Report will be disclosed in the branch office of the NHIDCL. The report will also made available to interested parties on request from the office of the NHIDCL. The draft IEE report will also be made available to all stakeholders as part of the consultation process required under the SPS 2009. The final report will also be disclosed on ADB website.

VIII. ENVIRONMENTAL MANAGEMENT PLAN AND GRIEVANCE REDRESS MECHANISM

A. Introduction

433. The Environmental Management Plan (EMP) is the synthesis of all proposed mitigation and monitoring actions, set to a time-frame with specific responsibility assigned and follow-up actions defined. It contains all the information for the proponent, the contractor and the regulatory agencies to implement the project within a specified time-frame

434. This EMP consists of a set of mitigation, monitoring and institutional measures to be taken for the project to avoid, minimize and mitigate adverse environmental impacts and enhance positive impacts. The plan also includes the actions needed for the implementation of these measures. The major components of the Environmental Management Plan are:

- Mitigation of potentially adverse impacts;
- Monitoring of EMP implementation during project implementation and operation; and
- Institutional arrangements to implement the EMP.

B. Objectives of Environmental Management Plan

435. The main objectives of this EMP are:

- To ensure compliance with Asian Development Bank's applicable safeguard policies, and regulatory requirements of Manipur and the Government of India;
- To formulate avoidance, mitigation and compensation measures for anticipated adverse environmental impacts during construction and operation, and ensure that environmentally sound, sustainable and good practices are adopted;
- To stipulate monitoring and institutional requirements for ensuring safeguard compliance; and
- The project road should be environmentally sustainable.

C. Impacts and Mitigation Measures

436. The identified environmental issues and suggested mitigation measures with institutional arrangements for implementation, supervision and monitoring have been provided in a matrix format in Table 78. However, anticipated potential impacts and suggested mitigation measures specific to this project are summarised in following paragraphs. These mitigation measures will be implemented as part of this project.

1. Impacts

437. Following are anticipated potential adverse environmental impacts:

- Impacts due to acquisition of about 68.1 hectare of land for widening of roads,
- Impacts on surrounding area due to tree cutting (3691) for the proposed improvement work;
- Impacts do to diversion of about 50.51 hectare of forest land for non-forest purpose;
- Temporary impact on land and air environment due to locating construction camp;
- Temporary impact on land, air and water environment due to establishing and operating construction plants (Hot Mix Plant and Diesel Generator [DG] sets);

- Impact on biophysical environment due to quarry operation;
- Impacts on roadside flora and fauna particularly on sections of road passing through Reserved Forest Area;
- Impact on air quality, water quality, drainage, road users due to construction activities of project road ;
- Impact on land and water environment due to disposal of waste materials; and
- Impact on occupational health and safety due to all onsite and offsite construction works.

2. Mitigation Measures

a. Compensatory Tree Plantation

438. The compensatory plan is being developed in consultation with local forest department. As per compensatory afforestation, the tree plantation will be done three times of tree cutting (1:3 of tree cutting) as detailed in Table 75.

Table 77: Details of Trees to be Cut and Planted

Subproject	Road Section (From / To)	Length (km)	Tree to be cut in the project road	Proposed tree to be planted in the project area in consultation with Forest Dept. (1:3 of tree cutting)
SASEC Tranche 2 subrpoject	Imphal-Moreh Section	65.80	3691	11073

b. Wildlife Protection

439. To minimize the likely impacts on the wilidlife and other animals in forest areas along the project road, following measures were incorporated in the project design as well as proposed for implementation during construction and operation phase of the Project.

- Improvement proposals are restricted to minimum width in the length passing through forest areas. Forest areas are avoided to the possible extent.
- Adequate measures are included in the design to minimize impacts on wildlife.
- Signage for no-noise zones, wildlife conservation boards should be installed at the required project sites.
- Noise generating equipment like DG set, compressors will have acoustic enclosures. These will not be installed at least in one km area of reserved forests. Noise generating activities should not be permitted during night.
- Drivers should be warned to move slowly in the wild life movement areas.
- If any wildlife come within the vicinity of 100m from the construction site construction works must immediately stop and resume only after the wild animal have moved away
- Provisions of signage as a precautionary measure to provide awareness about animal movement will be made to avoid accidents
- project staff and work crews should not be allowed to have fire-arms and animal traps etc.;
- construction facilities such as workers camp, construction camp, hot mix plant, batching plant should be located at least 1 km away from the forest stretches.

- employment agreements should specify heavy penalties for illegal hunting, trapping and wildlife trading – all other ancillary works should also agree not to participate in such activities.
- Strict anti-poaching surveillance measures need to be implemented, especially during project construction phase in the areas of reserved forests.

c. Slope Protection and Bio-engineering Measures

440. The bio-engineering measures are suitable for slope protection in hill roads. The following items have been suggested as bio-engineering measures for slope protection in hill roads.

- Turning of slopes through rough grassing; and
- Tree plantation along the hill section (slopes) of the project road to control the soil erosion.

441. The above items as bio-engineering measures have been incorporated in EMP budget.

d. Excavated Road Side Debris and its Disposal

442. The provision has been made in cost estimate to use the roadway excavated materials as necessary for the construction of road, which are as follows:

- For all types of soil, such as ordinary rock, hard rock and
- Excavation from drain and foundation of other structures.

443. As per above description, the Contractor will use the excavated road side material for construction of road. The rest unsuitable material will be disposed suitably. The lead and lift has been considered in cost estimates. The Contractor will not dispose the excavated unsuitable material generated from hill section to other side (valley side) of the project road. Proper disposal plan will be prepared by the Contractor to dispose the unsuitable material generated from hill cutting/ road excavation.

e. Protection of Water Bodies

444. The surface water bodies in the project road require protection during construction phase of the project road particulary at locations of river/stream crossing (i.e. Imphal river at chainage km 330+300, Thoubal river at km 341+900, Wanjing river at km 348+400, and Pallel river at km 365+300, other local stream/rivers). The Contractor shall not disturb/ pollute these surface water due to construction activities of the project road. The Contractor will be responsible to protect these surface water and extra payment for the same will not be given. In order to check water quality pollution, comtractor will conduct monitoring of water quality in rivers along the projecty road, prior to start of the construction work.

f. Re-development of Borrow Area

445. Establishment of the contractors' facilities such as borrow areas, quarries, and construction camps will be monitored by the engineer. The items for redevelopment of borrow area such as preservation of top soil and re-application of stored top soil has been considered in proposed EMP cost. The Contractor will re-develop the borrow areas before closing of same. The estimated quantities for preservation and re-application of the top soil has been considered for redevelopment of borrow area.

g. Protection of Sensitive Receptors

446. Sensitive receptors along the project road will be protected by implementing suitable measures such as timely scheduling of construction activities in these areas, provision of sign boards, appropriate noise barriers such as raised boundary walls are adopted to minimize impacts. Table 76 shows the locations identified for implementation of these mitigation measures.

