Environmental Impact Assessment

Document Stage:Draft

Project No: 52159-002
January 2026

Sikkim Major District Roads Upgradation Project Phase -1

Prepared by : Road & Bridge Department, Government of Sikkim

CURRENCY EQUIVALENTS
(as of 16 August 2025)
Currency unit – Indian rupees (INR/Rs)
Rs 1.00 = $ 0.011409
$ 1.00 = Rs 87.65

ABBREVIATIONS

AADT	Annual Average Daily Traffic
ACGIH	American Conference of Government Industrial Hygienists
ADB	Asian Development Bank
AE	Authority Engineer
AI	Affected Individuals
AoA	Area of Analysis
AP	Affected Persons
APHA	American Public Health Association
ATREE	Ashoka Trust for Research in Ecology and the Environment
BOD	Biochemical Oxygen Demand
C&D Waste	Construction and Demolition Waste
CHA	Critical Habitat Assessment
CO	Carbon monoxide
CPCB	Central Pollution Control Board
CR	Critically Endangered
CRTN	Calculation of Road Traffic Noise
CTE	Consent to establish
CTO	Consent to operate
DE	Divisional Engineer
DO	Dissolved Oxygen
DPR	Detailed Project Report
EAAAs	Ecologically Appropriate Areas of Analysis
EC	Environmental Clearance
EE	Executive Engineer
EHS	Environmental, Health and Safety
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
EN	Endangered
EOO	Extent of Occurrence
ES	Environment Social
ESMU	Environmental and Social Management Unit
FC	Forest Clearance
FDGs	Focus Group Discussions
Fi	Financial Intermediary
GIIP	Good International Industry Practice
GOI	Government of India
GRM	Grievance Redress Mechanism
IBA	Important Biodiversity Area
IBAT	Integrated Biodiversity Assessment Tool
IEE	Initial Environmental Examination
IFC	International Finance Corporation
IMD	India Meteorological Department
INTACH	Indian Heritage Society and Indian National Trust for Art and Culture Heritage
IRC	Indian Road Congress
IRM	India Resident Mission
IUCN	International Union for the Conservation of Nature
IWPA	Indian Wildlife Protection Act
KBA	Key Biodiversity Area
LC	Least Concern
LPCD	Liters per Capita per Day
MBT	Main Boundary Thurst
MCTO	Main Central Thrust
MDR	Major district road
MoEF&CC	Ministry of Environment, Forests and Climate Change
MoRTH	Ministry of Road Transport and Highways
NAAQ	National Ambient Air Quality
NAAQM	National Ambient Air Quality Standards
NGO	Non-Government Organizations
NH_3	Ammonia
NO_2	Nitrogen dioxide
NOC	No Objection Certificate
NT	Near Threatened
NWMP	National Water Quality Monitoring Programme

O_3	Ozone
ODR	Other district road
OSHA-USA	Occupational Safety and Health Administration
PIU	Project Implementation Unit
PM	Particulate Matter
PMU	Project Management Unit
PUC	Pollution Under Control Certificate
REA	Rapid Environment Assessment
RFCTLARR	Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act
RoW	Right of Way
R&BD	Road and Bridge Department
SEA	Sexual Exploitation and Abuse
SEIAA	State-level Environmental Impact Assessment Authority
SH	Sexual Harassment
SH	State Highway
SMA	Stone Mastic Asphalt
SO_2	Sulfur Dioxide
SPCB	State Pollution Control Board
SPCB	State Pollution Control Board
SPS	Safeguard Policy Statement
SPWD	State Public Works Development
TDS	Total Dissolved Solids
UNESCO	United Nations Educational, Scientific, and Cultural Organization
VEC	Valued Environmental Components
VOC	Vehicle Operating Cost
VU	Vulnerable
WBM	Water Bounded Macadam
WC	Wildlife Clearance
WHO	World Health Organisation
WLS	Wildlife Sanctuary

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0. Executive Summary

A. Introduction

1. The Road and Building Department has sought a loan from the Asian Development Bank for the upgrading of six roads and three bridges in Sikkim. The Environmental Impact Assessment (EIA) Report has been prepared in line with the Asian Development Bank's Safeguard Policy Statement, 2009. The EIA assesses the environmental impacts of the upgradation of the proposed roads and construction of bridges and provides mitigation measures demonstrating the mitigation hierarchy.

2. The project is classified as Category 'A' as per the Safeguard Policy Statement, 2009 due to the number and diversity of adverse impacts identified. These include localized and transboundary impacts to terrestrial and aquatic biodiversity via habitat loss and reduced landscape connectivity. Some areas of the project qualified as Critical Habitat for multiple criteria including: (i) habitat loss and increased mortality risk to critically endangered species such as the Chinese pangolin , (ii) induced impacts on other species like the Golden mahseer, (iii) presence of a migratory stop-over area and corridor linkages between Protected Areas, (iv) large-scale construction work that involves scrapping of about 476,983 square meters of existing bituminous road and construction of about 531.300 square meters involving hill cutting and muck disposal, v) about 9 km of cumulative road length traverses through reserved forest notified by the Government of Sikkim (vi)The upgradation of roads and bridges involves tree felling and landslide mitigation measures, which can have significant impacts on the environment.

3. The information above was derived from detailed consultations with NGOs/CSOs were conducted, site visits, literature review, as well as specialized field methods including camera trapping, genetic research via eDNA. The assessment established Critical Habitat areas along multiple project roads due to the presence of endangered species, biological corridors, and ecosystem services. Portions of the Critical Habitat Assessment has been included in Section 3.9 along with portions of the resulting Biodiversity Action Plan in Section 21.

4. The project roads are exempted from the environmental clearance under the EIA Notification 2006 and amendments as the length of the roads are less than 100 km and acquisition of right of way is less than 60 meters.

B. Description of Project

5. The estimated civil cost of the project is USD 8.82 million, the environmental mitigation cost is USD 195 thousand, and the BAP budget is USD 100 thousand.

6. The proposed project for the improvement of six roads and the construction of three bridges is located in the four districts of East, West, North, and South Sikkim. It is part of the core network of road connectivity with a cumulative length of approximately 77 km.

7. The project engineering team has undertaken a feasibility study and worked on various alternatives for the location, type of structure, and geometric alignments. After considering technical feasibility, cost, environmental, and social risks and benefits, the project proposal was finalized.

8. The improvement of the road includes increasing the carriageway of the existing single lane of 3.5 meters to an intermediate lane of 5.5 meters, with a 1-meter earthen shoulder on the valley side and a 1.5-meter paved shoulder on the hillside. A side drain on the hillside will be provided, which will connect to the nearest culverts or bridges. The designed improvements will be accommodated within the existing right of way varying from 8 to 8.5 meters. Therefore, additional land is not required for the improvement works.

9. The project involves three standalone bridges and two bridges on the two road sections of S1 and E1. The standalone bridges are new constructions, and the existing two bridges will be closed to traffic. The bridge structure will be retained for use in the emergency situation after the Engineer of the Road and Bridge Department (R&BD) verifies the structural integrity. All the bridges will be single-span steel truss.

10. E1 – Rorathang Rongli is 8.9 km in length and traverses through five settlements in East Sikkim district. Two landslide locations at chainage km 2.968 and km 4.180 have been identified and mitigation measures are provided. Approximately 524 trees within the right of way will be felled. There are 48 cross drainage structures and 3 minor bridges available.

11. E4 – Khamdong Linzey – Tintek is 21.76 km in length and traverses through nine settlements in East Sikkim district. Two landslide locations have been identified at chainage km 1.350 and km 15.230, and mitigation measures will be implemented for the prevention of landslides. Approximately 2,225 trees available within the existing right of way will be felled. There are 125 cross drainage structures and 6 minor bridges available.

12. S1 – Melli-Phong via Rateypani is 22.65km in length and traverses through four settlements in South Sikkim district. Eight landslide locations have been identified at chainage km 0.750, km 14.250, km 14.700, km 19.750, km 20.050, km 21.100, km 21.760, and km 21.870, and mitigation measures will be implemented for the prevention of landslides. Approximately 1,635 trees available within the existing right of way will be felled. There are 80 cross drainage structures, 2 minor bridges, and 1 major bridge available.

13. S6 – Assangthang Salghari to CCCT Nandugaon is 14.79 km in length and traverses through four settlements in South Sikkim district. Two landslide locations have been identified at chainage km 1.350 and km 15.230, and mitigation measures will be implemented for the prevention of landslides. Approximately 599 trees available within the existing right of way will be felled. There are 43 cross drainage structures available.

14. N9 – Mangan Bazar to D.A.C is 2.1 km in length and traverses through three settlements in North Sikkim district. Three landslide locations have been identified at chainage km 0.800, km 10.225, and km 10.400, and mitigation measures will be implemented for the prevention of landslides. Approximately 10 trees available within the existing right of way will be felled. There are 18 cross drainage structures available.

15. W10 – Geyzing to Sakyong is 6.12 km in length and traverses through four settlements in West Sikkim district. Three landslide locations have been identified at chainage km 3.410, km 3.630, and km 3.950, and mitigation measures will be implemented for the prevention of landslides. Approximately 738 trees available within the existing right of way will be felled. There are 9 cross drainage structures and 1 minor bridge available.

16. Br 04 – Bhaley Khola Sirsiray – Kalung Dara is a new construction of a bridge with a single span of 60 meters.

17. Br 06 – Ramam River along Nayabazar Singla road is a new construction of a bridge with a single span of 100 meters.

18. Br 08 – Bridge over Andheri Kholcha along Manpur Fatak to Jorethang Road is a new construction of a bridge with a single span of 60 meters in length.

C. Description of Environment

Physical Environment

19. Sikkim's geographical location with significant altitudinal variation allows it to have diverse climatic conditions, ranging from tropical in the southern lower parts to alpine in the northern higher regions. The state experiences five seasons: winter, summer, spring, autumn, and monsoon. Temperature conditions vary dramatically across these zones.

20. Sikkim is prone to several natural hazards, including seismic activities, landslides, hydrological challenges, and flash floods. The state's mountainous terrain and heavy rainfall contribute to frequent landslides and flooding, especially during the monsoon season.

21. The baseline of 12 parameters of ambient air quality monitoring was conducted at 15 locations in 9 projects. The air quality analysis indicates that most pollutants are within the prescribed National Ambient Air Quality (NAAQ) Standards. Concentrations of sulfur dioxide (SO_2), nitrogen dioxide (NO_2), carbon monoxide (CO), lead, ammonia (NH_3), ozone (O_3), arsenic, nickel, benzene, and benzo(a)pyrene were all found to be well below their respective NAAQ limits. However, particulate matter levels, while compliant with national standards, frequently exceeded the WHO Guidelines.

Specifically, $PM_{2.5}$ concentrations ranged from 10 to 23 µg/m³, with many results surpassing the WHO guideline of 15 µg/m³. Similarly, PM_{10} levels, ranging from 28 to 55 µg/m³, also showed values exceeding the WHO's recommended guideline of 45 µg/m³ at several locations.

22. Similarly, the noise environment is assessed through baseline monitoring at various locations. The study helps in understanding existing noise levels and how they might be affected by the road and bridge improvement projects. The daytime equivalent noise level varies from a minimum of 50.8 dB(A) in E4 to a maximum of 60.8 dB(A) in W10. The nighttime noise varies, with the minimum nighttime noise level being 40.6 Leq dB(A), recorded at two locations: S6 and E4, and the maximum nighttime noise level being 45.1 Leq dB(A), recorded at location W10.

23. Groundwater and surface water quality along the project roads has been assessed, including the availability, usage, and potential contamination sources of water bodies in the area. The comprehensive analysis of 20 surface water samples demonstrates high water quality. Every measured parameter for all samples was well within the desirable limits set by IS: 10500:2012, suggesting the water is safe and suitable for drinking purposes without requiring significant treatment. Local utilization of drinking water is visible along all project roads via pipes crossing along and across the rights of ways.

Ecological Environment

24. None of the project roads are within a Protected Area. S1, BR06 and BR08 traverse through reserved forests and an Important Bird Area. The project roads fall between 180 and 1600 meters above sea level, coinciding with heightened biodiversity richness and land use change.

25. Sikkim, known as the “green state” in India is primarily forested. Approximately 90% of the area along the project roads, within 1500 m, are classified as forest based on satellite derived landcover. Sikkim’s forest landscape is characterized by remarkable biodiversity including some of the worlds most Threatened species.

26. Further, forests play a critical role in regulating the hydrological cycle by capturing rainfall, recharging groundwater, and maintaining perennial river systems such as the Teesta and Rangit. By stabilizing slopes and reducing erosion, Sikkim’s forests safeguard both biodiversity and human settlements downstream.

27. The forests and rivers provide a wide array of ecosystem services vital for sustaining rich biodiversity, human livelihoods, hydroelectric power, and clean drinking water across the Eastern Himalayan region. The rivers and streams in Sikkim play a vital role in sustaining diverse aquatic and terrestrial life. Migratory river species like Golden mahseer migrate up rivers to spawn. The distance they travel can vary significantly depending on the specific river system, habitat availability, and environmental conditions. Rivers hold cultural significance for local communities and are considered intangible cultural resources.

D. Anticipated Environmental impacts and mitigation measures

28. The environmental impacts associated with the pre-construction, construction, and operation phases of the road have been assessed across key environmental attributes selected during the screening process. The assessment of impacts is based on existing environmental baseline conditions, applicable regulatory standards, and recognized good industry practices. The mitigation measures will be implemented in line with the mitigation hierarchy, prioritizing avoidance followed by minimization, mitigation, and as a last resort, compensation or offsetting.

29. A critical habitat assessment has been conducted based on robust baseline data generated over one year and supplemented with extensive consultation with civil society organizations and the forest department. The CHA delineated critical habitat for the Chinese pangolin and Golden mahseer, 2 out of 22 species assessed based on camera trapping and eDNA surveys. Additionally, the assessment identified two biological corridors, designated as Critical Habitat, which function to support the long-term persistence of a number of Endangered species and connect the network of Protected Areas in Sikkim. These corridors fall between Fambong Lho and Maenam wildlife sanctuaries.

30. Lastly, the provisioning service of clean drinking water provided by the forests and streams qualified under Criterion 6 of ADB SPS as Critical Habitat as they are essential for the social

fabric, traditional practices of communities and provide vital resources for the livelihoods of local people, and hold spiritual, historical, or cultural value for communities. Communities and local peoples have constructed pipes crossing the roads to provide these water resources for drinking, irrigation, and watering livestock.

31. Accordingly, a Biodiversity Action Plan has been prepared, which includes structural mitigation measures such as enlarging the size of culverts and implementing vehicle speed-calming interventions. The management measures also emphasize awareness and training programs for rescue operations in the event of chance encounters with pangolins or other wildlife.

32. The environmental impacts of pre-construction activities, construction, and operation activities on ambient air quality, noise and vibration, surface and groundwater quality, land pollution, terrestrial flora and fauna, private land, community properties, noise and vibration, occupational health and safety, and community health and safety have been assessed.

- The pre-construction activities of site clearance will impact at minimum 1.280 ha of forest land, causing the felling of 5,818 trees.
- Land for offsite facilities like labor camps and construction camps needs to be arranged by the contractor before construction.

33. The safety of road users will be augmented by providing speed breakers, crash barriers at accident-prone areas, warning signage at schools and hospitals, and pedestrian crossings. The construction stage risks of accidents will be addressed by providing traffic diversion measures.

34. Working camps will be located outside the existing habitations to avoid conflicts with the community. The camps will be provided with facilities such as medical care, sanitation, water supply, waste management, and fire safety. Accommodation will be provided with individual beds, ventilation facilities, and adequate space to maintain privacy for individuals.

35. Materials will be sourced from legal and sustainable sources. The borrow area will be suitably rehabilitated.

36. Cultural features like crematorium, shrines, churches and temples of local importance are present within the ROW and adjacent to the ROW. The Road E4 has a cremation ground, a shrine and local idols are available within the right of way. A church and a temple are located adjacent to the RoW in the E4. Road S1 has cremation ground at the upstream of the bridge and 3 churches near the ROW. Road N9 has two churches adjacent to the right of way. Road W10 has a monastery near the RoW.

E. Environmental Management Plan

37. A project-specific Environmental Management Plan (EMP) has been prepared and included in the tender document. The Environmental Management Plan caters to the pre-construction, construction, and operation stages of the project. It defines the roles and responsibilities of contractors and the Project Management Unit (PMU) in project design, implementation, supervision, and monitoring.

38. An Environmental and Social Management Unit (ESMU) will be established under the PMU. An Authority Engineer will also be employed for supervision and monitoring of the works of contractor.

39. An independent external environmental monitoring will be conducted by engaging an independent or third party. The independent third party/ external monitor will be hired by PMU/ESMU after the Project approval from the Asian Development Bank, for half-yearly monitoring of the project under construction and annually during operation. The primary purpose of an independent third-party monitoring is to provide an objective assessment of the borrower's (or client's) compliance with ADB's SPS 2009 and the effectiveness of their Environmental Management Plans (EMP) and Biodiversity Action Plan. This includes verifying the accuracy of monitoring information submitted by the borrower. The independent monitoring helps identify any gaps or deficiencies in safeguard implementation, allowing for timely corrective actions and preventing or minimizing negative environmental and social consequences.

40. The ESMU will also hire an Independent National Biodiversity Specialist for supervision and monitoring of implementation of Biodiversity Actin Plan (BAP). The role and responsibility include technical signoff of the BAP, conducting regular site visits, provide trainings and regular reporting of the status of implementation of BAP and further recommendations.

41. An Environmental Monitoring Plan has been prepared for the effective implementation of environmental mitigation measures, evaluating the performance of the mitigation measures, and compliance with regulatory requirements. The monitoring plan has been devised for monitoring at the site level, project level, and PIU level.

42. The monitoring plan stipulates the schedule, parameters, standards, location, and responsibilities. It covers the pre-construction, construction, and operation stages of the project. It identifies air quality, noise level, water quality, and soil quality testing.

43. The impact on cultural resources are limited to relocation of small idols available within RoW and temporarily restricting access to local cultural resources like cremation ground available outside the RoW. The relocation of the idols will be done in consultation with the community. A alternative access route will be established for the impacted access with immediate restoration following completion of construction at the site. Necessary mitigation measure, like information board, will be implemented at the impacted locations.

44. A project-specific budget has been prepared for environmental management and environmental monitoring.

F. Public Consultation, Disclosure

45. The Roads and Building Department organized a series of public consultations and focused group discussions in collaboration with the DPR consultant. These consultations were held separately for different road sections to address specific concerns and gather localized feedback. Project information was shared with the local community through verbal communication, and feedback was actively collected from participants. The minutes of the meetings were systematically recorded

46. The key findings of the consultations are given below.

- Establish a grievance redressal mechanism.
- Use responsible construction methodology to avoid damage and disturbance to private and community assets.
- Avoid disturbance to the livelihood of the local community working adjacent to the road.
- Avoid water logging and provide passage for stormwater.
- Provide measures to avoid any negative impact on wild animals.

47. A grievance redressal mechanism will be established in the early phase of the project as per SPS 2009 to ensure that concerns of affected people are effectively and efficiently addressed. This mechanism is designed to be a systematic process that is accessible, transparent, and responsive to the complaints of individuals and communities who may be adversely impacted by a project. The primary objective is to resolve grievances at the local level in a timely and culturally appropriate manner, without resorting to legal action.

48. Three layered grievance redressal mechanisms will be implemented that will work at field, PIU and PMU level.

G. Conclusion

49. The project is classified as Category A as per the ADB SPS 2009 and will require an Environmental Impact Assessment for the upgrade of six roads totalling 77 km and three bridges, with specific measures for carriageway improvement, landslide mitigation, and tree felling.

50. The assessment ensures that environmental impacts of the proposed roads and bridges are mitigated in line with ADB's Safeguards Policy.

51. Critical habitats for endangered species like Chinese pangolin and Golden mahseer have been identified, ensuring biodiversity conservation through a Biodiversity Action Plan.

52. EMP includes roles and responsibilities, monitoring schedules, and budget allocation, ensuring effective implementation and compliance with regulations.

53. Series of consultations have addressed community concerns, leading to the establishment of a grievance redressal mechanism to handle complaints efficiently and transparently.

54. Key issues identified in the consultations include the requirement of a grievance redressal mechanism, avoidance and minimization of construction impacts on roadside houses, and prevention of water logging. These concerns are addressed in the Environmental Management Plan.

1. Policy, Legal, and Administrative Framework

1. Applicable Acts and Policies relevant in the context of the project are discussed below. The Project Authority (R&BD) will ensure that project activities implemented are consistent with the following regulatory/legal framework.

1.1 Legal Framework

2. The Government of India has laid out various policy guidelines, acts and regulations pertaining to environment. The Environment (Protection) Act, 1986 provides umbrella legislation for the protection of environment. As per this Act, the responsibility to administer, the legislation has been jointly entrusted to the Ministry of Environment, Forests and Climate Change (MoEF & CC) at national level, and to the State Pollution Control Board (SPCB), Sikkim at state-level.

1.1.1 Applicable National and State Regulations

3. The key environmental and other regulations relevant to Improvement and up gradation of roads under phase-1 in the State of Sikkim and West Bengal are presented in Table 1-1.

Table 1-1: Applicable Acts and Rules

#	Applicable act and rules	Objective	Type of activity involved in project	Applicability (Yes/No)	Competent Authority	Responsible Agency for Obtaining clearance
1.	Environment (Protection) Act, 1986	This is an umbrella Act to protect and improve overall environment. All environmental related act and regulation comes under this.	All construction and operational related activities where disturbance to natural environment occurs. All environmental act notifications are under this act.	Yes	MoEF&CC, SPCB, Central Pollution Control Board (CPCB)	PIU, State Public Works Department (SPWD)
2.	EIA Notification dated 14 September 2006 and amendments thereafter	To ensure and regulate the all-new development work which is listed in EIA schedule	According to EIA Notification 2006, the National Highway project or State Highway project located at an altitude of 1,000 m or more, was within the purview of this notification and considered as a category B project. But later amendment dated 22 August 2013 Highway projects of length up to 100 km and land acquisition up to 40 m have been exempted from the environmental clearance process. So Environmental Clearance is not required.	No	MoEF&CC, State-level Environmental Impact Assessment Authority (SEIAA), GOI	Not applicable, the Project Proponent does o have any responsibility.
3.	The Air (Prevention and Control of Pollution) Act, 1981	To control air Pollution by controlling emission of air pollutants as per the prescribed standards.	Consent to establish (CTE) and consent to operate (CTO) is required from SPCB under section 21 of Air (Prevention and control of Pollution) Act 1981 before Establishment/ Operation of stone crusher, Hot Mix Plant, RCC Plant and D.G sets	Yes	State Pollution Control Board, Sikkim	Contractor
4.	The Water (Prevention and Control of Pollution) Act, 1974	To control water Pollution by controlling discharge of pollutants as per the prescribed standards.	Consent to establish (CTE) and Consent to operate (CTO) is required from SPCB under section 25 of this Act before Establishment/ Operation of stone crusher, Hot Mix Plant, RCC Plant and D.G sets	Yes	SPCB	Contractor
5.	The Noise Pollution (Regulation and Control) Rules, 2000 & amendments.	The standards for noise for day and night have been promulgated by the MoEF&CC for various activities	This act will be applicable for all construction equipment deployed at worksite and in operation, is required before Establishment/Operation of stone crusher, Hot Mix Plant, RCC Plant and D.G sets	Yes	SPCB	Contractor
6.	Ancient Monuments and Archaeological Sites and Remains Act, 1958	Conservation of cultural and historical remains of India	Ancient Monuments and Archaeological Site Remains Act, 1958 is also not applicable. However,	No	Archaeological Dept. GoI, Indian Heritage Society and Indian National Trust	PIU, SPWD

#	Applicable act and rules	Objective	Type of activity involved in project	Applicability (Yes/No)	Competent Authority	Responsible Agency for Obtaining clearance
			the responsibility is being designated for the contingency purpose in case of the Chance Find of within 300m regulated zone of ASI structure/ Monument as per the stated law.		for Art and Culture Heritage (INTACH)	
7.	Public Liability Insurance Act, 1991	To provide public insurance liability for the purpose or providing immediate relief to the persons affected by accident occurring while handling any hazardous substances	Contractor needs to stock hazardous material like diesel, Bitumen, Emulsions, chlorine etc.	Yes	SPCB	Contractor
8.	The Forest (Conservation) Act,1980	To regulate the non-forest activity and conservation of Forest of India	In case of project corridor falls under forest notified PF/RF/Social Forestry zone.	Yes	State Forest Department and GOI MoEF&CC	PIU, SPWD
9.	Traditional Forest Dwellers (Recognition of Forest Rights) Act 2006	Recognising the rights of Scheduled Tribes in the Forest.	Using of forest land for non-forest purpose, diversion of forest land for road construction	Not applicable	District Collector or District Magistrate of the concerned district	Not applicable, the Project Proponent does o have any responsibility.
10.	Sikkim Private and Other Non-Forest Lands Tree Felling Rules, 2006.	To protect irregular cutting of tree from private or other non-forest areas	In case of involvement of cutting of tree from private land or other non-forest trees.	Yes	DFO, District Forest Office, Sikkim	PIU, SPWD
11.	The West Bengal Trees (Protection and Conservation in Non-Forest Areas) Act, 2006	To protect irregular cutting of tree from private or other non-forest areas	In case of involvement of cutting of tree from private land or other non-forest trees.	Yes (In Br06 if tree felling is unavoidable)	DFO, District Forest Office, Darjeeling, West Bengal	PIU, SPWD
12	The West Bengal Land (Requisition & Acquisition) Act, 1948 (Act II of 1948).	Sets out rules for acquisition of land by West Bengal government	In case of involvement of Private land acquisition, impact on private structure	Maybe required (status to be updated based on joint survey to find nature of lands along Br06 in WB)	Revenue Department, State Government	PIU, SPWD
13.	Wildlife (Protection) Act, 1972	To protect wildlife through national parks and sanctuaries	In case of Project corridor traverse through natural protected area (national park, wildlife sanctuary etc.) In case of project activity are envisaged near to protected area (NP, WLS etc.)	Yes	Chief Wildlife Warden, Conservator of Forests, Standing Committee of NBWL	PIU, SPWD
14.	Right to fair compensation and Transparency in land acquisition, Rehabilitation and resettlement Act, 2013	Sets out rules for acquisition/purchase of land by government	In case of involvement of private land acquisition, impact on private structure	Yes	Revenue Department, State Government	PIU, SPWD

#	Applicable act and rules	Objective	Type of activity involved in project	Applicability (Yes/No)	Competent Authority	Responsible Agency for Obtaining clearance
15.	Solid Waste Management Rules, 2016	To manage collection, transportation, Segregation, Treatment, and disposal of solid wastes (other than Hazardous water, plastic Waste, BIO Medical waste)	Applicable for Waste generated from the camp, offices.	Yes	SPCB, CPCB	Contractor
16.	Construction and Demolition Waste Management Rules, 2016	To manage collection, transportation, segregation, treatment, and disposal of waste arising of construction and demolition activities	Applicable in construction and demolition activity involved in the project road widening work.	Yes	SPCB, CPCB	Contractor
17.	Hazardous and other Wastes (Management and Transboundary Movement) Rules, 2016	To manage, store, transport hazardous and other waste	Applicable in case of storing of waste oil, diesel, bitumen etc.	Yes	SPCB, CPCB	Contractor
18.	Plastic Waste Management Rules, 2016	To manage and safe segregation, reuse of the plastic waste	Applicable in case of using of plastic trash bag and sheet (not less than 50-micron thickness); handling and disposal of plastic trash from the construction camp to authorized vendor.	Yes	SPCB, CPCB	Contractor
19.	Central Motor Vehicles Rules, 1988 and central motor vehicles rules 1989 & The Motor Vehicles (Amendment) Act, 2019	Vehicles used for construction of roads	All vehicles used for road work need Pollution Under Control (PUC) Certificate	Yes	Motor Vehicles Department	Contractor
20.	Mines and Minerals (Development and Regulation) Act,1957	For regulation of illegal mining of mineral and borrow earth	Permission will be required if ordinary earth mining is needed for road development Or For extraction of riverbed sand	Yes	State Mines and Geology Department	Contractor
21.	Guidelines to regulate and control Ground water extraction in India (with effect from 1 June 2019	To protect the ground water and regulate the illegal extraction	In case of withdrawal of Ground Water during construction phase, the case will be not applicable if water source from government approved vendor	Yes	Central/State Ground Water Board and NoC from CGWA	Contractor with support of Roads & Bridge Department, Sikkim
Transboundary Impact Amongst three bridges and six roads of Phase I, BRO**6** is falling both in Sikkim and West Bengal. Necessary land take mechanism as per prevalent act (RFCTLR 2013) shall be followed in land involvement of 1.50-acre mouza in Darjeeling district of West Bengal. The communication for the same has been done from PMU Sikkim R&BD on December 2023 and August 2024. (Annex 19 for communication from R&BD Sikkim to Darjeeling PWD). Based on the respective legal (land purchase mechanism) and EHS (IFC/WHO) guidelines, the construction of bridges shall be done. All necessary environmental and social mitigation measures as suggested in the EMP for BR06 shall be followed.						

