MINISTRY OF ROAD TRANSPORT AND HIGHWAYS
NATIONAL HIGHWAY AND INFRASTRUCTURE DEVELOPMENT CORPORATION

PREPARATORY STUDY FOR NORTH EAST ROAD NETWORK CONNECTIVITY IMPROVEMENT PROJECT (PHASE-2)

WIDENING AND IMPROVEMENT OF NH-40 (SHILLONG – DAWKI)

ENVIRONMENT IMPACT ASSESSMENT

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ABBREVIATIONS

ADT	Average Daily Traffic
BRDB	Border Roads Development Board
BRO	Border Roads Organization
COD	Chemical Oxygen Demand
CPCB	Central Pollution Control Board
DPR	Detailed Project Report
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
GHG	Green House Gas
GOI	Government of India
GSDP	Gross State Domestic Products
IRC	Indian Road Congress
MLCU	Martin Luther Christian University
MOEFCC	Ministry of Environment, Forests & Climate Change
MORTH	Ministry of Road Transport & Highways
MSPCB	Meghalaya State Pollution Control Board
NABL	National Accreditation Board for Laboratories
NHAI	National Highway Authority of India
NHIDCL	National Highways and Infrastructure Development Corporation
NOC	No-objection Certificates
PAPs	Project Affected Persons
PCU	Passenger Car Unit
PIU	Project Implementation Unit
PUC	Pollution under Control Certificate
PWD	Public Works Department
RAP	Resettlement Action Plan
RO	Regional Offices
ROB	Road over Bridge
ROW	Right of Way
SC	Supervision consultants
SPCBs	State Pollution Control Boards

EXECUTIVE SUMMARY

The Government of India has requested the Government of Japan to provide financing for about 1,200 km of roads that enhance connectivity in North-East States. Out of 10 candidate projects on the road and bridge constructions, Shillong - Dawki section of NH40 in the State of Meghalaya has been selected as one of the priority project. The project objective is to improve intra-state connectivity for North East States and regional road connectivity for Meghalaya and North East India to neighboring country of Bangladesh. The residents of the North Eastern Region, Bangladesh and Myanmar and countries beyond should benefit from the increased regional connectivity, which is expected to result in increased trade and economic development over the longer term.

The existing road is about 84 km in length and stretches over two districts in Meghalaya. NH40 is the most important road in the State, connecting Meghalaya with other States of India such as Assam and other countries. This is the lifeline of many Khasi people who depend on the road network for the supply of essential commodities. The current condition of road, however, is poor and the road is prone to landslide and slope failures. The riding quality of the road is poor, particularly in monsoon season. The proposed road construction length after changes of the alignment as a number of bypasses are inserted will be 71.5 km.

The significant environmental impacts attributable to the widening and improvement of the road with new bypasses pertains to clearance of roadside trees for widening and forest clearance of protected forest, resettlement site development, temporary deterioration of ambient air quality and noise levels during construction phase from land clearing, changes on the geographical conditions, quarry development, workforce camp set-up and operations, and community and occupational health as well as the safety of the general public. These impacts will have to be mitigated through compensatory afforestation, controlled construction activities in terms of noise, dust, wastewater, CO2 emissions, and construction debris generation in order to minimize disturbances to human and wildlife through good construction practices. Implementation of road safety measures to separate road users from active construction fronts should also be the measures to maintain safety of the traffic and pedestrians.

NH-40 is the road already exists and new road construction in terms of a number of bypasses inserted throughout the project area. At a place, bypass construction work is taking place inside a state government forest while majority of the project area is largely made up of agricultural fields and settlements as well as private forests. Though the forest is designated as Important Bird Area (IBA) of "Tawny-breasted Wren-babbler (Spelaeornis longicaudatus)" by BirdLife International, the forest cannot be considered to be critical national habitat for vulnerable species.

During operation and maintenance stage, the main impacts are the increase of traffic and vehicular CO2 emissions, road safety to motorists and pedestrians. Road safety measures would be implemented as per IRC guidelines. Road safety appurtenances such as information boards, regulatory and warning signs in terms of the use of road coupled with crash barriers/guard-rails will all reduce traffic accidents that would otherwise be increased.

Adequate slope protection based on the geo-technical measures and retaining wall as well as cross drains and side drains would be installed in the various locations of the project area. These road facilities are maintained in order to avoid soil erosion and reduce the risk of landslide.

A number of consultations were organized during the project preparation period in order to engage major stakeholder representatives. Such consultation sessions are to incorporate their concerns in the overall design of the Project. These involved officials of NHIDCL, PWD, District Administration Officials, Forest Department, Traffic Department and those directly affected persons and the village representatives of the project area. Most of the interviewed local residents strongly supported the implementation of the Project.

NHIDCL as Project Implementing Unit (PIU) is the Executive Agency of the Project. It will ensure the effective implementation of the environmental management and monitoring plan. There is a need for the PIU to organize its Environmental Management and Monitoring Unit in order to provide well-established support to the Project Director to ensure the Contractors maintain environmental compliance. The same unit should also function as Environmental Management and Monitoring Unit.

1. INTRODUCTION

1.1 Project Background

In India, roads are one of most important modes of ground transportation as it constitutes 85% of passenger and 60% of freight transported in India. However, the development of the road network in mountainous regions of Northeastern Region of India has been much worse than the rest of India. This is due to financial and technical reasons. Thus Northeastern Region has suffered greater economic disparity comparing to other areas of India.

While 63.4% of the roads in India have been paved, only 28.5% of the roads in Northeastern Regions are paved, out of which only 53% of national highways are more than 2-lane road. This is because the Northeastern Region is located far from the major parts of India. Furthermore, the roads leading to neighboring countries have been underdeveloped due to security concerns.

The severe natural conditions of the Northeastern Region featured by steep mountainous and a prolonged monsoon season have also been obstacles to appropriately develop the road network. Acceleration of economic growth in this part of the country has therefore been much delayed. The regional connectivity of the road network should promote cross-border trade and commerce and help safeguard India's international borders. This would lead to the formation of a more integrated and economically consolidated South and Southeast Asia. In addition, there would be overall economic benefits for the local population and would promote the integration of the peripheral areas.

Approximate aggregate length of 10,000 km of road in the Northeastern Region has been identified for development. The development of the road network envisages creating customized and specialized skills in terms of addressing issues like complexities of geographical terrains and addressing extensive coordination with central and state government.

The Government of India (GOI) thus launched in recent years "Special Accelerated Road Development Program for Northeastern Region" for which improvement of the road network is of great importance. The GOI stated in their "Twelfth Five Years Plan (from April, 2012 to March, 2017)" that the improvement of national highways in Northeastern Region should interconnect major cities within the region. It is within this context that the GOI requested Government of Japan to provide assistance in carrying out the improvement of Shillong-Dawki section of NH-40 from the capital city of Meghalaya State to the border of Bangladesh stretching approximately 71.5 km. after realignment.

1.2 Purpose and Objectives of the Study

As per MOEFCC EIA Notification, dated 14.09.2006 (as amended in August 2013), any highway project falls under Category A if the project entails: 1) New National Highways; and 2) Expansion of National Highways greater than 100km involving additional right of way or land acquisition greater than 40m on the existing alignments and 60m on re-alignments and bypasses. The proposed expansion & widening of NH-40 does not involve additional land acquisition beyond 30 m i.e. it is not a Category A project as defined in the EIA Notification of 2013.

While DPR consultant undertook a preliminary environmental assessment during the preparation of the DPR for NH-40, the project does not require environmental clearance from MOEFCC. On the other hand, the project has been classified as Category A as per JICA's Guidelines for the Environmental and Social Considerations and the project requires a full EIA study including SIA and RAP survey.

It is therefore JICA Study Team's obligation to support EIA/RAP studies, which supplement the environmental studies carried out by DPR consultants. Thereby additional requirements short of JICA's guidelines are fulfilled.

EIA/RAP studies carried out with assistance from JICA Study Team aimed to:

- Review the environmental assessment undertaken as part of the DPR study;
- Identify gaps between Indian laws and regulations relating to the EIA study and JICA Guidelines for

Environmental and Social Considerations;
- Study the baseline of social and environmental conditions along the areas directly and indirectly affected during design, construction operation and maintenance of the NH-40 widening project;
- Carry out environmental impact analysis with respect to the proposed project;
- Identify environmental issues that require further studies;
- Carry out analysis of alternatives including comparison with a "no project' scenario;
- Develop cost effective measures for mitigating adverse environmental and social impacts and enhancing positive aspects;
- Develop an Environmental Management Plan (EMP) for the mitigation of environmental impacts and monitoring of the implementation of mitigation measures during the operation and maintenance period;
- Consult and inform the project affected persons (PAPs) and other stakeholders concerned with the project to encourage their active participation.

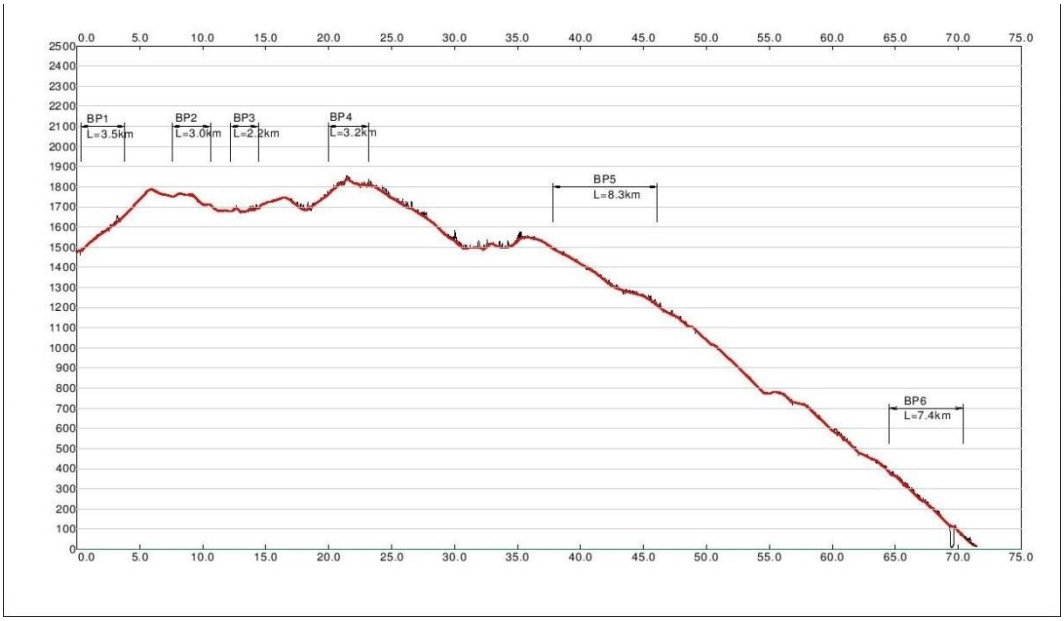
1.3 Extent of the Study Area

1.3.1 Extent of the Study

The Shillong-Dawki section of NH-40 stretching from the capital city of Shillong, Meghalaya State running to the border town of Dawki located on the border between India and Bangladesh. While Shillong is located on the plateau of 1,525 m above sea level, Dawki is on the plane of 35 m above sea level. Thus NH-40 initially begins in the highland area of 1,525 m, passing through approximately 1,800 masl highland area and gradually go down to 35 masl as is shown in Figure 1-1 and Figure 1-2.
The entire stretch of present section was surveyed and screened during May - June 2016. The collection of water samples, soil samples and other data pertaining to air quality and noise were monitored along the road. At present NH-40 is in good condition with footpath on both side of the road and drainage system in place up to the area of Eastern Air Force Headquarters. The length is approximately 8 km from the starting point while this section is climbing the mountain slope to 1,800 m thereafter the width of road, without road furniture, is generally two lanes up to the 63.5 km post climbing down East Khasi Hills. The last 8 km section of NH-40 is particularly narrow without appropriate road furniture, causing traffic congestion going out to Bangladesh and coming into India. Thus improvement of NH-40 to widen the road and place appropriate road furniture is needed.

Source: JICA Study Team

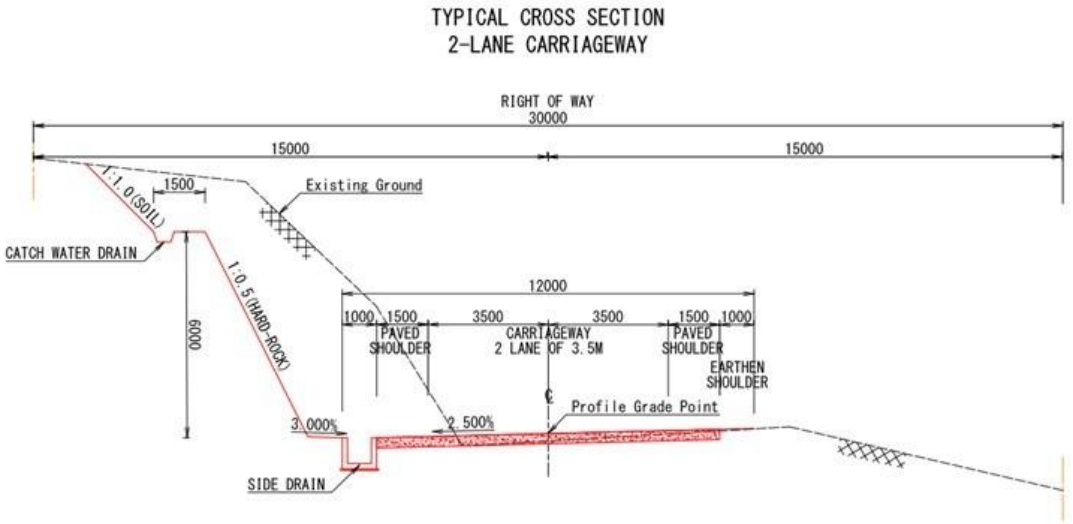
Figure 1-1 Location of the Project Area (NH-40)



Source: JICA Study Team

Figure 1-2 Profile of the Project Area

As Figure 1-3 shows, the Right of Way (ROW) of the new NH-40 has to be 30 m wide throughout most of the project area. In some places, it is not possible to maintain or not necessary to secure 30 m of ROW of 30 m wide. Thus depending on the locations no land acquisition takes place. With the project, urban and rural built-up areas, protected, private forest, grassland, limestone quarries are directly affected along the proposed bypasses & parallel alignment, local built-up areas would be involved in the resettlement of the local residents. To some extent, land acquisition for the bypasses would cause local farmers becoming landless depending on the farming areas subject to land acquisition for ROW.



Source: JICA Study Team

Figure 1-3 Typical Cross Section of the Hillside Road of NH-40

1.3.2 Project Impact Area

(1) Geographical Extent of the Impacts

As Figure 1-1 and Figure 1-2 shows length of the project area is 71.5 km. Because of the Wildlife Protection Law of India states, extent of impact area has to be 5 km radius from the centerline of the road construction project as per Figure 1-4.

(2) Study Components of Natural Environment and Socio-economic Environment

1) Legal Framework Related to the Project

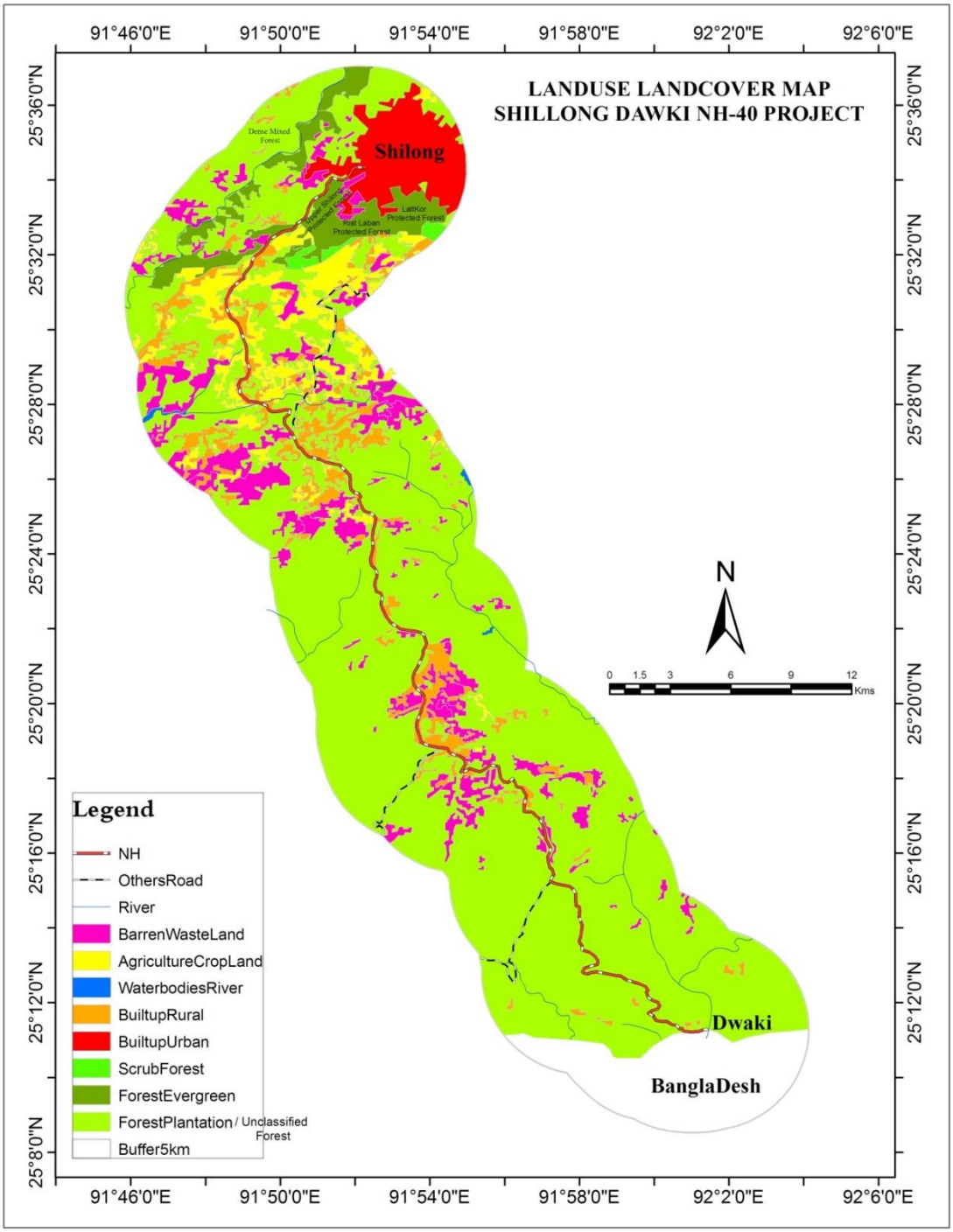
Legal framework of the Government of India including those of Meghalaya State that depict impacts induced to the environment and socio-economic conditions by the Project is widely studied. There are JICA Guidelines as well as World Bank and ADB safeguard policies that have to be studied in relation to the laws and regulations of the Government of India including those of Meghalaya State.

2) Natural Environment

As is shown in Figure 1-4, the entire length of NH-40 is 71.5 km and it is the primary area of study including the area within 5 km radius, which is compulsory study area according to India's wildlife protection act, from the centerline of NH-40.

While this project is a road improvement project of the existing NH-40, it involves 6 locations of bypasses that are generally the new road construction works that a large area of forestland has to be cleared. Thus environmental components subject to study are meteorology, geography and geomorphology, geology, soil erosion, hydrology and groundwater, forest and plant biology, wildlife and wildlife conservation areas, aesthetic value of land scape and natural disaster prone areas. For the environmental pollution, air quality; water quality; soil; solid waste are all studied in terms of their effect on the environment in conjunction with the implementation of the Project.

While main aim of this project is to improve NH-40, there are six bypasses subject to new construction in the rural area including built-up area of human settlements, forested areas and agricultural fields. There are impacts induced by the road construction project on the air quality, water, soil, solid waste, traffic accidents, water rights, climate change, fauna and flora, public hygiene and safety, and involuntary resettlement that are taking place within the scheduled tribal area of Kashi living on the East Kashi Hill of Meghalaya State.



Source: SOI Toposheets, Resourcesat I – LISS-III Image

Figure 1-4 Geographical Extent of the Environmental Study

3) **Socio-economic Environment**

Study on Socio-economic environment included migration of population and involuntary resettlement, local economy, utilization of land and local resources, social institutions, existing social infrastructures and services, vulnerable social groups such as poor and indigenous peoples, equality of benefits and losses and equality in the development process, gender, children's rights, cultural heritage, local conflicts

of interest, infectious diseases, and working conditions.
Because of the Project is taking place in its entirety within the territory of Khasi Tribe and a part in Jaintia Tribe's territory, who are Scheduled Tribes in India and that they are subject to resettlement, careful examination of socio-economic impact on the Scheduled Tribes, especially the involuntary resettlement is important in terms of the successful implementation of the Project. Thus information dissemination on the Project's plan through stakeholder dialogues, where resettlement agreement has to reach among the project-affected households (PAHs).

Those who are subject to resettlement should be given ample supply of resettlement compensation, employment opportunities and enhancement of livelihood, be it traditional or modern. On the hand, there are a number of issues such as land and natural resource use of the tribal/clan areas, local tribal organizations including social and NGO organizations, gender relationships, women in development, child rights, cultural and traditional heritage, advantages and disadvantages on the interests of different local groups, HIV/AIDS, direct and indirect impacts induced by the project implementation, cumulative and intensifying impacts of the project otherwise improvement of economic conditions in the rural area as a whole. These issues are studied as a whole in relation to the project implementation of 2-lane improvement of NH-40.

Resettlement plan has to be drawn based on the laws and regulations of the Government of India. LARR 2013 is especially important act for drawing clear picture of resettlement action plan. However, JICA Guidelines including World Bank's Safeguard policy, such as OP4.12 Annex A and B should also be referred to. Regarding the scheduled tribe of Khasi and Jaintia, elements of Indigenous People's Plan (IPP) was considered in resettlement plan.

During the process of resettlement dialogue for agreement based on the World Bank's policy on the replacement basis for which lost asset has to be compensated, contents of further resettlement package of enhancing livelihood and increasing opportunities for employment and other benefit has to be generally agreed. PAHs will have to be supported in different way at the time of resettlement. In order to monitor the livelihood of PAHs after resettlement, 3-5 years of monitoring works should be included in the resettlement study for which every PAH is satisfied after the resettlement.

1.4 Structure of the Report

1.4.1 Analyses, Compilation and Preparation of Report

The data collected by survey teams were compiled. Along with the field monitoring studies and secondary data, these were used to identify the environmental problem. The following analyses were carried out based on compiled information:

1) The levels of environmental parameters were compared with the prescribed limits suggested by Central Pollution Control Board (CPCB). This gave a clear idea that special attention is paid in areas where the level of pollution is higher than desirable.
2) The mitigation measures have been suggested to reduce the adverse impacts due to the proposed widening and detailed environmental management plan have been prepared covering both the phases i.e. construction and operation of highway.

The report is organized as follows:

- Chapter 1 gives Project background, Purpose, extent and objective of the study.

- Chapter 2 describes the Description of the Project location along with the Project components.
- Chapter 3 discusses the Environmental legislation and policy within which the project is to be implemented. The chapter presents the clearance requirements at various levels.
- Chapter 4 discusses the Scoping, Analysis of Alternatives, Anticipated Impacts and Proposed Mitigation Measures.
- Chapter 5 describes the Environment along the project area.
- Chapter 6 describes the Anticipated Environmental Impact and its Mitigation.
- Chapter 7 discusses Environmental Management Plan and its implementation arrangement.
- Chapter 8 provides Public Consultation and Information Disclosure.
- Chapter 9 discusses Conclusion and Recommendations.

1.5 Methodology

The study has been carried out in following stages;

- The baseline environmental information in the study area viz., climate, physiographic features, drainage, geology, flora, fauna, ambient air, water and noise and socio-economic conditions.
- Reviews of literature, laws and guidelines and discussions with concerned agencies and organizations, National / State Authorities and on-site;
- Reconnaissance survey along with public consultation was during May 2016 to August 2016 and processes of public consultation continued till the completion of study to inform the people about the project and collect the information / suggestions on environmental issues.
- The institutional arrangement for monitoring with regard to air, water, soil and noise pollution.
- Assessment of the potential significant impacts and identification of the mitigation measures to address impacts adequately.
- Field observations including public consultation.
- Screening, testing and monitoring of environmental factors like air, water, soil and the noise level.
- Collection of secondary data from various departments.
- Compilation, analysis and presentation of the report.

1.5.1 Review of Laws and Guidelines

The JICA guidelines, World Bank operational manual and environmental safeguard policies procedures & practices and following Government of India's guidelines are reviewed.

- Environmental Guidelines for Selected Infrastructure Projects;
- Project Terms of Reference (TOR);
- Environmental guidelines for Road/Rail/Highway Projects, Government of India, 1989
- Handbook of environmental procedures and guidelines, 1994, Government of India
- Guidelines for Environmental Impact Assessment of Highway Projects (IRC: 104-1988); and
- The Environmental (Protection) Act, 1986 and EIA Notification 2006 dated 14th September 2006.

1.5.2 Screening, Testing & Monitoring of Physical Environmental Factors

The entire stretch of present section was surveyed and screened. The collection of water samples, soil samples and other data pertaining to air quality and noise were done through NABL Accredited Laboratory.

(1) Ambient Air Quality

Ambient air quality was monitored along the road at selected sites. The locations selected were those of the city / town area, the market place and the rural areas. The air quality parameters considered for the study include Particulate Matter10 (PM10), Particulate Matter 2.5 (PM2.5), Nitrogen Oxides (NOx) Sulphur Di-oxide (SO_2), and Carbon monoxide (CO).

a) Particulate Matters (PM10 & PM2.5)

PM10 and PM2.5 were monitored using a Respirable Dust sampler (RDS) and PM2.5 Sampler. A pre-conditioned and weighted glass fiber filter papers was placed on top of the RDS/PM2.5 samplers. A known quantity of the air was sucked through the filter paper in a prescribed sampling time. The flow was noted from the manometer. The multiplication of time with rate gave the total quantity of air passed through the filter paper. After sampling, the filter paper was removed, conditioned, and weighed finally for getting the concentrations in ambient air.

b) Sulphur Di-Oxides (SO_2)

A known quantity of the air was bubbled through impingers containing tetrachloromercurate. SO_2, formed a disulfiltomercurate complex, which gave a pinkish blue colour with p-rosaniline and formaldehyde solution. The intensity of colour produced was proportional to concentration of sulphur dioxide. The measurement was made by using spectrophotometer at the wavelength of 560 nm.

c) Nitrogen Di-Oxides (NOx)

A known quantity of air was passed through impingers containing sodium hydroxide-sodium arsenite solution. The estimation of NOx was done colorimetrically using hydrogen peroxide, sulfanilamide, NEDA, etc. The intensity of the colour was measured at 540 nm using a spectrophotometer.

d) Carbon Monoxide (CO)

FID based samplers were used to monitor the carbon monoxide levels.

(2) Water Quality

Samples of ground water were collected from springs whereas samples of surface water were collected from rivers. To assess the water Quality of the area samples were tested for physico-chemical parameters.

(3) Soil Quality

The samples were collected from 30 m corridor of the road, at 5-15 cm depth. Besides studying their particle size (sand/silt/clay ratio) they were monitored for physico-chemical parameters to assess the soil quality of the area.

(4) Noise Level

The noise level (Leq) was measured using noise meter at various sites along the entire stretch of road during day (6.00 am to 10 pm) and night (10 pm to 6.00 am).

The noise levels is expressed as an equivalent noise level (Leq) which is the measurement duration of sound pressure level as the averaging time. It is calculated as follows:

$$Leq = 10 \text{ Log}10 [\sum_{1}^{n} 10 \text{ Li}/10]$$

Where, Li = Instantaneous sound intensity level dB (A) at the measuring site, n = No. of observations

1.5.3 Secondary Available Data

The secondary data were collected from following sources:

1.	General information	Deputy Commissioner /Gazetteer Office
2.	Meteorological data	Indian Meteorological Department
3.	Statistical data	District Statistical Office
4.	Irrigation and hydrogeology data	Central Ground Water Board
5.	General Land use and Cropping Pattern	Asst. Director of Agriculture
6.	Relief and slope	Survey of India
7.	Rocks and minerals	Geological Survey of India
8.	Industries	District Industries Center
9.	Maps and Topo sheets	Survey of India
10.	Forests/Wild life/Bio-diversity	Divisional Forest Office
11.	Flora and Fauna	Divisional Forest Office
12.	Archaeological Data	Archaeological Survey of India

2. DESCRIPTION OF THE PROJECT

2.1 Location of the Project

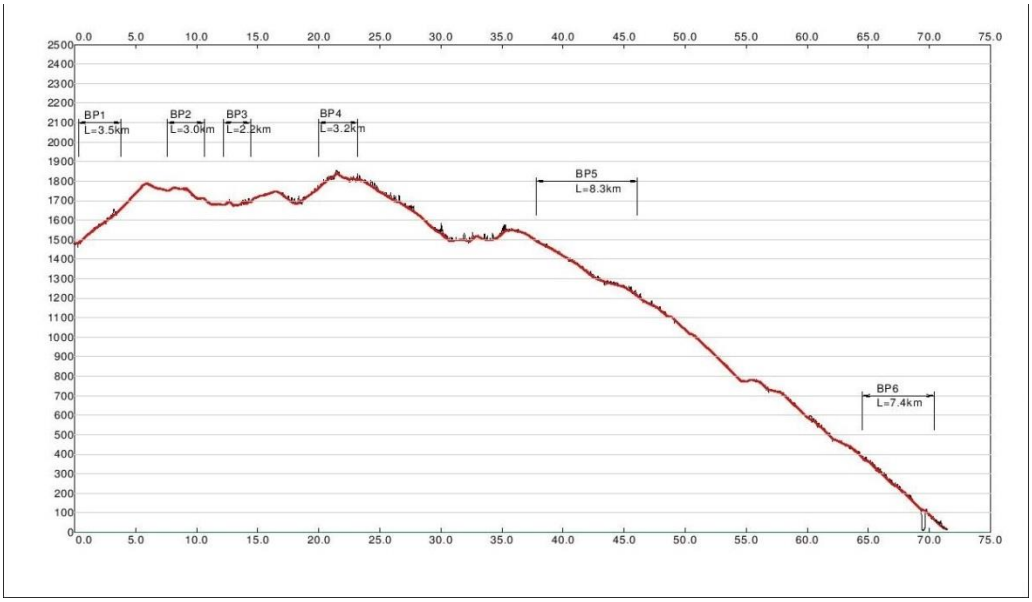
The existing Shillong-Dawki section of NH-40 stretching approximately 84 km from the capital city of Shillong, Meghalaya to Dawki located on the India and Bangladesh border. While Shillong is located on the plateau of 1,525 m above sea level, Dawki is on the plane of 35 m above sea level. Thus the section of NH-40 included in the project begins in the highland area of 1,525 m, passes through approximately 1,800 masl highland area and gradually goes down to 35 masl as is shown in Figure 2-2. The proposed road construction length after change in the alignment will be 71.5 km.

Source: JICA Study Team

Figure 2-1 Location of the Project Area (NH-40)

2.2 Description of the Project Corridor

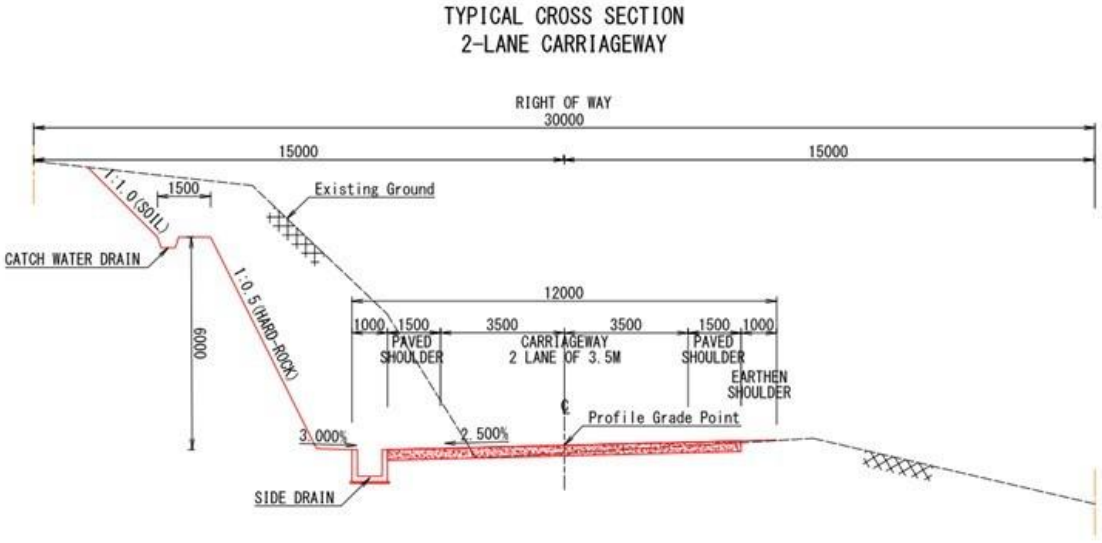
At present Shillong–Dawki section of NH-40 is in good condition with footpath on both side of the road and drainage system in places up to the area of Eastern Air Force Headquarters. The length is approximately 8 km from the starting point while this section is climbing the mountain slope to 1,800 m thereafter the width of road, without road furniture, is generally two lanes up to the 61 km post climbing down East Khasi Hills. The last 6-7 km section of NH-40 nearer Dawki is particularly narrow without appropriate road furniture, causing traffic congestion going out to Bangladesh and coming into India. Thus improvement of NH-40 to widen the road and place appropriate road furniture appears to be urgently needed. The profile of the project area is shown in Figure 2-1.



Source: JICA Study Team

Figure 2-2 Profile of the Project Area

As Figure 2-3 shows, the Right of Way (ROW) of the new NH-40 has to be 30 m wide throughout most of the project area. In some places, it is not possible to maintain or not necessary to secure 30 m of ROW of 30 m wide. Thus depending on the locations no land acquisition takes place. With the project, urban and rural built-up areas, forest, grassland, limestone quarries are directly affected along the proposed bypasses & parallel alignment, local built-up areas would be involved in the resettlement of the local residents.



Source: JICA Study Team

Figure 2-3 Typical Cross Section of the Hillside Road of NH-40

2.3 Proposed Improvement Components

Improvement proposals for a highway essentially consist of two components, geometric and structural.

Geometric improvement deals with visible dimensions of roadway and is dictated by the traffic and economic considerations. Geometric design involves several design elements such as horizontal and vertical alignments, sight distance considerations, cross sectional elements, lateral and vertical clearances, intersection treatment, control of access etc. The structural component deals with the pavement, embankment, and structure design aspects, i.e., the ability of the highway to adequately carry and support the vehicle/ wheel loads over the design period. The improvement proposals for the proposed widening to 2-lane with paved shoulder configuration system include the provisions for the following major items:

- Alignment and Geometry;
- Geometric Improvements and Re-alignments;
- Lane Configuration;
- Cross-Sectional elements;
- Pavement Improvement Options;
- Cross-Drainages works
- Bridges & Other Structures and
- Road Appurtenances.

2.3.1 Alignment & Geometry

Alignment design is one of the most important features influencing the efficiency and safety of a highway. The ideal highway alignment is the one which will cause the least over-all transportation cost taking into account the cost of construction, maintenance, and recurring cost of vehicles operation. Hence, the aim of designing the geometric has been to establish a safe, easy, short and economically possible alignment, considering the physical features of the region and traffic needs apart from least disturbance to the eco-system.
The existing alignment of the project highway is in zig-zag with substandard horizontal and vertical geometry; most of the horizontal curves are of radius less than 75m and vertical gradients are also steep. To develop the project road to National Highway standards, in hilly terrain, entails a thorough and elaborate study of the corridor of project road.
The alignment proposals are based on the findings from various engineering activities/surveys carried out on the project road. The proposed alignment has been selected in consistent with the prevailing terrain conditions of the area in such a way that,

- It fits well with natural terrain and requires least mitigation measures against adverse environmental impacts with due to consideration to least deforestation, resettlement etc;
- Least disturbance to existing traffic during construction;
- As direct as possible so that there is maximum economy in vehicle operations and maintenance;
- To utilize the existing facility as much as possible in order to minimize the cost and effort of land acquisition;
- Consistent with the IRC guidelines.

Generally the widening of the existing road is proposed on hill side and the centerline of the proposed alignment is designed such that, the proposed outer/valley side shoulder edge matches with the existing shoulder edge. Widening of the road on the valley side is generally not possible, which will require high retaining walls for the widening. However, the most optimal rehabilitation method is not necessarily to widen the road entirely on one side. At some locations, where too high cutting is involved, alignment is shifted to valley side, to minimize the cutting on hill side thus achieving the most optimum alignment, duly keeping in mind the stability and steepness of the valley side slopes.

As the alignment is passing through hilly terrain, construction of diversions at bridge locations would be expensive or in some cases may not be possible because of grade requirement. Hence, the sitting of new

bridges are proposed on one side leaving adequate gap, so that, there would be undisturbed movement of traffic during construction.

2.3.2 Geometric Improvements

When the proposed center line meets minimum one of the following condition:

- The horizontal distance between centerline of existing road and centerline of proposed road is less than 30m;
- The proposed centerline is located at a distance of more than 30m from the centerline of existing road but passes through the existing roadway at an interval of less than 200m along the length of road.

To improve the existing sharp and blind curves along the project road, geometric improvements have been proposed in entire length. Total length of major geometric improvements is 27,750m. Locations of these improvements are given below.

Table 2-1 Locations of Geometric Improvements

Sl. No	Exist. Chainage		Exist. Length (m)	Prop. Chainage		Prop Length (m)
	Start	End		Start	End	
1	82+050	83+470	1,420	0+300	1+420	1,120
2	86+000	86+220	220	3+500	3+700	200
3	87+040	87+410	370	4+500	4+870	370
4	87+550	87+970	420	5+010	5+370	360
5	92+880	94+365	1,485	10+500	11+920	1,420
6	96+765	97+200	435	14+440	14+860	420
7	97+895	98+070	175	15+470	15+630	160
8	98+520	103+280	4,760	16+080	19+840	3,760
9	107+220	112+900	5,680	22+770	27+810	5,040
10	114+180	114+620	440	29+050	29+500	450
11	117+400	121+845	4,445	31+800	35+630	3,830
12	131+820	132+930	1,110	45+760	46+750	990
13	133+450	133+660	210	47+190	47+330	140
14	134+210	134+980	770	47+870	48+600	730
15	135+480	136+080	600	48+820	49+280	460
16	138+060	141+990	3,930	51+750	54+300	2,550
17	145+880	152+300	6,420	58+720	64+470	5,750
	Total Length (m)		32890			27,750

Source: JICA Study Team

2.3.3 Bypasses/Re-alignments

As mentioned in previous chapters, existing road is passing through congested built-up areas at some locations. Bypasses have been proposed at these locations to have smooth geometry and better level of service for through traffic. Re-alignments have been proposed to improve the gradient or curvature or both when crossing high and steep mountain ranges. The proposed locations of proposed Bypasses/re-alignments were critically examined/studied for alternative improvements. The most economical with minimum disturbance has been considered. Details of these bypasses are given in subsequent sections and

summary is presented below:

Table 2-2 Locations of Bypasses / Realignment

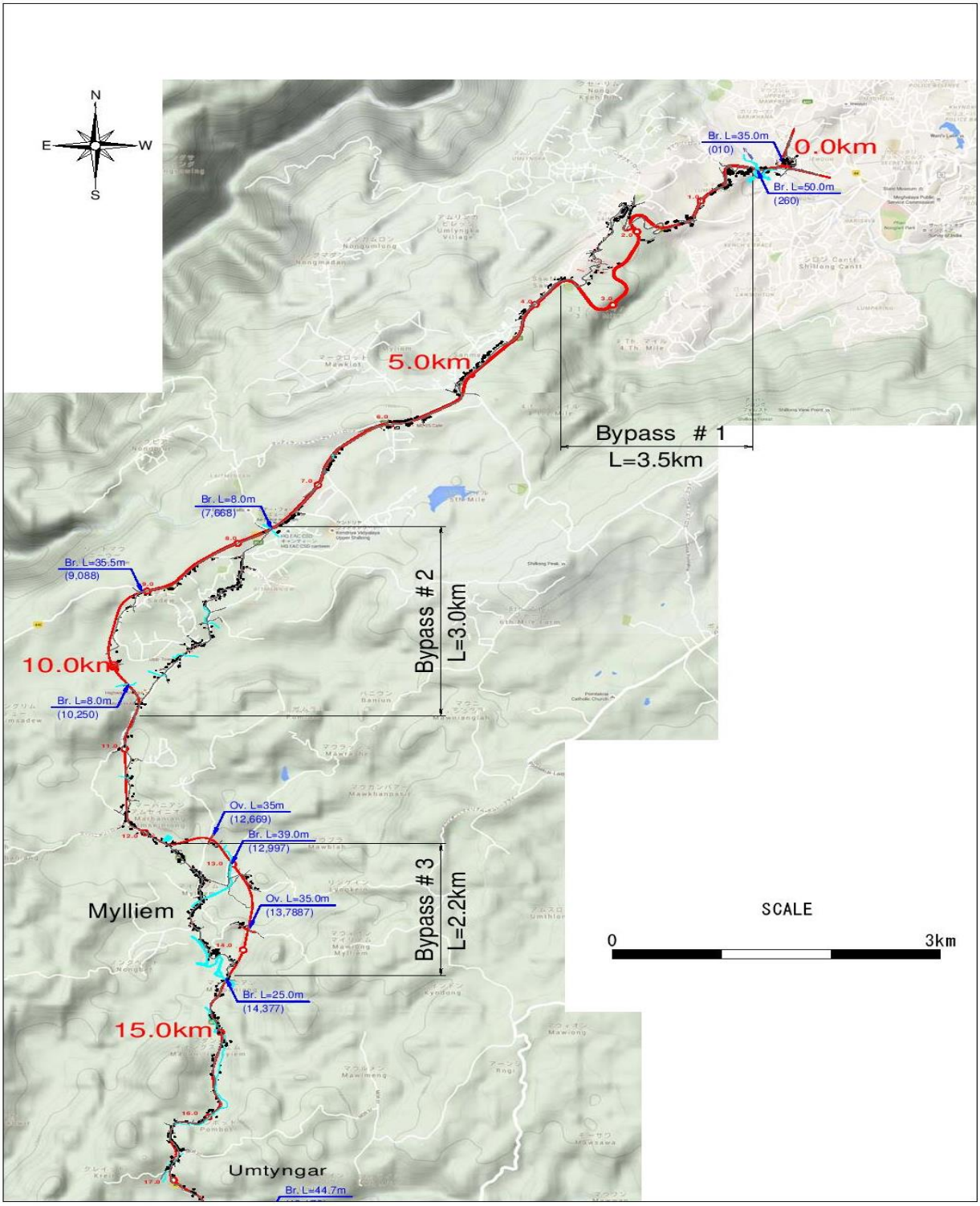
Sl. No	Location	Prop. Chainage		Prop Length (m)	Remarks
		Start	End		
1	3rd Mile	0+000	3+500	3500	Bypass no. 1 (Bypass started at km. 1+420 & realignment at 0+000 to 1+420)
*2	Ritmawniew	7+700	10+500	2800	Bypass no. 2
3	Mylliem	12+260	14+320	2060	Bypass no. 3
4	Laitlingkot	19+840	22+770	2930	Bypass no. 4
5	Mawkajum	29+500	30+600	1100	To improve geometrics
**6	Pynursala	37+550	45+760	8210	Bypass no. 5
7	Mawrwngkang & Dawki	63+500	71+500	8000	Bypass no. 6 & 7

Source: JICA Study Team & TRANSYS Consultant Pvt. Ltd.

*Overlapping portion of Riwmawniew Bypass (Bypass No.2) with NH44E (Ch 7+700 to Ch 9+100) will be excluded from the Project component.

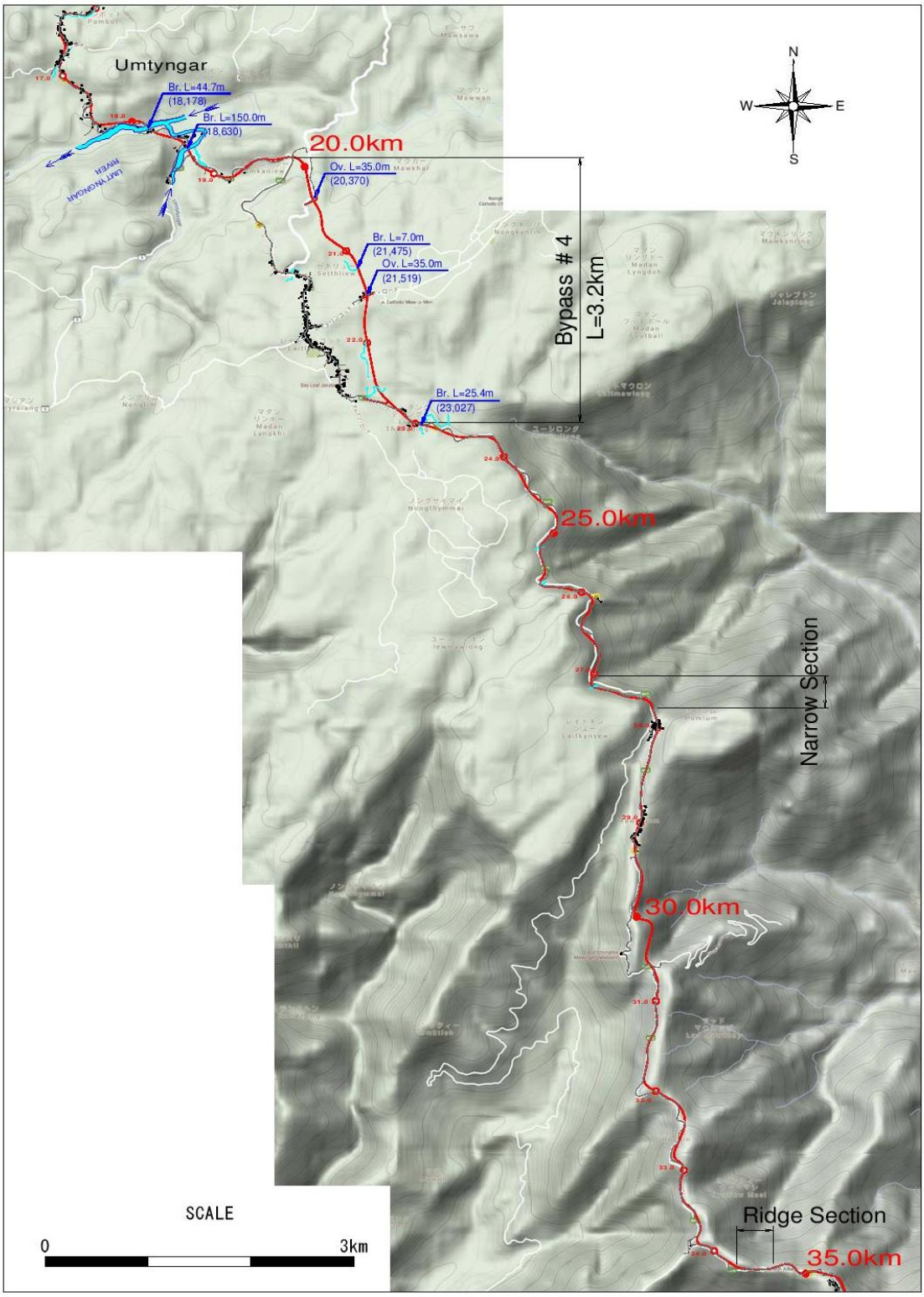
**Pynursla Bypass (Bypass No.5) might be excluded from the Project component in case that alignment is not agreed in the consultation meeting with concerned parties.

The details of the proposed Bypasses / Realignment are shown in Figure 2-4 to 2-7.



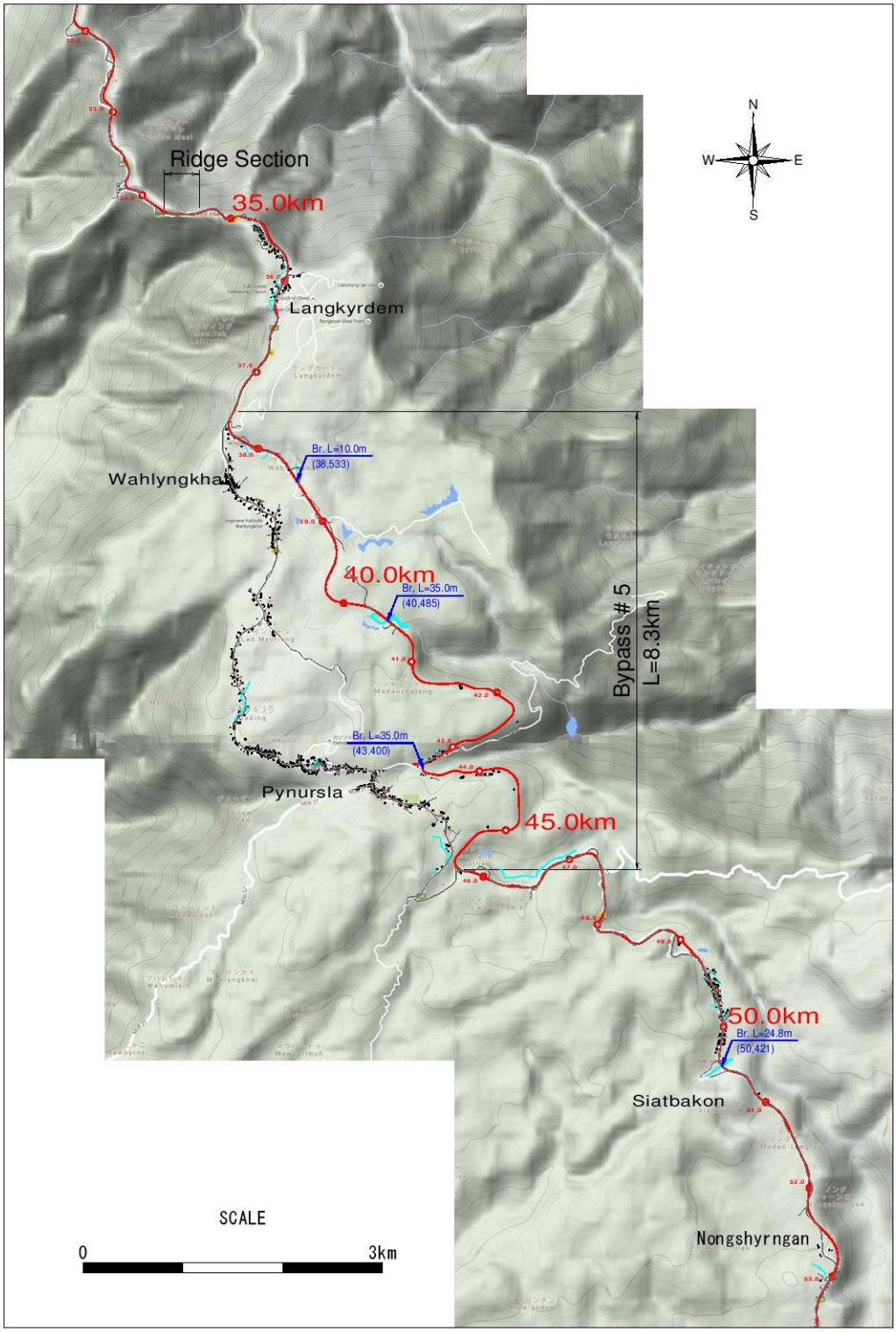
Source: JICA Study Team

Figure 2-4 The details of the proposed Bypasses / Realignment (1)



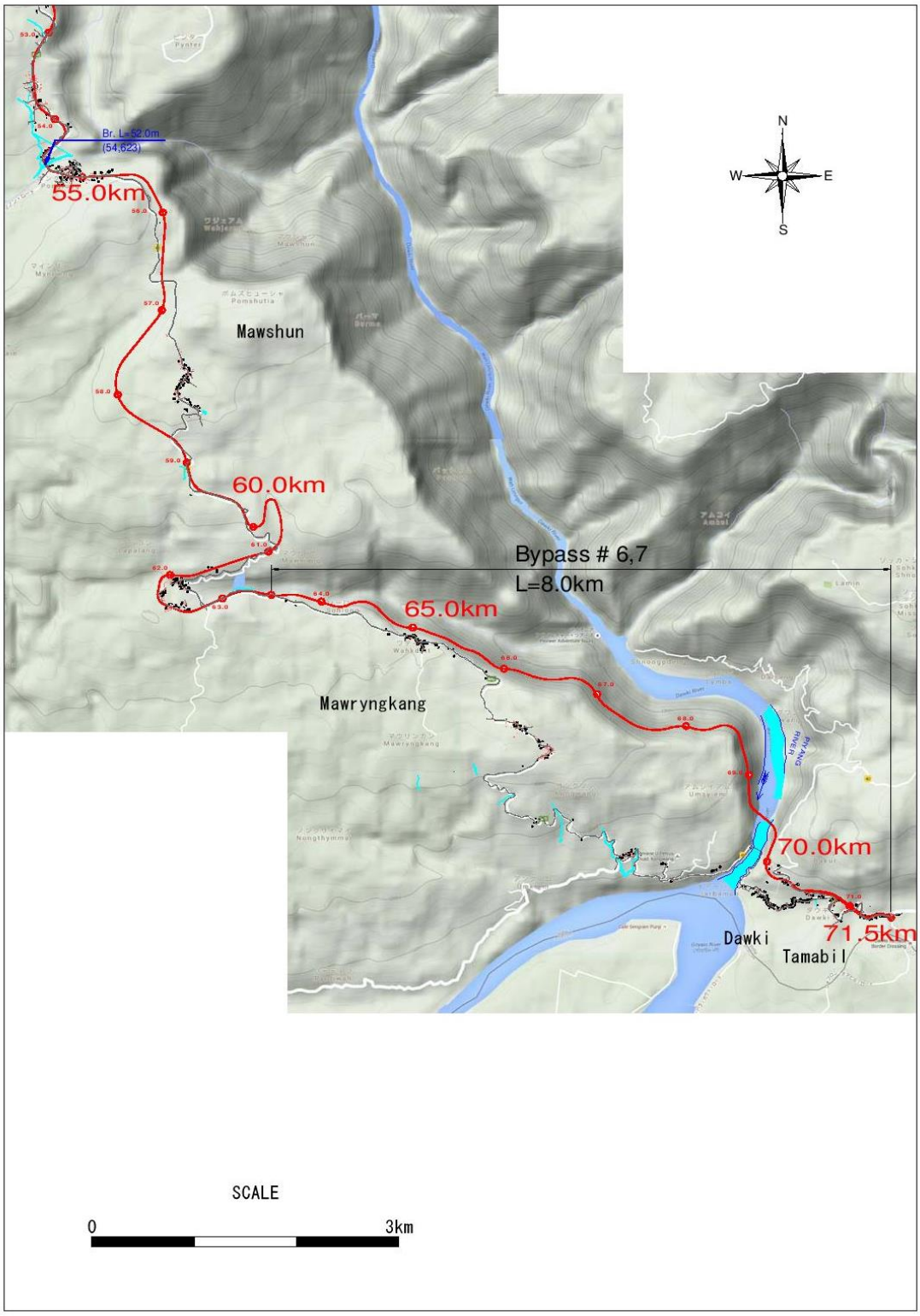
Source: JICA Study Team

Figure 2-5 The details of the proposed Bypasses / Realignment (2)



Source: JICA Study Team

Figure 2-6 The details of the proposed Bypasses / Realignment (3)



Source: JICA Study Team

Figure 2-7 The details of the proposed Bypasses / Realignment (4)

(1) The current and projected traffic

The current (2016) average daily traffic for various sections are presented in Table 2-3 proposed traffic volume in NH-40 till 2050 is presented in Table 2-4.

Table 2-3 Average Daily Traffic (ADT in pcu)

Sl. No.	Veh. Type	ADT (In pcu)					
		Km 83+500	Km 90+000	Km 97+000	Km 114+500	Km 152+000	Km 162+500
1	Car	12569	10174	4098	2102	937	521
2	Mini-Bus	318	157	69	38	10	10
3	Pvt. Bus	304	145	68	39	3	3
4	Govt. Bus	140	111	82	15	39	17
5	LCV	1216	871	758	426	834	656
6	2 Axle	1016	965	441	264	43	1670
7	3 Axle	55	100	7	1	0	6
8	4-6 Axle	1	10	1	0	0	0
9	>=7 Axle	0	0	0	0	0	0
10	2W	1411	494	387	126	23	23
11	3W	620	313	222	115	5	0
12	Tractor with Trailer	0	3	0	0	0	0
13	Tractor w/out Trailer	0	1	0	0	0	0
14	Cycle	4	3	1	0	0	0
Total		17654	13349	6135	3127	1894	2904

Source: PFR by TRANSYS Consulting Pvt. Ltd.

Table 2-4 Summary of Projected Traffic

Section		Exisitng Chainage		Length (m)	Traffic (PCU)							
		From	To		2016	2020	2025	2030	2035	2040	2045	2050
1	Railbong Point to 3rd Mile	81+740	84+000	2260	17072	23107	32780	45249	60959	80190	105513	138863
2	3rd Mile to Junction with NH44E	84+000	90+300	6300	12909	17594	25113	34814	47029	61957	81639	107593
3	Junction with NH44 to Junction with SH5 (Cherrapunji Road)	90+300	101+730	11430	5928	7992	11285	15516	20849	27388	35988	47300
4	Junction with SH5 (Cherrapunji Road) to Pynursala	101+730	131+000	29270	3021	4077	5761	7924	10650	13992	18387	24169
5	Pynursla to Dawki	131+000	162+000	31000	1825	2431	3375	4562	6062	7915	10337	13506
6	Dawki to Tambil	162+000	163+000	1000	2788	3517	4648	6073	7884	10162	13101	16894

Source: PFR by TRANSYS Consulting Pvt. Ltd.

(2) Proposed RoW

In Hilly terrain, as per IRC: 73, minimum right-of-way (ROW) width of 24m and 20m is desirable for National Highways at open areas and built-up areas respectively. However, the proposed ROW has been worked out on the basis of actual requirement in order to accommodate the proposed 2/4-lane road along

with cut/fill slopes.

(3) Junctions/Grade Separated Structures

Road junction/intersection is a key element of highway design. The efficiency, safety, speed, and capacity of road system very much depend on the intersection design. The main objective of intersection design is to reduce the severity of potential conflicts between motor vehicles, buses, trucks, bicycles, pedestrians, and facilities while facilitating the convenience, ease, and comfort of people traversing the intersections. There are 6 major intersections details of which are given below:

Table 2-5 Details of Major Junctions

Sl. No	Proposed Chainage	Classification of cross road	Type of Junction	Road Leading to	Proposal
1	0+000	NH 40/NH 44	+ Junction	Left- Guwahati Right- Jowai	VOP
2	1+990	Existing NH40	T Junction	3rd Mile, Upper Shillong	At-grade
3	9+088	NH 44E	T Junction	Nongstoin	VUP
4	18+520	SH 5	Y Junction	Cherrapunji	At-grade
5	43+350	City Road	Y Junction	Pynursala	At-grade
6	73+710	NH 40	T Junction	Jowai	At-grade

Source: TRANSYS Consultants Pvt. Ltd.

As per traffic requirements, grade separation is proposed for 2 junctions – at 0+000 and at 9+088. At junction 0+000 with NH40/NH44 Vehicular Overpass (VOP) has been proposed, where cross road is elevated with a span of 1x35m and the project road is at ground level. At 9+088, junction with NH44E Vehicular Underpass (VUP) has been proposed, where cross road is at ground level and project road is elevated with a span of 1x35m. The proposal, whether to elevate project road/cross road has been decided based on the terrain and profile of the roads.