Table 78: Sensitive Locations along the Project Road

Chainage		Sensitive Features (Left Side of Road)	Distance from the edge of existing road (m)
Start	End		
330+400	330+500	Abdul Ali Govt. High School	6
331+100	331+200	Lillong Higher Secondary Madrassa	18
331+200	331+300	Galaxy Institute of School	18
339+300	339+400	Temple	6
339+400	339+500	Temple	2
340+600	340+700	Nimaichand High School	5
341+200	341+300	The Fancier Abhiram Higher Secondary School	5
344+800	344+900	The Khangabok Govt High School	22
345+300	345+400	KM Blooming Higher Secondary School	19
346+200	346+300	Wangbal Jr. High School	10
348+900	349+100	The Y.K College	12
352+400	352+500	Khongjom Standard School	18
357+700	357+800	Sora High School, Mosque	8
391+200	391+300	Chamol Baptist Church	19

Chainage		Sensitive Features (Right Side of Road)	Distance from the edge of existing road (m)
Start	End		
330+000	330+100	Lilong Higher Secondary School	30
330+900	331+000	Mosque (Jama Masjid)	5
331+500	331+600	The Lilong Girls High School	14
331+700	331+800	Mosque	14
332+700	332+800	Mosque	7
333+500	333+600	Mosque	16
333+600	333+700	Mosque	15
337+000	337+100	Small temple	10
337+900	338+000	Temple	10
340+700	340+800	Waikhom Mani Girls College	7
342+800	342+900	RK Muktasana Educational Institute	5
343+900	344+000	Athokpam Jr. High School	13
344+400	344+500	Thoubal District Hospital	4
347+800	347+900	Royal Academy School	8
352+700	352+800	Small Temple	15
363+000	363+100	Temple	15
364+800	364+900	Temple(Ibhidhou Pakhangba)	2
365+700	365+800	Ideal High School	6

D. Environmental Monitoring and Reporting Program

447. Environmental monitoring is an essential tool for environmental management as it provides the basic information for rational management decisions. To ensure the effective

implementation of mitigation measures and environmental management plan during construction and operation phase of the up gradation of subproject road, it is essential that an effective Environmental Monitoring Plan be designed and followed.

448. Environmental monitoring program has the underlying objective to ensure that the intended environmental mitigations are realized and these results in desired benefits to the target population causing minimal deterioration to the environmental parameters. Such program targets proper implementation of the EMP. The broad objectives are:

- To evaluate the performance of mitigation measures proposed in the EMP.
- To evaluate the adequacy of environmental assessment.
- To suggest ongoing improvements in management plan based on the monitoring and to devise fresh monitoring on the basis of the improved EMP.
- To enhance environmental quality through proper implementation of suggested mitigation measures.
- To meet the requirements of the existing environmental regulatory framework and community obligations.

1. Performance Indicators

449. The significant physical, biological and social components affecting the environment at critical locations serve as wider/overall Performance Indicators. However, the following specific environmental parameters can be quantitatively measured and compared over a period of time and are, therefore, selected as specific Performance Indicators (Pis) for monitoring because of their regulatory importance and the availability of standardized procedures and relevant expertise.

- Air Quality with respect to PM2.5, PM10, CO, Nox and SO2 at selected location.
- Surface Water Quality with reference to DO, BOD, Oil and grease, COD, Suspended Solids and Turbidity, Alkalinity, coliform at crossing points on rivers/streams at selected points.
- Ground Water and Drinking Water Quality.
- Noise levels at sensitive receptors (schools, hospitals, community/religious places).
- Survival rates of trees planted as compensatory plantation to compensate for lost forestlands and compensatory plantation raised for removal of roadside trees.
- Incidences of Wildlife Collisions.
- Accidents of construction and operation.

2. Ambient Air Quality (AAQ) Monitoring

450. Ambient air quality parameters recommended for monitoring road development projects are PM2.5, PM10, Carbon Monoxide (CO), Oxides of Nitrogen (Nox) and Sulphur Dioxide (SO2). These are to be monitored, right from the commencement of construction activity at selected locations of plants and machinery, crushers on sites, excavation works etc. Data should be generated once in a season excluding monsoon at the monitoring locations in accordance with the revised National Ambient Air Quality Standards formulated by MoEFCC in 2009 (Annex 3).

3. Water Quality Monitoring

451. 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, BOD, Coliform, Chloride, Lead, Zinc and Cadmium. The location, duration and the pollution parameters to be monitored and the responsible institutional arrangements are

given in the Environmental Monitoring Plan. The monitoring of the water quality is to be carried out at locations identified along the project road during construction and operation phase. The Indian Standard Specifications – IS10500: 1991 is given in Annex 2.

4. Noise Level Monitoring

452. The measurements for monitoring noise levels would be carried out at sensitive receptors and construction sites along the project road. The Ambient Noise Standards formulated by Central Pollution Control Board (CPCB) in 1989 and World Bank (IFC) Air Quality Standards to be complied. The CPCB standards are given in Annex 4. Sound pressure levels would be monitored on twenty-four hour basis. Noise should be recorded at "A" weighted frequency using a "slow time response mode" of the measuring instrument.

5. Success of Re-vegetation

453. The project involves widening and up-gradation including construction of cross drainage structures, hence these will require felling of trees. Such lost vegetation will be required to be replaced by compensatory plantation. As per policy of the State Government 03 trees have to be planted for each tree removed. These compensatory plantations will have to be monitored by the implementing agency with the help of the Forest Department. Such monitoring will be conducted through random samples. Such sampling should cover at least 5% of the area planted up.

E. Environmental Reporting System

454. The monitoring plan covering various performance indicators, frequency and institutional arrangements of the project in the construction and operation stages, along with the estimated cost, is summarized in Table 79.

455. The reporting system will operate linearly with the contractor who is at the lowest rank of the implementation system reporting to the Authority's Engineer, who in turn shall report to the NHIDCL PIU. All reporting by the contractor and Authority's Engineer shall be on a quarterly basis. The PIU shall be responsible for preparing targets for each of the identified EMP activities.

456. The environmental compliance monitoring and the progress reports on environmental components may be clubbed together and submitted to the PIU quarterly during the implementation period. The operation stage monitoring reports may be annual or biannual provided the Project Environmental Completion Report shows that the implementation was satisfactory. Otherwise, the operation stage monitoring reports will have to be prepared as specified in the said Project Environmental Completion Report.

457. Responsibilities for overseeing EMP implementation will rest with the Authority's Engineer staff reporting to the PIU. Capacity to quantitatively monitor relevant ecological parameters would be an advantage but monitoring will primarily involve ensuring that actions taken are in accordance with contract and specification clauses, and specified mitigation measures as per the EMP.

458. During the implementation period, a compliance report may include description of the items of EMP, which were not complied with by any of the responsible agencies. It would also report to the management about actions taken to enforce compliance. It may however, be noted that certain items of the EMP might not be possibly complied with for a variety of reasons. The intention of the compliance report is not to suppress these issues but to bring out the

circumstances and reasons for which compliance was not possible (such as jurisdictional issues). This would help in reinforcing the implementation of the EMP.

459. Photographic records will also be established to provide useful environmental monitoring tools. A full record will be kept as part of normal contract monitoring. Reporting and Monitoring Systems for various stages of construction and related activities have been proposed to ensure timely and effective implementation of the EMP.

460. The reporting system has been prepared for each of the stage of road construction namely:

- Pre construction stage
- Construction Stage
- Operation Stage

461. This reporting shall be done through:

- Reporting by the Contractor to the Authority's Engineer
- Reporting by Authority's Engineer to PIU.

462. The stage-wise reporting system is detailed out in the following Table 77.

Table 79: Stage-wise Reporting System of PIU

Format* No.	Item	**Contractor**	Authority's Engineer		**NHIDCL Project Implementation Unit (PIU)**	
		Implementation and Reporting to Authority's Engineer	**Supervision**	**Reporting to PIU**	**Oversee / Field Compliance Monitoring**	**Reporting to Environment Officer of PIU**
C1	Monitoring of construction site and construction camp	Before start of work	-	Quarterly	-	Quarterly
C2	Target sheet for Pollution Monitoring	-	As required	After Monitoring	-	After Monitoring
C3	Target sheet for roadside plantation	-	Monthly	Quarterly	Quarterly	Bi-annual
C4	Target sheet for monitoring of cleaning water bodies	-	Monthly	Quarterly	Quarterly	Bi-annual
O1	Target sheet for Pollution Monitoring	-	-	-	As per monitoring plan	After Monitoring
O2	Target sheet for survival reporting of roadside plantation	-	-	-	Quarterly	After Monitoring
O3	Target sheet for monitoring	-	-	-	Quarterly	After Monitoring

Format* No.	Item	Contractor	Authority's Engineer		NHIDCL Project Implementation Unit (PIU)	
		Implementation and Reporting to Authority's Engineer	**Supervision**	**Reporting to PIU**	**Oversee / Field Compliance Monitoring**	**Reporting to Environment Officer of PIU**
	of cleaning water bodies					

Formats will be developed and provided by Authority's Engineer to the contractor.