PIU = Project Implementation Unit

1.1.2 Other Applicable National Laws and Regulations

4. Other key laws, including amendments thereof, pertaining to environment, health and safety aspects that are applicable to proposed interventions include:

- Easement Act, 1882, as amended
- Wetland (Conservation and Management) Rules, 2017
- Public Liability Insurance Act, 1991, as amended
- The Public Liability Insurance Rules, 1991, as amended
- Plastic Waste Management Rules, 2016, as amended
- Batteries (Management and Handling) Rules, 2001, as amended
- Petroleum Rules, 2002, as amended
- Gas Cylinder Rules, 2004, as amended
- The Insecticides Act, 1968 and Insecticides Rules, 1971 and as amended.

5. Environmental issues during road construction stage generally involve equity, safety and public health issues. The following laws will also apply:

- Workmen's Compensation Act, 1923: The Act provides for compensation in case of injury by accident arising out of and during employment.
- Payment of Wages Act, 1936: It lays down as to by what date the wages are to be paid, when it will' be paid and what deductions can be made from the wages of the workers.
- Child Labour (Prohibition and Regulation) Act, 1986: The Act prohibits employment of children below 14 years of age in certain occupations and processes and provides for regulation of employment of children in all other occupations and processes. Employment of child labour is prohibited in Building and Construction Industry.
- The Building and Other Construction Workers' (Regulation of Employment and Conditions of Service) Act, 1996: The Act regulates the employment and conditions of service of building and other construction workers and to provide for their safety, health and welfare measures and for other matters connected therewith or incidental thereto.
- Inter-state Migrant Workmen (Regulation of Employment and Condition of Service) Act, 1979: The Inter-State Migrant Workmen Act, 1979 was an Act of the Parliament of India enacted to regulate the condition of service of inter-state labourers in Indian labour law. The Act's purpose was to protect workers whose services are requisitioned outside their native states in India
- Employees Provident Funds and Miscellaneous Act, 1952: The Act provides the institution of provident funds pension fund and deposit-linked insurance fund for employees in factories and other establishments.
- Employees State Insurance Act, 1948: The Act provides certain benefits to employees in case of sickness, maternity and employment injury and to make provision for certain other matters in relation thereto
- The Bonded Labour System (Abolition) Act, 1976: The Act provides for the abolition of bonded labour system with a view to preventing the economic and physical exploitation of the weaker sections of the people and for matters connected therewith or incidental thereto.

1.2 Key Statutory Clearances/Permissions Requirements during Construction Stage

6. During the construction stage, some of the key statutory requirements that need to be obtained by the Contractor as part of mobilization (pre-construction) have been listed Table 1-2.

Table 1-2: Key Statutory Clearances

Sl. No	Clearance/Consents Requirement	Statute under which clearance/permission is required	Statutory Authority	Time Line	Current status	Responsible Agency for Obtaining clearance
Pre-construction stage clearance/permission required						
1	Forest Clearance and Tree felling Permission	Forest (Conservation) Act, 1980and Sikkim Private and Other Non-Forest Lands Tree Felling Rules, 2006	Forest Department	Before start of construction	Joint verification of 7 out of 9 subprojects have been completed. The report from the forest department is awaited. Subsequently, the application for diversion of forest land will be filed after the data of Joint verification is received.	PMU/ PIU R&BD, Sikkim
2	Wildlife Clearance	Wildlife (Protection) Act, 1972	Wildlife wing of Forest Department	Before start of construction	Filing of application for permission of wildlife is contingent on Tender approval.	PMU/ PIU R&BD, Sikkim
Construction stage clearance/permission required						
3	No Objection Certificate (Consent to Establish and Consent to Operate)	Air (Prevention and Control of Pollution) Act, 1981 Water (Prevention and Control of Pollution) Act, 1974 Hazardous and Other Waste (Management and Transboundary Movement) Rules, 2016	Sikkim State Pollution Control Board	Before start of construction	This will be applied by the contractor after after their onboarding.	Contractor
4	Labour License	Building and Other Construction Workers (Regulation of Employment and Conditions of Service) Act, 1996 Interstate Migrant Workmen (Regulation of Employment and Conditions of Service) Act, 1979	State Labour Department	Before mobilisation of team to the site	This will be applied by the contractor after their onboarding.	Contractor
5	Sand or Stone quarry in case non-approved sand mining or stone queries are selected by the contractor	EIA Notification, 2006, Mines and Minerals (Development and Regulation) Amendment Act, 2015	DEIAA/SEIAA and Department of Mines	Before start of quarrying	If case it is required, it will be obtained by the contractor.	Contractor
6	Traffic Management and Regulation during construction and maintenance	National Road Safety Policy and Guidelines of Indian Roads Congress	Traffic Police Department and District Administration.	Before start of construction on the operating road	This will be applied by the contractor after their onboarding.	Contractor with support of R&BD, Sikkim

1.3 Forest Clearance Project

7. As per EIA Notification 2006 and its 2014 amendment, and further amendments, for upgradation of state highways, project roads require Forest Clearance from the MoEF&CC if the

implementation of the project requires diversion of forest land i.e., Forest Clearance shall be required from Department of Environment & Forest (Regional Office) Shillong, Government of Sikkim if the project involves diversion of forest land. All linear projects and other proposal related with diversion of forest land from 0 ha to 40 ha, are forwarded to regional office MoEF&CC for diversion (Online Submission & Monitoring of Environmental, Forest and Wildlife Clearance Guideline; User manual version 1.0 issued by MoEF&CC, 2015). The project roads pass through reserve forests/village forest, see section 3.6.1.

8. As per discussion with Sikkim PWD, it is perceived that around 16 m PROW land belongs to government department (PWD, Irrigation etc..), where existing ROW is available around 8-16m on the project roads. During reconnaissance site visit, it was observed that majorly sufficient ROW i.e., 16 m was available along all the project roads, however widening, curve treatment at hair bend sections would require additional land for which further approval from competent authority shall be required.

9. No land will be required from wildlife sanctuary for the implementation of the project. However, national parks and wildlife sanctuaries (NP/WLS) such as Kanchendzonga National Park (4.6 km) for N9, Kitam Bird Sanctuary (3.6 km) for S6, Pangolakha Wildlife Sanctuary (1 km) for E1, Fambonglho Sanctuary (0.5 km) for E4, Maenam Sanctuary (3.0 km) for Br04 (Bhaley Khola Sirsiray - Kalung Dara), Kitam Bird Sanctuary (3.5 km) for Br06 on Ramam River along Nayabazar Singla road km 0.0 to 1.0 Ch. 22 are located within 5 km radius of the project road. Nonetheless, since eco-sensitive zones extend a maximum of between 25 to 200 m from these PA, the have been notified by the MoEF&CC have notified for all the protected areas, withstanding that Wildlife Clearance from the Standing Committee of the National Board for Wildlife will not be required from the Standing Committee of the National Board for Wildlife.

10. Furthermore Importantly, Wildlife (Protection) Act, 1972, a is separate regulation, and the project is required to get the No Objection Certificate (NoC) from PCCF before start of works. The Forest Clearance Process is provided below:

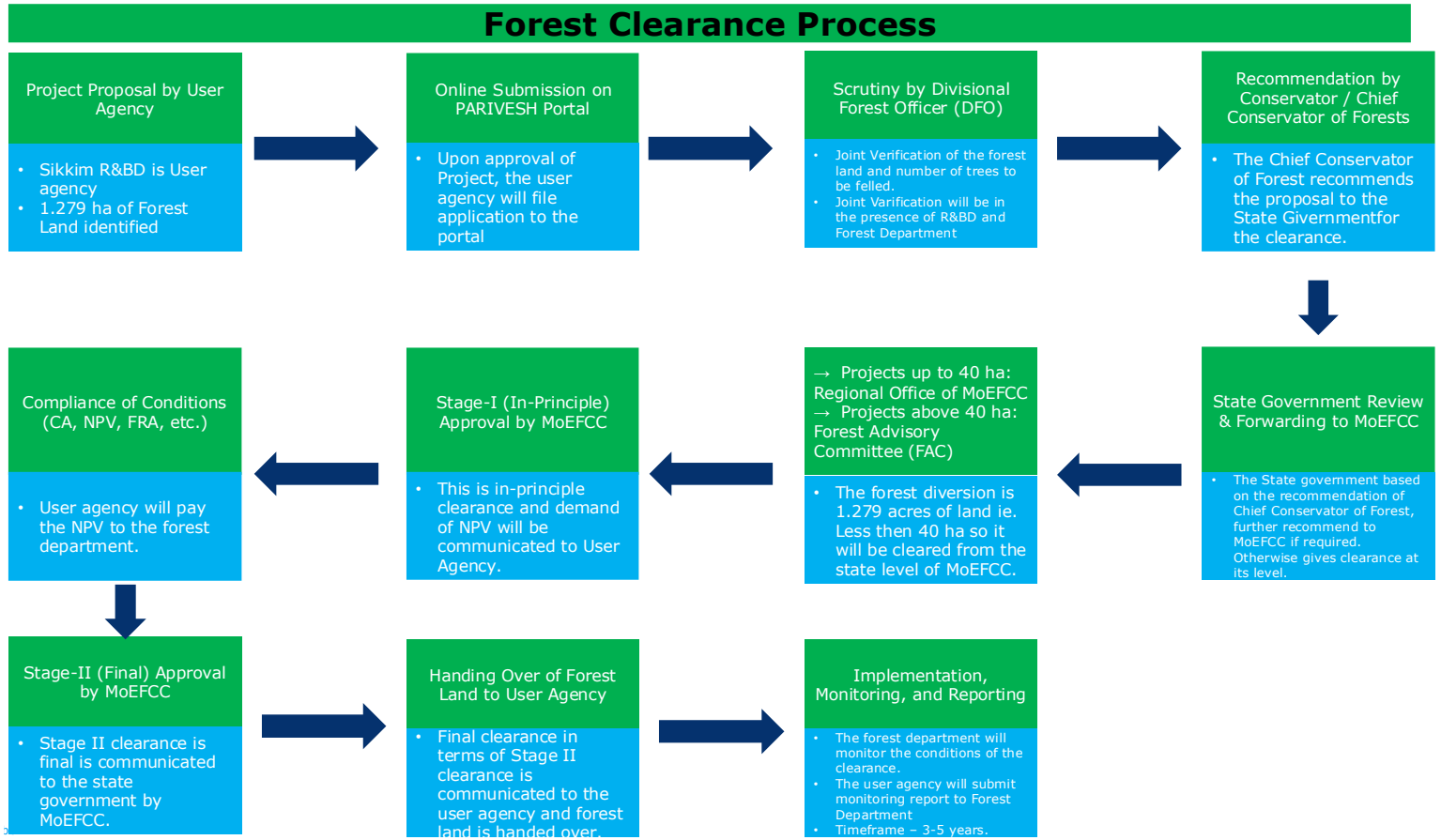


Figure 1-1Indian Road Congress (IRC) Code of Practices applicable for the Project

11. Key Indian Road Congress (IRC) Code of Practices applicable for the project road with respect to environment are given in

Sl. No	IRC Code Theme	Year	Purpose
1	Recommendations for Road Construction in Areas Affected by Water Logging, Flooding and/or Salts Infestation	IRC:34-2011	Construction in waterlogged areas
2	Recommended Practice for Construction of Earth Embankments and Sub-Grade for Road Works (First Revision)	IRC:36-2010	Issues relating to borrow pits
3	Guidelines for Pedestrian facilities	IRC: 103 -1988	Safety of pedestrians
4	Recommended Practice for Recycling of Bituminous Pavements	IRC:120-2015	For recycling of bituminous pavements
5	Guidelines for Use of Construction and Demolition Waste in Road Sector	IRC:121-2017	Use of construction and demolition waste in road sector
6	Guidelines on Landscaping and Tree Plantation	IRC: SP:21-2009	Landscaping and tree plantation along of the road.
7	Guidelines for Road Drainage	IRC: SP: 42-1994	Drainage
8	Highway safety code	IRC: SP: 44-1994	Highway safety
9	Guidelines for Traffic Management in work zones	IRC: SP-55-2014	Worksite safety management
10	Guidelines for use of fly ash in Road Embankments	IRC: SP:58-2001	Use of fly ash in road embankments
11	Guidelines for Use of Geotextiles in Road Pavements and Associated Works	IRC: SP:59-2002	Use of geotextiles in road pavements and associated works
12	Guidelines for Soil and Granular Material Stabilization Using Cement Lime and Fly Ash	IRC: SP-89-2010	Soil and granular material stabilization using cement lime and fly ash
13	Guidelines on Requirements for Environmental Clearance for Road Projects	IRC: SP-93-2017	Requirements for Environmental Clearance for road projects
14	Guidelines for the use of Waste Plastic in Hot Bituminous Mixes (Dry Process) in Wearing Courses	IRC: SP-98-2013	Use of waste plastic in hot bituminous mixes (dry process) in wearing courses
15	Use of Cold Mix Technology in Construction and Maintenance of Roads Using Bitumen Emulsion	IRC: SP-100-2014	Use of cold mix technology in construction and maintenance of roads using bitumen emulsion
16	Interim Guidelines for Warm Mix Asphalt	IRC: SP-101-2014	Warm mix asphalt
17	Guidelines on Preparation and Implementation of Environment Management Plan	IRC: SP-108-2015	Preparation and implementation of Environment Management Plan

1.4 Environmental Standards and IS Codes

12. Environmental standards applicable are as given below:

- National Ambient Air Quality Standards, 2009
- Measurement of Air Pollution - IS: 5182-1977

- Ambient Noise Standards
- Measurement of Noise from Moving Road Vehicles - IS: 3028-1980
- Measurement of Noise from Stationery Road Vehicles - IS: 10399-1982
- Measurement of Noise Pollution from Machines - IS: 4758-1968
- Stack Emissions of CPCB for Hot Mix Plants
- Discharge Standards of CPCB for Disposal of Treated Sewage
- Drinking Water Quality Standards - IS:10500:2012
- CPCB Standards for Surface Water Use

1.5 Asian Development Bank's Safeguard Policy Statement (SPS), 2009

13. The Asian Development Bank's Safeguard Policy Statement (SPS) 2009 requires that environmental considerations be incorporated into ADB's funded project to ensure that the project will have minimal environmental impacts and be environmentally sound. Occupational Health & Safety of the local population should also be addressed as well as the project workers as stated in SPS. A Grievance Redress Mechanism (GRM) to receive application and facilitate resolution of affected peoples' concerns, complaints, and grievances about the project's environmental performance is also established in this assessment report. Projects are classified using Rapid Environment Checklist into one of the following environmental categories:

a. Category A: A proposed project is classified as category 'A' if it is likely to have significant adverse environmental impacts that are irreversible, diverse or unprecedented. These impacts may affect an area larger than the sites or facilities subject to physical works. An Environmental Impact Assessment (EIA) is required.

b. Category B: A proposed project is classified as category 'B' if its potential adverse environmental impacts are less adverse than those of category A projects. These impacts are site-specific, few if any of them are irreversible, and in most cases mitigation measures can be designed more readily than for category 'A' projects. An Initial Environmental Examination (IEE) is required.

c. Category C: A proposed project is classified as category 'C' if it is likely to have minimal or no adverse environmental impacts. No environmental assessment is required although environmental implications need to be reviewed.

d. Category Fi: A proposed project is classified as category Fi if it involves investment of ADB funds to or through a financial intermediary (Fi).

1.6 World Bank Group's Environment, Health, and Safety Guidelines

14. The World Bank Group's Environmental, Health, and Safety (EHS) Guidelines are technical reference documents with general and industry-specific examples of Good International Industry Practice (GIIP). EHS Guidelines are applied as required by their respective policies and standards. These industry sector EHS guidelines are designed to be used together with the General EHS Guidelines document, which guides users on common EHS issues potentially applicable to all industry sectors. The EHS Guidelines contain the performance levels and measures that are generally considered to be achievable in new facilities by existing technology at reasonable costs. Application of the EHS Guidelines to existing facilities may involve the establishment of site-specific targets, with an appropriate timetable for achieving them. The applicability of the EHS Guidelines should be tailored to the hazards and risks established for each project based on the results of an environmental assessment in which site-specific variables, such as host country context, the assimilative capacity of the region. Defined as the exercise of professional skill, diligence, prudence, and foresight that would be reasonably expected from skilled and experienced professionals engaged in the same type of undertaking under the same or similar circumstances globally. The circumstances that skilled and experienced professionals may find when evaluating the range of pollution prevention and control techniques available to a project may include but are not limited to, varying levels of environmental degradation and environmental assimilative capacity as well as varying levels of financial and technical feasibility. Applicability of specific technical recommendations should be based on the professional opinion of qualified and experienced persons. When host country regulations differ from the levels and measures presented in the EHS Guidelines, projects are expected to achieve whichever is more stringent. If less stringent levels or measures than those provided in these EHS Guidelines are appropriate, given specific project circumstances, a full and detailed justification for any proposed

alternatives is needed as part of the site-specific environmental assessment. This justification should demonstrate that the choice for any alternate performance level is protective of human health and the environment.

15. The World Bank Group EHS Guidelines for Roads and Infrastructure Projects, Water and Sanitation, and General EHS Guidelines contain information on cross-cutting environmental, health, and safety issues may be used.

16. In addition, the Bank Directive on Disadvantaged and Vulnerable Individuals/Groups (2016) and the Labour Influx Guidance Note (2016)7 will be consulted for addressing various project activities including the applicability of Environmental Clearance (EC), Forest Clearance (FC) and Wildlife Clearance (WC).

Table 1-3: Requirement of Forest Clearance and Wildlife Clearance for the roads and bridges under Phase-I

#	Name of the Road	Reserve Forest Proximity[1]	Nearest Wildlife Sanctuary/ National Park *(Approx. Shortest Distance as per GIS measurement)*	Environmental Clearance required	Forest Clearance required	Wildlife Clearance required
1	N9 Mangan Bazaar to DAC	No Reserve Forest	Kanchendzonga National Park (4.6 km)	Not required	Not Required	Not required
2	S1 Melli - Phong via Rateypani	No Reserve Forest (other forest managed lands present)	Kitam Bird Sanctuary (7 km)	Not required	Forest Clearance and tree felling approval will be required	Not required
3	S6 Assangthang – Salghari to CCCT Nandugaon	No Reserve Forest (other forest managed lands present)	Kitam Bird Sanctuary (4 km)	Not required	Forest Clearance and tree felling approval will be required	Not required
4	E1 Rorathang Rongli	No Reserve Forest (other forest managed lands present)	Pangolakha W.S. (1.5 km)	Not required	Forest Clearance and Tree felling approval will be required	Not required
5	E4 Khamdong-Lingzey-Tintek	No Reserve Forest (other forest managed lands present)	Fambonglho Sanctuary (0.8 km)	Not required	Forest Clearance and Tree felling approval will be required	Not required; NOC might be required
6	W10 Geyzing to Sakyong	No Reserve Forest (other forest managed lands present)	Barsey Rhodendron Sanctuary (5.8 km)	Not required	Forest Clearance and Tree felling approval will be required	Not required
7	Br04 Bhaley Khola Sirsiray - Kalung Dara	No Reserve Forest (other forest managed lands present)	Maenam Sanctuary (3.0 km)	Not required	Forest Clearance and Tree felling	Not required

[1] Approx. shortest distance as per GIS measurement

#	Name of the Road	Reserve Forest Proximity[1]	Nearest Wildlife Sanctuary/ National Park *(Approx. Shortest Distance as per GIS measurement)*	Environmental Clearance required	Forest Clearance required	Wildlife Clearance required
					approval will be required	
8	Br06 on Ramam River along Nayabazar Singla Road Km 0.0 to 1.0 Ch. 22	Jhum RF Salghari RF RF areas are on approach roads	Kitam Bird Sanctuary (7.2 km)	Not required	Forest Clearance and Tree felling approval will be required	Not required
9	Br08 Bridge over Andheri Kholcha along Manpur Fatak to Jorethang Road	Jhum RF	Kitam Bird Sanctuary (3.5 km)	Not required	Forest Clearance and Tree felling approval will be required	Not required

2. Description of the Project

17. This Chapter describes the nature, type, location, and other characteristics of the proposed Project.

2.1 Scope of the Project

18. The project is improvement of six existing road and construction of three bridges. The improvement work includes.

- Increase the carriage way up to 5.5 meters and 7.00 meters
- Pavement strengthening,
- drainage,
- slope stabilization and
- providing paved shoulders and

19. The detailed improvement plan and right of way details are provided in Table 2-V of Section 2.6. project will require additional right of way of area 1.398 ha including 1.28 ha of forest land. The details of the requirements are provided in Table No. 4-II in Section 4.1.1

2.2 Project Location

20. Sikkim is situated in the Himalayas and is characterized by mountainous terrain. It lies between 27°04' N and 28°07' N, and between 88°00' E and 88°55' E in the physiographic zone of Eastern Himalayas. The six sub-project roads and three bridges under the project are located primarily in four districts of Sikkim namely: East, West, North and South.

2.3 Project Category and Rationale for Categorization

21. Project categorization has been done using Rapid Environment Assessment (REA) checklist of ADB for roads and highways (Appendix 2) after survey and initial consultations. Project scope is limited to improvement and widening of existing roads.

22. The rationale for categorization is based on the sensitivity of the area and the level of impact on the area. According to the Sikkim PWD, it is perceived that around 16 m PROW land belongs to government department (PWD, Irrigation etc..), where existing ROW is available around 8-16 m on the project roads. It was observed that the existing roads are well within the 16 m ROW of PWD, and construction of roads will not be causing stress on natural resources such as land, water, soil etc. Widening and improvement are confined to available ROW. Additionally, in terms of sensitivity to biodiversity, Sikkim is renowned for its abundant biodiversity. There are 5 protected area falling within 5 km periphery of the project road. However, these Protected areas have notified eco-sensitive boundary which are approximately 25-200 m around the protected area boundary. The nearest project site, which is located approximately 500 m Fambong Lho Sanctuary is located at E4 Khamdong-Lingzey-Tintek. The impact of the project is discussed in detail in Chapter 5.

23. Although most of the adverse impacts are co-terminus with the construction stage, site-specific, limited within the ROW, and are easily mitigated through good engineering and housekeeping practices, the critical habitat assessment established the EAAAs as critical habitats for two species, Chinese pangolin [Manis pendactyla; CR (IUCN v.2025-1)] and Golden mahseer [Tor putitora; EN (IUCN v.2025-1)]. The critical habitats designated herein also serve as important dispersal corridors between Fambonglho and Maenam Wildlife Sanctuaries, which host other threatened species as well. Hence, the project is classified as environment Category A in accordance with the ADB's SPS 2009.

Figure 2-1: Location of the Projects under Phase-1 and 2

2.4 Traffic Details

24. The annual average daily traffic (AADT) on the project roads and bridges surrounding network is presented in the succeeding table for the years 2021, 2026, 2031, 2036, 2041 based on the traffic study prepared during the feasibility study. Since the project roads and bridges are not

connecting major industrial places and no major activities are planned in the near future, induced or diverted traffic is not expected. Total (motorized traffic) traffic projection has been done assuming 5% growth rate. A uniform traffic growth rate of 5.6% per year has been considered for traffic projection.

Table 2-1: Present and Projected Traffic (Annual Average Daily Traffic) for Phase–1 Roads and Bridges (Total Motorized Traffic)

Roads and Bridges	2021	2026	2031	2036	2041
	No. of Vehicles	No. of Vehicles	No. of Vehicles	No. of Vehicles	No. of Vehicles
N9 Mangan Bazaar to DAC	1,655	2,173	2,884	3,748	4,921
S1 Melli - Phong via Rateypani	509	668	878	1,153	1,514
S6 Assangthang – Salghari to CCCT Nandugaon	1,635	2,147	2,819	3,702	4,802
E1 Rorathang Rongli	724	951	1,248	1,639	2,153
E4 Khamdong-Lingzey- Tintek	185	243	319	419	550
W10 Geyzing to Sakyong	366	481	631	829	1,088
Br04 Bhaley Khola Sirsiray - Kalung Dara	15	20	26	34	45
Br06 Ramam River along Nayabazar Singla Road km 0.0 to 1.0 Ch. 22	558	733	962	1,264	1,659
Br08 Bridge over Andheri Kholcha along Manpur Fatak to Jorethang Road	1,804	2,369	3,111	4,085	5,364

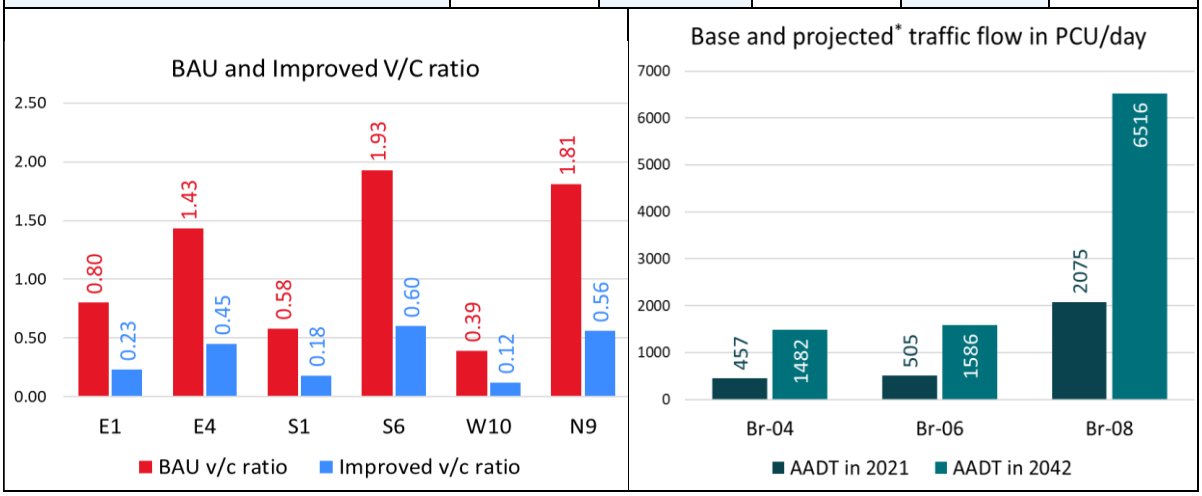


Figure 2-2: Base and Projected Traffic at Roads and Bridges

2.5 Characteristics of the Existing Roads and Bridges

25. Existing sub-project roads under the project have varying width and road conditions. The ROW is generally 8-16 m. It further varies within the length of individual roads with comparatively reduced width in settlement areas. All sub-project roads (N1, S1, E1, E4, S6, and W10) are single lane with or without earthen shoulder. Now, these are planned anddesigned to upgrade into intermediate carriageway + 1 m earthen shoulders at valley side + 1.5 m paved shoulder at hillside + side drain (based on the road section).

26. The existing pavement type is flexible i.e., bituminous layer over granular base. Overall pavement condition is in fair to poor condition in all roads. Typical distresses present are cracking, ravelling, edge breaks and potholes occurred due to poor drainage facility, water accumulation and poor vertical geometry.

27. In all project roads, the lined drains, at hillside, were observed throughout the stretch of project corridor to facilitate discharge of hillside runoff to corresponding CD structure. Damages to the longitudinal drains were observed at the location of landslides.

28. There are existing minor bridges and culverts in the project roads. One new bridge will be constructed along the Bhaley Khola Sirsiray to Kalung Dara road whereas other bridges, one over the Ramam River along Nayabazar Singla road (km 0 to 1.0 Ch 22) and another over Andheri Kholcha along Manpur Fatak to Jorethang road need reconstruction and repairs.

29. Bus shelters are present in some built-up areas. Most of the roads have inadequate road safety provisions. Horizontal curve is mostly insufficient in built-up areas. Vertical curves are deficient to severely deficient throughout the stretches of all sub-project roads.

30. During inventory, the existing condition of the selected corridors was found to be very poor and needed improvement for the smooth movement of the vehicle. However, main challenges incorporating the improvements are the topography of the corridors and short width of existing row. Keeping the aforementioned facts in mind, the following improvements were recommended:

Table 2-2: List of Roads under Phase-I

Sr. No.	Corr. No.	Name of the Road	Existing Carriageway Width (m)	Existing Shoulder Width (m)	Existing Road Width (m)
1	E1	Rorathang-Rongli	5.25	1.3	7.85
2	E4	Khamdong Linzey - Tintek	3.50	1.13	5.76
3	S1	Melli-Phong via Rateypani	3.50	1.2	5.90
4	S6	Assangthang Salghari to CCCT Nandugaon	3.50	1.7	6.90
5	N9	Mangan Bazar to D.A.C. (Mangan) (Dr. Lobzang Tenzing Marg)	3.88	1.35	6.58
6	W10	Geyzing to Sakyong	3.65	1	5.65

31. The pavement conditions have been assessed based on visual observations (formation of cracks, rutting, potholes, and ravelling) and pavement investigation. The existing roads condition varies from good to very poor; about 70% road pavements are in poor condition. There were some stretches which were damaged because of the poor condition of the sub-grade and other factors. The environment concerns associated due to poor pavement were slow movement of vehicles, traffic congestion resulting in air and noise pollution, indirectly affecting the population residing along the roads.