At other locations at-grade junctions are proposed and these will be developed as per IRC SP: 41 – 1994.

There are 45 minor junctions with local roads and the list of these junctions is given in Appendix 5.3. In order to improve the functional efficiency of the proposed facility, it is very important to have smooth maneuvering of traffic from the highway to these roads and vice versa. Typical geometric improvements are being provided without channelizing islands for minor junction improvements, as the traffic intensity is very negligible. Realignment of intersecting roads is suggested only in case of minor roads intersecting at angle less than 60 deg. The typical layouts as given in fig 3.5 and 3.6 of 2-lane manual are generally followed. In addition to these junctions all ingress/egress which will be effected due to the proposed improvements needs to be re-established.

2.3.4 Slip Roads

Slip roads have been provided at proposed VOP/VUPs at the following locations.

Table 2-6 Locations of Slip Road

From	To	Width	Length (m)	Remarks
8720	9310	5.5	590	On both sides
190	630	5.5	440	On both sides along Guwahati-Shillong-Jowai Road
Total Length (m)			2060	Both side length

Source: TRANSYS Consultant Pvt. Ltd.

Culverts

Existing road is a single/two lane road, which has to be widened to 4-lanes/2-lane with paved shoulders with improved vertical and horizontal geometric. Following categories of existing culverts have been proposed for reconstruction:

- Culverts whose pipe / box/ slab or its abutment are damaged.
- Culverts where the proposed centerline of the project road falls outside of the existing carriageway, because of improvement of geometric.
- Culvert requires reconstruction on account of the vertical profile of proposed road not matching with existing road or deck level of the culvert due to geometric improvements.
- Culverts where bedding underneath the pipe has been washed away due to storm water action. Now water flows underneath the pipe until water level increases above inlet level.
- Pipe culvert-having dia. of less than 0.9m, considered for reconstruction with 1.2m dia. pipe.

It has been found that there is not even single culvert, which does meet any one or many of above-mentioned conditions. Hence all new culverts will be constructed on new alignment of 4-lane road.
Details of proposed culverts are given in Appendix 5.5 and summary is presented below:

Table 2-7 Summary of Proposed Box Culverts

Type	Span	Number of Culverts	
PIPE	1 x 1.2	106	106
SLAB	1 x 3	1	10
	1 x 4	4	
	1 x 6	5	
BOX	1 x 2	187	207
	1 x 3	11	
	1 x 4	4	
	1 x 5	2	
	1 x 6	3	
Total Number of Culverts			323

Source: TRANSYS Consultant Pvt. Ltd.

2.3.5 Bridges

(1) General

In this section of NH-40, there are 9 bridges consisting of one major bridge and 8 minor bridges. All minor bridges are 2-lane and constructed with RCC/PSC. Major bridge over Piyang River is single lane cable suspended bridge. Summary of existing bridges is given below:

Table 2-8 List of existing bridges

Sl. no	Exist. Chainage	Design Chainage	Span (m)	Width (m)	Superstructure	Foundation
1	82+015	0+275.000	2 x 24	12.5	Box Girder	Open
2	90+258	7+668.169	1 x 8	15.3	RCC Slab	Open
3	96+777	14+376.500	1 x 25.4	8.4	RCC T-beam	Open
4	100+808	18+178.031	1x9.6 + 1x25.5 + 1x9.6 (Skew)	8.4	RCC T-beam	Open
5	101+930	18+630.000	1 x 25	11.5	RCC T-beam	Open
6	107+487	23+066.966	1 x 25.4	8.4	RCC T-beam	Open
7	137+410	50+420.674	1 x 25	12.0	RCC T-beam	Open
8	142+313	54+623.357	1x14 + 1x24 + 1x14	12.0	RCC T-beam	Open
9	160+350	72+380.000	1 x 103	4.4	Cable Suspended	Open

Source: TRANSYS Consultant Pvt. Ltd.

Recommendations to retain or abandon any bridge, has been considered based on the overall condition of structure, designed loads, hydraulic behaviour, improvement of road alignment etc. As per condition survey carried out, except the bridge at Ch. 72+380, all other bridges are in good condition and hence to be retained. Dawki Bridge at ch 72+380 is single lane and is to be reconstructed.
Existing bridges will need normal repair and rehabilitation. The wearing coat, railing, kerb, expansion joint etc. of some of the existing bridges, which are in bad condition, would require replacement or repair.
In addition to the existing bridges, 7 new bridges are required along bypasses/re-alignments. Thus total number of bridges along the proposed alignment are 16 consisting of 15 minor and 1 major. The following table gives details of bridge improvement proposals.

(2) **Width of the bridges:**

i. All new/reconstructed bridges are proposed with 16m total width as per fig. 7.6 of 2-lane manual.
ii. For the bridges, which are in proposed 4-lane configuration, additional bridge of 12.5m width has been proposed besides the existing bridge as per fig.7.4B of 4-lane manual.

For the bridges, which are in proposed 2-lane+paved shoulder configuration, if the width of existing bridge is >= 12m no widening has been proposed. If the width of existing bridge < 12m, additional bridge of 12.5m width has been proposed besides the existing bridge.

2.3.6 Longitudinal Drains

RR Masonry/CC longitudinal drains are existing for most of the length and these drains are in fairly good condition. However, all these drains need to be re-constructed due to the proposed widening. Provisions have been made for throughout road side drainage for the proposed road in order to facilitate the effective drainage of runoff. The safety and durability of roads depends on the proper provision of roadside drains. Proposed locations of Drain are given in Appendix 5.6.

- RCC Covered Drain (1500mm x 1200mm): Proposed on both sides of road at built-up areas - Length 12968m
- PCC Open drain on hill side (600mm x 900mm) : Proposed on hill side at open areas - Length 68679m

2.3.7 Protection Works

The proposed road alignment passes through hilly terrain, major stretch of the road passes through reaches with either full cutting or part cutting and filling. Due to high cut & fill natural stability of the hill slopes are disturbed. Watercourses along the slopes cause erosion affecting road stability. Soil movement along slopes tend to disturb the road formation. All these have to be effectively countered to obtain a stable road, to avoid instability of the slopes and landslides in future by provision of structures/slope stability arrangements to act as retaining, restraining and protective structures.
The alignment is so designed to minimize the height of cut & fill and least disturbance to natural hill slopes. Various types of retaining structures/Slope stability arrangements are proposed considering the following factors.

- Height of Cut/Fill
- Cross slope the existing ground/hill
- Soil properties
- Height of hill above the finished road level

(1) Proposed Cut Slopes

Geologically the project area comprises of rocks from the oldest Precambrian gneissic complex to the recent alluvium formations. The type of soils encountered and the proposed side slopes of cutting adopted are given below:

Table 2-9 Proposed Cutting Slopes

From	To	Length (m)	Type of Soil/Rock				Prop. Cut Slope
0+000	3+500	3500	Cs	Sandstone	Soft Rock	Cretaceous - Tertiary Sediments	1H : 1V
3+500	5+200	1700	Ss	Sandstone	Soft Rock	Sandstone - Shillong Group of Rocks	1H : 2V
5+200	9+500	4300	Cs	Sandstone	Soft Rock	Cretaceous - Tertiary Sediments	1H : 1V
9+500	11+200	1700	Ss	Sandstone	Hard Rock	Sandstone - Shillong Group of Rocks	1H : 2V
11+200	21+300	10100	Mg	Granite	Soft Rock	Mylliem Pluton	1H : 1.25V
21+300	21+700	400	Cs	Sandstone	Soft Rock	Cretaceous - Tertiary Sediments	1H : 1V
21+700	35+000	13300	Ss	Sandstone	Hard Rock	Sandstone - Shillong Group of Rocks	1H : 2V
35+000	63+800	28800	Cs	Sandstone	Soft Rock	Cretaceous - Tertiary Sediments	1H : 1V
63+800	75+130	11330	Ss	Sandstone	Hard Rock	Sandstone - Shillong Group of Rocks	1H : 2V

Source: TRANSYS Consultant Pvt. Ltd.

(2) Breast Walls

Breast walls are provided to protect uphill slopes, which fail by slumping, sliding, toe failures and failures below formation level. Breast walls would also serve the following functions.

- To keep the road edge defined
- To protect the hill slope to the height of breast wall from silps
- To protect the drain to some extent
- Drainage from hill-slope through weep holes on to side drain
- To protect the buildings/structures on uphill

Generally breast walls have been proposed under 2 scenarios - a) At built-up areas to restrict the width cutting and thus the requirement of RoW b) At high cutting locations. The height of breast walls considered is 1.5m and 3.0m as per site requirement. At built-up areas generally PCC breast walls have been proposed and at rural areas Gabion walls have been proposed. Total Length of breast wall proposed is 13690m. Details are given in Appendix 5.7.

(3) Retaining Walls

Retaining walls are permanent structures usually built at the toe of the slope or at shoulder edge to resist lateral pressure due to existing soil, earth filling, back fill, water pressure etc. Total length of retaining walls is 11855m of various heights ranging from 2m to 12m as per the site condition. Locations of Retaining walls are given in Appendix 5.8.

(4) Guard/Parapet Wall

Parapet is proposed throughout the project length, where, ground slope is steeper on valley side. The length of Parapet wall is 28500 m.

(5) Crash Barrier

Steel Crash barrier (W-Beam) is proposed where the embankment height is 3m or more, on curves having radii less than 150m for upgrades and 300m for downgrades and at locations where, ground slope is steeper than 2 horizontal 1 vertical (2:1) on valley side. With these criteria, the length of W-beam crash barrier is 25900 m.

2.3.8 Road Facilities

(1) Bus-bays

The project road passes through built-up areas at many places. Bus shelters are present at few locations and these are to be re-located due to the proposed widening. Parking of bus /maxi cabs on main carriageway interferes the free flow movement of NH traffic and accidents also take place. Therefore, 14 numbers of bus-bays are proposed on each side along the highway to avoid congestion and reduce accidents. The locations of proposed bus bays along the highway are shown in layout plans and detailed list is given below:

Table 2-10 Location of Bus-bays

on LHS	on RHS	Remarks
1+290	1+370	Mahadev Khola
3+920	3+950	4th Mile
4+950	4+970	5th Mile
7+700	7+770	Elephant Falls
11+080	11+080	Marbaniang Umseiniong
16+600	16+600	Pombot
27+900	28+070	Pomlum
29+080	29+020	Mawkajum
36+010	35+880	Lyngkyrden
43+300	43+270	Pynursla
49+790	49+790	Siatbakan
53+600	53+700	Nongshyrngan
54+800	54+850	Pongtung
62+460	62+530	Pomshitia

Source: TRANSYS Consultant Pvt. Ltd.

(2) Truck lay-byes

Truck lay-byes are proposed at the following locations.

Table 2-11 Location of Truck Lay bye

on LHS	on RHS	Remarks
74+690		11m wide, 200m length followed by 1:10 taper
	74+790	11m wide, 160m length followed by 1:10 taper

Source: TRANSYS Consultant Pvt. Ltd.

(3) Lighting

As per section 12.4.3 of manual lighting has been provided at Built-up areas, Bus-bays, Truck lay-byes and grade separated structures. List of the locations where lighting has been proposed is given below:

Table 2-12 Location of Street Lighting

From	To	Length (m)	Remarks	
Along NH40				
0	8640	8640	Double Arm	Median
8640	9500	860	Single Arm	Both sides
16400	16900	500	Single Arm	Both sides
27800	28100	300	Single Arm	Both sides
28800	29400	600	Single Arm	Both sides
35500	36300	800	Single Arm	Both sides
42900	43500	600	Single Arm	Both sides
49100	50400	1300	Single Arm	Both sides
53400	55100	1700	Single Arm	Both sides
61900	62800	900	Single Arm	Both sides
73500	75130	1630	double Arm	Median
Along NH44				
0	800	800	Single Arm	Both sides
Total Length		18630		

Source: TRANSYS Consultant Pvt. Ltd.

2.3.9 Traffic Signs & Other Road Appurtenances

Provision have to be made for the traffic safety all along the stretches of the proposed road i.e. road sign-mandatory, informatory & cautionary, road markings, way side amenities etc. as per IRC:35-1997, IRC:67-2012, IRC:93-1985, and IRC:SP:73-2007.

The road furniture proposed to be provided includes routine and special road signs, hectometer, and kilometer and 200 m stones. Road delineators and warning/caution/informatory signs are also considered in the estimate. Road marking would be generally standard centre-line using thermoplastic paints. Boundary Pillars are proposed in the entire length on both sides at an interval of 200m.
Reflective Pavement Marker (RPM) or road stud is a device, which is bonded to or anchored within the road surface for lane marking and delineation for night time visibility. It reflects incident light in directions close to the direction from which it came. Design details, Optical performance details and details of fixing and placement shall be in-accordance with Ministry's letter No.RW/NH-33023/10/97-DO III dated, the 11th June, 1997 on 'Technical Specifications for Reflective Pavement Markers (Road Studs)'.

The size of "Chevron" Signboard is 400mm x 550mm.The signboard shall be in accordance with specification Cl. 801.3 of MoRTH guidelines for high intensity grade sheeting. Chevron sign boards shall be installed at 10m c/c at all curves with their embankments height more than 3 along the outer edge facing the traffic of nearby lane.

3. POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK

3.1 Country's Legal Framework and Regulatory Requirement

Within the framework of environmental laws of India, the Environmental (Protection) Act of 1986 and its enforcement rights has been given to Ministry of Environment, Forest & Climate Change (MOEFCC). It has overall authority for the administration and implementation of the EIA related policies, laws and regulations, sustainable development and pollution control in India. MOEFCC identifies the need to enact new laws and to issue amendment to the existing environmental legislations when required, in order to continue to conserve and protect the environment in India. Central Pollution Control Board (CPCB) and respective State Pollution Control Board (SPCB) implement the acts. At the state level, the Meghalaya Forest and Environment Department perform a role similar to MOEFCC.

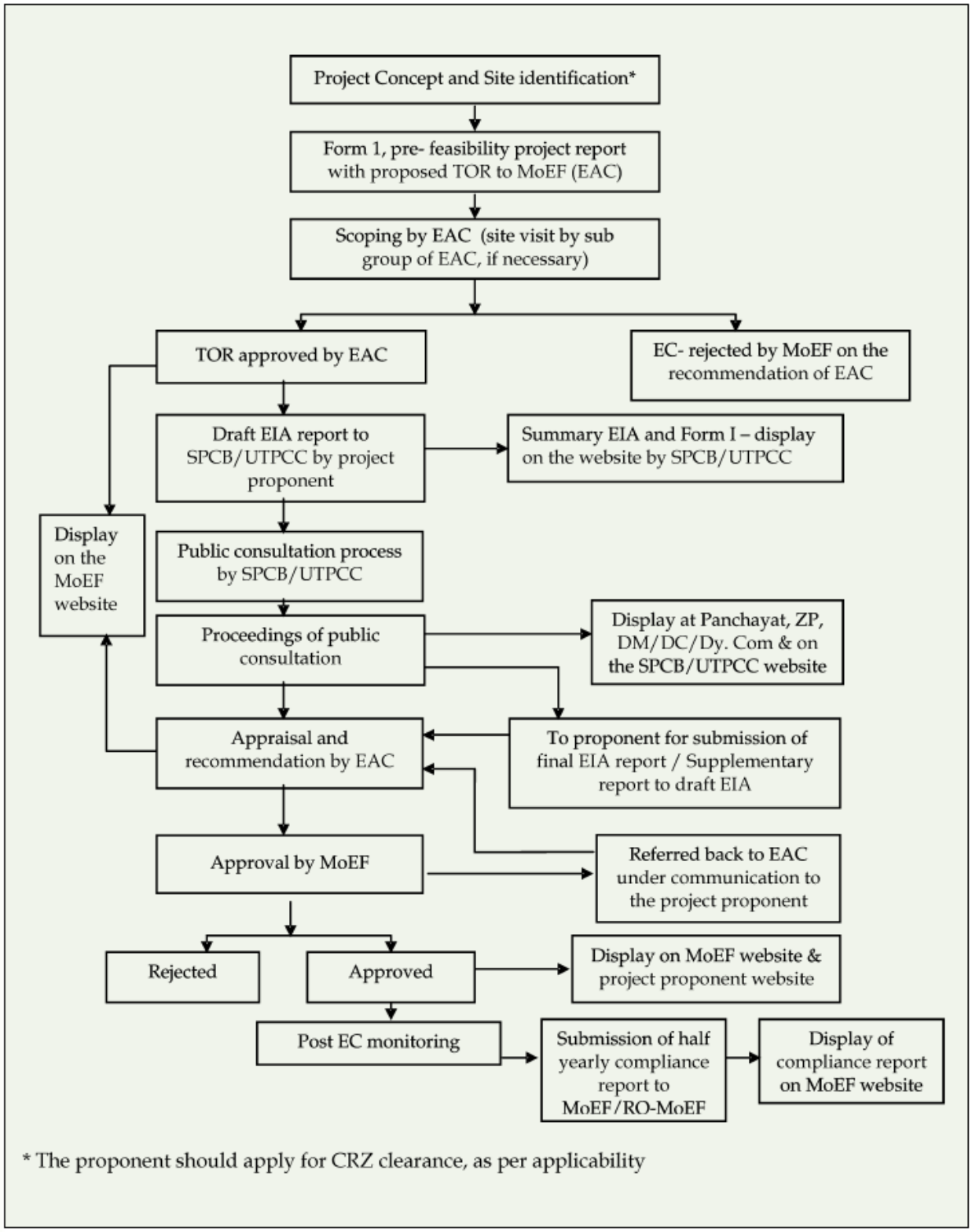
3.1.1 Central Level Laws and Regulations

(1) The Environment (Protection) Act, 1986

The Environment (Protection) Act, 1986 is the umbrella legislation which aims to protect the environment of India. Subject to the provisions of the Act, the Central Government has the power to take all measures as it deems necessary or expedient for the purpose of protecting and improving the quality of the environment and preventing, controlling and abating environmental pollution.
The implementation of Environment (Protection) Rules, which was formulated in 1986, provides various standards for emission and discharge of environmental pollutants (Schedule I to IV).
The central government has delegated the power vested on it under the Section 5 of the Act to the State Government of Meghalaya. This law is applicable to this project for environment protection in general.

(2) Notification on the Environmental Impact Assessment of Development Projects

The Environmental Impact Assessment Notifications in 2006 has been subject to amendments in 2009, 2012, 2013, and 2014. The Expert Appraisal Committee or State Level Expert Appraisal Committee are requested to establish and are given power to make recommendations for decision making at central government level. The Expert Appraisal Committee of the central government and the State Level Expert Appraisal Committee are to meet once every month for screening, scoping and appraisal of development projects.
Those projects intended to promote economic development at the national level as well as projects for each industrial sector in India are obliged to follow the EIA notification guidelines
Flow of environmental clearance for Category A project defined by the Notification is as shown in Figure 3-1.



Source: Environmental Impact Assessment Guidance Manual for Highways, 2010

Figure 3-1 Environmental Clearance for Category A

(3) Wildlife Protection Act 1972

Amendments were made to the Wildlife Protection Act in 1982, 1986, 1991, 1993, 2002, 2006 and 2013 in order to protect wildlife in India. Code of conduct in terms of wildlife protection, trade of wildlife products, punishment for illegal hunting etc. have been amended from time to time.

(4) The Forest (Conservation) Act, 1980 (amended in 1988)

The Forest (Conservation) Act, 1980 amended in 1988 pertains to the cases of diversion of the use of forest area and felling of roadside trees and those in the plantation areas. Depending on the size of the area subject to clearing, license for felling trees should be obtained. The level of governments that is empowered to issue permission differs depending on the type of forest clearance:

- If the area of forests subject to clearing exceeds 20ha (or, 10ha in the hilly area) then prior permission of the Central Government is required;
- If the area of forest clearance has a forest density of more than 40%, permission to undertake any work is needed from the Central Government, irrespective of the area to be cleared;
- If the area of forest subject to clearing is between 5ha to 20ha, the Regional Office of Chief Conservator of Forests is empowered to approve; and
- If the area of forest subject to clearing is below or equal to 5ha, the State Government can issue permission.

(5) The Water (Prevention and Control of Pollution) Act, 1974

The Water (Prevention and Control of Pollution) Act, 1974 resulted in the establishment of the central and state level Pollution Control Board (CPCB/SPCB). Their responsibilities include managing water quality and effluent standards as well as monitoring water quality, prosecuting offenders and issuing licenses for construction and operation of certain facilities.

(6) The Air (Prevention and Control of Pollution) Act, 1981

The CPCB and the SPCB are empowered to set air quality standards, monitor and prosecute offenders under this Act. Powers have also been conferred to give instructions to the concerned authority in charge of vehicle registration under the Motor Vehicles Act, 1988, with regards to ensuring emission standards for automobiles.

(7) The Motor Vehicles Act, 1988

The Indian Motor Vehicles Act empowers the State Transport Authority to enforce standards for the control of vehicular pollution and prevention of air pollution. The authority also checks emission standards of registered vehicles, collects road taxes, and issues vehicular licenses. In August 1997, the Pollution under Control Certificate (PUC) program was launched in order to control vehicular emissions in all states of India.

(8) The Land Acquisition Act, Rehabilitation and Resettlement Act 2013

The new "Rights to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013 (LARR 2013)" replaced the Land Acquisition Act of 1894. It has so far served as the basic policy document on which GOI passes resolution to acquire land for different projects while it traditionally did not allow compensation on are placement basis. The LARR 2013 came into force on 1st January 2014 and Meghalaya States put the act into practice.

3.1.2 Recent Policy Initiatives

Ministry of Environment, Forest & Climate Change (MOEFCC) has overall authority for the administration and implementation of the EIA related policies, laws and regulations, sustainable development and pollution control in India. MOEFCC identifies the need to enact new laws and to issue amendment to the existing environmental legislations as and when required. The recent notifications issued by MoEFCC related to the development projects are as follows:

1. MoEFCC notification S.O 2296(E) dated July 01, 2016 regarding environmental clearances for quarries clusters.
2. MoEFCC notification S.O 1595(E) April 29, 2016 related to building & construction projects and township & area development projects.
3. MoEFCC notification G.S.R. 317(E) dated March 29, 2016 related to Construction and Demolition Waste Management Rules, 2016.
4. MoEFCC notification S.O 141(E) dated January 15, 2016 regarding screening, scooping and appraisal committee & environmental clearances for mining of minerals and pipeline projects.

3.1.3 JICA Guidelines (ESCs)

Application of JICA's Guidelines for Environment and Social Considerations (ESCs) is required if a project is funded by JICA. If a significantly adverse impact on the environment or society has been identified in JICA-assisted project, the following has to be thoroughly considered and studied.

(1) **ESCs are pre-requisite**

a. JICA will take necessary measures to ensure that the appropriate ESC is given;

b. When JICA reviews a project proposal and finds that the project could cause negative impacts on the environment or society, JICA advises the project proponents to provide appropriate ESC;

c. If the negative impact of the project cannot be avoided or mitigated to an acceptable level, JICA will not support its implementation.

(2) **Respect human rights**

a. Development project should aim for fair distribution of its benefits and must not burden or exclude certain stakeholders for the sake of others;

b. The project proponents must respect the rights of all people concerned, and pay special attention to vulnerable social groups such as women, elderly, the poor, people with disabilities, indigenous peoples, ethnic minorities, and other minority groups to ensure that they are involved in decision-making processes and that they benefit from the project;

c. JICA's ESC Guidelines defines 'stakeholders' as local residents including non- titleholders who are affected by the project as well as local NGOs. By involving local stakeholders from the early stage of the project, the project proponents can receive their inputs and plan appropriate measures to address their concerns, avoid conflict, and achieve higher results with their support. For this reason, the project proponents should conduct a series of consultations with local stakeholders in an interactive and meaningful manner. During this process, appropriate consideration must be given to socially vulnerable or different people such as women, children, the elderly and ethnic minorities.

(3) **Avoid adverse impacts**

a. Priority should be given to the avoidance of adverse impacts on the environment or society when a project is planned;

b. Minimization or mitigation of impacts should be considered only if avoidance is not feasible and if the benefit of the project outweighs the cost of mitigation measures;

c. The project proponents must assess the environmental and social impacts at the earliest possible stage of planning, and implement ESC measures in accordance with the ESC Guidelines.

(4) **Information on ESC must be disclosed to the public**

a. Information disclosure is key in ESC. Project proponents must proactively release relevant information to the public;

b. Sharing information with a wide range of stakeholders from the early stage, the project proponents can utilize their feedback to improve the plan/project. In addition, the project proponents can ensure that unnecessary concerns and misunderstandings among the stakeholders are ameliorated.

(5) **Host country's laws, standards, policies and plans**

a. JICA-funded project must comply with the laws, standards, policies, and plans of the host country;

b. If the standard set by the host country differs from the international standard, the project proponents are advised to adopt international standard that better serves the purpose of attaining a higher level of ESC.

(6) **The World Bank's Safeguard Policies**

ESC in a JICA project must be in line with the World Bank's Safeguard Policies including:

a. Operational Policy on Environmental Assessment (OP 4.01);

b. Natural Habitats (OP 4.04);

c. Involuntary Resettlement (OP 4.12);

d. Indigenous Peoples (OP 4.10), and other relevant policies.

3.1.4 World Bank Safeguard Requirements

In respect of the Safe Guard Policies as listed above, the World Bank Performance Standards is imposed on the borrowers in terms of the requirement on the environmental impact assessment and resettlement action plan as guidelines for environmental study. It is compulsory requirement for financing economic development projects that developing countries borrow fund from the World Bank. Major points of concern of its Performance Standards are summarized as follows:

a. PS 1: Assessment and Management of Environmental and Social Risks and Impacts

Performance Standard 1 underscores the importance of managing environmental and social performance throughout the life of the project.

b. PS 2: Labor and Working Conditions

The requirements labor and working conditions set out in part guided by a number of international conventions and instruments, including those of the International Labor Organization (ILO) and the United Nations (UN).

c. PS 3: Resource Efficiency and Pollution Prevention

This Performance Standard outlines a project-level approach to resource efficiency and pollution prevention and control in line with internationally disseminated technologies and practices. The Performance Standard promotes the ability of private companies to adopt such technologies and practices as far as their use is feasible in the context of a project that relies on commercially available skills and resources.

d. PS 4:Community Health, Safety, and Security

Performance Standard 4 recognizes that project activities, equipment, and infrastructure can increase community exposure to risks and impacts. In addition, communities that are already subjected to impacts from climate change may also experience an acceleration and/or intensification of impacts due to project activities. While acknowledging the public authorities' role in promoting the health, safety, and security of the public, this Performance Standard addresses the client's responsibility to avoid or minimize the risks and impacts to community health, safety, and security that may arise from project related-activities, with particular attention to vulnerable groups.

e. PS 5:Land Acquisition and Involuntary Resettlement

Involuntary resettlement refers both to physical displacement (relocation or loss of shelter) and to economic displacement as a result of project-related land acquisition and/or restrictions on land use. However, where involuntary resettlement is unavoidable, it should be minimized and appropriate measures to mitigate adverse impacts on displaced persons and host communities should be carefully planned and implemented.

f. PS 6: Biodiversity Conservation and Sustainable Management of Natural Resources

This Performance Standard recognizes that protecting and conserving biodiversity, maintaining ecosystem services, and sustainable management of the living natural resources are fundamental to sustainable development. The requirements set out in this Performance Standard have been guided by the Convention on Biological Diversity. This Performance Standard addresses how clients can sustainably manage and mitigate impacts on biodiversity and ecosystem services throughout the project's lifecycle.

g. PS 7: Indigenous Peoples

Performance Standard 7 recognizes that Indigenous Peoples, as social groups with identities that are distinct from mainstream groups in national societies.

h. PS 8: Cultural Heritage

Consistent with the Convention Concerning the Protection of the World Cultural and Natural Heritage, this Performance Standard aims to ensure that clients protect cultural heritage in the course of their project activities.

3.1.5 Safeguard Policy of Asian Development Bank

(1) Latest Development of ADB Operations

The ADB's Environment Policy mandates the consideration of environment in all aspects of ADB's operations. "Environment Policy and Operations Manual (OM) 20: Environmental Considerations in

ADB Operations" outline ADB's environmental assessment procedures and requirements. In 2003, ADB up-dated the old guidelines of 1993 and that the contents are summarized as follows:

a. Introduced check-list system of Rapid Environmental Assessment (REA) for determining the environment category;
b. Introduction of Country Environmental Analysis (CEA) as a requirement in preparation of the Country Strategy and Program (CSP);
c. Introduction of Strategic Environmental Assessment (SEA) as an optional tool for environmental assessment for program loans, sector development program loans, and sector loans;
d. Establishing a new category FI for lending activities to financial intermediaries and other intermediaries and outlining environmental assessment requirements to apply to this category;
e. Strengthening the requirements of Environmental Management Plans (EMP);
f. Recommending environmentally responsible procurement; and
g. Strengthening public consultation as in integral part of environmental assessment and management.

(2) General Contents of EIA Study

a. Coordinate with government concerned and environment agencies;
b. Prepare a project description, define the study area, collect environmental baseline data, prepare site maps, and other relevant maps for the study area;
c. Identify potential environmental impacts based on the information obtained on the proposed project and the baseline environmental conditions of the study area;
d. Identify alternatives and analyze the environmental impacts of each alternative and propose measure to avoid or prevent impacts;
e. Estimate the magnitudes of environmental impacts and assess the significance of the impacts;
f. Recommend environmental mitigation measures and estimate the mitigation costs;
g. Prepare an EMP to be implemented by the executing agency during project implementation, operation and abandonment;
h. Prepare the EIA and SEIA reports;
i. Conduct public consultation and ensure information disclosure; and develop plans for public consultation and information disclosure during project implementation;
j. Assess the executing agency's capacity to undertake an environmental review of the environmental assessment report and EMP recommendations, and recommend measures for capacity building, if necessary; and
k. Ensure that the proposed project, with EIA and EMP implementation, conforms to the Government and ADB environmental assessment requirements, policies and regulations.
l. Economic assessment should be carried out that includes i) costs and benefits of environmental impacts; ii) costs, benefits, and cost effectiveness of mitigation measures; and iii) for environmental impacts that have not been expressed in monetary values, a discussion of such impacts, if possible in quantitative terms.

3.1.6 JICA/WB/ADB Guidelines on EIA

Application of JICA's Guidelines for Environment and Social Considerations (ESCs) is required if a project is funded by JICA. If a significantly adverse impact on the environment or society has been identified during JICA-assisted project, the following has to be thoroughly considered and studied.

JICA guidelines, World Bank and ADB Operational Manual and Environmental Safeguard policies, procedures & practices described in the Section 9.3.7 to 9.3.9 are compared to the following Government of India's guidelines in order to find the differences and elaborate a way to fill in the gaps if any.

- "Environmental Guidelines for Selected Infrastructure Projects";
- "Project Terms of Reference (TOR)";
- "Environmental guidelines for Road/Rail/Highway Projects", Government of India, 1989
- "Handbook of environmental procedures and guidelines", 1994, Government of India
- "Guidelines for Environmental Impact Assessment of Highway Projects" (IRC: 104-1988); and
- The Environmental (Protection) Act, 1986 and EIA Notification 2006 dated 14th September 2006.

Based on the above, a study on the India's laws and regulations comparing to JICA/WB/ADB Guidelines is carried out in following stages:

- The baseline environmental information in the study area viz., climate, physiographic features, drainage, geology, flora, fauna, ambient air, water and noise and socio-economic conditions.
- Reviews of literature, laws and guidelines and discussions with concerned agencies and organizations, National / State Authorities and on-site;
- Reconnaissance survey along with public consultation was during May 2016 to August 2016 and processes of public consultation continued till the completion of study) to inform the people about the project and collect the information / suggestions on environmental issues.
- The monitoring network with regard to air, water, soil and noise pollution.
- Assessment of the potential significant impacts and identification of the mitigated measures to address impacts adequately.
- Field observations including public consultation.
- Screening, testing and monitoring of environmental factors like air, water, soil and the noise level
- Collection of secondary data from various departments.
- Compilation, analysis and presentation of the report.

Table 3-1 Environmental Clearance Applicable to the Project

No.	Items	JICA Guideline	Laws in India	Principle for this Project
1	Requirement of EIA	Environmental and social surveys at the EIA level (Category A projects) Proposed projects likely to have significant adverse impacts on the environment and society. Category A includes projects in sensitive sectors (ex. Roads, railways, and bridges), projects that have characteristics that are liable to cause adverse environmental impacts (ex. Large-scale	Projects requiring EIA (Category A projects) i) New National Highways ii) Expansion of National Highways greater than 100 km involving additional right of way or land acquisition greater than 40m on the existing alignments and 60m on re-alignments and bypasses. Projects whose requirement of EIA are judged by State level Environment Impact	EIA will be prepared as category A in accordance with JICA Guideline though not required by Laws in India

No.	Items	JICA Guideline	Laws in India	Principle for this Project
		involuntary resettlement), and projects located in or near sensitive areas. IEE level (Category B projects) Projects whose potential adverse impacts on the environment and society are less adverse than those of Category A projects.	Assessment Authority (Category B projects) i) State Highway ii) State highway Expansion projects in hilly terrain (above 1,000 m AMSL) and or ecologically sensitive areas	
2	Scope of Impacts to Be Assessed	In addition to the direct and immediate impacts of projects, their derivative, secondary, and cumulative impacts as well as the impacts of projects that are indivisible from the project are also to be examined and assessed to a reasonable extent.	Factors which could lead to environmental effects or the potential for cumulative impacts shall be identified. Indirect impacts on the avifauna of the area shall be examined.	Derivative, secondary, and cumulative impacts as well as the impacts of projects that are indivisible from the project are also to be examined
3	Stakeholder meetings/ Public consultation	Stakeholder meetings shall be held at the stages of scoping draft and report draft.	Public consultation shall be conducted after submission of draft report.	To hold Stakeholder meetings at the stages of scoping draft and report draft.
4	Disclosure of EIA	EIA reports are required to be made available to the local residents of the country in which the project is to be implemented. The EIA reports are required to be available at all times for perusal by project stakeholders such as local residents and copying must be permitted.	MOEFCC shall display the Summary of the draft EIA report on its website, and also make the full draft EIA available for reference at a notified place during normal office hours in the Ministry at Delhi.	To disclose EIA in accordance with JICA Guideline.
5	Certificate regarding the environment and society	If the project requires a certificate regarding the environment and society other than an EIA, indicate the title of said certificate and confirm the approval.	Forest Clearance will be required. The Contractor has to obtain permits from MSPCB for setting up hot-mix plants, batching plants, etc., under the Air and the Water Acts, whose results shall be reported to the Project proponents.	To confirm requirement of permits in accordance with laws in India.
6	Monitoring	After projects begin, project proponents etc. monitor whether any unforeseeable situations occur and whether the performance and effectiveness of	Project proponents are required to submit environmental management plan & monitoring programme. It shall be mandatory for the project management to	To implement environmental monitoring in accordance with laws in India.

No.	Items	JICA Guideline	Laws in India	Principle for this Project
		mitigation measures are consistent with the assessment's prediction. They then take appropriate measures based on the results of such monitoring. In cases where sufficient monitoring is deemed essential, project proponents etc. must ensure that project plans include feasible monitoring plans. Project proponents etc. should make efforts to make the results of the monitoring process available to local project stakeholders.	submit half-yearly compliance reports in respect of the stipulated prior environmental clearance terms and conditions	

Source: JICA Study Team

3.1.7 Central Level Institutions

(1) National Highways Authority of India

Widening of NH-40 has been initiated and is being carried out by National Highways and Infrastructure Development Corporation Limited (NHIDCL), under the auspice of Ministry of Road Transport & Highways (MORTH). Though the primary responsibility of the Project rests with the NHIDCL, there are various institutions involved in the Project and their level of responsibilities in the project implementation are as follow:

National Highway Authority of India (NHAI) and Regional Offices under the Ministry of Road Transport and Highway (MORTH) promote national highway development project while the Border Roads Organization (BRO) under Border Roads Development Board (BRDB) have control over roads in border regions. The NHIDCL was established for promoting development of National Highways in North East and border areas of India, and started operation from 1st January 2015.

The NHAI has been established under National Highways Authority of India Act of 1988. . It is the main nodal agency responsible for developing, managing and maintaining India's network of national highways. It became an autonomous body in 1995. NHAI maintains 70,934 km of national highways and expressways across India.

Development of NH-40 widening project has been promoted by NHIDCL, which is a company fully owned by the Ministry of Road Transport & Highways of the Government of India. Function of NHIDCL is to promote survey, design, build, operate, maintain and upgrade national highways and develop strategic roads such as interconnecting roads in various parts of the country including those in areas with international boundaries with the neighboring countries.

The company also proposes to improve road connectivity and efficiency of the international trade corridors by expanding about 500 km of roads in the North Bengal and Northeastern Region of India.

(2) Ministry of Environment, Forest, and Climate Change (MOEFCC)

The primary responsibility for administration and implementation of the Government of India's (GOI)

policy with respect to environmental management, conservation, ecologically sustainable development and pollution control rests with the Ministry of Environment, Forest and Climate Change (MOEFCC). Established in 1985, the MOEFCC is the agency primarily responsible for the review and approval of EIAs pursuant to GOI legislation.

(3) Central Pollution Control Board (CPCB)

Statutory authority attached to MOEFCC, the main responsibilities of Central Pollution Control Board (CPCB) include the following:

- Planning and implementing water and air pollution control programs;
- Advising the central government on water and air pollution control programs;
- Setting air and water standards; and
- Coordinating the various State Pollution Control Boards.

The role of the CPCB for this Project will only be in an advisory capacity while the Project shall adhere to the norms and standards set up by the Meghalaya State Pollution Control Board (MSPCB).

3.1.8 State Level Institutions

(1) Public Works Department

Public Works Department (PWD) of the State of Meghalaya is the premier agency of the state government engaged in planning, designing, construction, and maintenance of the government assets in the field of infrastructure development. Assets in infrastructure development include roads, bridges, urban centers, footpaths, new capital complex, and airport. Assets such as hospitals, schools, colleges, technical institutes, police buildings, prisons, and courts among others are also under PWD's jurisdiction. PWD Meghalaya also sustains and preserves these assets through a system of maintenance, which includes specialized services such as rehabilitation works, roads signage, and aesthetic treatments like interiors, landscaping etc.

(2) MOEFCC Regional Offices

MOEFCC has set up regional offices that cover Northeastern Region including Meghalaya. It is located in Shillong, Meghalaya. This office is responsible for collecting and furnishing information relating to the EIA of various projects in respect of pollution control measures, methodology, and status, legal and enforcement measures and environmental protection in special conservation areas such as wetlands, mangroves and biosphere reserves.

(3) Meghalaya State Pollution Control Board (MSPCB)

Meghalaya State Pollution Control Board (MSPCB) has the mandate for environmental management at the state level, with emphasis on air and water quality. It is responsible for planning and executing state-level air and water initiatives, advising state government on air, water and industry issues, establishing standards based on National Minimum Standards, enforcing and monitoring of all activities within the state under the Air Act, the Water Act and other relevant acts pertaining to pollution control.
MSPCB also conducts and organizes public hearings for projects as defined by the various Acts and as stipulated by the amendment related to the EIA Act. It also issues No-objection Certificates (NOC) for environment clearance for industrial development defined in such a way as to include road projects' quarrying etc., which usually relate to water and soil contamination.

(4) Meghalaya Forest and Environment Department

The Meghalaya Forest and Environment Department is responsible for the protection and management of the forest areas in the state that are designated for protection, conservation and production purposes. The Forest and Environment Department follows what is laid out in the Forest Working Plans for the various forest divisions to manage and protect the forest resources. These plans form the basis for managing the forest resources. It is responsible for granting licenses for clearances of the forest areas for various projects, according to the provisions of the Forest (Conservation) Act, 1980.The State Forest and Environment Department performs the functions similar to the MOEFCC at the state level but more specific to forestry activities including social forestry and production forestry development and licensing.

3.1.9 Requirements of Environmental/Forest Clearance

Environmental Clearance is not required for this project as per MoEFCC notification, 2013 however forest clearance will be applicable as alignment is passing through forest area and forest land diversion shall be required. The forest clearance is the most important requirement for the implementation of the Project.

The application has to be processed by State Government as well as Central Government as follows:

1) Part 1 of the application is filled in by NHIDCL, the project proponent;
2) Part 2 will be cleared by the Forest Division of the East Khasi District of Meghalaya State;
3) Part 3 will have to be cleared by the State Environment and Forest Department;
4) Part 4 have to be cleared by the Nodal Officer under Forest Conservation Act; and
5) Part 5 will be the responsibility of the Secretary of Department of Environment and Forest, Government of Meghalaya before forwarding the forest clearance application to the MOEFCC for appraisal for issuing of the Forest Clearance Permit.

3.1.10 Other Environmental Clearance

General environmental clearances are subject to issue to the Contractor before the commencement of the construction works as follows:

1) The Contractor has to obtain permits from MSPCB for setting up hot-mix plants, batching plants, etc., under the Air and the Water Acts;
2) Clearance from the State Department of Mining is required for establishing quarries;
3) Clearance from the Water resource department/Authorities is required for establishment of new tube-wells/bore-holes in case they are required during construction work;
4) The provisions as laid down in the Factories Act, 1948, Labor Act, 1988 and the Building and Other Construction Workers (Regulation of Employment and Conditions of Service) Act, 1996 with respect to hygiene and health during the construction stage would apply for the project's implementation works; and
5) The provisions of the Hazardous Wastes (Management and Handling) Rules, 1989 and the Chemical Accidents (Emergency Planning, Preparedness, and Response) Rules, 1996 may also be applied during the construction and the operation period.

Table 3-2 Environmental Clearance Applicable to the Project

No.	Activity	Statute	Requirement	Competent Authority	Responsible Agency for Obtaining Clearance	Time Required
Pre-Construction Stage (Responsibility: MORTH)						
1	Road-side tree cutting and clearing forest	Forest Conservation Act1980 & MOEF Letter Dt.18.02.1998	Permission for Road-side tree cutting	State and Central Government	MORTH	2-3 months
2	Filling of Roadside water bodies (ponds and borrow pits)	State Fisheries Policy Draft Wetlands (Conservation & Management) Rules, 2008	Permission for filling of water bodies	State Irrigation Department State Fisheries Department State Wetlands Conservation Committee	MORTH	2-3 months
Construction Stage (Responsibility: Contractor)						
1	Establishing stone crusher, hot mix plant, wet mix plant and Diesel Generator Sets	Water Act of 1974, Air Act of 1981, Noise Rules of 2000 and Environmental Protection Action of 1986 and as Amended	Consent-forest abolishment	States Pollution Control Boards for respective section	Contractor	4-6 months
2	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 Environmental Protection Action of 1986 and as Amended	Consent-for operation	States Pollution Control Boards for respective section	Contractor	4-6 months
3	Use and storage of explosive for quarry blasting work	India Explosive Act 1984	Explosive license for use and storage	Chief Controller of Explosives	Contractor	2-3 months
4	Storage of fueloil, lubricants, diesel etc. at construction camp	Manufacture storage and Import of Hazardous Chemical Rules 1989	Permission for storage of hazardous chemical	States Pollution Control Boards for respective section and or Local Authority (DC)	Contractor	4-6 months
5	Quarry Operation	State Minor Mineral Concession Rules, The Mines Act of1952, Indian Explosive Act of1984, Air Act of1981 and Water Act of 1974	Quarry Lease Deed and Quarry License	State Department of Mines and Geology	Contractor	4-6 months
6	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	Contractor	4-6 months

Source: JICA Study Team based on the Indian laws and regulations

3.1.11 Environmental and Emission Standards of India

Based on the Acts and Rules as above, CPCB has set up various environmental standards as follows:

1) National Ambient Air Quality Standards
2) Water Quality Criteria
3) Vehicular Exhaust
4) Auto Fuel Quality
5) Noise and Emission Limits for Diesel Engines for Generators
6) Noise Standards

Other than the above, there are a large number of environmental standards set up for each sector of manufacturing industries. Since this is a road construction project consisting of widening the existing road as well as inserting bypasses in built-up areas. During the construction period, construction debris, soil contamination, air and water pollution, noise and vibration are subject to monitoring in order to maintain emissions and discharges within the standards set up by CPCB. During the operation and maintenance period, increasing traffic could cause noise and vibration. However, standards on the disposal of construction debris, soil contamination, and vibration that could be caused by the Project are not clearly defined. Following is a set of environmental standards the Government of India has imposed to date.

Table 3-3 Standards for Ambient Air Quality

S. No.	Pollutant	Time Weighted Average	Concentration in Ambient Air		
			Industrial, Residential, Rural and Other Area	Ecologically Sensitive Area (notified by Central Government)	Methods of Measurement
(1)	(2)	(3)	(4)	(5)	(6)
1	Sulphur Dioxide (SO_2), µg/m³	Annual*	50	20	- Improved West and Gaeke
		24 hours**	80	80	-Ultraviolet fluorescence
2	Nitrogen Dioxide (NO_2), µg/m³	Annual*	40	30	- Modified Jacob & Hochheiser (Na-Arsenite)
		24 hours**	80	80	- Chemiluminescence
3	Particulate Matter (size less than 10µm) or PM_{10} µg/m³	Annual*	60	60	- Gravimetric - TOEM
		24 hours**	100	100	- Beta attenuation
4	Particulate Matter (size less than 2.5µm) or $PM_{2.5}$ µg/m³	Annual*	40	40	- Gravimetric - TOEM
		24 hours**	60	60	- Beta attenuation
5	Ozone (O_3) µg/m³	8 hours**	100	100	- UV photometric - Chemilminescence
		1 hour**	180	180	- Chemical Method
6	Lead (Pb) µg/m³	Annual*	0.50	0.50	- AAS /ICP method after sampling on EPM 2000 or equivalent filter paper - ED-XRF using Teflon filter
		24 hours**	1.0	1.0	
7	Carbon Monoxide (CO) mg/m³	8 hours**	02	02	- Non Dispersive Infra Red (NDIR) spectroscopy
		1 hour**	04	04	
8	Ammonia (NH_3) µg/m³	Annual*	100	100	-Chemiluminescence
		24 hours**	400	400	-Indophenol blue method

Source: Central Pollution Control Board, India

Table 3-4 Water Quality

Designated best use	Class	Criteria
Drinking water source without conventional treatment but after disinfections	A	Total coliform organisms MPN/100ml shall be 50 or less pH between 6.5 and 8.5 Dissolved oxygen 6 mg/l or more Biochemical oxygen demand 2 mg/l or Less
Outdoor bathing (organised)	B	Total coliform organisms MPN/100ml shall be 500 or less pH between 6.5 and 8.5 *Dissolved oxygen 5 mg/l or more Biochemical oxygen demand 3 mg/l or Less
Drinking water source with conventional treatment followed by disinfection	C	Total coliform organisms MPN/ 100ml shall be 5000 or less pH between 6 and 9 Dissolved oxygen 4 mg/l or more Biochemical oxygen demand 3 mg/l or less
Propagation of wild life, fisheries	D	pH between 6.5 and 8.5 Dissolved oxygen 4 mg/l or more *Free ammonia (as N) 1.2 mg/l or less
Irrigation, industrial cooling, controlled waste disposal	E	pH between 6.0 and 8.5 Electrical conductivity less than 2250 micro mhos/cm Sodium absorption ratio less than 26 Boron less than 2mg/l

Source: Central Pollution Control Board, India

Table 3-5 Vehicle Emission Standards (1991 to Date)

Norms	Passenger Car	Heavy Diesel Vehicles			
	CO (g/km)	CO (g/km)	HC (g.km.hr)	NOx (g.km.hr)	PM (g.km.hr)
1991Norms	14.3-27.1	14	3.5	18.0	-
1996 Norms	8.68-12.40	11.2	2.4	14.4	-
1998Norms	4.34-6.20	-	-	-	-
India stage 2000 norms	2.72	4.5	1.1	8.0	0.4
Bharat stage-II	2.2	4.0	1.1	7.0	0.2
Bharat Stage-III	2.3	2.1	1.6	5.0	0.1
Bharat Stage-IV	1.0	1.5	1.0	3.5	0.0

Source: Central Pollution Control Board, India
Note: Bharat indicates Indian nomenclature of vehicular emission which is the same as Euro Stage.

Table 3-6 Fuel Quality

Diesel Specification

Contents	1996	2000	2005	2010
Cetane No, Min	45	48	48	51
Sulphur % W/w, Max	0.5	0.25 0.25(metro)	0.05	0.035
Distillation T95	-	370	370	360
Polyaromatic	-	-	-	11

Gasoline Specification

Contents	1996	2000	2005	2010
RVP at 38 Deg.c,kpa	35-70	-	35-60	60
Benzine % by Vol.,Max	5	5.0 3.0(metro)	3.0 (all) 1.0 (metro)	1
Lead G/m3, Max	0.15% (low Pb) 0.013% (unleaded)	0.013	0.013	0.005
Sulphur % by mass, Max	0.10 (low Pb) 0.20 (unleaded)	0.1	0.05	0.015
Aromatics % v/v., Max	-	-	45	42
Oxygen %by Vol., Max	-	-	2	2.7

Source: Central Pollution Control Board, India

Table 3-7 Noise Standard for Diesel Generator

No.	Description
1	The maximum permissible sound pressure level for new diesel generator (DG) sets with rated capacity upto 1000 KVA, manufactured on or after the 1st January, 2005 shall be 75 dB(A) at 1 metre from the enclosure surface.
2	Noise limits for diesel generator sets not covered by 1, shall be as follows:-
	2.1 Noise from DG set shall be controlled by providing an acoustic enclosure or by treating the room acoustically, at the users end.
	2.2 The acoustic enclosure or acoustic treatment of the room shall be designed for minimum 25 dB (A) insertion loss or for meeting the ambient noise standards, whichever is on the higher side (if the actual ambient noise is on the higher side, it may not be possible to check the performance of the acoustic enclosure/acoustic treatment. Under such circumstances the performance may be checked for noise reduction upto actual ambient noise level, preferably, in the night time). The measurement for Insertion Loss may be done at different points at 0.5 m from the acoustic enclosure/ room, then averaged.
	2.3 The DG set shall be provided with proper exhaust muffler with insertion loss of minimum 25 dB (A).
	2.4 Guidelines for the manufacturers/ users of Diesel Generator sets shall be as under:-
	2.4 (1) The manufacturer shall offer to the user a standard acoustic enclosure of 25 dB (A) insertion loss and also a suitable exhaust muffler with insertion loss of 25 dB(A).
	2.4 (2) The user shall make efforts to bring down the noise levels due to the DG set, outside his premises, within the ambient noise requirements by proper citing and control measures.
	2.4 (3) Installation of DG set must be strictly in compliance with the recommendations of the DG set manufacturer.
	2.4 (4) A proper routine and preventive maintenance procedure for the DG set should be set and followed in consultation with the DG set manufacturer which would help prevent noise levels of the DG set from deteriorating with use.

Source: Central Pollution Control Board, India

Table 3-8 Ambient Noise Standards

S. No.	Type of vehicle	Noise Limits from 1st January, 2003, dB(A)
1.0	**Two wheeler**	
1.1	Displacement upto 80 cc	75
1.2	Displacement more than 80 cc but upto 175 cc	77
1.3	Displacement more than 175 cc	80
2.0	**Three wheeler**	
2.1	Displacement upto 175 cc	77
2.2	Displacement more than 175 cc	80
3.0	**Vehicles used for carriage of passengers and capable of having not more than nine seats, including the driver's seat**	74
4.0	**Vehicles used for carriage of passengers having more than nine seats, including the driver's seat, and a maximum gross Vehicle Weight(GVW) of more than 3.5 tonnes**	
4.1	With an engine power less than150 KW	78
4.2	With an engine power of 150 KW or above	80
5.0	**Vehicles used for carriage of passengers having more than nine seats, including the driver's seat: Vehicles used for carriage goods.**	
5.1	With maximum GVW not exceeding 2 tonnes	76
5.2	With maximum GVW greater than 3 tonnes but not exceeding 3.5 tonnes	77
6.0	**Vehicles used for transport of goods with a maximum GVW exceeding 3.5 tonnes.**	
6.1	With an engine power less than 75 KW	77
6.2	With an engine power of 75 KW or above but less than 150 KW	78
6.3	With an engine power of 150 KW or above,	80"

Source: Central Pollution Control Board, India

4. SCOPING, ANALYSIS OF ALTERNATIVES, ANTICIPATED IMPACTS AND MITIGATION MEASURES

4.1 Procedures of Scoping Analysis

Depending on the scale and nature of project intervention during the various stages of the project in relation to the natural and social environment of the project area, there are positive and negative impacts induced by the project. These impacts are different in the scale of intensity, in the spatial extent, in the time line if irrevocable of temporal nature.

The scoping matrix as per Table 4-1 highlights anticipated impacts that occur on various environmental and social components during the scoping stage of the Project. It is a generic scoping matrix that is applicable to development project in general and has been prepared based on the initial environmental assessment.

In terms of the impacts caused by the project to the natural environment, mountain slopes are cut at a number of places while filling should also take place i.e. soil erosion and the changes of natural drainage during the construction period should take place. At places where bypasses are created and roadside widening takes place, significant amount of forest areas are cleared. Agricultural fields are also permanently put under the ROW of the project area.

The majority of its Population are from the major tribes of the Khasis, the Jaintias and the Garos. Besides the Khasis, Jaintia and Garos, the State has a host of other tribes that have reside in the State for years and have ownership of land and legal residency. Such groups are the Mizo, Hmar, (Mikir, Rabha,), Paitei, Meitei etc. All these groups are from neighboring states who migrated to Meghalaya and have settled here for countless years. These groups continue to follow their own customs and traditions. Agriculture is the main stay of the people in the project region, which comprises almost 75% of the work force. Apart from agriculture other allied activities in the region are dairy, goat rearing, and piggery operations. The project area represents mostly rural and some urban area.

4.2 Configuration of the Project's Road Alignment

There are a number of alternatives for the Project as follows:

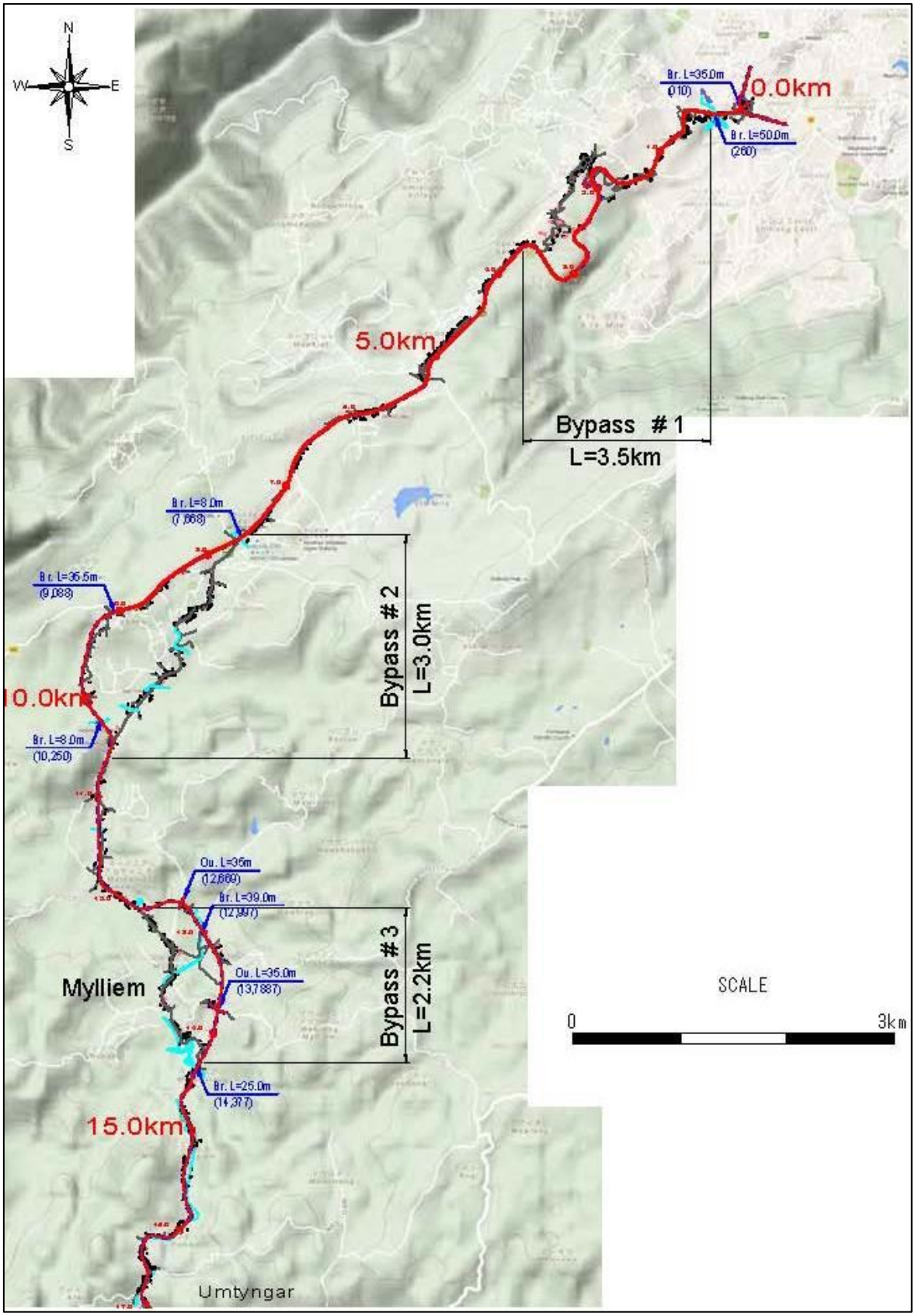
a. Do nothing option:
   There is no project intervention is implemented i.e. present road is continued to use;

b. Widening Option:
   The existing road is widened on both side of the road. Where appropriate, mountain-side is widened as geographical conditions makes not possible to widen on the steep valley side.

c. Bypass Inserting Option – DPR Design

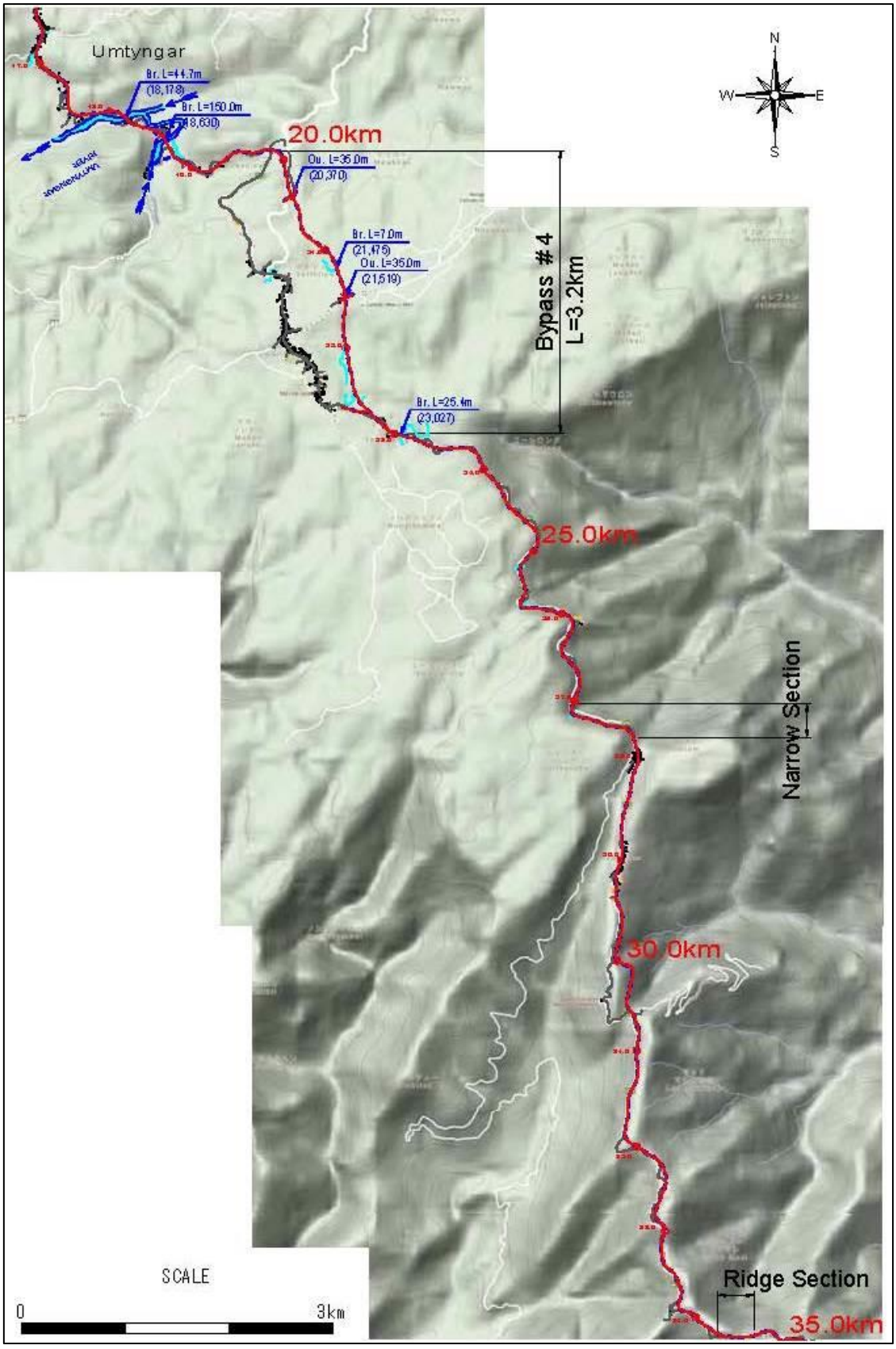
   A number of bypasses are inserted where built up areas have to be avoided for reducing the number of PAPs based on the DPR design. Original bypasses of DPR are as shown in blue dashed line in Figure 3-1 to 3-4.

d. Bypass Inserting Option – JICA Study Team's Design:
   JICA Study Team reviewed DPR design and concluded that the alignment of Bypass No. 1, No.6 and No.7 are in need of re-designing. The concept of Bypass No. 2 to No.5 where built up areas has to be avoided for reducing the number of PAPs remains the same as DPR Design. Bypasses No. 6 and No. 7 have been put together in order to improve geometric configuration as is shown in red line as per Figure 3-1 to 3-4. Bypas No.5 will not be included in the project due to public agreement unreached during this study , while the the plan to insert the bypass is advantageous according to results of alternative comparison and analysis.