Table 80: Environmental Management Plan

Sl.	Environmental Issue	Location/ Sources	Mitigation Measures	Monitoring Indicators	Monitoring Methods	Implementing Agency	Supervising & Monitoring Agency
PRE-CONSTRUCTION PHASE							
1.	Forest clearance	Forest locations	• Obtain forest clearance before commencing work on the road sections located in the forest areas. • Coordinate with forest department for clearing of forest areas. • Avoid vegetation clearing as much as possible.	Forest Clearance papers, Forest areas diversion	Review documents, Observations	Forest Dept. / PIU	ADB/MoRTH
2.	Tree cutting	Cutting of about 3691 nos. trees during site clearance	• Restricting tree cutting within construction limit. • Avoiding tree cutting at ancillary sites. • Providing and maintaining compensatory tree plantation of 11073 numbers i.e. three times of cutting.	No. of trees to be cut	Observations	Forest Dept. / PIU	PIU
3.	Removal of utilities	Work site clearance	• Necessary planning and coordination with concerned authority and local body. • Prior notice to and consultation with concerned authority, local body and public to be affected so as to ensure that work does not get affected and impact on public is minimum.	Utility shifting plan	Observations	Concerned utility agencies / PIU	Authority's Engineer/ PIU
4.	Religious places	Work site	• Suitable mitigation measures have been incorporated in Social report.	Resettlement Plan	Observations	PIU	Authority's Engineer/PIU
5.	Air, Water and Noise quality	Sensitive locations	• Undertake monitoring of water, air and noise quality at sensitive locations prior to start of the construction work.	Parameters as we GOI requirements	Sampling	Contractor	Authority's Engineer/PIU
CONSTRUCTION PHASE							
1.	Air Pollution	Construction plants, equipment and vehicles	Refer Annex 5 and Annex 6	SPM, PM10, vehicle maintenance record	SPM, PM10 Measurement	Contractor	Authority's Engineer/PIU
		Temporary diversion	• Maintaining diversion and detour for road traffic in good shape and traffic regulated. • Regular sprinkling of water, as necessary.	Complaints from local residents	Observations	Contractor	Authority's Engineer/PIU
		Dust during earth works or from spoil dumps	• Maintaining adequate moisture at surface of any earthwork layer completed or non-completed unless and until base course is applied, to avoid dust emission. • Stockpiling spoil at designated areas and at least 5 m away from traffic lane. Refer Annex 7	Dust pollution, Complaints from local residents	Observations, public discussions	Contractor	Authority's Engineer/PIU

Sl.	Environmental Issue	Location/ Sources	Mitigation Measures	Monitoring Indicators	Monitoring Methods	Implementing Agency	Supervising & Monitoring Agency
		Borrow pits and haul road	Refer Annex 8	SPM, PM10, Dust pollution, Complaints from local residents	Measurement Observations, public discussions	Contractor	Authority's Engineer/PIU
		Storage of construction materials	Sprinkling of water as necessary.	Dust pollution, Complaints from local residents	Observations, public discussions	Contractor	Authority's Engineer/PIU
2.	Water Pollution	Construction of Bridges or Culverts – Earthwork and marginal spillage of construction materials causing temporary turbidity and suspended solids	• Constructing and maintaining diversion channel, sedimentation basin, dykes, etc. as may be required to temporarily channelize water flow of streams / river. • Storage of construction material and excavated soil above high flood level.	Placement and no. of slabs, hume pipe/ bridge height, Total solids and turbidity level	Review of design document, turbidity level check	Contractor	Authority's Engineer/PIU
		Construction vehicles	• Strictly avoiding cleaning / washing of construction vehicle in any water body.	Equipment/ vehicle maintenance record	Review records, site visit and observations	Contractor	Authority's Engineer/PIU
		Soil erosion from construction site	• Proper planning of site clearing and grubbing so as not to keep the cleared site before working for long duration. • Providing temporary side drains, catch water bank or drains, sedimentation basin, as necessary to avoid or minimize erosion and prevent sedimentation to receiving water bodies.	Soil erosion planning and cases	Review of design document, turbidity level check	Contractor	Authority's Engineer/PIU
		Seepage from Construction Debris	Refer Annex 7	Planning for seepage and spoil disposal, number of cases	Review of planning and practices for seepage and spoil disposal, control, site visits	Contractor	Authority's Engineer/PIU
		Construction camp and workers' camp	Refer Annex 6	Planning for waste management	Review of planning and practices for waste management, site visit, observations	Contractor	Authority's Engineer/PIU

Sl.	Environmental Issue	Location/ Sources	Mitigation Measures	Monitoring Indicators	Monitoring Methods	Implementing Agency	Supervising & Monitoring Agency
3.	Ground water Pollution	Wastewater logging	• All wastewater will be diverted to a ditch that will be managed for the period of construction and after construction such ditches will be filled and restored to original condition.	Planning for water diversion	Review of plans, field observations	Contractor	Authority's Engineer/PIU
		Borrow pit excavation	• Excavation of borrow pit should not touch the aquifer.	Planning for borrow pit excavation	Review of plans, field observations	Contractor	Authority's Engineer/PIU
		Human wastes and wastewater at construction camp	• Providing septic tanks for treating sewage from toilets before discharging through soak pits. • Locating soak pits at least 50m from any ground water sources. • Decanting and or controlled disposal of oil and grease as collected at collection tanks of maintenance yard and chemical storage areas. Refer Annex 6	Planning for waste management	Review of planning and practices for waste management, site visit, observations	Contractor	Authority's Engineer/PIU
4.	Noise Pollution and Vibration	Vehicles and Construction machinery	• Site Controls: Stationary equipment will be placed along un-inhabited stretches as per distance requirements computed above as far as practicable to minimize objectionable noise impacts. • Scheduling of Project Activities: Operations will be scheduled to coincide with period when people would least likely to be affected. Construction activities will be avoided between 4 P.M. and 10 A.M. near residential areas. • Protection devices (ear plugs or ear muffs) will be provided to the workers operating in the vicinity of high noise generating machines. • Construction equipment and machinery should be fitted with silencers and maintained properly. • Source-control through proper maintenance of all equipment. • Use of properly designed engine enclosures and intake silencers. • Noise measurements should be carried out along the road to ensure the effectiveness of mitigation measures. • Vehicles and equipment used should confirm to the prescribed noise pollution norms.	Noise level, complaints from local residents, vehicle maintenance record, awareness programs implemented, Number of noise barriers constructed near sensitive receptors (table 76)	Noise level measurement, field observations, discuss with local residents	Contractor	Authority's Engineer/PIU