32. High embankments are observed along the existing road where hilly; valley areas are present. As the terrain along the road is uneven, the existing roads are at grade with natural ground at few locations and have high embankments at location approaching major, minor bridges and hilly, valley areas. The average embankment height varies from 2 m to 4 m in rural areas, from 5 m to 10 m in hilly, valley areas, and at level in built-up areas. Embankment has been designed for ensuring the stability of the roadway.

33. Electric lines and transformers, water pipelines, OFC lines and telephone lines were observed along the project roads. Vehicular underpasses are not proposed. There are no railway crossings in the up gradation of project roads. Railway lines do not cross the proposed roads.

34. All the proposed roads are accident-prone area. All accident black spots were reviewed, and appropriate measures will be implemented. The designed upgradation of the project road will be helpful in avoiding accidents and enhance road safety. Geometry of the roads has been designed as per the applicable Design speed and relevant codes and standards. The deficient curves (horizontal and vertical) along the existing geometry will be improved. Super-elevation as per the curve radius will be provided in order to avoid overturning of vehicles due to speed. Adequate sight distances will be provided in order to avoid blind spots both horizontally and vertically.

Table 2-3: Corridor Characteristics

Name of Road	E1	E4	S1	S6	N9	W10
District	East Sikkim	East Sikkim	South Sikkim	South Sikkim	North Sikkim	West Sikkim
Villages/settlements enroute	5	9	4	4	3	4
Corridor Length (km)	8.9	21.76	22.65	14.79	2.10	6.12
Terrain	Hilly; Elevation 600-800 m amsl	Hilly	Hilly	Hilly	Hilly	Hilly
ROW (m)	8-8.5	8-8.5	8-8.5	8-8.5	8-8.5	8-8.5
Carriageway Configuration	3.5 m	3.5 m	3.5 m	3.5 m	3.5 m	3.5 m
Existing	Single Lane	Single Lane	Single Lane	Single Lane	Single Lane	Single Lane
Approved Proposal of Improvement	Intermediate carriageway +1m earthen shoulders at valley side+1.5 m paved shoulder at hill side+ Side drain (based on the road section)	Intermediate carriageway +1m earthen shoulders at valley side+1.5m paved shoulder at hill side+ Side drain (based on the road section)	Intermediate carriageway +1m earthen shoulders at valley side+1.5 m paved shoulder at hill side+ Side drain (based on the road section)	Intermediate carriageway +1m earthen shoulders at valley side+1.5 m paved shoulder at hill side+ Side drain (based on the road section)	Intermediate carriageway +1m earthen shoulders at valley side+1.5 m paved shoulder at hill side+ Side drain (based on the road section)	Intermediate carriageway +1m earthen shoulders at valley side+1.5 m paved shoulder at hill side+ Side drain (based on the road section)
CD Structure	48 (Slab culvert, Non-Vented Causeway)	125 (Slab culvert, Non-Vented Causeway)	80 (Slab culvert, Causeway- Box Culvert)	43 (Slab culvert, Causeway- Box Culvert)	18 (Box culvert)	09 (Culvert)
No. of existing Bridges	Major Bridge:0 Minor Bridge:03	Major Bridge:0 Minor Bridge: 6	Major Bridge:01 Minor Bridge: 02	Major Bridge:0 Minor Bridge: 0	Major Bridge:0 Minor Bridge: 0	Major Bridge: 0 Minor Bridge: 01
Forests / environmentally sensitive areas	3 km - Pangolakha WLS&ESZ	Fambong Lho Wildlife Sanctuary (600 m)	Kitam Bird Sanctuary and ESZ - 7 km	Kitam Bird Sanctuary and ESZ - 4 km	Kangchenjunga NP is located at 5 km from the road	Rabdengtse Bird Park, Boundary to Project Road at 650 m Areal Distance and 3.7 km from Biosphere Kangchenjunga NP.
Potential Impact on Land	Nil (Likely land acquisition in hair pin bends)	Nil (Likely land acquisition in hair pin bends)	Nil (Likely land acquisition in hair pin bends)	Nil (Likely land acquisition in hair pin bends)	Nil (Likely land acquisition in hair pin bends)	Nil (Likely land acquisition in hair pin bends)

Name of Road	E1	E4	S1	S6	N9	W10
Potential Resettlement Impact	Encroachment	Nil	Nil	Encroachment	Nil	Encroachment
Religious Structures Affected	None	3 Temples and 1 Church	None	None	None	None
Heritage trees, sacred grooves	None	None	None	None	None	None
River/stream crossings	None	None	2	None	None	None
Waterbodies/ponds	None	None	None	None	None	None
Transshipment areas/truck parking locations	1 Private Parking Area	None	None	4 Private Parking Areas	None	None
Other features / issues if any **Landslide:**	Landslide prone area: From chainage Ch. 2+ 968; 4+180. Appropriate landslide correction measure should be adopted at these locations.	Landslide prone area: From chainage Ch. 1+350; 15+230 Appropriate landslide correction measure should be adopted at these locations.	Landslide prone area: 0+750, 14+250, 14+700, 19+750, 20+050, 21+100, 21+760 & 21+870 Appropriate landslide correction measure should be adopted at these locations.	Landslide prone area: From chainage Ch. 1+350; 15+230 Appropriate landslide correction measure should be adopted at these locations.	Landslide prone area: From chainage Ch. 0+800, 10+250, 10+400 Appropriate landslide correction measure should be adopted at these locations.	Landslide prone area: From chainage Ch. 3+410, 3+630, 3+950 Appropriate landslide correction measure should be adopted at these locations.
Trees within existing RoW Nil **(Likely land acquisition in hair pin bends)**	Approximately 524 at re-treatment areas	Approximately 2225 at re-treatment areas	Approximately 1635 at re-treatment areas	Approximately 599 at re-treatment areas	Approximately 10 at re-treatment areas	Approximately 738 at re-treatment areas

2.6 Characteristics of the Bridges

35. Major bridges are provided where there is river or water way across the project road. It shall be provided, widened, reconstructed, or extended. Bridges on the main road shall be designed for all the load cases of IRC: 6-2017 as applicable. Bridges that need to be reconstructed are as follows:

Table 2-4: List of Major Bridges under Phase-1

Sr. No.	Design Chainage (km.)	Proposed & Existing Span Arrangement (n x L (m))	Total Length (m)	Proposed Type of Super-structure	Deck Width (m)		Remarks
					Existing	Proposed	
Road S1 - Melli to Phong via Rateypani							
1	8+200	1 x 120	120	Steel Truss	4.50 m	12.00 m	New construction & Existing Bridge to be closed to the traffic. But this can be used in emergency situation after verification of structural integrity by the Engineer of the Road and Building Department.
Road E1 - Rorathang to Rongali							
1	4+075	1 x 60	60	Steel Truss	7.50 m	12.00 m	New construction & Existing Bridge to be closed to the traffic. But this can be used in emergency situation after verification of structural integrity by the Engineer of the Road and Building Department.
Standalone Bridges							
1	Br 04 Bhaley Khola Sirsiray - Kalung Dara	1 x 60	60	Steel Truss	--	12.00 m	New Construction
2	Br-06 - Ramam River along Nayabazar Singla road Km 0 to 1.0 Ch 22	1 x 100	100	Steel Truss	4.50 m	12.00 m	New construction & Existing Bridge to be closed for the traffic. But this can be used in emergency situation after verification of structural integrity by the Engineer of the Road and Building Department.
3	Br-08 - Bridge over Andheri Kholcha along Manpur Fatak to Jorethang Road	1 x 60	60	Steel Truss	7.50 m	12.00 m	Same as above.

36. Besides the major bridges, 10 minor bridges need to be reconstructed, along with new construction of two new minor bridges. All minor bridges are either of the three types – slab-integral, RCC-T-girder, or steel composite structure.

2.6.1 Br04 Baley Khola Sirsiray - Kalung Dara

37. At the selected bridge location there is no existing bridge for vehicular load. There is a suspension foot bridge exists at the site of selected bridge location.

This is the connecting road of the Dorjee Kazi Marg and Sripatam. The existing road is made of gravel. Cars, jeep even loaded truck move through this approach road up to the selected bridge location. These vehicles cannot cross the channel because of non-existence of vehicular bridge.

The depth of riverbed from the formation level of foot bridge is ~16 m. Formation level of the selected bridge to riverbed level is ~20 m.

Boulders and exposed rocks were observed along the waterway. No landslide was noticed in the vicinity of the selected structure location. However, the hill to upstream side of the existing foot over bridge experiences frequent landslide during rainy session. New bridge has been designed and at the site selected on downstream side of the foot bridge to avoid landslide on approach road of the selected bridge.

Approved Improvement Proposals: The existing bridge is not designed for vehicular traffic, but for pedestrians. Hence, to improve the connectivity between Dorjee Kazi Marg and Sripatam, a new bridge is proposed on the downstream of the existing pedestrian bridge after improving the approach road as per present IRC codal provision.

2.6.2 Br06 over Ramam River along Nayabazar Singla road km 0.0 to 1.0 Ch. 22

38. The age of the structure is ~50 years as per the information collected from R&BD. At present, limited traffic is permitted over the bridge, with height restriction of 2.6 m and only one vehicle is permitted on the bridge at a time.

39. The bridge connects Jorethang to Singla which connects Darjeeling to Sikkim directly and the only means of road transport available that connects Jorethang to Darjeeling.

40. The bridge has the following characteristics: number of spans: 1; span between expansion joints: 97.40 m; clear span: 97.40 m; width: 4.20 m; clear roadway width between the kerbs: 3.90 m.

41. There was a suspension-type foot bridge constructed on the downstream side of the existing bridge and foundation of the same is visible at site.

42. The bridge is of steel-suspension-type with RCC pylon (0.65 m thick and varying width with bottom width 2.6 m). The superstructure deck is of steel chequer plate supported on five stringers made by ISMC 150 rolled channel and the stringers are supported on 64 floor beams of ISMC 250 which are hanging by tie rod of 25 mm diameter and connected to four high-strength suspension cables at both side of elevation of the carriageway. The suspension cables are supported on the pylons and anchored inside hill through block-mass system. The railings are made of three angle section running horizontally and connected to the tie rods. The overall condition of the structure is poor.

43. As-built drawing, traffic volume details, Geotech details etc. were not available with R&BD as the bridge is more than 50 years old.

44. Due to height restriction and age of the bridge, only passenger vehicles can ride the bridge. New bridge with wide carriageway and having present-day load-carrying capacity should be constructed on the upstream side of the existing bridge.

2.6.3 Br08 Bridge over Andheri Kholcha along Manpur Fatak to Jorethang Road

45. The road is SH-15 and the only means of road transport available that connects Jorethang to Manpur Fatak/Melli.

46. The bridge has the following characteristics: No. of spans: 1; span between expansion joints: 11.0 m; clear span: 10 m; overall width: 9.50 m; clear roadway width between the kerbs: 7.5 m.

47. The bridge is completely covered undersoil due to major land slide at the bridge location. Therefore, the inventory and condition survey could not be completed.

48. Solid slab of depth 0.75 m has been designed as superstructure. Retaining wall has been provided at the approach of the bridge. However, this is totally covered with soil.

49. The bridge is located on landslide zone. Opening of the bride has been closed by the debris from landslide. Clearance of silted bed is thereby necessary.

50. Potential Landslide Zone is located in the vicinity of the structure. Major landslide area is located to the upstream hill of the bridge. The hill is made of gravel and soil with boulder with unstable slope. River Rangeet flows ~150 m away from the existing bridge.

New bridge on the downstream side with longer length was recommended and finalised. The new bridge on the downstream side, as per the design it has larger span and higher opening and improve the geometry of the road. However high retaining wall will be constructed on the downstream side. After the construction of new bridge, old bridge will be retained for use by local community and retrofitting might be undertaken and alternatively,will be used in emergency situations and/or disaster mitigation operations.The Engineers of the Road and Building Department will check for the structural integrity of the bridge subsequently, the emergency traffic will be allowed. R&BD has a budget embedded in its system for maintenance /retrofitting of bridges, as necessary.

2.7 Improvement or Strengthening Proposals

51. The main road upgrade components include improvement of road geometry, reconstruction and widening of bridges and cross drainage structures, provision of roadside drains, raising of embankment in waterlogged sections, junction/intersection improvement, pavement, traffic markings, speed limit signs, safety provisions for road users and wildlife, and provision of road facilities like bus bays/bus shelters. Environmental enhancement measures include afforestation, wildlife warning signs, restoration of utilities (e.g. water) during and post construction, and rainwater harvesting are also included in the design.

52. Presently, no speed limit signs are posted along the Project Roads nor are any speed breakers noticed at major settlements and intersection. The signage at such locations will follow the IRC Code 67:2012. Project roads improvements will be developed following the Indian Road Congress IRC: SP: 73-2018, Manual of Standard in Figure 2-3,2-4, 2-5, 2-6 and Table 2-VI.

53. The detailed inventories of project roads reveals that the existing roads E4, S1 and S6 have uniform carriageway widths with gravel roads observed along some stretches with a carriageway width of 3.5 m with valley on one side and hill on the other. In N1 road, the width is 2.5 to 2.8 m. The embankment is hill and valley on one side and hill and built-up on the other. In E1 road, the width is 4.8 to 5.1 m with valley on one side and hill on the other. In W10 corridor, width is 3.7 m with gravel and earthen roads at some stretches, and the embankment is hill is with exposed rock chainage at km1+000 and 1+350.

Table 2-5: Existing and Proposed ROW

Corr.	Name of the Road	Existing ROW (m)			ROW proposed (m)			
		Carriageway width	Shoulder (both side)	Roadway width (Existing ROW)	Carriageway width	Shoulder		Roadway width (Proposed ROW)
						Valley Side	Hill Side	
E1	Rorathang-Rongli	5.25	1.3	7.85	7.00	1 (Earthen Shoulder)	1 (Paved Shoulder)	9.00
E4	Khamdong Linzey - Tintek	3.50	1.13	5.76	5.50	1 (Earthen Shoulder)	1.5 (Paved Shoulder)	8.00
S1	Melli-Phong via Rateypani	3.50	1.2	5.90	5.50			8.00
S6	Assangthang Salghari to CCCT Nandugaon	3.50	1.7	6.90	5.50			8.00
W10	Geyzing to Sakyong	3.65	1	5.65	5.50			8.00
N9	Mangan Bazar to D.A.C. (Mangan)	3.88	1.35	6.58	5.50			8.00

54. A minimum 15 m turning radius is used for the design of curves along all the corridors except at the hair pin bends. It was found that most hair pin bends had a turning radius of 6 to 6.5 m. Due to the shortage of ROW, it is recommended that this radius be increased to 6.5 to 7 m. At the same time, turning radius of vehicle can be further increased by providing paved shoulder and extra widening towards hill side.

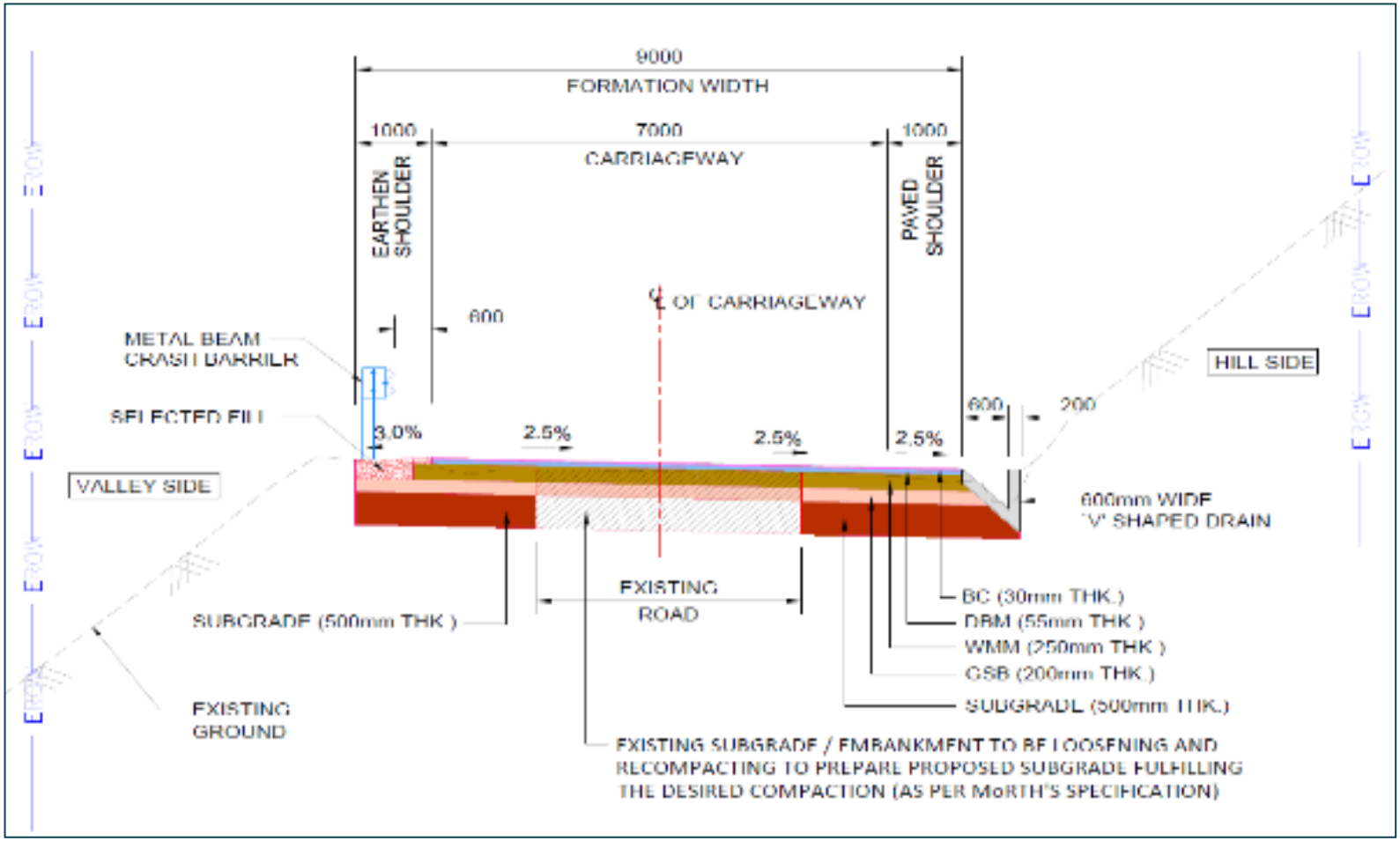


Figure 2-3: Typical cross-section provided along the E1 project corridor

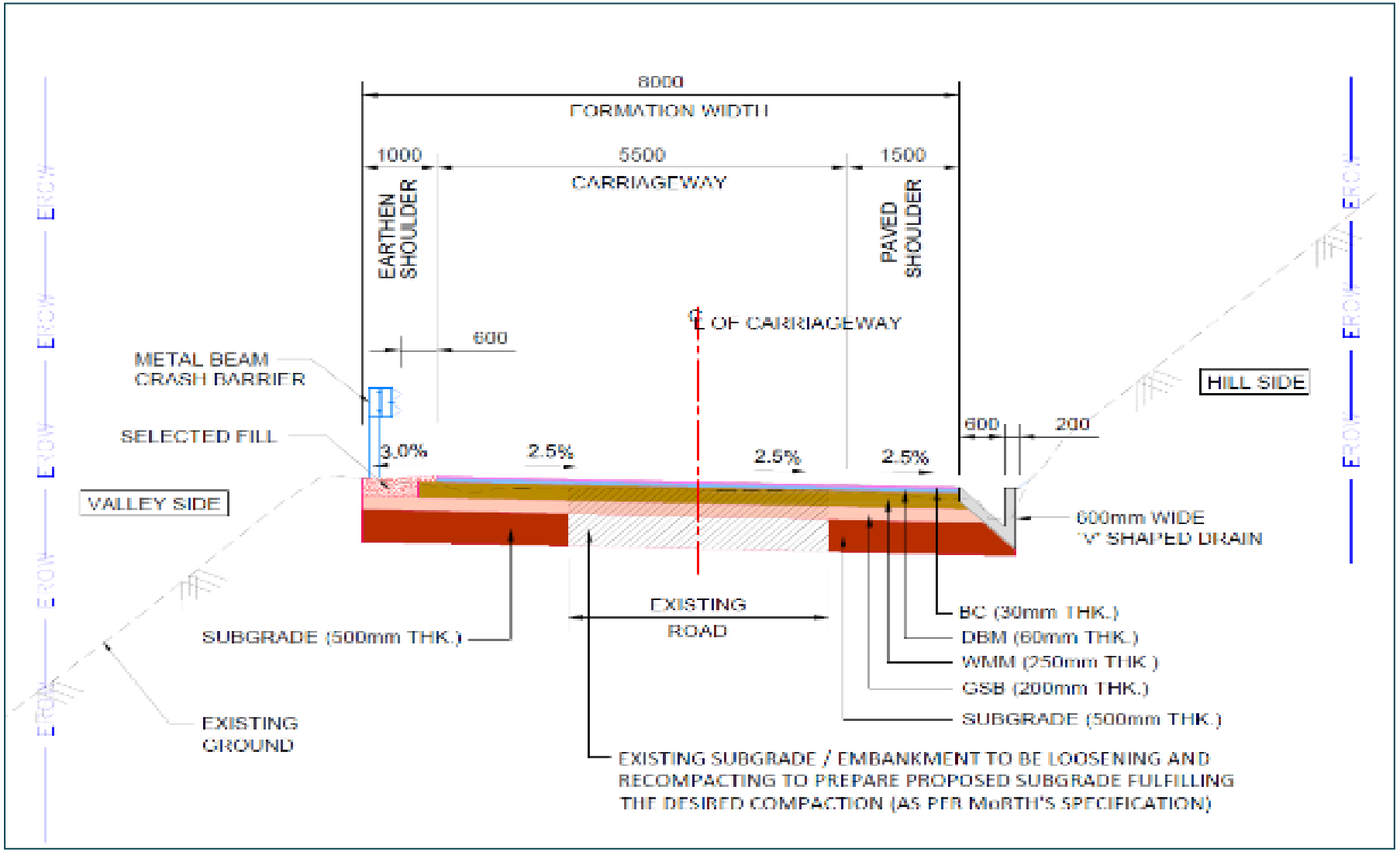


Figure 2-4: Typical cross-section provided along other project corridors

55. The horizontal geometry of the Project roads is fair to poor considering its present class. Back-to-back same direction sharp curve was observed and the same can be negotiated by single curve. However, some curve locations will have to be improved to enhance the level of service of the road. At many locations sharp blind hairpin bends are encounter and the same can be improved with proper geometry improvement. In N1 on right side at km 0+025(R), S1 road 16 hairpin bends located at 0+150(R), 2+250(R), 7+570 (L), 9+075(L), 9+900(R), 12+075(R), 13+090, (R), 13+200(L), 13+300(R), 14+710(L), 18+200, (L), 18+270(R), 19+220(L), 19+410(R), 21+050(L), 22+150(L); in Project road S6, 0+655 (L), 0+715 (R), 0+820(L), 1+600 (R), 1+650 (L), 2+050(R), 4+700(L), 5+400(R), 6+000(L), 6+480 (R), 7+335(L), 8+990(R), 12+300 (R); in E1 road at km 8+780 and 8+830 on right side; in E4 13+550 and 13+580 right and left side; in W10 there are no hairpin bends.

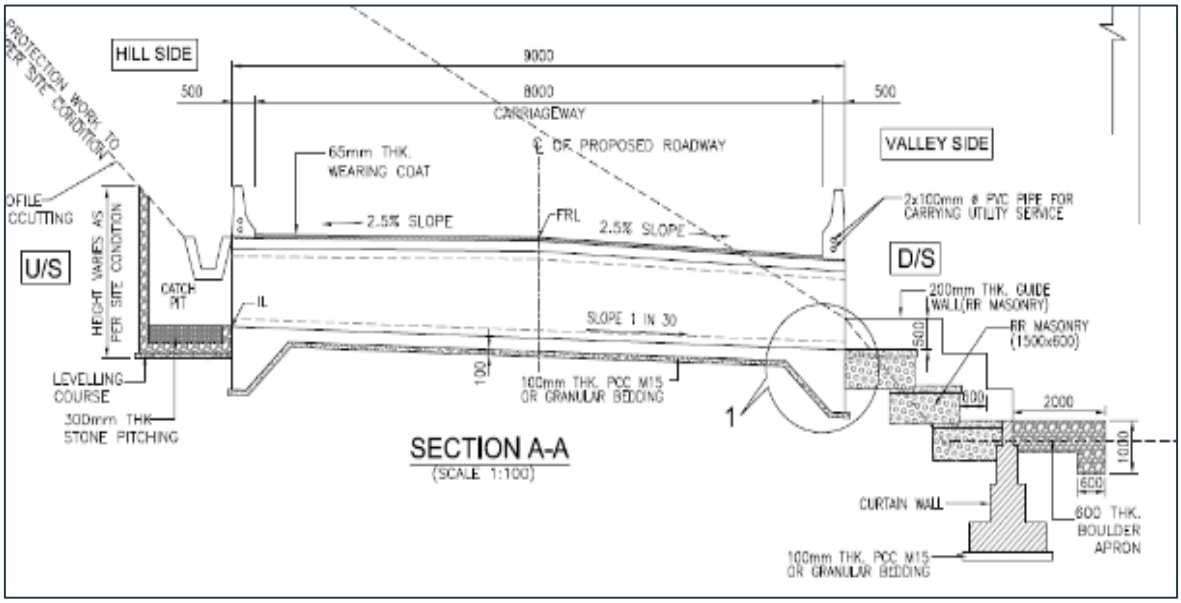


Figure 2-5: Elevation of Box Culvert

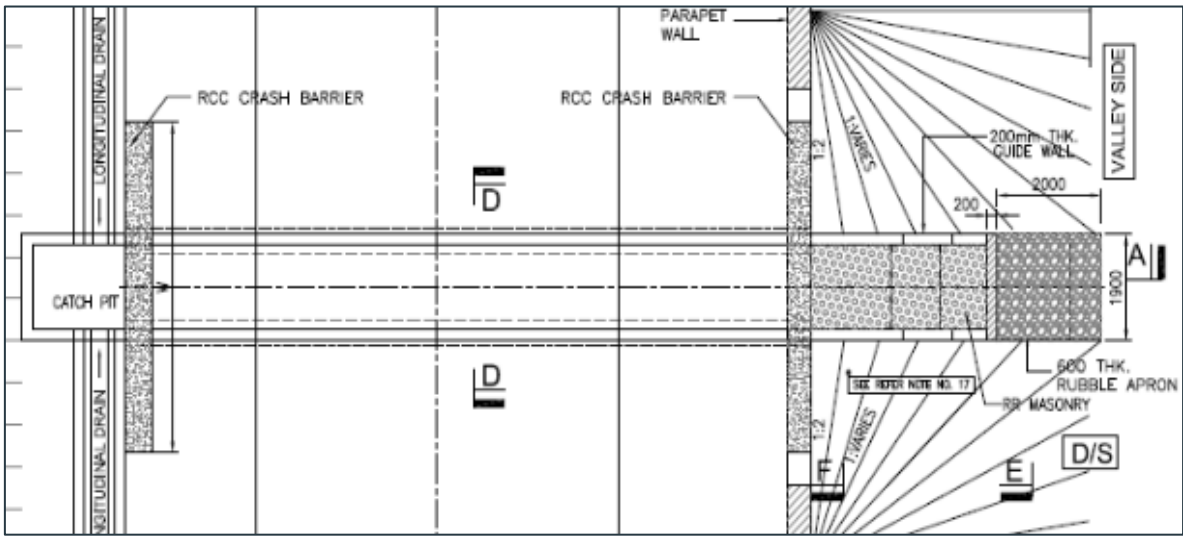


Figure 2-6: Plan of Box Culvert

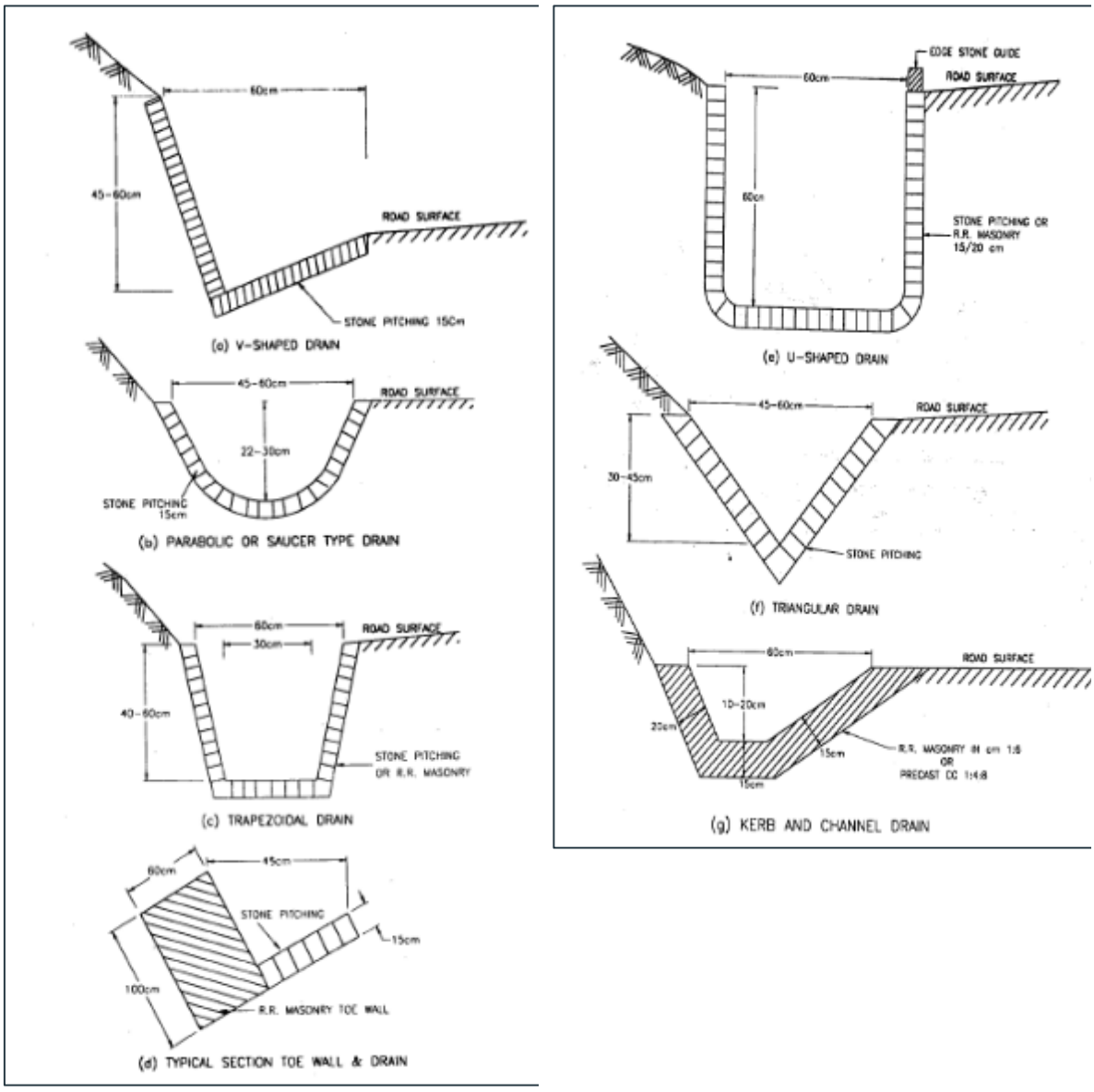


Figure 2-7: Road-Side Drains

56. Except hair pin bend location, minimum 15 m radius is used for the design of curves in all the corridor whereas, existing radius of the corridor is found less than 15 m. It is also found in case of hair pin bend location, existing radius is 6 to 6.5 m. Due to the shortage of ROW, radius is improved 6.5 to 7 m. However, turning radius of vehicle is improved by providing paved shoulder and extra widening towards hill side.