Dashed Blue Line: DPR Design、**Solid Red Line**: JICA Study Team's Design
Source: JICA Study Team

Figure 4-1 Bypasses No. 1–3 – DPR Design/ JICA Study Team Design

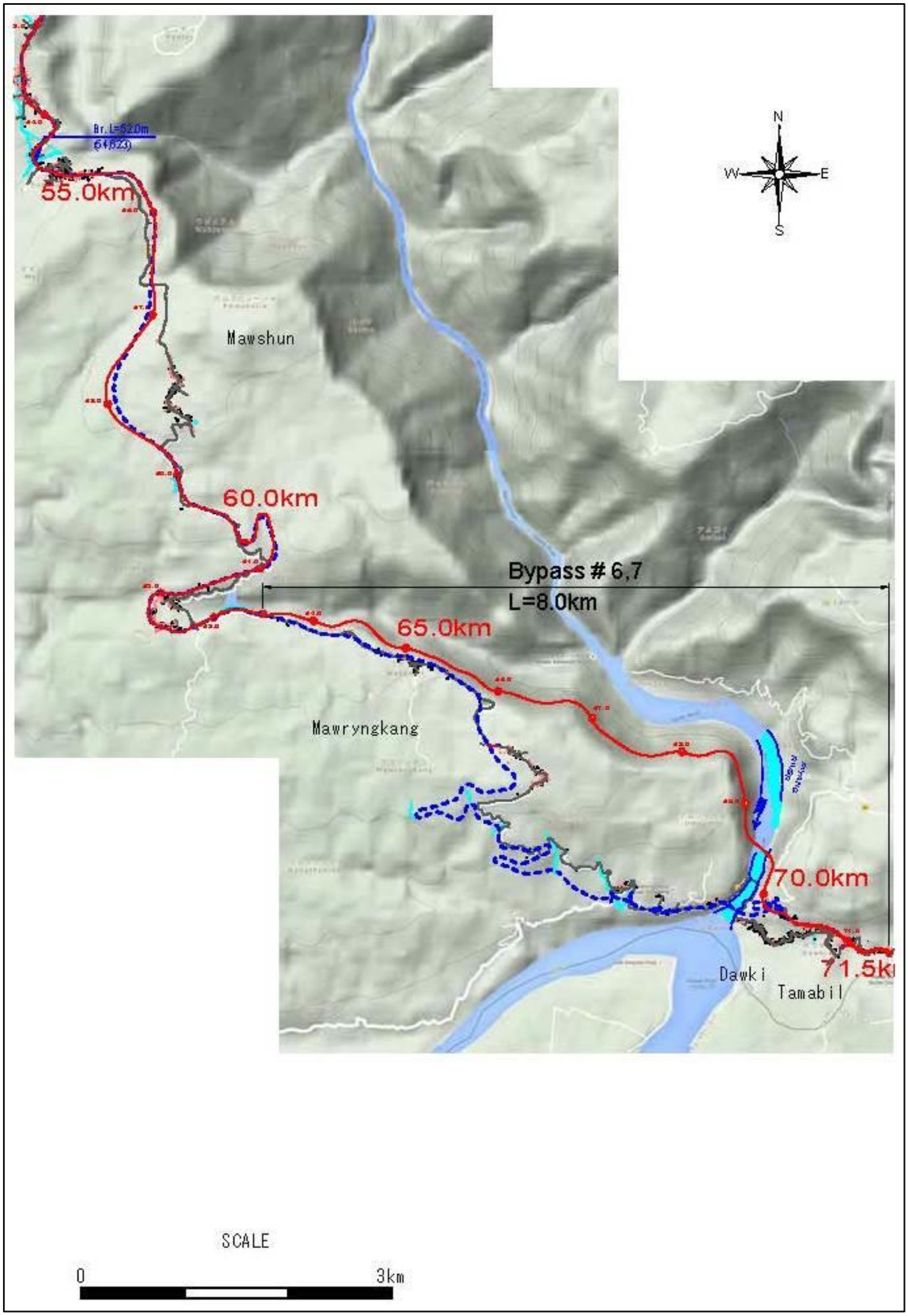


Dashed Blue Line：DPR Design、**Solid Red Line**：JICA Study Team's Design
Source: JICA Study Team

Figure 4-2 Bypass No. 4 – DPR Design/ JICA Study Team Design

Dashed Blue Line：DPR Design、**Solid Red Line**：JICA Study Team's Design
Source: JICA Study Team

Figure 4-3 Bypass No. 5 – DPR Design/ JICA Study Team Design



Dashed Blue Line：DPR Design、**Solid Red Line**：JICA Study Team's Design
Source: JICA Study Team

Figure 4-4 Bypasses No. 6–7 – DPR Design/ JICA Study Team Design

4.3 Scoping Matrix: Preliminary Analysis of the Environmental Impacts

Depending on the scale and nature of project intervention during the various stages of the project in relation to the natural and social environment of the project area, there are positive and negative impacts of the project. These impacts are different in intensity, continuity, cumulative nature, spatial perspective, and irrevocability in terms of temporal and or eternal perspectives.

The scoping matrixes as per Table 4-1 highlights anticipated impacts that may occur on various environmental and social sectors during the scoping stage of the project. It is a generic scoping matrix that is applicable to development projects in general and has been prepared based on the initial environmental assessment.

Within each table, the following is the abbreviations:

"A" denotes that severe/irrevocable impact is expected (+: Positive impact, -: Negative impact)

"B" denotes that significant impact is expected (+: Positive impact, -: Negative impact)

"C" denotes that impact is unknown l

"D" denotes that impact with little significance occurs

Table 4-1 Scoping Matrix of 4 Options

Item	Scoping Analysis of the Anticipated Environmental Impacts											
	No-project			Two-lane Widening			Bypass Inserting Option – DPR Design			Bypass Inserting Option – JICA Study Team's Design		
	Pre-construction	Construction Stage	Operation Stage	Pre-construction	Construction Stage	Operation Stage	Pre-construction	Construction Stage	Operation Stage	Pre-construction	Construction Stage	Operation Stage
Natural Environment												
Climate/Meteorological Phenomena	D	D	D	D	D	D	D	D	D	D	D	D
Topography	D	D	D	D	B-	D	D	B-	D	D	B-	D
Geology	D	D	D	D	D	D	D	D	D	D	D	D
Soil Erosion	D	D	D	D	B-	B-/B+	D	B-	B-/B+	D	B-	B-/B+
Hydrology	D	D	D	D	C	C	D	C	C	D	C	C
Groundwater	D	D	D	D	D	D	D	D	D	D	D	D
Forest/Flora	D	D	D	D	A-	C	D	A-	C	D	A-	B-
Eco-system/Bio-diversity	D	D	D	D	A-	B-	D	A-	A-	D	A-	A-
Wildlife Reserve	D	D	D	D	D	D	D	D	D	D	D	D
Coastal Zone	D	D	D	D	D	D	D	D	D	D	D	D
Landscape	D	D	D	D	C	C	D	C	C	D	C	C
Natural Disasters	D	D	D	D	B-	B+	D	B-	B+	D	B-	B+
Living Environment/Pollution Control Measures												
Air Pollution	D	D	D	D	B-	B-	D	B-	C	D	B-	B-
Offensive Odour	D	D	D	D	D	D	D	D	D	D	D	D
Water Pollution	D	D	D	D	B-	C	D	B-	C	D	B-	B-
Bottom Sediment Contamination	D	D	D	D	C	C	D	C	C	D	C	C
Soil Contamination	D	D	D	D	C	D	D	C	D	D	C	D
Ground Subsidence	D	D	D	D	D	D	D	D	D	D	D	D
Noise and Vibration	D	D	D	D	A-	A-	D	A-	B-	D	A-	B-
Sunshine Obstruction	D	D	D	D	D	D	D	D	D	D	D	D
Wastes/Hazardous Materials	D	D	D	D	B-	B-	D	B-	B-	D	B-	B-

Item	Scoping Analysis of the Anticipated Environmental Impacts											
	No-project			Two-lane Widening			Bypass Inserting Option – DPR Design			Bypass Inserting Option – JICA Study Team's Design		
	Pre-construction	Construction Stage	Operation Stage	Pre-construction	Construction Stage	Operation Stage	Pre-construction	Construction Stage	Operation Stage	Pre-construction	Construction Stage	Operation Stage
Social Environment												
Involuntary Resettlement	D	D	D	A-	D	D	A-	D	D	A-	D	D
Land Use	D	D	D	B-	B-	B-	A-	A-	A-	A-	A-	A-
Utilization of Local Resources	D	D	D	D	A-	D	D	A-	D	D	A-	D
General, Regional /City Plans	D	D	B-	D	D	B+	D	D	B+	D	D	B+
Social Institutions and Local Decision-making Institutions	D	D	D	B-	B-	B-	B-	B-	B-	B-	B-	B-
Social Infrastructure and Services	D	D	B-	B-	B-	B+	B-	B-	B+	B-	B-	B+
Local Economy and Livelihood	D	D	D	A-	A-	B+	A-	A-	B+	A-	A-	B+
Unequal Distribution of Benefit and Damage	D	D	B-	A-	A-	B-	A-	A-	B-	A-	A-	B-
Local Conflicts of Interest	D	D	B-	C	C	C	C	C	C	C	C	C
Water Use, Water Rights and Communal Rights	D	D	D	D	D	D	D	D	D	D	D	D
Cultural and Historical Heritage	D	D	D	D	D	D	D	D	D	D	D	D
Religious Facilities	D	D	D	B-	A-	C	B-	A-	D	B-	A-	D
Sensitive Facilities (e.g. hospital, school, precision machine factory)	D	D	D	A-	A-	C	C	A-	D	C	A-	D
Poor People	D	D	B-	A-	A-	B+	A-	A-	B+	A-	A-	B+
Ethnic Minorities/ Indigenous People	D	D	B-	A-	A-	D	A-	A-	D	A-	A-	D
Gender	D	D	D	C	C	C	C	C	C	C	C	C
Children's Rights	D	D	D	C	D	C	C	D	C	C	D	C
Public Health (sanitation and infectious diseases)	D	D	B-	D	B-	B-	D	B-	B-	D	B-	B-
Occupational Health and Safety (OHS)	D	D	D	D	B-	B-	D	B-	B-	D	B-	B-
Others												
Accidents	D	D	D	D	B-	B+/ B-	D	B-	B+/ B-	D	B-	B+/ B-
Climate Change	D	D	D	D	B-	B+/ B-	D	B-	B+/ B-	D	B-	B+/ B-

Source: JICA Study Team

Table 4-2 Scoping Matrix for the Two-lane Widening of NH-40 (Bypass Inserting Option – JICA Study Team's Design)

Item		Scoping Analysis of the Anticipated Environmental Impacts			
		Pre-construction	Construction Stage	Operation Stage	Rationale of the Impact Assessment
Natural Environment					
1.1	Climate/ Meteorological Phenomena	D	D	D	P: No impact is expected.
					C: Impacts on microclimate should occur but of negligible scale.
					O: Impacts on microclimate should occur but of negligible scale.
1.2	Topography	D	B-	D	P: No impact is expected.
					C: Changes in topographic conditions over the project area takes place due to the need for cutting and filling work.
					O: Topographic conditions should become stable after the completion of construction works, which include slope protection and stabilization.
1.3	Geology	D	D	D	P: No impact is expected.
					C: No impact is expected.
					O: No impact is expected.
1.4	Soil Erosion	D	B-	B-	P: No impact is expected.
					C: Soil erosion occurs particularly during the construction period with monsoon rains.
					O: The project is expected to improve the conditions and thus reduce risk over time as geo-technical measures of slope protection and stabilization should prevent soil erosion. However, periodical monitoring has to be carried out during and after the rainfalls.
1.5	Hydrology	D	C-	C-	P: No impact is expected.
					C: Construction work may cause minor and temporary impacts on hydrology because of cutting and filling, or the local use of water.
					O: Cutting and / or filling should result in permanent changes of local hydrology.
1.6	Groundwater	D	D	D	P: No impact is expected.
					C: The project does not envision the use of groundwater. There is no tunnelling works.
					O: No impact is expected during the operation and maintenance stage.
1.7	Eco-system/ Forest/Flora	D	A-	A-	P: No impact is expected.
					C: During the construction period, ecosystem in the mountain including local flora and fauna as well as forest/wooded areas are damaged to some extent. Birdlife International calls for Important Bird Area. However, significant area of forest areas must be cleared for the project and wildlife habitat including that of bird species is lost.
					O: Increase of traffic volume will cause negative impacts on the ecosystem including fauna and flora along the road. Birdlife International calls for Important Bird Area. It is in the area within 5 km of the project area. Because of the forest clearing at Bypass No. 6, thick riparian forest is lost permanently causing negative impacts to the habitat for wildlife including bird species. Increase in emissions due to growing traffic volume will negatively affect the existing forest and surrounding ecosystem as access to the forest area becomes easy through the improved road.
1.8	Wildlife Reserve	D	D	D	P: There is no wildlife reserve within 5 km radius of the project area.
					C: There is no wildlife reserve within 5 km radius of the project area.
					O: There is no wildlife reserve within 5 km radius of the project area.
1.9	Coastal Zone	D	D	D	P/C/O: There is no coastal zone subject to project intervention.
1.10	Landscape	D	C	C	P: No impact is expected.
					C: Changes in landscape during the construction work should cause significant landscape changes while it would be temporary during the construction period.

Item		Scoping Analysis of the Anticipated Environmental Impacts			
		Pre-construction	**Construction Stage**	**Operation Stage**	**Rationale of the Impact Assessment**
					O: The project should improve several viewpoints located along the road while the project itself causes no significant of landscape across the valley.
1.11	Natural Disasters	D	B-	B+	P: No impact is expected.
					C: Many areas of the project area are prone to landslides during the construction period. Thus appropriate slope protection measures during the construction period are provided. There is no residential area prone to land slide or flood events along the project area.
					O: There is no residential or critical area prone to land slide or flood events along the project area. Slope protection/ stabilization measures and drainages are expected to significantly reduce the risk of natural disasters upon completion of the project.
Pollution					
2.1	Air Pollution	D	B-	B-	P: No impact is expected.
					C: Some negative impacts are expected due to the operation of construction equipment and vehicles. One example is dust incidental to earthwork especially during the dry season.
					O: Air pollution is expected to increase due to increased traffic volume on the road.
2.2	Offensive Odour	D	D	D	P/C/O: No impact is expected.
2.3	Water Pollution	D	B-	B-	P: No impact is expected.
					C: Turbid water due to the earthworks, bridge pier construction work and wastewater effluents from construction workers' camps / yards are expected to pollute the surrounding rivers / canals to some extent.
					O: Some impacts on water quality in surrounding water bodies are expected due to water discharge from road users and wastewater from maintenance activities.
2.4	Bottom Sediment Contamination	D	C	C	P: No impact is expected.
					C: There is a possibility that rainwater will wash out construction materials such as cement, sand and other debris into the natural drainage. Contractors are instructed to provide silt trap at places where natural drainage is likely to be affected. No toxic chemicals are used or stored in the project area for the construction works of the project.
					O: Some wastewater will be generated from maintenance activities along the road while the impacts on bottom sediment from the wastewater will be negligible.
2.5	Soil Contamination	D	C	D	P: No impact is expected.
					C: Impacts on soil from deposition of pollutants from construction materials in the construction site are expected to be small. Since there is no major industrial activity along the road, it is unlikely that soil along the road is already polluted.
					O: No impact is expected.
2.6	Ground Subsidence	D	D	D	P: No impact is expected.
					C: No impact is expected.
					O: No impact is expected.
2.7	Noise and Vibration	D	A-	B-	P: No impact is expected.
					C: Noise and vibration generated by the operation of construction equipment and vehicles, although they are temporary. Construction schedule should take into account the location of schools, hospitals and religious facilities that require silence during parts of the day.
					O: Noise and vibration level are likely to increase due to greater traffic volume along the road. Specific measures may be required to minimize impacts on schools, hospitals and religious facilities.
2.8	Sunshine Obstruction	D	D	D	P: No impact is expected.
					C: No impact is expected.

Item		Scoping Analysis of the Anticipated Environmental Impacts			
		Pre-construction	**Construction Stage**	**Operation Stage**	**Rationale of the Impact Assessment**
					O: No impact is expected.
2.9	Wastes / Hazardous Materials	D	B-	B-	P: No impact is expected.
					C: Waste will be generated from construction workers' camps. Waste generated from construction and demolition work may include hazardous materials that must be treated before final disposal.
					O: Waste will be generated from road users and workers of maintenance works.
Social Environment					
3.1	Involuntary Resettlement	A-	D	D	P: Though bypasses are planned to avoid densely-populated areas, expansion of the existing road will result in involuntary resettlement of 30 households at maximum per village. The number of household to be resettled is estimated to be approximately 400.
					C: Resettlement will be completed before construction begins and thus no resettlement is expected during operation.
					O: No impact is expected, as relocation will be completed before construction begins.
3.2	Land Use	A-	A-	A-	P: Land acquisition and involuntary resettlement are likely to cause changes in the existing land use patterns.
					C: Land usage, including cultivation, shifting cultivation, quarry, and agro-forestry, might be significantly affected at bypass sections. Land clearance for construction yards and workers' camps is temporary.
					O: Land usage will be permanently changed especially at bypass sections.
3.3	Utilization of Local Resources	D	A-	D	P: No impact is expected.
					C: Mass-scale use of local resources such as sand and quarrying for the construction activities may make the materials scarce for their needs that exist locally.
					O: No impact is expected as use of local resources is not expected during operation.
3.4	General, Regional / City Plans	D	D	B+	P/C: No impact is expected.
					O: Better infrastructure network may trigger an influx of outsiders and economic development in the region.
3.5	Social Institutions and Local Decision-making Institutions	B-	B-	B-	P/C/O: Land acquisition and involuntary resettlement are likely to affect social institutions such as social capital and local decision-making institutions.
3.6	Social Infrastructure and Services	B-	B-	B+	P: Communal facilities such as public hall may be affected by the project. Access to social infrastructure and services may be temporarily affected due to resettlement and land acquisition.
					C: Access to social infrastructure and services may be temporarily affected due to construction of construction yard and accommodation for workers as well as traffic jams due to the operation of construction vehicles.
					O: In the long term, the project is expected to improve access to social infrastructure and services by providing a better road network.
3.7	Local Economy and Livelihood	A-	A-	B+	P: Loss of income source and livelihood due to involuntary resettlement and change in land usage are expected to negatively affect the local economy and livelihood. Realignment of the bridge section can negatively affect rental boats, tea stalls and open stalls nearby the boat slip, though the affect will be relatively minor.
					C: Loss of income source and livelihood due to involuntary resettlement and change in land usage are expected to negatively affect the local economy and livelihood, especially cultivation, quarry and agro-forestry. On the other hand, construction work will

Item		Scoping Analysis of the Anticipated Environmental Impacts			
		Pre-construction	**Construction Stage**	**Operation Stage**	**Rationale of the Impact Assessment**
					have a positive impact on the local economy by creating employment and business opportunities in the project area.
					O: The project will have a positive impact on the local economy as an improved road network ensures a more stable supply of essential goods and transport of cash crops. However, bypasses may negatively affect the business of shops and tea stalls in detoured villages, and business of rental boats, tea stalls and open stalls nearby the boat slip of the detoured bridge section. In the long-term, this will lead to regional economic development with more job and business opportunities. Meanwhile, it is suggested that a proposal be made to village/district council to ensure that the improved infrastructure network will not lead to uncontrolled development and deforestation.
3.8	Unequal Distribution of Benefit and Damage	A-	A-	B-	P: Land acquisition and involuntary resettlement will lead to unequal distribution of benefits and damage between those who are directly affected by the project and those who are not.
					C: While resettling households and households whose livelihood depends on affected lands will bear much of the damage, others may even enjoy benefits from new business opportunities created by construction work, resulting in the unequal distribution of benefits and damage.
					O: People residing along the road may accrue greater benefits compared to others, potentially increasing the rich-poor gap within the community. Over the long term, the project is expected to have a positive impact on the local economy through an improved road network.
3.9	Local Conflicts of Interest	C	C	C	P: Expectation for unequal distribution of benefits and damage may trigger and / or intensify local conflicts of interest in the community.
					C/O: Unequal distribution of benefits and damage may trigger and / or intensify local conflicts of interest in the community though the impact is relatively minor.
3.10	Water Usage, Water Rights and Communal Rights	D	D	D	P/C: Water usage of the affected households may be curtailed due to resettlement. However, rainwater is commonly used for both household and agricultural use in the region and thus, the impact will be minor, if any.
					O: No impact is expected.
3.11	Cultural and Historical Heritage	D	D	D	P/C/O: The targeted roads do not traverse or run near major cultural or historical heritage sites.
3.12	Religious Facilities	B-	A-	D	P: A number of churches, several memorial stones and graves are located along the road. Several memorial stones are directly affected. Graves can be affected in private yards. The targeted roads do not traverse sacred groves of traditional religious beliefs.
					C: Roadside religious facilities may be affected by noise and vibration during construction and operation due to construction work and greater traffic volume.
					O: Several memorial stones are directly affected, which requires appropriate protection or realignment of the route.
3.13	Sensitive Facilities (e.g. hospital, school, precision machine factory)	C	A-	D	P: Though no impact is expected, further study will be required.
					C: Noise and vibration during construction work may affect schools, public health centres and other medical facilities.
					O: No impact is expected as sufficient noise control measures will be implemented.
3.14	Poor People	A-	A-	B+	P: Given the limited coping capacity of the poor, it is necessary to assess their vulnerability and develop appropriate mitigation

Item		Scoping Analysis of the Anticipated Environmental Impacts			
		Pre-construction	**Construction Stage**	**Operation Stage**	**Rationale of the Impact Assessment**
					measures.
					C: The poor may bear a disproportionally higher burden due to their limited capacity to cope, although they can benefit from employment opportunities during construction work.
					P: In the long-term, economic development in the region is likely to benefit the poor, however, the poor may fail to benefit from the project due to the lack of skills and coping capacity.
3.15	Ethnic Minorities/ Indigenous People	A-	A-	D	P/C: East Khasi Hills and Jaintia Hills of Meghalaya State are home to tribal groups (Scheduled Tribe) with distinct languages and cultures. Preparation of RAP and livelihood restoration plan, therefore, must take this into account.
					O: Resettlement will be completed before construction. Negative impacts shall be minimized by considering relocation places and livelihood restoration plans.
3.16	Gender	C	C	C	P: Resettlement may affect gender-related work division such as cultivation, harvest and processing of crops.
					C: Equal opportunity should be sought for employment during construction work. Prevailing social and cultural norms must be carefully studied to avoid gender-related conflicts. Project may affect gender-related work division such as cultivation, harvest and processing of crops.
					O: Project may affect gender-related work division such as cultivation, harvest and processing of crops.
3.17	Children's Rights	C	D	C	P: Though child labour is unlawful according to Article 24 of the Indian Constitution, the project may affect children who help their families with work at roadside shops and tea stalls.
					C: Child labour is unlawful according to Article 24 of the Indian Constitution. Only adults are eligible for potential employment opportunities created by the project.
					O: Though child labour is unlawful according to Article 24 of the Indian Constitution, the project may affect children who help their families with work at roadside shops and tea stalls.
3.18	Public Health (sanitation and infectious diseases)	D	B-	B-	P: No impact is expected.
					C: Influx of construction workers is likely to increase health risks, particularly that of STD / STI and HIV / AIDS. The risk of malaria should be properly managed in construction work in areas where malaria is prevalent.
					O: An increase in traffic volume and road users may have negative impacts on public health.
3.19	Occupational Health and Safety (OHS)	D	B-	B-	P: No impact is expected.
					C: Occupational health and safety of construction work should be properly managed through adequate EMP.
					O: Maintenance and repair work should take into account the occupational health and safety of the workers.
Others					
4.1	Accidents	D	B-	B+ / B-	P: No impact is expected.
					C: Increased risk of accidents associated with construction activities is expected due to the operation of heavy equipment and vehicles. Special attention is required for construction in the foggy area.
					O: Risks of accidents is expected to increase due to greater traffic volume and speed. Speed limits and use of headlight / hazard lights shall be required especially in the foggy area. Putting in place accident-prevention measures (such as mirrors at curves) will reduce the risk of accidents.
4.2	Climate Change	B-	B-	B+ / B-	P: No impact is expected.
					C: The use of construction machines and operation of vehicles will result in an increase in GHG emissions, though the impact is small

Item		Scoping Analysis of the Anticipated Environmental Impacts			
		Pre-construction	Construction Stage	Operation Stage	Rationale of the Impact Assessment
					and short-term.
					O: GHG emissions will increase due to an increase in traffic volume. The project is expected to improve the resilience of the road against climate change by factoring long-term climate change (changes / increase in precipitation etc.) into the road design.

Note:
P: Pre-Construction; C: Construction; and O: Operation Period
A: Severe/irrevocable impact is expected (+: Positive impact, -: Negative impact)
B: Significant impact is expected (+: Positive impact, -: Negative impact)
C: Further study is required as impact is unknown
D: Impact with little significance occurs

Source: JICA Study Team

4.4 Analysis of the Alternatives

4.4.1 Criteria for Analysis of the Alternatives

Criteria for the analysis of the selected four alternatives are shown in Table 4-3. These criteria are based on the importance particular to the Project being a road improvement project running through Khasi Hills of Meghalaya State.

Table 4-3 Criteria for the Evaluation of the Alternatives

No.	Alternative Models	Criteria of Evaluation
1	Do nothing Option (No project is implemented)	Environmental Pollution - CO_2 emissions increase/decrease - Noise and vibration increase/decrease - Health conditions improve/worsen Socio-economic Conditions - Road accidents increase/decrease - Living standards improve/worsen - Impacts of resettlement - Impacts of land acquisition Natural Environment - Mountain slopes are stabilized/destabilized - Effects on ecological conditions Road Conditions - Improvement of infrastructure for communication - Improvement of transportation of goods - Contribution to economic development of local/state economy Others - Technical viability of the road construction - Expected benefits of the project in terms of socio-economic conditions and natural environment (Is it worth implementing the project despite effects on the natural/social/economic conditions)
2	Road Widening Option (Entire Section of NH-40 is subject to Road Widening)	
3	Bypass Insertion Option – DPR Design (Seven bypasses are inserted while widening of no bypass sections are implemented)	
4	Modified Bypass Insertion Option – JICA Study Team's Design (Bypass No.6 has been modified)	

Source: JICA Study Team

4.4.2 Weighted Average Analysis of the Alternatives

Based on the above four alternatives, each alternative is evaluated using weighted average analysis. Evaluation parameter for items of the purple shaded area is impact i.e. if each item is negatively or positively affected as a result of the implementation of the Project. It means larger the value larger the negative impacts on the alternative.

On the other hand, those items in the light-green shaded area are the conditions of improvement in terms of the local economy and society. It means larger the value larger the benefit of each alternative.

Table 4-4 Weighted Average Analysis of the Alternatives

Evaluation Criteria \ Options	Zero Option				Road Widening Option				Bypass Insertion Option – DPR Design				Modified Bypass Insertion Option - JICA Study Team Design			
	FI	QL	QT	Total	FI	QL	QT	Total	FI	QL	QT	Total	FI	QL	QT	Total
1 Environmental Pollution																
1) CO2 Emission	5	1	1	10	5	2	2	20	5	2	2	20	5	2	2	20
2) Noise and Vibration	5	2	2	20	5	2	2	20	5	2	2	20	5	2	2	20
3) Effect on the Health Conditions	5	1	1	10	5	2	2	20	5	2	2	20	5	2	2	20
Total for Impacts on Environmental Pollution	-	-	-	40	-	-	-	60	-	-	-	60	-	-	-	60
2 Socio-economic Conditions																
1) Road Accidents	5	3	3	30	5	3	3	30	5	3	3	30	5	3	3	30
2) Living Standards	7	5	0	35	7	5	0	35	7	5	0	35	7	5	0	35
3) Resettlement	10	1	1	20	10	10	10	200	10	8	5	130	10	8	5	130
4) Land Acquisition and/or Effect of Bypasses																
a. Commercial & Industrial Area	2	1	1	4	2	10	10	40	2	5	5	20	2	5	5	20
b. Agricultural Area	4	1	1	8	4	3	3	24	4	3	3	24	4	3	3	24
c. Residential Area	7	1	1	14	7	10	10	140	7	5	5	70	7	5	5	70
Total for Impacts on Socio-economics	-	-	-	111	-	-	-	469	-	-	-	309	-	-	-	309
3 Natural Environment																
1) Slope Stabilization	5	1	1	10	5	5	5	50	5	8	8	80	5	5	5	50
2) Ecological Changes																
a. Forest	10	1	0	10	10	3	5	80	10	5	10	150	10	5	10	150
b. Wildlife	4	1	0	4	4	3	0	12	4	5	0	20	4	5	0	20
c. Avifauna	3	1	0	3	3	3	0	9	3	5	0	15	3	5	0	15
d. National Parks	3	1	0	3	3	1	0	3	3	1	0	3	3	1	0	3
Total for Impacts on the Natural Environment	-	-	-	30	-	-	-	154	-	-	-	268	-	-	-	238
Total for Impacts (showing Negativity)	-	-	-	181	-	-	-	683	-	-	-	637	-	-	-	607
4 Road Conditions																
1) Road as communication infrastructure	10	3	3	60	10	10	10	200	10	10	10	200	10	10	10	200
2) Road for transportation of goods	7	3	3	42	7	5	5	70	7	5	5	70	7	5	5	70
3) Contribution to economic development	5	4	4	40	5	5	5	50	5	5	5	50	5	5	5	50
Total for Importance of Road Conditions	-	-	-	142	-	-	-	320	-	-	-	320	-	-	-	320
5 Others																
1) Technical Viability of the Road	5	4	0	20	5	3	3	30	5	5	5	50	5	5	5	50
2) Worth to Implement the Project	8	4	0	32	8	3	3	48	8	5	5	80	8	8	8	128
Total for Importance of Others	-	-	-	52	-	-	-	78	-	-	-	130	-	-	-	178
Total for Importance (showing positivity)	-	-	-	194	-	-	-	398	-	-	-	450	-	-	-	498

Note: QL - Qualitative assessment of importance/impact 1 (lowest) to 10 (highest) in terms of Impact/Importance
QT - Quantitative assessment of importance/impact 1 (lowest) to 10 (highest) in terms of Impact/Importance
FI - Factor of Importance from 1 to 10
0 - Quantitative or Quantitative assessment is not appropriate to carry out
"1-3 (Shaded in Magenta)" are assessed in terms of impacts with 1 (low impact) to 10 (high impact)
"4 Road Conditions" and "5 Others (Shaded in Light Green)" are assessed in terms of importance i.e. 1 (lowest) to 10 (highest)

Source: JICA Study Team

As shown above, the two "bypass insertion" options show a high value in the area shaded purple compared to the "No-project Implemented Option" alternative. This means that the impacts on the natural and socio-economic conditions are comparatively large for the bypass options. On the other hand, comparing the values in the sections shaded green show that the "No-project Implemented Option" has a lower value while the "bypass insertion" options show higher values. This indicates that there are more socio-economic benefits that can be expected from the "bypass insertion" options. The findings from this analysis suggests that JICA Study Team's "modified bypass insertion option" is considered better in terms of this weighted average analysis, and is presented in the following section.

4.4.3 Result of the Analysis of Alternatives

(1) Do-nothing Option

Do-nothing option of the project is to take no project intervention on the existing NH-40. This option is assessed as follows:

Positive Impacts

- There will be no involuntary resettlement involved in Zero Option
- No forest and agricultural areas lost to the road construction works
- No construction works should cause significant traffic jam, dust emanation during dry season and muddy road during rainy season.
- No significant impact will be caused to the near-by "Important Bird Area."

Negative Impacts

- Transportation capacity of the existing road has already been saturated at its beginning area and ending area. The local business of the transportation of goods such as limestone exportation to Bangladesh will not be able to expand if no NH-40 widening project was implemented.
- Meghalaya State Government is trying to exploit local mineral resources including uranium. If no project was carried out the transportation of these mineral resources could not be effectively exploited.
- Current traffic conditions around the villages along NH-40 cause traffic jam and the function of NH-40 as one of the important trunk lines of road in Meghalaya State is somewhat deteriorated.
- Road accident might increase as number of vehicles increase while the road width not improved.
- The function of NH-40 as one of the important trunk lines of road in India will not be improved for a long period.

(2) Widening of the Road

Road widening option of NH-40 is to widen the existing road and upgrade it as two-lane road with appropriate drainage, footpath and other ancillary road furniture. This option is assessed as follows:

Positive Impacts

- Transportation capacity already been saturated could be eased with widening option.
- Local business such as limestone exportation to Bangladesh and transportation of agricultural products to Shillong will be able to expand if NH-40 widening project was implemented.
- Meghalaya State Government is trying to exploit local mineral resources including uranium and that the transportation of these mineral resources could effectively be able to transport if NH-40 widening project was implemented.
- Current traffic conditions around the villages along NH-40 causing traffic jam will somehow be improved.

Negative Impacts

- Involuntary resettlement of the local residents will be approximately 850 households.
- Forest area of approximately 140 ha will have to be lost to road construction area.
- Construction works should cause significant traffic jam throughout the construction period, dust during dry season and muddy road during rainy season.
- Increase of traffic volume including heavy load vehicles should increase to cause noise and vibration along the built-up areas over time.
- Significant impact could be caused to the near-by "Important Bird Area".
- Increase of traffic speed after the improvement of road condition may increase traffic accidents.

(3) Bypass Insertion Option – DPR Design

Bypass insertion option of NH-40 is to widen the existing road and upgrade it as two-lane road with appropriate drainage, footpath and other ancillary road furniture. Where a concentration of population along the road might be adversely affected, bypasses are inserted in order to reduce the number of involuntary resettlement. This option is assessed as follows:

Positive Impacts

- Traffic conditions bypassing the local built-up areas will be a positive effect to the local resident.
- Transportation capacity already been saturated could be improved i.e. the local business such as limestone exportation to Bangladesh will be able to expand if NH-40 widening project was implemented.
- Meghalaya State Government is trying to exploit local mineral resources including uranium and that the transportation of these mineral resources could effectively be able to exploit if NH-40 widening project was implemented.

Negative Impacts

- Involuntary resettlement of the local residents will be reduced to approximately 350 households from 850 households in the case of road widening option. However, this does not become positive impacts of the Project as a whole.
- Forest area of approximately 190 ha will have to be lost including bypass areas to road construction area.
- Construction works should cause significant traffic jam throughout the construction period, dust during dry season and muddy road during rainy season.
- Increase of traffic volume including heavy load vehicles should cause noise and vibration along the road while some traffic is diverted to bypasses.
- Current traffic congestions along the built-up areas of NH-40 might not be reduced or increased on long term.
- Significant impact could be caused to the near-by "Important Bird Area".
- Increase of traffic speed after the improvement of road condition may increase traffic accidents.

(4) Bypass Insertion Option – JICA Design

Bypass insertion option of NH-40 based on DPR Design is reviewed in terms of the configuration of bypass at the end of the road approaching to the border between India and Bangladesh. It involves widening of the existing road and upgrades it as two-lane road with appropriate drainage, footpath and other ancillary road furniture. Where a concentration of population along the road might be adversely affected, bypasses are inserted the same as those of DPR Design in order to reduce the number of involuntary resettlement. This option is assessed as follows:

Positive Impacts

- Traffic conditions bypassing the local built-up areas will be a positive effect to the local resident.
- Transportation capacity already been saturated could be improved i.e. the local business such as limestone exportation to Bangladesh will be able to expand if NH-40 widening project was implemented.
- Meghalaya State Government is trying to exploit local mineral resources including uranium and that the transportation of these mineral resources could effectively be able to exploit if NH-40 widening project was implemented.

Negative Impacts

- Involuntary resettlement of the local residents will be reduced to approximately 300 households from 850 households in the case of road widening option. However, this does not become positive impacts of the Project as a whole.
- Forest area of approximately 190 ha will have to be lost including bypass No. 6-7 areas where dense forest involved to road construction area.
- Construction works should cause significant traffic jam throughout the construction period, dust during dry season and muddy road during rainy season.
- Increase of traffic volume including heavy load vehicles should cause noise and vibration along the road while some traffic is diverted to bypasses.

- Current traffic congestions along the built-up areas of NH-40 might not be reduced or increased on long term.
- The existing road which is narrow and deteriorated its surface in the section near the border will be left out of the Project while the local population demands renewal and up-grading of the road.
- Significant impact could be caused to the near-by "Important Bird Area".
- Increase of traffic speed after the improvement of road condition may increase traffic accidents.

4.5 Selection of the Alternatives

Based on the result of analysis as above, four alternatives have been assessed in terms of their advents and disadvantages as per Section 4.4.3. As a result, "Bypass Insertion Option – JICA Review's Design" was relatievy advantageous as follows:

a. Entire length of the project area has been shortened as Bypass No. 6-7 is inserted;
b. Because of the short length of Bypass No.6-7, forest clearing is reduced;
c. Because of the insertion of Bypass No. 6-7, no resettlement is induced to this section; and
d. Because of the large scale bridge is constructed, esthetics of original landscape is lost while new bridge could become one of the tourism sources of Dawki.

It is to be noted that the Bypass No.5 will not be included in the project due to public agreement unreached during this study, while the plan to insert the bypass is advantageous according to results of alternative comparison and analysis.

Table 4-5 Assessment of the Alternatives

Alternatives	Do-nothing Option	Widening the Existing Road	Bypass Insertion By DPR	Bypass Insertion by JICA Study Team's Review
Outline of the Alternatives	No project implementation and the existing road is continued to use	Based on IRC, 2-lane widening for the entire length is implemented	A number of bypasses are inserted in order to avoid built-up areas	Generally the same as DPR while Bypass No.6 -7 are significantly improved
Scale of Involuntary Resettlement	◎ No involuntary resettlement is involved i.e. the largest advantage among others	× Largest involuntary resettlement of approximately 850 households is involved.	○ Involuntary resettlement is reduced to approximately 400 households.	○ Involuntary resettlement is reduced to 314 households
Impacts on the Natural Environment	◎ There is no significant impacts caused to the natural environment	○ There is a limited amount of impacts induced by the Project to the natural environment	× Bypasses will cause significant impacts on the forested area including wildlife and biological diversity as well as the agricultural areas.	× Bypasses will cause significant impacts on the forested area including wildlife and biological diversity as well as the agricultural areas.
Pollution to Air Quality, Water Quality and Soil	△ No short-term impact. However, present deterioration of the road conditions will lead to significant traffic congestions, air pollution and other side effects caused by the increase of traffic.	○ GHG as emission could increase as traffic volume increased all along the present road	◎ No air quality deterioration in the built-up areas while GHG emission could increase as a whole	◎ No air quality deterioration in the built-up areas while GHG emission could increase as a whole
Traffic Safety	× Traffic safety could increase as no project intervention is carried	○ Widened road could allow speeding vehicles i.e. noise and vibration could	◎ Bypasses could avoid built-up areas for any contact with human,	◎ Bypasses could avoid built-up areas for any contact with human,

Alternatives	Do-nothing Option	Widening the Existing Road	Bypass Insertion By DPR	Bypass Insertion by JICA Study Team's Review
	out	increase. Traffic jam could increase at the built-up area.	bicycles and other vehicles.	bicycles and other vehicles.
Impacts on the Socio-economic Conditions	△ Natural disaster from significant rainfall could cause shut-down of the road net work that will cause disruption of the economic activities.	○ Increase of road width leads to increase of traffic and increase of economic activities. Traffic jam should increase at the built-up areas.	◎ Traffic flow avoiding built-up area should cause to enhance general economic activities.	◎ Traffic flow avoiding built-up area should cause to enhance general economic activities.
Cost of the Project	◎ No additional cost will be required.	△ Land acquisition and involuntary resettlement is the largest financial and economic loss as well as the social up- heaval. Cost of construction works could be small while narrow road area would cause additional construction arrange-ment for traffic safety.	○ Cost of involuntary resettlement is small. Shortening of the entire length of the project could reduce cost of construction.	○ Cost of involuntary resettlement is smallest. Shortening of the entire length of the project could reduce cost of construction.
Land Acquisition	◎ No additional cost will be required.	△ Land acquisition and involuntary resettlement is the largest financial and economic loss as well as the social up- heaval. Border Area's land acquisition is not possible.	× Land acquisition is a part in the area of the Min. of Defense i.e. negotiation for land acquisition takes time.	◎ Land acquisition is a part in the area of the Min. of Defense i.e. negotiation for land acquisition takes time.
Ranking	4	3	2	1
	Taking into the current road conditions, NH-40's role on the state economy, this option is not recommended.	Large-scale involuntary resettlement should be avoided. Cost of the project is largest among the alternatives.	Scale of involuntary resettlement is halved. Land acquisition for the agricultural areas and forest areas is the largest among other options. This option causes a largest economic impact as the same as that of JICA Study Team's Review Option.	Scale of involuntary resettlement is further reduced than DPR Option. Land acquisition for the agricultural areas and forest areas is slightly smaller than DPR Option. This option causes a largest economic impact as the same as that of DPR Option.

Legend: ◎-Highest ○-Good but other alternatives are available △-Other alternatives are better ×-Should be avoided N/A-Not applicable

Source：JICA Study Team

4.5.1 TOR of Natural and Socio-economic Environment Survey

TOR of the Natural Environment and Socio-economic Survey is shown in Table 4-6.

Table 4-6 TOR of Natural and Socio-economic Environment Survey

Scoping No.	Survey	Locations	Methods and Duration	Items Subject to Investigation	Method of Assessment and Estimation of Impacts
Natural Environment					
1.2	Geography/ Geomorphology	Entire Project Area	• Field survey, interview survey and map location study for the disaster-prone areas • Present conditions examined in May–July 2016	• Areas subject to cut and fill slope creation	Assessment of the Impact: Based on the secondary data and field survey, impact areas are assessed. Estimation of the Impact: Qualitative analysis on the assessed impacts.
1.4	Soil Erosion	Entire Project Area	• Field survey, interview survey and map location study for the disaster-prone areas • Present conditions examined in May–July 2016	• Areas subject to cut and fill slope creation	Assessment of the Impact: Based on the secondary data and field survey, impact areas are assessed. Estimation of the Impact: Qualitative analysis on the assessed impacts.
1.5	Hydrogeography	Entire Project Area	• Field survey, interview survey and map location study for the disaster-prone areas • Present conditions examined in May–July 2016	• Existing waterways such as rivers, streams and agricultural canals as well as sewerage channel	Assessment of the Impact: Based on the secondary data and field survey, impact areas are assessed. Estimation of the Impact: Qualitative analysis on the assessed impacts.
1.7	Ecosystem/ Biological Diversity	NH40: 4 locations (approximately every 20 km)	• Field Survey • Document survey • Hearing Survey on manger of parks and experts. • Bird survey (hearing survey on NGO/ Experts, Field Survey) • Present conditions examined in May–July 2016	• Rare species, breeding colony, wetland, parks, pictures • Area of investing within the 5 km of radios from the centre of the alignment of NH40.	Assessment of the Impact: Based on the field observation and secondary data, baseline data are determined. Estimation of the Impact: Forest clearing areas and the rare species of wildlife including bird species are analysed qualitatively.
1.7	Wildlife Reserve/ Sanctuary	NH40: 4 locations (approximately every 20 km)	• Field Survey • Document survey • Hearing Survey on manger of parks and experts. • Bird survey (hearing survey on NGO/ Experts, Field Survey) • Present conditions examined in May–July 2016	Exiting wildlife reserves adjacent to the project area	Assessment of the Impact: Based on the field observation and secondary data, baseline data are determined. Estimation of the Impact: Forest clearing areas and the rare species of wildlife including bird species are analysed qualitatively.

Scoping No.	Survey	Locations	Methods and Duration	Items Subject to Investigation	Method of Assessment and Estimation of Impacts
1.7	Wildlife/Plant Distribution	NH40: 4 locations (approximately every 20 km)	• Field Survey • Document survey • Hearing Survey on manger of parks and experts. • Bird survey (hearing survey on NGO/ Experts, Field Survey) • Present conditions examined in May–July 2016	Rare species, breeding colony of wildlife, wetland, forest reserves and other areas based on the local knowledge on the plants and wild life.	Assessment of the Impact: Based on the field observation and secondary data, baseline data are determined. Estimation of the Impact: Forest clearing areas and the rare species of wildlife including bird species are analysed qualitatively.
1.7	Forest	NH40 : within ROW and trees which will be hindrance to construction	• Hearing Survey, Filed Survey (counting of deforestation trees), review of documents • Present conditions examined in May–July 2016	Number, type, height, girth of trees, and forest areas subject to clearing for the Project.	Assessment of the Impact: Based on the field observation and secondary data, baseline data are determined. Estimation of the Impact: Forest area clearing area (ha), number of trees subject to cutting are estimated quantitatively as well as qualitatively.
1.10	Landscape	Entire Project Area	• Field survey and hearing survey along the project area • Present conditions examined in May–July 2016	• Field survey on the existing landscape and viewpoint areas • Investigation of the secondary data on the viewpoint construction works	Assessment of the Impact: Based on the secondary data and field survey, impact areas are assessed. Estimation of the Impact: Qualitative analysis on the assessed impacts based on the past incidents, existence of important facilities or scenery.
1.11	Natural Disaster	Entire Project Area	• Field survey and hearing survey along the project area • Present conditions examined in May–July 2016	• Field survey on the existing landscape and viewpoint areas • Areas subject to cut and fill slope creation	Assessment of the Impact: Based on the secondary data and field survey, impact areas are assessed. Estimation of the Impact: Qualitative analysis on the assessed impacts based on the past incidents, risk of flood on road/ residential areas, collapse of slopes.

Scoping No.	Survey	Locations	Methods and Duration	Items Subject to Investigation	Method of Assessment and Estimation of Impacts
Living Environment					
2.1	Air Quality	NH40: 9 locations (approximately every 10 km)	• Continuously 24 hours per location (1 weekday) • Accordance with environmental standard in India • Present conditions examined in May–July 2016	• SPM, RPM, NOx	Assessment of the Impact: Baseline data obtained on site are compared against the Indian standard for quantitative analysis. Estimation of the Impact: General trend of increase of the traffic and vehicles are taken into account of CO_2 increase is quantitatively analysed.
2.3	Water Quality	NH40: 9 locations (river crossing points and wells for approximately every 10 km),)	• According to the environmental standard in India • Present conditions examined in May–July 2016	• Water temperature, door, turbidity (NTU), pH、 BOD5, COD, total suspended solids	Assessment of the Impact: Baseline data obtained on site are compared against the Indian standard of water by CPCB for quantitative analysis. Estimation of the Impact: Water use during the construction period and operation and maintenance period is analysed
2.5	Soil Contamination	NH40: 9 locations (approximately every 10 km)	• Soil sampling and laboratory analysis • Present conditions examined in May–July 2016	• Based on IS2770 Method	Assessment of the Impact: Baseline data obtained on site are compared against the Indian standard put out by CPCB for quantitative analysis. Estimation of the Impact: Monitoring and analysis during the construction period and operation and maintenance period for soil analysis.
2.7	Noise and Vibration	NH40: 9 locations (approximately every 10 km)	• Continuously 24 hours per location (1 weekday) in accordance with noise standard in India and international standard for vibration • Present conditions examined in May–July 2016	• Noise level and noise-level-based traffic vibration	Assessment of the Impact: Baseline data obtained on site are compared against the Indian standard of noise by CPCB for quantitative analysis. Estimation of the Impact: Based on noise measurement result, framework of traffic vibration prediction is suggested.
2.9	Solid Waste	Entire Project Area	• Solid waste produced during the construction period • Present conditions examined in May–July 2016	• Solid waste production and disposal during the construction period • Solid waste produced during the maintenance works of the Project	Assessment of the Impact: Field observation during the construction period based on the Central/State Pollution Control Board Estimation of the Impact: Field observation during the maintenance period based on the Central/State Pollution Control Board

Scoping No.	Survey	Locations	Methods and Duration	Items Subject to Investigation	Method of Assessment and Estimation of Impacts
Social Environment					
3.1	Involuntary Resettlement	NH40: within ROW	• Census and inventory Interview Survey, Land property survey, Livelihood survey • Hearing Survey, Filed Survey • Focused Group Discussion	• Census and inventory using questioners. Resettlement cost will be calculated based on the survey result.	- Estimate the number of Involuntary resettlement affected by ROW and evaluate the result in quantitative by Census study. - Evaluate affected land and property of PAHs in quantitative by survey. - Evaluate socio-economic situation in quantitate by survey
3.2	Land Use	NH40: within ROW	• Hearing Survey, Filed Survey	• Land utilization , Range of Impact by project	Estimate the impact and evaluate the result in quantitative based on result of Field Survey, Review of Document and Similar Examples
3.3	Utilization of Local Resources	NH40: villages along the proposed alignment	• Hearing Survey, Filed Survey • Focused Group Discussion	• Utilization of Resource, Industrial Structure	Estimate the impact based on result of Field Survey, Review of Document and Similar Examples
3.4	General, Regional/ City Plans	NH40: villages along the proposed alignment	• Hearing Survey, Filed Survey	• Development of region, City planning	Estimate the impact based on result of Hearing Survey, Review of Document and Similar Examples
3.5	Social Institutions and Local Decision-making Institutions	NH40: 100 m from the proposed alignment	• Hearing Survey, Filed Survey • Focused Group Discussion	• Social Institution, Decision –making institution, the relationship	Estimate the impact based on result of Field Survey, Review of Document and Similar Examples
3.6	Social Infrastructure and Services	NH40: villages along the proposed alignment	• Hearing Survey, Filed Survey • Focused Group Discussion	• Name of Institution, distant from ROW, location, Accessibility	Estimate the impact based on information of water facility, sewage treatment facility, power distribution facility, telecommunication facility /public facilities(medical, education, religious, culture)
3.7	Local Economy and Livelihood	NH40: villages along the proposed alignment	• Hearing Survey, Filed Survey • Focused Group Discussion	• Economy situation, social structure, livelihood, situation of burn agriculture	Estimate the impact and based on result of Field Survey, Review of Document and Similar Examples
3.8	Unequal Distribution of Benefit and Damage	NH40: villages along the proposed alignment	• Hearing Survey, Filed Survey • Focused Group Discussion	• Livelihood, PAPs, Utilization of Affected Land	Estimate the impact based on result of Field Survey, Review of Document and Similar Examples
3.9	Local Conflicts of Interest	NH40: villages along the proposed alignment	• Hearing Survey, Filed Survey • Focused Group Discussion	• Livelihood, PAPs, Utilization of Affected Land, Social relationship	Estimate the impact based on result of Field Survey, Review of Document and Similar Examples

Scoping No.	Survey	Locations	Methods and Duration	Items Subject to Investigation	Method of Assessment and Estimation of Impacts
3.12	Religious Facilities	NH40: 100 m from the proposed alignment	• Hearing Survey, Filed Survey • Focused Group Discussion	• Name of Institution, distant from ROW, location, local information, Photograph	Estimate the impact based on result of Field Survey, Review of Document and Similar Examples
3.13	Sensitive Facilities (e.g. hospital, school, precision machine factory)	NH40: 100 m from the proposed alignment	• Hearing Survey, Filed Survey • Focused Group Discussion	• Name of Institution, distant from ROW, location, local information, Photograph	Estimate the impact based on result of Field Survey, Review of Document and Similar Examples
3.14	Poor People	NH40: villages along the proposed alignment	• Hearing Survey, Filed Survey • Focused Group Discussion	• Social structures, traditional livelihood, rehabilitation policy considering the above.	Estimate the impact based on result of Field Survey, Review of Document and Similar Examples
3.15	Minority/ Indigenous People	NH40: villages directly affected by the proposed alignment	• Hearing Survey, Filed Survey • Focused Group Discussion	• Social structures, traditional livelihood, rehabilitation policy considering the above.	Estimate the impact based on result of Field Survey, Review of Document and Similar Examples
3.16	Gender	NH40: villages along the proposed alignment	• Hearing Survey, Filed Survey • Focused Group Discussion	• Social Structure, Livelihood, Literacy, Condition of Employment	Estimate the impact based on result of Field Survey, Review of Document and Similar Examples
3.17	Children's Rights	NH40: villages along the proposed alignment	• Hearing Survey, Filed Survey • Focused Group Discussion	• Social Structure, Livelihood, Literacy, Condition of Employment	Estimate the impact based on result of Field Survey, Review of Document and Similar Examples
3.18	Public Health (sanitation and infectious diseases)		• Review of documents	• Rate of disease, epidemic and that of tendency	Estimate the rate of disease, epidemic and that of tendency by Review of Document and Similar Examples
3.19	Occupational Health and Safety (OHS)		• Review of documents	• Risk of Safety and Health, countermeasure	Estimate the impact based on Similar Examples
Others					
4.1	Accidents				
4.2	Climate Change	NH40: within ROW	• Filed Survey • review of documents	• Square meters of deforestation	

Source: JICA Study Team

4.5.2 Primary Data Collection

(1) Wildlife and Vegetation

The following method has been employed obtaining primary data in respect of the distribution of wildlife and vegetation:

a. Forest Area: There area 9 locations of transection (10 m × 10 m each) along the project area i.e. almost every 9 km along the road for forest and wildlife species research works;

b. Bush/scrub Area: There area 9 locations of transection (5 m × 5 m each) along the project area i.e. almost every 9 km along the road for vegetation as well as wildlife species research works;

c. Grassland Area: There area 9 locations of transection (1 m × 1 m each) along the project area i.e. almost every 9 km along the road for vegetation as well as wildlife species around the transection area for research works;

At each transection area, density as well as the number of wildlife and plant species is recorded. Each species are identified based on the data of Meghalaya Forest and Environment Department. Aquatic species in Umungot River near Dawki have also been identified based on the local knowledge as well as the data of Meghalaya Department of Environment and Forest.

(2) Living Environment/Pollution Control

1) Air Quality

Ambient air quality was monitored along the road at selected sites. The locations selected were those of the city/town area, the market place and the rural areas. Entire stretch of the Project's present road section has been surveyed and screened are examined through NABL Accredited Laboratory. The air quality parameters considered for the study include Particulate Matter10 (PM10), Particulate Matter 2.5 (PM2.5), Nitrogen Oxides (NOx) Sulphur Di-oxide (SO2), and Carbon monoxide (CO).

a. Particulate Matters (PM10 & PM2.5)

PM10 and PM2.5 were monitored using a Respirable Dust sampler (RDS) and PM2.5 Sampler. A pre-conditioned and weighted glass fiber filter papers are placed on top of the RDS/PM2.5 samplers. A known quantity of the air was sucked through the filter paper in a prescribed sampling time. The flow was noted from the manometer. The multiplication of time with rate gave the total quantity of air passed through the filter paper. After sampling, the filter paper was removed, conditioned, and weighed finally for getting the concentrations in ambient air.

b. Sulphur Di-Oxides (SO_2)

A known quantity of the air was bubbled through impingers containing tetrachloromercurate. SO_2, formed a disulfiltomercurate complex, which gave a pinkish blue colour with p-rosaniline and formaldehyde solution. The intensity of colour produced was proportional to concentration of sulphur dioxide. The measurement was made by using spectrophotometer at the wavelength of 560 nm.

c. Nitrogen Di-Oxides (NOx)

A known quantity of air was passed through impingers containing sodium hydroxide-sodium arsenite solution. The estimation of NOx was done colorimetrically using hydrogen peroxide, sulfanilamide, NEDA, etc. The intensity of the colour was measured at 540 nm using a spectrophotometer.

d. Carbon Monoxide (CO)

FID based samplers are used to monitor the carbon monoxide levels.

2) Water Quality

Samples of ground water were collected from springs whereas samples of surface water were collected from rivers. To assess the water Quality of the area samples were tested for physico-chemical parameters.

3) Soil Quality

The samples were collected from 60 m corridor of the road, at 5-15 cm depth. Besides studying their particle size (sand/silt/clay ratio) they were monitored for physico-chemical parameters to assess the soil quality of the area.

4) Noise Level

The noise level (Leq) was measured using noise meter at various sites along the entire stretch of road during day (6.00 am to 10 pm) and night (10 pm to 6.00 am).

The noise levels is expressed as an equivalent noise level (Leq) which is the measurement duration of sound pressure level as the averaging time. It is calculated as follows:

$$Leq = 10 \text{ Log10 } [\sum_{1}^{n} 10 \text{ Li}/10]$$

Where basis of Leq is callculated by using Li = Instantaneous sound intensity level dB (A) measured on site and n = No. of observations

4.5.3 Secondary Data Collection

(1) Data Sources

The secondary data were collected from following sources:

Table 4-7 Secondary Data Collection

1.	General information	District Collector/Gazetteer Office
2.	Meteorological data	Indian Meteorological Department
3.	Statistical data	District Statistical Office
4.	Irrigation and hydrogeology data	Central Ground Water Board
5.	General Land use and Cropping Pattern	Asst. Director of Agriculture
6.	Relief and slope	Survey of India
7.	Rocks and minerals	Geological Survey of India
8.	Industries	District Industries Center
9.	Maps and Topo sheets	Survey of India
10.	Forests/Wild life/Bio-diversity	District Forest Office
11.	Flora and Fauna	District Forest Office
12.	Archaeological Data	Archaeological Survey of India

Source: JICA Study Team

(2) Analyses, Compilation and Preparation of Report

The data collected by survey teams were compiled. Along with the field monitoring studies and secondary data, these were used to identify the environmental problem.