Sl.	Environmental Issue	Location/ Sources	Mitigation Measures	Monitoring Indicators	Monitoring Methods	Implementing Agency	Supervising & Monitoring Agency
			• Constructing noise barriers as proposed for schools and hospitals prior to taking up road construction activities at those sections. • Movements of heavy construction vehicles and equipment near public properties will be restricted. • Comply with siting criteria for stone crushers, Hot Mix Plant/s (HMP) and concrete batching plant/s (CBP), and installations and maintenance of pollution control devices as mentioned in Annex 5. • No hot mix plant or other source of air pollution (especially dust pollution) must be located within the degraded airshed for particulate matter (SPM/PM10). Specific measures such as watering of roads etc. shall be adopted for upgrading works in degraded airshed to avoid generation of additional SPM to add to the already poor quality air. • Construction workers in high noise level zone must be provided with ear protection equipments. Site specific mitigation measures will provided by contractor particularly in sentitive and urban locations. • Refer Annex 9 for identification, and operation of quarry areas and adopting controlled blasting. • Construction of noise barriers near sensitive receptors (listed in table 76) in consultation with the respective authority of the receptor				
5.	Land Pollution	Spillage from plant and equipment at construction camp	• Providing impervious platform and oil and grease trap for collection of spillage from construction equipment vehicle maintenance platform. • Collection oil and lubes drips in container during repairing construction equipment vehicles. • Providing impervious platform and collection tank for spillage of liquid fuel and lubes at storage area.	Vehicle maintenance record, review plans for waste management and oil handling practices	Check equipment maintenance records, field visits, observations	Contractor	Authority's Engineer/PIU

Sl.	Environmental Issue	Location/ Sources	Mitigation Measures	Monitoring Indicators	Monitoring Methods	Implementing Agency	Supervising & Monitoring Agency
			• Providing bulk bituminous storage tank instead of drums for storage of bitumen and bitumen emulsion. • Providing impervious base at bitumen and emulsion storage area and regular clearing of any bitumen spillage for controlled disposal. • Reusing bitumen spillage. • Disposing non-usable bitumen spills in a deep trench providing clay lining at the bottom and filled with soil at the top (for at least 0.5 m). Refer Annex 7 and Annex 8				
		Domestic solid waste and wastewater generated at camp	• Collecting kitchen waste at separate bins and disposing of in a pit at designated area/s. • Collecting plastics in separate bins and disposing in deep trench at designated area/s covering with soil. • Collecting cottons, clothes etc. at separate bins. • Solid waste to be stored, collected, transported, and disposed of to a suitably licensed engineered landfill with records of transfer notes kept i.e., no waste should be burned, bitumen spills and plastics should not just be disposed of in trench, kitchen waste should not be disposed of in a pit, etc.	Planning for waste management	Review of planning and practices for waste management, site visit, observations	Contractor	Authority's Engineer/PIU
		Borrow pits	• Controlled operation and redevelopment of borrow pits to avoid water logging and land contamination.	Plan for borrow pit management	Review plans, observations	Contractor	Authority's Engineer/PIU
6.	Loss of topsoil	All construction sites	• The topsoil from all areas of cutting and all areas to be permanently covered shall be stripped to a specified depth of 150 mm and stored in stockpiles. At least 10% of the temporarily acquired area shall be earmarked for storing topsoil. • The stockpile shall be designed such that the slope does not exceed 1:2 (vertical to horizontal), and the height of the pile be restricted to 2m. To retain soil and to allow percolation of water, the edges of the pile shall be protected by silt fencing. • Stockpiles will not be surcharged or otherwise loaded and multiple handling will be kept to a	Planning for top soil conservation	Review plan, field visits and observations	Contractor	Authority's Engineer/PIU

Sl.	Environmental Issue	Location/ Sources	Mitigation Measures	Monitoring Indicators	Monitoring Methods	Implementing Agency	Supervising & Monitoring Agency
			minimum to ensure that no compaction will occur. The stockpiles shall be covered with gunny bags or tarpaulin. • It shall be ensured by the contractor that the topsoil will not be unnecessarily trafficked either before stripping or when in stockpiles. • Such stockpiled topsoil will be returned to cover the disturbed area and cut slopes. Residual topsoil will be distributed on adjoining/proximate barren/rocky areas as identified by the Authority's Engineer in a layer of thickness of 75mm – 150mm. Top soil shall also be utilized for redevelopment of borrow areas, landscaping along slopes and incidental spaces.				
7.	Compaction of soil	All construction sites	• Construction vehicle, machinery and equipment shall move or be stationed in the designated area (RoW or CoI, as applicable) only. While operating on temporarily acquired land for traffic detours, storage, material handling or any other construction related or incidental activities, topsoil from agricultural land will be preserved as mentioned above.	Planning for top soil management, traffic diversion plan	Review plans, field visits and observations	Contractor	Authority's Engineer/PIU
8.	Ecology	Site clearance	• Restricting tree cutting within corridor of impact.	No. of tree to be cut	Review clearance papers, field observations	Contractor	Authority's Engineer/PIU
		Ancillary sites	• Minimizing tree cutting and vegetation clearance during site selection. • Preservation of trees within ancillary sites and avoiding impact on forest resources by providing buffer area from boundary of forest areas of 1km for locating construction plants, construction camp, and quarry and 500 m for borrow areas. • Preservation of trees of ecological, socio-cultural importance • Providing cooking at camp for discouraging and prohibiting use of fire-wood i.e. cutting of trees by the workers.	No. of tree to be cut	Review clearance papers, field observations	Contractor	Authority's Engineer/PIU
9.	Occupational health and	Construction camp	• Water supply, sanitation, drainage and medical health facilities at campsite.	Planning for health and	Review records, field	Contractor	Authority's Engineer/PIU

Sl.	Environmental Issue	Location/ Sources	Mitigation Measures	Monitoring Indicators	Monitoring Methods	Implementing Agency	Supervising & Monitoring Agency
	safety of workers		• Ground water must not be used for drinking purpose. • Providing and using PPEs. • Using working reverse horn for all construction equipment and vehicles. • Providing earth link circuit breaker (ELCB) for all electrical connections. • Maintaining first aid at construction sites. • Maintaining emergency response system. • Provide adequate safety measures for communities and workers working on landslide prone zones. Refer Annex 5 and Annex 6	safety, practices being implemented	check, observations,		
10.	Accidents and safety	Construction sites	• Providing and maintaining traffic management comprising diversion; warning, guiding and regulatory signage; channelisers and delineators; lighting, flagmen; dust control system etc. as specified in the contract. • Providing adequate light at construction zone if working during night time is permitted by the Engineer. • Conducting induction and periodic training for all workers and supervisors.	Planning for Traffic management, training plans	Check records, field observations	Contractor	Authority's Engineer/PIU
		Construction camp	• Conducting periodic mock drilling on critical accident prone activities. • Conducting periodic training for all personnel working at plant site.	Planning for health and safety	Check record, observations, discussion with workers	Contractor	Authority's Engineer/PIU
OPERATION							
1.	Air Pollution	Vehicular gaseous emission	• Periodical monitoring of air pollutants and if values exceed the standard limits (Annex 3), suitable mitigation measures such controlling speed of traffic to be taken.	PM10 level, gaseous emissions	PM10 monitoring, vehicle maintenance record check	PIU	SPCB and Traffic Police
2.	Noise Pollution	Vehicular	• Periodical monitoring of noise level will be carried out. If values exceed the standard (Annex 4) limits, suitable measures will be taken. • Providing and maintaining signage on noise regulation at silence zones.	Noise level	Noise level measurements , field observations	PIU	SPCB
3.	Road Safety	Traffic and Vehicles Slow moving traffic	• Maintenance as per Standard Highway Safety Signage and Traffic Management.	Traffic movement	No. of accidents	PIU	PIU and Traffic Police