Table 2-6: Horizontal Curve Improvement under Phase-I

Corr.	Name of the road	Sharp bend details		Hair pin bend details		
		Minimum radius (m)	Maximum radius (m)	Existing radius (m)	Minimum radius provided (m)*	Provision as per code (m)
E1	Rorathang-Rongli	6.5	500	6.1	6.5	17
E4	Khamdong Linzey - Tintek	7	500	6.4	7	17
S1	Melli-Phong via Rateypani	6.5	500	5.6	6.5	17
S6	Assangthang Salghari to CCCT Nandugaon	7	1000	5.6	7	17
N9	Mangan Bazar to D.A.C. (Mangan)	7	400	6.5	7	17
W10	Geyzing to Sakyong	15	450	--	--	--

58. The project corridors have major and minor junctions include leading to villages, schools, agriculture fields. All junctions will be improved as per IRC guidelines, mostly at grade. Bus shelters have been provided at all important habitations. Bus bays have been designed at locations of bus shelters along sub-projects having adequate land width with additional paved area in order to enable a bus to stop without obstructing the flow of traffic.

59. The typical cross sections of the existing project roads are a combination of carriageway and earthen shoulder with right side hill and left side valley. Hence, there is lot of scope for horizontal and vertical geometry improvement due to the present deficiency in the existing project road. The project roads traverse through mountainous terrain. Hence, a significant number of hair pin bends are found along the project corridor without provision of extra widening and with restricted width of carriageway. The same can be negotiated with proper horizontal geometry improvement. During inventory, few stretches of water-logged area and water submergence area are found due to the deficiency of longitudinal profile and existing cross fall of the project road. Similarly, at many locations sharp turns are encountered, and hence horizontal alignment may need to be improved.

60. The Project Roads traverses through a predominantly mountainous terrain except for some stretch where it passes through steep terrain. It is observed that the common terrain pattern in the roads is i.e., right side hill and left side valley.

61. Design Speed: It is the most important consideration in geometric design. It influences sight distance, extra widening, super elevation, the length of vertical curves and horizontal curves. Design speed is defined as the highest continuous speed at which individual vehicles can travel safely on the road when weather conditions are conducive, traffic volumes are low, and the design features of the highway are the factors governing safety. The design speed is different from the legal speed limit or the desired speed because the legal speed limit is imposed to curb a common tendency of drivers to travel beyond an accepted safe speed and desired speed is the maximum speed at which driver would travel when unconstrained by either traffic or local geometry. The main factors that affect the choice of design speed are the type of road, topography, traffic conditions and its volume, the cost of land, vehicle characteristics, individual psychology aesthetic features, economy, etc. For the selected project corridors under consideration a min design speeds of 20kmph in Hilly terrain where there is a restriction of RoW. The design speed consideration in this project are consistent with codal provisions of IRC: SP: 73-2018 provided in Table 2-7.

Table 2-7: Design Speed

Nature of Terrain	Cross Slope of the Ground	Design Speed (km/h)	
		Ruling	Minium
Plain and rolling	Up to 25 percent	100	80
Mountainous and steep	More than 25 percent	60	40

62. Design speed is reduced where site conditions are restrictive (intersections, bridge approaches, curves, built-up sections, educational and other sensitive receptors, forest and potential wildlife crossing sections, etc.) and adequate land width is not available. In built-up sections, it is generally restricted to 30 km/h which is further reduced to 20 km/h in exceptional cases. Gradual changes will be introduced by providing successive sections of increasing/decreasing design speeds so that road users become progressively conditioned to such changes. Warning signs will be provided at all locations with reduced speed limit.

63. Project roads traverses through mountainous terrain and the same needs unidirectional cross fall towards inner edge of the carriageway at one side hill and one side valley area as per the IRC hill road manual. Some of the existing horizontal curves are geometrically deficient when considered with horizontal geometry requirement. It needs to be redesigned, thus warranting for existing super elevation improvements. This issue will further be deliberated after completion of topographical survey work.

64. Improvement in Pavement: During inventory, it is found that hillside of the all the corridors is connected with drain directly or through earthen shoulder. Hence, there is chance of erosion both carriageway and earthen shoulder and which may help to damage existing drain. It will be improved by incorporating paved shoulder with carriageway towards hill side and the same also help to canalize the cross-water flow over the carriageway to side drain. Moreover, existing pavement is found mix type i.e., mix of bituminous pavement and gravel road. All the corridors will be implemented to upgrade by incorporating continuous bituminous pavement.

Table 2-8: Improvement in gradient

Sl. No.	Corr. No.	Category	Name of the Road	Vertical Gradient			
				Maximum gradient (%)	Average gradient (%)	Existing gradient (%)	Maximum gradient as per code (%)
1	E1	SH 6	Rorathang-Rongli	13.8	5.12	13.85	7
2	E4	MDR	Khamdong Linzey - Tintek	15.14	5.43	15.20	
3	S1	MDR	Melli-Phong via Rateypani	15	6.29	18.78	
4	S6	ODR	Assangthang Salghari to CCCT Nandugaon	14.61	5.80	14.72	
5	N9	ODR	Mangan Bazar to D.A.C. (Mangan) (Dr. Lobzang Tenzing Marg)	17.7	8.88	24.25	
6	W10	ODR	Geyzing to Sakyong	14.5	2.95	25.39	

65. Improvement in Longitudinal Correction: Drainage requirement of the hilly road is mostly provided by both longitudinal gradients of the road and cross fall of the road. In case of hilly road, attainment of level is also dependent on longitudinal gradient of the road. Hence, deficiency in longitudinal profile of the road may cause drainage problem and some unavoidable steep gradient of the road. Hence, due to the deficiency of longitudinal profile of the project road, some patches of water logging area and steep gradient were encountered along the project corridor. The deficiencies can be negotiated by vertical geometry improvement.

66. During several site visit, several depressions in the existing pavement was found and the same effects the ease of traffic movement. Due to this type depression, water movement over the carriage way during rainfall is found very poor and the same damages the pavement of the corridor. All the depressed locations are improved by longitudinal profile correction and also connecting the water flow with nearest cross drainage structures.

67. The pavement design: Based on the Existing Subgrade strength & the future traffic during the design life, the new pavement composition, as per the catalogue 4 of IRC SP: 72-2015 and IRC:37-2018, is given in Table 2-9.

Table 2-9: Recommended Pavement Thickness

Design period	Corridor no.	Traffic (msa)	Effective CBR	New pavement thickness (mm)			
				BC / SMA	DBM	WMM	GSB
For project roads							
20 Years	E-1	10	9	30 / 25	55	250	200
	E-4	10	9	30 / 25	55	250	200
	S-1	10	11	30 / 25	50	250	200
	S-6	10	14	30 / 25	50	250	200
	W-10	10	8	30 / 25	60	250	200
	N-9	10	8	30 / 25	60	250	200
For approaches of standalone bridges							
20 Years	BR-04	10	8	30 / 25	60	250	200
	BR-06	10	8	30 / 25	60	250	200
	BR-08	10	8	30 / 25	60	250	200

Note: 25 mm Thick Stone Mastic Asphalt (SMA) will be used in perennial subsidence zone and intermittent built-up area along the project corridor to prevent waterlogging on pavement surface and seepage through pavement surface

68. The trees, which are falling under proposed ROW of the project road i.e., within 12-16 m of ROW, have been marked as impacted. Subsequently based on the verification of trees with forest department, the tree felling approval shall be applied under the project. Felling of non-forest trees falling within the project influence zone will be required to get permission from District Forest office as per Sikkim Private and Other Non-Forest Lands Tree Felling Rules, 2006. Similarly, permission for cutting of tree from forest-notified area (RF/PF) will require approval from State Forest department under Forest (Conservation) Act 1980.

69. With improvement of the roads and bridges, safety of the commuters will be increased as this will improve the visibility and additional carriageway space. Road users will also be facilitated with different project amenities, slope protection measures, road markings and sign etc., which will improve the safety of commuters along the project road.

70. The project road traverses through built-up areas/ settlements. The presence of these settlements obstructs the flow of traffic due to reduction in speed. The traffic flowing through these sections also creates potential hazard to pedestrians.

71. As per MoEF&CC notification, New Delhi, dated 14 January 1997 (amended on 13 January 1998, 05 January 1999 and 06 November 2000), the construction of rainwater harvesting structure is mandatory in and around water crisis area, notified by central ground water board. The provision of rainwater harvesting structures has been provided as per Ministry Policy Circular No – RW/NH-33044/14/2003-S& R(R) dated on 05 September 2019.

72. Substandard horizontal and vertical geometry will improve the sight distance and permit vehicles to maintain the design speed.

73. Road Signs: As per the applicability and requirement, road signs will be place all along the road in order to guide the road user to traverse safely. A combination of road signs like mandatory – regulatory signs, cautionary-warning signs and informative signs will be installed. Variable message signs will also be placed at identified locations in order to inform road user about various details like climatic conditions ahead, diversions, accident zones, speed reduction zones etc.

74. Pedestrian Signals will be installed at the urban locations where pedestrian movement is heavy. At crossings with medium pedestrian crossings a push button traffic light can be installed. Pedestrians can push the button and wait for the light to turn green and then move on and cross cautiously.

75. Hazardous locations on Straight Sections: In particularly busy reaches where the road is congested and vehicles move at a fast pace, guard rails should be provided on both sides of the carriageway so as to channelize the pedestrian on to the planned crossing locations.

76. At Junctions/Intersections: Railing barriers will be provided to prevent people from crossing the junctions diagonally at signalized intersections. The barrier must open only at planned crossing facility (at zebra crossing). At signalized junctions' sufficient length of guard rail will be provided to guide the pedestrian to the neared planned pedestrian crossing.

77. School Colleges: Guardrails will be provided near schools in order to prevent children to run straight into the road.

78. Bus Stops, Railway Stations and Temple etc. Guard rails will be provided alongside walks with suitable access at bus stops, railway stations and other areas of heavy pedestrian activity such as cinema houses, stadiums etc.

79. Zebra Crossings: Zebra crossings will be provided along with stop lines as per IRC 35 for safe crossing of pedestrians. Feet over bridges, Foot paths are not provided.

80. Detailed road safety schedule and traffic calming measures are provided in the form of detailed design report. The schedule contains the provision and locations of road markings and road Signs for all the major junctions, minor junctions, schools, temples, Govt. Offices, other community buildings etc.

81. In this project, the cutting /excavated materials will be reused in construction of pavement, structure and slope protection work. The existing bituminous surface will be scrapped and reused after proper treatment in new construction of pavement. The excess lime quantity present in the vicinity of project road will be used in stabilization of sub-base layer.

Table 2-10: Brief of design standards considered under the project

Design aspect	Guidelines
Geometric Design	Hill Road Manual - IRC: SP:48-1998 Guidelines for the Alignment Survey and Geometric Design of Hill Roads - IRC:52-2019 Geometric Design Standards for Rural (Non-Urban) Highways - IRC:73-1980
Pavement Design	MoRD Specification for Rural Roads (First Revision), 2014 MoRT&H Specifications for Roads and Bridge Works, 2013 Guidelines for the Design of Flexible Pavements, IRC:37-2018
Structural Design	Standard Specification & Code of practice for Road Bridges: Section - I General Features of Design (Eighth Revision) – IRC: 5-2015 Standard Specification & Code of practice for Road Bridges: Section - II Loads & Load Combinations (Seventh Revision) – IRC: 6-2017 Code of Practice for Concrete Road Bridges – IRC: 112-2020 Other relevant codes and guidelines
Geotechnical Design	All applicable IRC and / BIS codes / MORT&H Technical Specification, Fifth Revision, 2013 guidelines of practice. In addition, some international design manuals and popular standard technical text books will also be referred.

2.8 Construction Schedule and Logistics

82. As per the traffic projection based on base year of 2021, 20 years projections of traffic have been done. Accordingly, the design and Detailed Project Report has been finalised. The

pavement has been designed for the first 10 years. Subsequently, pavement will be laid depending on the achieved traffic.

83. Construction Logistics and Sources. Detailed road safety schedule and traffic calming measures are provided in the form of detailed design report. The schedule contains the provision and locations of road markings and road signs for all the major junctions, minor junctions, schools, temples, government offices, other community buildings etc.

84. Development period including studies and tendering was one year and it was scheduled to complete in 2024 but it is delayed and rescheduled. The tendering process will be completed and all project will be awarded in 2026. The construction period is two years and it will be completed in 2028. Subsequently, the upgraded road will be opened to traffic at the beginning of year 2028. In accordance with IRC: 37:2018, a design period of 20 years commencing from 2026-28 till 20448 has thus been considered in estimating design lane traffic loading.

Sl No	Packages	Preparation of DPR	Tendering	Construction	Operation
1	All Packages	2023-24	2024-26	2026-28	2028-48
Remarks		One year of time for surveys, investigation, design, drawings and report preparation	The approval of tender documents, its advertisement, evaluation and award required about one year of time	Two years for the construction period.	20 years of operation period.

2.9 Labour Requirements and Labour Camps

85. It is expected that 35-315 labours will be engaged during the construction phase comprising skilled, semi-skilled and unskilled labours at each corridor. The construction may be done in stages from corridor-to-corridor. Major portion (75%) of the labours will be unskilled and will be hired from the local community. They will be daytime labours. The remaining 25% will be from outside the community, who will be stayed in the labour camps. Details of the amenities to be provided in the labour camp provided in the Annexure 6.

86. The contractor will ensure that, at the beginning of the working relationship, project workers are provided with written contracts and/or other forms of information and documentation that contain clear and understandable terms and conditions of their employment. The contracts, information, and/or documentation will set out in the OHS plan to be prepared by the contractor. The hiring is to be done in an unbiased, gender-neutral manner providing equal opportunity to all.

87. The approximate number of various types of labours required at various corridors are mentioned in the table below –

Table 2-11: Approximate labour requirement in various corridors

Labour Description	E1	E4	S1	S6	N9	W10	Br04	Br06	Br08
Skilled Labour (no.)	18	43	45	30	5	12	30	30	30
Mate (no.)	36	86	90	60	10	24	44	44	44
Unskilled Labour (no.)	72	172	180	120	20	48	96	96	96
Total	126	301	315	210	35	84	170	170	170

88. The daily water requirement for daytime labours is 15 Liters per Capita per Day (LPCD) as per WHO/SEARO Technical Note for Emergencies for domestic uses. For residential labours, it is 35 gallon/day as per Temporary Labor Camps (OSHA Standard 1910.142) or 132.5 LPCD or around 135 LPCD as per MoEF&CC construction manual. Accordingly, the total water requirement for residential labours and daytime labours are provided in Table No 2-12. The water requirement shall be

fulfilled by procuring water from nearby areas from approved government water vendors from the sources approved by the local bodies like Panchayat or Municipal Corporations

Table 2-12: Assessment of Water Requirements

Description	E1	E4	S1	S6	N9	W10	Br04	Br06	Br08
Total Labour Requirement (Number)	126	301	315	210	35	84	170	170	170
Water requirement for day time Labour (Liter)	1,418	3,386	3,544	2,363	394	945	1,913	1,913	1,913
Water requirement at the Labour Camp (Liter)	4,253	10,159	10,631	7,088	1,181	2,835	5,738	5,738	5,738

89. To ensure the sustainability of water sources for drinking purposes in a labor camp for road construction, it is crucial to adopt several mitigation measures. Firstly, employ sustainable water practices that include careful assessment of water quality and regular testing for contaminants to ensure compliance with health standards. The community's collaboration is essential; working closely with local authorities and communities helps manage and monitor water sources effectively, ensuring the extraction does not negatively impact local access. Conducting environmental impact assessments can identify adverse effects on the ecosystem, allowing for the implementation of appropriate mitigation measures.

90. Additionally, explore alternative water sources such as rainwater harvesting and greywater recycling to reduce dependency on primary sources. Developing reliable infrastructure, including efficient, leak-proof pipelines and storage tanks, and keeping them well-maintained can prevent wastage and contamination. Finally, educate and train labor camp residents on water conservation and sustainable practices to promote responsible water use and proactive reporting of issues. These measures collectively support the long-term sustainability of water sources while safeguarding the needs of both the labor camp and the local community.

2.10 Construction Materials and Equipment

91. The soil characteristics seem to be non-uniform along the project alignments and vary from red soil laterite soil, morrum, alluvial etc. Such variation in soil characteristics implies substantial variation in embankment/subgrade design. Good earth for embankment is generally available within 0–13 km lead distance other than those dominated by black cotton soil where soil needs to be borrowed from comparatively far distances. Sand is also available in all project districts or nearby districts. Water requirement for construction will be met through combination of groundwater and surface water. Most of the sub-project roads lie within 100 km distance from operational thermal power plants and hence fly-ash utilization is mandatory as per Fly-Ash Notification 2016.

Source of Energy for the construction work

92. . The project location being hilly terrain, the primary sources of the energy is diesel for heavy machineries such as excavators, bulldozers, dumpers and compactors that will be used for cutting, grading, and stabilising steep slopes. Due to difficult topography and limited grid electricity access energy will be sourced for site office and labour camps. A temporary storage and its quantity within permission limit of 1,000 litres will be done in the equipment and Diesel Generator.

93. Fuel supply will be managed through periodic refuelling from authorised local depots, thereby avoiding bulk storage on site and minimising risks associated with handling and spillage. Safety protocols, including the use of fire extinguishers, spill containment measures, and restricted access to the storage area, will be implemented to align with environmental and safety standards applicable to such ecologically sensitive zones.

94. **Borrow Area/Toe/Hill cut.** The Toe/Hill Cut provided in Table No 2-XII are considered a borrow area for the project corridor because it involves a cutting section, allowing the cut soil to be used as selected subgrade material with a high CBR value. These borrow areas are integral to the project site and involve hill cutting for road construction. Consequently, these sites are included in the pre-project clearance as detailed in this report and listed in Table No 1-II.

Table 2-13: Details of Identified Borrow Areas the Project Corridor

Sl. No.	Sample No.	Chainage	Side	Offset	Name of the Village	Quantity (Cum)	Remarks	GPS Co-ordinate (Zone 45R)	
								Easting	Northing
E1 - Rorathang - Rongli (SH-6) from Km. 0+000 to Km. 8+900									
1	RR-TS-1	0+050	R	20M	Rorathang	40430	Road hill cut materials	661056	3009168
2	RR-TS-3	2+000	R	20M	Mulukey	40430	Road hill cut materials	662565	3009546
3	RR-TS-5	4+000	R	20M	Sudunglakha	40430	Road hill cut materials	663937	3009940
4	RR-TS-7	6+000	L	20M	Takchang	40430	Road hill cut materials	665243	3010357
E4 - Khamdong Linzey - Tintek (MDR) from Km. 0+000 to Km. 22+200									
5	KT-TS-1	0+000	R	20M	Byang	40430	Road hill cut materials	646627	3016745
6	KT-TS-3	2+000	R	20M	Khamdong	40430	Road hill cut materials	645370	3016748
7	KT-TS-5	4+000	R	20M	Dungdung	40430	Road hill cut materials	644594	3017937
8	KT-TS-7	6+000	R	20M	Sumik Lingzey	40430	Road hill cut materials	644931	3019677
9	KT-TS-9	8+000	R	20M	Lingmo	40430	Road hill cut materials	645653	3020939
10	KT-TS-11	10+000	R	20M	Subithang	40430	Road hill cut materials	647072	3021619
11	KT-TS-13	12+000	R	20M	Tumindhanbari	40430	Road hill cut materials	648439	3022521
12	KT-TS-15	14+000	R	20M	Tuminmonastic	40430	Road hill cut materials	649474	3022992

Sl. No.	Sample No.	Chainage	Side	Offset	Name of the Village	Quantity (Cum)	Remarks	GPS Co-ordinate (Zone 45R)	
								Easting	Northing
13	KT-TS-17	16+000	R	20M	Tumin	40430	Road hill cut materials	649351	3024641
14	KT-TS-21	20+000	R	20M	Samdong	40430	Road hill cut materials	648420	3027548
S1 - (Melli-Phong via Rateypani (MDR) from Km. 0+000 to Km. 22+500)									
15	MR-TS-1	0+050	L	0.2	Phong	40430	Road hill cut materials	643132	3006194
16	MR-TS-3	2+000	R	0.2	Tangji	40430	Road hill cut materials	643112	3005158
17	MR-TS-5	4+000	R	0.2	Tangji	40430	Road hill cut materials	643648	3004535
18	MR-TS-7	6+000	R	0.2	Rateypani	40430	Road hill cut materials	642586	3003554
19	MR-TS-9	8+000	L	0.2	Rateypani	40430	Road hill cut materials	642277	3002573
20	MR-TS-11	10+000	R	0.2	Rateypani	40430	Road hill cut materials	642786	3002869
21	MR-TS-13	12+000	R	0.2	Passi	40430	Road hill cut materials	642866	3001981
22	MR-TS-15	14+000	R	0.2	Passi	40430	Road hill cut materials	643306	3001566
23	MR-TS-17	16+000	R	0.2	Passi	40430	Road hill cut materials	643796	3001038
24	MR-TS-19	18+000	R	0.2	Devithan	40430	Road hill cut materials	644464	2999605
25	MR-TS-21	20+000	R	0.2	Phong	40430	Road hill cut materials	644765	2998694

Sl. No.	Sample No.	Chainage	Side	Offset	Name of the Village	Quantity (Cum)	Remarks	GPS Co-ordinate (Zone 45R)	
								Easting	Northing
26	MR-TS-23	21+900	R	0.2	Melli	40430	Road hill cut materials	644397	2997408
S-6 - (Assangthang Salghari to CCCT Nandugaon. Section of ODR from 0+000 to Km. 14+900)									
27	AN-TS-2	1+000	R	0.2	Namchi	40430	Road hill cut materials	631084	3004273
28	AN-TS-4	3+000	R	0.2	Assangthang	40430	Road hill cut materials	631044	3004078
29	AN-TS-6	5+000	L	0.2	Tinik	40430	Road hill cut materials	629801	3003447
30	AN-TS-8	7+000	R	0.2	Sangbung	40430	Road hill cut materials	629514	3003084
31	AN-TS-10	9+000	R	0.2	Dungmacha	40430	Road hill cut materials	630382	3002621
32	AN-TS-14	13+000	R	0.2	Sird	40430	Road hill cut materials	628431	3002879
N9 - Mangan Bazar to D.A.C. (Mangan) (Dr. Lobzang Tenzing Marg). Section of ODR from 0+000 to Km. 2+100									
33	MD-TS-2	2+000	L	0.2M	Mangan	40423	Road hill cut materials	651387	3042032
W10 - Geyzing to Sakyong road (ODR) from Km. 0+000 to 6+000									
34	GS-TS-1	0+500	L	20m	Geyzing	40430	Road hill cut materials	624996	3019324
35	GS-TS--3	2+000	L	20m	Unglok	40430	Road hill cut materials	625161	3021375
36	GS-TS-5	4+000	L	20m	Unglok	40430	Road hill cut materials	625161	3021379

95. Sand is available in this section. Consultant has identified altogether three sand sources for the project roads. The details of these sand sources are presented in table below.

Table 2-14: Details of Sand Source Quarries the Project Corridor

Sl. No.	Sample No.	Chainage	Side	Offset (km)	Name of the Village	Name of the River	Quantity	Rate	GPS Co-ordinate (Zone 454R)	
									Easting	Northing
Sand Quarries for East Districts										
1	SQ-1	Gangtok	L	90 km	Baharikhala	Rangeet	Plenty	Rs 200/cft	626267	3018368
Sand Quarries for South & West Districts										
1	SQ-1	22+500	L	15 km	Baharikhala	Rangeet	Plenty	Rs 200/cft	629801	3001007
Aggregate Quarries for North Districts										
1	SQ-1	3044701	L	3044701	3044701	Teesta	Plenty	-	651279	3044701

96. Cement. For construction of structures 43 grade ordinary Portland cement conforming to IS:8112-2013 and 53 grade ordinary Portland cement conforming to IS: 12269-2013 shall be used. Other types of cement in IRC: 112-2019 Cl18.4.1 may be used for special requirement with the approval of engineer in charge.

97. Admixtures. To improve workability of concrete, admixtures conforming to IS: 9103-1999 (Reaffirmed in 2018) shall be used.

98. Aggregates. Coarse aggregates shall consist of clean, dense, strong, non-porous, durable and crushed stone. Natural sand is to be used as fine aggregate. It should be dense, durable, clean and free from veins and adherent coating and other deleterious substances. The Aggregates shall conform to IS: 383-2016 and shall be tested to conform to IS: 2386-1963 parts I to VIII. Size of coarse aggregate shall be selected as per mix design requirement.

99. Aggregate is easily available in this section because the project road lies in Hilly area and River belt. The details of the aggregate sources are presented in Table below.

Table 2-15 : Locations of Aggregates Identified for the Project

Sl. No.	Sample No.	Offset (km)	Name of the Village	Rate (INR/100 ft^3)	Royalty (Extra)	Remarks
1	AQ-1	30 km	Makha/Tanak	INR 20 mm - INR 50, 10 mm - INR 50, 6 mm- INR 50, Dust - INR 15	INR 500/300 ft^3	Chetri Chandra, Ph-9800856214
2	AQ-2	15.2 km from S6 End Point, 18.4 km from S1 Start Point	Majhitar (Jorthang)	20 m -INR 50, 10 m - INR 45, Dust INR 15/ft^3	INR 540/300 ft^3 for aggregate, INR 315/300 ft^3 for dust	Jindal Factory Jawala Sharma Ph-9932001227 Zone: 45R, Easting: 631432, Northing: 2999012
3	AQ-3	30 km	Baghey Khola	20 mm – INR 50, 10 mm – INR 50, 6 mm – INR 50, Wash sand- 22.5/ft^3	-	Ugen Aggregate & Dolomiter, Amit Roy Ph-8972457683
4	AQ-4	53 km from S1 (Melli to Phong via Rateypani) end point	Yangyang	20 mm – INR 50, 10 mm INR 50, 6 mm – INR 50, Dust – INR 15	-	Asmita Enterprise, Yangang H k Basnett Ph-7029776525 Zone: 45R, Easting: 640522, Northing: 3022708
5	AQ-5	10	Sankalang		Aggregate – INR 360/200 ft^3, sand – INR 210/200 ft^3, Boulder INR 180/200 ft^3	651279

100. Water. Water used for mixing and curing shall be clean and free from oils, acids, alkalis, salts, sugar, organic materials or other substances that may be deleterious to concrete or steel. The pH value of water shall not be less than 6. Other permissible limits for solids in water are given in Table 18.6 of IRC-112-2019.