The following analyses were carried out based on compiled information:

a. A number of the levels of environmental parameters were compared with the prescribed limits suggested by Central Pollution Control Board (CPCB). This gave a clear idea that special attention is paid in areas where the level of pollution is higher than desirable;

b. Based on the obtained data from the field observation, practice to identify sources of impacts induced by the Project is carried out for further assessment of the impacts;

c. Studying and analyzing the identified impacts for mitigation measures are carried out in respect of the impacts occurring during construction period and those occurring during the Operation and Maintenance Period; and

d. Environmental management and monitoring plan that are necessary to implement during the Construction Period and Operation and Maintenance Period area elaborated for the identified impacts.

The mitigation measures have been suggested to reduce the adverse impacts due to the proposed widening and detailed environmental management plan have been prepared covering both the phases i.e. construction and operation of highway.

4.5.4 Environmental Monitoring Carried Out by Meghalaya State Government

Based on the above environmental standards set up by CPCB, Meghalaya State's SPCB carries out various environmental monitoring works periodically. The following is selected result of latest monitoring works of Meghalaya State.

(1) Water Quality

Based on the national standards set up by CPCB, Meghalaya State's SPCB carries out water quality monitoring works as per Table 4-8.

Table 4-8 Water Quality Monitoring Works of Meghalaya State

Name of Stations	Location	Frequency	Parameters Analysed on a Regular basis	Parameters Analysed once a year
1 Surfce Water			i) Field Observation: Weather, Colour & intensity, Odour, Visible effluent discharge, human activities around station, ii) Physico-chemical & bacteriological parameters: Dissolved Oxygen, pH, Conductivity, Biological Oxygen Demand, Nitrate Nitrogen, Nitrite Nitrogen, Total and Fecal Coliform iii) Biomonitoring: Saprobity Index, Diversity Index	Turbidity, Alkalinity, Total Hardness, NH3-N, Kjeldahl-N, Calcium, Magnesium, Potassium, Sodium, Sulphates, Phosphates, COD, As, Zn, Cu, Cr, Cd, Pb, Fe, Ni, Flouride and Boron.
Umtrew River	Byrnihat	Quaterly		
Kyrhukhla river	Khliehriat	Quaterly		
Umiam Lake	Umiam	Quaterly		
Ward's Lake	Shillong	Quaterly		
Thadlaskein Lake	Thadlaskein	Quaterly		
Myntdu River	Jowai	Quaterly		
Ganol River	Tura	Quaterly		
Simsang River	Williamnagar	Quaterly		
2 Ground Water				
Police Bazaar Spring	Shillong	Half Yearly		
Mawpdang Spring	Shillong	Half Yearly		
Wah U Dkhar	Sohra	Half Yearly		
Umsahep Spring	Shangpung	Half Yearly		
Narbong Well	Byrnihat	Half Yearly		

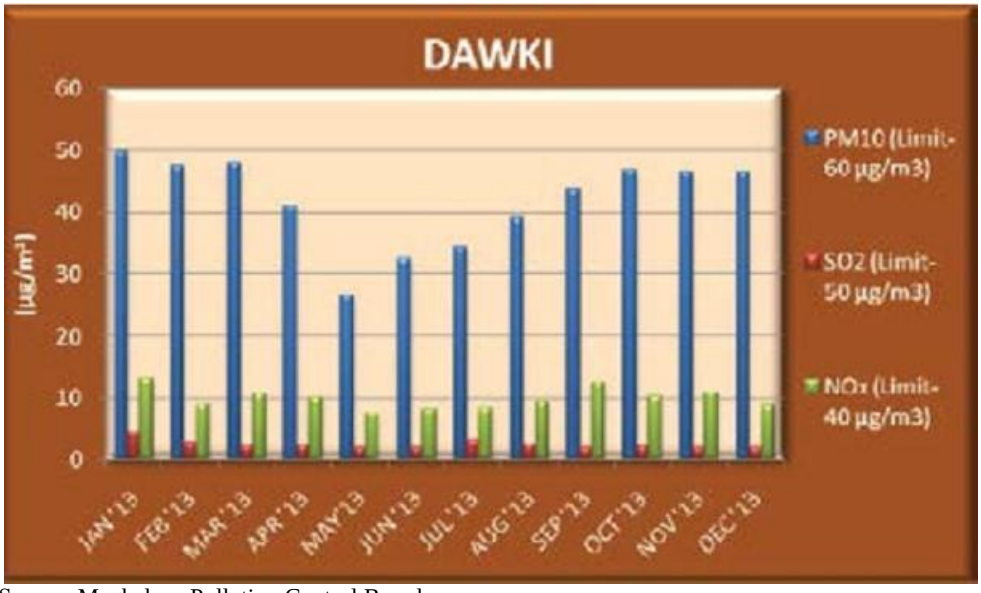
Source: MSPCB

(2) Air Quality Monitoring

Meghalaya State's SPCB carries out air monitoring works at 8 strategic points within the state. SO2, NOx and PM10 are monitoring periodically. Figure 4-5 shows air quality monitoring works carried out in Shillong and Figure 4-6 shows those in Dawki.

Source: Meghalaya Pollution Control Board

Figure 4-5 Air Monitoring Result in Shillong, Meghalaya



Source: Meghalaya Pollution Control Board

Figure 4-6 Air Monitoring Result in Dawki, Meghalaya

(3) Vehicular Emission

Meghalaya State's SPCB carries out vehicular emission based on the standard set out by CPCB. One of the samples of vehicular emission, in terms of the number/percentage of vehicles in the state if their exhaust emissions are up to the national standard, is shown in Table 4-9.

Table 4-9 Air Quality Monitoring Works of Meghalaya State

PERIOD	TYPE OF VEHICLES	TOTAL NO. OF VEHICLES TESTED	PERCENTAGE PF VEHICLES COMPLYING TO EMISSION STANDARDS	PERCENTAGE NOT COMPLYING TO EMISSION STANDARDS
01/04/2009 to 31/03/2010	Petrol Driven	1287	95%	4.10%
	Diesel Driven	22	100%	0%
01/04/2010 to 31/03/2011	Petrol Driven	1154	99.80%	0.20%
	Diesel Driven	9	100%	0%
01/04/2011 to 31/03/2012	Petrol Driven	2524	97.70%	2.30%
	Diesel Driven	722	96.20%	3.70%
01/04/2012 to 31/03/2013	Petrol Driven	2231	93.00%	6.90%
	Diesel Driven	1497	91.60%	8.40%
01/04/2013 to 31/03/2014	Petrol Driven	3725	95%	5%
	Diesel Driven	1473	92.90%	7%
01/04/2014 to 31/03/2015	Petrol Driven	3506	98.80%	1.20%
	Diesel Driven	1428	95.40%	4.60%
01/04/2015 to 31/03/2016	Petrol Driven	6524	99%	1.00%
	Diesel Driven	2399	93.20%	6.80%

Source: Meghalaya Pollution Control Board

(4) Noise Monitoring

Meghalaya State's SPCB monitors ambient noise within the city/built-up area before and during the holiday and political events as loud speakers are generally used for political slogans etc. During the national holiday of Deepawali Festival where a large number of fireworks are carried out, noise pollution is also a major concern of the general public. There is no evidence monitored by Meghalaya State's SPCB on the diesel generators, vehicles, etc.

(5) Soil Contamination

Meghalaya State's SPCB monitors heavy metals discharged into rivers within the state. It is considered discharged from the public dump of solid waste. Table 4-10 shows the result of the analysis of soil components.

Table 4-10 Soil Contamination of Meghalaya State

No	Monitoring stations/sampling source	Purpose	Parameters Analysed
1	Mawiong Municipal dumping ground, Shillong	Quality of the Compost	Heavy Metals
2	National Water Monitoring Programme (NWMP)	Quality of the Sediment	Heavy Metals
	1) Umtrew River	Quality of the Sediment	Heavy Metals
	2) Kyrhukhla River	Quality of the Sediment	Heavy Metals
	3) Umiam Lake	Quality of the Sediment	Heavy Metals
	4) Ward's Lake	Quality of the Sediment	Heavy Metals
	5) Thadlaskein Lake	Quality of the Sediment	Heavy Metals
	6) Myntdu River	Quality of the Sediment	Heavy Metals
	7) Ganol River	Quality of the Sediment	Heavy Metals
	8) Simsang River	Quality of the Sediment	Heavy Metals

Source: Meghalaya Pollution Control Board

5. DESCRIPTION OF THE ENVIRONMENT

This chapter assesses existing environment and socio-economic conditions against which likely environmental and social impact of the project is analyzed. The baseline data presented below have been collected by monitoring surveys as well as literature reviews and interactions with local people and government officials at various levels. A more detailed socio-economic profile can be found in the RAP report prepared for this project.

5.1 Natural Environment

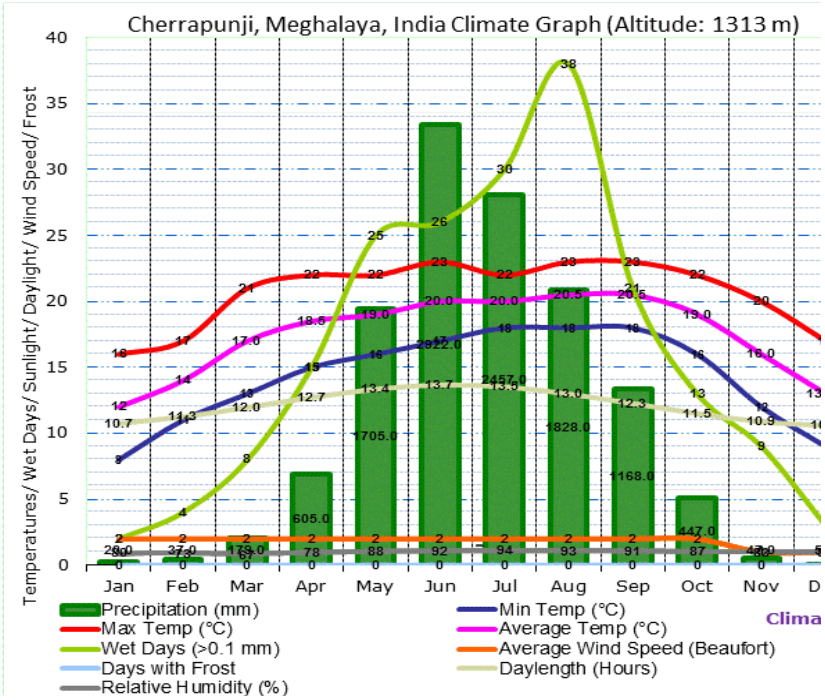
5.1.1 Climate

Meghalaya experiences tropical monsoon climate, which varies from Western to Eastern parts of the Plateau. Table 5-1 and Figure 5-1 show climatic conditions of Cherrapunji in Meghalaya State, which is located approximately 10 km to the west from NH-40 where the world's highest rainfall is recorded. As is shown, almost all of the rainfall occurs in the period between April – October. It is compared to the average sunshine hours of 12 hours a month. Because of it being a high altitude area, temperatures are cool especially compared to the flat plain areas of India. The wind speed and direction data have been collected for Shillong from Indian Metrological Department (IMD) during April to June, 2016 and Windrose diagram has been prepared and shown in Figure 5-1.

Table 5-1 Precipitation of Meghalaya State

Parameters	January	February	March	April	May	June	July	August	September	October	November	December	Annual Average
Average High Temperatures (°C)	16	17	21	22	22	23	22	23	23	22	20	17	21
Average Low Temperatures (°C)	12	14	17	19	19	20	20	21	21	19	16	13	17
Average Precipitation (mm)	20	37	179	605	1705	2922	2457	1828	1168	447	47	5	11420
Average Sun Shine Hours	11h 44m	11h 15m	11h 57m	12h 43m	13h 21m	13h 40m	13h 31m	12h 59m	12h 15m	11h 30m	10h 52m	10h 34m	12h 00m

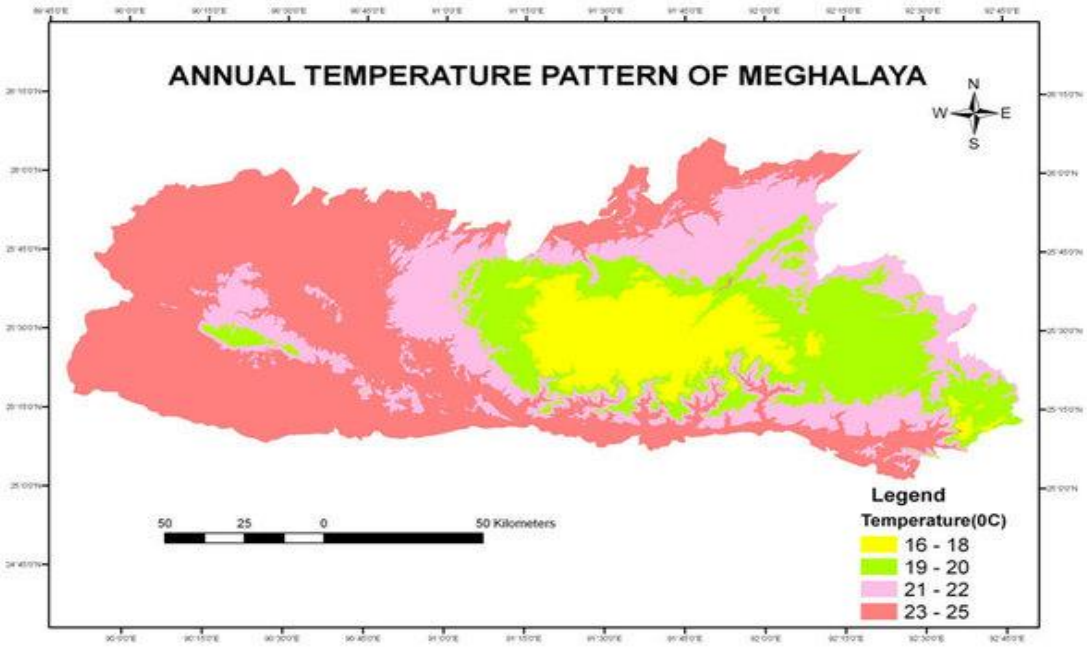
Source : http://www.meghalaya.climatemps.com/precipitation.php



Source：http://www.meghalaya.climatemps.com/precipitation.php

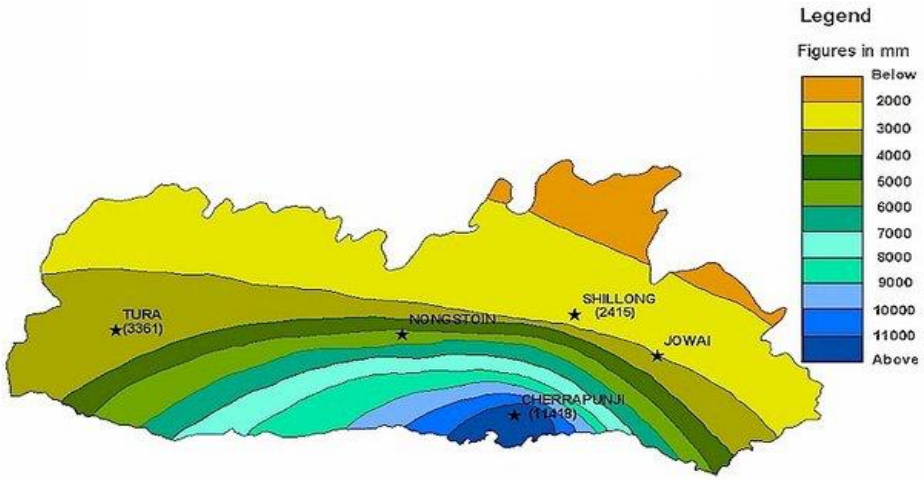
Figure 5-1 Precipitation and Temperatures of Meghalaya State

Figure 5-2 and Figure 5-3 show rainfall patterns in Meghalaya. Because the eastern half of Meghalaya is highland and monsoonal rainfall comes from the Bay of Bengal in the south, the southern half of East Khasi Hill receives a high rainfall.



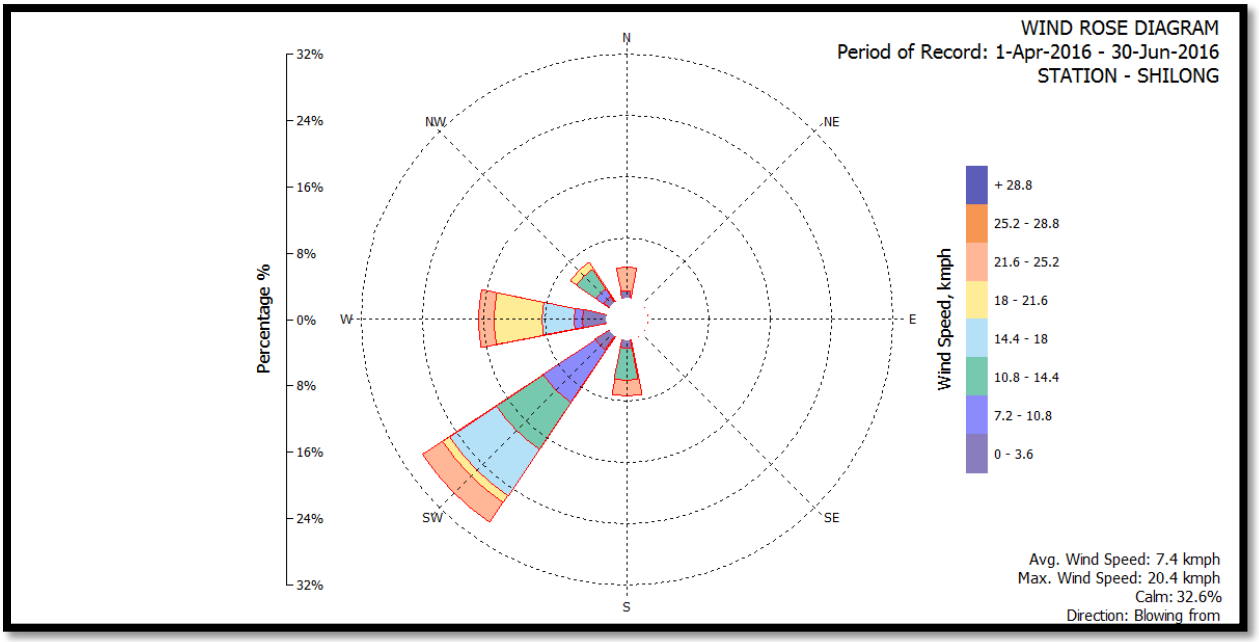
Source：http://www.meghalaya.climatemps.com/precipitation.php

Figure 5-2 Temperature Patterns of Meghalaya State



Source: http://www.meghalaya.climatemps.com/precipitation.php

Figure 5-3 Rainfall Patterns of Meghalaya State



Source: IMD

Figure 5-4 Windrose Diagram

5.1.2 Land Use

Table 5-2 shows land use patterns of Meghalaya State. There is no pastures and grazing areas in Meghalaya State. Modern agricultural areas in Meghalaya State is on the increase at the cost of thick forested areas while in the western half of Meghalaya State, slash and burn agriculture is still maintained as one of the major means of growing staple food.

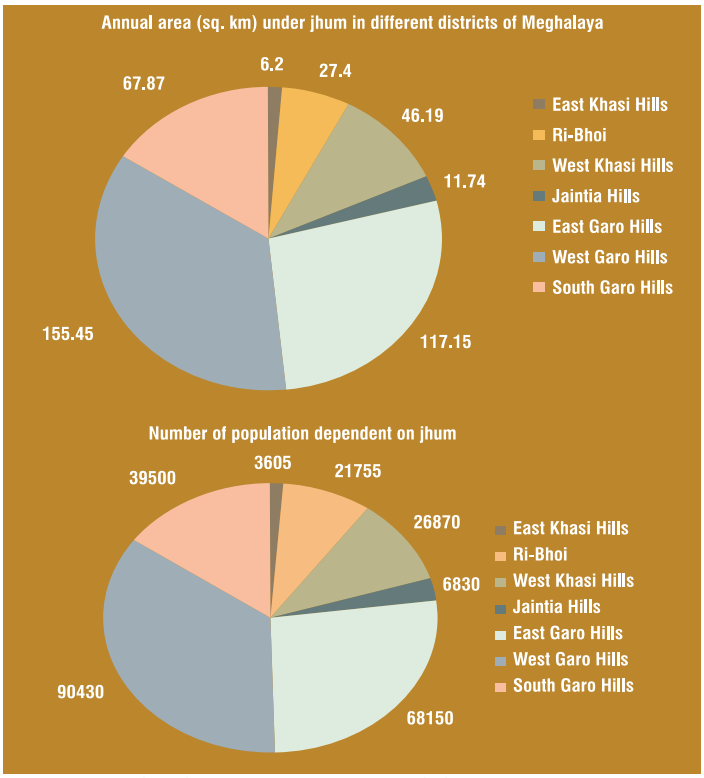
There is not much slash and burn agriculture in the area along NH-40. As is shown in Figure 5-5, East Khasi Hills, where most of NH40 runs through, accounts for only 6.2% of total area of slash and burn agriculture in Meghalaya. More people dependent on slash and burn agriculture are seen in

the western half of the state. The land on both side of the alignment belongs to Indian army from starting point to Km. 1.40

Table 5-2 Land Use in Meghalaya State

Land Use	Area in '000 ha	Percentage
Total geographical area	2,243	
Reporting area for land utilization	2,227	100.00
Forests	948	42.57
Not available for cultivation	226	10.15
Permanent pastures and other grazing lands	0	0.00
Land under misc. tree crops and groves	160	7.18
Culturable wasteland	393	17.65
Fallow lands other than current fallows	157	7.05
Current fallows	59	2.65
Net area sown	284	12.75

Source: Land Use Statistics, Ministry of Agriculture, GOI, 2008-09.



Source: State of Environment Report 2005, Meghalaya State Government

Figure 5-5 Area and Number of Population Dependent on Jhum

5.1.3 Preparation of Landuse Map

The Digital Satellite data of IRS Resourcesat I LISS-III acquired from NRSA was evaluated on ERDAS Imagine Software. The standard False Colour Composite (FCC) was been generated by assigning blue, green and red colors to visible green, visible red and near infrared bands respectively. Expressing image pixel addresses in terms of a map coordinate base is often referred to as geo-coding. As various thematic layers were to be overlaid for this project, all the layers were geo-

referenced to real world coordinates. The 1:50,000 scale toposheets of the study area were used for the purpose of geo-referencing. A large number of GCPs were selected for reasonably accurate geo-referencing/geo-coding. A map projection system (real world) was also defined.

Histogram of the scene under study has been generated to check the range of spectral values present in the scene. In order to use total grey range and to optimize the contract, the actual grey level ranges of three bands were linearly stretched independently. The zoomed images were studied wherever necessary. The interpretation key necessary for identifying different features has been developed systematically on the basis of image characteristics and associated elements viz. shape, size, shadow, pattern, color/tone, texture, association, location and available ground truth. Among these characteristics, shape, size, shadow and pattern are basically dependent on the scale of the image whereas the color/tone and texture depends upon the brightness, contrast and resolution of the image. Various land units were identified, delineated and the map was validated.

The land use in the proposed project area is mixed. The proposed project road passes through mostly forest area (classified and unclassified forest), grassland, agricultural land along with barren lands / waste land, builtup (Urban / rural) area etc. There are also some settlements along the project road.

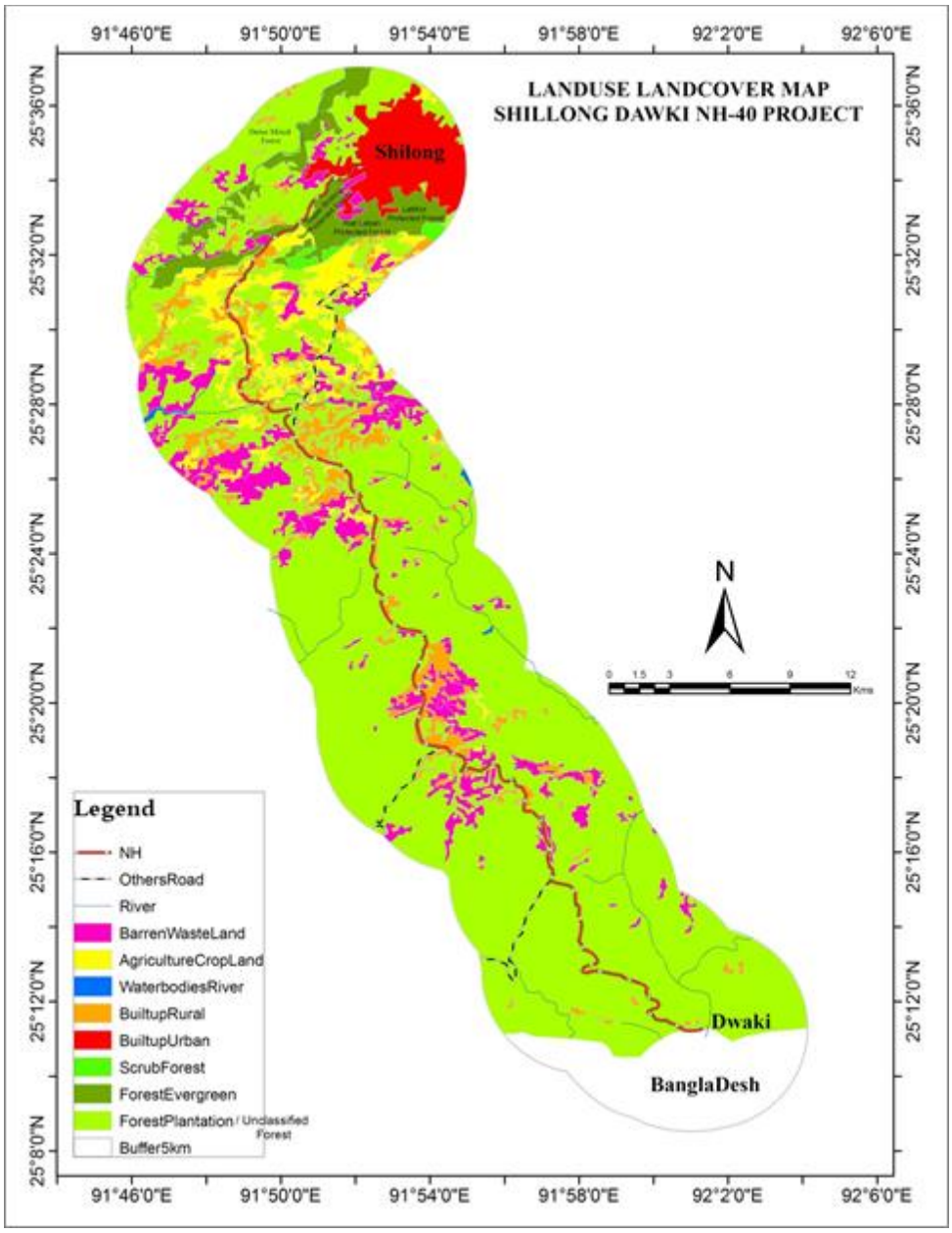
IRS-P6 LISS III (linear Imaging Self Scanner) Satellite imageries with spatial resolution of 23.5 meter GSD (ground sampling distance) at nadir, 4 band multi-spectral (0.52-0.59, 0.62-0.68, 0.77-0.86, 1.55-1.70) & 7 bit radiometric accuracy has been procured from NRSA, India for the project road. General remote sensing data interpretation techniques have been used and the colours and tone of features (relative brightness or colour of objects) (e.g. like agricultural land is in red colour, forest land dark red to bright red, water bodies is in dark blue/black, builtup area (settlements) in cyan and barren / waste land is in greyish green) identified. After interpretation of all the features, the outer boundary of all the features (agricultural land, barren / wasteland, forest, water bodies & builtup / settlement) have been digitized and marked in the project area of 500m on either side of the project road.

Prior to ground truthing, the satellite data was classified using unsupervised classification technique. Further, after collecting ground truth details maximum likelihood classification based supervised classification method was used with remote sensing image data.

After the supervised classification procedure, a land-use map was prepared which the team at field verified, and any errors or omissions were identified.

A reclassification of the land-use categories implementing the details and corrections, if any, was done. The reclassification output was used for the preparation of the final land-use classification map.

A land use map of the study area based on the satellite imagery in a scale of 1:25000 delineating the crop land agriculture, barren / waste lands, water bodies, built-up areas, forest area and other surface features. The land use map along the existing road has been prepared covering 5 km. on both side of the existing road and same is presented in Figure 5-6.



Source: SOI Toposheets, Resourcesat I - LISS-III Image

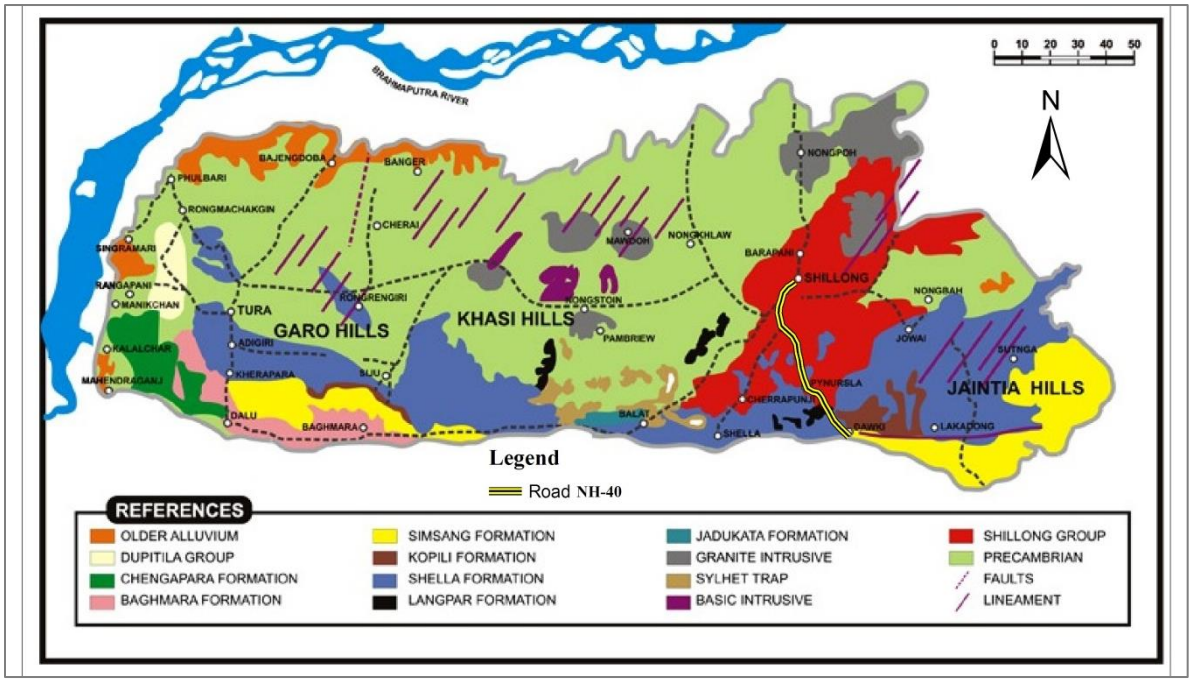
Figure 5-6 Map of Land Use

5.1.4 Topography, Geology, and Soil

The proposed alignment passes through East Khasi Hills and Jaintia Hills Districts of Mehgalaya. The topography is mostly hilly with deep gorges and ravines on the southern portion. The most important physiographic features of the area is the Shillong Plateau interspersed with river valley, then fall sharply in the southern portion forming deep gorges and ravine in Mawsynram and Shella-Bholaganj bordering Bangladesh. The geology of Meghalaya consists of older and stable rock types, which are resistant to weathering, mostly belonging to Periods of Archean Genessic complex, Shillong Groups of rocks, Lower Gondwana rocks, Sylhet Traps, and Cretaceos-Tertiary sediments. The layers of land surface in the project area mainly comprises of Schist, Gneisses, Quartzite, sand

stone, Shale, Lime, Stone, Granite, Granodiorite and Pegmatite. The geological map of Meghalaya is shown in Figure 5-7.

The Soil type of an area is dependent on factors like geology, relief, climate and vegetation. The Red Loamy soil is a product of weathering of rocks like granites, gneisses etc. which are relatively rich in clay forming minerals. This soil type are rich in organic matter, nitrogen and acidic in nature. They are found exposed in the central part of the alignment. Laterite soil is a weathering product of rocks like quartzite, schist, conglomerate etc, which are found exposed in the northern area of East Khasi Hills. The soils are rich in iron and aluminum. Alluvial soils are found exposed in the southern part of the district that are rich in potash but poor in phosphate contents.



Source: Department of Mining & Geology, Government of Meghalaya

Figure 5-7 Geological map of Meghalaya

5.1.5 Hydrogeology

The district of East Khasi Hills is covered mainly by crystalline rocks with Tertiary sedimentary rocks. The secondary porosity in consolidated formation e.g. fractures; joints, etc developed due to major, minor tectonic movements and prolonged physicochemical weathering, form the conduits as well as reservoirs of ground water. The weathered mantle varies from 10 to 30 m bgl. Ground water occurs under water table condition in the top weathered quartzite and in semi-confined condition in the fractured and jointed rocks. At hydro geologically feasible locations, well drilled down to the depth of about 80 -150 m below ground level may yield a moderate discharge of 5-15 m^3 /hr in Archaean and Pre-Cambrian Group of rocks.

Depth to water level is found to occur between 2 and 15 m bgl. The valley areas are found to be favorable for the construction of dug wells and bore wells in other steep areas. The zones are not uniform in characteristics as the aquifer material, fracture density, and distribution and hydrogeological characteristics vary widely over short distances. Consequently, their water yielding capabilities vary considerably.

Ground water development in the district is mainly through dug /open well tapping the water in the weathered zone and bore wells are constructed to tap ground water from the fractures/joints in the hard rocks. In the shallow aquifer, the depth to water level ranges from less than 2 m bgl to 6 m bgl. Springs play a major role to cater water requirement of the people throughout the year. Most of the springs are gravity springs. It is observed that discharge of most of the springs lie within the range of 5000-25000 lpd in pre- & post monsoon period.

5.1.6 Ecological Resources

(1) Wildlife

In the area of East Khasi Hill as a whole, there are number of wildlife known to exist such as Hoolock, Golden Cat, Leopard Cat, Jungle Cat, Indian Civet, Binturong or Bear Cat, Himalayan Black Bear, Barking Deer and Pangolin. However, there is no information of the local residents have observed any in the past decade.

(2) Forest Tree Species

Table 5-3 shows the major tree species found in Meghalaya State.

Table 5-3 Major Tree Species of Forest in Meghalaya

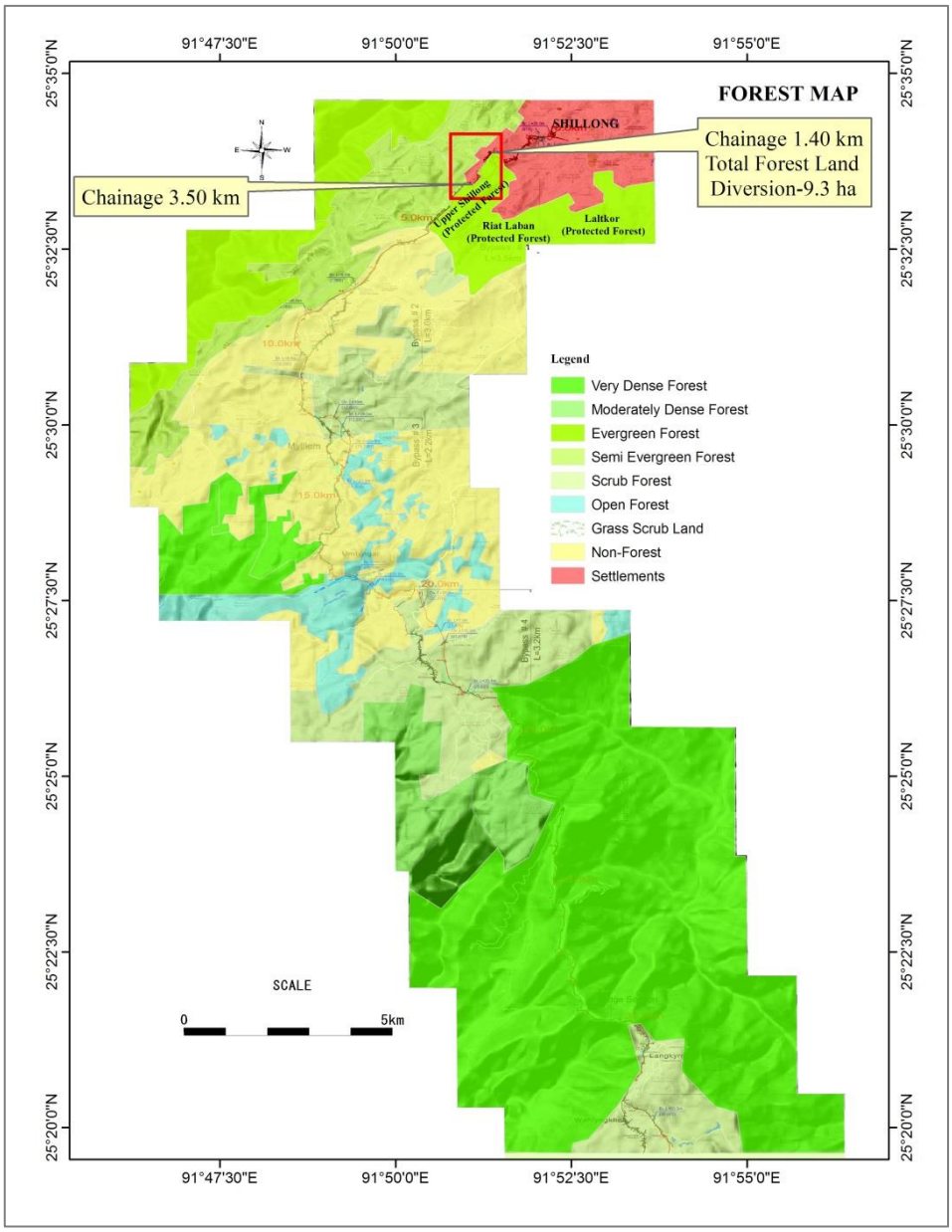
Botanical name	Local name	Botanical name	Local name
1 Ammora wallichii	Amari	25 Talauma phellocarpa	Kharikasopa
2 Lagerstroemia	Ajhow, Jarul, Sida spp.	26 Schima wallichii	Makrisal, Nagaplu
3 Phoebe goalparensis	Bonsum	27 Phoebe cooperiana	Makahi
4 Ailanthus grandis	Borpat	28 Mesua ferrea	Nahar
5 Tetrameles nudiflora	Bhelu	29 Dillenia indica	Outenga
6 Chukrassia velutina	Bogipoma	30 Kydia calycina	Pichola
7 Dysoxylum binecteri ferum	Bandordima	31 Garuga pinnata	Rahimula, Thutmala
8 Morus laevigata	Bola	32 Artocarpus	Sam, Champ, Kathal
9 Terminalia spp.	Bahera, Bhomda	33 Bombax ceiba	Simul
10 Michelia spp.	Champ, Sopa	34 Pinus kesiya	Pine
11 Canarium resiniferum	Dhuna	35 Aquilaria agallocha	Agar, Diang Agar & Bolagar
12 Gmelina arborea	Gamari	36 Artocarpus lakoocha	Haldu
13 Cinnamomum spp.	Gonsordi	37 Adina oligocephala	Chamkoroi
14 Terminalia myriocarpa	Hollock	38 Albizzia odoratissima	Haldu
15 Castanopsis indica	Hingori	39 Adina cordiflolia	Boal
16 Pterospermum acerifolium	Hatipolia	40 Caroya arborea	Kum
17 Albizzia spp. ,	Hiraru, Moroi, Sundi, Saw	41 Ficus spp.	Dimonu
18 Altingia excelsa	Jutuli	42 Podocarpus nerifolia	Jinari
19 Lannea coromondelica	Jia	43 Quercus spp.	Oak
20 Syzigium jambosa	Jam, Jamoon	44 Shorea robusta	Sal
21 Cedrela toona	Jatipoma, Poma	45 Trewia nudiflora	Bhura
22 Duabanga grandiflora	Khokan, Ramdala	46 Callicarpa arborea	Maksi
23 Anthocephalus cadamba	Kadam	47 Tectona grandis	Teak
24 Machilus spp.	Kowla		

Source: Forest and Environment Department, Government of Meghalaya

Forest and Environment Department of Meghalaya classified the forest in the state into six types. Growing stock for each of the forest type which is defined as listed below has been presented in the report. The six forest types with the definition as given below have been identified on the basis of predominance of economically important tree species.

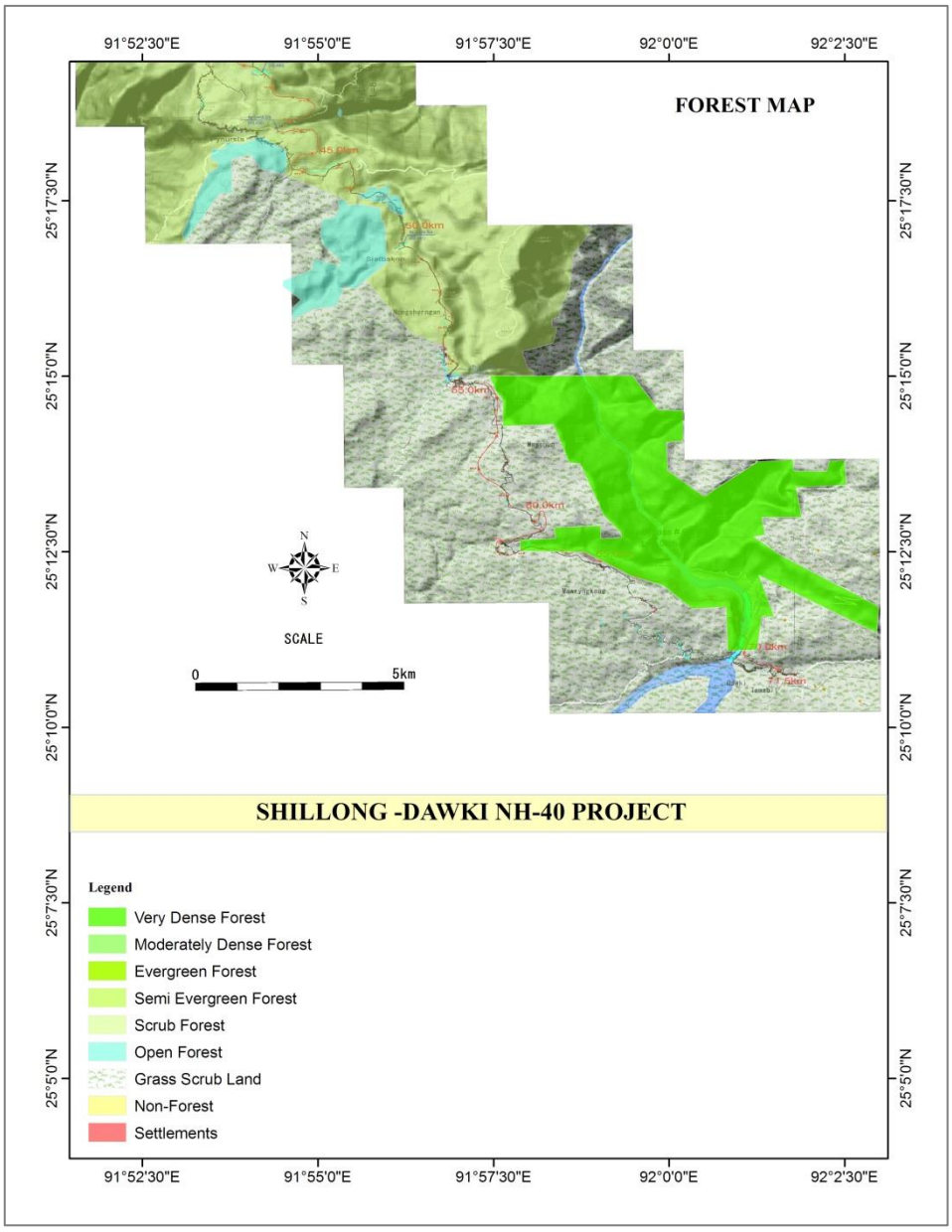
1) Khasi Pine Forest - Forest where Khasi pine constitutes more than 50% of the stand.
2) Teak Forest – Forests in which Teak trees constitute more than 20% of the stand.
3) Sal Forests - Forests in which Sal trees constitute more than 20% of the stand.
4) Hardwood Mixed with Conifers – Forests where the Conifers and broad-leaved tree species constitute the same proportion.
5) Upland hardwood – Forests above 1000m altitude with predominance of hardwood species.
6) Miscellaneous – Forests which do not belong to any of the above types.

There are a number of forested areas known as “Sacred Forest” in East Khasi Hills. A clan in the project area generally forming a village owns each “Sacred Forest”. However, based on the hearing survey, there is no “Sacred Forest” directly affected by the Project. The protected forest area is at the starting of the alignment through which bypass no.1 is crossing. Map is attached as Figure 5-8. There is no government protected/reserved forest area along the project alignment except this. The whole profile covering forest area is presented in Figure 5-9.



Source: Forest and Environment Department

Figure 5-8 Forest Map



Source: SOI Toposheets, Resourcesat I - LISS-III Image

Figure 5-9 (Contd). Map of Forest Area

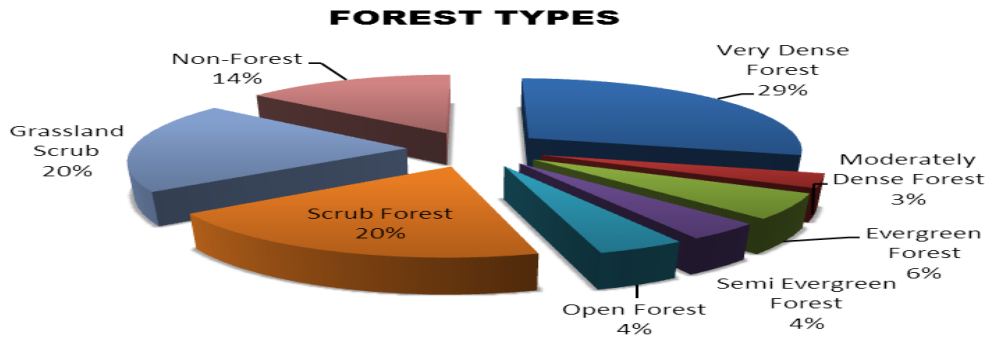


Figure 5-10 Profile of Forest Area

(3) Flora of the Study Area

The forests of Meghalaya can be broadly grouped into tropical, subtropical and temperate types. The Indian Institute of Remote Sensing have classified the vegetation of Meghalaya into tropical evergreen, tropical semi-evergreen, tropical moist deciduous, subtropical broad leaved, subtropical pine and temperate forest types, grasslands and savannas. The general vegetation pattern along the NH 40 is discussed below. There are no Sanctuaries or National parks or Biosphere reserves near the highway.

The temperate forests occur at 1,500 m and above, mostly along the southern slope of Khasi. The annual rainfall in these areas ranges from 200-500 cm with a severe winter during November to March. Ground frost is common during December and January. Subtropical Pine forests have developed as a stable secondary community on the disturbed evergreen and semi-evergreen subtropical broad-leaved forest sites, which are seasonally dry and nutrient-poor. Such forest is observed as we start from Shillong to Mylliem, Umatyngar upto Pynursla; covering Bypass 1 to 5.

Tropical forests occur up to an elevation of 1,200 m where average annual rainfall ranges between 100 and 250 cm. They may be evergreen, semi-evergreen and moist deciduous depending on the annual rainfall. Mostly semi evergreen and moist deciduous type of vegetation is observed as we approach Dawki. The common species of semi evergreen type are such as *Careya arborea, Dillenia pentagyna* and *Callicarpa arborea* whereas *Shorea robusta, Tectona grandis, Terminalia myriocarpa, Sterculia villosa, Logerstroemia flos-reginae, Artocarpus gameziana, Tetrameles nudiflora, Lannea coromandelica, Salmalia malabarica Erythrina stricta, Premna milliflora, Vitex peduncularis, Albizia lebbeck, Terminalia bellirica* etc, represent the moist deciduous type of vegetation.

The dominant tree and shrub species of Upper Shillong Protected Forest is given hereunder as representative of the flora of higher elevations (1500m to 1800m) along NH 40.

Trees – The dominant tree is Pinus kesiya. The other tree species occurring alongside Pine though not growing as tall as Pine are: *Quercus griffithii, Q. fenestrata, Lyonia ovalifolia, Rhododendron arboreum, Acer oblongum, Magnolia campbellii, Lindera latifolia, Prunus acuminata, P. nepalensis, Schima wallichii, Myrica sapida, Rhus succedanea, R. griffithii, R. semialata, Docynia indica, Glochidion acuminatum, Glochidion khasicum, Machilus duthei, Castanopsis indica, Cedrella toona, Magnolia grandiflora,* and *Lindera latifolia.*

Shrubs – *Elaegnus latifolia, Salix psilostigma, Corylopsis himalayana, Machilus duthiei, Osbeckia crinata, O. nepalensis, O. stellata, Desmodium multiflorum, D. heterocarpon, D. racemosum, Viburnum foetidum, V. simonsii, V. odoratissimum, Lindera melastomacea, Sabia purpurea, Schizandra neglecta, Holboellia latifolia, Daphne cannabina, Gaultheria fragrantissima, Inula cappa, Virburnum coriaceum, V. corylifolium, Ardisia neriifolia,* and *A. griffithii.*

Grasslands are seen along the project area basically in Pynursla blocks of East Khasi Hills District of Meghalaya. Forest in the region is rich in biodiversity. However, it is under severe pressure due to human interference such as illicit logging of trees for timber and firewood and expansion of human habitation. As a result, forest cover in the region is disappearing at an alarming rate. These forests also harbour aromatic and medicinal plants. The indigenous people from this region are also dependent on these medicinal/ economically important plants.

METHOD OF ASSESSMENT

Floral /vegetation assessment carried out through quadrat methods: for trees 10m X 10m, for shrubs 5m X 5m and for herbs 1m X 1m square shaped quadrats were used. Quadrats were laid randomly in the corridors upside and downside of the road. All species in the quadrats were recorded & ecological parameters including density, frequency were calculated. Also the Meghalaya Government records were referred for the flora and fauna. Faunal species were recorded with the visual observation during site visits, secondary data from the Forest and Environment Department and local information from local

community. While impacts on river and river ecosystem are expected to be negligible, aquatic ecosystem of Umngot River, the major rivers that NH-40 passes through, has been summarized based on a review of literature. The assessment of flora and fauna along the NH 40 was carried out in the month of May and June of 2016.

Table 5-4 List of Trees, Shrubs, Herbs, Grasses, Bamboo, Orchids, Bryophytes, Pteridophytes

Sl. No.	Botanical Name	Local Name	English Name
	Ammora wallichii	Amari	---
	Lagerstroemia	Ajhow, Jarul, Sida	Crepe Flower
	Phoebe goalparensis	Bonsum	---
	Ailanthus grandis	Borpat	---
	Tetrameles nudiflora	Bhelu	False Hemp Tree
	Chukrassla velutina	Bogipoma	Bastard cedar / Chittagong wood
	Dysoxylum binecteri ferum	Bandordima	Cup-Calyx White Cedar
	Morus laevigata	Bola	Himalayan Mulberry
	Terminalia bellirica	Bahera, Bhomda	Belliric Myrobalan/ Bahera
	Michelia champaca	Champ, Sopa	Champa
	Canarium resiniferum	Dhuna	Black Dammar/ Black Dhup
	Gmelina arborea	Gamari	Gamhar
	Cinnamomum spp.	Gonsordi	--
	Terminalia myriocarpa	Hollock	Hollock
	Castanopsis indica	Hingori	Indian Chestnut/ Oak Chestnut
	Pterospermum acerifolium	Hatipolia	Kanak Champa
	Albizzia spp.	Hiraru, Moroi, Sundi, saw	--
	Altingia excelsa	Jutuli	Rasamala
	Lannea Coromondelica	Jia	Indin Ash Tree
	Syzigium jambosa	Jam, Jamoon	Malabar Plum
	Cedrela toona	Jatipoma, poma	Chinese Toon
	Duabanga grandiflora	Khokan, Ramdala	Duabanga
	Anthocephalus cadamba	Kadam	Kadam
	Machilus spp.	Kowla	Fragrant Bay Tree
	Talauma phellocarpa	Kharikasopa	Egg Magnolia
	Schima wallichii	Makrisal, Nagaplu	Needle wood tree
	Phoebe cooperiana	Makahi	---
	Mesua ferrea	Nahar	Nag Kesar
	Dillenia indica	Outenga	Elephant Apple
	Kydia calycina	Pichola	Kydia
	Garuga pinnata	Rahimula, Tutmala	Grey downy balsam
	Artocarpus	Sam, Champ, Kathal	Jackfruit
	Bombax ceiba	Simul	Red Silk Cotton Tree
	Pinus Kesiya	Pine	Khasi Pine
	Aquilaria agallocha	Agar, Diang agar, Bolagar	Agarwood / Aloeswood
	Artocarpus lakoocha	Haldu	Monkey jack
	Adina oligocephala	Chamkoroi	--
	Albizzia odoratissima	Haldu	Black Siris
	Adina cordiflolia	Boal	Haldu
	Caroya ardorea	Kum	Wild guava / Ceylon oak
	Ficus spp.	Dimonu	--
	Podocarpus nerifolia	Jinari	Brown Pine
	Quercus spp.	Oak	Oak
	Shorea Robusta	Sal	Sal
	Trewia nudiflora	Bhura	Gutel / False White Teak
	Callicarpa arborea	Maksi	Beautyberry Tree
	Tectona grandis	Teak	Teak

Source: Forest and Environment Department, Government of Meghalaya

General Tree Species

Sl. No.	Scientific Name	Family (Known English/ Local Name)	English Name
	Lannea coromandelica	Anacardiaceae (Poison oak)	Indin Ash Tree
	Mangifera indica	Anacardiaceae	Mango
	Spondias piñata	Anacardiaceae	Wild Mango
	Spondias axillaris	Anacardiaceae	Hog Plum
	Areca catechu	Arecaceae	Betel Nut /Areca Nut
	Caryota urens	Arecaceae	Fish-Tail Palm
	Bombax ceiba	Bombacaceae	Red Silk Cotton Tree
	Calophyllum polyanthum	Clusiaceae	Poonspar Tree
	Anogeissus acuminata	Combretaceae	Button Tree
	Terminalia bellirica	Combretaceae	Belliric Myrobalan/ Bahera
	Terminalia myriocarpa	Combretaceae	Hollock
	Dillenia pentagyna	Dilleniaceae	Dog Teak
	Shorea robusta	Dipterocarpaceae	Sal Tree
	Glochidion arborescens	Euphorbiaceae	Alpine Cheese Tree
	Albizia chinensis	Fabaceae	Silk Tree/ Chinese Albizia
	Albizia lebbeck	Fabaceae	East Indian Walnut/ Indian Siris
	Albizia odoratissima	Fabaceae	Black Siris
	Albizia procera	Fabaceae	White Siris
	Bauhinia variegata	Fabaceae	Kachnar /Orchid Tree
	Erythrina arborescens	Fabaceae	Himalayan Coral Tree
	Erythrina stricta	Fabaceae	Indian Coral Tree
	Persea parviflora	Lauraceae	Fragrant Bay Tree
	Careya arborea	Lecythidaceae	Wild Guava/ Ceylon Oak
	Lagerstroemia parviflora	Lythraceae	Crepe Flower
	Melia azedarach	Meliaceae	Bead Tree /Lilac Tree
	Artocarpus chaplasha	Moraceae	Chaplash
	Artocarpus gameziana	Moraceae	---
	Artocarpus heterophyllus	Moraceae	Jackfruit
	Ficus amplissima	Moraceae	Bat Tree
	Ficus semicordata	Moraceae	Drooping Fig
	Morus macroura	Moraceae	Himalayan Mulberry
	Syzygium grande	Myrtaceae	Sea Apple
	Pinus kesiya	Pinaceae	Khasi Pine
	Podocarpus nerifolia	Podocarpaceae	Brown Pine
	Neolamarckia cadamba	Rubiaceae	Kadam
	Citrus grandis	Rutaceae	Pomelo
	Sterculia villosa	Sterculiaceae	Elephant Rope Tree
	Callicarpa arborea	Verbenaceae	Beauty Berry Tree
	Callicarpa tomentosa	Verbenaceae	Velvety Beauty Berry
	Premna mollissima	Verben aceae	Dusky Fire-Brand Teak
	Tectona grandis	Verbenaceae	Teak
	Vitex peduncularis	Verbenaceae	--

Source: Forest and Environment Department, Government of Meghalaya

Scrub Species

Sl. No.	Scientific Name	Family	English Name
	Mimosa rubicaulis	Fabaceae	Himalayan Mimosa
	Bauhinia acuminata	Leguminosae	Dwarf White Orchid Tree
	Ficus tinctoria	Moraceae	Dye Fig
	Canthium gracillipes	Rubiaceae	---
	Glycosmis mauritiana	Rutaceae	Orange Berry
	Brugmansia suaveolens	Solanaceae	Angel's Trumpet
	Solanum kurzii	Solanaceae	---
	Symplocos chinensis	Symplocaceae	Sapphire Berry
	Daphne cannabina	Thymelaeaceae	Indian Paper Plant
	Clerodendron serratum	Verbenaceae	Blue Fountain Bush
	Clerodendron viscosum	Verbenaceae	Hill Glory Bower
	Duranta plumerii	Verbenaceae	Sky Flower
	Duranta repens	Verbenaceae	Golden Dewberry
	Leea indica	Vitaceae	Bandicoot Berry

Source: Forest and Environment Department, Government of Meghalaya

Herb Species

Sl. No.	Scientific Name	Family	English Name
	Adhatoda vasica	Acanthaceae	*Malabar Nut*
	Andrographis wrightiana	Acanthaceae	---
	Justicia simplex	Acanthaceae	*Water Willow*
	Achyranthes aspera	Amaranthaceae	*Prickly Chaff Flower*
	Alternanthera sessilis	Amaranthaceae	*Sessile Joyweed*
	Amaranthus spinosus	Amaranthaceae	*Prickly Amaranth*
	Hydrocotyl javanica	Apiaceae	*Java Pennywort*
	Acorus calamus	Araceae	*Sweet Flag*
	Alocasia acuminate	Araceae	---
	Arisaema tortuosum	Araceae	*Whipcord Cobra Lily*
	Ageyratum conyzoides	Asteraceae	*Goat Weed*
	Artemisia parviflora	Asteraceae	*Japanese Wormwood*
	Blumea heiracifolia	Asteraceae	---
	Eclipta prostrata	Asteraceae	*False Daisy*
	Mikania scandens	Asteraceae	*Climbing Boneset*
	Xantihum strumarium	Asteraceae	*Common Cocklebur*
	Sonchus aspera	Asteraceae	*Prickly Sow-Thistle*
	Vernonia cinerea	Asteraceae	*Purple Fleabane*
	Chenopodium album	Chenopodiaceae	*Bathua*
	Commelina paludosa	Commelinaceae	*Swamp Dayflower*
	Ipomoea laciniata	Convolvulaceae	*Cut-Leaved Morning Glory*
	Ipomoea carnea	Convolvulaceae	*Bush Morning Glory*
	Euphorbia hirta	Euphorbiacea	*Asthma Weed*
	Phyllanhus fraternus	Euphorbiaceae	*Gulf Leaf-Flower*
	Croton bonplandianum	Euphorbiaeae	*Ban Tulsi*
	Cassia tora	Fabaceae	*Ring-worm plant*
	Mucuna pruriens	Fabaceae	*Velvet Bean*
	Desmodium concinnum	Fabaceae	*Blue Desmodium*
	Flemingia involucrata	Fabaceae	----
	Anisomeles indica	Lamiaceae	*Indian Catmint*
	Hyptis suaveolens	Lamiaceae	*American Mint*
	Leucas aspera	Lamiaceae	*Common Leucas*
	Pogostemon benghalensis	Lamiaceae	*Bengal Pogostemon*
	Polygonum barbatum	Polygonaceae	*Bearded Knotweed*
	Polygonum hydropiper	Polygonaceae	*Water Pepper*
	Hedyotis articularis	Rubiaceae	*Jointed Hedyotis*
	Hedyotis diffusa	Rubiaceae	---
	Clerodendron nutans	Verbenaceae	*Bridal Veil*
	Phyla nodiflora	Verbenaceae	*Frog Fruit*
	Costus speciosus	Zingiberaceae	*Crepe Ginger*
	Zingiber zerumbet	Zingiberaceae	*Shampoo Ginger*

Source: Forest and Environment Department, field study and public consultation

Grass Species

Sl. No.	Scientific Name	Family	English Name
	Cyperus diffusus	Cyperaceae	Dwarf Umbrella Grass
	Cyperus distans	Cyperaceae	Slender Cyperus
	Cyperus rotundus	Cyperaceae	Nut Grass /Nut Sedge
	Fimbristylis dichotoma	Cyperaceae	Tall Fringe Rush
	Kyllinga bulbosa	Cyperaceae	Whitehead Spike sedge
	Cynodon barberi	Poaceae	--
	Cynodon dactylon	Poaceae	Bermuda grass
	Eragrostis gangetica	Poaceae	Slim-Flower Love grass
	Eragrostis nutans	Poaceae	Futiu, Chikatu
	Heteropogon contortus	Poaceae	Black spear grass /Tangle head Grass
	Ischaemum rugosum	Poaceae	Wrinkle duck beak, Saromacca grass
	Oplismenuscom positus	Poaceae	basket grass
	Panicum notatum	Poaceae	---
	Panicum repens	Poaceae	Torpedo grass
	Thysanolaena maxima	Poaceae	Broom grass

Source: Forest and Environment Department, field study and public consultation

Bamboo Species

Sl. No.	Scientific Name	Family	English Name
	Bambusa arundinacea	Poaceae	Thorny Bamboo
	Bambusa pallida		--
	Bambusa tulda		Spineless Indian Bamboo
	Dendrocalamus strictus		Solid Bamboo/ Calcutta Bamboo

Source: Forest and Environment Department, field study and public consultation

Orchid Species

Sl. No.	Scientific Name	Family	English Name
	Cymbidium elegans	Orchidaceae	The elegant cymbidium
	Dendrobium herbaceum		Grassy Dendrobium
	Habenaria commelinifolia		Commelina-Leaf Habenaria
	Nervilia prainiana		----
	Vanda tessellata		Checkered Vanda

Source: Forest and Environment Department, field study and public consultation

Bryophytes Species

Sl. No.	Scientific Name	Family	English Name
	Anthoceros fusiformis	Anthocerotopsida	Hornwort
	Anthoceros laevis	Anthocerotopsida	Smooth Hornwort
	Bryuma piculatum	Bryopsida	---
	Polytrichum xanthopilum	Bryopsida	Juniper Haircap
	Riccia discolor	Hepaticopsida	Leafy Liverworts
	Riccia melanospora	Hepaticopsida	Leafy Liverworts
	Marchantia polymorpha	Marchantia	Umbrella Liverwort

Source: Forest and Environment Department, field study and public consultation

Pteridophyte Species

Sl. No.	Scientific Name	English Name
	Adiantum caudatum	Maiden Hair Fern
	Adiantum pedatum	Maiden Hair Fern
	Azolla pinnata	Aquatic fern
	Botrychium virginianaum	Moonwort fern
	Drynariamollis	Polypodiaceae fern
	Equisetum diffusum	Horse tails
	Equisetum sylvaticum	Horse tails
	Gleichenia linearis	Wild fern
	Lycopodium cernum	Lycopodium
	Marsilea hirsuta	Aquatic fern
	Marsilea minuta	Aquatic
	Ophioglossu mnudicaule	*Ophioglossumnudicaule*
	Pteriscretica	---
	Salvinia auriculata	Aquatic fern

Source: Forest and Environment Department, field study and public consultation

FAUNA OF THE STUDY AREA

A study and survey of Birds (resident, migratory), land animals including mammals, reptiles and insects and aquatic flora and fauna including fish species was undertaken during the study period. There are no large game animals like deer and hence there are no chances of occurrence of any hunting animals. None of the species observed in the ROW (Right of Way) is reported to be under rare, endangered, endemic and threatened species. Though More than 110 mammal species are reported from the Meghalaya Forests, but none is endemic to the state. There are no National Parks or Sanctuaries or Biosphere Reserves or other protected areas within the study area.