Sl.	Environmental Issue	Location/ Sources	Mitigation Measures	Monitoring Indicators	Monitoring Methods	Implementing Agency	Supervising & Monitoring Agency
		Lighting	• Maintenance of road / flyover lighting.	Traffic movement	No. of accidents	PIU	PIU/Traffic police
4.	Tree plantation	-	• Roadside tree plantation three times of cutting.	Survival rate of trees	Field observations	Forest Dept. / PIU	PIU
5.	Contamination of Soil and Water Resources from Spills due to traffic & accidents	Vehicular Traffic	• Contingency plans to be in place for cleaning up of spills of oil, fuel and toxic chemicals. • Spill of oil, fuel and automobile servicing units without adequate preventive systems in place to be discouraged.	Incidences of spills, accidents	Review of records, field consultations	PIU	PIU
6.	Soil Erosion and Sedimentation	-	• Maintaining the slope protection measures provided at stretches of high embankment and protection measures for bed scouring at cross drainage locations as per maintenance manual to be prepared before operation.	Cases of landslides	Maintenance Records	PIU	PIU
7.	Maintenance of drainage system	-	• The drains will be periodically cleared to maintain storm water flow. • Road drains will be cleared of debris before onset of every monsoon.	Maintenance plans	Maintenance Records	PIU	PIU

Note: PIU – Project Implementation Unit of MoRTH, Authority's Engineer

Table 81: Environmental Monitoring Plan

Environmental Features / Stage	Parameters and Standards	Location	Frequency	Duration	Action Plan in case criteria exceeds the standards	Responsible party	
						Implementation	Supervision
Air Quality and Noise Levels							
Construction Stage	• SPM, $PM_{2.5}$, PM_{10}, SO_2, NOx, CO, HC (Standards given in Annex 3) • Leq - Noise levels on dB (A) scale (Standards given in Annex 4)	• Wherever the contractor decides to locate the Hot mix plant • Along the project road at different zone including sensitive receptor zones as suggested by Authority's Engineer for regular monitoring • At hot mix plant and equipments yards	Once in a season excluding monsoon for 2 years	Continuous 24 hours/ or for 1 full working day	Check and modify control devices like bag filter/cyclones of hot mix plant Provide additional noise barriers	Contractor Through approved monitoring agency	Authority's Engineerngineer, PIU

Environmental Features / Stage	Parameters and Standards	Location	Frequency	Duration	Action Plan in case criteria exceeds the standards	Responsible party	
						Implementation	Supervision
Operations Stage	• SPM, $PM_{2.5}$, PM_{10}, SO_2, NOx, CO, HC (Standards given in Annex 3) • Leq - Noise levels on dB (A) scale (Standards given in Annex 4)	Along the project road at different zone as suggested by Authority's Engineerfor regular monitoring	Once in a season excluding monsoon for 2 years	Continuous 24 hours/ or for 1 full working day	-	Contractor Through approved monitoring agency	Authority's Engineer, PIU
Water Quality							
Construction Stage	pH, Temperature, DO, Oil & Grease, Conductivity, TSS, TDS, Alkalinity, Total Hardness, Calcium, Magnesium Chloride, Phosphate, Sulphate, Nitrate, COD, BOD, Iron, Total Coliform, Faecal Coliform, Salinity (Surface Quality Standards by CPSB as given in Annex .2)	At identified locations	Once in a season Excluding monsoon for 2 years	-	Check and modify petrol interceptors, Silt fencing devices.	Contractor Through approved monitoring agency	Authority's Engineer, PIU
	pH, Temperature, Conductivity, TSS, TDS, Alkalinity, Total, Hardness, Calcium, Magnesium Chloride, Phosphate, Sulphate, BOD, Coliform, Nitrate, Iron. (Ground Quality Standards by CPSB as given in Annex 2)	At identified locations	Once in a season Excluding monsoon for 2 years	-	Check and modify petrol interceptors, Silt fencing devices.	Contractor Through approved monitoring agency	Authority's Engineer, PIU
Operation Stage	pH, Temperature, DO, Oil & Grease, Conductivity, TSS, TDS, Alkalinity, Total Hardness, Calcium, Magnesium Chloride, Phosphate, Sulphate, Nitrate, COD, BOD, Iron, Total Coliform, Faecal Coliform, Salinity (Surface Quality Standards by CPSB as given in Annex 2)	At identified locations	Once in a season Excluding monsoon for 2 years	-	Check and modify petrol interceptors, Silt fencing devices.	Contractor Through approved monitoring agency	Authority's Engineer, PIU
	pH, Temperature, Conductivity, TSS, TDS, Alkalinity, Total, Hardness, Calcium, Magnesium Chloride, Phosphate, Sulphate, BOD, Coliform, Nitrate, Iron. (Ground Quality Standards by CPSB as given in Annex 2)	At identified locations	Once in a season Excluding monsoon for 2 years	-	Check and modify petrol interceptors, Silt fencing devices.	Contractor Through approved monitoring agency	Authority's Engineer, PIU
Soil Quality							
Construction	Chemical properties including oil and grease	At identified locations	Once in a season excluding for 2 years	-	Check oil and chemical spillage	Contractor Through approved monitoring agency	Authority's Engineer, PIU

Environmental Features / Stage	Parameters and Standards	Location	Frequency	Duration	Action Plan in case criteria exceeds the standards	Responsible party	
						Implementation	Supervision
Operation	Chemical properties including oil and grease	At identified locations	Once in a season excluding for 2 years	-	Check oil and chemical spillage	Contractor Through approved monitoring agency	Authority's Engineer, PIU
Tree Plantation							
Operation	Survival rate of plants	All along the project corridor	1 samples (quadrants) for each km	-	Once every year after monsoon for 3 years	Contractor Through approved monitoring agency	Authority's Engineer, PIU
Accidental and Health and Safety							
Construction	No. of accidents or near miss involving workers.	All along the project corridor	Once in a months	-	Corrective measures	Contractor	Authority's Engineer, PIU
Operation	No. of accidents or near miss involving workers.	All along the project corridor	Once in 3 months	-	Corrective measures	Contractor / PIU	PIU
Wildlife Collision							
Construction	No. of wildlife accidents.	At forest areas	Once in a months	-	Corrective measures	Contractor	Authority's Engineer/ Forest Officials
Operation	No. of wildlife accidents.	At forest areas	Once in 3 months	-	Corrective measures	Contractor / PIU	Forest Officials

Note: PIU – Project Implementation Unit, Authority's Engineer-Construction Authority's Engineer

F. Institutional Requirements

463. The Ministry of Road Transport and Highways (MoRTH) will be the executing agency (EA) for the project and the Implementing Agency (IA) will be the National Highways and Infrastructure Development Corporation Limited (NHIDCL). A Project Implementation Unit (PIU) will be established by NHIDCL to implement the subproject. EA together with IA will be responsible for the implementation of the Project. The Project Director of PIU will be overall responsible for EMP implementation. The following key players are involved in EMP implementation during construction stage:

- MoRTH as Project EA
- NHIDCL as subproject PIU and its environmental units;
- Authority's Engineer i.e. Engineer and his representatives; and
- Contractors.

464. The PIU will have an Environmental and Social Management Unit (EMSU). It is recommended that two senior officers of PIU could be designated as an Environment Officer and as a Social Officer for monitoring implementation of proposed enviornmental and social safeguard measures respectively. EMSU will be headed by the Project Director but coordinating and supervising implementation of safeguard measures will be undertaken by the designated Environmental and Social Officers. Field level enviornmental staff will also be recruited by PIU to ensure the contractor is following EMP. There is a need for capacity building of environmental unit through various trainings. Enviornment Expert of Authority's Engineer will work as field level enviornmental staff.

465. The Project Director of PIU with the assistance of designated Environmental and Social Officer will be overall responsible for ensuring compliance of safeguard measures and will be reporting to the regulatory bodies and ADB certifying that relevant environmental safeguard measures have been complied with during project implementation. At the field level, the Executive Engineer with his Assistant Engineer/s will supervise implementation of safeguard measures for this subproject and submit monthly reports to PIU.