101. It was observed that water supply pipeline was running all along the corridor at each road, this can be used for time being. Consent for usage of water need to be taken in written from the Village Council Presidents.

102. The other source for domestic water requirement can be met through government approved private water tankers during construction phase.

103. The grade of concrete shall be as mentioned in the execution drawings for each component of the structure.

104. Cement and water content shall be as per mix design requirement; however minimum grade of concrete, minimum cement content and maximum water cement ratio shall be conforming to Table 14.2 of IRC-112-2019 for severe Condition. The cement content shall be minimum 360kg/m3 of concrete.

105. Reinforcement. Deformed or TMT reinforcement bar conforming to IS: 1786-2008 (Reaffirmed in 2018) shall be used for components of the structures. The reinforcement grade shall be Fe500D as per Seismic Zone V; Steel shall be procured from. Original Producer. who manufacture billets directly from iron ores and roll the billets to produce steel conforming to IS: 1786. No re-rolled shall be incorporated in construction.

106. Structural Steel. The grade and Quality of Structural steel is given in IS: 2062-2011., wherein its Tensile Strength and Yield strength has been mentioned. In Composite Steel Plate Bridge, E350-Fe490/490BR will be adopted for built up sections and E250- Fe 410BR for rolled sections.

107. Construction Machinery. The details of minimum construction machinery required at each corridor have been mentioned below.

Table 2-16: Minimum machinery requirements in various corridors

Equipment Details	Unit	E1	E4	S1	S6	N9	W10	Br04	Br06	Br08
Dozer 80 HP	Nos.	2	4	5	3	1	2	1	1	1
Motor Grader	Nos.	1	1	1	1	1	1	1	1	1
Road Marking Machine	Nos.	1	1	1	1	1	1	1	1	1
Tractor Trolley	Nos.	2	4	4	2	1	1	1	1	1
Air Compressor 250 cfm	Nos.	1	1	2	1	1	1	1	1	1
Tractor with ripper	Nos.	1	1	1	1	1	1	1	1	1
Hydraulic Excavator	Nos.	1	1	1	1	1	1	1	1	1
Tipper	Nos.	7	14	17	9	2	5	3	2	1
Water Tanker	Nos.	1	2	2	2	1	1	1	1	1
Vibratory Roller	Nos.	1	1	1	1	1	1	1	1	1
Front End Loader	Nos.	2	4	5	3	1	2	1	1	1
Loader	Nos.	1	1	1	1	1	1	1	1	1
Smooth Wheeled Roller 8-10 tonnes	Nos.	1	1	1	1	1	1	1	1	1
Smooth Wheeled tandem Roller 6-8 tonnes	Nos.	1	1	1	1	1	1	1	1	1
Wet Mix Plant	Nos.	1	1	1	1	1	1	1	1	1
Batch Mix HMP @ 75 tonne per hour	Nos.	1	1	1	1	1	1	1	1	1
Concrete batching and mixing plant @ 15 Cum/hr.	Nos.	1	1	1	1	1	1	1	1	1
Paver Finisher	Nos.	1	1	1	1	1	1	1	1	1
Generator 100 KVA	Nos.	1	1	1	1	1	1	1	1	1
Electric Generator Set, 125 KVA	Nos.	1	1	1	1	1	1	1	1	1
Generator 250 KVA	Nos.	1	1	1	1	1	1	1	1	1
Plate Compactor	Nos.	2	7	7	3	1	2	1	1	1
Needle Vibrator	Nos.	1	2	1	1	1	1	1	1	1
Mechanical Broom	Nos.	1	1	1	1	1	1	1	1	1
Bitumen Pressure Distributor	Nos.	1	1	1	1	1	1	1	1	1
Emulsion Pressure Distributor	Nos.	1	1	1	1	1	1	1	1	1
Concrete mixer 0.40/0.28 cum capacity	Nos.	1	2	2	1	1	1	1	1	1
Generator 63 KVA	Nos.	1	2	2	1	1	1	1	1	1
Transit Mixer 4 Cum Capacity	Nos.	1	1	1	1	1	1	1	1	1
Concrete Pump	Nos.	1	1	1	1	1	1	1	1	1
Grouting pump with agitator	Nos.	1	1	1	1	-	-	1	-	-
Crane 35 tonne capacity	Nos.	1	1	2	-	-	-	1	1	1
Mastic Cooker	Nos.	1	2	2	1	1	1	1	1	1
Bitumen Boiler	Nos.	1	2	2	1	1	1	1	1	1
Drilling Machine	Nos.	1	1	1	1	-	-	1	-	-

3. Description of the Environment (Baseline)

3.1 Physical Environment

108. Sikkim's geographical location with its altitudinal variation allows it to have tropical, temperate and alpine climatic conditions. Temperature conditions vary from sub-tropical in the southern lower parts to cold deserts in the snowy north. The state has five seasons: winter, summer, spring, autumn and monsoon.

109. Topography/Landforms. Sikkim is situated in the Himalayas and is characterized by mountainous terrain. It lies between 27°04'N and 28°07'N and 88°00'E and 88°55'E in the physiographic zone of Eastern Himalayas. The state shares its boundary with stretches of Tibetan Plateau in the north, Chumbi Valley of Tibet and Bhutan in the east, Darjeeling district of West Bengal in the south and Nepal in the west. Almost the entire state is hilly, with an elevation ranging from 280 meters (920 ft) in the south to 8,586 m (28,169 ft) in northern peaks. The summit of Kanchenjunga (8,596 m), the world's third-highest peak is the state's highest point which is situated on the border between Sikkim and Nepal. The state is surrounded by mountain ranges of Greater Himalayas on three sides.

110. Sikkim is divided into four major physiographic zones: Lower hills (300 m to 1800 m), upper hills (1800 m to 3000 m), alpine zone (3000 m to 4500 m) and snow land (4500 m and above). The slope of the state is from north to south and glaciers are the major physiographic features of the state. Glaciers are mostly found in the Sikkim North district. Zemu Glacier is the most significant of all the glaciers, which is 26 km in length and is situated at the base of Mt. Kanchenjunga. The project corridors that are following in the north district has snow-fed influenced region.

111. The topographic details for individual corridors are given below and covered in depth by covering slope and contour parameters. The slope map provides a colorized representation of slope, generated dynamically using server-side slope function on Terrain service. Corridor wise slope and contour maps given below:

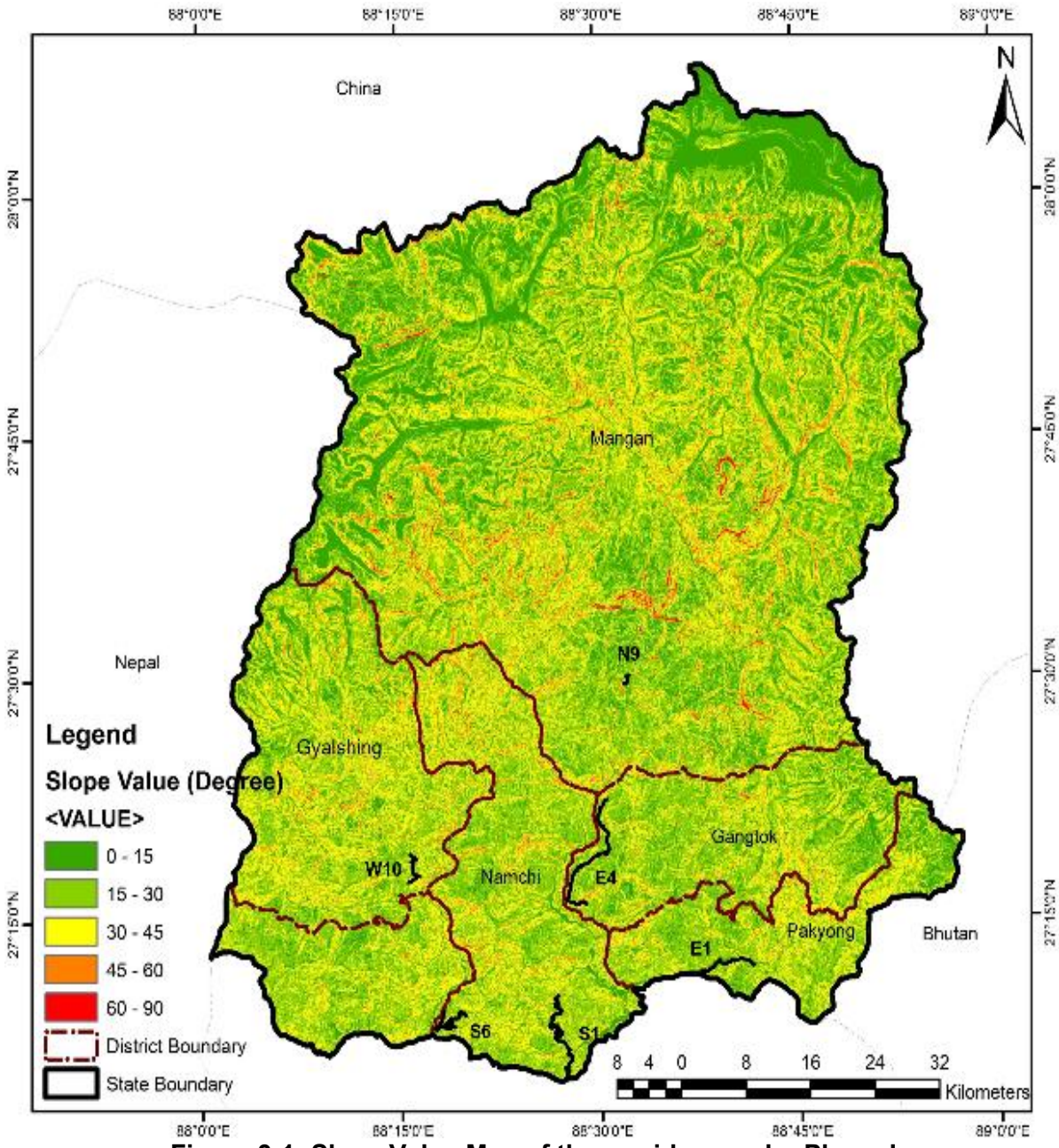


Figure 3-1: Slope Value Map of the corridors under Phase-I

3.1.1 Topography of the Project Corridors

N9: MANGAN BAZAAR TO D.A.C. IN MANGAN DISTRICT

Slope:

The slope for N9 ranges mostly between 0 and 30 degrees, representing a shallow slope. However, towards the southwestern direction the slope is steeper ranging from 30 to 90 degree.

Contour:

The map represents the contour levels for the road N9 along with a 2 km buffer around the road ranging from 700 - 1900 m amsl. The road N9 lies on a height ranging between 1100 m amsl and 1300 m amsl. Contour lines near the road are further apart indicating a slope that is less steep, whereas as we move towards the south of the road the slope has become relatively steeper. As we move towards the east direction the contour intervals increase from 1500 to 1900 m amsl.

E1: RORATHANG - RONGLI IN PAKYONG DISTRICT

Slope:

The map represents the steepness of slope along the road E1 and in its nearby area. The slope for E1 ranges mostly between 0 and 30 degrees, representing from flat terrain to moderate slope. However, in a few parts the slope ranges from 15 to 45 degrees as can be seen that represents a relatively moderate slope.

Contour:

The map represents the contour levels for the road E1 along with a 2 km buffer around the road ranging from 500 to 1600 m amsl. The road E1 lies on a height ranging between 500 m amsl and 700 m amsl. Contour lines nearby the road are closer to each other indicating a steep slope. As we move towards the south direction the contour intervals are relatively increasing (1200 to 1600 m amsl).

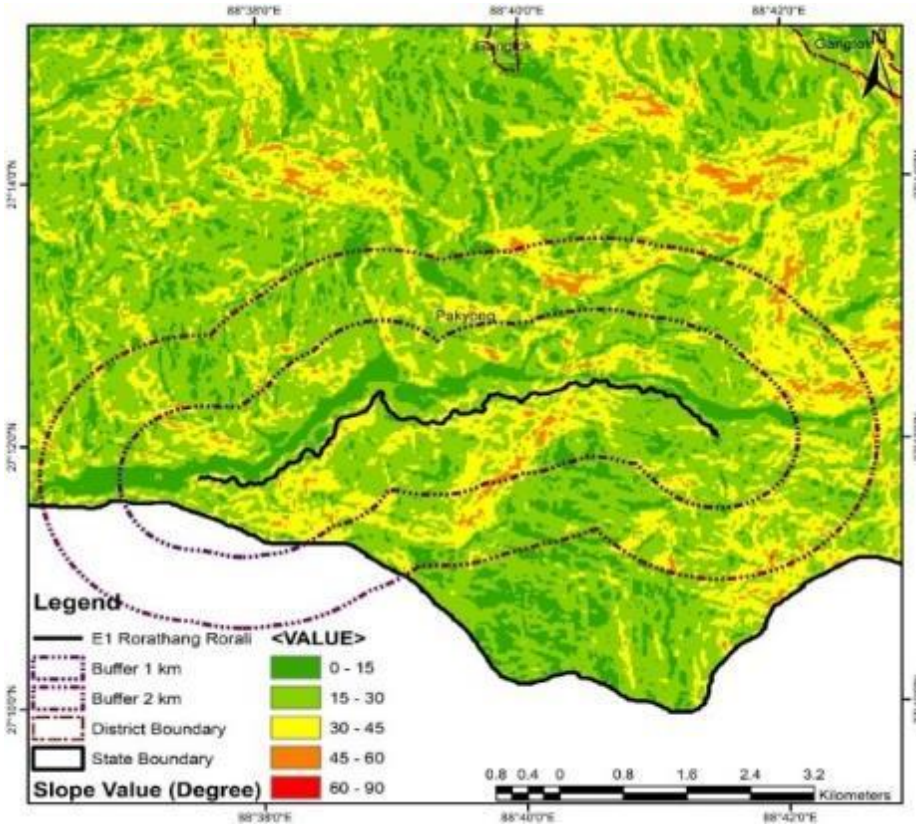


Figure 3-2: Elevation map of N9

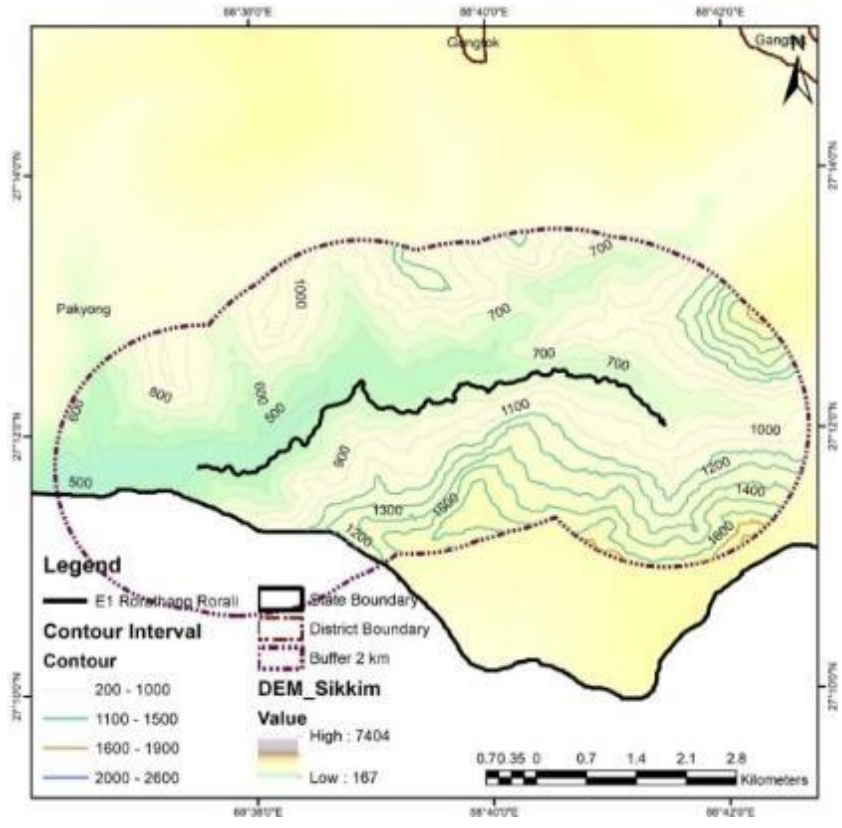


Figure -: Elevation map of E1

E4: KHAMDONG-LINGZEY-TINTEK IN GANGTOK DISTRICT

Slope:

The map represents the steepness of slope along the road E4 and in its nearby area. The slope for E4 ranges mostly between 0 and 45 degrees, representing from flat terrain to moderate slope. However, in a few parts of the immediate area of influence the slope ranging from 45 to 60 degree represents a relatively steeper slope.

Contour:

The map represents the contour levels for the road E4 along with a 2 km buffer around the road ranging from 500 to 2200 m amsl. The road E4 lies on a height ranging between 1000 m amsl to 1600 m amsl. Contour lines near the road are closer to each other, indicating a very steep slope. As we move towards the eastern direction the contour intervals are relatively increasing along with the steepness of slope (1800 - 2200 m amsl).

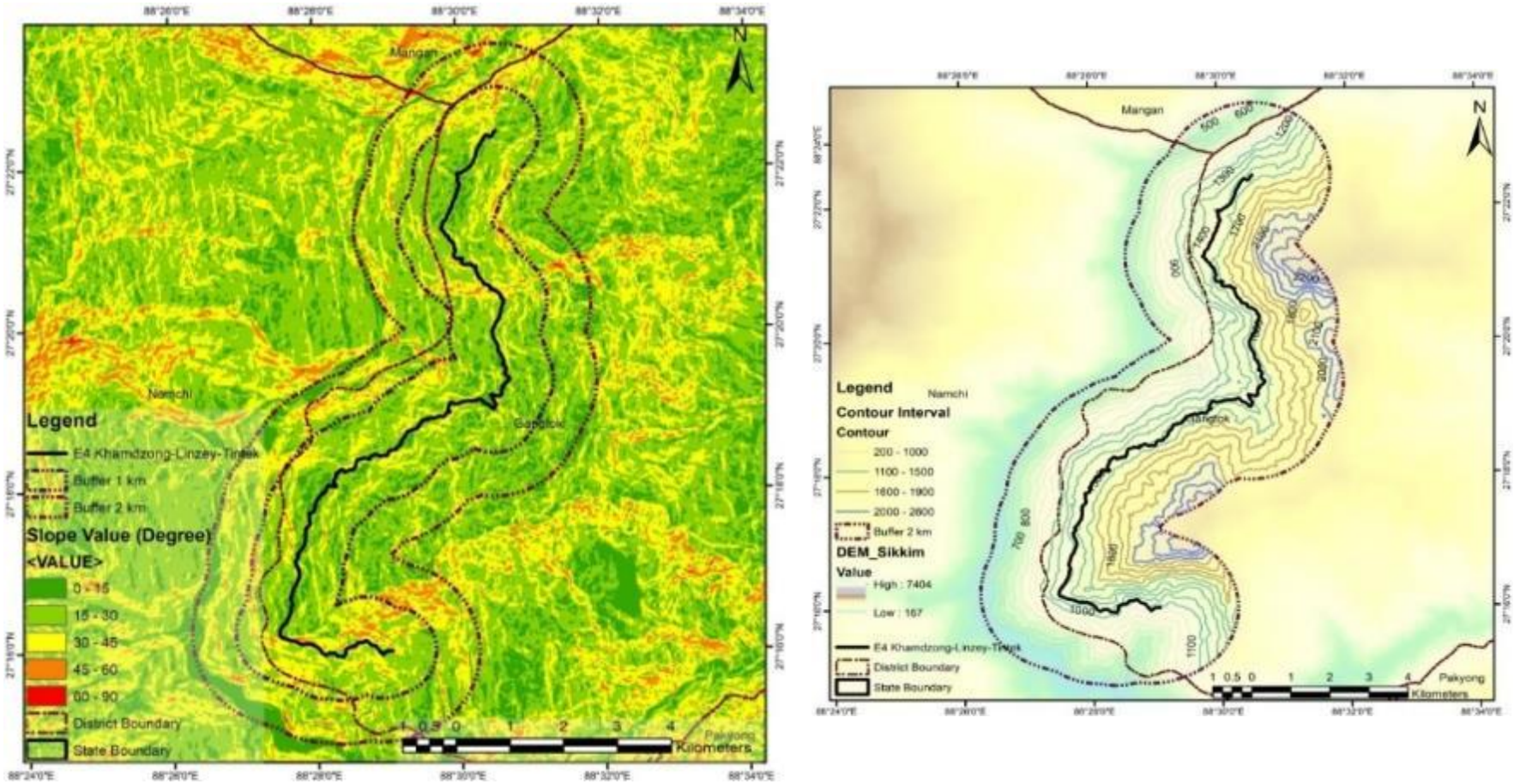


Figure 3-3: Elevation map of E4

S1: MELLI-PHONG VIA RATEYPANI IN NAMCHI DISTRICT

Slope:

The map represents the steepness of slope along the road S1 and in its nearby area. The slope for S1 ranges mostly between 0 and 45 degrees, representing from flat terrain to moderate slope. However, in a few parts of the immediate area of influence the slope ranging from 30 to 90 degree represents a relatively steeper slope.

Contour:

The map represents the contour levels for the road S1 along with a 2 km buffer around the road ranging from 200 to 1900 m amsl. The road S1 lies ranging between 200 m amsl to 1300 m amsl. Contour lines near are relatively closer to each other indicating a slope that is steep.

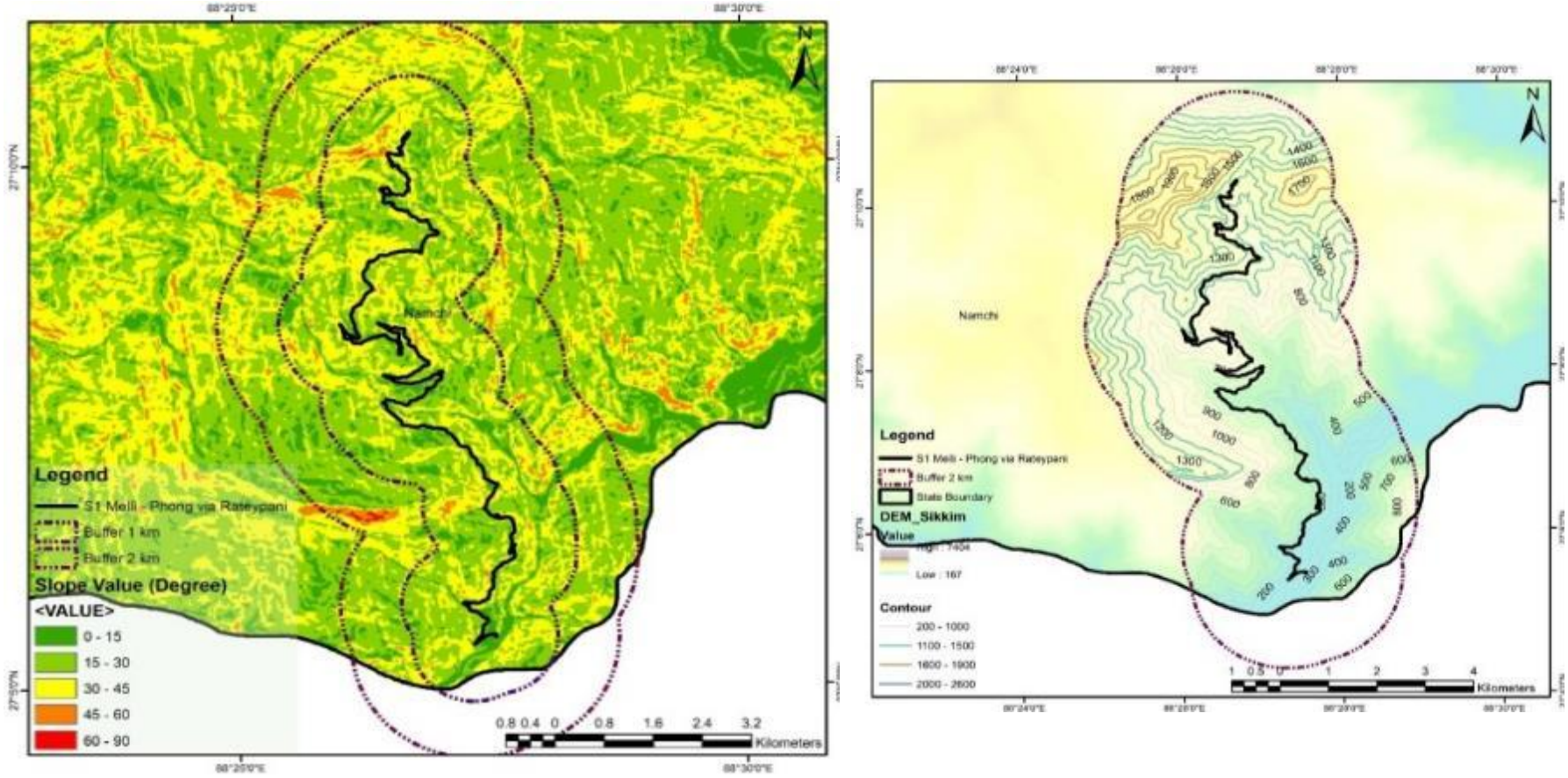


Figure 3-4: Elevation map of S1

S6: ASSANGTHANG - SALGHARI TO CCCT NANDUGAON

Slope:

The map represents the steepness of slope along the road S6 and in its nearby area. The slope for S6 ranges mostly between 0 to 45 degrees, representing from flat terrain to moderate slope. However, in a few parts of the immediate area of influence the slope ranging from 30 to 90 degree represents a relatively steeper slope

Contour:

The map represents the contour levels for the road S6 along with a 2 km buffer around the road ranging from 200 to 1900 m amsl. The road S6 lies on a height ranging between 200 m amsl and 1300 m amsl. Contour lines near are relatively closer to each other indicating a slope that is steep, whereas as we move towards the north of the road the contour level has increased from 1300 and 1900 m amsl. As we move towards the south the contour intervals are ranging from 200 to 400 m amsl.

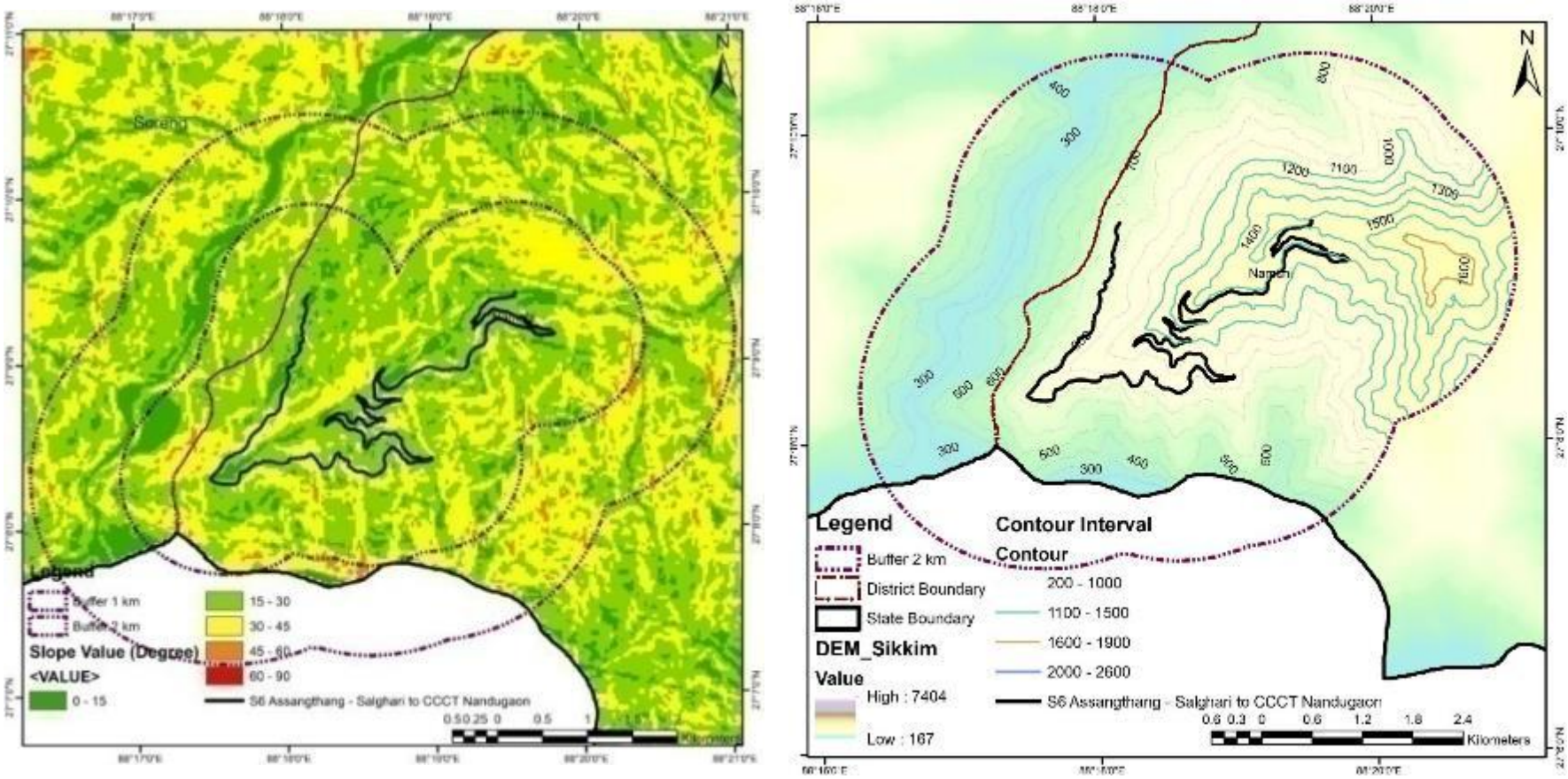


Figure 3-5: Elevation map of S6

W10: GYALSHING TO SAKYONG IN GYALSHING DISTRICT

Slope:

The map represents the steepness of slope along the road N9 and in its nearby area. The slope for N9 ranges mostly between 0 and 30 degrees, representing a shallow slope.