Chiriqui olingo (Bassaricyon pauli), Barking Deer (Muntiacus muntjak), Porcupine (Hystrix indica), Flying squirrel (Petaurista petaurista) are common in the the primary forests of War area.

METHOD OF ASSESSMENT

As far as the larger vertebrates including carnivores and reptiles are concerned, the data is based mainly on secondary sources corroborated by local residents. Birds have been watched using binocular and interaction with local people. Fauna of Meghalaya (Volume I and II), published by the Zoological Society of India, Meghalaya Flora and Fauna by the Directorate of information and Public relations, Government of Meghalaya and published Scientific reports have been used as references.

Avi Fauna

Sl. No.	Common Name	Latin name	Residential status	WPA Schedule
	Little cormorant	*Phalacrocorax niger*	Local migrant	IV
	Eastern Grey Heron	*Ardea cinerea*	Local migrant	IV
	Little egret	*Ardea alba*	Local migrant	IV
	Cattle Egret	*Bubulcus ibis*	Local migrant	IV
	Common Pochard	*Aythya ferina*	Local migrant	IV
	Black winged kite	*Elanus caeruleus*	Local migrant	IV
	Indian Red jungle Fowl	*Gallua gallus murghi*	Resident	IV
	Common sandpiper	*Tringa hypoleucos*	Resident	IV
	Indian Blue rock Pigeon	*Columba livia*	Resident	IV
	Indian Ring Dove	*Streptopelia decaocto*	Resident	IV
	Northern Ring nosed Parakeet	*Psittacula krameri*	Resident	IV
	Indian Cuckoo	*Cuculus micropterus*	Local migrant	IV
	Indian Koel	*Eudynamis scolopacea*	Local migrant	IV
	Indian Pied Kingfisher	*Ceryle rudis*	Local migrant	IV
	Indian Pied Myna	*Sturnus contra*	Resident	IV
	Indian House Crow	*Corvus splendens*	Resident	IV
	Eastern Jungle Crow	*Corvus macrorhynchos*	Resident	IV
	Black headed Bulbul	*Pycnonotus atriceps*	Resident	IV

Mammalian Fauna

Sl. No.	Common Name	Latin name	IUCN status	WPA Schedule
	Rhesus monkey	*Macaca mulatto mulatto*	Common	II
	House shrew	*Suncus murinus*	Common	II
	Indian fulvus fruit bat	*Rousettus leschenaultia*	Common	II
	Jackal	*Canis aureus*	Occasional	II
	Jungle cat	*Felis chaus affinis*	Occasional	II
	Mongoose	*Herpestes eduardsii*	Occasional	II

Reptilian Fauna

Sl. No.	Common Name	Latin name	IUCN status	WPA Schedule
	Garden Lizards	*Calotes versicolor*	Common	IV
	Lizards	*Gecko gecko*	Common	II
	House Gecko	*Hemidactylus brooki*	Common	II
	Common skink	*Mabuya craniata*	Common	IV
	Rat snake	*Ptyas korros*	Common	II
	Banded Krait	*Bungarus fasciatus*	Scarce	II
	Checkered keel-back	Natrix piscator	Occasional	IV

Fishes (Pisces)

Sl. No.	Latin name	Common name	Local name (Khasi)	Status
	Cirrhinus mrigala	Mrigala	Kha mirka	Very common
	Cyprinus carpio	Carp	Kha dkhar	Very common
	Labeo bata	Major Carp	Kha bah	Common
	Labio rohita	Rohu		Very common
	Barilius barila		Kha Ilong	Common
	Mystus vittatus		Kha tynkriong	Very Common
	Anabas testudineus	Climbing Perch	Kha Koi	Scarce
	Channa orientalis	Murrels	Dohthli	Common
	Puntius chola	Major Carp	Shalynni	Common

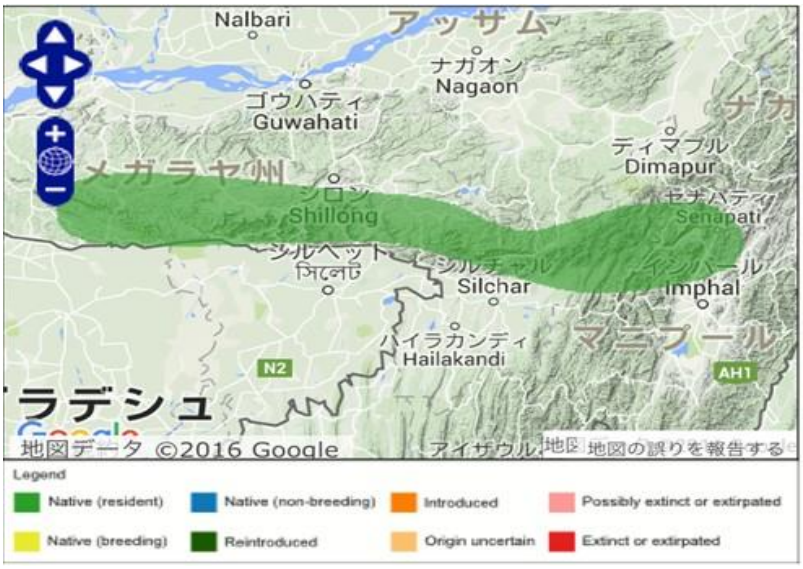
Source: Forest Department, field study and public consultation

(4) Vulnerable Species of the Project Area

As is shown in Figure 5-11, Bird Life International (http://www.birdlife.org) reports that there is an Important Bird Area (IBA) of "Tawny-breasted Wren-babbler (*Spelaeornis longicaudatus*)" in Meghalaya State though the Government of India does not define the IBA as wildlife/bird sanctuary. IUCN has declared "Tawny-breasted Wren-babbler (Spelaeornis longicaudatus)" as Vulnerable (VU), a species when the best available evidence indicates that it meets any of the criteria A to E for Vulnerable (see IUCN Red List Criteria), and it is therefore considered to be facing a high risk of extinction in the wild. It appears that the species used to inhabit in the area from Meghalaya to Manipur while in recent years there is no clear observation record. According to Bird Life International (http://www.birdlife.org), general habitat of "Tawny-breasted Wren-babbler (Spelaeornis longicaudatus)" along with other bird species appears to have been concentrating in the area in the south of Meghalaya state as is shown in Figure 5-12.

Source: http://www.birdlife.org/datazone/speciesfactsheet.php?id=7900

Figure 5-11 Location of IBA by Bird Life International



Source: http://www.birdlife.org/datazone/species/factsheet/22716137

Figure 5-12 General Habitat of "Tawny-breasted Wren-babbler

NH-40 is running on the western fringe of the IBA i.e. it is in the area of 5km radius of affected area from the center of NH-40. Thus, detailed survey on inhabitation of and impact on Tawny-breasted Wren-babbler was implemented during the Study.

Methodology:

a) Strip transects (500m-1000m length and 20m width) were randomly laid in the study area and surveys were undertaken.

b) Point surveys using fixed observation points with a radius of 20-30 m. were conducted.

c) Purposive surveys using foraging behavior and nesting behavior as the determinants were undertaken.

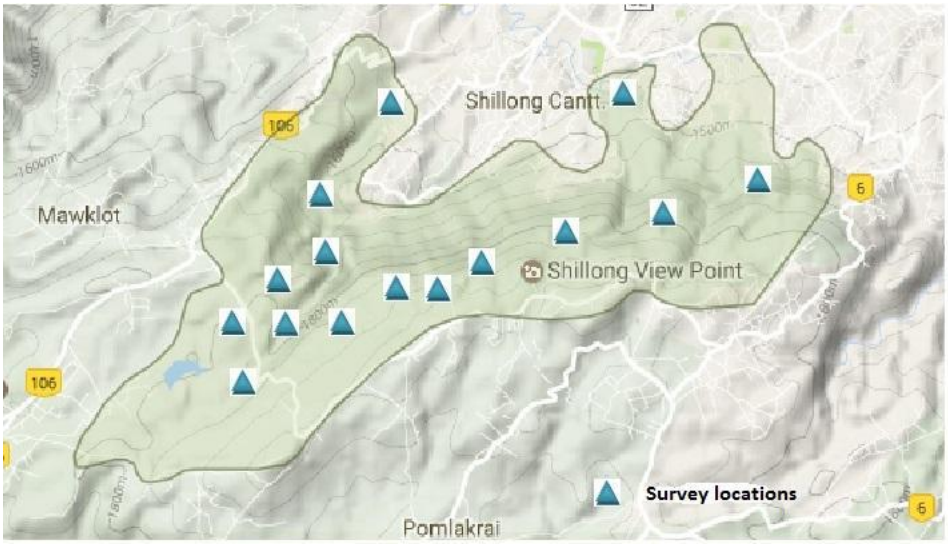


Figure 5-13 Survey Locations

The results:

The forest patch through which the proposed bypass deviates from the existing road is a *Pinus kesiya* regrowth stand which is devoid of dense undergrowth. Further, the area is criss-crossed with walking paths used by the local villagers. In fact during the surveys conducted in the area, there were a lot of

instances where the local people were seen using the paths of the forest. This area therefore is unsuitable for habitation by Tawny-breasted Wren-babbler which forages and roosts in thick undergrowth offering ample camouflage and cover.

The conclusion:
Tawny-breasted Wren-babbler could not been observed during the survey; even since 1970s-80s in the area. In the area around Upper Shillong Forest, there was sacred forest and good habitat for a long time ago. Due to extensive logging and shifting cultivation, the forest was degraded. Upper Shillong Forest is currently not a dense forest, which cannot be a good habitat for the Wren-babbler.
It is considered that the Wren-babbler had migrated to south and the Upper Shillong Forest is not a significant habitat for the Wren-babbler now.

Though Bypass No. 1 has to clear the forest area of 9.3 ha that it is currently a part of protected forest administered by Meghalaya Forest and Environment Department, "protected forest" is not defined in Indian Forest Act unlike national sanctuary and national park or reserved forest,. While national sanctuary and national park or reserved forest are considered to be "Protected Areas" defined in JICA Guideline, "protected forest" does not fall under the "Protected Areas" as it is not aiming at protection of ecosystem or habitat. Diversion of protected forest requires forest clearance equivalent with other "normal" forest, though development is limited in some extent in the area.

(5) Photographs of the Field Study

Pine Plantation


Area along roadside with very little plant diversity

Betel Nut/Areca Nut trees

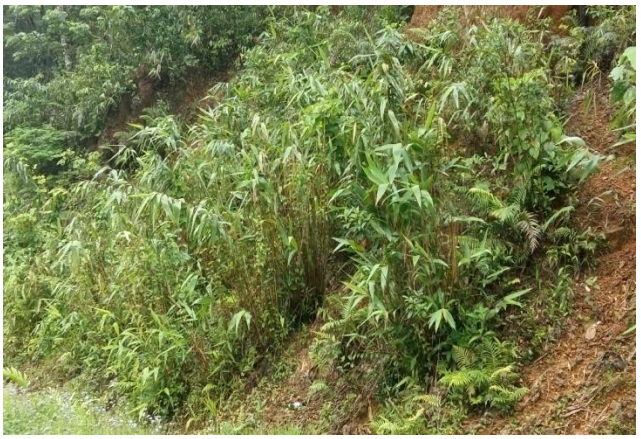
Young Pomleo/Shaddick fruits in the trees

Fish-tail Palm trees

Bamboo

Roadside weeds

Mature jack Fruits



Broom Grass Plantation

Riccia Colony

Adian Tum Colony

5.2 Living Environment and Pollution Prevention Measures

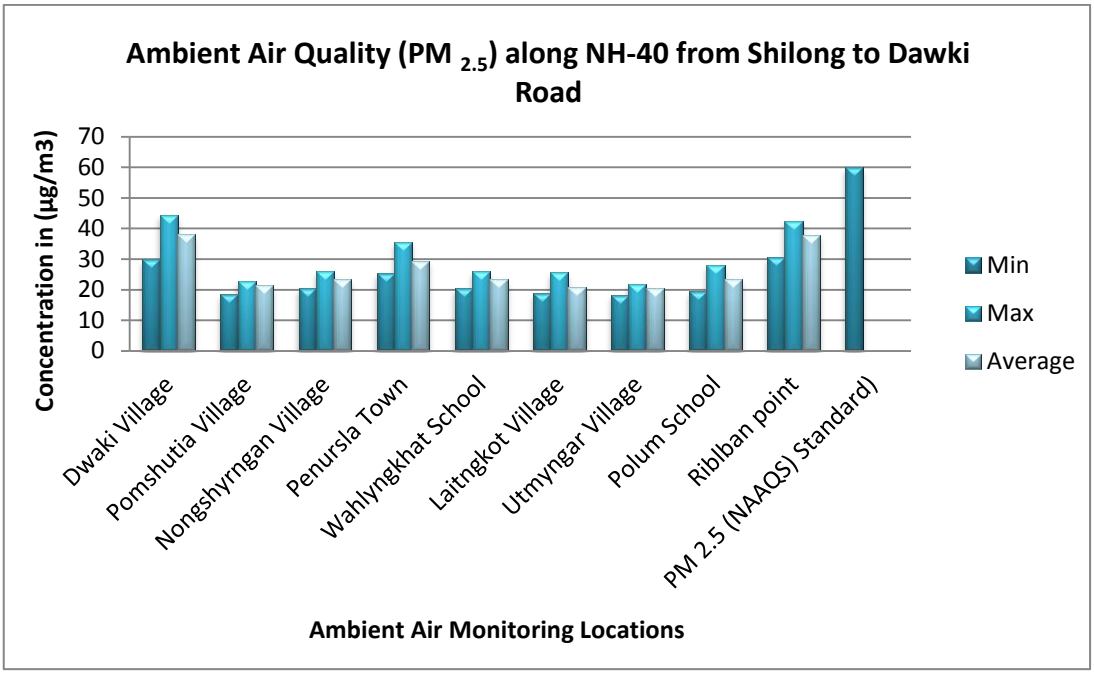
5.2.1 Ambient air quality

During the preparation of EIA report, Ambient Air Sampling was carried out during May – June 2016 at nine locations along the project road through NABL Accredited Laboratory. The Result of air monitoring are presented in Table 5-5 and the location wise comparative chart for various Ambient Air Quality parameters are presented from Figure 5-14 to Figure 5-18.

Table 5-5 Ambient Air Quality along NH-40 from Shillong to Dawki Dawki near PWD guest house (Latitude 250 11' 98.0" & Longitude 920 01' 11.4")

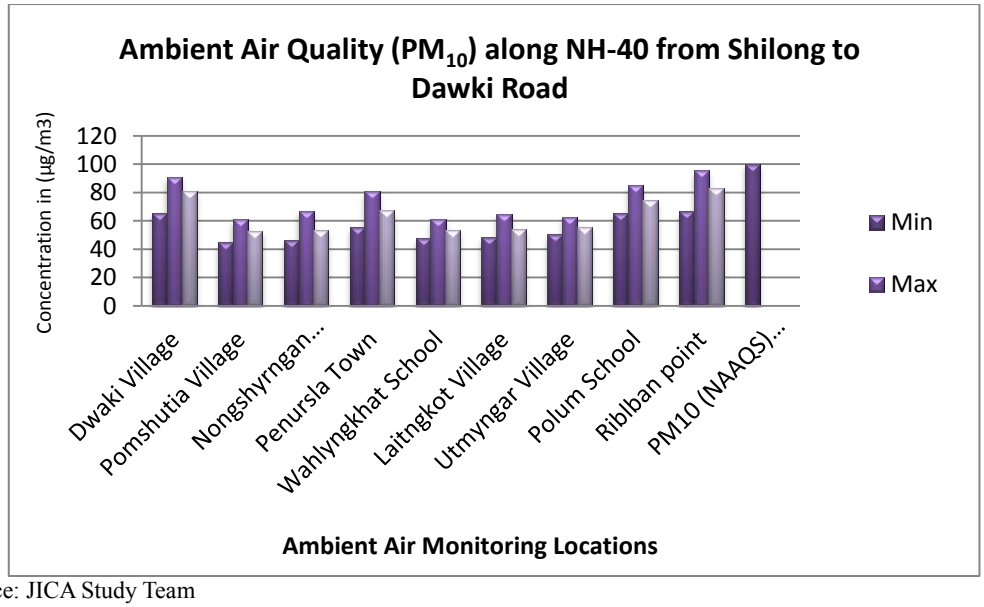
	PM2.5,µg/m3	PM10,µg/m3	SO_2 µg/m3	NOx ,µg/m3	CO, µg/m3
Min	29.8	65.6	5.6	10.5	910
Max	44.5	90.8	7.8	14.4	1140
Average	38.1	81.0	6.7	11.8	1021.3
Pomshutia village (Latitude 25^0 12' 49.4"& Longitude 91^0 52' 46.5")					
	PM2.5,µg/m3	PM10,µg/m3	SO_2 µg/m3	NOx ,µg/m3	CO, µg/m3
Min	18.5	44.5	4.8	9.5	280
Max	22.8	60.8	7.7	12.8	440
Average	21.3	52.9	6.6	11.4	361.7
Nongshyrngan Village (Latitude 25^0 15' 29.4"& Longitude 91^0 56' 54.8")					
	PM2.5,µg/m3	PM10,µg/m3	SO_2 µg/m3	NOx ,µg/m3	CO, µg/m3
Min	20.5	46.4	5	9.4	430
Max	25.9	66.8	7.8	13.6	640
Average	23.2	53.7	6.7	11.7	546.7
Pynursla Town (Latitude 25^0 18' 19.7"& Longitude 91^0 54' 39.3")					
	PM2.5,µg/m3	PM10,µg/m3	SO_2 µg/m3	NOx ,µg/m3	CO, µg/m3
Min	25.4	55.6	6.1	10.6	740
Max	35.6	80.6	8.8	15.5	990
Average	29.4	67.1	7.2	12.4	886.3
Wahlyngkhat School (Latitude 25^0 20' 11.1"& Longitude 91^0 53' 20.5")					
	PM2.5,µg/m3	PM10,µg/m3	SO_2 µg/m3	NOx ,µg/m3	CO, µg/m3
Min	20.5	47.6	5.8	9.6	480
Max	25.9	61.2	8.8	15.2	650
Average	23.2	53.6	7.0	12.2	593.3
Laitlyngkot Village (Latitude 25^0 26' 25.2"& Longitude 91^0 50' 47.9")					
	PM2.5,µg/m3	PM10,µg/m3	SO_2 µg/m3	NOx ,µg/m3	CO, µg/m3
Min	18.8	48.4	5.5	8.1	330
Max	25.5	64.8	8.1	10.5	560
Average	20.9	53.8	6.4	9.1	458.8
Umtyngar Village (Latitude 25^0 29' 37.8"& Longitude 91^0 49' 07.9")					
	PM2.5,µg/m3	PM10,µg/m3	SO_2 µg/m3	NOx ,µg/m3	CO, µg/m3
Min	18.3	50.3	5.2	10.2	450
Max	21.9	62.7	8.9	13.5	650
Average	20.3	55.6	7.0	11.7	583.3
Polum School (Latitude 25^0 31' 47.5"& Longitude 91^0 48' 38.8")					
	PM2.5,µg/m3	PM10,µg/m3	SO_2 µg/m3	NOx ,µg/m3	CO, µg/m3
Min	19.4	65.6	6	9.8	650
Max	27.8	85.2	8.4	14.6	990
Average	23.4	74.6	7.1	11.8	872.1
Rilban point (Latitude 25^0 34' 16.0"& Longitude 91^0 52' 07.4")					
	PM2.5,µg/m3	PM10,µg/m3	SO_2 µg/m3	NOx ,µg/m3	CO, µg/m3
Min	30.6	66.7	5.4	8.9	810
Max	42.5	95.6	8.8	15.2	1180
Average	37.9	83.1	6.9	12.1	989.2

Source: field monitoring during May-June, 2016



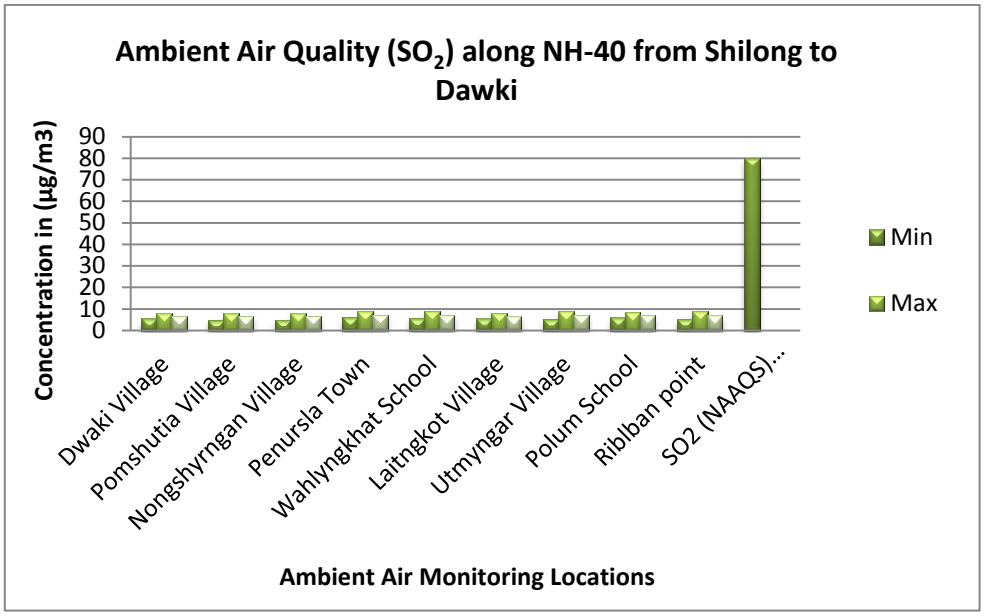
Source: JICA Study Team

Figure 5-14 Ambient Air Quality (PM 2.5) along NH-40 from Shillong to Dawki



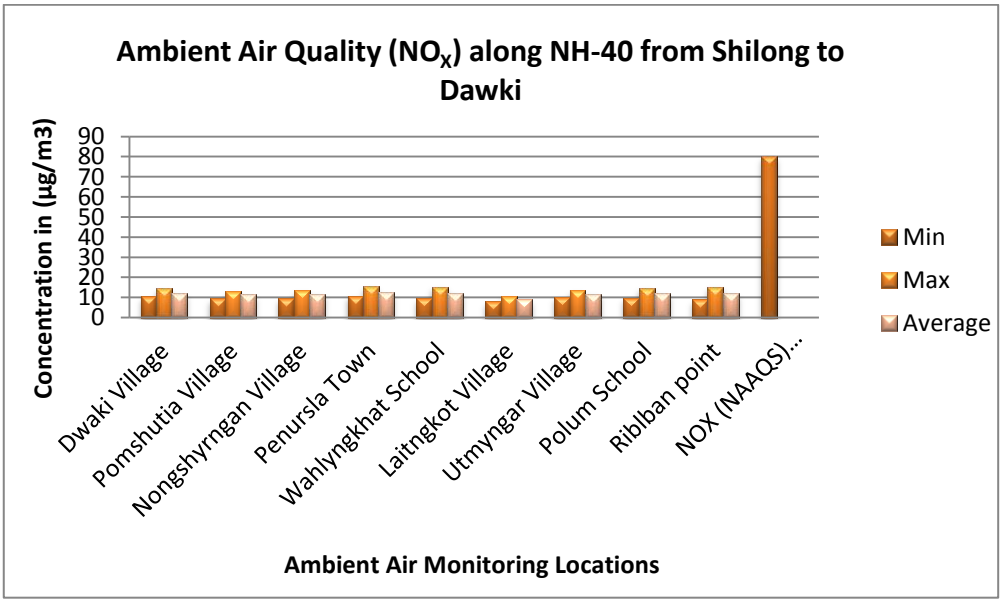
Source: JICA Study Team

Figure 5-15 Ambient Air Quality (PM10) along NH-40 from Shillong to Dawki



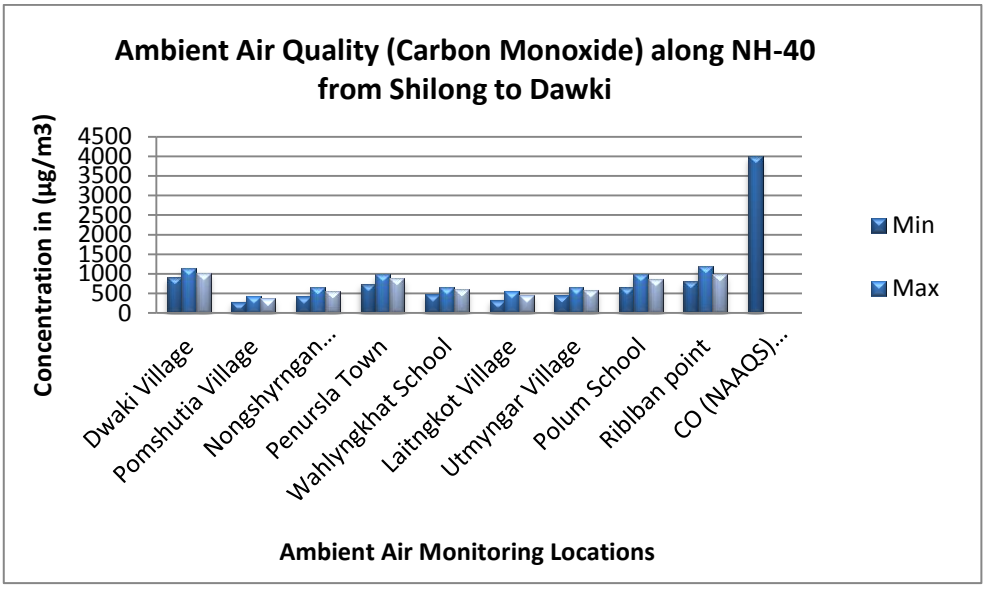
Source: JICA Study Team

Figure 5-16 Ambient Air Quality (SO2) along NH-40 from Shillong to Dawki



Source: JICA Study Team

Figure 5-17 Ambient Air Quality (NOX) along NH-40 from Shillong to Dawki



Source: JICA Study Team

Figure 5-18 Ambient Air Quality (Carbon Monoxide) along NH-40 from Shillong to Dawki

The Meghalaya Pollution Control Board measured air quality data at Shillong (Police Bazar) only and study team have measured data along the project alignment at 9 locations in both the cases values are well within the limits described by CPCB. The Ambient air quality Parameters values along the roads are generally less than the standard values.

5.2.2 Water quality

There are no major pollution sources in the area and water quality along the road is good. The monitoring of the water quality has been carried out at nine identified locations during May-June, 2016 in accordance to the Indian Standard Drinking Water Specification – IS 10500: 1991 and quality meeting the IS Standards except for Bacteriological parameters for surface water. Results of water monitoring are presented in Table 5-6.

Table 5-6 Water Quality along NH-40 from Shillong to Dawki Road

Sl. No.	Parameters	Unit	Limit (as per IS:10500-2012)		Surface Water Natural Drain Rilban Point Near Army Area (Latitude 25^0 34' 16.0" & Longitude 91^0 52' 07.4")	Tap Water Polum Secondary School (Latitude 25^0 31' 47.5" & 91^0 48' 38.8")	Surface water River Umtyngar Village (Latitude 25^0 29' 37.8" &91^0 49' 07.9")	Tap Water Wahlyngkhat Village (25^0 20' 11.1" & Longitude 91^0 53' 20.5")	Spring Water Nongthymmai Village (Latitude 25^0 25' 56.2" & Longitude 91^0 51' 77.0")	Tap Water Nongshyrngan Village (Latitude 25^0 15' 29.4" & Longitude 91^0 56' 54.8")
			Desirable Limit	Permissible Limit						
1.	pH	-	6.5-8.5	No Relaxation	7.15	7.36	7.11	7.28	6.95	7.34
2.	Colour	Hazen	5	25	<5	<5	<5	<5	<5	<5
3	TSS	Mg/l	-	-	7.5	BDL	8.4	BDL	6.6	BDL
4	Dissolved Oxygen	% By Mass	5	10	6.6	7.1	5.8	5.6	6.9	4.5
5	BOD (at 27^0C 3-Days)	mg/l	-	-	7.0	BDL	8	BDL	6.2	BDL
6	COD	mg/l	-	-	25	BDL	28	BDL	18	BDL
7	TKN	mg/l	-	-	3.4	2.2	2.4	2.4	2.2	1.4
8	Total Hardness (as $CaCO_3$)	mg/l	200	600	110.8	131	95	148	128	140
9.	Calcium (as $CaCO_3$)	mg/l	75	200	82	90	78	108	96	110
10	Magnesium (as $CaCO_3$)	mg/l	30	100	28.8	41	17	40	32	30
11	Ammonia (NH_3)	mg/l			2.5	BDL	2.4	BDL	2.3	BDL
12	Electrical Conductivity	Microm /hos/cm	-		410.85	398.81	318.39	372.49	383.32	385.86
13	Chloride (as Cl)	mg/l	250	1000	54.7	44.8	34.2	54.4	40.20	44.2
14	Sulphate (as SO_4)	mg/l	200	400	32.5	36.7	25.6	38	27.90	32
15	Phosphates	mg/l	-	-	<0.1	<1.0	1.0	<1.0	<1.0	<1.0
16	Nitrate (as NO_3)	mg/l	45	No Relaxation	0.89	0.93	0.74	0.84	0.97	0.82
16	Fluoride (as F)	mg/l	1	1.5	0.14	0.21	0.18	0.16	0.16	0.15
17	Arsenic (As)	mg/l	-	-	BDL	BDL	BDL	BDL	BDL	BDL
18	Lead (as Pb)	mg/l	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
19	Mercury(as Hg)	mg/l	-	-	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001

Sl. No.	Parameters	Unit	Limit (as per IS:10500-2012)		Surface Water Natural Drain Rilban Point Near Army Area (Latitude 25^0 34' 16.0" & Longitude 91^0 52' 07.4")	Tap Water Polum Secondary School (Latitude 25^0 31' 47.5" & 91^0 48' 38.8")	Surface water River Umtyngar Village (Latitude 25^0 29' 37.8" &91^0 49' 07.9")	Tap Water Wahlyngkhat Village (Latitude 25^0 20' 11.1" & Longitude 91^0 53' 20.5")	Spring Water Nongthymmai Village (Latitude 25^0 25' 56.2" & Longitude 91^0 51' 77.0")	Tap Water Nongshyrngan Village (Latitude 25^0 15' 29.4" & Longitude 91^0 56' 54.8")
			Desirable Limit	Permissible Limit						
20	Phenols	mg/l	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
21	Cyanides	mg/l	-	-	BDL	BDL	BDL	BDL	BDL	BDL
22	TDS	mg/l	500	2000	267.05	259.23	206.95	242.12	249.16	250.81
23	Iran (as Fe)	mg/l	0.3	1.0	0.21	0.18	0.16	0.14	0.23	0.12
24	Alkalinity as ($CaCO_3$)	mg/l	200	600	86.7	96.7	71.3	64.5	106	96
25	Sodium (as Na)	mg/l	-	-	33	19.7	25	18	16.40	14
26	Potassium (as K)	mg/l	-	-	12	6.6	9	6	5	6
Bacteriological Parameters										
1.	Faecal Coliform	MPN/100 ml	Shall Not be Detectable		750	Absent	230	Absent	250	Absent
2.	Total Coliform	MPN/100 ml	Shall Not be Detectable		1200	Absent	1350	Absent	1100	Absent

Sl. No.	Parameters	Unit	Limit (as per IS:10500-2012)		Spring Water Pomshutia Village (Latitude 25^0 12' 49.4" & Longitude 91^0 52' 46.5")	Tab Water PWD Gust House Near Dawki (Latitude 25^0 11' 98.0" & Longitude 92^0 01' 11.4")	Surface Water (Piyang River) Near Dawki (Latitude 25^0 11' 20.2" & Longitude 92^0 01' 01.9")
			Desirable Limit	Permissible Limit			
1.	pH	-	6.5-8.5	No Relaxation	6.98	7.16	7.13
2.	Colour	Hazen	5	25	<5	<5	<5
3	TSS	Mg/l	-	-	5.5	BDL	8.4
4	Dissolved Oxygen	% By Mass	5	10	6.9	4.8	6.1
5	BOD (at 27^0C 3-Days)	mg/l	-	-	5.3	BDL	5.0
6	COD	mg/l	-	-	15.6	BDL	21
7	TKN	mg/l	-	-	2.8	1.6	2.6
8	Total Hardness (as $CaCO_3$)	mg/l	200	600	98	148	113.5
9.	Calcium (as $CaCO_3$)	mg/l	75	200	80	112	81
10	Magnesium (as $CaCO_3$)	mg/l	30	100	18	36	32.5
11	Ammonia (NH3)	mg/l			2.3	BDL	2.6
	Electrical Conductivity	Microm/hos/cm	-		338.44	399.31	329.55
12	Chloride (as Cl)	mg/l	250	1000	21.8	42.6	22.7
13	Sulphate (as SO_4)	mg/l	200	400	18.6	28	30.5
14	Phosphates	mg/l	-	-	<0.1	<1.0	<1.0
15	Nitrate (as NO_3)	mg/l	45	No Relaxation	0.53	0.78	0.82
16	Fluoride (as F)	mg/l	1	1.5	0.10	0.14	0.15
16	Arsenic (As)	mg/l	0.05	No Relaxation	BDL	BDL	BDL
17	Lead (as Pb)	mg/l	0.05	No Relaxation	<0.01	<0.01	<0.01
18	Mercury (as Hg)	mg/l	-	-	<0.0001	<0.0001	<0.0001
19	Phenols	mg/l	-	-	<0.01	<0.01	<0.01
20	Cyanides	mg/l	-	-	BDL	BDL	BDL

Sl. No.	Parameters	Unit	Limit (as per IS:10500-2012)		Spring Water Pomshutia Village (Latitude 25^0 12' 49.4" & Longitude 91^0 52' 46.5")	Tab Water PWD Gust House Near Dawki (Latitude 25^0 11' 98.0" & Longitude 92^0 01' 11.4")	Surface Water (Piyang River) Near Dawki (Latitude 25^0 11' 20.2" & Longitude 92^0 01' 01.9")
			Desirable Limit	Permissible Limit			
21	TDS	mg/l	500	2000	219.99	259.55	214.21
22	Iron (as Fe)	mg/l	-	-	0.17	0.12	0.22
23	Alkalinity as ($CaCO_3$)	mg/l	200	600	112.0	110	95.1
24	Sodium (as Na)	mg/l	-	-	18.6	12	14
25	Potassium (as K)	mg/l	-	-	6	5	4.2
Bacteriological Parameters							
1.	Faecal Coliform	MPN/100 ml	Shall Not be Detectable		320	Absent	720
2.	Total Coliform	MPN/100 ml	Shall Not be Detectable		850	Absent	1480

Source: field monitoring during May-June, 2016

Water quality the data measured by Meghalaya pollution control board (MPCB) are available for pH DO, BOD and total coliform for various water bodies while study team monitored other parameters along the project alignments. In general the coliform value will be high in surface water and needs treatment before use as drinking water.

5.2.3 Soil quality

The monitoring of the soil quality has been carried out at nine identified locations during May-June, 2016 in accordance to the Indian Standard. Results of Soil monitoring are presented in Table 5-7 エラー! 参照元が見つかりません。.

Table 5-7 Soil Quality along NH-40 from Shillong to Dawki Road

S.No.	PARAMETERTS	TEST METHOD	UNIT	Rilban Point Near Army Area (Latitude 250 34' 16.0"& Longitude 910 52' 07.4"	Polum Secondary School (Latitude 250 31'47.5"& Longitude 910 48' 38.8")	Umtyngar Village (Latitude 250 29' 37.8"& Longitude 910 49' 07.9")	Laitlyngkot Village (Latitude 250 26' 25.2" & Longitude 910 50' 47.9")	Wahlyngkot Village (Latitude 250 20' 11.1" & Longitude 910 53' 20.5")	Penursla Town (Latitude 250 18' 19.7"& Longitude 910 54' 39.3")
1.	pH(1:5 suspension)	IS:2720(Part-26)	-	5.4	5.7	5.8	6.2	5.7	6.1
2.	Electrical Conductivity at 25OC (1:2suspension.)	IS:2720(Part-21)	µS/cm	346	356	440	430	432	428
3.	Calcium Sulphates	STP/SOIL	mg/kg	BDL	BDL	BDL	BDL	BDL	BDL
4.	Magnesium (as Mg)	STP/SOIL	mg/kg	36.2	35.6	42.8	39.0	31.6	40.4
5.	Organic Matter	IS:2720(Part-22)	% by mass	5.1	5.3	5.7	5.4	5.0	5.8
6.	Potassium (as K)	STP/SOIL	mg/kg	106.7	115.3	122.4	121.0	113.8	124.4
7.	Water Holding Capacity	STP/SOIL	% by mass	25.83	26.45	29.45	27.98	25.50	27.47
8.	Porosity	STP/SOIL	% by mass	19.62	18.92	22.81	20.50	19.78	18,57
9.	Sand	STP/SOIL	% by mass	48.92	47.55	51.23	49.90	48.56	50.10
10.	Clay	STP/SOIL	% by mass	37.25	35.68	38.25	36.98	35.57	38.11
11.	Silt	STP/SOIL	% by mass	11.23	16.77	10.52	15.90	16.06	14.61
12.	Sodium Sulphates	STP/SOIL	mg/kg	15.40	12.31	15.63	13.75	14.68	12.98
13.	Sodium Absorption Ratio	STP/SOIL	-	4.25	4.23	4.55	4.20	4.67	4.24

14.	Nitrogen	STP/SOIL	% by mass	0.061	0.055	0.063	0.060	0.054	0.056
15.	Phosphorus	STP/SOIL	mg/kg	14.30	14.8	16.34	14.78	15.36	16.29
16.	Bulk Density	STP/SOIL	gm/cc	1.23	1.32	1.44	1.30	1.40	1.26
17.	Texture	STP/SOIL	-	Sandy Clay	Sandy Clay	Sandy Clay	Sandy Clay	Sandy Clay	Sandy Clay
18.	Moisture Retention capacity	STP/SOIL	%by mass	19.2	18.5	20.55	19.4	21.42	20.80
19.	Infiltration Rate	STP/SOIL	mm/hr	19.8	21.3	18.47	18.5	20.4	19.8
20.	Moisture	STP/SOIL	%	16.20	16.12	16.78	16.59	16.82	16.40
21.	Sulphates	STP/SOIL	mg/1000g	15.72	12.96	18.25	14.56	12.08	16.96
22.	Available Sulphur (as S)	STP/SOIL	mg/kg	0.060	0.075	0.063	0.074	0.065	0.076
23.	Available Manganese (as Mn)	STP/SOIL	mg/kg	0.046	0.042	0.048	0.045	0.042	0.046
24.	Available Iron(as Fe)	STP/SOIL	mg/kg	0.69	0.63	0.72	0.070	0.073	0.062
25.	Exchangeable Sodium Percentage	STP/SOIL	mg/kg	0.060	0.051	0.066	0.055	0.067	0.065

S.No.	PARAMETERTS	TEST METHOD	UNIT	Nongshymgan Village (Latitude 25015' 29.4"& Longitude 910 56' 54.8")	Pomshutia Village (Latitude 250 12' 49.4"& Longitude 910 52' 46.5")	PWD Guest House Dawki (Latitude 250 11' 98.0"& Longitude 920 01' 11.4")
1.	pH(1:5 suspension)	IS:2720(Part-26)	-	5.5	5.9	6.5
2.	Electrical Conductivity at 25OC (1:2suspension.)	IS:2720(Part-21)	µS/cm	358	396	423
3.	Calcium Sulphates	STP/SOIL	mg/kg	BDL	BDL	BDL
4.	Magnesium (as Mg)	STP/SOIL	mg/kg	40.5	41.8	39.4
5.	Organic Matter	IS:2720(Part-22)	% by mass	5.8	5.2	5.4
6.	Potassium (as K)	STP/SOIL	mg/kg	119.8	120.3	113.5
7.	Water Holding Capacity	STP/SOIL	% by mass	30.76	28.05	31.67
8.	Porosity	STP/SOIL	% by mass	23.56	22.56	20.34
9.	Sand	STP/SOIL	% by mass	50.45	47.65	52.51
10.	Clay	STP/SOIL	% by mass	37.45	35.78	33.04
11.	Silt	STP/SOIL	% by mass	15.45	12.28	11.98
12.	Sodium Sulphates	STP/SOIL	mg/kg	13.67	14.32	15.67
13.	Sodium Absorption Ratio	STP/SOIL	-	4.34	4.23	4.76
14.	Nitrogen	STP/SOIL	% by mass	0.060	0.056	0.051
15.	Phosphorus	STP/SOIL	mg/kg	15.2	16.5	14.9
16.	Bulk Density	STP/SOIL	gm/cc	1.39	1.40	1.30
17.	Texture	STP/SOIL	-	Sandy Clay	Sandy Clay	Sandy Clay
18.	Moisture Retention capacity	STP/SOIL	%by mass	19.5	18.9	21.0
19.	Infiltration Rate	STP/SOIL	mm/hr	21.2	19.3	20.6
20.	Moisture	STP/SOIL	%	16.54	16.11	16.72
21.	Sulphates	STP/SOIL	mg/1000g	15.67	12.34	16.34
22.	Available Sulphur (as S)	STP/SOIL	mg/kg	0.061	0.069	0.070
23.	Available Manganese (as Mn)	STP/SOIL	mg/kg	0.045	0.042	0.049
24.	Available Iron(as Fe)	STP/SOIL	mg/kg	0.73	0.69	0.65
25	Exchangeable Sodium Percentage	STP/SOIL	mg/kg	0.067	0.059	0.060

Source: Field Monitoring May-June, 20reporting.

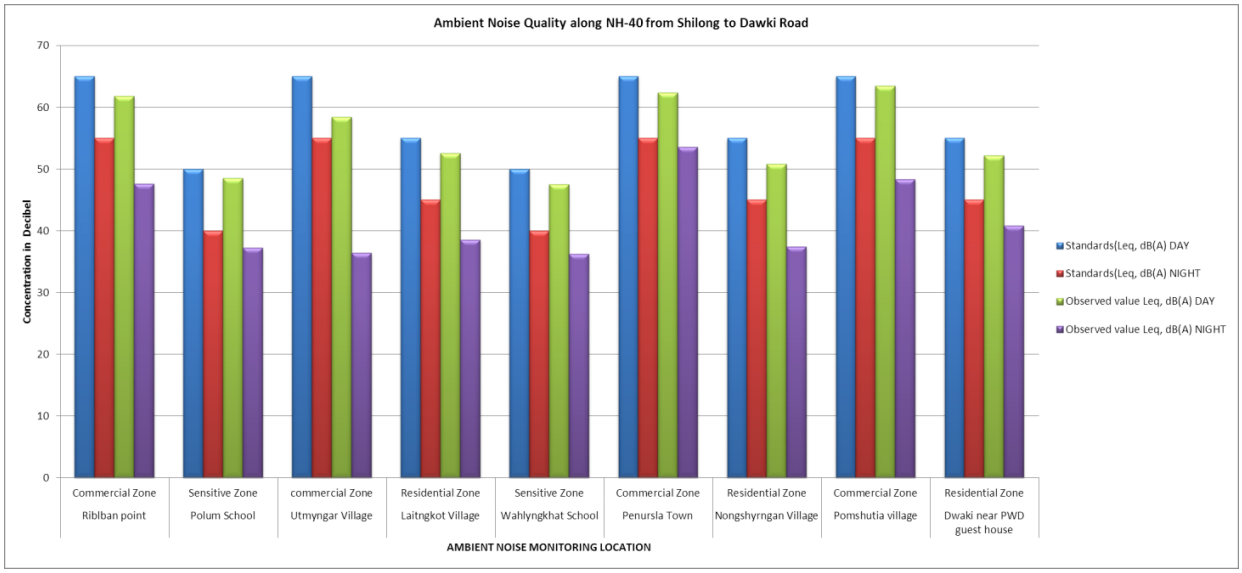
5.2.4 Noise Levels

The monitoring of the noise levels has been carried out at nine identified locations along the project road during May-June, 2016 as per Ambient Air Quality standard with respect to noise,(2000). Result of noise levels are presented in Table 5-8 and the location wise comparative chart for noise levels are presented in Figure 5-19. Observed values of Leq.dB(A) at all nine locations were within the standards of respective zone areas.

Table 5-8 Noise Levels along NH-40 from Shillong to Dawki Road

	Date of Monitoring	Location	ZONE	Standards(Leq, dB(A)		Observed value Leq, dB(A)	
				day	night	day	night
1	25.05.2016	Rilban point (Latitude 25^0 34' 16.0" & Longitude 91^0 52' 07.4")	Commercial Zone	65	55	61.8	47.6
2	25.05.2016	Polum School (Latitude 25^0 31' 47.5" & Longitude 91^0 48'38.8")	Sensitive Zone	50	40	48.5	37.2
3	25.05.2016	Utmyngar Village (Latitude 25^0 29' 37.8s & Longitude 91^0 49' 07.9s)	commercial Zone	65	55	58.4	36.4
4	25.05.2016	Laitlyngkot Village (Latitude 25^0 26' 25.2" & Longitude 91^0 50' 47.9")	Residential Zone	55	45	52.6	38.5
5	25.05.2016	Wahlyngkhat School (Latitude 25^0 20'11.1" & Longitude 91^0 53' 20.5")	Sensitive Zone	50	40	47.5	36.2
6	26.05.2016	Penursla Town (Latitude 25^0 18' 19.7" & Longitude 91^0 54' 39.3")	Commercial Zone	65	55	62.4	53.6
7	26.05.2016	Nongshyrngan Village (Latitude $25^0$15'29.4" & Longitude $91^0$56'54.")	Residential Zone	55	45	50.8	37.4
8	26.05.2016	Pomshutia village (Latitude 25^0 12' 49.4" & Longitude 91^0 52' 46.5")	Commercial Zone	65	55	63.5	48.3
9	26.05.2016	Dawki near PWD guest house (Latitude 25^0 11' 98.0" & Longitude 92^0 01' 11.4")	Residential Zone	55	45	52.2	40.8

Source: field Monitoring during May-June, 2016



Source: Field monitoring May-June 2016

Figure 5-19 Ambient Noise Quality Results

5.2.5 Vibration

In India, "ISO 4866 : 1990 Mechanical vibration and shock-Vibration of buildings-Guidelines for the measurement of vibrations and evaluation of their effects on building" has been adapted as "Indian Standard" without major changes in terms of the vibration caused to the structures.

While it is the case, there is no concrete standard of vibration such as the noise level associated with vibration, which generally comes from the natural phenomena (wind, earthquake, etc) and man-made vibrations induced by blasting, traffic, etc. Because of the road improvement project, it would be appropriate to discuss traffic vibration in this section.

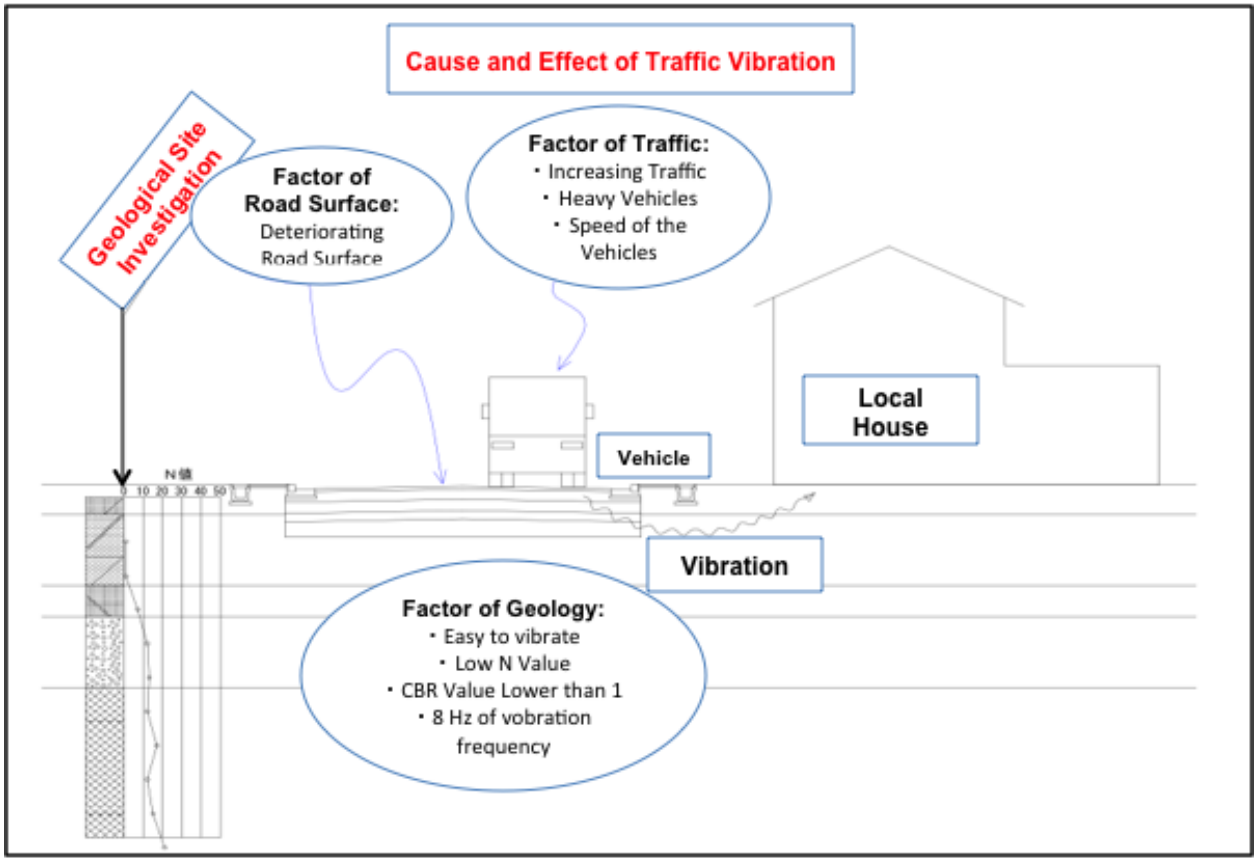
In Table 5-9, limit of noise level that the vibration is associated is shown. It is very likely that the local residents tend to complain on traffic vibration when the ambient noise exceed as is shown in the table.

Table 5-9 Noise Limit Associated with the Complaint on Vibration

Classification of Land Use		Limit of Complaints	
1	Regular Residential Area High-rise Residential Area Other Residential Area	Day	65 dB
		Night	60 dB
2	Out-skirt of Urban Area Commercial Area Industrial Area	Day	70 dB
		Night	65 dB

Source: http://www.city.toyohashi.lg.jp/4292.htm

As is shown in Figure 5-20, there are a number of factors necessary to cause vibration to the local house and structures such as 1) Passing Vehicles; 2) Conditions of the Road Surface; and 3) Conditions of the Local Geology. Further, the structure itself could easily vibrate from the ground as vibration recepter which depend much on the conditions of the structure.



Source: http://www.crearia.co.jp/

Figure 5-20 Cause of Traffic Vibration

Depending on the country adapting "ISO 4866: 1990" as a standard of traffic vibration, the frequency range of vibrations depends upon the distribution of spectral content over the frequency range of the excitation and upon the mechanical response of the building. This pinpoints the spectral content as a most important property of vibration input. For simplicity's sake, the International Standard of ISO 4866: 1990 deals with frequencies ranging from 0.1 Hz to 500 Hz that it covers the response of buildings of a wide variety and building elements to excitation.

The reaction of buildings and building components to dynamic excitation depends upon response characteristics. For example natural frequencies, mode shapes and modal damping as well as the spectral content of the excitation should cause damages to the building. Cumulative effects should also be considered, especially at high response level and long exposure times where fatigue damage is a possibility. Table 5-10 shows typical range of structural response for various sources.

Table 5-10 Typical Range of Structural Response

Vibration forcing function	**Frequency range** Hz	**Amplitude range** µm	**Particle velocity range** mm/s	**Particle acceleration range** m/s2	**Time charac-teristic**	**Measuring quantities**
Traffic road, rail, ground-borne	1 to 80	1 to 200	0.2 to 50	0.02 to 1	C/T	pvth
Blasting vibration ground-borne	1 to 300	100 to 2 500	0.2 to 500	0.02 to 50	T	pvth
Pile driving ground-borne	1 to 100	10 to 50	0.2 to 50	0.02 to 2	T	pvth
Machinery outside ground-borne	1 to 300	10 to 1 000	0.2 to 50	0.02 to 1	C/T	pvth/ath
Acoustic traffic, machinery outside	10 to 250	1 to 1 100	0.2 to 30	0.02 to 1	C	pvth/ath
Air over pressure	1 to 40				T	pvth
Machinery inside	1 to 1 000	1 to 100	0.2 to 30	0.02 to 1	C/T	pvth/ath
Human activities a) impact b) direct	0.1 to 100 0.1 to 12	100 to 500 100 to 5000	0.2 to 20 0.2 to 5	0.02 to 5 0.02 to 0.2	T	pvth/ath
Earthquakes	0.1 to 30	10 to 105	0.2 to 400	0.02 to 20	T	pvth/ath
Wind	0.1 to 10	10 to 105	-	-	T	ath
Acoustic Inside	5 to 500	-	-	-		
NOTES	C = continuous T = transient pvth = particle velocity time history ath = acceleration time history					
1 The ranges quoted are extremes but indicate the values which may be experienced and which may have to be measured (see also note 3). Extreme ranges of amplitude of displacement and frequency have not been used to derive particle velocity and acceleration.						
2 The frequency range quoted refers to the response of buildings and building elements to the particular type of excitation. It is indicative only						
3 Vibration values within the ranges given may cause concern. There are no standards which cover all varieties of building, condition and duration of exposure, but many national codes associate the threshold of visible effects with peak particle velocities at the foundation of a building of more than a few millimetres per second. A significant probability of some damage is linked to peak particle velocities of several hundred millimetres per second. Vibration levels below the threshold of human perception (see ISO 2631-2) may be of concern in delicate and industrial processes.						

Source: Indian Bureau of Standard

In the event if there were significant damages, road surface improvement and/or vibration measurement, geological site investigation would have to be carried out in order to assess

vibration receptor's structural damages. In order to carry out such investigation, it is obvious that the exceeding the noise level at the location should become an indicator for investigation.

With regard to vibration in the project, under normal conditions, ground-borne vibration from road traffic is not an environmental concern. Vehicles traveling on properly maintained roadways do not generate vibration of concern.

In India there is no concrete standard of vibration such as the noise level associated with vibration, which generally comes from the natural phenomena (wind, earthquake, etc) and man-made vibrations induced by blasting, traffic, etc. Because this is the road improvement project, it would be appropriate to discuss vibration mainly from construction work. Although ambient vibrations data was not measured, anticipated environmental impacts are discussed in Chapter 6.