466. PIU may engage independent agencies for carrying out pollution monitoring activities and also for indepndent monitoring of environmental safeguards implementation. The Authority's Engineer shall be interacting with these agencies and facilitate them in carrying out such activities.

467. The Authority's Engineer will have an Environmental Safeguards Specialist in its team and it will liaise with PIU environment unit to ensure that Contractor complies with the requirements of various environmental safeguard measures through supervision, monitoring and reporting on the same. Efforts must be made by SC to ensure that environmental mitigation and good-construction-practices are not only considered but actually implemented as integral component of each civil activity. It should be considered as day-to-day activity. Implementation of environmental safeguard measures needs team effort and as such the Team Leader of Authority's Engineer will delegate the responsibilities to each member of the supervision team with respect to their core responsibilities. The project should have a provision of Environmental Specialist within Authority's Engineer to supervise implementation of safeguard measures. His role would be more on advisory. He will assist the Team Leader of Authority's Engineer on the following:

- Advise PIU on preparing reports to ADB and other statutory bodies;
- Preparing procedures for implementing EMP;
- review Contractor's EMP, traffic management plan and safety plan and recommend for its approval / improvements, to the Team Leader;

- provide training to PIU, Authority's Engineer and Contractors' staff on implementing environmental safeguard measures;
- advise on obtaining various statutory environmental clearances on time;
- conduct periodic field visits to examine environmental compliances and suggest corrective actions ; and
- any other issues as will be required to ensure environmental compliance.

468. Besides, the Team Leader of Authority's Engineer will nominate a senior engineer from the site office for being directly responsible for day-to-day supervision of implementation of stipulated safeguard measures, to ensure accountability. He will provide guidance to the field staff of SC and Contractor for implementing each of the activities as per the EMP. He will be responsible for record keeping, providing instructions through the Engineer for corrective actions, ensuring compliance of various statutory and legislative requirements and assist Engineer for submitting reports to PIU. He will maintain a close co-ordination with the Contractor and PIU for successful implementation of the environmental safeguard measures.

469. Responsibilities of various agencies involved in the project implementation are described in following paragraphs.

1. Executing Agencies (EAs) Responsibilities

470. The EA's responsibilities will mainly be focussed on addressing national or state level environment safeguard issues and decisions concerning the subprojects. Specific responsibilities on environment safeguards at the EA level are:

- Ensure that all environment safeguard requirements as given in ADB SPS 2009, and applicable laws and rules under MoEFCC are being complied with during all stages of respective subprojects under the loan.
- Reviewing and approving all environment safeguards related documents such as IEE, environmental monitoring reports etc. prepared for subprojects under the investment program with recommendations and clarifications from the IA where necessary.
- Timely endorsement and signing of key documents and forwarding to the respective agency such as those required for processing of environmental clearance, forestry clearance etc. and disclosure on ADB website.
- Taking proactive and timely measures to address any environment safeguards related challenges at the national or state level such as delays in processing of clearances (during pre-construction stage), significant grievances (during construction stage)
- Recruiting an external monitor to conduct third party environmental monitoring for category A and B subprojects.

2. Implementing Agencies (IAs) Responsibilities

471. The IA's responsibilities will mainly be focussed on implementing environment safeguard requirements in accordance with the IEE and EMP at the subproject and site level. Specific responsibilities on environment safeguards at the IA level are:

- Where necessary hire an environmental consultant to prepare IEE report including EMP as may be required.
- Ensure that the consultant follows all procedures for conducting the environmental assessment as given in ADB's SPS.

- Review the budgetary needs for complying with the Government's and ADB's requirements on environment safeguards and ensure the proposed budget is in line with project requirements.
- Prepare forms, reports and all documents etc. for processing of environmental, forestry and related clearances in a timely manner and submit them for further review and signing to the authorized officer in the respective EA office.
- If any problems or long delays are encountered when processing the clearance documents, immediately alert the authorized officer at the EA level and seek ways resolve the problem at the soonest.
- Provide necessary support to the consultants preparing the environmental assessment reports to facilitate smooth and efficient preparation of documents, conduction of meetings, conduction of public hearings etc. required by ADB, MoEFCC, SPCB, Forestry Department, Wildlife Board etc.
- Review the IEE report including EMP and EMOP prepared by the consultant and provide comments if necessary.
- After receipt of satisfactory IEE report including EMP and EMOP forward the respective reports to the respective EA for further endorsement and forwarding to ADB for disclosure on the ADB website.
- Ensure that all necessary regulatory clearances are obtained prior to commencing any civil work of the respective contract package or road section.
- Ensure that for Engineering Procurement and Construction (EPC) based contracts updating of the EMP and EMOP based on detailed design and implementation of the EMP is included under the contractor's responsibilities.
- Ensure that the EMP which includes required mitigation measures and monitoring requirements with defined Bill of Quantity (BOQ), forms part of bidding document for the case of item rate based contracts.
- Ensure that contractors have access to the IEE report including EMP and EMOP of the subprojects.
- Ensure that contractors understand their responsibilities to mitigate environmental problems associated with their construction activities.
- Ensure and Monitor that all required permits, no objection certificates etc. are obtained by the contractor for establishment and operation of equipments and facilities as detailed in IEE.
- With the support of the EFP of the contractors and ISC ensure that the contractor implements the EMP including EMOP as given in the respective IEE report.
- In case of unanticipated environmental impacts during project implementation stage, with the support of ISC prepare and implement an updated EMP to account for such impacts after seeking concurrence from ADB. The updating shall be carried out after due consultation with the stake holders and concerned government agencies.
- In case during project implementation a subproject needs to be realigned, review the environmental classification and revise accordingly, and identify whether supplementary IEE study is required. If it is required, prepare the TOR for undertaking supplementary IEE and hire an environment consultant to carry out the study.
- Ensure that construction workers work under safe and healthy working environment.
- Ensure effective implementation of Grievance Redress Mechanism to address affected people's concerns and complaints.

- Submit semi-annual environmental monitoring reports for category B subprojects on the implementation of all environment safeguard requirements including the EMP and EMOP under the respective subproject to ADB and make these reports available for public disclosure.

3. ADB's Responsibilities

472. ADB is responsible for the following:

- Review REA checklist and endorse or modify the tranche classification proposed by the EA
- Review IEE reports and disclose the draft and final reports on the ADB website as required;
- Issue subproject's approval based on IEE reports;
- Monitor implementation of the EMP through due diligence missions;
- Provide assistance to the EA and IA of subprojects, if required, in carrying out its responsibilities and for building capacity for safeguard compliance;
- Monitor overall compliance of the subproject to SASEC RIP project EARF; and
- If necessary provide further guidance to the IA on the format, content, and scope of the IEE reports and annual and/or semi-annual monitoring reports for submission to ADB.

473. For ensuring that EMP is properly implemented, Contractor shall appoint a full time qualified and experienced Environmental and Safety Officer (ESO) from the commencement to completion of the project. The qualification and responsibilities of ESO as stipulated below should be considered. The qualification of ESO will be as given below:

- Diploma or Graduate in Civil Engineering with post graduate specialization in Environmental Engineering or Environmental Science or equivalent;
- 5 to 10 years of total professional experience; and
- About 3 to 5 years of experience in similar projects i.e. management of environmental issues in design and construction of road / highway / flyover / bridge projects.