Contour:

The map below represents the contour levels for the road N9 along with a 2 km buffer around the road ranging from 700 to 1900 m amsl. The road N9 lies on a height ranging between 1100 m amsl and 1300 m amsl. Contour lines near the road are further apart indicating a slope that is less steep, whereas as we move towards the south of the road the slope has become relatively steeper. As we move towards the east direction the contour intervals have increased from 1500 - 1900 m amsl.

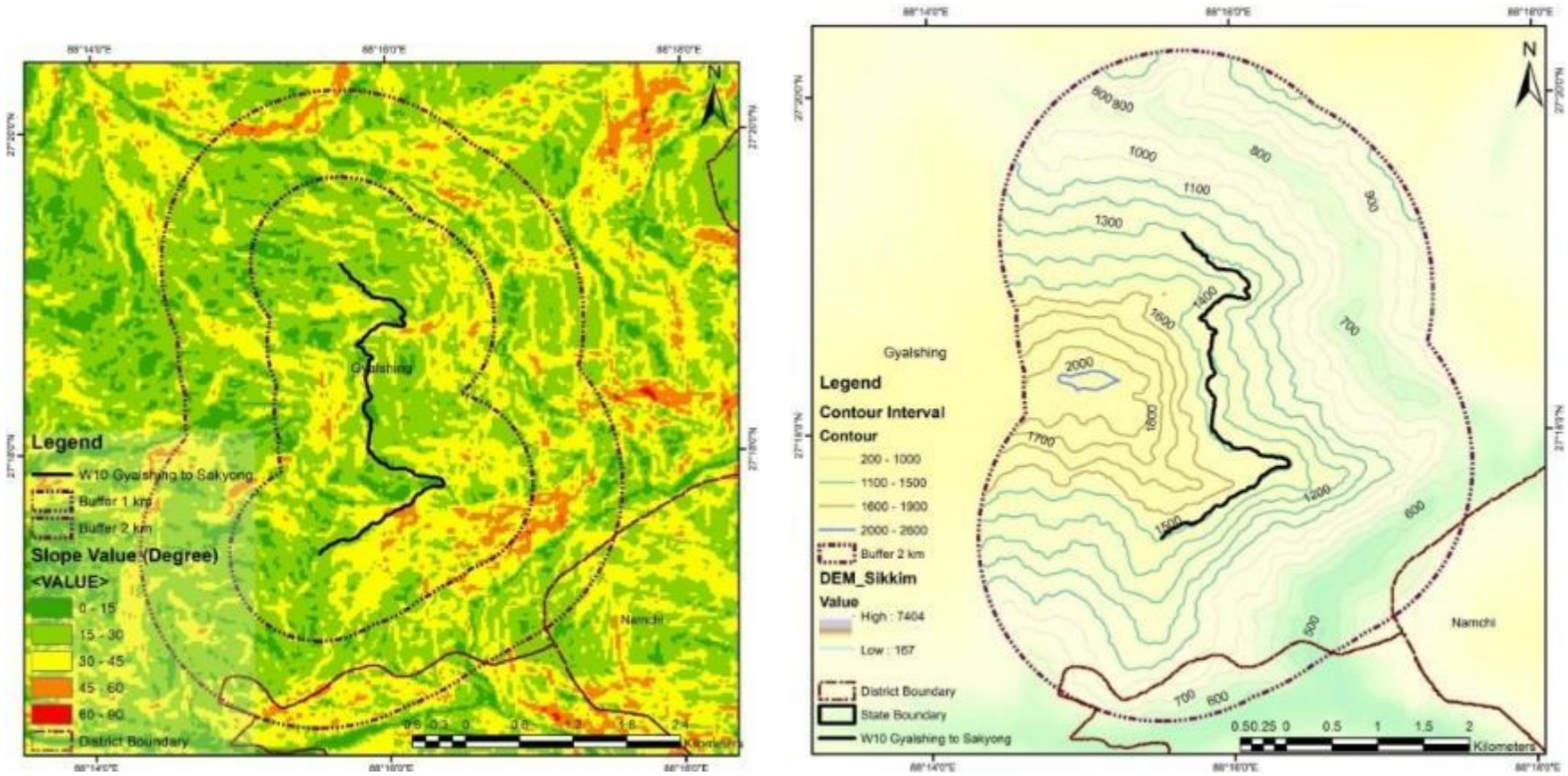


Figure 3-6: Elevation map of W10

3.1.2 Geology and Soils

112. In spite of low accessibility, a number of base metal occurrences represent thick vegetal and soil / debris / moraine cover, the state of Sikkim. Most of the occurrences are in Daling Group of rocks in parts of West, South and East districts of Sikkim. Base metal occurrences at Bhotang, Pachekhani and Dikchu have been explored in detail. The Bhotang and Pachekhani lodes that are mined presently are possibly the only working mines in Himalayas. Among non-metallic minerals coal, graphite, dolomite, limestone, marble, wollastonite, talc, sillimanite and asbestos etc. also occur.

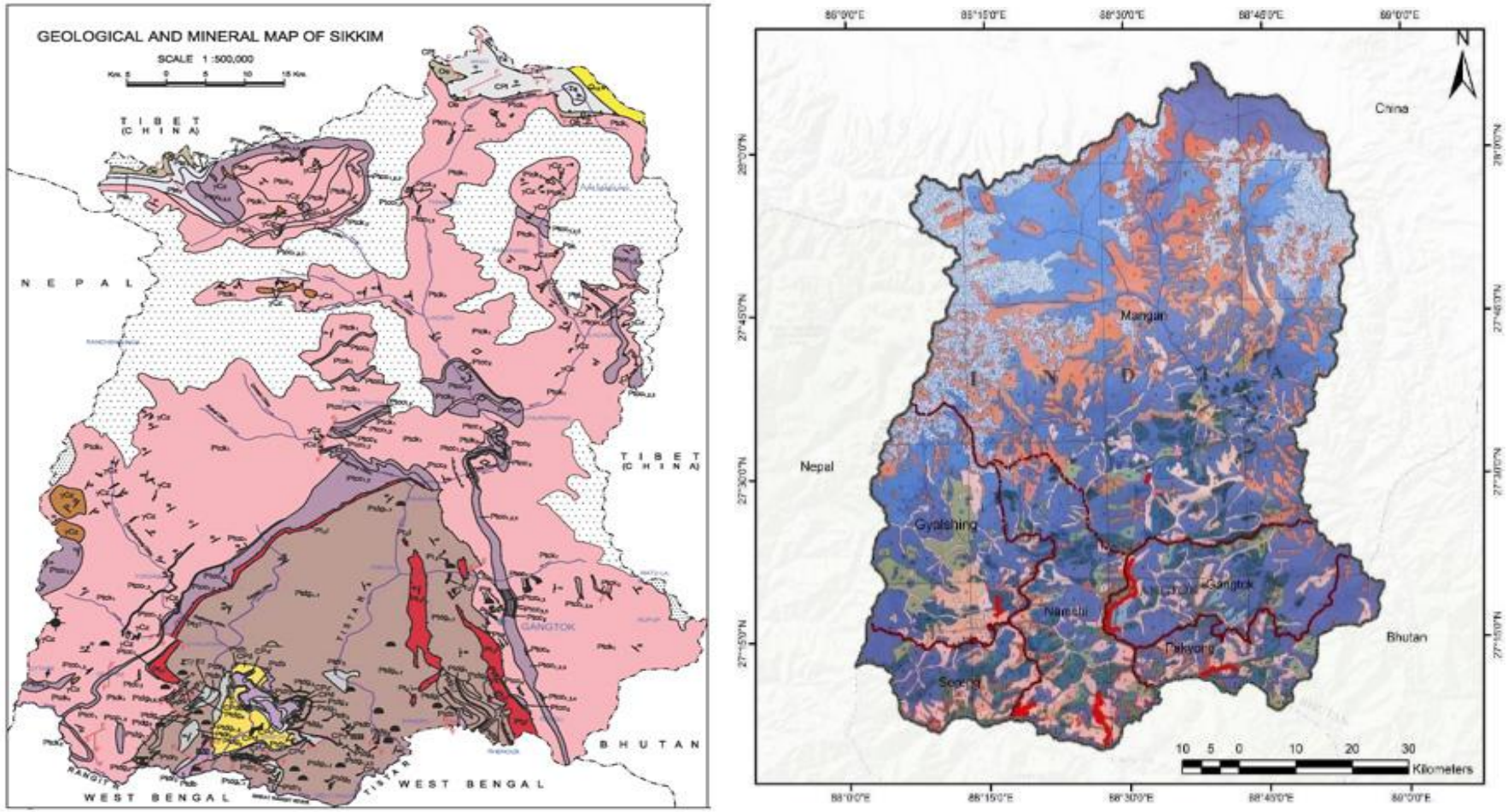


Figure 3-7: Geological and mineral map of Sikkim

113. The texture of the soil in state is generally coarse-loamy to fine loamy, with large concentrations of iron oxide; it also ranges from neutral to acidic and is lacking in organic and mineral nutrients. North district of the state has majorly loamy skeletal soil, while rest of the district has generally coarse loamy soil. This type of soil tends to support evergreen and deciduous forests. Heavy rainfall in the state causes extensive soil erosion and the loss of soil nutrients through leaching. In many

places, the soil is good for the crops; it is sandy alluvial in the lower regions and black, white or red in the higher hills. Soils are porous with poor water holding capacity and deficit in potash, phosphorous, nitrogen and even humus.

114. Mostly the soil profile of the corridors under phase 1 is either – Soil of Valleys, Soil of Southern Sikkim or Soils of Summit and Ridges according to their topography and location. As such temperature regimes of most of the corridors are thermic soil temperature regime, the valley areas are also observed to be of mesic soil temperature regime.

Table 3-1: Soil characteristics of corridors

Sl. No.	Name of Corridor	Characteristics		
		Soil Type	Temperature Regime	Moisture Regime
1	N9: MANGAN BAZAAR TO D.A.C. IN MANGAN DISTRICT	Soils of Valleys	Thermic soil temperature regime Mesic soil temperature regime	Udic Moisture Regime
2	E1: RORATHANG - ROHLI IN PAKYONG DISTRICT	Soils of Summit and Ridges	Thermic soil temperature regime Ridges with 30% Slope	Udic Moisture Regime
3	E4: KHAMDZONG-LINZEY-TIMTEK IN GANGTOK DISTRICT	Soils of Valleys	Thermic soil temperature regime Mesic soil temperature regime	Udic Moisture Regime
4	S1: MELLI-PHONG VIA RATEYPANI IN NAMCHI DISTRICT	Soils of Southern Sikkim	Thermic soil temperature regime	Udic Moisture Regime
5	S6: ASSANGTHANG - SALGHARI TO CCCT NANDUGAON	Soils of Southern Sikkim	Thermic soil temperature regime	Udic Moisture Regime
6	W10: GYALSHING TO SAKYONG IN GYALSHING DISTRICT	Soils of Valleys	Thermic soil temperature regime Mesic soil temperature regime	Udic Moisture Regime

3.1.3 Climate

115. Sikkim's climate ranges from sub-tropical in the south to tundra in the north. Most of the inhabited regions of Sikkim experience a temperate climate, with temperatures seldom exceeding 28 °C (82 °F) in summer. The average annual temperature for most of Sikkim is around 18 °C (64 °F).

116. Figure 3-8 describes the temperature profile of the Sikkim based on IMD data of last 30 years. This shows lowest temperature is perceived in the month of January at around 1.8 °C at Gangtok and maximum in the month of August at 27 °C.

Figure 3-8: Temperature profile of Sikkim based on IMD data

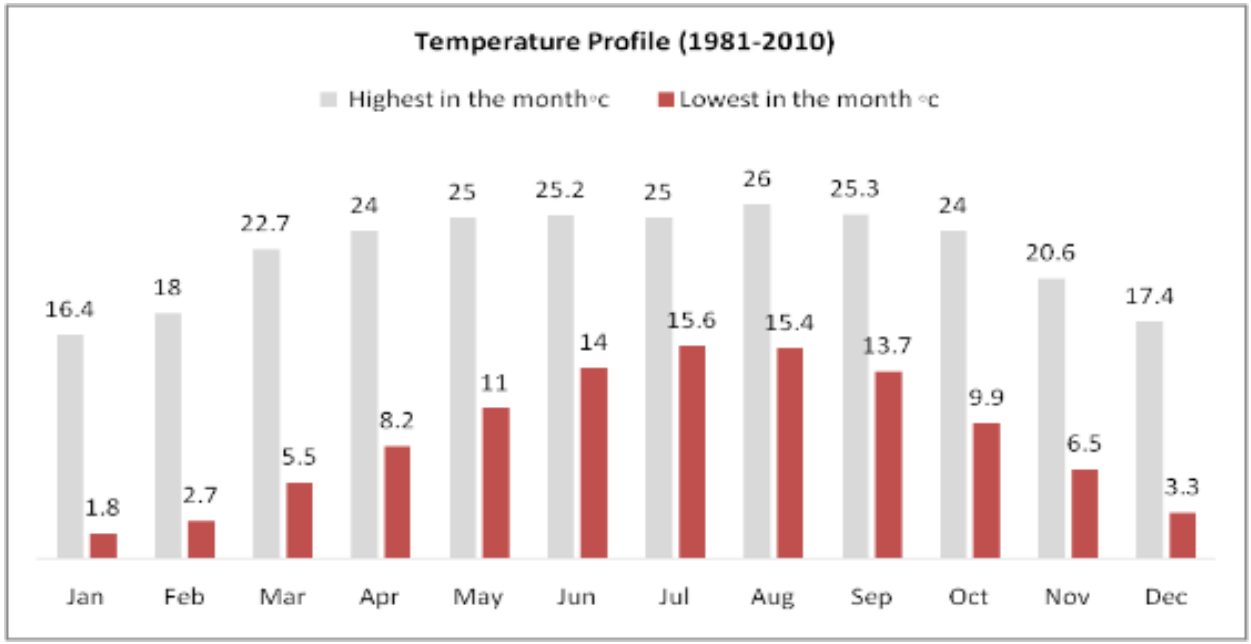


Figure 3-9: Temperature patterns of Gangtok, Sikkim

3.1.4 Rainfall

117. South Sikkim receives the highest rainfall over other districts during all the months and season. The district receives 71-72% of annual rainfall in SW monsoon season. It experiences the highest rainfall in the month of June. During the whole southwest monsoon season West Sikkim and South Sikkim have shown significant decreasing trend. For the annual rainfall also, West Sikkim and South Sikkim show significant decreasing trend. Trends suggest, during June to September there is a significant increase in heavy rainfall days in South Sikkim, compared to other districts. Average annual rainfall received over this district is around 480 mm in June, 600 mm in July, 500 mm in August, 400 mm in September and around 2000 mm during the SW monsoon with the annual rainfall reaching around 3000 mm.

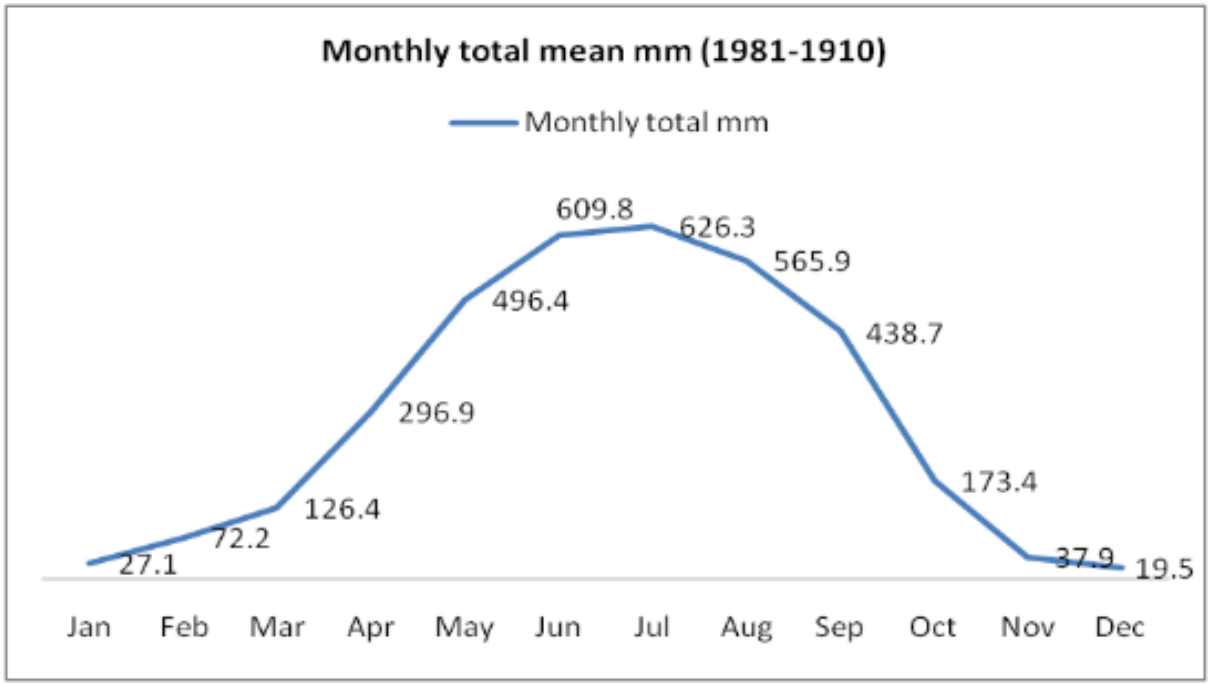


Figure 3-10: Rainfall pattern of the last 30 years of Sikkim

118. The following table presents the rainfall pattern from 2009 to 2021. July was the heaviest rainfall month while January, November and December received the lowest rainfall. The district-wise rainfall pattern of last 10 to 12 years has been presented below.

EAST SIKKIM												
year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2009	5.7	4.2	87.3	251.7	335.4	355.4	408.6	451.1	180.1	201.6	1.7	5.4
2010	5.7	18	186.7	359.4	272.7	504.6	601	49.8	375.8	95.6	23.6	0.1
2011	21.6	40.5	68.5	14.7	278.8	515.9	587.3	459.1	376.7	44.9	60.8	2.3
2012	17.8	21.5	28.4	312.2	201.6	614.4	481.3	442.2	410.9	72.9	0.1	1
2013	4.3	32.1	127.7	256.1	409	382.6	412.1	325.1	195.5	191.8	40.7	7.9
2014	0	5.4	68.2	96.7	441.4	472.7	478.7	522.3	273	16.7	2.4	4.2
2015	7.4	17.4	73.3	270.3	387.8	603.1	561	284.7	316.1	99.6	55.8	1
2016	15.2	7.4	125.3	220.4	338.7	391.1	569.1	213.3	348.2	98.2	0.1	0.4
2017	7.7	9	112.3	266.1	315.7	318.3	485.7	400.6	274.5	83.3	6.5	0
2018	0.6	24.9	113	268.5	302.7	456	408.9	442.6	279.5	44.5	11.4	23.7
2019	2.1	49.2	102.1	203	429.4	384.7	657.7	363.9	337	70.1	3.2	11.5
2020	39.9	29.5	121.7	164.9	205.7	476.5	683.2	515.9	538.5	55.3	0.1	19.1
2021	16	21.9	92.3	158.2	354.4	543.2	468.7	542.7	242.4	327.2	5.4	22.6

NORTH SIKKIM												
year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2009												
2010					424.9	582.8	531.6	599.1	329.1	106.7	111.8	11.2
2011	31.8	72.4	79.7	150.3	190.8	393.8	442.8	397.2	261.5	126.8	68.8	12.4
2012	96.4	39.5	208.3	365.3	139.7	599.2	595.9	316.2	785.4	302.4	0	17.5
2013	9.6	62.8	120.8	200.5	615.5	313.6	530.2	301.8	310.3	226.7	82.4	10.4
2014	0	29.8	163	194.4	417	651.6	605.1	629.8	297.5	36.7	25.2	13.6
2015	22	34	180.6	239.4	498.4	796.4	393.6	664.7	320.2	102.8	59	37.5
2016	81.8	34.9	306.8	226.7	383.7	548	487.3	301.6	638.1	139.8	0	0
2017	7.7	9	112.3	266.1	315.7	318.3	485.7	400.6	274.5	83.3	6.5	0
2018	15.2	66.4	216.2	221	397.3	584.2	688.2	510.8	751.9	203.5	68.9	15.1
2019	25.7	92.7	236.2	155.3	443.7	531.4	588	351.4	559.8	88.7	8.5	26.3
2020	83.1	25.2	155	343.7	375	993.7	818.9	467.2	409.7	220.9	23.5	17.2
2021	31.9	64.5	263.1	336.7	488.2	528.1	531.2	565.6	316.1	302.7	25.2	34.3

SOUTH SIKKIM												
year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2009												
2010					130	346.7	547.4	378.8	528.7	93.1	0.2	0
2011	11.5	5.4	90.4	117	152.7	308.5	663.3	513.4	318.2	13.9	28.6	1
2012	10.1	3.6	9.1	122	187.5	367.2	372.1	359.7	385.1	16.9	0	0
2013	4	25.7	66.2	111	263.8	288.4	297.8	339.6	189.2	141.5	2.2	13.5
2014	0	5.6	54.6	10	164.7	279.3	391.1	651.4	353.5	44.1	0	1.6
2015	2.4	9.2	74.4	155	269.9	394.8	625.8	377.3	448.5	84	30	3.8
2016	15.2	2.1	30.5	30.4	234.8	384.2	629.2	175.1	359.9	127.6	0	1.8
2017	5.6	0	69	147.9	229	156.7	497.5	373	425.2	75.2	7	0
2018	2.9	14.5	78.5	153.4	224.7	372.6	400.3	416.2	363.5	34.1	0	26.2
2019	5.6	58.3	73.1	202.7	241.8	221.7	503.4	164.8	453	109.3	5.3	14.1
2020	21.9	31.6	70.4	135	200.4	556	929.6	679.7	766.2	47.2	0	10.2
2021	2.6	14.4	35.3	74.4	258.2	352.8	421.9	412	153.2	211.5	0.9	22.8

WEST SIKKIM												
year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2009												
2010												
2011							85.5	449	241	57	38	6
2012	16	5	21	126	240	486	376	520	548	81	0	10
2013	8	43	79	155	354	241	583	459.2	374.5	153	3.2	8.7
2014	0	1.3	41.3	59.8	204	543.3	204.7	439	109	66.5	6	1.7
2015	7	23.5	38.5	121	240.5	446.6	351	273	466.5	56	1	4
2016	11.2	4.5	70	84.5	234.5	401.7	501.5	176.7	585.1	110.5	0	0
2017				77.1	181.7	278	642.8	602.6	602.6	69.2	6.2	0
2018	2.9	18.5	39.5	105.8	194.8	335.2	548.8	555.7	200.1	45.5	0	14.3
2019	4	33.2	40	176.5	172.1	147.3	640.8	315	354.3	49.1	2.5	18
2020	20.9	21.3	36.4	58.3	116	299.6	438.2	245.2	277	63.7	0	6.7
2021	6.1	21.9	57	45.5	266.4	394	554.1	401.3	255.8	334.9	3.9	22.7

Figure 3-11: Rainfall Pattern of Last 30 Year in Sikkim

3.1.5 Snowfall

119. Sikkim is one of the coldest places in the country. The northeastern part of India is home to one of the tallest peeks in the world, Kanchenjunga, where the temperature falls as low as -32 °C. Sikkim is one of the few states in India to receive regular snowfall. The snow line ranges from 6,100 m (20,000 ft) in the south of the state to 4,900 m (16,100 ft) in the north. The project road elevation ranges from 1600 m amsl to 200 m amsl, detail elevation profile of the project roads discussed in subsection 3.1.1. The tundra-type region in the north is snowbound for four months every year, and the temperature drops below 0 °C (32 °F) almost every night. In northwestern Sikkim, the peaks are frozen year-round; because of the high altitude, temperatures in the mountains can drop to as low as -40 °C (-40 °F) in winter.

3.2 Natural Hazards

3.2.1 Seismicity

120. Sikkim is located in the earthquake-prone part of the eastern Himalayas. The Himalayan orogenic belt is one of the most seismically active continents - continent collision zones in the world, where the Indian Plate

continues to under thrust the Eurasian Plate. Sikkim is located at the convergence zone of the Indian and Eurasian tectonic plates. The Indian plate is moving northward and colliding with the Eurasian plate, resulting in the formation of the Himalayan Mountain range. The tectonic activity along the plate boundaries leads to frequent earthquakes in the region. The region is close to the epicenter of the great 1934 Bihar – Nepal earthquake. Sikkim has experienced moderate seismicity in the past and the region is designated under zone IV in the seismic zonation map of India. The design standard for road shall follow the prevalent BIS standard during construction of the project roads. Corridor wise earthquake profile map is presented in Annexure 8.
All the corridors are falling under Zone IV and as such Sikkim. The district mostly falls in the medium to medium-high hazard zone. The design standard for road shall follow the prevalent BIS standard during construction of the project roads.

3.2.2 Landslide

121. The physiographic set up of the region and the seismic influence makes state and project region vulnerable to landslides. During the monsoon, heavy rains increase the risk of landslides. The severe rains that followed the earthquake event also contributed to the density and severity of landslides. The instability induced in the hill slopes due to the earthquake has enhanced landslide vulnerability of the state. The landslide prone areas of around the project area are presented in Annexure 7.

3.2.3 Hydrology and Flash Floods

122. A first-order stream is the smallest of the streams and consists of small tributaries. These are the streams that flow into and "feed" larger streams but do not normally have any water flowing into them. Also, first- and second-order streams generally form on steep slopes and flow quickly until they slow down and meet the next order waterway. Going up in size and strength, streams that are classified as fourth-order are considered a river.

123. The first-order streams are dominated by overland flow of water; they have no upstream concentrated flow. Because of this, they are most susceptible to non-point source pollution problems and can derive more benefit from wide riparian buffers than other areas of the watershed.

Table 3-2: Corridor-wide Hazard Profile

Corridor	Seismicity	Landslide	Hydrology & Flash Floods
N9: MANGAN BAZAAR TO D.A.C. IN MANGAN DISTRICT	The vulnerable zones for earthquake vary from Low Hazard to Very High Hazard category. Road N9 and its area under influence predominantly Medium and Medium High Hazard which makes it prone to disaster.	The vulnerable zones for landslide vary from Medium Low Hazard to Very High Hazard category. Road N9 and its area under influence predominantly has Medium Low and Medium High Hazard which makes it prone to landslides.	N9 consists of First and Second Order streams which makes it highly susceptible to flash floods and glacier outburst. The fourth order stream within the 2 km buffer area of the road is River Teesta.
E1: RORATHANG - ROHLI IN PAKYONG DISTRICT	The road lies mostly in medium low hazard zone and very few parts coming under the medium hazard zone.	The vulnerable zones for landslides vary from Medium Low Hazard to Medium High Hazard category. Road E1 and its area under influence predominantly has Medium High Hazard to Very High Hazard towards east. which makes it prone to landslides.	E1 consists of First, Second as well as Third Order streams (Rangpo Chu) which makes it highly susceptible to flash floods and glacier outburst.
E4: KHAMDZONG-LINZEY-TIMTEK IN GANGTOK DISTRICT	The road lies mostly in medium high hazard zone and some parts coming under the medium hazard zone.	The vulnerable zones for landslide vary from Medium Low Hazard to Medium High Hazard category. Road E4 and its area under influence predominantly has Medium Low and Medium High Hazard which makes it prone to landslides	E4 consists of First and Second Order streams which makes it highly susceptible to flash floods and glacier outburst. The concentration of streams is very high in the influence area of the road. The fourth order stream within the 2 km buffer area of the road is Teesta River and also increases the susceptibility towards river floods.
S1: MELLI-PHONG VIA RATEYPANI IN NAMCHI DISTRICT	Most part of the road lies in the low hazard zone while the rest is in the medium low hazard zone.	The vulnerable zones for landslide vary from Medium Low Hazard to Very High Hazard category. Road S1 and its area under influence predominantly has Medium Low and Medium High Hazard at some portions which makes it prone to landslides.	S1 consists of First and Second Order streams which makes it highly susceptible to flash floods and glacier outburst.
S6: ASSANGTHANG - SALGHARI TO	The road lies in both medium hazard zone and the medium high zone along with very few	The vulnerable zones for landslide vary from Medium Low Hazard to Very High Hazard category. Its area	S6 consists of First and Second Order streams which makes it highly susceptible to flash floods and

Corridor	Seismicity	Landslide	Hydrology & Flash Floods
CCCT NANDUGAON	parts in very high hazard zone as well.	under influence predominantly has Medium Low and Medium High Hazard at some portions which makes it prone to landslides.	glacier outburst. The third-order stream i.e., the River Rangeet is in close proximity to the Project Road.
W10: GYALSHING TO SAKYONG IN GYALSHING DISTRICT	The vulnerable zones for earthquake vary from Low Hazard to Very High Hazard category. The road and its area under influence predominantly has Medium and Medium High Hazard which makes it prone to disaster	The vulnerable zones for earthquake vary from Low Hazard to Very High Hazard category. Its area under influence predominantly has Medium and Medium High Hazard which makes it prone to disaster	Road consists of First and Second Order streams which makes it highly susceptible to flash floods and glacier outburst. The third order stream within the 2 km buffer area of the road is River Rangeet and its tributary Rathong Chu.