5.2.6 Dust Emanation and Traffic Jam

Because of the use of heavy construction vehicles for the construction works while there is live traffic on the road, excessive dust emanation during construction period could cause deterioration of air quality at places. It is very likely to take place at the beginning point of the Project. Because of the construction works carried out along with the live traffic, excessive traffic congestion should also take place within the city limit where concentration of traffic is higher than any other part of NH-40.

5.2.7 Solid Waste Disposal

Among other waste disposal rules, Solid Waste Disposal Rule in India was revised and Construction and Demolition Waste Management Rules, 2016 was notified in March 2016 in order to control over the disposal of construction debris as is shown in Table 5-11. According to the rules, local authority is responsible for solid waste management, and Meghalaya State Pollution Control Board is responsible for its supervision and monitoring during the construction period of NH-40. Under the new Construction and Demolition Waste Management Rules, any materials subject to reuse and those of subject to disposal are separated and transport to the area designated by Meghalaya State Pollution Control Board.

Table 5-11 Rules Related to Solid Waste Disposal

(1)	Construction and Demolition Waste Management Rules, 2016	Municipal Solid Wastes (Management and Handling) Rules, 2000 was put out by CPCB in the Year 2000. Each state is subject to follow the rule for urban solid waste disposal. In March 2016, Construction and Demolition Waste Management Rules, 2016 was notified, which stipulates construction debris are subject to separation for reuse and disposal.
(2)	Toxic Waste Disposal Rule, 1989	Put out by CPCB in the Year 1989, revised in 2000, 2003, 2008 and 2009. Revised rule makes restriction of the toxic waste disposal over the state boundaries.
(3)	Biological and Medical Waste Disposal Rule, 1998	Put out by CPCB in the Year 1998 and 2003. It restricts any biological or medical waster used for medical examination, study and treatment unless otherwise transported, disposed, stored by the local authority.
(4)	Recovery of Plastic materials and Production Rule, 1999	Put out by CPCB in the Year 1999 and 2003. In order to control over the burden of plastic recycle plants, recycled plastics in terms of the reuse of it for food items is restricted. Thinner-than-film materials are also not allowed to produce.
(5)	Control and Disposal of Batteries Rule 2000	Put out by CPCB in the Year 2000, responsibilities of led batteries are described in terms of controling manufacture, dispose, sale, purchase and use.
(6)	Disposal of Electronics Rule 2012	Put out by CPCB in the Year 2012, manufacturer of the electric/electronics appliances are obliged to pledge capital for which establishing recovery and recycle system in terms of disposal of various appliances of their own brand.

Source: Ministry of the Environment Forest and Climate Change

5.2.8 Type of Cross Drainage

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

Based on the engineering calculations, the intervals, cross sections and work types of the cross drainages in the existing output drawings are confirmed. Planned cross drainages are installed at intervals of 200m to 340m, except bypass sections. Table 5-12 shows the details of the types of the planned cross drainages.

The planned conduits will be constructed with four work types, of which box culverts account for more than 60%.

Table 5-12 Work Types Adopted for the Planned Cross drainages

Work Type	Locations Applied	Ratio
1-Box	174	64%
1-Pipes	89	33%
Slab	8	3%
Total	271	100%

Source: JICA Study Team

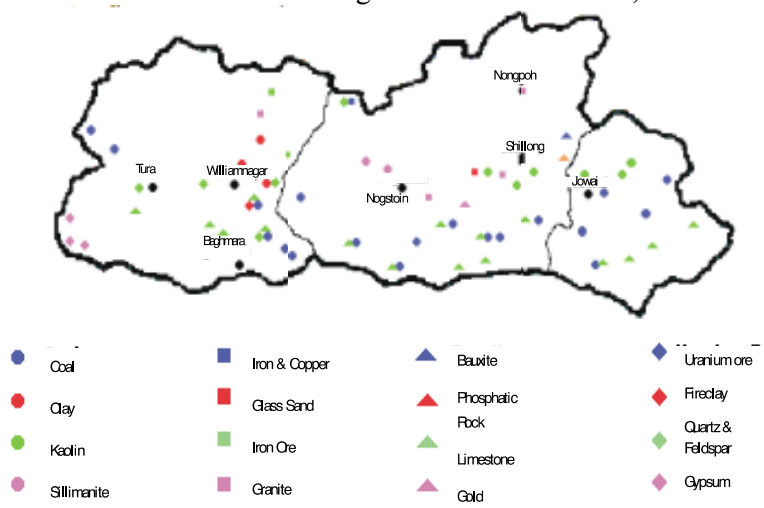
5.3 Economic Development

Meghalaya is primarily a rural-agrarian economy with 80% of the population residing in rural areas and around 65.8% of the working population engaged in agricultural and allied activities. Although efforts have been made by the Government to discourage jhum practice (shifting cultivation), it continues in certain parts, restricting overall productivity of land. Cultivators both of shifting and settled cultivation substantially depend on monsoon, as area under irrigation is virtually negligible. Though the production of principal crops like rice, maize and wheat

reveals increasing trends during the last few years, yet the production of rice which is a staple food of the state is not sufficient to meet the requirement of the state.
Meghalaya is an example of an industrially poor region in an industrially backward economy. It is undeveloped in terms of almost all criteria applied for identifying industrially backward states such as per capita income from industry and mining, worker engaged in registered units, per capita consumption of electricity, length of surfaced road, railway mileage and so forth. The number of registered manufacturing units in the state stood merely at 31 in 2001, which in fact was less than half of the number that existed in 1998. Out of 31 units, 27 are located in the East Khasi Hills and Ri-Bhoi districts alone, two each in Jaintia Hills and East Garo Hills.

5.3.1 Mineral Resource

In recent years, Meghalaya State Government began exploiting mineral resources. As is shown in Figure 5-21 the area to the south of Shillong is rich with limestone, coal and some uranium.

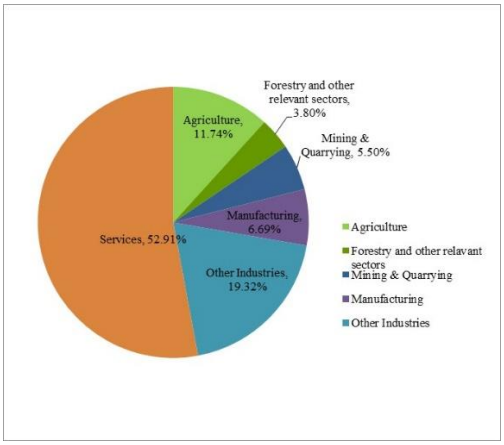


Source : State of Environment Report 2005, Meghalaya State Government

Figure 5-21 Mineral Resource of Meghalaya State

5.3.2 Economy and Industrial Structure

Gross State Domestic Product (GSDP) of Meghalaya in 2013-2014 is Rs 210,450 million (Rs 134,650 at constant 2004-05 prices), of which agriculture and forestry is 15.54%.



Source: Planning Commission, Government of India

Figure 5-22 Share of GSDP by Industries

5.4 Social and Cultural Resources

The existing road passes through predominantly agriculture land and few built-up areas named Shillong, Ritmawniew Mylliem, Umtyngar, Laitlyngkot, Mawkajem, Langkyrdem, Wahlyngkhat, Pynursla, Siatbakon, Pongtung, Pomshutia, Wahkdait and Dawki.The project road passes through two important districts of Meghalaya i.e. East Khasi Hills and West Jaintia Hills.The geographical areas of the districts are 2,748 km² and 1693 km^2 respectively. A major population in both the districts occupies the rural areas. Many families in the project region mainly depend on Agriculture, Allied Agriculture & other commercial works. It plays a significant role with respect to both generation of employment and share in the GDP (Gross Domestic Product).

According to the Census 2011, population of Meghalaya is 2,966,889, of which the male population is 1,491,832, and population density is 132/ /km2. The literacy rate of the whole state is 74.43%. English is the official language of the state, Khasi, and Garo are associate official languages. Pnar is mostly spoken in Jaintia Hills. Khasi speakers and Pnar speakers can communicate with each other.

Of the population, 86.15% is Scheduled Tribes (ST), of which the Khasi, Garo and Jaintia, known as hill tribes, are dominant. While each of the Khasi, Garo and Jaintia have their own traditional religion, many of them have converted to Christianity. As of May 2016, Meghalaya is divided into 11 districts; East Khasi Hills, West Khasi Hills, South West Khasi Hills, Ri Bhoi, West Jaintia Hills, East Jaintia Hills, East Garo Hills, West Garo Hills, North Garo Hills, South Garo Hills, and South West Garo Hills.

Most of the project area traverses through East Khasi Hills District. The district has a population of 825,922, which has grown 24.96% between 2001and 2011. The literacy rate is 84.15%, which is relatively higher than the average of the state. Ratio of Scheduled Tribes is 80.05%. The last part of the targeted section is within the West Jaintia Hills District, which was part of Jaintia Hills at the time of the 2011 census. Population of Jaintia Hills District is 395,124, which had increased 32.10% between 2001 and 2011. The literacy rate is 61.64%, relatively lower, and ratio of Scheduled Tribes is 95.19%.

Table 5-13 Population, Religion and Literacy Rate of Project Area

State/ District	Population	Area (km2)	Population density (person/km2)	Religion (%)	Literacy Rates (%)	Scheduled Tribes (%)
Meghalaya State	2,966,889	22,429	132	Christian: 75 Hindu: 12 Muslim: 4 Others: 9	74.43 %	86.15
East Khasi Hills District	825,922	2,748	301	Christian: 66 Hindu: 18 Muslim: 2 Others: 14	84.15%	80.05
Jaintia Hills District	395,124	3,819	103	Christian: 69 Hindu: 3 Others: 28	61.64%	95.19

Source: Census of India, 2011

Meghalaya is predominantly tribal State. The majority of its Population belong to Khasi, the Jaintia and the Garo tribes. Besides the Khasi, Jaintia and Garo, the State has a host of other tribes that have been residing in the State for years and have ownership of land and legal residency. Such groups are the Mizo, Hmar, (Mikir, Rabha,), Paitei, Meitei etc. All these groups

are mostly tribal groups from neighbouring states who migrated to Meghalaya and have settled here for countless years. These groups continue to follow their own customs and traditions. Agriculture is the main stay of the people in the project region which comprises almost 75% of the work force. Apart from agriculture other allied activities in the region are dairy, goatery, and piggery.The project area represents mostly rural and some urban area.

5.4.1 Cultural Heritage

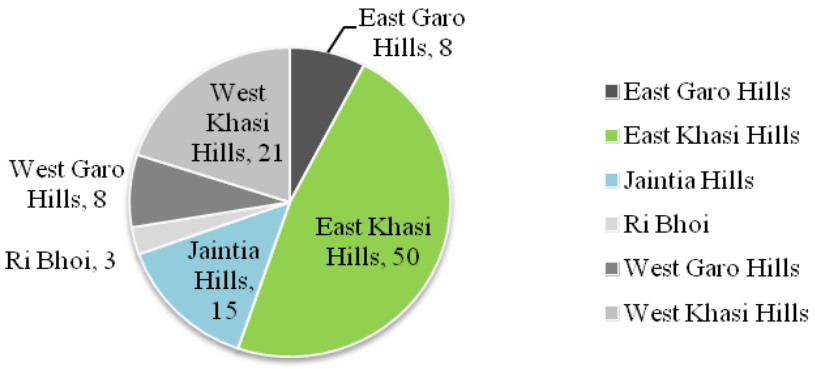
State-protected heritage in Meghalaya are as shown below. There is no state-protected heritage in the project area, East Khasi Hills District and West Jaintia Hills.

Table 5-14 State-protected heritage in Meghalaya

	Name	Place
1	Excavated Temple	West Garo hills
2	Excavated Temple	West Garo hills
3	Buddhist Stupa	West Garo hills
4	Fortress	West Garo hills

Source: Archeological Survey of India
(http://www.asi.nic.in/asi_protected_monu_meghalaya.asp)

Mawlyngnong introduced as “the cleanest village in Asia” in a travel magazine in India, is located 5km away from NH40. There are a number of “Living Root Bridges” in East Khasi Hills District and West Jaintia Hills District., Nongriat 25km away from NH40, has a “Double-Decker Root Bridge,”which is a prominent sightseeing spot in Meghalaya. Stone monuments, monolith or *mawbynna* based on the Khasi and Jaintia tradition can be found along NH40, though they are not directly traversed by the targeted section.
There are a number of forested areas known as “Sacred Forest” owned by clans in the East Khasi Hills District.“Sacred Forests” are protected based on traditional religious beliefs, and it is forbidden to cut any trees or take any leaves and flowers from the forests. According to C.P.R Environmental Education Center, research institute of MoEFCC, there are 105 sacred forests in Meghalaya, 50 of which are in the East Khasi Hills District and 15 in Jaintia Hills District.



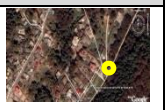
Source：C.P.R Environmental Education Center(http://www.cpreecenvis.nic.in/Database/Groves_811.aspx)

Figure 5-23 Distribution of Sacred Forests in Meghalaya

5.4.2 Monoliths

There are number of upright stones along the project alignment which are called as Monoliths. In the Khasi Hills area number of ancient monoliths and table stones, which are either memorial where the ashes of the dead are deposited in cairns or cenotaphs, commemorating memorable events. The upright stones represent men generally and are of considerable size, sometimes projecting 6 meters (20 feet) or more above ground. Monolith is a symbol of remembrance in the Jaintia Hills. The list of Monoliths along the project alignment are as presented エラー! 参照元が見つかりません。below.

Table 5-15 The list of Monoliths along the project alignment

Sl. No.	Distance from Starting Point (0.00 Km)	Side from Existing Road from Shillong	Distance from the Center Point of the existing Road	Altitude	Latitude	Longitude	Photographs of Monolith	Monolith location on Satellite Image
1	4.88km	R.H.S	14 to 15 meter	1739 m	25˚33' 6.27" N	91˚50' 35.87" E		
2	5.79 km	R.H.S	6 meter	1783 m	25˚32' 46.72" N	91˚50' 14.87" E		
3	8.14 km	R.H.S	10 meter	1789 m	25˚32' 44.99" N	91˚50' 5.18" E		
4	17.88 km	L.H.S	7 meter	1768 m	25˚32' 00.00" N	91˚49' 13.80" E		
5	18.11km	R.H.S	8 meter	1691 m	25˚27' 57.01" N	91˚49' 18.70" E		
6	21.52km		Median	1687m	25˚27' 56.70" N	91˚49' 25.70" E		
7	53.75 km	-	-	1839m	25˚27' 0.40"N	91˚50 '45.68"E		
8	4.88km	L.H.S	8 meter	830 m	25˚15' 29.48" N	91˚56' 54.93" E		

6. Anticipated Environmental Impacts and their Mitigations

6.1 Natural Environment

6.1.1 Geography/ Geomorphology

Impacts

There is moderate impact, if any, caused by the project for geographic/geomorphological changes. However, a number of cut and fill slopes are created with slope protection where needed. Most of them are within the range of 5 m high at locations where geometry of road alignment is improved. Some of the cut and fill can go up to 20 m high at locations where bypass roads are inserted. At these places, permanent changes of geographic conditions should take place.

Mitigation Measures

During the construction period, protection measures against heavy rains should be provided as much as possible in order to avoid soil erosion, natural disaster and deterioration of the cut and fill slopes.

Upon commencement of the operation and maintenance, there will be regular inspection and maintenance conducted. Where slope protection measures are applied, the change of geographical conditions will be insignificant

6.1.2 Hydrology

Impacts

During the construction period, temporary diversion or blockade of the rivers, streams or agricultural canals are implemented in order to construct road and its structures such as bridges, culverts and side ditches. Protection measures are always provided to these areas in order to avoid soil erosion, accidental changes of topography as well as the natural disasters.

Mitigation Measures

While during the construction period, protection provided to each construction area such as barricade, placing of sandbags etc. should prevent any accidents and unwanted changes of hydrogeography.

During the operation and maintenance period, no change of hydrogeography takes place i.e. mitigation measures is not necessary.

6.1.3 Climatic Conditions

Impacts

No significant climatic conditions should take place as a result of the implementation of the Project. The use of construction machines and operation of vehicles during construction phase will result in an increase in green house gas (GHG) emissions, though the impact is small and short-term. During the operation phase, GHG emissions will increase due to an increase in traffic volume. The project is expected to improve the resilience of the road against climate change by factoring long-term climate change (changes / increase in precipitation etc.) into the road design.

Mitigation Measures

Afforestation program is carried out in order to help fighting to reduce atmospheric temperatures of global warming. It also rejuvenate the forest area lost for the project. Monitoring of the ecological conditions for elaboration of further mitigation measures should be carried out.

6.1.4 Soil Erosion

Impacts

There is moaderate impact, if any, on the soil within the project area. However, as stated above, a number of cut and fill slopes are created causing certain amount of soil erosion on each construction area. Most of them are within the range of 5 m high at locations where geometry of road alignment is improved. Some of the cut and fill can go up to 20 m high at locations where bypass roads are inserted. At these places, permanent changes of geographic conditions should take place.

Mitigation Measures

During the construction period, protection measures against heavy rains should be provided as much as possible in order to avoid soil erosion, natural disaster and deterioration of the cut and fill slopes.

Upon commencement of the operation and maintenance, there will be regular inspection and maintenance conducted. Where slope protection measures are applied, the change of geographical conditions will be insignificant.

6.1.5 Ground Water

Impacts

There is no significant impact on ground water during the construction period as well as the operation and maintenance period as no tunnel construction work is planned.

6.1.6 Forest

Impacts

In terms of the impacts on the natural environment, the most significant impacts caused by the project is the permanent loss of the existing forest area as is shown in Table 6-1. The total area of deforestation will be approximately 98.5 ha (97.9ha without Bypass No. 5) in case that plantation at Bypass No.5-6 and Bypass No.6-7 is deducted from estimation of deforestation area as it is not defined to be “forest” by Forest Department, .

Table 6-1: Forest Areas Subject to Clearance by the Project

Location		Area	Tree cutting (no.)	Remarks
1	Bypass No.1	9.3	11,160	Protected Forest (admin. by Forest Dep. of Meghalaya State)
2	Bypass No.1-2	2.8	3,360	Private Forest
3	Bypass No.2 (excluding CH7.7-9.1)	3.6	4,320	Private Forest
4	Bypass No.3	5.0	6,000	Private Forest
5	Bypass No.3-4	1.0	1,200	Private Forest
6	Bypass No.4	3.2	3,840	Private Forest
7	Bypass No.4-5	44.4	53,280	Private/ Clan Forest

8	Bypass No.5	0.6	720	Private/ Clan Forest
9	Bypass No.5-6 (plantation	17.5 10.5	21,000 12,600)	Private/ Clan Forest
10	Bypass No. 6&7 (plantation	34.9 14.0	41,880 16,750)	Private/ Clan Forest
11	Bypass No.7-end	0.7	840	Private/ Clan Forest
	Total	123.0	147,600	
	Excluding plantation of Bypass No.5-6, No. 6&7	**98.5**	**118,250**	
	Excluding No.5	97.9	117,530	

Source: JICA Study Team

Bypass No. 1 subject to inserting into the Meghalaya State's protected forest has to clear 9.3 ha of forest mainly of Kashi Pine forest. It is inside the Upper Shillong Protected Forest. This is also an Important Bird Area, which, as stated above, ENVIS Centre on Wildlife and Protected Area and Birdlife International asserts that the area next to NH40 on the northern slope of Khasi Hills is an Important Bird Area for the indigenous birds including Tawny-breasted Wren-babbler, categorized as Vulerable in the Red List of IUCN. Though the area is affected by the Project, it came out through the Study that this area is unsuitable for habitation by the Wren-babbler and could not be "critical national habitat" defined in JICA Guideline for the Wren-babbler.

Bypass No. 6 has to cut through very thick riparian forest, which is also an important area of which such thick forest area would contribute to function as carbon sequestration area for fighting against global warming.

As is explained in the Section 7.3.5, Meghalaya State Forest Department examines the area of forest subject to clearing while at the same time it designates the area of afforestation. By the same token, it would be the measures to mitigate the loss of forest subject to clearing for the Project.

Mitigation Measures

The number of tree-cutting should be minimized.

Because of the significant loss of forested area, afforestation equivalent with the hectare of forest area cut under the Project, namely 98.5 ha (or 97.9ha if Bypass No.5 is excluded), will be required to be conducted by NHIDCL.

6.1.7 Afforestation for Mitigation Measures against Global Warming

Impacts

Any road project is subject to which emission of greenhouse gas as a result of project implementation is inevitable. The World Bank has put out "Greenhouse Gas Emissions Mitigation in Road Construction and Rehabilitation" in 2010. Based on this report, this Project emits 794 tons of greenhouse gas for every km of construction work as is shown in Table 6-2.

Table 6-2: Greenhouse Gas Emission of Road Project

Parameter \ Category of Road	Express-way	National Rod	Provincial Road	Rural Road (Gravel)	Rural Road (Dirt)
Emissions (t CO2 eq./km)	3,234	794	207	90	103
Factor Equivalent to Expressway	100	25	6	3	3

Source: "Greenhouse Gas Emissions Mitigation in Road Construction and Rehabilitation" 2010, World Bank

This project, excluding 1.4km overlapping portion of NH44E, runs for 70.1 km of NH40 improvement project. effect of greenhouse gas emission for the lifetime of the Project (Estimated at 10 years) is calculated as follows:

794 (t CO_2 eq./km) × 70.1 km = 55,659 t (CO_2 eq.)
(794 (t CO_2 eq./km) × 61.8 km = 49,069 t (CO_2 eq.) if 8.3km of Bypass No.5 is excluded.)

Mitigation Measures

Because of afforestation is the most popular and inexpensive method of carbon sequestration, the following method of calculation is carried out in order to find the area of afforestation.

1 ton of Carbon = 3.666 tons of CO_2

Note: Atomic volume of CO_2 is 44; it is divided by Carbon whose atomic volume is 12.

Because of the experiences of which 1 ha of forest sequester 125.5 tons of carbon[1], 1 ha of forest should sequester 125.5 tons × 3.666 tons of CO_2 = 460.2/ha of CO_2. Thus:
55,659 t (CO_2 eq.) / 460.2 ton/ha = Forest Area of 120.95 ha
(49,069 t (CO_2 eq.) / 460.2 ton/ha = Forest Area of 106.63 ha if Bypass No.5 is excluded)

is obtained. Provided that 13 ha of afforestation are carried out, area square to sequester greenhouse gas will be assured around 10 year period. Such afforestation should contribute to recover the area lost in the past decades as a result of shifting cultivation, especially slush-and-burn agriculture. It should also contribute to safeguard forest area of water resources while it contributes to fight against global warming.

6.1.8 Impact on Wildlife Reserve

Impacts

There is no wildlife or sanctuary formally declared by the Government of India within the 5 km radius of the project area. However, ENVIS Centre on Wildlife and Protected Area and Birdlife International jointly listed up a number of important bird areas. One of them is "Upper Shillong Important Bird Area" that NH40 borders a portion of the bird area. It is a habitat of a large number of indigenous birds including Tawny-breasted Wren-babbler, one of the vulnerable species listed by IUCN as VU (vulnerable) species.

Within this area, Meghalaya State Department of Environment and Forest maintains "Upper Shillong Protected Forest" of 766 ha, within which Bypass No. 1 has to go through and 9.3 ha of protected forest has to be cleared.

Mitigation Measures

Because of a large forested area is lost for ROW of the road construction project as well as the

[1] The following reports have been consulted.
1) United States Department of Agriculture, Forest Service, Methods for Calculating Forest Ecosystem and Harvest Carbon with Standard Estimates for United States Forest Types, 2006, http://www.treesearch.fs.fed.us/pubs/22954.
2) US Department of Agriculture, Forest Service, Carbon Storage and Accumulation in United States Forest Ecosystems, 1992, http://www.nrs.fs.fed.us/pubs/gtr/gtr_wo059.pdf

road construction project as being one of the greenhouse gas emitter, compensatory afforestation program in total of 219.5 ha (or 204.5 ha without Bypass No.5) should be considered as mitigation measures.

6.1.9 Impacts on Wildlife

Impacts

During the construction period, ecosystem in the mountain including local flora and fauna as well as forest/wooded areas are damaged to some extent.

As is shown in Figure 5-11, Birdlife International asserts that an area on the north slope of Khasi Hills that is facing Shillong City is an Important Bird Area (IBA). The area is to the east of NH40 from 0 km to 6 km post. IUCN declares that Tawny-breasted Wren-babbler is vulnerable species that are very likely to inhibit in the area. the habitat from north to south. However, it was found through EIA survey that Upper Shillong Forest is currently not a dense forest, which cannot be a good habitat for the Wren-babbler.

Habitation by the Wren-babbler tends to be the dense and untouched forest which forages and roosts in thick undergrowth offering ample camouflage and cover. The forest patch through which the proposed bypass deviates from the existing road, however, is a *Pinus kesiya* regrowth stand which is devoid of dense undergrowth. Further, the area is criss-crossed with walking paths used by the local villagers. During the surveys conducted in the area, there were a lot of instances where the local people were seen using the paths of the forest. This area therefore is unsuitable for habitation by the Wren-babbler and thus the Upper Shillong Forest could not be "critical national habitat" defined in JICA Guideline for the Wren-babbler. .

It is considered that the "Tawny-breasted Wren-babbler" had migrated to south and the Upper Shillong Forest is not a "critical national habitat" for the Wren-babbler anymore. The proposed bypass lies in an area devoid of conducive habitat of the species and does not pose any threat to the habitat of the species.

Mitigation Measures

Though it cannot be considered that the Project significantly affect any habitat of vulnerable species, a) monitoring during construction, b) securing undergrowth for feeding, c) prohibiting disposal of waste into the area, d) preparing nesting site on trees are recommended. Among them, "b) securing undergrowth for feeding would be achieved by forbidding contractors or residents to enter the area through facilitating awareness or providing educational program. "c) prohibiting disposal of waste into the area" also need to be achieved through facilitating awareness or providing educational program to contractors.

6.1.10 Landscape

Impacts

While the landscape viewed along NH40 itself remains intact, there are a number of landscape viewpoints created for tourism purposes. These areas are generally "landscaped area" where parking place, safety rails, teahouses, etc. During the construction period, these viewpoints are closed temporarily for construction works.

Mitigation Measures

Viewpoints are generally closed during the construction period while in the operation and maintenance period, all of the viewpoints are open for the general public.

6.2 Living Environment

6.2.1 Air Quality

Impacts

CPCB has a policy of adapting EU's air quality standard including CO_2 emissions. Based on the EU standard of CO_2 emission, standardized passenger car emit 125 g/km of CO_2 (http://ec.europa.eu/eurostat/tgm/table.do?tab=table&init=1&language=en&pcode=tsdtr450&plugin=1).

Based on the study on traffic demand, using the rate of increase of vehicles over the next 20 years, approximately 8.89% per year of the increase of vehicles is assessed. Thus for assessing the CO_2 emission, the project area is sub-divided into the following sections based on the level congestions:

a. Section 1–2: Beginning Point of the Project in Shillong to 8.56 km;
b. Section 3–4: The section for mountainous area; and
c. Section 5–6: Lowland area via Dawki.

As indicated in the right hand side column of each table, SO_2 NO_x and CO values should exceed in general around or beyond 2035 while PM2.5 and PM10 values should exceed around 2020–25.
Adverse impacts to air quality during construction and operation phases, however, will be minimal through necessary mitigation measures as provided in Environmental Management Plan.

Table 6-3: Projected Increase of Vehicular Emission (0 km–8.56 km)

Annual Emission Increase: Section 1-2

Section	Km	Item / Value at Nearest Point / Year		2016	2020	2025	2030	2035	Limit of Standard[1]	Assessment of the Increase of Emission
1	0-2.26km	Increase of Vahicles	—	17,822	23,341	32,383	43,131	56,800	—	—
		CO2 Emission/t・year[2]	—	38,139,080	49,950,517	69,299,471	92,301,408	121,551,790	—	—
		Rate of Increase of CO2 Emission	—	—	31.0%	81.7%	142.0%	218.7%	—	—
		PM2.5,μg/m3	37.9	—	49.6	68.9	91.7	120.8	40/40	Exceed by 2020
		PM10,μg/m3	83.1	—	108.8	151.0	201.1	264.8	60/60	Already Exceeded
		SO_2 μg/m3	6.9	—	9.0	12.5	16.7	22.0	50/20	Exceed by 2030-2035
		NOx ,μg/m3	12.1	—	15.8	22.0	29.3	38.6	40/30	Exceed by 2030-2035
		CO, μg/m3	989.2	—	1,295.5	1,797.4	2,394.0	3,152.6	2000/2000	Exceed by 2025-2030
2	2.26-8.56km	Increase of Vahicles	—	12,807	16,773	23,271	30,995	40,817	—	—
		CO2 Emission/t・year[2]	—	27,406,980	35,894,752	49,799,031	66,328,366	87,347,872	—	—
		Rate of Increase of CO2 Emission	—	—	31.0%	81.7%	142.0%	218.7%	—	—
		PM2.5,μg/m3	23.4	—	30.6	42.5	56.6	74.6	40/40	Exceed by 2020-25
		PM10,μg/m3	55.6	—	72.8	101.0	134.6	177.2	60/60	Exceed by 2020
		SO_2 μg/m3	7.1	—	9.3	12.9	17.2	22.6	50/20	Exceed beyond 2035
		NOx ,μg/m3	11.7	—	15.3	21.3	28.3	37.3	40/30	Exceed beyond 2035
		CO, μg/m3	872.1	—	1,142.2	1,584.6	2,110.6	2,779.4	2000/2000	Exceed by 2025-2030

Note : 1. Limit of standard indicates "Residential Area/Ecologically vulnerable area", which is compared to the value of "Ecologically Vulnerable Area"
2. EU standard of CO2 emission of a regular passenger car at 125g/km

Source: JICA Study Team

Table 6-4: Projected Increase of Vehicular Emission (8.56 km – 49.26 km)

Annual Emission Increase: Section 3-4

Section	Km	Item□ / Value at Nearest Point□ / Year□		2016	2020	2025	2030	2035	Limit of Standard[1]	Assessment of the Increase of Emission
3	8.56-19.99km	Increase of Vahicles	—	5,935	7,773	10,784	14,363	18,915	—	—
		CO2 Emission/t・year[2]	—	60,388,625	79,090,609	109,727,340	146,148,127	192,462,573	—	—
		Rate of Increase of CO2 Emission	—	—	31.0%	81.7%	142.0%	218.7%	—	—
		PM2.5,μg/m3	20.3	—	26.6	36.9	49.1	64.7	40/40	Exceed by 2025-2030
		PM10,μg/m3	55.6	—	72.8	101.0	134.6	177.2	60/60	Exceed by 2020
		SO_2 μg/m3	7.0	—	9.2	12.7	16.9	22.3	50/20	Exceed beyond 2035
		NOx ,μg/m3	11.7	—	15.3	21.3	28.3	37.3	40/30	Exceed beyond 2035
		CO, μg/m3	583.3	—	763.9	1,059.9	1,411.7	1,859.0	2000/2000	Exceed beyond 2035
4	19.99-49.26km	Increase of Vahicles	—	2,925	3,831	5,315	7,079	9,322	—	—
		CO2 Emission/t・year[2]	—	29,761,875	38,978,944	54,077,922	72,027,510	94,853,079	—	—
		Rate of Increase of CO2 Emission	—	—	31.0%	81.7%	142.0%	218.7%	—	—
		PM2.5,μg/m3	23.2	—	30.4	42.2	56.1	73.9	40/40	Exceed by 2020-25
		PM10,μg/m3	53.6	—	70.2	97.4	129.7	170.8	60/60	Exceed by 2020
		SO_2 μg/m3	7.0	—	9.2	12.7	16.9	22.3	50/20	Exceed beyond 2035
		NOx ,μg/m3	12.2	—	16.0	22.2	29.5	38.9	40/30	Exceed beyond 2035
		CO, μg/m3	593.3 年匚	—	777.0	1,078.0	1,435.9	1,890.9	2000/2000	Exceed beyond 2035

Note : 1. Limit of standard indicates "Residential Area/Ecologically vulnerable area", which is compared to the value of "Residential Area"
2. EU standard of CO2 emission of a regular passenger car at 125g/km

Source: JICA Study Team

Table 6-5: Projected Increase of Vehicular Emission (49.26 km–81.26 km)

Annual Emission Increase:（Section5-6）

Section	Km	Item□ / Year□ / Value at Nearest Point□		2016	2020	2025	2030	2035	Limit of Standard[1]	Assessment of the Increase of Emission
5	49.26-80.26km	**Increase of Vahicles**	—	1,596	2,090	2,900	3,863	5,087	—	—
		CO2 Emission/t･year[2]	—	12,768,000	16,722,171	23,199,711	30,900,178	40,692,467	—	—
		Rate of Increase of CO2 Emission	—	—	31.0%	81.7%	142.0%	218.7%	—	—
		PM2.5,μg/m3	23.2	—	30.4	42.2	56.1	73.9	**40/40**	Exceed by 2020-25年
		PM10,μg/m3	53.7	—	70.3	97.6	130.0	171.1	**60/60**	Exceed by 2020年
		SO_2 μg/m3	6.7	—	8.8	12.2	16.2	21.4	**50/20**	Exceed beyond 2035
		NOx ,μg/m3	11.4	—	14.9	20.7	27.6	36.3	**40/30**	Exceed beyond 2035
		CO, μg/m3	361.7	—	473.7	657.2	875.4	1,152.8	**2000/2000**	Exceed beyond 2035
6	80.26-81.26km	**Increase of Vahicles**	—	1,588	2,080	2,885	3,843	5,061	—	—
		CO2 Emission/t･year[2]	—	12,704,000	16,638,350	23,083,422	30,745,290	40,488,495	—	—
		Rate of Increase of CO2 Emission	—	—	31.0%	81.7%	142.0%	218.7%	—	—
		PM2.5,μg/m3	38.1	—	49.9	69.2	92.2	121.4	**40/40**	Exceed by 2020
		PM10,μg/m3	81.0	—	106.1	147.2	196.0	258.2	**60/60**	Already exceeded
		SO_2 μg/m3	6.7	—	8.8	12.2	16.2	21.4	**50/20**	Exceed beyond 2035
		NOx ,μg/m3	11.8	—	15.5	21.4	28.6	37.6	**40/30**	Exceed beyond 2035
		CO, μg/m3	1021.3	—	1,337.6	1,855.7	2,471.7	3,255.0	**2000/2000**	Exceed by 2025-30

Note : 1. Limit of standard indicates "Residential Area/Ecologically vulnerable area", which is compared to the value of "Residential Area"

2. EU standard of CO2 emission of a regular passenger car at 125g/km

Source: JICA Study Team

Mitigation Measures

During the construction period, construction plants and equipments or vehicles should be equipped with mufflers on the exhaust pipe. Contractors will be advised to refrain from idling of vehicles/equipments while standby and stop engines in such case. Monitoring of the vehicular emissions and periodical maintenance of the construction plant should reduce excessive emission. Planting of trees/vegetation on the periphery of the construction site will be taken up.

The above projected increase of vehicular emission during the operation and maintenance period is in need of further elaborated for accuracy. Thus, monitoring works during the operation and maintenance period is inevitable. Local communities should be well informed of the risk of air pollution. Awareness raising campaign including distribution of facemask might be done in cooperation with local authorities.

It would be necessary to disclose monitoring result on website of MOEFCC, Forest Department and/or SPCB. EMP prepared in accordance with JICA guideline can be incorporated into Indian procedure, according to Forest and Environment Department.

6.2.2 Water

Impacts

Depending on the water sources, water quality of the surface water during the construction period could temporarily be deteriorated. There will be no contamination of drinking water during the operation and maintenance period.

Mitigation Measures

In order to avoid permanent contamination, fuel, oils and other foreign matters should be strictly administered for storage during the construction period. Protective measures during piling of foundations in th river should be considered as necessary. No mitigation measures are required during the operation and maintenance period.

6.2.3 Bottom Sediment

Impacts

Bottom sediment in the rivers and streams as well as agricultural waterways could be blocked with construction debris, or contaminated by fuel, oil and other foreign matters. Unless a large scale operation is carried out for maintenance works during the operation and maintenance period, there will be no significant impact induced by the Project.

Mitigation Measures

Strict prevention measures for which construction works carried out in the vicinity of rivers and streams as well as agricultural waterways provide silt trap and other measures.

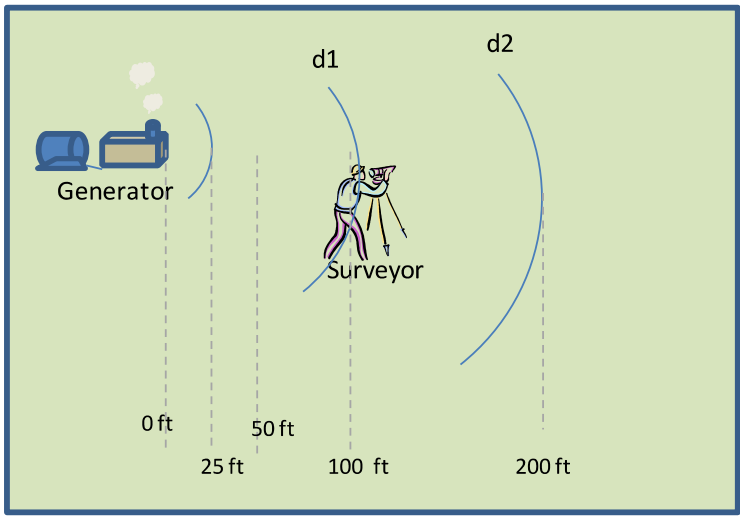
6.2.4 Noise

Impacts

During the construction period, construction noise could be strongly felt by the local residents in and around built-up areas. In the forest area, construction noise has to scare wildlife including birds. Wildlife including birds will not return to the original forest.

It is ideal to carry out construction works away from the residential areas. As is shown in Figure 6-1, noise level is reduced by 6 dB at every 100 ft (30 m). Thus, source of noise at 85 dB

emanated by diesel generator, for instance, reduced to 79 dB as a person moves to a place 200 ft (60 m) away from the source of noise.



Source: https://www.faa.gov/air_traffic/nas/nynjphl_redesign/

Figure 6-1: Noise Level Increase and Decrease by Distance

Major sources of noise are movement of vehicles transporting construction materials to the construction yard, and the noise and vibration generating activities at the yard itself. Mixing, casting and material movement are primary noise generating activities in the yard and will be uniformly distributed over the entire construction period.

Construction activities are expected to produce noise levels in the range of 80-95 dB(A). The major work will be carried out during the daytime. The noise levels in the project area during the construction stage will be intermittent and temporary in nature.

During the operation stage of the project, reduction of vehicular engine noise (as a result of reduced congestion from earlier, smoother flow of traffic due to two separate lanes), vehicular body noise (as a result of reduced development roughness) and reduction of blowing of horns will bring the noise levels down. However, as described in section 6.2.1, Table 6-3, Table 6-4 and Table 6-5, traffic volume, especially heavy vehicles, will increase in future due to the improved road and to aggravate noise and vibration slightly.
Adverse impacts quality during construction and operation phases, will be minimal through necessary mitigation measures as provided in Environmental Management Plan.

Mitigation Measures

Noise measurement during the construction period has to be constantly carried out at the time of construction plants in operation. Mufflers should be installed on the exhaust pipes of the construction plants, periodical maintenance of construction should be carried out in order to reduce excessive noise. Where construction works are carried out in the vicinity of residential areas, noise barriers should be provided especially in the area near schools and hospitals. Grievance needs be properly conveyed, probably through local authorities.

During the operation and maintenance period, increase of traffic volume, speed of vehicles and increase of heavy vehicles could cause excessive noise. Periodical monitoring of noise level measurement has to be carried out in order to elaborate further measures on the noise level

management. Development of greenbelt along the main road can also bring about considerable reduction in noise levels.

6.2.5 Vibration

Impacts

As described in Section 5.2.5, increase of traffic volume will cause increase of vibration. The impact of such vibration is low to moderate. Vehicles traveling on properly maintained roadways do not generate vibration of concern. The noise and vibration level will be increased during construction period, which will have significant impact for a limited period on the surrounding environment. However, Major sources of noise and vibration are movement of vehicles transporting construction materials to the construction yard, and the noise and vibration generating activities at the yard itself. Mixing, casting and material movement are primary noise generating activities in the yard and will be uniformly distributed over the entire construction period.

Mitigation Measures

Noise monitoring is an indicator of excessive vibration. Holding village meeting before the commencement of the construction works is important for the increase of understanding among the local residents. Interviewing the local residents during the construction period must be carried periodically.

Continuous noise monitoring works should be carried out during the operation and maintenance period in order to which values of noise level should be used as an important indicator.

6.2.6 Dust

Impacts

During the construction period, in the dry season, dust emanation from the construction area could cause public nuisance. During the rainy season, mud on the road could also cause public nuisance both against pedestrians and traffic.

There will be no dust emanated during dry season and mud during the rainy season after the completion of the construction works and that NH40 is put into operation.

Mitigation Measures

The Contractor is requested to sprinkle water during the dry season within the construction area. During the rainy season, mud barriers should be provided in order to prevent mud from spilling over to the live road and sidewalk.

There is no dust emanation or mud spillage during the operation and maintenance period.

6.2.7 Traffic Jam

Impacts

Because of the heavy traffic concentrating at the intersection in Shillong, 0 km post of the Project, heavy traffic congestion is expected. In Dawki, road construction works should cause heavy traffic jam because of the concentration of trucks transporting stone materials to Bangladesh.

No significant traffic jam should take place during the operation and maintenance period.

Mitigation Measures

The Contractor should provide a number of traffic guides, traffic barriers, signboards, colour cones and movable signals in order to maintain smooth flow of live traffic during the construction period.

No mitigation measures is required during the operation and maintenance period.

6.2.8 Solid Waste

Impacts

Various types of waste could be produced during the construction period ranging from oil, spare parts of the construction plants including electrical parts, waste from workforce camp, removal of old structures, surplus soil from excavation etc. Based on the CPCB's rules as per Table 6-6. It is NHIDCL/ contractor's responsibility to follow the Waste Management and Handling Rules as below. The surplus soil from excavation will be dumped at the approved dumping gound, if any.
No significant amount of waste will be produced during the operation and maintenance period.

Table 6-6: Rules of the Disposal for Various Types of Waste

Construction and Demolition Waste Management Rules, 2016	Municipal Solid Wastes (Management and Handling) Rules, 2000 was published as a basic rule of solid waste management CPCB put out for all the municipalities of India. State government is requested to follow the rules. Construction and Demolition Waste Management Rules, 2016 was notified on 29 March 2016, in supersession of Municipal Solid Wastes Rules, in order to manage construction debris.
Hazardous and Other Waste (Management and Handling) Rules, 1989	Amended in 2000, 2003, and changed in 2008 including method of disposal and transportation beyond state/international borders. Further amendment was made in 2016 for utilization of hazardous material.
Bio-medical Waste (Management and Handling) Rules, 1998	Amended in 2003 and further amended in March 2016 in order to handle medical waste produced hospitals, veterinary institutions, pathological laboratories, blood banks, etc.
Plastic Waste (Management and Handling) Rules, 1999	Amended in 2003 and further amended in 2016 in order to control thick plastic materials.
e-Waste (Management and Handling) Rules, 2001	Amended in 2016, it deals with disposal of all electrical waster ranging from led-batteries, parts of electrical appliances in terms of reuse and disposal.

Source: Central Pollution Control Board, India

Mitigation Measures

In accordance with Construction and Demolition Waste Management Rules, 2016, NHIDCL shall prepare a comprehensive waste management plan and obtain necessary approval. State Pollution Control Board shall monitor the implementation of these rules and prepare annual report.

These various types of waste should be separated using boxes/cases for disposal and reuse during the construction period. Depending on the type of waste, the Contractor should transport them to the locations designated by the Meghalaya State Pollution Control Board.

Unless otherwise carried out a large operation of maintenance works, no significant waste will be produced i.e. no mitigation measures is required during the operation and maintenance period.

6.2.9 Other Measures for Climate Change

Impacts

Inproper maintenance of road facilities such as sediment deposition in culverts can cause natural disasters or exacerbate their impacts. Frequency and intensity of heavy rain is likely to increase due to climate change in addition to the present heavy rainfall patterns in Meghalaya. In the project area, a drastic increase of annual rainfall or unexpected drought could happen for the period from 2021 to 2050. With the predicted increase of the rainfall frequency and intensity, river water and groundwater level are expected to be high, which could cause inundation and damage to the road facilities.

Mitigation Measures

Implementation of climate change measures is carried out in order to provide further safety measures of the road construction project in view of the recent changes of climatic conditions, especially unpredictably amount of rainfall.

NHIDCL will be responsible for regular maintenance of road facilities to reduce the risk of natural disaster during the operation period.
The design of various components of the road (slope protection, drainage etc.) takes into account likely effect of climate change.
For designing the road and bridges, data value of the 50-year event of rainfall has been taken into account. Thus Table 6-7 shows adaptation measures for climate change taken into consideration in the road design.

Table 6-7: Adaption Measures for Climate Change in NH40

Factor	Design Policy considering Adaptation
Side Slope	Retaining wall is built all along the road.
	Slope protection work is constructed on some weathered and loosen slopes.
	Cut slope is covered with vegetation works to prevent erosion and collapse.
	Replacement of subgrade and subsurface drainage are planned as counter measure against sinking.
Embankment	Proper materials are used for the embankment.
	Flood level is confirmed in site reconnaissance and interview survey near river bank in south of NH40.
Bridge & Drainage System	Rainfall intensity is carefully determined based on the authorized data: ATLAS of Statewise Generalized Isopluvial Maps of Eastern India published by the Indian Meteorological Department. The pluvial value from higher edge of counter range is applied.
	The capacity of all structures is determined to be capable for the discharge of 50 years return period.
Pavement	Super elevation or camber is installed properly.
	Pavement material is examined not to rise over 60°C on the surface.
Road Sign	Wind load and visibility is taken into consideration.

Source: JICA Study Team

6.3 Major Impacts on Social Environment

6.3.1 Involuntary Resettlement

As per the preliminary ROW design, the project will affect 313 households (HHs) (307 houses, 45 shops, 4 workshops and 1 other structures; some households overlap. The total number with

their structures affected will be 297 if Bypass No.5 will be excluded). The public structures including a school, church, and resort etc., will only be partially affected in terms of land and not in terms of the building. The total number of people with their structures affected is approximately 1,500, though some of the households will not be subject to permanent resettlement.

Table 6-8: Summary of Households with Their Structures Affected

Large Classification	Medium Classification	Small Classification	No. of HHs	No. of HHs excluding BP5
Villages under the Project 27 villages	HHs with their Structures Affected	Houses	307	291
		Shops	45	45
		Workshops	4	4
		Other Buildings	1	1
		Total※1	313	297

*1) 44 households are affected in terms of both house and shop.
Source: JICA Study Team

Mitigation

Relocation sites shall be secured within same area as much as possible. Appropriate compensation and rehabilitation shall be provided. Resettlement Action Plan prepared by NHIDCL shall be referred to for further information

6.3.2 Land Use

The project will lead to significant changes in land use especially at the bypass sections. Moreover, the development of the resettlement sites to accommodate relocated households and the construction of spoil banks is likely to cause changes in land use patterns, potentially affecting existing agricultural and plantation activities.

For sections where NH40 passes through a community forest, *jhum* area and plantation, engineering work should be scheduled in a way that minimizes the disruption of access to such areas by local people. At the same time, proper management of effluent and soil erosion shall be carried out to avoid negative impacts on such resources.

Table 6-9: Summary of Households of Lands Affected

Large Classification	Medium Classification	Small Classification	No. of HHs
Villages under the Project 29 villages	Households of Lands Affected	Agricultural/open field	46
		Stone and sand quarry	14
		Betel nut Plantation owners	75
		Total	135

Source: JICA Study Team

Mitigation

Relocation sites shall be secured within same area as much as possible. Appropriate compensation and rehabilitation shall be provided.

6.3.3 Utilization of Local Resources

This project shall use mass-scale of local resources such as sand and quarrying, in short term, may hinder the ability of local purposes to utilize it for other purpose. After completion of

construction, further influx of outsiders and economic development may lead negative impact for local employment or business.

Mitigation

For construction material, actual utilization of local resources shall be considered. In designing livelihood restoration plan, the impact mentioned above shall be examined.

6.3.4 General, Regional/City Plans

The project will create new opportunities for village and district-level development planning. In particular, the construction of a spoil bank will create a large area of flat land where such surface space is a scarce commodity. The development of a spoil bank, therefore, should be coordinated with the village/district's development plan so that the land will benefit the community. Similarly, the development of the resettlement site should be coordinated with the village development plan to ensure proper supply of basic utilities and integration of new sites with the existing village area.

6.3.5 Social Institutions and Local Decision-Making Institutions

Meghalaya is a state predominantly inhabited by the Scheduled Tribes. The traditional leaders/ headmen, the *Durbar Shnong* and chieftains, must be involved in the decision-making process of the project from the planning stages. Their support and influence can facilitate the smooth execution of the project, and reduce impediments. The activities of RAP and rehabilitation and resettlement (R&R) should be built on existing social institutions; the local people are the best guide and have the expertise to guide the project based on their traditions and cultures. To minimize any potential disturbance and avoid the risk of conflicts, however, the resettlement will be planned within the village where relocation takes place.

6.3.6 Social Infrastructure and Services

The Shillong–Dawki road is the connecting road not only to the people along the area, but is also the connecting road that is being used every day by people from Shillong who go to their work/office in various blocks and sub divisions. The road also serves as the connecting link for school and college-going children in the periphery of Shillong (BP 1 and 2) who attend school in the main part of Shillong. The construction period will affect the aforementioned activities greatly.

Proposed alignments shall not avoid the Health centre at the end point Dawki, so that it will be necessary to be resettled. Noise pollution is as shown in 7.7.3(2) 4).

Mitigation

In order to alleviate negative impact by access inhibition to social infrastructure and social service, preparation must be made before implementation. Discussions and assistance can be taken with District Authorities and link with the traffic police. Any construction activity that may require road blockade, the community must be made aware at least 24 hours in advance.

Health centre mentioned above shall be constructed in alternative place in advance of main project. PIU shall pay the cost.

6.3.7 Local Economy and Livelihood

One of the major outcomes from the project will be the increased business ventures and opportunities that the area will be exposed to, and in terms of tourism, social events and

increased trade and commerce with neighbouring villages and the state as a whole. The people along the project road especially towards the end, are very enterprising and it is expected that they will take advantage of the project in a positive manner.

While the project overall will have significant positive impacts on the local and regional economy, the improved transport network may pose a risk to some groups, at least in the short and medium-term.

6.3.8 Unequal Distribution of Benefits and Damages and Local Conflicts of Interest

Roadside locations offer critical advantages for local businesses (tea stalls, restaurants, petty shops). Resettlement from the roadside to an inner part of the village may significantly undermine the viability of these businesses, and therefore, business owners to be affected may be worse off compared with farmers to be relocated. Likewise, the allocation of plots in the resettlement site may become a source of conflicts among the affected households who wish to be relocated to more advantageous plots.

Mitigation

A sound arbitration and conflict resolution mechanism by local leaders should be in place for the smooth implementation of RAP and R&R activities.

6.3.9 Water Usage, Water Rights, and Communal Rights

The Khasi tribal community inhabits the major segment of NH40 from Shillong to Dawki falling within East Khasi Hills District, and in certain segments of NH40 falling within West Jaintia Hills District, particularly around the proposed Bypasses No. 6 and No. 7, the Pnars or Jaintia tribes predominately inhabit the area. Both the communities have maintained a close symbiotic relationship with the environment since time immemorial and their ethno-cultural traits have been greatly influenced by the natural surroundings. Like any other tribal group, the Khasis and Jaintias have a very close affinity to nature, and the forest is an important component of nature that is intricately linked to their daily lives.

Water sources are mostly located within forest and vegetation areas since trees and all varieties of forest act as catchment for recharging the aquifers and replenishing ground water level, which then provide water supply to natural springs and small rivulets. Traditional systems of conserving and sustaining all such sources have been practiced for generations by both the tribes, and this tradition continues even today.

6.3.10 Religious and Sensitive Facilities

Access to religious structures such as churches, temples, and mosques may be rendered difficult because of the construction. People should not be stopped from attending their religious duties because of the construction. The majority of the people in the project area are Christians, and they will go to church every Sunday and other weekdays when necessary.

Mitigation

Access to these places must be built temporarily for this matter. Noise pollution is as shown in 7.7.2 (5).

Sacred Groves

Sacred forests are an integral part of the Khasi culture and beliefs. Sacred forests are found in various parts of the state, wherein clans, traditional heads/dorbar, declare a section of their forests as sacred and revere as a place of sanctity. People who visit these forests are warned not to misuse or abuse the forest creatures and vegetation. The sacred grove in Mawphlang is one such grove and is located near the project road, a few kilometres away from Pomlum village. It is one of the largest and oldest sacred groves in the state. The Mawphlang Sacred grove will not be affected by this project.

While "Raid Shabong Law Adong" in Wahpathew-urksew near Pynursla is located in a few hundred meters west of the current road of NH40, Bypass No. 5 is designed in the east to current road and it shall not disturb the forest. Moreover, while "Law Lyngdoh Mawshun" in Mawshun is located within 1 km east of current road of NH40, the alignment is designed in west to current road of proposed design, therefore, it shall avoid it. Both are distant from proposed construction areas so that negative impact by drainage shall not be expected.

Source: JICA Study Team

Figure 6-2 : Location of Sacred Groves along NH40

Table 6-10: Sacred Groves in East Khasi Hills and Jaintia Hills

Name	Location	Area (Ha)
District - East Khasi Hills		
Diengkain	Wmwai	400.0
Dienglengbah	Rngiksheh	0.50
Ingkhrum	Cherrapunji	0.25
Ingkhrum	Cherrapunji	0.25
Kharai Law Lyngdoh	Nongkhieng	150.0
Khlaw Ram Jadong	Mawsmai	50.0
Kynsang	Mawlong	150.0
Law Adong	Mawsmai	400
Law Adong Laitryngkew	Laitryngkew	20.00
Law Adong, Khlieh Shnong	Cherrapunji	90.0
Law Blei Beh	Mawsmai	120.0
Law Dymmiew	Sohrarim	200
Law Kyntang, Khlieh Shnong	Cherrapunji	90.0
Law Lieng	Sohrarim	20.0
Law Lyngdoh	Mawphlong	75.0
Law Lyngdoh Lyting Lyngdoh	Lyntilew	100.00
Law Lyngdoh Mawshun	Mawshun	100.00
Law Lyngdoh, Smit	Nongkrem	6.0
Law Mawsaptur	Sohrarim	50.0
Law Nongshim	Mawmihthied	5.0
Law Suidnoh	Lait-Ryngew	80.0
Law-ar-Liang	Lait-Ryngew	25.0
Lawthymmal	Cherrapunji	2.00
Law–u-Niang	Lait-Ryngew	10.0
Lum Diengjri	Khada Snoing	25.0
Lum Shillong	Laitkor	7.0
Madan Jadu	Lait-Ryngew	5.0
Maw Kyrngah	Wmwai	1200.00
Mawlong Syiem	Mawsmai	120.0
Mawlot	Phyllut	20.0
Raid Shabong Law Adong	Wahpathew-urksew in Pynursla	700.0
Niangdoh	Wahlong	0.0
Mawmang	Khada Snoing	15.0
Mawryot	Wahlong	40.0
Mawsawa	Mawmluh	50.0
Mawthoh	Wmwai	30.0
Nongbri	Pyndeng-Nongbri	5.0
Pohsurok	Cherrapunji	0.50
Pom Shandy	Mawsmai	80.0
Rangbaksaw	Cherrapunji	1
Rilaw Khaiti	Wahlong	35
Swer	Lum Swer	12
Umkatait	Dieng Ksiar	100
Umthri	Nongduh	80
Umtong	Wmwai	400
Wahkhem	Khadar Blang	10
Wanning Sawkpoh	Shngimawlein	7
Lum Shyllong	**Laitkor**	**7**
Rijaw	Wahlong	35
Dienglengbah	Rngiksheh	0.50

Name	Location	Area (Ha)
District - Jaintia Hills		
Blai Law	Raliang	50.0
Dpepat Myndihati	Sutnga	15.0
Ka Pun Lyngdoh	Raliang	15.0
Khlaw Blai	Dien Shynrum	15.0
Khlaw Byrsan	Raliang	50.0
Khloo Lyndoh	Jowai	15.0
Khloo Paiu Ram Pyrthai	Jowai	150.0
Law Kyntang	Shanpung	400.0
Lawianlong	Jowai	12.0
Lumtiniang Mokaiaw	Syndai	25.0
Mokhain	Jowai	45.0
Poh Lyndoh	Shanpung	30.0
Poh Moorang	Raliang	20.0
Poh Puja Ko Patti	Raliang	4.0
Trepale Jowai	Jowai	70.0

Source: C.P.R Environmental Education Centre

Monoliths

Monolith are traditional structures and are sacred to the Khasi people, especially those who still follow the indigenous religion. In the view of land use, ROW and securement of slope, 7 Monoliths placed along the planning roads are difficult to avoid. The JICA Team studied whether the Monoliths could be relocated or not.

Table 6-11: List of Monoliths

Sl. No.	Distance from starting point (0.00 Km)	Side from existing road from Shillong	Distance from the center point of the existing road	Altitude	Latitude	Longitude	Photographs of Monolith	Monolith location on satellite image	GPS Datum	Remarks	Within ROW or not	If yes, feasibility of relocation / protection
1	4.88 km	R.H.S	14 to 15 meters	1739 m	25˚33' 6.27" N	91˚50' 35.87" E			WGS 84	These monoliths are memorial where the ashes of the deceased are deposited in cairns.	Outside of ROW	Avoid
2	5.79 km	R.H.S	6 meters	1783 m	25˚32' 46.72" N	91˚50' 14.87" E			As above	As above	Within ROW	May be in carriage way. Located in land of State government. Details were already confirmed and consulted by Block Development Officer
3	6.06 km	R.H.S	10 meters	1789 m	25˚32' 44.99" N	91˚50' 5.18" E			As above	As above	Within ROW	May be in carriage way. Located in land of State government. Details were already confirmed and consulted by Block Development Officer

Sl. No.	Distance from starting point (0.00 Km)	Side from existing road from Shillong	Distance from the center point of the existing road	Altitude	Latitude	Longitude	Photographs of Monolith	Monolith location on satellite image	GPS Datum	Remarks	Within ROW or not	If yes, feasibility of relocation / protection
4	8.14 km	L.H.S	7 meters	1768 m	25˚32' 00.00" N	91˚49' 13.80" E			As above	As above	Within ROW	Section excluded from NH40.
5	17.88 km	R.H.S	8 meters	1691 m	25˚27' 57.01" N	91˚49' 18.70" E			As above	As above	Within ROW	Relocation will be done in consultation with the local people as Monolith does not belong to any specific clan
6	18.11 km	R.H.S	Median	1687 m	25˚27' 56.70" N	91˚49' 25.70" E			As above	As above	Outside ROW	Avoid
7	21.3 km	-	-	1839 m	25˚27' 0.40"N	91˚50 '45.68"E					Within ROW	May be under flyover. Relocation were already confirmed by land owner and Block Development Officer. Consensus and ritual ceremony will be examined by religious group.
8	53.75 km	L.H.S	8 meters	830 m	25˚15' 29.48" N	91˚56' 54.93" E			As above	As above	Within ROW	Relocation will be done in consultation with the local people as Monolith does not belong to any specific clans.