474. The responsibilities of ESO of Contractor will include the following:

- Directly reporting to the Project Manager of the Contractor;
- Discussing various environmental issues and environmental mitigation, enhancement and monitoring actions with all concerned directly or indirectly;
- Prepare Contractor's EMP, traffic management plan and safety plan as part of their Work Program;
- Ensure contractor's compliance with the EMP stipulations and conditions of statutory bodies;
- Assisting his project manager to ensure environmentally sound and safe construction practices;
- Assisting his project manager to ensure the timely procurement of materials that are included in the Bill of Quantities relating to environmental mitigation and enhancement measures;
- Conducting periodic environmental and safety training for contractor's engineers, supervisors and workers;
- Preparing a registers for material sources, labour, pollution monitoring results, public complaint and as may be directed by the Engineer;

- Assisting the PIU on various environmental monitoring and control activities including pollution monitoring; and
- Preparing and submitting monthly reports to SC on status of implementation safeguard measures.

475. As mentioned above, there will need for capacity building of PIU on various environmental and social aspects of the project through various environmental training. Recently, there has been change of statutory requirements for this similar projects based on new EIA Notification. This has changed the landscape of legal and administrative framework for implementing the projects. Thus, there is a need for the PIU staff to updating the information and keeping abreast with the changing legal and administrative requirement. The requirements of various statutory permits and clearances are mentioned in Table 54 (Chapter 4). For successful implementation of EMP, it is essential to orient engineers of PIU, Authority's Engineer and Contractor who would be mobilized for this project. One day environmental orientation workshop will be conducted at Imphal by ADB supported consultant, once most of the staff has been mobilized. The training program is included in Annex 11.

G. Environmental Management Budget

476. An environmental management budget of INR 8,298,505 (Indian Rupees Eight million two nine eight thousand and five hundred five only) (US$ 0.14 milions) has been estimated for implementation of the environmental management plan. This budget also includes cost of environmental monitoring and associated trainings. A detail of environmental management budget is given in Table 80.

Table 82: Environmental Management Cost Estimate *

SL. No.	ITEM DESCRIPTION	QUANTITY	UNIT	RATE (Rs.)	AMOUNT (Rs.)	RESPONSIBILITY
A.	**Forest Clearance and Compensatory Afforestation**					
A.1	Payment of Forest Compensation for diversion 50.51 ha of forest land					PIU through Forest Department
A.1.4	Crop Compensation				1,999,003	
A.1.5	Compensatory Afforestation				1,146,296	
A.1.6	Net Present Value (NPV)				1,858,206	
Total (Rupees) Amount to be Deposited by MPWD					**5,003,505**[28]	
B.	**Environmental Monitoring**					
B.1	Ambient air quality monitoring during construction and operations phases as detailed in **Table 79** (Chapter IX)	36	No.	8,000	288,000	PIU through Approved Monitoring Agency
B.2	Ambient noise level monitoring during construction and operations phases as detailed in **Table 79** (Chapter IX)	36	No.	2000	72,000	
B.3	Water quality monitoring of surface water during construction and operations phases as detailed in **Table 79** (Chapter IX)	24	No.	5000	120,000	
B.4	Water quality monitoring of drinking water during construction and operations phases as detailed in **Table 79** (Chapter IX)	18	No.	5000	90,000	
B.5	Soil quality monitoring during construction and operations phases as detailed in **Table 79** (Chapter IX)	18	No.	10,000	180,000	
B.6	Monitoring survival rate of plantation as detailed in **Table 79** (Chapter IX)	3	No.	20,000	60,000	
C.	**Noise Barrier at sensitive location**					
C.1	Provide the Noise barrier at sensitive areas like schools and hospitals. The noise barriers of hollow brick wall/reinforced concrete panels with height of 3.5m. The design of the noise barrier shall be approved by the engineer in charge**.**	500	Rm	4,000	2,000,000	Contractor through BOQ
D.	**Enhancement of common property resources as per directed by the engineer including the following items**					
D.1	Provision and erection of cement concrete, standard sitting benches including clearing of the area around the benches.	20	No.	1,000	20,000	
D.2	Boundary fencing with barbed wire fencing of approved make and specification including provision and erection of struts	300	Rm.	550	165,000	
F.	**Wildlife Conservation Activities**					
F.1	Supporting widlife conservation programmes as prioritized in the forest working plan concern forest division and management plan of the YLWLS	1	Lump Sum	200000	200,000	PIU through Authority's Engineer
G.	**Environmental Training**					

[28] Estimate based on unit rates used by Forest Department in previous projects. Exact figure will be determined by State Forest Department.

SL. No.	ITEM DESCRIPTION	QUANTITY	UNIT	RATE (Rs.)	AMOUNT (Rs.)	RESPONSIBILITY
G.1	Training at site as per Annex 11 **of EIA.**	1	Lump Sum	100000	100,000	PIU through Authority's Engineer
		Grand Total (Rupees)			**82,98,505**	

* Cost estimate is preliminary based on the current unit rates. Therefore this estimate is tentative only.

H. Grievance Redress Mechanism

477. Grievances related to the implementation of the project, particularly regarding the environmental management will be acknowledged, evaluated, and responded to the complainant with corrective action proposed using understandable and transparent processes that are gender responsive, culturally appropriate, and readily accessible to all segments of the affected people. Records of grievances received, corrective actions taken and their outcomes will be properly maintained and form part of the semi-annual environmental monitoring report to ADB.

478. Depending on the nature and significance of the grievances or complaints, the grievance redress mechanism (GRM) will comprise procedures to address grievances i) first at the PIU level and ii) second at the EA level and iv) third at the Grievance Redress Committee (GRC). Most serious complaints which cannot be addressed at the EA level will be forwarded to the GRC. The GRC will comprise members from the EA, IA, Authority's Engineer, contractor, local community, women groups and local forestry authority.

479. All the parties involved in project implementation i.e. contractor, engineer, and employer will maintain complaint registers at their following respective offices:

- Contactor's main site offices i.e. office of the Project Manager,
- Authority's Engineer's main site office i.e. office of the Engineer's Representative; and
- Executive Engineer's office i.e. Employer's field office.

480. Environment complaints will be received through the Grievance Focal Point (GFP), these will be designated personnel from within the community and appointed by the community, who will be responsible for receiving the Environmental complaints. The Contractor will record the complaint in the onsite Environmental Complaints Register (ECR) in the presence of the GFP.

481. All public complaints regarding environmental issues received by GFP will be entered into the register with specific details such as name and address of the person or representative of the community registering a complaint, the details of complaint, and time. The Executive Engineer and Engineer's Representative will immediately communicate the details of the complaint to the Contractor. The Environemnt and Safety Officer (ESO) of the contractor will promptly investigate and review the environmental complaint and implement appropriate corrective actions to mitigate the cause of the complaints. The Engineer's Representative will decide on the exact time frame within which the action will be taken on case-to-case basis depending on the nature and sensitivity of the same. However, in all the cases, it will be responsibility of the contractor to take action immediately upon receiving any complaint. The contractor will report to Engineer's Representative about the action taken on the complaint, within 48 hours of receiving the complaint, for his further intimating to PIU and the Executive Engineer. The person making a complaint would be intimated by the complaint receiving person or his representative, about the action taken, within 48 hours, along with his/her feedback. Figure 26 shows the proposed Grievance Redress Mechanism.