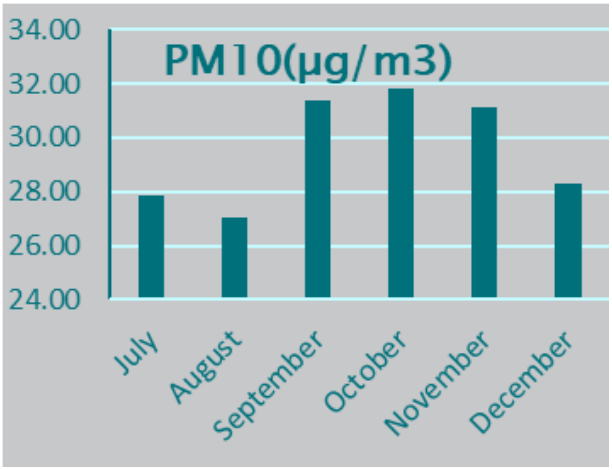
3.3 Air Environment

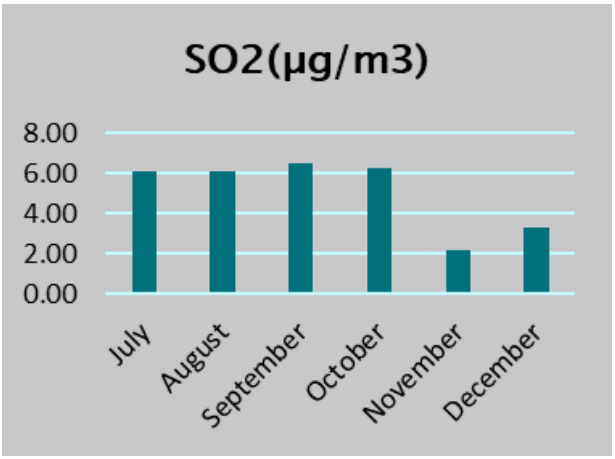
124. Ambient air quality level of representative city from project corridors has been presented have an idea about prevailing air quality of the region and it is observed that all the three major parameters such SOx, NOx and Particulate Matter are found well within permissible limits. Air quality parameters are being regularly monitored in the eight monitoring stations namely Rangpo, Singtam, Gangtok, Ravangla, Namchi, Pelling, Mangan and Chungthang.

125. As per SPCB, the ambient air quality in the state has been well within the permissible limits as per the provisions of the Air (Prevention and Control of Pollution) Act, 1981. While AQI for majority of the towns are under 'Good' category, three major towns i.e., Rangpo, Singtam and Deorali (Gangtok) in East Sikkim have fallen under 'Satisfactory' category. Proximity of these towns to the National Highway NH10 which is subjected to heavy movement of vehicles can be a reason for these towns to fall under 'Satisfactory' category.

126. Vehicular pollution is a secondary source of pollution in the state as the traffic density in the entire state is very less. The level of pollution in rural areas is much lower than that of the urban areas. Also, the traffic flow in rural areas is much less than that of the urban locations.

127. The graphical presentation of Air quality in Sikkim for the period of July 2021 to December 2021 is presented below: Namchi Monitoring Station being regulated under CPCB, located at a distance of 9 km. The Air Pollution data has been studied for the month of July – December 2021 for PM 10, SO2 and NO2. NAAQS standard for these pollutants have also been mentioned below to compare the standards with the current pollutant level.





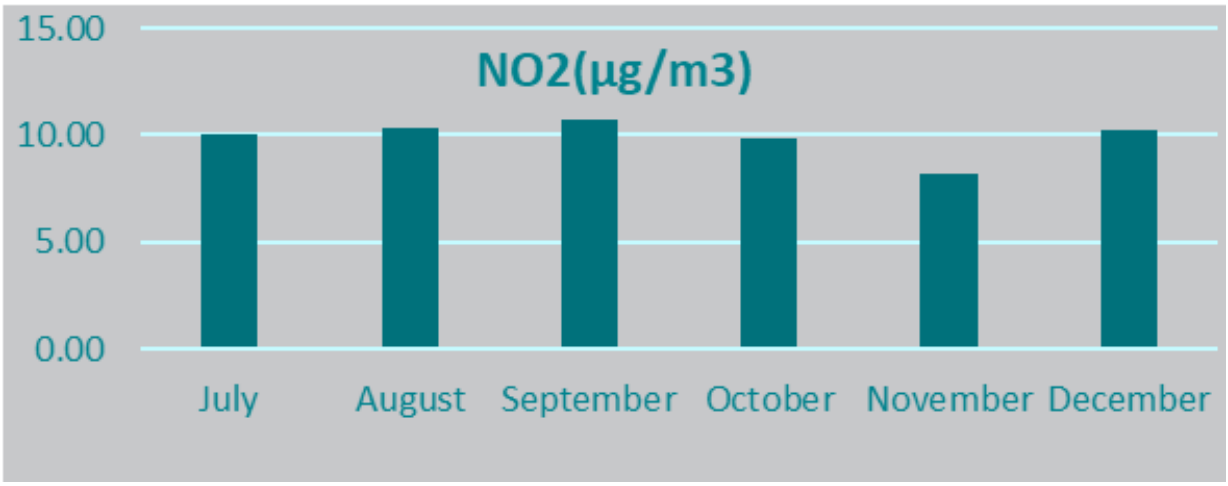


Figure 3-12: Monitoring Record – SPCB, Namchi

128. The pollutant level for each pollutant is below the National Ambient Air Quality Standards which indicates Good AQI which is between 0 – 50. Air quality is satisfactory and poses little or no health risk.

3.3.1 Baseline Monitoring of Ambient Air Quality

129. The collection of base line data of ambient air quality occupies important role for the EIA study. The ambient air quality status along the project corridors forms basis for prediction of the impacts due to the project activities.

3.3.2 Description of Sampling Locations

130. Ambient Air Quality was monitored for 24 hours once in each study area from last week of October to 2nd week of November, 2022. i.e., in the post-monsoon season. For assessment of existing ambient air quality in the area along the project corridor alignments and bridge locations samples were collected from 17 locations between 27.10.2022 to 14.11.2022. At each location 24-hour samples of air were collected through air sampler to monitor the concentration of PM 10, PM 2.5, So 2 and No 2 and Carbon monoxide, Ozone, Ammonia, Lead, Nickel, Arsenic, benzene and benzopyrine. The ambient air quality monitoring locations given in the below along with monitoring locations and chainage of locations. The test report and photographic clips of sampling are provided in separate Annexure 4.

131. Table 3-3 along with monitoring locations and chainage of locations. The test report and photographic clips of sampling are provided in separate Annexure 4.

Table 3-3: The ambient air quality monitoring locations

Sl. No.	Location Code	Location Name	Chainage	Latitude	Longitude	Distance from project road	Date of Monitoring	Remarks
1	N9_AQ1	N9	CH 0 +000	27°29'29.51"N	88°31'55.13"E	80 m	07.11.2022	North Sikkim Administration Centre
2	S1_AQ4	S1	CH 0 +500	27°10'16.08"N	88°26'43.78"E	10 m	11.11.2022	Melli PHC
3	S1_AQ3	S1	CH 8 +630	27° 8'21.86"N	88°26'12.33"E	20 m	12.11.2022	Settlement (Near Passi)
4	S1_AQ2	S1	CH 15 + 530	27° 7'45.90"N	88°26'48.28"E	10 m	13.11.2022	Govt. Senior Secondary School
5	S1_AQ1	S1	CH 22 + 460	27° 5'28.28"N	88°27'32.41"E	40 m	14.11.2022	Settlement (Near Evangelical Presbyterian Church of Sikkim, Suiram)
6	S6_AQ1	S6	CH 0 + 000	27° 9'23.78"N	88°19'32.29"E	60 m	27.10.2022	Assangthang Government Junior School
7	S6_AQ2	S6	CH 3 + 530	27° 8'57.08"N	88°19'8.70"E	0 m	28.10.2022	Govt Primary School Dhargaon
8	S6_AQ3	S6	CH 13 + 830	27° 8'53.75"N	88°18'1.70"E	55 m	29.10.2022	Centre for Computers and Communication Technology
9	E1_AQ2	E1	CH 0 + 560	27°11'43.57"N	88°37'48.62"E	10 m	08.11.2022	Settlement (Near Swiss Garnier)
10	E1_AQ1	E1	CH 7 + 930	27°12'21.77"N	88°41'9.33"E	40 m	09.11.2022	BDO Office
11	E4_AQ1	E4	CH 0 + 50	27°15'57.83"N	88°28'58.15"E	50 m	04.11.2022	Birkuna Junior High School
12	E4_AQ2	E4	CH 7 + 020	27°18'1.86"N	88°28'3.93"E	110 m	05.11.2022	Lingzey Junior School
13	E4_AQ3	E4	CH 18 + 700	27°21'15.24"N	88°29'46.40"E	10 m	06.11.2022	Samdong PHC
14	W10_AQ1	W10	CH 0 + 000	27°17'18.46"N	88°15'28.44"E	80 m	01.11.2022	ATM Near Geyzing Market
15	W10_AQ2	W 10	CH 4 + 960	27°18'48.72"N	88°16'6.63"E	10 m	02.11.2022	Panchayat Bhawan near Unglok
16	Br04_AQ1	Br-04	20m (approx.) upstream from location of bridge	27°18'27.23"N	88°26'19.41"E	10 m	03.11.2022	Settlement near bridge site
17	Br06_AQ2	Br-06	20m (approx.) upstream from location of bridge	27° 7'44.23"N	88°16'17.77"E	10 m	30.10.2022	Settlement near bridge site

Figure 3-13: Monitoring pictures on corridor S1 (Melli-Phong via Rateypani)

132. The results of ambient air quality monitoring carried out along the project Corridors and bridges are presented in along with monitoring locations and chainage of locations. The test report and photographic clips of sampling are provided in separate Annexure 4.

133. Table **3-3**. National ambient air quality standards for industrial, residential, rural & other areas are met for all monitored parameters at all 17 ambient air quality-monitoring locations. The identifications of locations and analysis were done as per NAQM Vol-1, CPCB Guidelines. All monitored parameters meet the CPCB Guidelines however in some of the monitoring locations as per WHO guidelines, some of the parameters are above the permissible limit.

134. In E1 AQ2, E4 AQ1, E4 AQ3, W10 AQ1 and W10 AQ2 the monitored result exceeds the permissible limit for PM10 as per WHO guidelines while in S1 AQ2, S6 AQ2, E1 AQ2, E4 AQ1, E4 AQ3, W10 AQ1 and BR06 AQ2 the monitored result exceeds the permissible limit for PM2.5 as per WHO guidelines. All other parameters in monitoring stations are within the permissible limit.

Table 3-4: Ambient Air Quality Monitoring Result

Sl. No	Reference Method	Parameter	Unit	Result																	National AAQ Standards, CPCB	WHO Guidelines (2021) (ug/m3)
				N9_AQ1	S1_AQ4	S1_AQ3	S1_AQ2	S1_AQ1	S6_AQ1	S6_AQ2	S6_AQ3	E1_AQ2	E1_AQ1	E4_AQ1	E4_AQ2	E4_AQ3	W10_AQ1	W10_AQ2	Br04_AQ1	Br06_AQ2		
	IS 5182 (Part 23): 2006	PM_{10}	µg/m3	32	34	38	43	39	36	45	32	47	28	49	34	46	55	46	30	42	100	45
	IS 5182 (Part 24): 2019	$PM_{2.5}$	µg/m3	11	12	15	18	16	13	18	12	19	10	21	13	20	23	19	12	16	60	15
	IS 5182 (Part 2): 2001	SO_2	µg/m3	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	4	<4	<4	<4	80	40
	IS 5182 (Part 6): 2006	NO_2	µg/m3	14	11	12	17	18	14	18	12	13	10	19	16	18	21	17	11	10	80	25
	NAQM Vol-1, CPCB Guidelines	Lead	µg/m3	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	1.0	-
	IS 5182 (Part 10): 1999	CO	mg/m3	0.3	0.2	0.2	0.4	0.4	0.2	0.3	0.2	0.2	0.3	0.5	0.3	0.4	0.6	0.4	0.2	0.3	2 (8 hr.)	4
	IS 5182 (Part 25): 2018	NH_3	µg/m3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	400	-
	IS 5182 (Part 9): 1974	Ozone (O_3)	µg/m3	14	11	13	15	14	14	12	10	11	9	15	13	16	16	14	10	9	100 (8 hr.)	100

	NAQM Vol-1, CPCB Guidelines	Arsenic	ng/m³	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	6 (Annual*)	-
	NAQM Vol-1, CPCB Guidelines	Nickel	ng/m³	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	20 (Annual*)	-
	NIOSH 1501	Benzene	µg/m³	<1.8	<1.8	<1.8	<1.8	<1.8	<1.8	<1.8	<1.8	<1.8	<1.8	<1.8	<1.8	<1.8	<1.8	<1.8	<1.8	<1.8	5 (Annual*)	-
	IS 5182 (Part 12): 2004	Benzo(a) Pyrene	ng/m³	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	1(Annual*)	-

135. Ambient Air Quality monitoring is also taken for Ammonia (NH 3), Lead, Nickel, Arsenic, Benzene, Benzopyrene parameters also. All the results are within prescribed limits only. Detailed monitoring report, monitoring location maps are given in Annexure 4.

136. Following baseline analysis for “wind direction” is provided as sample for analysis of S6 corridor. Complete analysis can be referred in Annexure 3.

137. Wind direction is reported as the direction from which the wind blows and is based on surface observations or meteorological modelling system. Over the course of a season, wind usually blows in all directions with varying frequencies. Certain direction, which occurs more frequently than others, is known as the prevailing wind direction. Wind speed and direction and their frequency during monitoring period are represented by wind rose diagram. The wind rose denotes a class of diagrams designed to display the distribution of wind direction experienced at a given location over a period of time — long for a climatological record of prevailing winds or short to show wind character for a particular event or purpose. Wind rose summarizes a considerable amount of wind frequency information into a single graphic and shown below during the monitoring period (Dec, 2022 to Feb, 2023).

138. The wind rose diagram reveals that wind was blowing predominantly from the Southwest & South direction with frequency of approximately 38 % & 32 % respectively having wind speed in the range of 0.5-8.3 m s-1 during the monitoring period. The onsite average wind speed was observed 3.69 m/s with frequency of calm winds 6.62 % during the monitoring period. Wind class frequency distribution observed during the monitoring period is presented graphically in Figure 3-14.

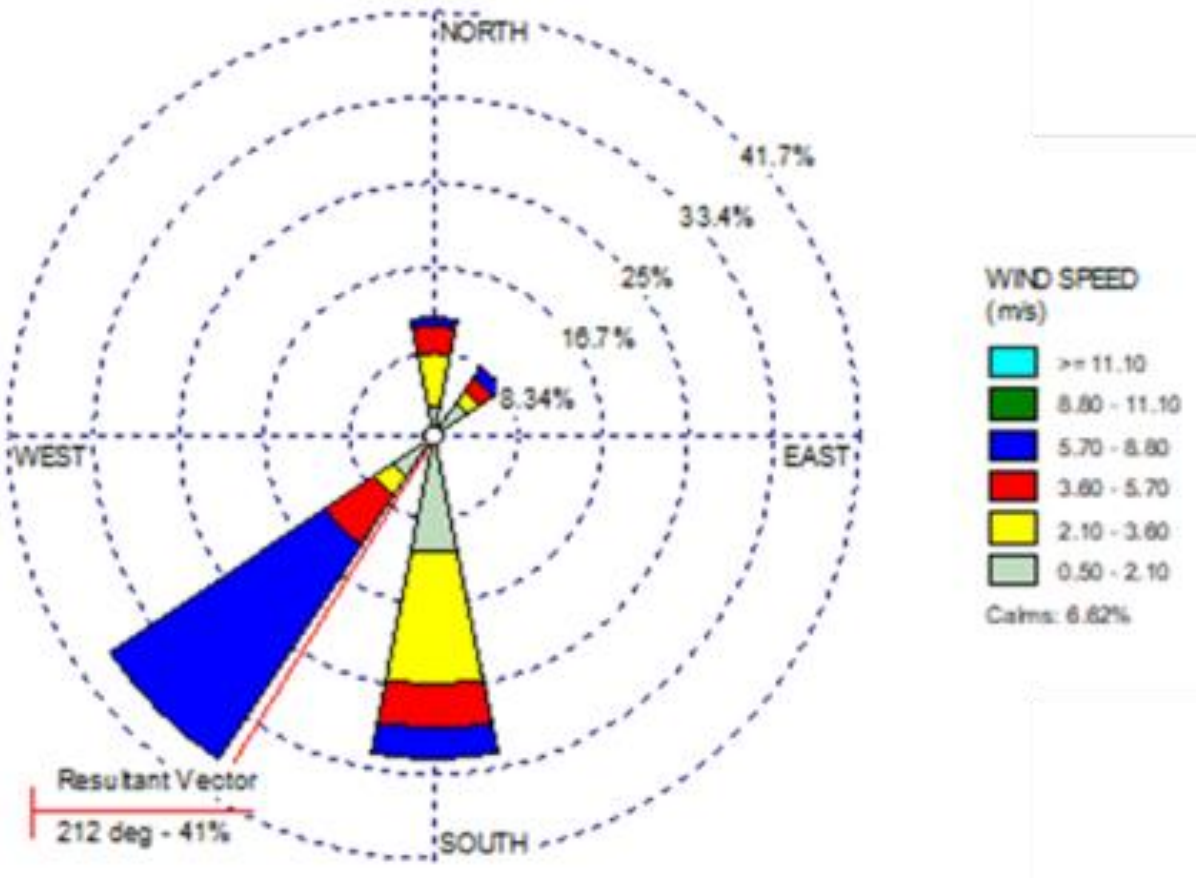


Figure 3-14: Wind Rose

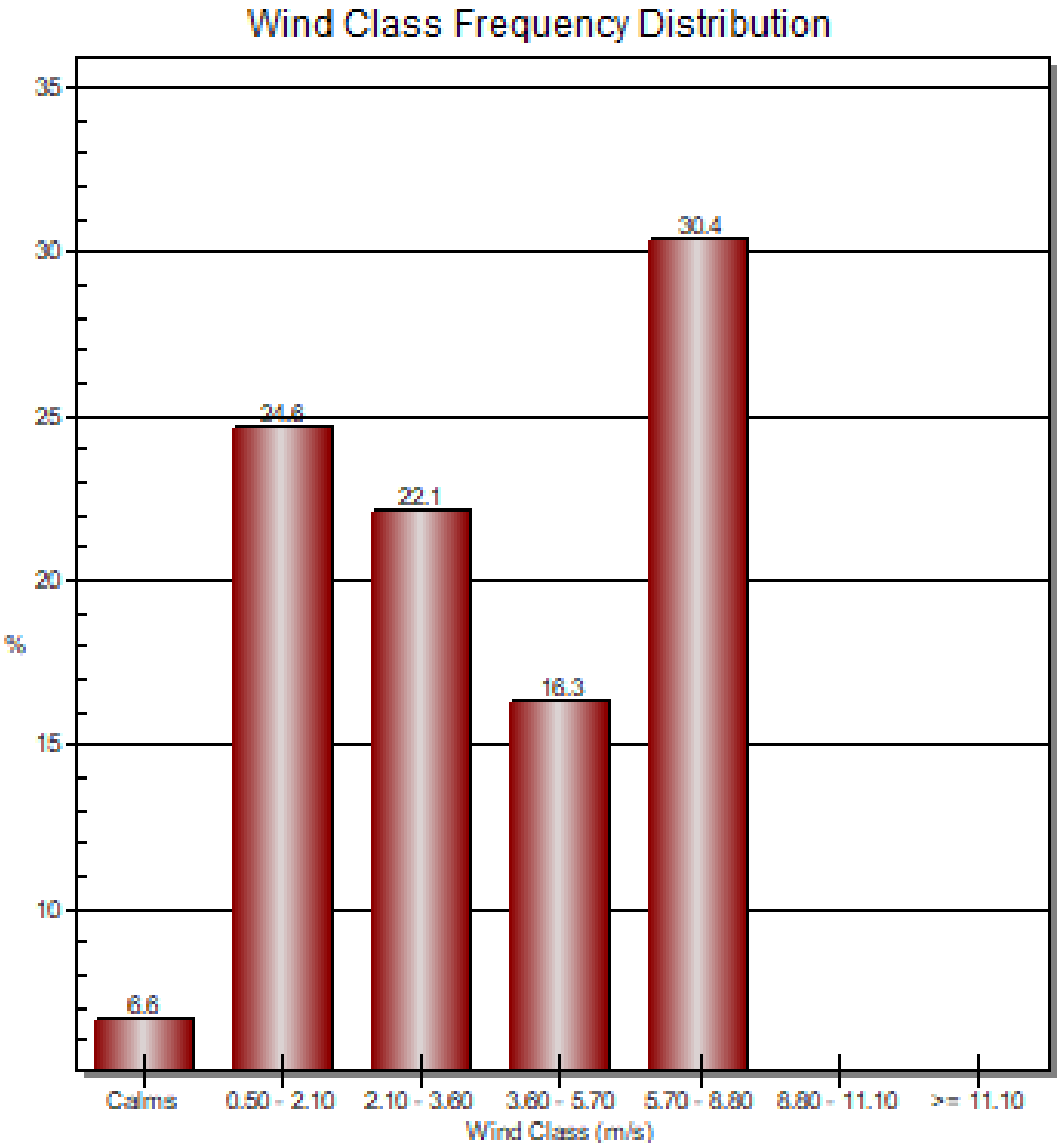


Figure 3-15: Wind Class Frequency Distribution: Replaced

3.4 Noise Environment

139. Seasonal variations are observed to have a considerable effect on the ambient noise levels. Long-period noise levels marginally increase during summer due to higher thermal variations, while increased atmospheric wind and pressure conditions during winter also raises the long-period noise levels. As population density in a region increases, diurnal variation in cultural noise levels becomes more prominent. Short-period cultural noise tends to be higher during day- time as opposed to night-time .

140. A preliminary reconnaissance survey was undertaken to identify the major noise generating sources along the project roads. The noise measurement at all 15 locations was carried out for 24 hours in the month of October and November 2022. Lutron Make Noise Level Meter instrument was used to ascertain noise status at monitoring sites along the project roads.

141. presents the ambient noise monitoring locations with chainage of locations on the project roads. The test report and photographic clips of sampling are provided in separate Annexure 4A.

Table 3-5: Ambient Noise Monitoring Locations

Sl. No.	Location Code	Location Name	Chainage	Latitude	Longitude	Distance from project road	Date of Monitoring	Remarks
1	N9_NQ1	N9	CH 0 +000	27°29'29.51"N	88°31'55.13"E	80 m	07.11.2022	North Sikkim Administration Centre
2	S1_NQ4	S1	CH 0 + 500	27°10'16.08"N	88°26'43.78"E	10 m	11.11.2022	Melli PHC
3	S1_NQ3	S1	CH 8 + 630	27° 8'21.86"N	88°26'12.33"E	20 m	12.11.2022	Settlement (Near Passi)
4	S1_NQ2	S1	CH 15 + 530	27° 7'45.90"N	88°26'48.28"E	10 m	13.11.2022	Govt. Senior Secondary School
5	S1_NQ1	S1	CH 22 + 460	27° 5'28.28"N	88°27'32.41"E	40 m	14.11.2022	Settlement (Near Evangelical Presbyterian Church of Sikkim, Suiram)
6	S6_NQ1	S6	CH 0 + 000	27° 9'23.78"N	88°19'32.29"E	60 m	27.10.2022	Assangthang Government Junior School
7	S6_NQ2	S6	CH 3 + 530	27° 8'57.08"N	88°19'8.70"E	0 m	28.10.2022	Govt Primary School Dhargaon
8	S6_NQ3	S6	CH 13 + 830	27° 8'53.75"N	88°18'1.70"E	55 m	29.10.2022	Centre for Computers and Communication Technology
9	E1_NQ2	E1	CH 0 + 560	27°11'43.57"N	88°37'48.62"E	10 m	08.11.2022	Settlement (Near Swiss Garnier)
10	E1_NQ1	E1	CH 7 + 930	27°12'21.77"N	88°41'9.33"E	40 m	09.11.2022	BDO Office
11	E4_NQ1	E4	CH 0 + 50	27°15'57.83"N	88°28'58.15"E	50 m	04.11.2022	Birkuna Junior High School
12	E4_NQ2	E4	CH 7 + 020	27°18'1.86"N	88°28'3.93"E	110 m	05.11.2022	Lingzey Junior School
13	E4_NQ3	E4	CH 18 + 700	27°21'15.24"N	88°29'46.40"E	10 m	06.11.2022	Samdong PHC
14	W10_NQ 1	W10	CH 0 + 000	27°17'18.46"N	88°15'28.44"E	80 m	01.11.2022	ATM Near Geyzing Market
15	W10_NQ 2	W10	CH 4 + 960	27°18'48.72"N	88°16'6.63"E	10 m	02.11.2022	Panchayat Bhawan near Unglok

Table 3-6: Primary Sampling and Monitoring

Location	Noise Quality	World Bank EHS Guidelines	
	Day Time [Leq dB (A)	Night Time [Leq dB (A)	**Residential Institutional and Educational** **Day time 55 dB(A): Night time 45 dB(A)**
N9	56.8	44.8	Daytime exceeds the guideline limit Nighttime is within the guideline limits
S1	55.1	44.4	Daytime - The baseline value exceeds the guideline limit Nighttime – the baseline values is within the guideline limits
	56.2	43.4	Daytime - The baseline value exceeds the guideline limit Nighttime – the baseline values is within the guideline limits
	53.9	41.1	Day and nighttime values are within guidelines limit
	52.3	42.2	Day and nighttime values are within guidelines limit
S6	53.8	42.3	Day and nighttime values are within guidelines limit
	51.8	40.6	Day and nighttime values are within guidelines limit
E1	53.1	43.1	Day and nighttime values are within guidelines limit
	54.2	43.1	Day and nighttime values are within guidelines limit
E4	52.8	41.5	Day and nighttime values are within guidelines limit
	53.6	42.1	Day and nighttime values are within guidelines limit
	50.9	40.6	Day and nighttime values are within guidelines limit
	54.1	43.7	Day and nighttime values are within guidelines limit
W10	60.8	45.1	Daytime - The baseline value exceeds the guideline limit Nighttime – the baseline values is within the guideline limits
	54.8	42.3	Day and nighttime values are within guidelines limit

Table 3-7: Ambient Noise Level for different Zone/Category Area as per CPCB

Area Code	Category of Area/Zone	Limits in dB(A) Leq	
		Day Time	Night Time
A	Industrial Area	75	70
B	Commercial Area	65	55
C	Residential Area	55	45
D	Silent Zone	50	40

142. Day and night-time Leq were compared with the stipulated noise standards. Day time Leq levels at Junctions are little high compared to stipulated standards due to unnecessary vehicles horn, traffic congestion. Night time Leq levels at all locations are within the stipulated limit. Noise monitoring location maps given in the Annexure 4.

3.5 Water Environment

143. The state of Sikkim is characterized with enormous water resources available in the form of lakes, snow-fed rivers and streams, some with marshy area. The major river basin of the state is Upper Teesta, Lechung Chhu, Tolung Chhu, Central Teesta, Upper Rangeet, Lower Teesta, Ronge Chhu, Rangpo Chhu and Lower Rangeet. The project roads of feasibility study are majorly falling under Teesta and Rangeet river basin. The State has two major rivers, Teesta and Rangeet, with a total length of 498 km. Besides river network, the state has 13 lakes, 9 hot springs and glaciers. Rainfall remains the principal mode of recharge of surface water. Due to mountainous slopes, most of the precipitation causes surface run-off resulting in streams, springs and kholas.