Source: JICA Study Team

6.3.11 Poor People

People from Below Poverty Line (BPL) or poor people in general must be considered when planning and executing R&R activities and RAP. It is noted that poor people are less exposed to big development projects and hence may feel intimidated and unable to voice concerns, grievances and suggestions. Improvement of transportation system will lead acceleration of market competition and accordingly it might expose a part of residents in short or medium-term. The project will make the positive impact in whole, although in case the poor have difficulty to be involved in market competition, their life may go worse furthermore.

Mitigation

Measures can be taken to ensure the poor are included into the project, and their grievances heard and redressed. Allowance shall be offered for the vulnerable people and the skill development shall be implemented in livelihood restoration plan.

6.3.12 Indigenous People and Ethnic Minorities

The majority of Meghalayans are Scheduled Tribes (STs) as per the Constitution of India. The majority of project affected persons (PAPs) are Khasi, with few Garo and Bengali. STs will not be excluded from this project, however, there should be a conscious effort made to accommodate and include them in the decision-making and grievance redress processes.

Mitigation

Fee, prior and informed consultation shall be required in accordance with World Bank OP4.10 and social consent shall be confirmed. A rehabilitation policy will be elaborated considering traditional livelihoods.

6.3.13 Gender

The positive impact the project will hav the broadening of business activities in trade and commerce, women and men in majority of the affected areas are interested and adept to managing their own business even if it's a small one. However there is inevitability of negative impacts, in that the relocation may affect the women social relationships, adjustments in running a household in a different setting with lesser earnings, reduction in land and assets. All this can result in the women opting for involuntary work to supplement income, which could lead to vulnerabilities that may affect her social, economic, physical and emotional health.
Attempts to involve women through official structures or general assemblies are problematic. Women are often excluded or marginalized from formal political institutions. It is often unacceptable or difficult for women to express their opinions in public.

Mitigation

Field teams of the RAP implementing agency should consists of both male and female member. Both men and women shall be invited to all the stakeholders and community meetings and are consulted regularly on the process of the project. Authority in charge of disbursement of compensation should ensure that both men and women PAPs, receive compensation in their name, the implementing agency can assist by helping them open bank accounts and have identity cards registered/recognized by the government. Assistance can be provided to both men and women in getting support and capacity building in an alternative livelihood. Their involvement and consultation should be considered and integrated into the monitoring and evaluation process of the project.
Equal wage for equal volume of work should be followed in all construction sites.

6.3.14 Public Health (Sanitation and Infectious Diseases) and Occupational Health and Safety (OHS)

The health and safety measures at the design, construction, and operation phases are outlined in Table 6-12.

Table 6-12: Health and Safety Measures

Stage	Health and Safety Measures
Design Stage	
Geometric correction at critical curves	Critical curves have been rectified to maintain the project design speed and visibility. (IRC-86-1983 " Geometric Design for Road in Plains")
Construction Stage	
Health hazards to workers due to bad water and sanitation	At every workplace, good and sufficient potable water (as per Indian Standard (IS) codes) supply shall be ensured to avoid water-borne diseases and to ensure the health of workers. Adequate provision for drainage, sanitation, and waste disposal shall be provided at workplaces. Preventive medical care shall be provided to workers.
Health/social hazards, sexual harassment to female workers	Segregation of male and female areas in the construction camp.
Hygiene at construction camps	The contractor, during the progress of construction work will provide, erect and maintain necessary (temporary) living accommodation and ancillary facilities for workers that meet standards and scales approved by the resident engineer. There shall be provided within the precincts of every workplace and accommodation, latrines and urinals in an accessible place, as per standards set by the Building and other Construction Workers (Regulation of Employment and Conditions of Service) Act. Except in workplaces provided with water-flushed latrines connected with a well-designed septic tank, all latrines shall be provided with low cost 'Twin Pit Latrine' system. The pit can be closed after the construction is over. There shall be adequate supply of water, close to latrines and urinals. All temporary accommodation shall be constructed and maintained in such a fashion that uncontaminated water is available for drinking, cooking and washing. The sewage system for the camp must be properly designed, built and operated so that no health hazard occurs and no pollution to the air, ground or adjacent watercourses takes place. Compliance with the relevant legislation must be strictly adhered to. Garbage bins must be provided in the camp and regularly emptied and the garbage disposed of in lined landfill sites. Construction camps are to be situated away from vulnerable people and adequate health care is to be provided for the work force. On completion of the works, the whole of such temporary structures shall be cleared away, all rubbish burnt, excreta or other disposal pits or trenches filled in and effectively sealed off, and the entire site left clean and tidy, at the contractor's expense, to the entire satisfaction of the engineer.
Abandoned quarry will accumulate water and act as a breeding ground for disease vectors.	Reclamation measures shall be adopted with garlands of trees around the periphery. The quarry dust and waste shall be used for refilling. The remaining portion shall be covered with trees. If the quarry site is porous, allow for groundwater recharging.
Risk from operations	The contractor is required to comply with all the precautions as required for the safety of the workmen as far as those are applicable to this project. The contractor shall supply all necessary safety appliances such as safety goggles, helmets, masks, etc., to the workers and staff.

Stage	Health and Safety Measures
	The contractor must comply with all regulations regarding safe scaffolding, ladders, working platforms, gangways, stairwells, excavations, trenches and safe means of entry and egress.
Risk from electrical equipment	Adequate precautions will be taken to prevent any danger from electrical equipment. No material at any of the sites will be so stacked or placed as to cause danger or inconvenience to any person or the public. All necessary fencing and lights will be provided to protect the public. All machines to be used in the construction will conform to the relevant IS codes, will be free from patent defects, will be kept in good working order, will be regularly inspected and properly maintained as per IS provisions and to the satisfaction of the engineer.
Risk at hazardous activity	All workers employed for mixing asphaltic material, cement, lime mortars, concrete etc., will be provided with protective footwear and protective goggles. Workers who are engaged in welding works, will be provided with welder's protective eye-shields. Stone-breakers will be provided with protective goggles and clothing and will be seated at sufficiently safe intervals. The use of any herbicide or other toxic chemicals shall be strictly in accordance with the manufacturer's instructions. The engineer shall be given at least 6 working day notice of the proposed use of any herbicides or toxic chemicals. A register of all herbicides and other toxic chemicals delivered to the site shall be kept and maintained up to date by the contractor. The register shall include the trade name, physical properties and characteristics, chemical ingredients, health and safety hazard information, safe handling and storage procedures, and emergency and first aid procedures for the product.
Risk of lead pollution	No men below the age of 18 years and no women shall be employed for the work of painting with products containing lead in any form. No paint containing lead or lead products will be used except in the form of paste or readymade paint. Face masks will be supplied for use by the workers when paint is applied in the form of spray or a surface having lead paint is dry rubbed and scrapped.
Risk caused by force majeure	All reasonable precautions will be taken to prevent danger of the workers and the public from fire, flood, drowning, etc. All necessary steps will be taken for prompt first aid treatment of all injuries likely to be sustained during the course of work.
Risk from explosives	Only if provided in the contract or ordered or authorized by the engineer, the contractor shall use explosives. The contractor shall at all times take every possible precaution and shall comply with appropriate laws and regulations relating to the importation, handling, transportation, storage and use of explosives and shall, at all times when engaged in blasting operations, post sufficient warning flagmen, to the full satisfaction of the engineer. The contractor shall at all times liaison with and inform well in advance and obtain such permission as is required from all government authorities, public bodies and private parties concerned or affected or likely to be concerned or affected by blasting operations.
Malaria risk	The contractor shall, at their own expense, conform to all anti-malarial instructions given to them by the engineer, including filling up any borrow pits which may have been dug.
Operation Phase	
Dwellers in settlements may rush to highway and have an accident	Specially designed urban sections and footpath sections shall be constructed at the necessary locations.
Vehicles parked in	Specially designed parking areas shall be made at the required locations.

Stage	Health and Safety Measures
settlements may narrow the carriageway	
Fast moving vehicles may threaten safety in settlements	Specially designed pedestrian crossings shall be constructed at required locations.
Accidents involving hazardous materials	The rules defined in Hazardous Waste Handling Act shall be followed. Vehicles delivering hazardous substances shall be marked with appropriate signs. In case of spillage, the report to relevant departments will be made and instructions will be followed in implementing the contingency measures.
Other safety measures	A traffic management plan shall be developed especially along congested locations. Traffic control measures including speed limits will be enforced strictly. Further growth of encroachment and squatting within ROW shall be discouraged. Fences are recommended between the road and quarry places.

Source: JICA Study Team

6.4 Others

6.4.1 Accidents

While improvement of curve can reduce traffic accident, increase of traffic volume and speed might increase risk of accidents.

Mitigation

Traffic sign shall be installed. Sidewalk and pedestrian crossing will be required. Delineator shall be utilized in fog area.

6.5 Impact Analysis

Comparison between scoping and survey result is as shown below.

Table 6-13: Scoping and Survey Result

Sl. No.	Item	Impact Assessments of Scoping: Pre-construction	Construction Stage	Operation Stage	Impact Assessments of Study Result: Pre-construction	Construction Stage	Operation Stage	Rationale of the Impact Assessment
Natural Environment								
1.1	Climate/ Meteorological Phenomena	D	D	D	N/A	N/A	N/A	P: - C/O: A little influence occurs along the roadside
1.2	Topography	D	B-	D	N/A	B-	N/A	P: - C: Alteration of the topography (embankment / cut) on the roadside cannot be avoided. O: -
1.3	Geology	D	D	D	N/A	N/A	N/A	P/C/O: -
1.4	Soil Erosion	D	B-	B-/ B+	N/A	B-	B-/ B+	P: - C: Sediment collapse and soil erosion are likely to occur. O : The modified terrain (including slope protection works) will stabilize over the long term.
1.5	Hydrology	D	C	C	N/A	B-	B-	P: - C : The change of individual hydrological conditions is caused by routing of surface water by construction and embankment / cutting etc. O : Fine hydrological conditions limited to individual areas by the embankment/ cuts etc. are permanently altered.
1.6	Groundwater	D	D	D	N/A	N/A	N/A	P/C/O: -
1.7	Ecosystem/Biodiversity Forest/Flora	D	A-	A-	N/A	A-	A-	P: - C: Logging is inevitable in broad forest areas by the road construction. The mountain ecosystem and biodiversity are affected during the construction period. Cutting of forest areas as habitats of wild animals including birds is inevitable. O: Road construction facilitates access to forest areas. Therefore it makes it easier to hunt regardless of legal or illegal. Traffic volume increases and negative impact of ecosystem cannot be avoided. The increase in traffic increases the exhaust gas to existing forest areas. Plant trees in forested forests then restore forests.
1.8	Wildlife Reserve	D	D	D	N/A	N/A	N/A	P/C/O: -
1.9	Coastal Zone	D	D	D	N/A	N/A	N/A	P/C/O: -
1.10	Landscape	D	C	C	N/A	B-	B+	P: - C : Damage to the landscape by the road construction work is inevitable. O: Landscape gets better after construction. Dawki bridge will be new spot for scenery.
1.11	Natural Disasters	D	B-	B+	N/A	B-	B+	P: - C: Natural disasters such as slope collapse may be punished depending on work during the construction period and strong rain.

Sl. No.	Item	Impact Assessments of Scoping			Impact Assessments of Study Result			Rationale of the Impact Assessment
		Pre-construction	Construction Stage	Operation Stage	Pre-construction	Construction Stage	Operation Stage	
								O: Stabilize the entire slope at completion by installing a slope protector.
Living Environment/ Pollution								
2.1	Air Pollution	D	B-	B-	N/A	B-	B-	P: -
								C: Air pollution and dust diffusion by construction heavy equipment are inevitable.
								O: Exhaust gas increases as traffic volume increases.
2.2	Offensive Odour	D	D	D	N/A	N/A	N/A	P/C/O: -
2.3	Water Pollution	D	B-	B-	N/A	B-	B-	P: -
								C: In the vicinity of a river there is a possibility that water quality of a river will be contaminated by the excavation work etc. By the construction workers' camps, there is a possibility that emissions will flow into rivers. Groundwater contamination other than excavation work does not occur.
								O: The current flow path by the construction of the drainage channel is changed.
2.4	Bottom Sediment Contamination	D	C	D	D	B-	D	P: -
								C : Drainage by the construction machine washing etc. may also Bottom sediment contamination.
								O : -
2.5	Soil Contamination	D	C	C	D	B-	B-	P: -
								C: Drainage by the construction machine washing etc. may also Soil contamination.
								O: Drainage by maintenance may cause soil contamination.
2.6	Ground Subsidence	D	D	D	N/A	N/A	N/A	P/C/O: -
2.7	Noise/Vibration	D	A-	B-/B+	N/A	A-	B-	P: -
								C : Noise and vibration are generated by heavy equipment for construction during operation. Night work is not carried out near religious facilities, schools and hospitals, etc. It is mandatory to install mufflers in heavy machinery.
								O : Noise and vibration may increase as traffic volume increases.
2.8	Sunshine Obstruction	D	D	D	N/A	N/A	N/A	P/C/O: -
2.9	Waters/Hazardous Materials	D	B-	B-	N/A	B-	B-	P: -
								C: Construction waste is generated during construction. However, they are processed by the end of the construction.

Sl. No.	Item	Impact Assessments of Scoping			Impact Assessments of Study Result			Rationale of the Impact Assessment
		Pre-construction	Construction Stage	Operation Stage	Pre-construction	Construction Stage	Operation Stage	
								O: Waste is generated during maintenance work of the road, but it does not have important influence on the natural environment or social environment.
Social Environment								
3.1	Involuntary Resettlement	A-	D	D	A-	N/A	N/A	P: Though bypasses are planned to avoid densely-populated areas, the alignment still affect house structures of approximately 300 HHs, of which 70% need to be resettled.
								C: -
								O: -
3.2	Land Use	A-	A-	A-	A-	A-	A-	P: Land acquisition and involuntary resettlement are likely to cause changes in the existing land use patterns.
								C: The bypass construction section affects existing cultivated land or agriculture and forestry. Changes in land use necessary for securing construction yards are short-term.
								O: This project requires permanent modification of land use.
3.3	Utilization of Local Resources	D	A-	D	N/A	A-	N/A	P: -
								C: Procurement of large quantities of materials locally could affect demand.
								O: -
3.4	General, Regional / City Plans	D	D	B+	N/A	N/A	B+	P/C : -
								O: Improvement of the road transport network may bring about the influx of residents from the outside and economic development.
3.5	Social Institutions and Local Decision-making Institutions	B-	B-	B-	D	D	D	P/C/O: Resident relocation may affect existing social organizations and regional decision making organizations.
3.6	Social Infrastructure and Services	B-	B-	B+	B-	B-	B+	P: Access to social infrastructure may be hindered due to resettlement and land acquisition.
								C: For improvement work, traffic congestion may occur and access to social infrastructure may be hindered.
								O: Improvement of road transport network contributes to improvement of convenience.
3.7	Local Economy and Livelihood	A-	A-/B+	B+	A-	A-/B+	B+	P: Loss of income source and livelihood due to involuntary resettlement and change in land usage are expected to negatively affect the local economy and livelihood.
								C: Construction work affects the lives and occupations of local residents. On the other hand, the construction work generates local employment and has a positive effect on the economy.

Sl. No.	Item	Impact Assessments of Scoping			Impact Assessments of Study Result			Rationale of the Impact Assessment
		Pre-construction	Construction Stage	Operation Stage	Pre-construction	Construction Stage	Operation Stage	
								O: Improvement of road transport network brings positive effect on regional economy by improving convenience. However, in the settlement of the bypass section, problems arise in access.
3.8	Unequal Distribution of Benefit and Damage	A-	A-/B+	B-/B+	A-	A-/B+	B-/B+	P: Land acquisition and involuntary resettlement will lead to unequal distribution of benefits and damage between those who are directly affected by the project and those who are not.
								C: Residents to be relocated are greatly affected. Meanwhile, neighbouring residents may benefit from creation of employment opportunities by the construction work, and deviation occurs.
								O: There is a possibility that the uneven distribution of benefits will expand between settlements on the roadside after the widening and villages detoured by the bypass. It is expected that uneven distribution of damage and benefits will be resolved by long-term benefits of the whole area by improving the road network.
3.9	Local Conflicts of Interests	C	C	C	C	D	D	P: Conflict of interests may arise by the compensation problems, and conflicts may occur.
								C/O: -
3.10	Water Usage, Water Rights and Communal Rights	D	D	D	N/A	N/A	N/A	P/C/O: -
3.11	Cultural and Historical Heritage	D	D	D C +	N/A	N/A	N/A	P/C/O: -
3.12	Religious Facilities	B-	A-	D	A-	A-	N/A	P: A number of churches, several memorial stones and graves are located along the road. Several memorial stones are directly affected. Graves can be affected in private yards. The targeted roads do not traverse sacred groves of traditional religious beliefs.
								C: Neighbouring religious facilities and cemetery may be affected by noise and vibration caused by construction.
								O: -
3.13	Sensitive Facilities (ex. hospital, school, precision machine factory)	C	A-	D	A-	A-	N/A	P: Relocation of one Public Health Centre will be required. School site will be partly affected.
								C: Schools and clinics along the road are affected by noise, vibration, and traffic congestion during construction.
								O: -
3.14	Poor People	A-	A-/B+	B+	A-	A-/B+	B-/B+	P: Given the limited coping capacity of the poor, it is necessary to assess their vulnerability and develop appropriate mitigation measures.

Sl. No.	Item	Impact Assessments of Scoping			Impact Assessments of Study Result			Rationale of the Impact Assessment
		Pre-construction	Construction Stage	Operation Stage	Pre-construction	Construction Stage	Operation Stage	
								C: Poor people may be more affected by negative influences. On the other hand, you can benefit from employment opportunities that occur in your business.
								O: In the long term, the economic development of the area that the project produces is thought to have a positive effect on the poor peoples.
3.15	Ethnic Minorities/ Indigenous People	A-	A-	D	A-	A-	N/A	P/C: Various specific schedules (Scheduled Tribes) live in the Meghalaya state of the target area. IPP shall be prepared with consideration of their unique culture and customs to implement resident relocation and to formulate a recovery plan for livelihood.
								O: -
3.16	Gender	C	C	C	D	B+/ B-	D	P: There is a possibility that resettlement and land acquisition may influence the role sharing such as cultivation, harvesting and processing. But the impact is limited.
								C: In consideration of regional cultural and social norms, employment opportunities are considered equally so that gender-derived conflicts do not arise. This project may influence role sharing such as cultivation, harvesting and processing.
								O: There is a possibility that this project may influence the role sharing such as cultivation, harvesting and processing. But the impact is limited.
3.17	Children's Rights	C	D	C	D	N/A	D	P: Child labour is prohibited by the Indian Constitution. Resettlement of residents and acquisition of land may affect the role of children helping at shops along roadside though impacts are minor.
								C : -
								O: Child labour is prohibited by the Indian Constitution. Resettlement of residents and acquisition of land may affect the role of children helping at shops along roadside though impacts are minor.
3.18	Public Health (sanitation and infectious diseases)	D	B-	B-	N/A	B-	B-	P: -
								C : The inflow of construction workers from the outside is expected to increase the risk of health, especially sexually transmitted diseases. Meanwhile, countermeasures against malaria are also necessary when constructing in areas where malaria is occurring.
								O : An increase in traffic volume has a negative impact on the health of roadside people.
3.19	Occupational	D	B-	B-	N/A	B-	B-	P: -

Sl. No.	Item	Impact Assessments of Scoping			Impact Assessments of Study Result			Rationale of the Impact Assessment
		Pre-construction	Construction Stage	Operation Stage	Pre-construction	Construction Stage	Operation Stage	
	Health and Safety (OHS)							C: Hygiene at work site and health and safety of workers need to be properly managed through implementation of environmental management plan.
								O: Consider thoroughly the hygiene and safety of workers in charge of maintenance and repair work.
Others								
4.1	Accidents	D	B-	B+/B-	N/A	B-	B+/B-	P: -
								C: The risk of traffic accidents caused by heavy machinery and construction vehicles increases. Pay particular attention to the construction site especially in areas where thick fog occurs.
								O: The accident risk increases due to an increase in traffic volume and an increase in traffic speed. Particular care needs to be taken in the dense fog area, such as speed limit and thorough use of headlights / hazard lamps. On the other hand, the risk is reduced by measures such as installation of traffic safety signs and curved mirrors.
4.2	Climate Change	B-	B-	B+/B-	B-	B-	B+/B-	P: CO_2 emission and absorption/fixation will be lost due to deforestation.
								C: Greenhouse gas emissions are generated by construction and heavy equipment emissions such as production and laying of road materials.
								O: As the number of vehicles using roads increases, the emissions of greenhouse gases gradually increase.

Note:
C: Construction
O: Operation
A: Severe/irrevocable impact is expected (+: Positive impact, -: Negative impact)
B: Significant impact is expected (+: Positive impact, -: Negative impact)
C: Further study is required as impact is unknown
D: Impact with little significance occurs
Source: JICA Study Team

7. ENVIRONMENTAL MANAGEMENT PLAN AND MONITORING PLAN

7.1 Overview

Descriptions of environment management measures during different stages of the project are provided in this chapter.

7.1.1 Pre-construction Stage

Required management measures during the pre-construction stage include the clearance of the ROW, plantation of trees, the measures for protecting/replacing community resources such as electric poles, public urinals, and water points that are likely to be impacted. Their enhancement shall also be completed before construction work starts so that the community can start using these when the construction activity begins.

7.1.2 Construction Stage

This will be most crucial and active stage for the Environmental Management Plan (EMP). In addition to the monitoring of the construction activity itself to ensure that the environment is not damaged beyond permissible limits, the enhancement of cultural and community properties, mitigation and enhancement measures for water bodies through proper treatment of spoil soils will be undertaken as the construction progresses. To facilitate implementation of the enhancement and mitigation measures suggested, working drawings of the same have been provided in the Appendices. In addition, the provision of proper risk management with respect to construction activities such as accidental spillage is critical at this stage to avoid damage to flora and fauna, agricultural land and other sensitive resources. Typical locations of concerns include the locations of hot-mix plants (spillage of fuel, bitumen etc.) and labor camp sites.

7.1.3 Operation Stage

The operation stage will essentially entail monitoring activity along the project area. In addition to checking the efficacy of the protection/ mitigation/ enhancement measures implemented, this will help verify or refuse the predictions made as a part of the impact assessment. Thus, it will complete a very important feedback loop for the project.

7.2 Environment Management Plan for Mitigation of Negative Impacts

The detailed measures adopted and/or to be adopted during different stages of the project to mitigate negative impacts and enhance positive aspects are shown in Table 7-3 and Table 7-4. The responsibility for implementation and supervision of EMPs are vested with three agencies, namely, Contractors, PIU, and Supervision consultants (SC). The Contractors herein mean the agency hired for execution of the construction works for the respective contract packages. PIU would be implementation agency with the support of PWD.

7.2.1 Dust Emanation and Mud Spillage

Because of the dust emanation during the dry season and mud spillage during the rainy season, the Contractor has to sprinkle water in the construction area during the dry season. Barriers and sand bags should be provided during rainy season in order to prevent mud from spilling over to the road and sidewalks.

7.2.2 Solid Waste

Various types of waste could be produced during the construction period ranging from oil, spare parts of the construction plants including electrical parts, waste from workforce camp, removal of old structures, etc. Thus, the Contractor should provide a number of boxes/cases in order to separate waste for disposal and reuse. These waste are transported periodically to the locations designated by Meghalaya State Pollution Control Board.

7.2.3 Noise Levels

The Contractor should provide various measures in order to lower the noise level during the construction period as follows:

- The plants and equipment used for construction will strictly conform to Central Pollution Control Board (CPCB) noise standards. Vehicles, equipment and construction machinery shall be monitored regularly with particular attention to silencers and mufflers to maintain noise levels to a minimum.
- Workers in the vicinity of high noise levels must wear earplugs, helmets and should be engaged in diversified activities to prevent prolonged exposure to noise levels of more than 90 dB(A).
- In construction sites within 150 m of human settlements, noisy construction will be stopped between 10 PM and 6 AM except for when laying the cement concrete pavement, for which a lower working temperature is a requirement.
- Noise barrier should be provided based on the measured values of noise level. Schools and hospitals should be protected from the noise with a provision of noise barriers.
- Near the sensitive receptors such as hospitals and schools, noise barriers such as earth, concrete, wood, metal or double-glazing of windows for façade insulation shall be used.
- Careful planning of machinery operation and scheduling of operations can reduce noise levels. Use of equipment emitting noise not greater than 90 dB(A) for the eight-hour operations shift and locating construction yards at a distance of at least 500 m from any residential areas should be adhered to.
- Use of noise shields on construction machinery and the provision of earplugs to the heavy machine operators are some of the mitigation measures, which should be followed by the contractors during the civil works.

Typical noise level emanated by the construction plant is shown in Table 7-1.

Table 7-1: Typical Noise Level Emanated by Construction Plants

Construction Equipment	Noise Level dB(A)
Bulldozer	80
Front end loader	72–84
Jack hammer	81–98
Crane with ball	75–87
Crane	75–77
Bulldozer	80
Backhoe	72–93
Front end loader	72–84
Cement & Dump trucks	83–94
Jack hammer	81–98
Scraper	80–93
Welding generator	71-82

Grader	80–93
Roller	73–75
Concrete mixer	74–88
Concrete pump	81–84
Concrete vibrator	76
Paver	86–88
Truck	83–94
Tamper	74–77
Air compressor	74–87
Pneumatic tools	81–98

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

The noise levels in the working environment prescribed by Occupational Safety and Health Administration of USA (OSHA-USA) are used by GOI through Model rules framed under the Factories, which can be applicable for construction yards.

The acceptable noise exposure limits for each shift being of eight hour duration id 90 dB(A). Hence noise generated due to various activities in the construction camps may affect workers, if equivalent eight hour exposure is more than the safety limit. Exposure to impulses or impact noise should not exceed 140 dB(A).

7.2.4 Traffic Jam

In the construction area within Shilling, the Contractor should provide a number of traffic guides, traffic barriers, signboards, colour cones and movable signals in order to maintain smooth flow of live traffic during the construction period.

In Dawki, the Contractor should also provide a number of traffic guides, traffic barriers, signboards, colour cones and movable signals in order to maintain smooth flow of live traffic during the construction period.

7.2.5 Afforestation Program

Afforestation program for the loss of the existing forest of 98.5 ha, approximately 118,250 trees, (or 97.9 ha, 117,530 trees if Bypass No.5 is excluded) should be carried out. Meghalaya State Department of Environment and Forest will identify the area of afforestation and tree species at the time of the examination for forest clearance.

Further, because of the road construction project emit greenhouse gas, afforestation program in order to sequester the amount of greenhouse gas. This is also a policy of the Government of India in respect of "Paris Agreement" of COP21 in terms of climate change measures. Thus approximately 121 ha (or 106.6 ha if Bypass No.5 is excluded) including the greenhouse gas sequestration for the increase of vehicles, afforestation program has to be carried out.
In total approximately 219.5 ha (or 204.5ha if Bypass No.5 is excluded) of afforestation program is planned. These afforestation programs also functions as habitat loss of the wildlife including bird species such as Tawny-breasted Wren-babbler.

7.3 Environmental Monitoring Plan

7.3.1 Air Quality and CO_2 Monitoring Works

Ambient air quality parameters recommended for monitoring road transportation developments are PM10, PM 2.5, Carbon Monoxide (CO), Oxides of Nitrogen (NOX), Sulphur Dioxide (SO_2) and Lead (Pb) should be monitored based on the monitoring post in Shillong and Dawki established by the Meghalaya State Pollution Control Board and NHIDCL should provide monitoring cost.

In the event that measured values of these locations showing excessively high values, further monitoring should be carried out in the mid-point of the project area and/or strategic monitoring plan should be elaborated for further environmental management plan.

7.3.2 Waste Management

Construction debris and other waste produced during the construction period are subject to separation for disposal and reuse. These are subject to transportation by the Contractor to the locations designated by MSPCB. This activity is subject to monitoring in terms of compliance of the waste management rule of India.

7.3.3 Noise and Vibration Level

The Contractor is requested to carry out noise monitoring works during the construction period.

Based on the baseline data obtained during the study period, further noise level monitoring works should be carried out by NHIDCL during the operation and maintenance period. Monitoring timing should be on the clear day of May to July period in order to match the measured timing of the baseline data.

CPCB put out noise standard in the Year 2000 as per Table 7-2, exceeding the standard could mean vibration is also causing some sort of problems to the near-by structures. Thus, the measured values should be used as indicator of which traffic vibration is occurring.

In the event noise level is exceeding, interview survey should be carried out if any troubles are occurring on the structures caused by traffic vibration. Further monitoring strategy should be elaborated if near-by structures are receiving excessive traffic vibration.

Table 7-2: Standard of Noise Level

Area	Limits in dB(A) Leq*	
	Day Time	Night Time
Industrial Area	75	70
Commercial Area	65	55
Residential Area	55	45
Silence Zone	50	40

Note:
1. Day time shall mean from 6.00 a.m. to 10.00 p.m.
2. Night time shall mean from 10.00 p.m. to 6.00 a.m.
3. Silence zone is an area comprising not less than 100 m around hospitals, educational institutions, courts, religious places or any other area which is declared as such by the competent authority.
4. Mixed categories of areas may be declared as one of the four above-mentioned categories by the competent authority.

* dB(A) Leq denotes the time weighted average of the level of sound in decibels on scale A which is related to human hearing.
A "decibel" is a unit in which noise is measured.
"A", in dB(A) Leq, denotes the frequency weighting in the measurement of noise and corresponds to frequency response characteristics of the human ear.
Leq: It is an energy mean of the noise level over a specified period.
Source: Central Pollution Control Board, India

7.3.4 Changes of Topography and Geographic Conditions

Cut and fill slopes are created during the construction period. Thus, monitoring works should be carried out in order to avoid unwanted changes of topography such as slope gradient and natural drainage system. The Contractor is to provide necessary protection works during the implementation of cut and fill slope works.

Because of the vegetation along the project area including plants used for slope protection will generally be rejuvenated over 7 years. Thus NHIDCL has to carry out periodical monitoring of slope stabilization over 7 years.

Quarry areas developed for obtaining construction materials should be monitored periodically in order to maintain slope gradient of cut slopes. Upon completion of the construction works, deposited topsoil should be back-filled in order to reinstate the environmental conditions. All these activities are subject to monitoring.

7.3.5 Soil Erosion

As above, monitoring on the soil erosion is a part of the monitoring works for topographic and geographical changes.

7.3.6 Hydrogeography

During the construction period, natural drainage system such as rivers and streams as well as agricultural waterways are subject to monitoring during heavy rains as well as after the rainfall period in order to avoid blockage of water flow caused by the construction debris. Periodical monitoring on the natural drainage should also be carried out.

7.3.7 Natural Disaster

Natural disaster is associated with heavy rainfall in general. As explained above, monitoring works on the topographic and geographic changes, soil erosion and hydrogeography should all cover the monitoring of natural disaster which has to be carried out by NHIDCL. The way the Contractor is providing appropriate measures to prevent natural disaster during the construction period are also subject to monitoring by NHIDCL.

7.3.8 Landscape

There is no significant impact on the changes of landscape. However, landscape viewpoints established along the road could be temporarily closed or changed its configuration, parking area, safety barriers, etc. These activities should be closely monitored.

7.3.9 Ecological and Biodiversity

Above monitoring program will cover the monitoring program for the ecological and biodiversity.

7.3.10 Afforestation

NHIDCL is required to carry out monitoring program in respect to the afforestation program for the Project as follows:

a. Permanent loss of the forest areas including trees and plants within ROW;
b. Changes of sun shine and its effect to the forest areas remaining outside ROW;
c. Strict prohibition of damaging plant species outside ROW;
d. CO_2 Emission of the Construction plants and vehicles used during the construction period;
e. Dust and muds accumulated on the plants during the construction period; and
f. Achievement of the afforestation area, number of planted trees and species as well as their rate of survival of planted trees.

Actual afforestation work can be done either by NGO or by contractor while Forest Department is generally said to be the authority to take up. NHICL shall bear the cost in either case.

The afforestation program compensates permanent losses of forest species.

Wildlife including bird species should be monitored during the construction period as well as the operation and maintenance period. These monitoring result should be used in order to elaborate further environmental management plan.

7.3.11 Illegal Logging and Poaching

Because of the access to forest area becomes easy as a result of road construction project, NHIDCL is required to monitor illegal logging and poaching periodically during the operation and maintenance period.

The project area goes through the habitat of bird species in the southern half of Meghalaya State. Its first 6–7 km borders the "Upper Shillong Important Bird Area". A number of bird species inhabit in the area including "Tawny-breasted Wren-babbler (Spelaeornis longicaudatus)".

Thus, the Contractors are requested to monitor the bird species during the construction period and the result has to be reported to the Meghalaya State Department of Environment and Forest. NHIDCL should carry out the same during the operation and maintenance period. Monitoring result should be reported periodically to the Meghalaya State Department of Environment and Forest.

7.3.12 Climate Change Measures

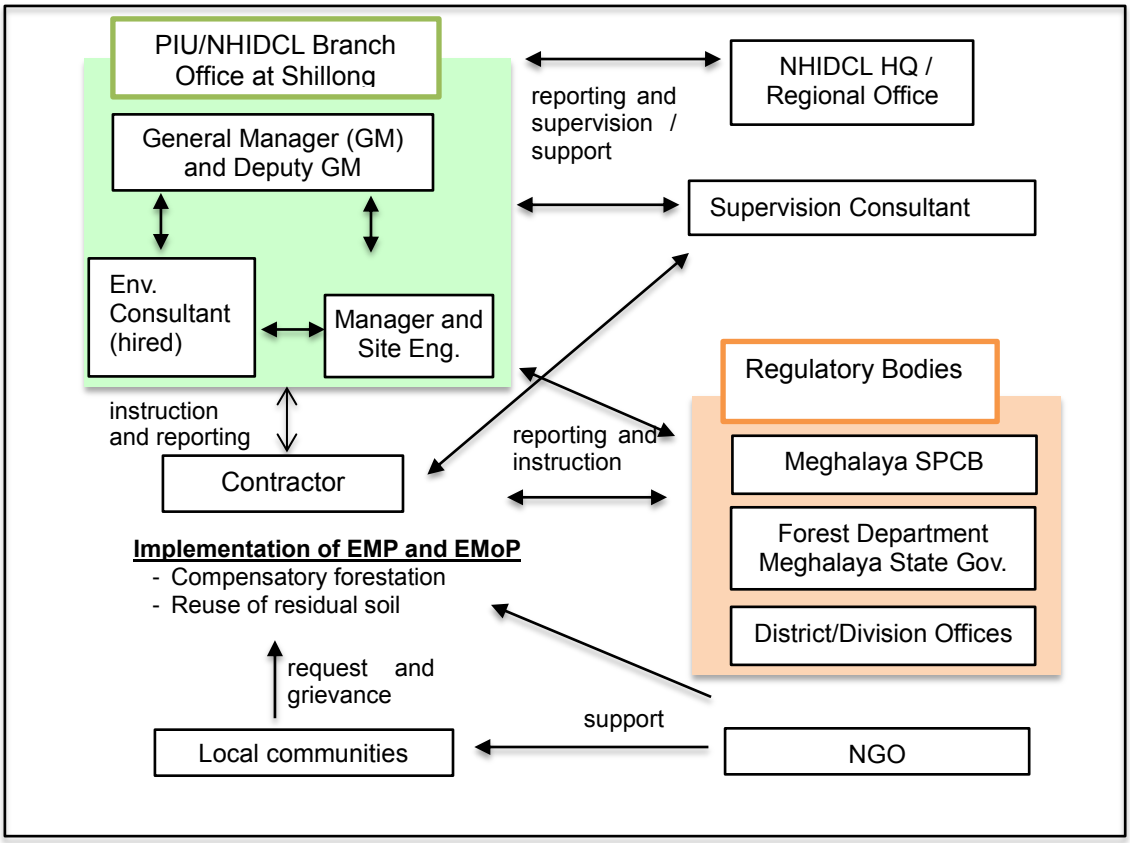
Construction works related to the climate change measures such as cut and fill slope protection, bridges and culverts crossing over natural drainage system as well as agricultural waterways and other measures designed to cope with the excessive rainfall should all be subject to monitoring if these are carried out as designed.

7.4 Organization of Environmental Management and Monitoring Plan

As is shown in Figure 7-1 and Figure 7-2, NHIDCL is the project implementation unit during the construction period as well as the operation and maintenance period. It is thus responsible for implementation of Environmental Management and Monitoring Plan. However, cost of monitoring works during the construction period is a part of construction contract. External consultant shall be employed and arranged in PIU for implemnation of EMP and EMoP, and supervising consultant shall support PIU so that the actual work is complied with JICA Guideline.

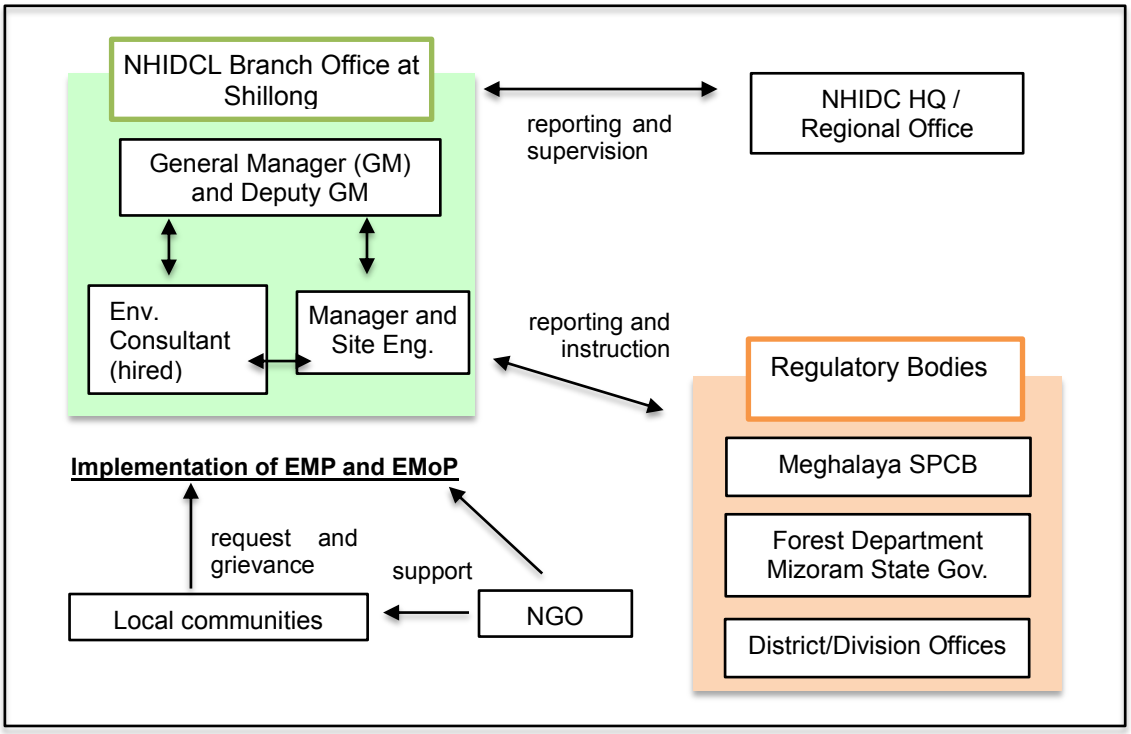
During the operation and maintenance period, air quality monitoring works in Shillong and Dawki should be cost-wise responsibility of NHIDCL while actual measuring works could be entrusted to MSPCB. Other 7 points of air quality monitoring locations should be subject to further monitoring works in the event excessive monitoring values at Shillong and Dawki are observed.
Afforestation program should begin as soon as the construction work is over. Area of afforestation, species of trees, rate of survival, achievement of afforestation, etc. should all be monitored. NGO could be employed for staff training on the monitoring of wildlife including bird species as well as to plant trees for 219.5 ha of afforestation area, while contractor can be in charge of afforestation.

Meghalaya State Department of Environment and Forestry could play an important role for guidance in respect of afforestation program. NHIDCL should therefore follow the guidance of Meghalaya State Department of Environment and Forestry.



Source: JICA Study Team

Figure 7-1: Organization of Environmental Management and Monitoring Plan during the Construction Period



Source: JICA Study Team

Figure 7-2: Organization of Environmental Management and Monitoring Plan during the Operation and Maintenance Period

7.5 Matrix of the Environmental Management and Monitoring Plan

The Environmental Management Plan for the pre-construction period is shown in Table 7-3. The Environmental Management Plan for the construction period is shown in Table 7-4 and for Operation and Maintenance Period in

Table 7-5.

Table 7-3 Environmental Management Plan for Pre-Construction Stage

Sl. No	Environmental Impacts/Issues	Mitigation Measures	Location	Time Frame	Responsibility	
					Implementation	Supervision
P1	Relocation of Project Affected Persons (PAP)	• All requirements of the RAP as applicable shall be complete before start of construction stage. The activities broadly include acquisition of land and structures, relocation of utilities, payment of compensation and provision assistance	All areas	Beforeconstruction begins	Government of Meghalaya, District Revenue authorities and NGO/Consultant/	PIU, SC
P2	Removal of vegetation	• Minimize the scale of vegetation clearing by factoring vegetation/forest cover in the final design of the road alignment process • Removal of trees to be carried out after forest clearance is obtained • Reforestation/replantation of trees at a term as instructed by the Forest Dept. • Activity shall be supervised to avoid poaching of animals	All areas	Before construction Begins (Reforestation/ replantation may extend to during/after construction)	PIU, Contractor, Forest and Environment Department	PIU, SC, Forest Dept.
P3	Setting up construction camps	• Camps shall be located at least 500m away from the nearest built-up area. • Sewage system for a construction laborer's camp shall be designed, built and operated so that no pollution to ground or adjacent water bodies/watercourses take place. • Garbage bins shall be provided in the camps and regularly emptied and the garbage disposed off in a hygienic manner, to the satisfaction of the relevant norms and the Engineer. • In relation to underground water resources, the contractor shall take all necessary precaution to prevent interference with such water resources.	All construction campsite identified by the contractor and approved by SC	During Establishment, Operation and Dismantling of Such Camps.	Contractor	PIU, SC

Sl. No	Environmental Impacts/Issues	Mitigation Measures	Location	Time Frame	Responsibility	
					Implementation	Supervision
		• All relevant provisions of the Factories Act, 1948 and the Building And other Construction Workers (regulation of Employment and Conditions of Service) Act, 1996 shall be adhered to.				
P4	Setting up hot mix plants	• Hot mix plants and batching plants shall be located sufficiently away from habitation and agricultural fields . • Where possible such plants will be located at least 1000m away from the nearest habitation.	All hot-mix and batching plants	During Erection, Testing, Operation and Dismantling of Such Plants.	Contractor	PIU, SC
P5	Finalizing sites for surplus soil dumping	• Location of dumping sites shall be finalized. The sites shall meet following conditions: i) dumping does not impact natural drainage courses; ii) no endangered/rare flora is impacted by such dumping	All areas identified as potential dumping sites	During mobilization	Contractor	PIU, SC
P6	Identification of hazard-prone locations	• The contractor shall identify locations sensitive to landslides (in addition to the ones that area already identified) and shall duly report these to the Supervision Consultant (SC) and to PIU.	All area	During mobilization	Contractor	PIU, SC
P7	Identify and prepare relocation sites	• Location of relocation sites shall be identified in consultation with district/village authorities and PAPs. • Sites to be developed including provision of necessary utilities such as water and electricity.	Near villages with large-scale resettlement		PIU	PIU

Source: JICA Study Team

Table 7-4: Environmental Management Plan during the Construction Stage

Sl. No	Environmental Impacts/Issues	Mitigation Measures	Location	Time Frame	Responsibility	
					Implementation	Supervision
Soil						
C1	Soil Erosion in borrow pits	• The depth of borrow pits shall be restricted so that the sides of the excavation shall have a slope not steeper than 1:4, from the edge of the final section of the bank.	On approved locations of borrow pits	Construction Stage	Contractor and Supervision Consultant	PIU
C2	Loss of top soil in borrow pits	• Agricultural fields or productive land shall be avoided for borrowing earth. If unavoidable, topsoil shall be preserved and used for tree plantation.	On approved locations of borrow pits	Construction Stage	Contractor and Supervision Consultant	PIU
C3	Compaction of soil	• Construction equipment and vehicles shall be restricted to move only within a designated area to avoid compaction of productive soil.	Throughout the corridor	Construction Stage	Contractor and Supervision Consultant	PIU
C4	Soil erosion in embankments	• Pitching shall be done for slope stabilization as per the IRC guidelines.	At embankments	Construction Stage	Contractor and Supervision Consultant	PIU
C5	Contamination of soil from fuel and lubricants	• Construction vehicles and equipment shall be operated and maintained in such a manner so that soil contamination from spillage shall be at a minimum. • Fuel storage shall only be done on wasteland and will be kept away from drainage channels and natural water bodies.	Near the workers' camp and sites for the installation of construction machineries	Construction Stage	Contractor and Supervision Consultant	PIU
C6	Contamination of land from construction waste and quarry materials	• Debris generated due to the dismantling of the existing pavement structure and the cutting of the hill side for the widening shall be suitably reused in the proposed construction, such as for fill materials for embankments. • Debris and other material obtained from existing embankment shall be dumped in approved landfill site alreadyidentified by concerned agency. All spoils shall	Solid waste dump site identified and approved by MSPCB or competent authority. Throughout the area.	Construction Stage	Contractor and Supervision Consultant	PIU

Sl. No	Environmental Impacts/Issues	Mitigation Measures	Location	Time Frame	Responsibility	
					Implementation	Supervision
		be disposed off as desired and the site shall be fully cleaned before handing over. • Construction waste including non-bituminous and bituminous waste shall be dumped in approved landfill siteidentified by StatePollution Control Board (SPCB) or competent authority. All spoils shall be disposed off as desired and the site shall be fully cleaned before handing over.				
C7	Loss of top soil in land acquisition	• Topsoil shall be stripped, stored and shall be laid on ground for landscaping purposes.	Throughout the area	Construction Stage	Contractor and Supervision Consultant	PIU
Water						
C8	Contamination of water by fuel / oil spillage from vehicles	• Construction vehicles / equipment shall be operated and maintained in such a manner so as to avoid contamination of water bodies due to oil spillage. • Fuel storage shall only be done on wasteland and will be kept away from drainage channels and natural water bodies.	Near the workers' camp and sites for the installation of construction machineries	Construction Stage	Contractor and Supervision Consultant	PIU
C9	Contamination of stagnant water body by fecal matters from workers' camp	• Labor camp shall not be allowed near any of the water bodies. • Proper sanitation facilities shall be provided.	Preapproved locations Away from water bodies.	Construction Stage	Contractor and Supervision Consultant	PIU
C10	Deposition of dust in open wells near construction site	• The mouth / opening of the well shall be covered with suitable material during any of the construction activities so as to prevent dust from entering the well.	All the wells along the project corridor	Construction Stage	Contractor and Supervision Consultant	PIU
C11	Using drinking water for construction purpose	• The contractor shall make arrangements for water required for construction in such a way that water availability and supply to nearby community is unaffected. • Wastage of water shall be kept to a	At respective planned construction sites	Construction Stage	Contractor and Supervision Consultant	PIU

Sl. No	Environmental Impacts/Issues	Mitigation Measures	Location	Time Frame	Responsibility	
					Implementation	Supervision
		minimum during construction.				
C12	Hand pump close to road may get affected in widening	• All the hand pumps shall be relocated to a suitable alternate place.	At the respective locations	Construction Stage	Contractor and Supervision Consultant	PIU
C13	Wells or water storage system may get affected in widening	• Alternate arrangements will be made for all wells or water storage systems	At the respective locations	Construction Stage	Contractor and Supervision Consultant	PIU
C14	Altering flow of natural drains	• Drain shall be channelized with slope protection – Gabion Structure.	At the respective locations	Construction Stage	Contractor and Supervision Consultant	PIU
C15	Sanitation of waste disposal in construction camps	• The construction of camps will be done with sufficient buffer from any habitations. • At construction sites and camps, a sufficient number of latrines will be provided. • The sewage generated from the camps will be properly disposed of so that it does not affect water bodies.	Wherever workers' camp is located	Construction Stage	Contractor and Supervision Consultant	PIU
Air						
C16	Emission from construction vehicles and machinery	• All vehicles, equipment and machinery shall be selected to meet recognized international and national standards for emissions and shall be maintained and operated in a manner that ensures relevant air, noise and discharge rules are followed. • Only unleaded petrol and low sulphur diesel or sulphur free diesel shall be used as fuel for vehicles, equipment and machinery.	Wherever the hot mix plant and batching plant is setup	Construction Stage	Contractor and Supervision Consultant	PIU
C17	Air pollution from various plants affecting settlements	• The asphalt plants, crushers and batching plants shall not be sited less than 500 m in leeward direction from the nearest human settlement.	Locations near settlements	Construction Stage	Contractor and Supervision Consultant	PIU
C18	Air pollution may exceed the limits prescribed by the Central Pollution	• Regular monitoring or air quality parameters during the construction period as envisaged in the Environmental Monitoring	Locations given in EMP	Construction Stage	Contractor and Supervision Consultant	PIU

Sl. No	Environmental Impacts/Issues	Mitigation Measures	Location	Time Frame	Responsibility	
					Implementation	Supervision
	Control Board	Plan.				
C19	Vehicles will generate dust and suspended particles	• The dust generated by vehicles on site shall be arrested using a water tanker fitted with a sprinkler capable of applying water uniformly at a controllable rate of flow to variable widths of surface but without any flooding.	Wherever the plants are set up and sensitive locations as suggested in monitoring plan	Construction Stage	Contractor and Supervision Consultant	PIU
Noise and Vibration						
C20	Noise levels from vehicles, Asphalt plants and equipment	• The plants and equipment used for construction shall confirm to CPCB norms. • Vehicles and equipment used shall be fitted with silencer. • Any vehicle and machinery shall be kept in good working order and engines turned off when not in use. • Regular monitoring of noise Parameters (Leq) during the construction period as envisaged in the Environmental Monitoring Plan.	Wherever the plants are setup All along the corridor Wherever the sensitive locations like schools, hospitals and other community places are located.	Construction Stage	Contractor and Supervision Consultant	PIU
C21	Noise from blasting operations	• Blasting as per Indian Explosives act will be carried out. • People living near such blasting operation sites shall be informed before the operational hours. • Workers at blasting sites shall be provided with earplugs.	At the sites where the blasting is required and in quarry sites	Construction Stage	Contractor and Supervision Consultant	PIU
C22	Noise barriers	• Construction of noise barriers in the form of walls at Sensitive locations upon consultation with stakeholders.	All along the corridor Wherever the sensitive locations like schools, hospitals and other community places are located.	Construction Stage	Contractor and Supervision Consultant	PIU

Sl. No	Environmental Impacts/Issues	Mitigation Measures	Location	Time Frame	Responsibility	
					Implementation	Supervision
C23	Vibration	• The vehicles, especially heavy vehicles will reduce the speed where there are communities	All the site	Construction Stage	Contractor and Supervision Consultant	PIU
Flora and Faun						
C24	Tree cutting for widening	• Three trees shall replace each tree cut for the project. • The engineer shall approve such felling only when the NHIDCL receives a "clearance" from the Forest Department applicable. Trees felled shall be replaced as per the compensatory afforestation criteria in accordance with the Forests (Conservation) Act, 1980.	Throughout the project area	Construction Stage	Contractor, Supervision Consultant, and Forest Department	PIU
C25	Damage or loss of important flora	• During construction, at any point in time, if rare / threatened / endangered flora species is found, it shall be conserved in a suitable manner in consultation with authorities. The Engineer shall approve detailed conservation processes, plans and designs as well as associated modification in the project design.	Throughout the project area	Construction Stage	Contractor and Supervision Consultant	PIU
Health and Hygiene						
C26	Health hazard to workers due to bad water and sanitation	• At every workplace, good and sufficient potable water (as per IS 10500) supply shall be ensured to avoid water-borne diseases and to ensure the health of workers. • Adequate drainage, sanitation, and waste disposal shall be provided at workplaces. • Preventive medical care shall be provided to workers.	Wherever workers' camp is setup	Construction Stage	Contractor and Supervision Consultant	PIU
C27	Health hazard to workers by various construction	• Personal protective equipment shall be provided to workers as per the Factories	Throughout theproject area	Construction Stage	Contractor and Supervision	PIU

Sl. No	Environmental Impacts/Issues	Mitigation Measures	Location	Time Frame	Responsibility	
					Implementation	Supervision
	activities	Act.			Consultant	
C28	Health / social hazard, sexual harassment to female workers	• Segregation of male and female areas in workers' camp.	Wherever workers' camp is setup	Construction Stage	Contractor and Supervision Consultant	PIU
C29	Hygiene at construction camps	• The Contractor during the progress of work will provide, erect and maintain necessary (temporary) living accommodation and ancillary facilities for labor to standards and scales approved by the resident engineer. • These shall be provided within the precincts of every workplace, latrines and urinals in an accessible place, and the accommodation, separately for each for these, as per standards set by the Building and other Construction Workers (regulation of Employment and Conditions of Service) Act, 1996. There shall be adequate supply of water, close to latrines and urinals. • All temporary accommodation shall be constructed and maintained in such a fashion that uncontaminated water is available for drinking, cooking and washing. The sewage system for the camp must be properly designed, built and operated so that no health hazard occurs and no pollution to the air, ground or adjacent Compliance with the relevant legislation must be strictly adhered to. Garbage bins shall be provided in the camp and regularly emptied and the garbage disposed off in a lined landfill sites. Construction camps are to be sited away from vulnerable people and adequate health care is to be provided for the	Wherever workers' camp is setup	Construction Stage	Contractor and Supervision Consultant	PIU

Sl. No	Environmental Impacts/Issues	Mitigation Measures	Location	Time Frame	Responsibility	
					Implementation	Supervision
		work force. • On completion of the works, the whole of such temporary structures shall be cleared away, all rubbish burnt, excreta or other disposal pits or trenches filled in and effectively sealed off and the whole of the site left clean and tidy, at the contractor's expense, to the satisfaction of the engineer.				
C30	Abandoned quarry will accumulate water and act as a breeding ground for disease vectors	• Reclamation measures shall be adopted with garlands of trees around the periphery. The quarry dust and waste shall be used for refilling. The remaining portion should be covered with trees.	All quarry locations	Construction Stage	Contractor and Supervision Consultant	PIU
Safety						
C31	Safety of vehicles plying on road while the construction activity is going on	• Prior arrangement / traffic diversion for safe passage of vehicles shall be made with proper direction and signage at the construction site. • Detailed Traffic Control Plans shall be prepared and submitted to the site engineer / project director for approval 5 days prior to commencement of works on any section of the road. • The traffic control plans shall contain details of temporary diversions, details of arrangements for construction under traffic and details of traffic arrangement after cessation of work each day.	Throughout the project area	Construction stage	Contractor and Supervision Consultant	PIU
C32	Risk from operations	• The contractor is required to comply with all the precautions as required for the safety of the workmen as far as those are applicable to this contract. • The contractor shall supply all necessary safety appliances such as safety goggles,	All construction sites	Construction stage	Contractor and Supervision Consultant	PIU

Sl. No	Environmental Impacts/Issues	Mitigation Measures	Location	Time Frame	Responsibility	
					Implementation	Supervision
		helmets, masks, etc., to the workers and staff. The contractor must comply with all regulations regarding safe scaffolding, ladders, working platforms, gangway, stairwells, excavations, trenches and safe means of entry and egress.				
C33	Risk from Electrical Equipment	• Adequate precautions will be taken to prevent danger from electrical equipment. No material or any of the sites will be so stacked or placed as to cause danger or inconvenience to any • All necessary fencing and lights will be provided to protect the public. All machines to be used in the construction will conform to the relevant Indian Standards (IS) codes, will be free from patent defect, will be kept in good working order, will be regularly inspected and properly maintained as per IS provisions and to the satisfaction of the Engineer.	All construction Site	Construction stage	Contractor and Supervision Consultant	PIU
C34	Risk at Hazardous Activity	• All workers employed on mixing Asphaltic material, cement, lime mortars, concrete etc., will be provided with protective footwear and protective goggles. Workers, who are engaged in welding works, would be provided with welder's protective eye-shields. Stone-breakers will be provided with protective goggles and clothing and will be seated at sufficiently safe intervals. • The use of any herbicide or other toxic chemical shall be strictly in accordance with the manufacturer's instructions. The Engineer shall be given at least 6 working days' notice of the proposed use of any herbicide or toxic chemical. A	All construction sites	Construction stage	Contractor and Supervision Consultant	PIU

Sl. No	Environmental Impacts/Issues	Mitigation Measures	Location	Time Frame	Responsibility	
					Implementation	Supervision
		register of all herbicides and other toxic chemicals delivered to the site shall be kept and maintained up to date by the Contractor. The register shall include the trade name, physical properties and characteristics, chemical ingredients, health and safety hazard information, safe handling and storage procedures, and emergency and first aid procedures for the product. This should comply with Hazardous Material Act.				
C35	Risk of Lead Pollution	• Nobody below the age of 18 years and no woman shall be employed on the work of painting with products containing lead in any form. No paint containing lead or lead products will be used except in the form of paste or readymade paint. • Facemasks will be supplied for use by the workers when paint is applied in the form of spray or a surface having lead paint dry rubbed and scrapped	All construction sites	Construction stage	Contractor and Supervision Consultant	PIU
C36	Risk caused by Force' Majure	• All reasonable precaution will be taken toprevent danger of the workers and the public from fire, flood, drowning, etc. All necessary steps will be taken for prompt first aid treatment of all injuries likely to be sustained during the course of work.	All construction Site	Construction stage	Contractor and Supervision Consultant	PIU
C37	Risk from Explosives	• Except as may be provided in the contract or ordered or authorized by the Engineer, the Contractor shall not use explosives. Where the use of explosives is so provided or ordered or authorized, the Contractor shall comply with the requirements of the following Sub-Clauses of this Clause besides the law of the land as applicable.	Place of use of Explosives	Construction stage	Contractor and Supervision Consultant	PIU

Sl. No	Environmental Impacts/Issues	Mitigation Measures	Location	Time Frame	Responsibility	
					Implementation	Supervision
		• The Contractor shall at all times take every possible precaution and shall comply with appropriate laws and regulations relating to the importation, handling, transportation, storage and use of explosives and shall, at all times when engaged in blasting operations, post sufficient warning flagmen, to the full satisfaction of the Engineer. • The Contractor shall at all times make full liaison with and inform well in advance and obtain such permission as is required from all Government Authorities, public bodies and private parties whatsoever concerned or affected or likely to be concerned or affected by blasting operations.				
C38	Malarial risk	• The Contractor shall, at his own expense, conform to all anti-malarial instructions given to him by the Engineer, including filling up any borrow pits which may have been dug by him	All construction sites	Construction stage	Contractor and Supervision Consultant	PIU
C39	First Aid	• At every workplace, a readily available first aid unit including an adequate supply of sterilized addressing material and appliances will be provided.	At the construction site / workers' camp	Construction stage	Contractor	PIU
Disruption to Road Users						
C40	Loss of access	• At all times, the contractor shall provide safe and convenient passage for vehicles, pedestrians and livestock to and from side roads and property accesses connecting the project road. Work that affects the use of side roads and existing accesses shall not be undertaken without providing adequate provisions to the prior satisfaction of the	Throughout the project area, particularly in built-up areas	During Construction	Contractor	PIU

Sl. No	Environmental Impacts/Issues	Mitigation Measures	Location	Time Frame	Responsibility	
					Implementation	Supervision
		engineer. • The works shall not interfere unnecessarily or improperly with the convenience of the public or the access to, use and occupation of public or private roads, and any other access footpaths to or of properties whether public or private.				
C41	Traffic Jams and Congestion	• Detailed Traffic Control Plans shall be prepared and submitted to the Site Engineer/ Project Director for approval 5 days prior to commencement of works on any section of road. The traffic control plans shall contain details of temporary diversions, details of arrangements for construction under traffic and details of traffic arrangement after cessation of work each day. • Temporary diversion (including scheme of temporary and acquisition) will be constructed with the approval of the designated Engineer. While approving temporary diversion construction, the Engineer will seek endorsement from the PIU. • Special consideration shall be given in the preparation of the traffic control plan to the safety of pedestrians and workers at night. • The Contractor shall ensure that the running surface is always properly maintained, particularly during the monsoon so that no disruption to the traffic flow occurs. As far as possible idling of engines shall be avoided to curb pollution.	Throughout Corridor	During Construction.	Contractor	Engineer

Sl. No	Environmental Impacts/Issues	Mitigation Measures	Location	Time Frame	Responsibility	
					Implementation	Supervision
		• The temporary traffic detours shall be kept free of dust by frequent application of water, if necessary.				
C42	Traffic Control and Safety	• The Contractor shalltakeall necessary measures for the safety of traffic during construction and provide, erect and maintain such barricades, including signs, markings, flags, lights and flagmen as may be required by the Engineer for the information and protection of traffic approaching or passing through the section of the highway under improvement. • All signs, barricades, pavement markings shall be as per the MORTH specification. Before taking up construction on any section of the highway, a traffic control plan shall be devised to the satisfaction of the Engineer as per EMP. Excavated pits shall be filled to avoid falling of animals/ human beings.	Throughout the project area	During Construction.	Contractor	Engineer
C43	Solid waste	• Construction debris and other waste produced during the construction period are subject to separation for disposal and reuse. These are subject to transportation by the Contractor to the locations designated by MSPCB. This activity is subject to monitoring in terms of compliance of the waste management rule of India. • Surplus soil from excavation, if any, will be dumped at the approved dumping	All construction sites	Construction stage	Contractor and Supervision Consultant	PIU

Sl. No	Environmental Impacts/Issues	Mitigation Measures	Location	Time Frame	Responsibility	
					Implementation	Supervision
		ground.				
Environment Enhancement						
C43	Hand pumps enhancement/relocation for ground water recharging	• Hand pumps within Right of Way shall be enhanced/relocated.	At the respective locations along the corridor.	Construction Stage	Contractor and Supervision Consultant	PIU
C44	Roadside landscape development	• Avenue plantation of foliage trees mixed with flowering trees, shrubs and aromatic plants shall be carried out where ever land is available between ditches and Right of Way.	Throughout the corridor	Construction Stage	Contractor and Supervision Consultant	PIU
C45	Providing better bus bays	• Bus shelters shall be provided at given locations	As per traffic plan	Construction Stage	Contractor and Supervision Consultant	PIU
C46	Better sitting arrangements where small space is available	• Designed sitting arrangements shall be provided.	As per the design	Construction Stage	Contractor and Supervision Consultant	PIU
C47	Landscaping of junctions	• All rotary junctionsshall be landscaped suitably	As per landscape design at the respective locations	Construction Stage	Contractor and Supervision Consultant	PIU
C48	Abandoned Quarry will accumulate water and act as a breeding ground for disease vectors.	• The abandoned quarry locations shall be planted suitably as the plan	Wherever quarries are located and abandoned	Construction Stage	Contractor and Supervision Consultant	PIU
C49	Erosion of embankments, shoulders, side slopes, and pavement leading to deterioration and affecting stability and integrity of road	• Earth works specifications will include provision for stable slope construction, compacting and laying out turf including watering until ground cover is fully established • Proper construction of Breast wall and retaining wall at the locations identified by the design team to avoid soil erosion. • The measures proposed for slope stabilization are: Discharge zones of drainage structures (culverts and minor bridges) provided with riprap	At the respective locations throughout the project area.	Construction Stage	Contractor and Supervision Consultant	PIU

Sl. No	Environmental Impacts/Issues	Mitigation Measures	Location	Time Frame	Responsibility	
					Implementation	Supervision
		• Construction in erosion and flood prone areas will not be in monsoon /season. • Side slopes will be kept flatter wherever possible, and in case of steeper slopes it will be supported by the retaining wall.				