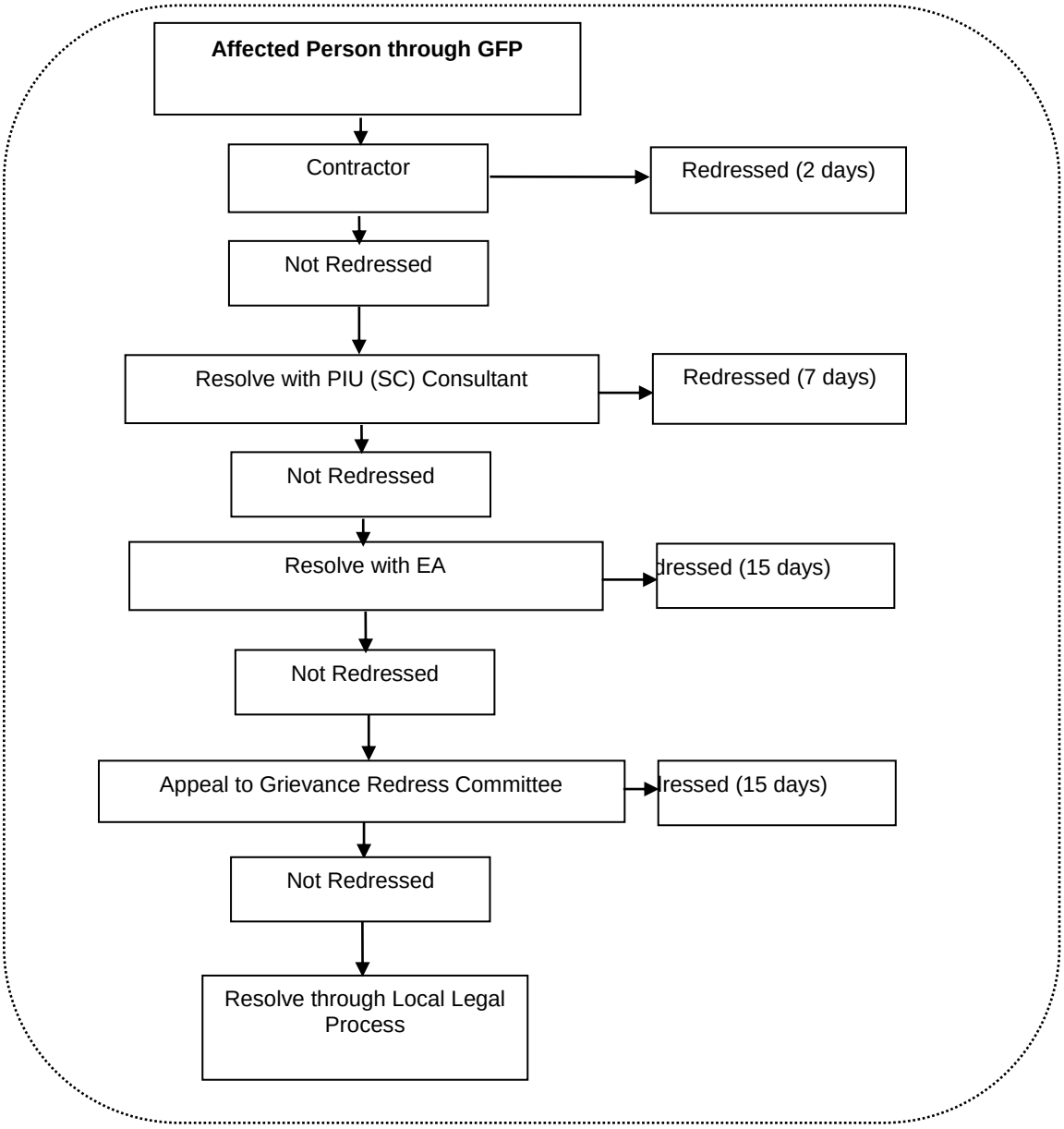


Figure 26: Grievance Redress Mechanism

IX. CONCLUSIONS AND RECOMMENDATIONS

482. The subproject road (65.8 km road section of Imphal-Moreh highway) proposed for improvement is classified as environment Category B project as per ADB SPS requirements, since the subproject involves widening of existing road. As per Government of India regulations EC is not required for this subproject since the project road is a national highway widening project with less then 100 km length. Forest Clearance from Central/State Government will be required for diversion of about 50.51 hectares of forest land for non-forest purpose. The categorization has been done based on environmental screening and assessment of likely impacts while the environmental impact assessment ascertains that it is unlikely to cause any significant environmental impacts. Few impacts were identified attributable to the proposed project, all of which are localized and temporary in nature and easy to mitigate.

483. About 33.28 km length of subproject roads passes through various categories of forests. There are no other ecologically sensitive areas along the subproject road neither there are any archaeological/protected monument located in the project vicinity. The project road alignment is passes through plain terrain for initial 38 kms (upto Pallel) and remaining section from Pallel onwards passes through hilly terrain. The land use pattern around the proposed alignment is predominantly mix of forest and agriculture land.

484. The potential adverse impacts of the road section upgrading are:

- Impacts due to acquisition of about 68.1 hectare of land for proposed road widening,
- Impacts on surrounding area due to tree cutting (3691) for the proposed improvement work;
- Impacts on flora and fauna do to diversion of about 50.51 hectare of forest land for non-forest purpose;
- Temporary impact on land and air environment due to locating construction camp;
- Temporary impact on land, air and water environment due to establishing and operating construction plants (Hot Mix Plant and Diesel Generator [DG] sets);
- Impact on biophysical environment due to quarry operation;
- Impacts on roadside flora and fauna particularly on sections of road passing through Reserved Forest Area;
- Impact on air quality, water quality, drainage, road users due to construction activities of project road ;
- Impact on land and water environment due to disposal of waste materials; and
- Impact on occupational health and safety due to all onsite and offsite construction works.

485. Measures such as use of EFRC slope protection measures are proposed to minimize the impacts of slope instability, use of bioengineering technique, compensatory afforestation, measures to minimize impacts on wildlife movement, engineering alternatives to limit impacts on forest areas etc. are proposed to minimize the potential impacts.

486. Besides, series of mitigation measures have been proposed that are described in the IEE Report and addressed comprehensively in the environmental management plan. These include provision of bioengineering applications for stabilizing slopes, use of spoil disposal areas to minimize destruction of forests down-slope of the alignment, proper sizing of hydraulic structures to assure adequate capacity and prevent destruction of adjacent land, provision of sign boards along precious ecological zones, identification of vulnerable community infrastructure that must

be preserved or replaced under construction contracts, limits on location and access of workers and other provisions regarding construction to assure minimum impact, and other basic provisions found in the EMP. All the above observations and mitigation measures will be included in the tender documents for contract works.

487. Application of these measures in parallel with MoRTH environmentally friendly road construction practices will reduce significantly any potential environmental impact. Impacts remaining on the physical environment (air and water pollution) are temporary and often occur away from the presence of people. The biological environment will reconstitute itself following any residual or remaining impacts on it.

488. Potential adverse effects during operations of the roadways have been minimized by aligning the road in optimal locations in relation to roadway safety and community impact, through provision of designs and budgets for superior roadway drainage structures.

489. In case of ARD issue identified EMP will be amended to include appropairte mitigation measures to minimize ARD impacts on water quality.

490. A systematic approach for surveillance and monitoring is provided by means of a management framework, and monitoring and reporting protocol. In general, the project received good support from local people. The local people appreciated that besides providing an all-weather efficient connectivity to large rural populations and improving the traffic scenario in the region, it will bear out several other socio-economic positive benefits. Follow-up public consultation is intended to provide future input to the identification of environmental impact during the construction phase as well as a grievance redress mechanism for project affected persons. The social component of the project has identified the numbers of affected persons and households, the amount and locations requiring total and partial land acquisition, and the amount of damage costs. The EMP is a living document and the same will be revised if necessary during project implementation or if there is any change in the project design and with approval of ADB during the construction period. The environmental mitigation measures are itemized in the EMP and the EA and IA shall ensure that EMP and EMoP are included in Bill of Quantity (BOQ) and forms part of bid document and civil works contract.

491. Before the start of civil works for the any section of the project road the project proponent (NHIDCL) must obtain necessary clearances / permits from staturoty authorities.