Source: JICA Study Team

Table 7-5: Environmental Management Plan during the Operation and Maintenance Period

Sl. No	Environmental Impacts/Issues	Mitigation Measures	Location	Time Frame	Responsibility	
					Implementation	Supervision
O1	Degradation due to Water quality road-run-off	• Silt fencing, oil & grease traps, etc. shall be provided at sensitive water bodies to ensure that the water quality is not impaired due to contaminants from road run-off Monitoring shall be carried out as specified in the monitoring plan	As specified in the monitoring plan	As per monitoring plan	PIU, SPCB	PIU
O2	Soil and water contamination from accidental spills	• Contingency plans to be in place for cleaning up of spills of oil, fuel and toxic chemicals • Monitoring shall be carried out as specified in the Monitoring Plan	As specified in the monitoring plan	Plan to be developed at state/district level by early operation stage	PIU, SPCB, Local Government Bodies	PIU
O3	Air quality degradation due to increases in traffic volume	• Monitoring shall be carried out as specified in the Monitoring plan • Share air quality data with SPBC and relevant agencies and discuss options for mitigate air quality degradation associated with greater traffic volume	As specified in the monitoring plan	As per monitoring plan	PIU, SPCB	PIU
O4	Increases in noise and vibration due to greater traffic volume	• Monitoring shall be carried out as specified in the Monitoring plan • Install noise barrier (wall etc.) in sensitive areas, if necessary	As specified in the monitoring plan	As per monitoring plan	PIU, SPCB	PIU

Sl. No	Environmental Impacts/Issues	Mitigation Measures	Location	Time Frame	Responsibility	
					Implementation	Supervision
O5	Traffic safety	• Traffic control measures including speed limits to be enforced strictly. • Local government bodies and development authorities will be encouraged to control building development along the highway	All area	Throughout operation stage	PIU, Local Government Bodies	PIU
O6	Accidents involving hazardous materials	• with the Hazardous Wastes (Management and Handling) Rules, 1989 including: For delivery of hazardous substances, permit license, driving license and guidance license will be required. • These vehicles will only be Harbored at designated parking lots. • In case of spill of hazardous materials, the relevant departments will be notified at once to deal with it with the spill contingency plan in case of spill of hazardous materials, the relevant departments	All area	Manual/guideline to be prepared during early operation stage	PIU	PIU
O7	Roadside tree plantation, flora and fauna	• Trees planted along the corridor shall be maintained for a period of three years. Maintenance works include, watering of the saplings, replacement of the bamboo fence every year for 3 years and all necessary measures for Monitoring of flora and fauna along the highway shall be carried out to assess conditions of ecosystem against the	All area and as per the monitoring plan	Immediately from the planting of sapling and as per monitoring plan	PIU, NGO	PIU

Sl. No	Environmental Impacts/Issues	Mitigation Measures	Location	Time Frame	Responsibility	
					Implementation	Supervision
O8	Compensatory Afforestation	• Forest areas of 98.5 ha lost to ROW of the Project as well as 121 ha of afforestation for greenhouse gas sequestration is carried out. • Tree species and the area of afforestation carried out in area of shifting agriculture is based on the guidance of Meghalaya State	Area based on the Monitoring Plan and the guidance of Meghalaya State Department of Forestry.		NHIDCL Meghalaya State Department of Forestry. NGO Groups	NHIDCL

Note: O-01 Denotes "No. 1 of the Operation and Maintenance Period"
Note 1: Field works are assisted by Meghalaya State Department of Environment and Forest while cost implication is the responsibility of NHIDCL.
Source: JICA Study Team

Table 7-6: Environmental Monitoring Plan

Sl. No	Item	Project Stage	Parameters	Guidance	Standards	Location	Frequency	Duration	Responsibility	
									Implementation	Supervision
M1	Air	Construction	PM10, PM2.5 SO2, NOx, CO,	• Dust sampler to be located 50m from the plan in the downwind direction. • Use method specified by CPCB for analysis	Air (P&CP) Rules, CPCB, 1994	Hot mix plant/ batching plant	Twice a year For three years	Continuous 24 hours	Contractor through approved monitoring agency	PIU
M2		Construction	PM10, PM2.5 SO2, NOx, CO,	• Dust sampler to be located 50m from the Earthworks site Downwind direction. Follow CPCB method for analysis	Air (P&CP) Rules, CPCB, 1994	Stretch of road where construction is underway(Minimum 5 locations)	Twice a year For three years	Continuous 24 hours	Contractor through approved monitoring agency	PIU
M3		Operation	PM10, PM2.5 SO2, NOx, CO,	• Use method specified by CPCB for analysis	Air (P&CP) Rules, CPCB, 1994	Sampling location specified in EIA report	Twice a year for one year	Continuous 24 hours	PIU	PIU
M4	Water	Construction	pH, BOD, COD, TDS, TSS, DO, Oil & Grease and Pb	• Sample collected from source and analyzed as per Standard Methods Examination of Water and Wastewater	Water quality standards by CPCB	Sampling locations specified in EIA report	Twice a year For three years		Contractor through approved monitoring agency	PIU
M5		Operation	pH, BOD, COD, TDS, TSS, DO, Oil & Grease and Pb	• Grab sample collected from source and analyze as per Standard Methods for Examination of Water • and Wastewater	Water quality standards by CPCB	Sampling locations specified in EIA report	Twice a year for one year		PIU	PIU
M6		Operation	Cleaning of drains and water bodies	• Choked drains, water bodies undergoing siltation and subject to debris disposal should be monitored under cleaning operations	To the satisfaction of the engineer (PWD)	All area	Post monsoon		PIU	PIU

M7	Noise	Construction	Noise levels on dB (A) scale	• Free field at 1m from the equipment whose noise levels are being determined.	Noise Standards by CPCB	At equipment yard	Once every 3 Month (max) for three years, as required by the engineer	Reading to be taken at 15 seconds interval for 15 minutes every hour and then averaged	Contractor through approved monitoring agency	PIU
M8		Operation	Noise levels on dB (A) scale	• Equivalent Noise levels using an integrated noise level meter kept at a distance of 15 m from edge of Pavement	Noise standards by CPCB	At maximum 9 sites those listed in EIA report for noise monitoring locations	Twice a year for 1 years	Readings to be taken at 15 seconds interval for 15 minutes every hour and then averaged.	PIU	PIU
M9	Soil erosion	Construction	Turbidity in Storm water; Silt load in ponds, water courses	• Visual observations during site visits	As specified by the engineer / Water quality standards	At locations of stream crossings and at locations of retaining wall and breast wall	Pre-monsoon and post- monsoon for three years		Contractor	PIU
M10		Operation	Turbidity in Storm water; Silt load in ponds, water courses	• Visual observations during site visits	As specified by the engineer / Water quality standards	As directed by the engineer	Pre-monsoon and post- monsoon for one year		PIU	PIU
M11	Construction camp	Construction	Monitoring of: 1.Storage Area; 2. Drainage Arrangement 3. Sanitation in Camps	• Visual Observations and as directed by the engineer	To the satisfaction of the engineer and Water quality standards	At storage area and construction workers' camp	Quarterly during construction stage		PIU	PIU

M12	Afforestation	Construction and operation	Plant survival percentage	• The success of tree planting. Monitor the rate of survival after six months, one year and 18 months in relation to total number of trees planted.		All area	Minimum three years after planting		NGO, PIU	PIU
M13	Flora and Fauna	Construction and operation	Condition of ecosystem	● Comparison to pre-project flora and fauna	As specified in TOR	As specified in TOR	Twice a year for three years		PIU	PIU

Source: JICA Study Team

7.5.1 Monitoring Form

Table 7-7 to Table 7-16 indicate JICA's standardized monitoring form. Monitoring works should be carried out every six months unless otherwise specifically explained.

Table 7-7: Environmental Clearance

Contents of Monitoring	Conditions During the Monitoring
Environmental Clearance Certificate obtained to date: (Name of the Certificate)	
Stakeholder meeting held for the commencement of the Construction works:	

Source: JICA Study Team

Table 7-8: Air Quality

Location of the Monitoring：Baseline Study Location #

Parameter	Baseline Data Value(Max.)	Measured Value (Max.)	Local Standard	Inter-national Standard (If any Referred to)	Remarks, (Conditions of the Monitoring Location、Interval/Timing of Monitoring, Methoding of Monitor)
SO_2	7.8 μg/m3		National Ambient Air Quality Standard: NAAQS		Baseline Study Location #, Clear day in the Beginning of Monsoon Period (May-July), National Ambient Air Quality Standard: NAAQS
NO_2	14.4 μg/m3				ditto
CO	1,141 μg/m3				ditto
O_2	-				ditto
PM10/ PM2.5	90.8/44.5				ditto

Source: JICA Study Team

Table 7-9: Water Quality

Location of the Monitoring：Baseline Study Location #

Parameter	Baseline Data Value(Max.)	Measured Value (Max.)	Local Standard	Inter-national Standard (If any Referred to)	Remarks, (Conditions of the Monitoring Location、Interval/Timing of Monitoring, Methoding of Monitor)
pH	7.15		Indian Standard Drinking Water Specification: IS 10500: 1991		Baseline Study Location #, Once a year in the beginning of Monsoon Period (May-July), based on the Indian Standard Drinking Water Specification e of the Certification
SS	7.5				ditto
BOD／COD	7.0				ditto
DO	6.6				ditto
All Nitrogen	0.89				ditto
All Phosphorous	<0.01				ditto
Heavy Metal	<0.01				ditto
Hydrocarbon／Oil	<0.01				ditto
Phenol	<0.01				ditto
Cyanide	BDL				ditto
Temperatures	^{O}C				ditto

Source: JICA Study Team

Table 7-10: Solid Waste

Monitoring Item	Conditions During the Monitoring Period	Remarks (Designated Area of Disposal/Reuse、CPCB's Rule, Timing and Method of Disposal)
Reused Item:		Based on the "Urban Solid Waste Management Rule 2016", Once a week or any time as disposal was made, etc.
Disposed Item:		ditto

Source: JICA Study Team

Table 7-11: Noise and Vibration

Location of the Monitoring：Baseline Study Location #

Parameter	Baseline Data Value(Max.)	Measured Value (Max.)	Local Standard	Inter-national Standard (If any Referred to)	Remarks, (Conditions of the Monitoring Location、Interval/Timing of Monitoring, Methoding of Monitor)
Noise level	61.8 dB				Baseline Study Location #, Beginning of Monsoon Period (May-July), Noise Standard of India 2000
Vibration level	-				Based on the complaints of local residents and the Noise Level exceeding the standard level, further investigation on the vibration should be considered.

Source: JICA Study Team

Table 7-12: Offnsive Odour

Contents of Monitoring	Conditions During the Monitoring
Source of Offensive Odor:	Description of the sources and the area of emanation, etc.

Source: JICA Study Team

Table 7-13: Natural Environment

Contents of Monitoring	Conditions During the Monitoring
Monitored Species of Plant/Anials/Bird:	
Classification of the species (Endangered/ Protected/Vulnerable,etc):	
Location of the Observation:	

Source: JICA Study Team

Table 7-14: Resettlement

Contents of Monitoring	Conditions During the Monitoring
Payment made before Resettlement	
Support during the resettling operation	
Payment for the Socially Vulnerable:	
Identifies Resettlement Area	
Use of GRM	
Stakeholder Meeting for Resettling Operation	

Source: JICA Study Team

Table 7-15: Livelihood of PAHs

Contents of Monitoring	Conditions During the Monitoring
Trainings Provided for Enhancement of Livelihood:	
Improvement of Socio-economic Conditions (1-5 year period monitored twice a year)	

Source: JICA Study Team

Table 7-16: Compensatory Afforestation

No.	Location of the Afforestation Area (Name of the Village)	Afforestation Area (ha)	No. of Saplings	Species of Trees
1				
2				
3				
4				
5				
6				
7				

Source: JICA Study Team

Compensatory Afforestation is probably the most important activity within the framework of the Project. As described above, approximately 98.5 ha of the existing forest is lost to the road project. While at the same time implementation of the road project itself emit greenhouse gas and this is compensated by planting trees over 121 ha of area as a measures for reducing the global warming based on the "Paris Agreement" of COP21. Thus the above monitoring form is suggested to add to JICA Pro forma system of monitoring forms.

7.5.2 Budget for Environmental Management and Monitoring Plan

Based on the above EMP, the annual cost for implementation including the cost of monitoring is estimated as per Table 7-17. Because of the damages made to the forest areas, the cost of tree planting amounts to 79% of the total cost of the management and monitoring plan.

Based on the concept of "REDD+ (http://www.wwf.or.jp/activities/nature/cat1248/redd/)", donors are encouraged to bear the cost of afforestation in order to safeguards forest areas as well as to increase forested areas in order to compensate for the GHG emissions released as a result of project implementation. Thus, afforestation should be considered as a sub-project of the NH40 2-lane widening project.

Table 7-17: Budget for EMP

Item of EMP/ Monitoring	Contents of EMP/ Monitoring	Unit	Unit Price (Rs)	Total (Rs)	Notes
1. Monitoring					
Air Quality	The area in the vicinity of the construction plant	No. of Places	33,750	1,215,000	Assumption is made: one section stretches over 10 km and monitoring is carried out at 5 locations.
Water Quality	Carried out as per IS 10500 and IS 2296	No. of Places	5,000	270,000	Based on the monitoring plan, 9 monitoring locations for the construction period as well as for 3 years after the completion of construction.
Noise	Carry out as per CPCB Guideline 1989 at the construction area	No. of Places	89,000	2,403,000	Based on the monitoring plan, 9 monitoring locations for the construction period as well as for 3 years after the completion of construction.
Rare plant and wildlife species	Carry out for bio-diversity	No.	150,000	4,050,000	Once every 6 months during the construction period, and once a year for 3 years during the operation and maintenance period.
Sub-total (I)				7,938,000	
2. Afforestation					
Afforestation for 97.8 ha of what was lost for the project	Based on the Forest Conservation Act (1980)	No.	200	29,520,000	Sapling for 1,200 pieces/ha
Afforestation for carbon sequestration of the project	Based on the Paris Agreement of COP 21	No.	200	31,200,000	Sapling for 1,200 pieces/ha
Sub-total (II)				60,720,000	
3. Personnel/Institutional Cost					
Monitoring Team	-	Lump Sum	-	18,000,000	-
Staff training for NHIDCL	-	Lump Sum	-	500,000	-
Laboratory Fee	-	Lump Sum	-	1,000,000	-
Stakeholder Meeting	-	Lump Sum	-	300,000	-
Sub-total (III)				19,800,000	
Sub-total (I+II+III)				88,458,000	
Contingency (10%)				8,845,800	
Grand Total				**977,303,400**	

Source: JICA Study Team

8. PUBLIC CONSULTATION AND INFORMATION DISCLOSURE

Stakeholder consultation is an important method of involving various stakeholders particularly, local community with reference to the proposed development initiatives. Consultations provide a platform to participants to express their views, concerns and apprehensions that might affect them positively or negatively. This process is of particular importance for this project given the high ST share among the affected population. The World Bank OP 4.10 on Indigenous Peoples emphasizes "a process of free, prior, and informed consultation with the affected Indigenous People's communities at each stage of the project, and particularly during project preparation, to fully identify their views and ascertain their broad community support for the project. Stakeholder through participation and consultation stakeholders influence development initiatives, and decision-making process. The effectiveness of participation and consultation is directly related to the degree of involvement by the likely project affected persons and the local community and integration of outcome of consultations wherever feasible in the proposed development initiatives.

The purpose of consultations was to inform people about the project, take note of their issues, concerns and preferences, and allow them to make meaningful choices. It ensured participation of potential project affected persons (PAPs), local community, and other stakeholders. People in general were informed in advance, and allowed to participate in free and fair manner. Consultations provided meaningful contributions with regard to reducing adverse impacts, address safety issues, etc. Concerns, views and suggestions expressed by the participants during these consultations were integrated into the design aspects wherever feasible. The following sections present details of the consultations.

8.1 1st Round Consultations with Stakeholder and Communities

Consultations for this project adopted the following framework to ensure a process of FPIC.

a) Conduct appropriate gender and intergenerationally inclusive consultations with the Project Affected Peoples' communities, the Affected Peoples' Organizations (village council, women's groups, etc.), and other local civil society organizations (NGOs) identified by the project affected communities,

b) Use consultation methods appropriate to the social and cultural values of the Affected Peoples' communities and their local conditions (including using local languages, allowing time for consensus building, and selecting appropriate venues) and give special attention to the concerns of women and their access to development opportunities and benefits; and

c) Provide the Affected Peoples' communities with all relevant information about the project (including an assessment of potential adverse effects of the project) in a culturally appropriate manner.

The consultations were informed through NGO and villages heads and followings are explained.

1) Outline and Purpose of the Project
2) Alignment, alternatives and reason of recommended alignment
3) Result of the scoping (anticipated positive and negative impact)

For most of the people, the issues of prime concern were increased frequency of accidents, loss of precious lives due to that and disturbing noise of vehicles. In addition, poor drainage condition of the road due to which there is temporary flooding of shops/ houses.

The details of 1st Round Consultation with Communities are summarized in Table 8-1.

Table 8-1: Details of All Meetings

Block	Date	Venue	No of parti-cipants	Observations
Mylliem	11/6/16	Sanmer Secondary School	34	Village council members were very receptive and welcomed the project. As they were apprehensive on how the PAP will respond, community meeting and FGD would be held for consensus building.
Khatarshnong Laitkroh(1)	16/6/16	PWD IB, Laitlyngkot	25	The village leaders present in the meeting unanimously agreed and welcomed the project. However, the village authority itself cannot decide on this matter, the opinion of the village people especially those affected is required and a meeting with them is essential. Consultation with PAHs was held on 25 June.
Khatarshnong Laitkroh (2)	25/6/16	Community hall	65	Information about the project was received with many queries which were clarified. PAPs supported the project and the survey to be conducted. Comparison of alternatives and justification of the proposed alignment were carefully explained.
Pynursla (north) (1)	10/6/16	PWD IB, Pynursla	7	A few traditional heads who attended the meeting informed the team that a state study was conducted a few years back indicating a different alignment. They suggested the team organize another meeting wherein potential project affected households can also be invited to discuss the project. Consultations were consciously held after 9 July, 12 and 19 August.
Pynursla (north)(2)	9/7/16	Community hall	30	Issues were raised: >Raid Nongkhlieng and Raid Shabong (community lands that are affected) are the two raids whose boundary remains uncertain to this day. >There was opinion that the people had already agreed to the alignment put forward by the government for a proposed by pass in 2009. Majority of the people present emphasized that the 2009 alignment should be followed. >Community suggested that this issue be resolved and made it clear that they are not against the construction of roads but that the outstanding issues should be resolved first.

Block	Date	Venue	No of parti-cipants	Observations
				It was agreed by the implementing agency that consultation meeting will be continuously held for find solution.
Pynursla (north) (3)	12/8/16	Urksew Community Hall	26	The following opinions were expressed from participants. >Community must be aware of survey before it starts. >Owners of affected land should be consulted. >Major part of the affected land belongs to 2 clans, the boundary issue between is yet to be resolved. >Members of Clan Shabong requested for a meeting with their leader who was not present. Meeting with all the clans in the BP5 affected area set for the 19th of Aug, at PWD IB.
Pynursla (north)(4)	19/8/16	PWD IB Pynursla	37	Presentation of the project, alignment, affected areas, benefits was made. All the clan leaders were present. Except for one clan, all the other clans supported the project and the new alignment. Resolution - status quo, request for concerned authority to have dialogue with Clan Shabong. It was agreed by the implementing agency that consultation meeting will be continuously held for finding solution.
Pynursla (middle) (1)	9/7/16	Community Hall	50	Local elders appreciated the meeting since this was the first time their consent, support and feedback was respected over a project. However a number of issues from previous road projects of the government, related to the nonpayment of compensation, is pending. The people ask that these issues be resolved first, before the current project starts. It was explained by the implementing agency that compensation of the Project will be made in accordance with LARR 2013 and JICA GL.
Pynursla (middle) (2)	13/7/16	Community Hall	23	PAPs were briefed about the project, presentation on alignments, activities that will take place, affected land and the process of surveys to be conducted. PAPs agreed to the survey and raised questions about the compensation and issues of rehabilitation. They suggest the team sit with them again to discuss in detail. Clarified that FGDs will be held and

Block	Date	Venue	No of parti-cipants	Observations
				they are also free to call anytime to clarify doubts. It was agreed by the implementing agency that community meeting. FGD will be continuously held
Pynursla (south)	15/7/16	Community Hall	45	Villagers requested repair and maintenance of the existing road. It was agreed by the implementing agency that repair and maintenance of the existing road will be considered.
Pynursla (BP6) / Amlarem	19/8/16	Wahkdait Community Hall	45	Traditional leaders and land owners were present. >Questions on compensation, duration of project, workers etc were raised and clarified. >Question on bypass #5 and the neglect of the existing road. >All leaders agreed to the survey to be conducted. Final consensus will depend on 2 criteria- (i) Existing road is improved and maintained, (ii). Compensation package is agreed on with affected persons, both of which would be satisfied. It was explained by the implementing agency that improvement of existing road will be considered and compensation package is to be prepared in accordance with LARR 2013/ JICA GL and agreed on with affected persons.

Source: JICA Study Team

Table 8-2: Participation details of 1st round consultations

CD Block/ Villages	Date	Total no of participants	Representation		
			Govt	Dorbar	PAP
Mylliem	11/6/16	34	3	31	
Khatarshnong Laitkroh(1)	16/6/16	21	3	18	
Khatarshnong Laitkroh (2)	25/6/16	65			65
Pynursla (north) (1)	10/6/16	7	2	5	
Pynursla (north)(2)	9/7/16	23			23
Pynursla (north)(3)	16/8/16	26		26	
Pynursla (north)(4)	19/8/16	37	1	36	
Pynursla (middle) (1)	9/7/16	50		2	48
Pynursla (middle) (2)	13/7/16	23		1	22
Pynursla (south)	15/7/16	45		45	
Pynursla (BP6) / Amlarem	19/8/16	45		5	40

Source: JICA Study Team

For the purposes of promoting information dissemination and community participation, several community meetings were held after block-level consultations. A brief description about the project, highlighting the importance of consultations with likely project-affected persons, local community, and other stakeholders was given. Design concepts (e.g. minimize surplus soil, install proper slope protection) with preliminary alignments were also provided and explained. Expected benefits and anticipated adverse impacts as well as the resettlement policy framework as per JICA Guidelines for Environmental and Social Considerations were conveyed. The consultations were held in the local language (Khasi) with assistance from a local person who helped in interpretation as well as prepared transcripts. The proceedings of the consultations were audio recorded as part of the documentation process.

Table 8-3: Community Meetings and Focus Group Discussions (FGD)

S. No	Meeting	Date	No of attendees	Area Coverage
1.	Dorbar & Village elders	20/06/2016	6	Umlympung Village (12 miles) to Laitlyngkot Village
2.	Soilyna Huts, Mylliem Marbaniang up to the end of Bypass 3, i.e. Mylliem Kyndong Nongkyntir	21/06/2016	6	Expansion 3 to end of Bypass #3
3.	Expansion 2, i.e. 4 miles up to the midpoint of Bypass 2	23/06/2016	7	Expansion 2 TO Banuin
4.	Bypass 2 i.e. Banuin Village	24/06/2016	7	Banuin Village

Source: JICA Study Team

The consultation meetings were attended mainly by village representatives (Durbar Shillong/Sangbar Shillong and Village Council members), who then shared the meeting outcomes with other members in the village. At the outset, NHIDCL/PWD and village representative introduced the consultant's team with the participants and stated the broad objective of such consultations. The Environment and Social Expert of the Study Team and Team leader of NGO provided brief description about the project, highlighting importance of consultations with likely project affected persons, local community, and other stakeholders. Design concepts (e.g. minimize surplus soil, install proper slope protection) with preliminary alignments

were also informed and explained. Expected benefits and likely anticipated adverse impacts as well as resettlement policy framework as per JICA Guidelines for Environmental and Social Considerations were conveyed. The consultations were held in local language (Khasi) with assistance from a local person who helped in interpretation as well as preparation of transcripts. The proceedings of the consultations were audio recorded as part of documentation process.

8.2 2nd Round Consultations with Communities

The second round stakeholder meeting was informed through NGO, village heads and local newspaper and held at 5th of November and 5th of December, 2016 to share the follows;

1) Outline and Purpose of the Project
2) Reason of recommended alignment
3) Result of Environmental Assessment (anticipated positive and negative impact, their analysis and mitigation)

As for resettlement, the meetings were aiming at sharing the result of the socio economic survey and discussing with PAPs on the comprehensive composition of resettlement and compensation. The followings are main questions.

- compensation policy
- rehabilitation and livelihood improvement policy
- provision of alternative lands

Summary of the meeting is shown in Table 8-4

Table 8-4: Details of All Meetings

Block	Date	Venue	No of parti-cipants	Observations
Mylliem/ Khatarshnong Laitkroh/ Pynursla/ Amlarem	5/11/16	Sanmer Secondary School	149	While there was concern about impact on paddy fields in BP3, it was explained that impact can be minimized by ensuring irrigation channel with box culvert and agreed. A major concern of the people present from BP3 was the impact on the business establishments like restaurants etc located at Mylliem after the realignment of NH-40. NHIDCL officials assured that there will be sufficient space available within proposed RoW for setting up temporary structures and relocate those affected. It was explained that an affected Public Health Center in Dawki will be rebuild before land acquisition, and old structure will be demolished only after operation of new structure of the PHC.

Pynursla/ Amlarem	5/12/16	Wahkdait Community Hall	91	Explained existing road will be repaired at the section of BP6&7. Answering to question about compensation policy, it was explained that it will follow LARR 2013 and also JICA guideline in case that the project is funded by JICA. Answering to question about dumping on roadside, it was explained that appropriate locations would be selected not to disturb residents. Answering to determination of PAHs, it was explained that it would be done through joint inspection by Deputy Commissioner and preparation of land owners. The economic benefits to the area was highlighted including tourism potential with a new bridge at Dawki. Attendees expressed their keenness that the project is started at the earliest.

Source: JICA Study Team

Table 8-5: Participation details of 2nd round consultations

CD Block/ Villages	Date	Total no of participants	Representation		
			Govt	Dorbar	PAP
Mylliem/ Khatarshnong Laitkroh/ Pynursla/ Amlarem	5/11/2016	149	3	14	132
Pynursla/ Amlarem	5/12/2016	91		7	83

8.3 Meeting with Government Officials and Other Key Persons

In addition to the block-wise public meetings, several meetings were held with various state and district level government department officials at different stages during the course of the EIA study. Discussions were focused on developing an understanding of existing state policies and practices with respect to management of environmental and social issues associated with the proposed project, likely challenges, perceived impact and suggestions and recommendations, among others.

During interaction and discussion with Govt. officials and Council Members, it generally emerged that people in the area are eager to see the commencement of the actual widening and strengthening of NH40. They pointed out that several attempts have been made in the past to improve the condition of the highway, but every time it turned out to be a false start. They further averred that this preparatory survey would lead to action on the ground. They revealed during discussion that Shillong-Dawki road which is one of the important roads in the state since the road connects directly to Bangladesh and strongly opined that improvement and strengthening of NH40 should be prioritized. This they averred would open up the market and other opportunities for people in the area. They pointed out that development of the area could be taken up based on the bio resources of the region on a sustainable basis. Tourism would be incentivized, thus generating employment opportunities for the thousands of locals passing out of educational institutions in the area. Locally available fruits, like Pineapple, Jackfruit, and Bananas could be quickly dispatched to other parts of the country and the surplus crop processed locally. Floriculture would also receive an impetus, considering the floral diversity of the area, thus becoming a revenue source for the

locals and the government too.

The officials pointed out that the machinery to organize and implement various schemes are in place. However, due to the lack of a proper road network, all schemes are operating below par. They further averred that the Project would receive their full cooperation and the locals would also participate in it eagerly. Considering the high expectations that the locals have for the Project, there would be very few hurdles, according to them. The Forest Officials, pointed out that there are no reserved forest or Wildlife Sanctuary along NH40.

8.4 Supplemental Meetings

For solving concerns regarding alignments, some re-alignment was re-examined. Accordingly, supplemental meetings were held for Bypass No.2 and No. 5.

Table 8-6: Details of All Meetings

Village	Date	Venue	No of parti-cipants	Observations
Mylliem/ Banium	19/5/17	Office chamber of the Deputy Commissio ner, East Khasi Hills, Shillong	10	Regarding Bypass No. 2, the realigned route was proposed by NHIDCL/DPR consultants slightly to Right Hand Side for minimizing impact on HHs and lands. The matter of BP-II has been elaborated to the DC/EE PWD NH/Local Headman/Local Villagers and it has been decided to safeguard the proposed football ground. Accordingly the consultant has been asked to shift the alignment slightly towards right of the proposed alignment. The consultant has agreed to modify the alignment. Hence the issue of Bypass No.2 is resolved.
Pynursla/ Wahlyngkhat, Uksew	19/5/17	Office chamber of the Deputy Commissio ner, East Khasi Hills, Shillong	17	Regarding Bypass No. 5, it has been proposed by DC, East Khasi Hills to go with existing alignment. since the Sordor/Headmen are not agreed to go with proposed alignment of Bypass No. 5. The issue of Bypass No.5 needs further examination.

Source: JICA Study Team

Table 8-7: Participation details of supplemental consultations

CD Block/ Villages	Date	Total no of participants	Representation		
			Govt	Dorbar	PAP
Mylliem/ Banium	19/5/2017	10	4	1	5
Pynursla/ Wahlyngkhat, Uksew	19/5/2017	17	4	3	10

8.5 Information Disclosure

The EIA report will be posted on the website of JICA as well as NHIDCL. Also, the Khasi version of the executive summary will be distributed to Durbar Shillong/Sangbar Shillong in each village along the targeted section of NH40 and will be shared with other members of the village.

9. CONCLUSIONS AND RECOMMENDATIONS

9.1 Key issues / Concerns Identified

Through the above exercise, the following key issues were identified:

- There is no critical issue in the natural environmental except cutting of trees especially at bypass no. 1 & 6.
- Protected forest exists from Chainage 1+420 to 3+500 for which forest clearances will be required.
- There is no Wildlife Sanctuary along the alignment or within 10 km from the project alignment.
- There is no archeological protected/protected monuments exists along the project road.
- Monoliths exist along the RoW of the existing Highway; they may be shifted after consulting with local villagers.
- Likely effect of land acquisition over the properties/owners and their financial loss.
- Air, Noise & Water pollution may increase during road construction and after increase in traffic volume in future.
- Project do not require Environmental Clearances from MoEFCC as per EIA notification 2006 and its amendments till date.
- During stake holder meeting and community survey, local people welcome the project and would like earlier implementation of the project, however some resistance was shown during stake holder meeting in bypass no. 5. The outcomes of stakeholder meeting at bypass no. 5 were that the area of Raid Nongblai, Raid Langkyrdem and Raid Nongkhlieng accepted the project. But Raid Shabong doesn't accept the project with regards to the proposed alignment of NH-40 which passes through the territory of Raid Shabong and Raid Nongkhlieng because there is a dispute between these two Raids. The resolution of meeting was that Authorities (NHIDCL) are to solve the issues amicably between these two Raids.

9.2 Summary of Key Benefits from the project

Availability of adequate and quality infrastructure is a pre-requisite for rapid development of any economy.
Improvement in the project road will result in the following benefits:

- Providing better level of service in terms of **improved riding quality and smooth traffic flow**.
- Faster transportation will ultimately lead to massive savings in the form of reduced wear and tear of vehicles, reduced vehicle operating costs (VOCs) and reduction in transportation costs etc.
- With the improvement of road surface, the traffic congestion due to obstructed movement of vehicles will be minimized and thus wastage of fuel emissions from the vehicles will be reduced.
- Introduction of additional safety measures like crash barrier, road illumination, retro-reflective boards, delineators etc. will result in lesser accidents.
- **Increased passenger comfort** due to good road condition shall be an added benefit.
- It will increase access of the villages and other small settlements to urban areas, thus providing connectivity of rural produce to urban markets, thereby enhancing the reach and export of perishable cash crops, leading to better remuneration for the producer.
- The reach and export of perishable cash crops will have quite a positive impact and this will prove to be a boon for the rural agricultural sector.
- Providing connectivity to the urban infrastructure.
- **Rural industrial produce**, whether from Commercial industries, small-scale industries or medium-scale industries will have easy access to the urban markets.
- **Strengthening of rural economies**: The rural sector / economy are sure to get strengthened, though at a gradual pace.
- **Higher education: Education is considered to be one of the most dominant indicators towards**

the development of a region. Though primary education facilities are present along the project road, access to high schools, higher secondary schools and colleges is not so easy at present. Provision of easy access to higher education can be directly linked to the improved educational scenario.

- **Access to medical facilities**: Villages in the project region are not yet well-equipped with all types of medical facilities and services like Public Health Centres (PHCs), dispensaries, hospitals. Due to inaccessibility, reaching even the nearest health centre sometimes becomes a colossal task. Even the doctor's reluctance will be converted into willingness to visit these areas after widening and improvement of the project road.
- By reducing the transportation costs, it will be more feasible to transfer construction materials which are important for many economic activities (house building, school building, etc) to hinterland. This will in turn, lead to direct as well as indirect strengthening of local economies.
- During the execution of the project, i.e. during the construction period, employment will be provided to workers from the local communities.
- The educated as well as uneducated people from villages will obtain access to new employment centres.
- The improvement of the road will reduce the number & frequency of collisions. This would be very beneficial from the safety point of view and will thus, reduce accident rate.
- Overall improved quality of life for the lesser developed areas in the neighborhood.

Value Addition

- Aesthetic enhancement: Landscaping & road side plantation.
- Wayside facilities: Truck-lay byes, footpaths etc.
- Under/over bridges, raised carriageway.
- Better road safety, signage, and improved road surface.

9.3 Recommendations/conclusion

Keeping in view the general scope for environmental as well as socio-economical parameters and most importantly sustainable environment and economic development, the following conclusions and recommendations have been drawn:

9.3.1 Recommendations

- Present road needs improvement as it needs to accommodate ever growing traffic.
- Widening shall be done to minimize cutting of trees and land acquisition.
- Bypasses shall be provided to minimize the R&R issues in congested locations.
- Road safety is critical due to terrain, engineering measures shall be undertaken to minimize the impact.
- Ribbon development and encroachments have been observed along the road. In addition, local slow moving traffic adds to the fast moving traffic on NH, thus causing reduction in traffic speed and increased travel time. If existing national highway can be developed without considering the proposal of bypasses, then R& R issues and conflict between pedestrian, non-motorized traffic, local traffic and through traffic will be the issue of concern both at present and future stage. Also plenty of trees and community properties are expected to have adverse effect.
- One of the major issues that surfaced during the public consultation was drainage of carriage way & drainage facility along the road side. This need to be developed in order to prevent houses/shops getting inundated during heavy rains.

9.3.2 Conclusion

Widening shall be done within the existing ROW or with minimum land acquisition to minimize the

environmental impacts along the project road. Bypass shall be provided at congested location to minimize resettlements. Measures will be undertaken such as tree plantation, noise barriers, and proper signage to reduce the impact along the project road. Proper compensation shall be paid to project affected persons.

Appendix TOR for Afforestation

Terms of Reference
for
Afforestation
of
The Project
for
Two-Lane WIDENING AND IMPROVEMENT
of
NH-40
(SHILLONG – DAWKI)

1 Introduction

These terms of reference aim at outlining tasks assigned to a working group subject to establishment by NHIDCL in order to prepare methodologies for afforestation program in respect of the Project of Two-lane Widening of NH-40: Shillong-Dowki Section (hereinafter referred to as "the Project").

They provide details on the following:

a. Background of the Afforestation Program;
b. Areas of Work Requiring technical and/or analytical inputs by the Afforestation Team;
c. Modality of Work; and
d. Eligibility of the Afforestation Team Members.

2 Terms of Reference

2.1 Background of the Afforestation Program

(1) Forested Areas within the ROW of the Project

Figure 1 to 4 shows the Project of Two-lane Widening of NH-40: Shillong-Dowki Section subject to implementation by NHIDCL. As a result of land acquisition for ROW of the project area, approximately 98.5 ha of the existing forested areas become subject to clearance for road constriction project as is shown in Table-1.

Table-1: Forest Areas Subject to Clearance by The Project

Location		Area	Tree cutting (no.)	Remarks
1	Bypass No.1	9.3	11,160	Protected Forest (admin. by Forest Dep. of Meghalaya State)
2	Bypass No.1-2	2.8	3,360	Private Forest
3	Bypass No.2 (excluding CH7.7-9.1)	3.6	4,320	Private Forest
4	Bypass No.3	5.0	6,000	Private Forest
5	Bypass No.3-4	1.0	1,200	Private Forest
6	Bypass No.4	3.2	3,840	Private Forest
7	Bypass No.4-5	44.4	53,280	Private/ Clan Forest
8	Bypass No.5	0.6	720	Private/ Clan Forest
9	Bypass No.5-6 (plantation	17.5 10.5	21,000 12,600)	Private/ Clan Forest
10	Bypass No. 6&7 (plantation	34.9 14.0	41,880 16,750)	Private/ Clan Forest
11	Bypass No.7-end	0.7	840	Private/ Clan Forest
	Total	123.0	147,600	
	Excluding plantation of Bypass No.5-6, No. 6&7	**98.5**	**118,250**	
	Excluding No.5	97.9	117,530	

Because of the significant loss of the forested areas, the same area of afforestation program has to be carried out and that 98.5 ha of afforestation is achieved over time.

(2) Afforestation for Global Warming Measures

Implementation of any road project is subject to emission of greenhouse gas as a result of project implementation. The World Bank has put out "Greenhouse Gas Emissions Mitigation in Road Construction and Rehabilitation" in 2010. Based on this report, this Project emits 794 tons of greenhouse gas for every km of construction work as is shown in Table-2.

Table-2: Greenhouse Gas Emission of Road Project

Parameter \ Category of Road	Express-way	National Rod	Provincial Road	Rural Road (Gravel)	Rural Road (Dirt)
Emissions (t CO2 eq./km)	3,234	794	207	90	103
Factor Equivalent to Expressway	100	25	6	3	3

Source: "Greenhouse Gas Emissions Mitigation in Road Construction and Rehabilitation" 2010, WB

The Project, excluding 1.4km overlapping portion with NH44E, runs for 70.4km from Shillong to Dowki, Thus, the effect of greenhouse gas emission for the lifetime of the Project (Estimated at 10 years) is calculated as follows:

794 (t CO_2 eq./km) x 70.1 km = 55,659 t (CO2 eq.)

Because of afforestation is the most popular and inexpensive method of carbon sequestration; the following method of calculation is carried out in order to find the area of afforestation.

1 ton of Carbon = 3.666 tons of CO_2

Not : Atomic volume of CO_2 is 44; it is divided by Carbon whose atomic volume is 12.

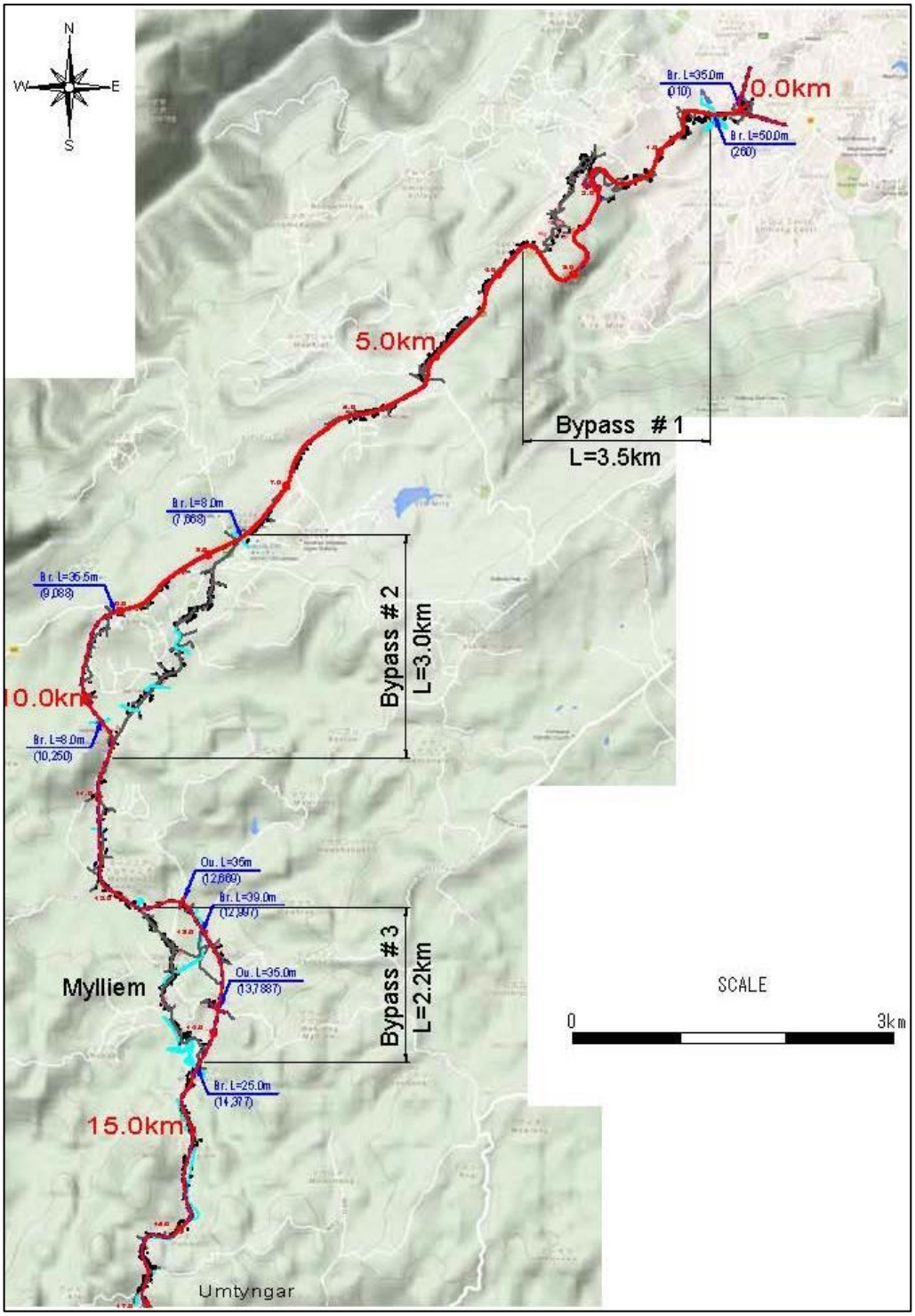
Because of the experiences of which 1 ha of forest sequester 125.5 tons of carbon[2], 1 ha of forest should sequester 125.5 tons x 3.666 tons of CO_2 = 460.2/ha of CO_2. Thus:

55,659 t (CO2 eq.) / 460.2 ton/ha = Forest Area of 120.95 ha

is obtained. Provided that 13 ha of afforestation are carried out, greenhouse gas is sequestered approximately 10 year period. Such afforestation should contribute to recover the area lost in the past

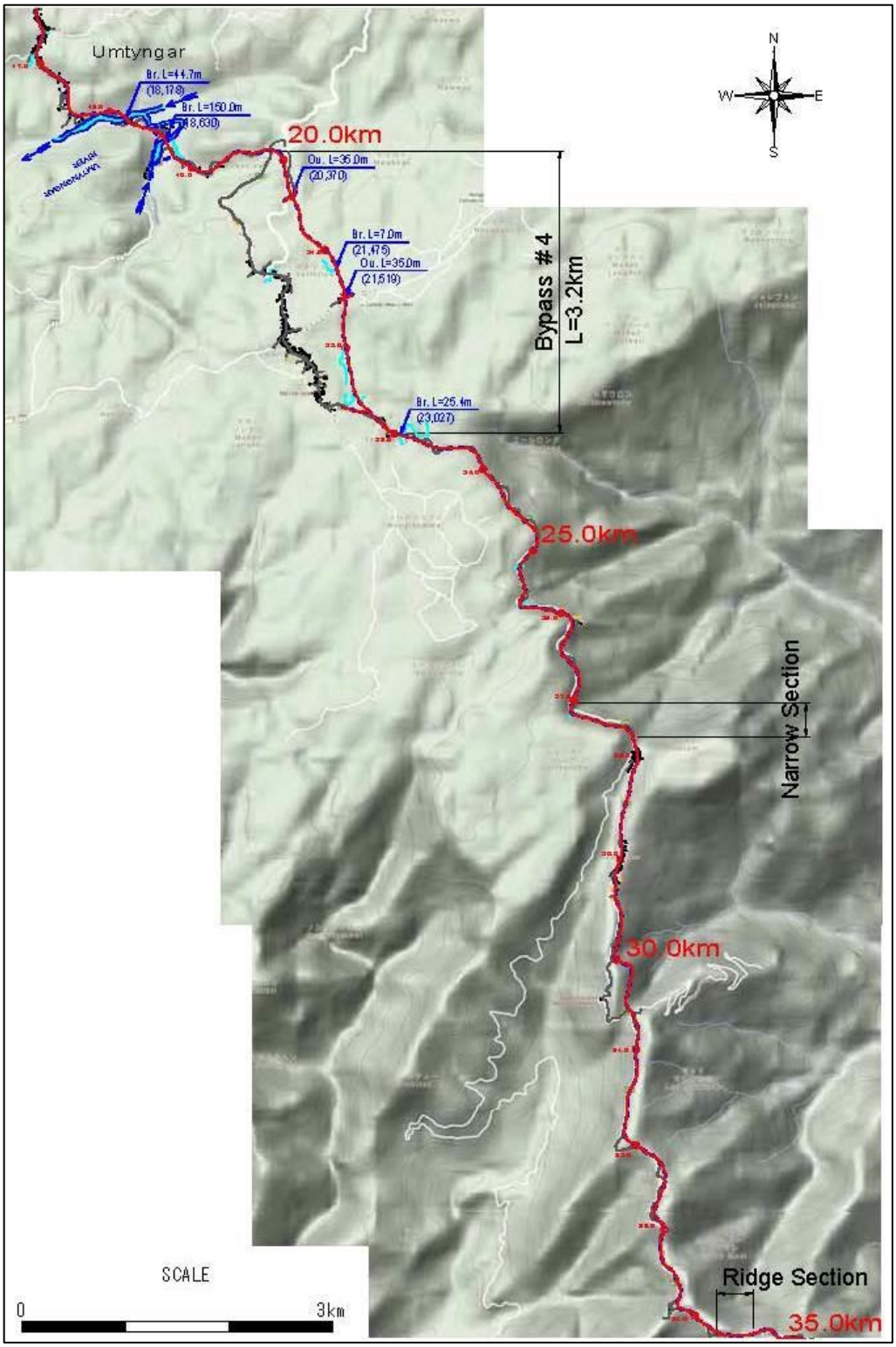
[2] The following reports have been consulted.
1) United States Department of Agriculture, Forest Service, Methods for Calculating Forest Ecosystem and Harvest Carbon with Standard Estimates for United States Forest Types, 2006, http://www.treesearch.fs.fed.us/pubs/22954.
2) US Department of Agriculture, Forest Service, Carbon Storage and Accumulation in United States Forest Ecosystems, 1992, http://www.nrs.fs.fed.us/pubs/gtr/gtr_wo059.pdf.

decades as a result of slush-and-burn agriculture. It should also contribute to safeguard forest area of water resources while it contributes to fight against global warming.



Dashed Blue Line：DPR Design、**Solid Red Line**：JICA Study Team's Design
Source: JICA Study Team

Figure 1：Bypass No.1-3 – DPR Design/ JICA Study Team Design

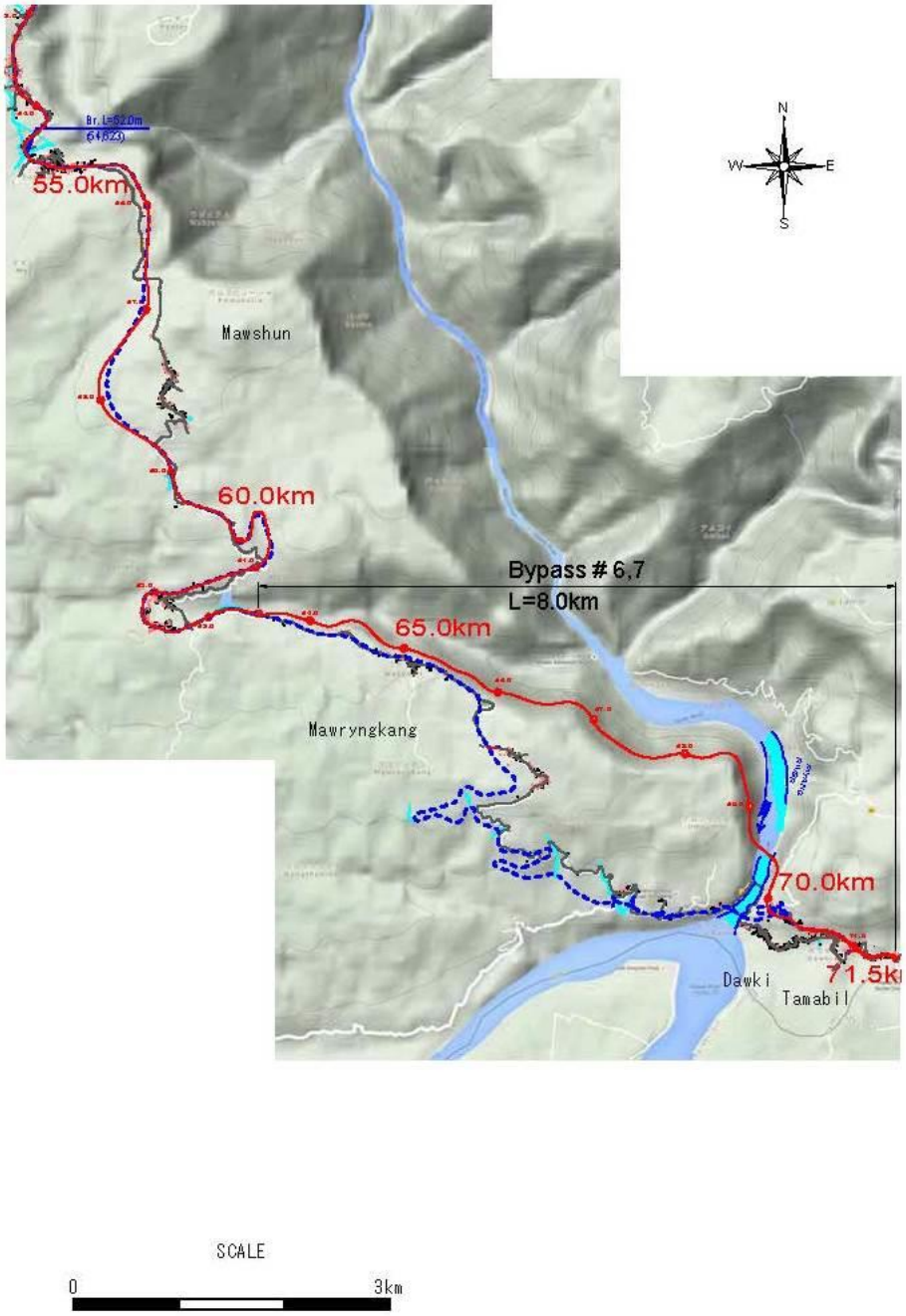


Dashed Blue Line：DPR Design、**Solid Red Line**：JICA Study Team's Design
Source: JICA Study Team

Figure 2：Bypass No.4 – DPR Design/ JICA Study Team Design

Dashed Blue Line：DPR Design、**Solid Red Line**：JICA Study Team's Design
Source: JICA Study Team

Figure 3：Bypass No.5 – DPR Design/ JICA Study Team Design



Dashed Blue Line：DPR Design、**Solid Red Line**：JICA Study Team's Design
Source: JICA Study Team

Figure 4：Bypass No.6-7 – DPR Design/ JICA Study Team Design

2.2 Number of Tree Planting

Number of tree planting over the total area of approximately 98.5 ha is 118,250 based on the rate of planting at 1,200 trees per ha of land area. The rate of tree planting per ha of land is subject to change depending on the local soil and climatic conditions and the guidance of planting trees by Meghalaya State Department of Environment and Forest.

2.3 Area of Work

Afforestation area of work is not necessarily be limited the area along the Project's road construction area. Thus, the following is subject to preparation by the Afforestation Team:

a. Contact NHIDCL as supervising organization of the Project as well as the afforestation program;
b. Contact Meghalaya State Department of Environment and Forest in order to identify and/or identified afforestation area;
c. Prepare recommendations on proposals for afforestation program based on the guidance of Meghalaya State Department of Environment and Forest in terms of the location (local place names) and area (in ha) of afforestation, species of trees subject to planting, number of trees subject to planting including method of monitoring, timing and period;
d. The Afforestation Team shall elaborate with the assistance of Meghalaya State Department of Environment and Forest, precise and workable recommendations for consideration of employing local residents of the area of tree planting;
e. Develop and reflect it in the recommendations the cut and fill slope design of the Project in terms of planting tree/scrub/grass species, if any, for slope stabilization;
f. Verify the contents of recommendations from the Meghalaya State Department of Environment and Forest in respect to the species of trees subject to planting, sapling purchase program, timing of planting and any other relevant methodologies for the afforestation program taking into account of relevant circumstances;
g. Obtain verification of NHIDCL for commencement upon verification obtained from the Meghalaya State Department of Environment and Forest;

2.4 Modality of Work

a. Afforestation Team shall operate under the guidance of NHIDCL's representative in Shillong who is the in-charge of the Project.
b. The representative of NHIDCL shall determine frequency of the meeting of the Afforestation Team with NHIDCL.
c. Contents of the report for each time of meeting shall be of the needs arising from the initial procedures for drawing the outline of afforestation program, employment of the local residents, resources available and project activities as a whole. The following has to be

reported as a result of the observation of the field works:

- ✓ Compile inputs on each tree planting area in terms of methodology of tree planting activities, recommendations from the local tribal council and/or residents and draft recommendations on the countermeasures including deadline of such countermeasures;
- ✓ Review each planting area's methodology and countermeasures and notify the changes, if any to the Meghalaya State Department of Environment and Forest for verification;
- ✓ Prepare draft final report for submission to NHIDCL based on the activities including changes made during the tree planting activities.
- ✓ Prepare final report consisting of a set of hard copies and an electrical file stored in CD-ROM based on the comments made on the draft final report.

2.5 Eligibility for Membership for Afforestation Team

Afforestation Team should be formed by a team leader, deputy team leader and three staff based on the competence requirements as follows:

a. Members of Afforestation Team should be able to demonstrate relevant working experiences of at least five years, or scientific knowledge on methodological issues related to project-based afforestation and/or reforestation activities;

b. Demonstrate technical/scientific expertise, through publications, in at least one of the following areas:

- ✓ Baseline and/or monitoring methodologies of afforestation program; and
- ✓ Afforestation project implementation including monitoring and verification.

c. Have working knowledge of report drafting skills, strong operational and analytical skills and ability to work as a leader/deputy team leader/members of a team;

d. Team leader has to hold an advanced university degree in forestry, sociology, environmental studies, biological sciences, engineering, development studies or any discipline related to the afforestation program. Deputy-team leader and members should also hold one of the above qualifications.

e. Afforestation Team shall initially be composed of five members selected by NHIDCL based on application submitted in response to a public call/advertisement for experts.

f. NHIDCL shall announce on its web site and news papers as well as notifications sent out to

relevant educational and NGO organizations.

g. Afforestation Team members shall be designated initially to serve for one (1) year. Thereafter, members shall be nominated for continuation of the afforestation program once a year. Thereafter monitoring works shall be continued until such time as the limit of assignment is determined by NHIDCL upon verification of the completion of afforestation program.