144. The Teesta is a perennial and major river system in the state with substantial flows even in lean season. Teesta River originates as Chhombo Chhu from a glacial lake Khangchung Chho at an elevation of 5,280m in the northeastern corner of the state. The river flows generally in North South direction bisecting the State of Sikkim. It is the single major river in the State draining 95 % of the total area of the State. The major tributaries of Teesta River are Lachung Chhu, Chakung Chhu, Dik Chhu, Rani Khola, Zemu Chhu, Rangyong Chhu, Rangeet River are major tributaries of river Teesta.

145. Drainage: The project roads of DPR study are majorly falling under Teesta and Rangeet river basin. The State has two major rivers, Teesta and Rangeet, with a total length of 498 km. Besides river network, the state has 13 lakes, 9 hot springs and numerous glaciers. Rainfall remains the principal mode of recharge of surface water. The Teesta is a perennial and major river system in the state with substantial flows even in lean season.

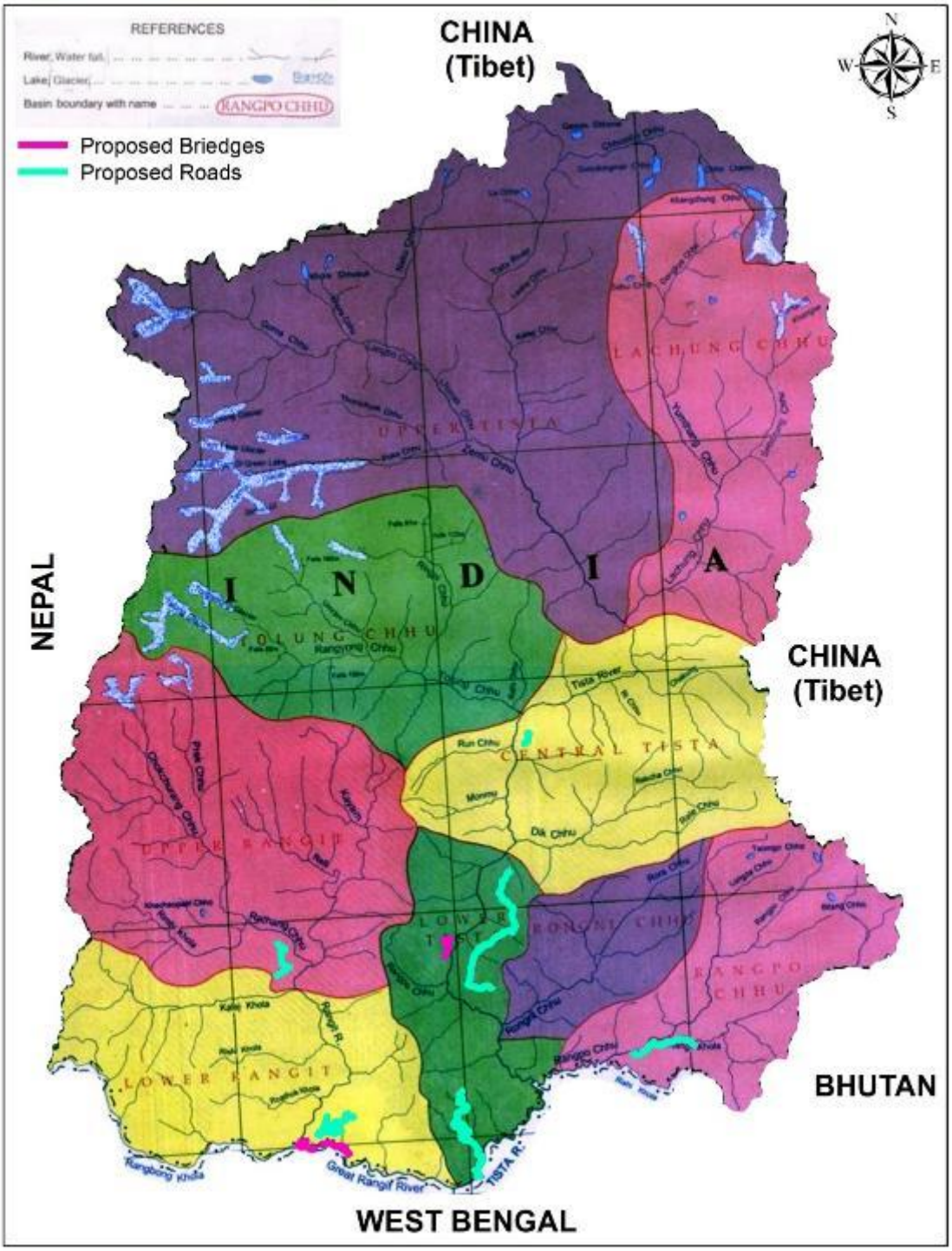


Figure 3-16: River Basins in Sikkim

146. Teesta river originates as Chhombo Chhu from a glacial lake Khangchung Chho at an elevation of 5,280m in the northeastern corner of the state. The river flows generally in North South direction bisecting the State of Sikkim. It is the single major river in the State draining 95 % of the total area of the State. Lachung Chhu, Chakung Chhu, Dik Chhu, Rani Khola, Zemu Chhu, Rangyong Chhu, Rangeet River are major tributaries of river Teesta.

147. The water quality in Sikkim varies from excellent to highly poor depending upon the seasons. A study on water quality Index of Eastern region of Sikkim revealed that the present status of water quality is not suitable for drinking purpose, and therefore water should be treated properly before use. The study was conducted by Shubra Punia et al and mean values of WQI for different sample sites at different seasons i.e., winter, summer and monsoon are 55.17± 9.98, 66.7± 10.34, and 68.29± 11.5 respectively, which indicates the poor quality of water.

148. SPCB Sikkim has been implementing the National Water Quality Monitoring Programme (NWMP) to regularly monitor the water quality in a systematic manner to know the nature and extent of water quality degradations and the existing quality of water in the water bodies. The SPCB Sikkim collects water samples from River Teesta and its tributaries from 14 identified sites. The average Water quality of tributary streams of Teesta is meeting the desired criteria for Conductivity, DO, and Ph. However, BOD level shows slightly higher than the stipulated CPCB standard of 2 mg/l or less. The month wise (July 2021- December 2021) average water quality parameters are presented in **Table 3-8**.

Table 3-8: Teesta River Water Quality (for July 2021 to December 2021) in the project region

Month	pH	Cond. µmhos/ cm	NO3-N mg/l	D.O mg/l	B.O.D mg/l	T. Coliform MPN/100ml	Faecal Coliform 100/ml
July	6.78	210.71	2.25	9.25	3.72	153.93	68.57
August	6.74	215.93	2.19	9.74	2.21	156.43	70.71
September	6.88	215.71	2.18	9.43	4.04	157.86	73.93
October	6.91	211.79	2.13	9.40	2.36	160.36	73.21
November	6.82	218.36	1.86	9.26	2.21	162.50	73.21
December	6.91	224.21	1.93	9.33	2.28	165.36	73.93

3.5.1 Ground Water of the Project Road

149. Most of the hill slopes are having more than 20% slope. Geologically the rock types are comprised mostly of Phyllite, Slates, Quartzite and granite gneiss and most of the rain water flows out as surface run off. In this type of terrain, the scope for ground water storage is limited to mostly in secondary porosity and structurally controlled at higher altitude aquifers. These aquifers are the main source of springs. Groundwater stored in the hill slopes emanates in the form of springs, which are being used as a source for water supply. Ground water development potential is limited due to presence of hard rocks having steep slopes.

150. Ground Water Quality: The chemical quality of ground water in the area indicates that ground water is fresh and fit for both drinking and irrigation purposes as concentration of chemical constituents are within the permissible limit as per BIS standard. The Specific Conductance varies from 36-85 µs/cm at 25˚C. In general, the ground water is of bi-carbonate type; i.e., bi-carbonate content varying from 12-110 mg/lit., the chloride contents varying from 7-14 mg/lit and that of calcium varying from 4034 mg/lit. Bacterial contamination is very common in the spring water especially in the hilly terrains and proper safeguards have to be taken before it put to use for human consumption.

151. To determine the ground and surface water quality in the study area, 13 ground water samples were collected in the month of November, 2022. Chainage wise locations are given in the following Table.

Table 3-9: Chainage-wise sample locations

#	Location Code	Location Name	Chainage	Latitude	Longitude	Distance from road	Date of Monitoring	Remarks
1	N9-GW1	N9	CH 0 +000	27°29'29.6"N	88°31'57.8"E	10 m	07.11.2022	North Sikkim Administration Centre
2	S1-GW3	S1	CH 0 + 500	27°10'13.86"N	88°26'41.74"E	10 m	11.11.2022	Melli PHC
3	S1-GW2	S1	CH 8 + 630	27° 7'29.52"N	88°26'38.96"E	100 m	13.11.2022	Settlement (Near Passi)
4	S1-GW1	S1	CH 22 + 460	27° 5'28.98"N	88°27'32.52"E	50m	14.11.2022	Settlement (Near Evangelical Presbyterian Church of Sikkim, Suiram)
5	S6_GW1	S6	CH 0 + 000	27°09'23.3"N	88°19'33.1"E	200 m	27.10.2022	Assangthang Government Junior School
6	S6_GW2	S6	CH 13 + 830	27°08'56.4"N	88°18'03.0"E	10 m	28.10.2022	Centre for Computers and Communication Technology
7	E1_GW1	E1	CH 0 + 560	27°11'43.6"N	88°37'48.3"E	40 m	08.11.2022	Settlement (Near Swiss Garnier)
8	E1_GW2	E1	CH 7 + 930	27°12'22.0"N	88°41'08.6"E	50 m	09.11.2022	BDO Office
9	E4_GW1	E4	CH 0 + 50	27°15'59.1"N	88°29'00.5"E	50 m	04.11.2022	Birkuna Junior High School
10	E4_GW2	E4	CH 7 + 020	27°17'59.9"N	88°28'04.5"E	150 m	05.11.2022	Lingzey Junior School
11	E4_GW3	E4	CH 18 + 700	27°21'15.0"N	88°29'46.9"E	100 m	06.11.2022	Samdong PHC
12	W10_GW1	W10	CH 0 + 000	27°17'20.2"N	88°15'29.8"E	50 m	01.11.2022	ATM Near Geyzing Market
13	W10_GW2	W10	CH 4 + 960	27°18'49.2"N	88°16'06.2"E	10 m	02.11.2022	Panchayat Bhawan near Unglok

152. Samples were collected in polyethylene carboys for chemical analysis. Samples collected for metal content were acidified with 1 ml of HNO3. Selected physic-chemical characteristics have been analysed for projecting the existing water quality status in the study area. Parameters like temperature, Dissolved Oxygen (DO), and pH were analysed at the time of sample collection. The samples were collected and analysed as per the procedures specified in "Standard Methods for the Examination of Water and Wastewater" published by American Public Health Association (APHA).

153. Around 43 parameters are taken for Monitoring. In that Chlramine, pesticides, Polychlorinated biphenyls, Polynuclear aromatic Hydrocarbon (PaH), Trihalomethanes are not detected in all the project corridors. Odour and taste are unobjectionable and agreeable. pH is below 8 in all corridors. Total Dissolved Solids is ranging from 65-130. (Acceptable limit 500 and Permissible is 2000 mg/L). Total Hardness (as CaCO3) is 45-90 (Acceptable limit 300 and Permissible is 600 mg/L). Chloride (as Cl), Sulphate (as SO4), Nitrate (as NO3), Fluoride (as F), Calcium (as Ca), Magnessium (as Mg), Sulphide (as S), Cyanide (CN), Phenol (as C6H5OH), Boron (as B), Copper (as Cu), Barium (as Ba), Iron (as Fe), Manganese (as Mn), Zinc (as Zn), Nickel (as Ni), Chromium (as Cr), Lead (as Pb), Cadmium (as Cd), Aluminum (as Al), Silver (as Ag), Molybdenum (as Mo), Selenium (as Se), Arsenic (as As), Mercury (as Hg), Ammonia (as NH3-N), Anionic detergents are all in acceptable limits. The details of remaining parameters whether they are acceptable or permissible according to Central Pollution Control Board (CPCB), GOI standards are given in the following table.

Table 3-10: Ground water monitoring result

Sl. No.	Parameter	Unit	Concentrations												IS: 10500:2012	
			GW_1	GW_2	GW_3	GW_4	GW_5	GW_6	GW_7	GW_8	GW_9	GW_10	GW_11	GW_12	GW_13	Desirable Limit	Permissible limit
1	Colour	Hazen Unit	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	5	15
2	Odour		Unobj.	Unobj.	Unobj.	Unobj.	Unobj.	Unobj.	Unobj.	Unobj.	Unobj.	Unobj.	Unobj.	Unobj.	Unobj.	Agreeable	Agreeable
3	Taste		Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable
4	Turbidity	NTU	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1	5
5	pH		7.25	7.32	7.17	7.17	6.91	7.12	7.25	7.38	6.93	7.06	7.16	6.32	7.14	6.5 – 8.5	No relaxation
6	Conductivity	µmhos/cm	164	118	206	148	193	220	157	178	108	162	124	195	130	-	-
7	Free residual chlorine	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.2	1
8	Total Dissolved Solids	mg/L	97	68	120	87	120	129	92	104	64	98	76	120	75	500	2000
9	Mineral oil	mg/L	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.5	No relaxation
10	Total Hardness (as CaCO3)	mg/L	78	52	90	68	92	104	62	70	48	74	56	66	60	200	600
11	Total Alkalinity (as CaCO3)	mg/L	22	24	30	32	38	16	28	40	12	26	18	10	16	200	600
12	Chloride (as Cl)	mg/L	36	22	47	30	46	67	32	32	26	36	29	66	31	250	1000
13	Sulphate (as SO4)	mg/L	11	7	10	6	7	5	9	8	7	9	6	<4	7	200	400
14	Nitrate (as NO3)	mg/L	1.2	0.6	0.9	0.5	1.2	0.6	0.9	0.7	0.5	0.6	0.3	0.8	0.5	45	No relaxation
15	Fluoride (as F)	mg/L	0.13	0.11	0.15	0.12	0.13	0.19	0.15	0.12	0.15	0.11	0.14	0.18	0.15	1	1.5
16	Calcium (as Ca)	mg/L	26	15	28	23	29	30	19	23	15	21	18	19	17	75	200
17	Magnessium (as Mg)	mg/L	3	4	5	3	5	7	4	3	3	5	3	5	4	30	100
18	Sulphide (as S)	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.05	No relaxation
19	Cyanide (CN)	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.05	No relaxation
20	Phenol (as C6H5OH)	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	No relaxation
21	Boron (as B)	mg/L	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.5	2.4
22	Copper (as Cu)	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.05	1.5
23	Barium (as Ba)	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.7	No relaxation
24	Iron (as Fe)	mg/L	0.12	0.15	0.19	0.1	0.12	0.1	0.09	0.13	<0.05	<0.05	<0.05	0.1	0.11	1	No relaxation
25	Manganese (as Mn)	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.1	0.3
26	Zinc (as Zn)	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	5	15
27	Nickel (as Ni)	mg/L	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.02	No relaxation
28	Chromium (as Cr)	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.05	No relaxation
29	Lead (as Pb)	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	No relaxation
30	Cadmium (as Cd)	mg/L	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	0.003	No relaxation
31	Aluminum (as Al)	mg/L	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	0.03	0.2
32	Silver (as Ag)	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.1	No relaxation
33	Molybdenum (as Mo)	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.07	No relaxation
34	Selenium (as Se)	ppb	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	10	No relaxation
35	Arsenic (as As)	ppb	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	10	No relaxation
36	Mercury (as Hg)	ppb	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1	No relaxation
37	Ammonia (as NH3-N)	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.5	No relaxation
38	Anionic detergents	mg/L	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	0.2	1
39	Chloramine	mg/L	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	4	No relaxation
40	Pesticides	mg/L	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	*	*
41	Polychlorinated biphenyls	mg/L	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	0.0005	No relaxation
42	Polynuclear aromatic Hydrocarbon (PaH)	mg/L	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	0.0001	No relaxation
43	Trihalomethanes	mg/L	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	**	**

N.B.- Unobj : Unobjectionable, N.D.- Not Detected

Table 3-11: GoI Standards and Acceptable limits

Corridor No.	CPCB (GoI Limits)		Remarks
	Acceptable (A)	Permissible (P)	
N9	√	√	All are within Acceptable limits
S1 (3 Samples)	√	√	All are within Acceptable limits
S6 (2 Samples)	√	√	All are within Acceptable limits
E1 (2 Samples)	√	√	All are within Acceptable limits
E4 (2 Samples)	√	√	All are within Acceptable limits.
W10 (2 Samples)	√	√	All are within Acceptable limits.

3.5.2 Surface Water

154. To determine the surface water quality in the study area, 20 surface samples were collected in November 2022. Along the Project area there are perennial river/streams located. During sampling period water is available in all the streams. The details of the surface water sampling locations are provided in **Error! Reference source not found.** and the surface water monitoring result are presented in **Error! Reference source not found.**. The test report and photographic clips of sampling are provided in Separate Annexure 4A & 4B.

Table 3-12: The surface water sampling locations

Sl. No.	Location Code	Location Name	Sample No.	Chainage	Latitude	Longitude	Distance from road	Date of Monitoring	Remarks
1	N9_W1	N9	SW_1	CH 2 + 035.5 (850 mdisplacement from chainage mentioned	27°30'19.28"N	88°31'36.79"E	850 m	07.11.2022	Teesta River
2	S1_W1	S1	SW_4	Teesta River Near Melli PHC	27°05'28.3"N	88°27'34.6"E	70 m	12.11.2022	Teesta River
3	S1_W2	S1	SW_3	Stream at 1+600	27°05'47.2"N	88°27'13.1"E	20 m	13.11.2022	Teesta River
4	S1_W3	S1	SW_2	Rabhi Khola (Stream)	27°07'41.2"N	88°26'31.1"E	20 m	14.11.2022	Stream
5	S6_W1	S6	SW_5	CH 12 + 500 (1300 m displacement from chainage mentioned)	27°07'37.0"N	88°18'22.3"E	1300 m	29.10.2022	Rangeet River
6	S6_W2	S6	SW_6	CH 10 + 000 (1500 m displacement from chainage mentioned)	27°07'37.0"N	88°18'22.3"E	1500 m	29.10.2022	Rangeet River
7	E1_W1	E1	SW_8	CH 0 + 300	27°11'49.8"N	88°37'40.1"E	175 m	08.11.2022	Rangpo Chu (River)
8	E1_W2	E1	SW_7	CH 8 + 100	27°12'19.2"N	88°41'17.9"E	170 m	09.11.2022	Rangpo Chu (River)
9	E4_W1	E4	SW_12	CH 21 + 700 (1400 m displacement from chainage mentioned)	27°23'13.2"N	88°30'14.9"E	1400 m	03.11.2022	Teesta River Barrage (upstream)
10	E4_W2	E4	SW_9	CH 3 + 100 (2000 m displacement from chainage mentioned)	27°15'53.0"N	88°26'19.9"E	2000 m	04.11.2022	Teesta River (downstream)

Sl. No.	Location Code	Location Name	Sample No.	Chainage	Latitude	Longitude	Distance from road	Date of Monitoring	Remarks
11	E4_W3	E4	SW_11	CH 12 + 800	27°18'59.5"N	88°30'28.6"E	20 m	05.11.2022	Stream Over Road
12	E4_W4	E4	SW_10	CH 4 + 530	27°16'49.9"N	88°27'42.7"E	20 m	06.11.2022	Stream Over Road
13	W10_W1	W10	SW_13	CH 4 + 900 (1000 m displacement from chainage mentioned)	27°18'40.7"N	88°16'45.1"E	1000 m	02.11.2022	Tashiding HEP
14	W10_W2	W10	SW_14	CH 0 + 900 (1600 m displacement from chainage mentioned)	27°16'51.8"N	88°16'35.6"E	1600 m	02.11.2022	Rangeet River
15	Br04_W1	Br04	SW_15	Upstream	27°18'37.3"N	88°26'08.4"E	20	03.11.2022	Bhaley Khola Sirsiray - Kalung Dara
16	Br04_W2	Br04	SW_16	Downstream	27°18'37.1"N	88°26'10.1"E	20	03.11.2022	
17	Br06_W1	Br06	SW_17	Upstream	27°07'41.3"N	88°16'20.9"E	20	30.10.2022	Ramam River along Nayabazar Singla Road Km 0.0 to 1.0 Ch. 22
18	Br06_W2	Br06	SW_18	Downstream	27°07'41.9"N	88°16'22.2"E	20	30.10.2022	
19	Br08_W1	Br08	SW_19	Upstream	27°07'37.3"N	88°18'46.4"E	20	29.10.2022	Bridge over Andheri Kholcha along Manpur Fatak to Jorethang Road.
20	Br08_W2	Br08	SW_20	Downstream	27°07'35.9"N	88°18'46.3"E	20	29.10.2022	

Table 3-13: Surface water sample test report

Sl. No.	Parameter	Unit	Concentrations																			IS: 10500:2012	
			SW_1	SW_2	SW_3	SW_4	SW_5	SW_6	SW_7	SW_8	SW_9	SW_10	SW_11	SW_12	SW_13	SW_14	SW_15	SW_16	SW_17	SW_18	SW_19	SW_20	Desirable Limit	Permissible limit
1	Colour	Hazen Unit	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	5	15
2	Odour		Unobj.	Unobj.	Unobj.	Unobj.	Unobj.	Unobj.	Unobj.	Unobj.	Unobj.	Unobj.	Unobj.	Unobj.	Unobj.	Unobj.	Unobj.	Unobj.	Unobj.	Unobj.	Unobj.	Unobj.	Agreeable	Agreeable
3	Taste		Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable
4	Turbidity	NTU	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1	5
5	pH		6.81	6.68	6.76	7.12	7.24	7.18	6.72	6.68	7.12	7.12	6.88	7.29	7.41	6.91	7.11	7.12	6.84	7.26	6.78	7.85	6.5 – 8.5	No relaxation
6	Conductivity	µmhos/cm	118	221	162	122	147	138	145	112	242	165	136	204	279	226	192	163	198	221	237	244	-	-
7	Free residual chlorine	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.2	1
8	Total Dissolved Solids	mg/L	70	129	96	74	89	86	86	68	143	96	80	116	164	133	113	95	117	130	142	146	500	2000
9	Mineral oil	mg/L	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.5	No relaxation
10	Total Hardness (as CaCO3)	mg/L	52	68	52	40	65	62	58	52	90	74	62	84	92	78	72	64	72	84	102	106	200	600
11	Total Alkalinity (as CaCO3)	mg/L	26	30	16	12	20	25	28	18	56	24	22	34	42	36	32	28	24	36	14	18	200	600
12	Chloride (as Cl)	mg/L	23	48	42	37	39	33	27	26	42	37	29	41	56	47	37	32	45	51	74	75	250	1000
13	Sulphate (as SO4)	mg/L	6	9	7	<4	5	7	9	4	13	9	8	12	17	11	13	9	12	10	7	7	200	400
14	Nitrate (as NO3)	mg/L	0.5	0.8	0.5	0.4	0.7	0.5	0.8	0.5	0.8	0.5	0.6	0.9	0.8	0.7	0.4	0.6	0.8	0.5	0.6	0.8	45	No relaxation
15	Fluoride (as F)	mg/L	0.1	0.16	0.16	0.14	0.16	0.12	0.14	0.21	0.21	0.15	0.13	0.21	0.32	0.27	0.19	0.15	0.15	0.21	0.25	0.22	1	1.5
16	Calcium (as Ca)	mg/L	16	18	15	13	21	19	17	15	29	22	20	26	27	24	24	20	23	26	28	31	75	200
17	Magnessium (as Mg)	mg/L	3	6	4	2	3	4	4	4	4	5	3	5	6	4	3	3	4	5	8	7	30	100
18	Sulphide (as S)	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.05	No relaxation
19	Cyanide (CN)	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.05	No relaxation
20	Phenol (as C6H5OH)	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	No relaxation
21	Boron (as B)	mg/L	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.5	2.4
22	Copper (as Cu)	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.05	1.5
23	Barium (as Ba)	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.7	No relaxation
24	Iron (as Fe)	mg/L	<0.05	<0.05	0.1	0.08	0.09	0.1	<0.05	<0.05	0.1	<0.05	<0.05	<0.05	0.12	0.1	<0.05	<0.05	0.12	0.09	0.14	0.12	1	No relaxation
25	Manganese (as Mn)	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.1	0.3
26	Zinc (as Zn)	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	5	15
27	Nickel (as Ni)	mg/L	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.02	No relaxation
28	Chromium (as Cr)	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.05	No relaxation
29	Lead (as Pb)	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	No relaxation
30	Cadmium (as Cd)	mg/L	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	0.003	No relaxation
31	Aluminum (as Al)	mg/L	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	0.03	0.2
32	Silver (as Ag)	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.1	No relaxation
33	Molybdenum (as Mo)	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.07	No relaxation
34	Selenium (as Se)	ppb	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	10	No relaxation
35	Arsenic (as As)	ppb	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	10	No relaxation
36	Mercury (as Hg)	ppb	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1	No relaxation
37	Ammonia (as NH3-N)	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.5	No relaxation
38	Anionic detergents	mg/L	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	0.2	1
39	Chloramine	mg/L	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	4	No relaxation
40	Pesticides	mg/L	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	*	No relaxation
41	Polychlorinated biphenyls	mg/L	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	0.0005	No relaxation
42	Polynuclear aromatic Hydrocarbon (PaH)	mg/L	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	0.0001	No relaxation
43	Trihalomethanes	mg/L	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	**	**

155. Samples were collected in polyethylene carboys for chemical analysis. Samples collected for metal content were acidified with 1 ml of HNO3. Selected physic-chemical characteristics have been analysed for projecting the existing water quality status in the study area. Parameters like temperature, and pH were analysed at the time of sample collection. All the samples were having DO, BOD limit within permissible limit.

156. The samples were collected and analysed as per the procedures specified in "Standard Methods for the Examination of Water and Wastewater" published by American Public Health Association (APHA). Around 43 parameters are taken for Monitoring. In that Chloramine, pesticides, Polychlorinated biphenyls, Polynuclear aromatic Hydrocarbon (PaH), Trihalomethanes are not detected in all the project corridors. pH is below 8 in all corridors. Total Dissolved Solids is ranging from 70-116. (Acceptable limit 500 and Permissible is 2000 mg/L). Total Hardness (as CaCO3) is 52-90 (Acceptable limit 300 and Permissible is 600 mg/L). Total Alkalinity (as CaCO3) is 12-56 (Acceptable limit 200 and Permissible is 600 mg/L). Chloride (as Cl), Sulphate (as SO4), Nitrate (as NO3), Fluoride (as F), Calcium (as Ca), Magnessium (as Mg), Sulphide (as S), Cyanide (CN), Phenol (as C6H5OH), Boron (as B), Copper (as Cu), Barium (as Ba), Iron (as Fe), Manganese (as Mn), Zinc (as Zn), Nickel (as Ni), Chromium (as Cr), Lead (as Pb), Cadmium (as Cd), Aluminum (as Al), Silver (as Ag), Molybdenum (as Mo), Selenium (as Se), Arsenic (as As), Mercury (as Hg), Ammonia (as NH3-N), Anionic detergents are all in acceptable limits.

157. The details of remaining parameters whether they are acceptable or permissible according to Central Pollution Control Board (CPCB), GOI standards are given in the following **Table 3-14**.

Table 3-14: GoI Acceptable limits for surface water

Corridor No.	CPCB (GoI Limits)		Remarks
	Acceptable (A)	Permissible (P)	
N9	√	√	All are within acceptable limits
S1 (3 Samples)	√	√	All are within acceptable limits
S6 (2 Samples)	√	√	All are within acceptable limits
E1 (2 Samples)	√	√	All are within acceptable limits
E4 (2 Samples)	√	√	All are within acceptable limits.
W10 (2 Samples)	√	√	All are within acceptable limits.

3.5.3 Solid Waste Management

158. In Sikkim, waste management initiatives have been developed in many places, especially in tourism oriented areas. Three solid waste processing facilities have been observed in the state at Mangan (north Sikkim), Martam (East Sikkim) and Vegetable market under Gangtok Municipal Corporation. Other than this, generally waste is being dumped at low lying area, but single use plastic is found totally banned in the state which seems a good initiative from the state and district authority.

159. Project activities will mostly generate C&D waste and bituminous waste (hazardous) in nature during excavation, dismantling, grading and construction of the road. C&D waste will mostly be utilised completely in filling and resurfacing the road. Cut bituminous waste will also be filled in upgradation process.

160. Large quantities of solid waste will be generated at the site during the construction. Stored materials may also generate waste in form of oil spills form storage tanks, filling platforms and transfer tanks. The contractor is expected to manage the waste being generated as per respective solid waste management laws.

3.6 Biological Environment

161. India is one of the 17 megabiodiverse countries in the world. Of the 36 recognized biodiversity hotspots across the globe, four belong to India: Western Ghats and Sri Lanka, Himalaya, Indo-Burma and Sundaland.

162. Sikkim falls in the Himalaya Biodiversity Hotspot. The state is endowed with rich floral and faunal diversity. Forest is one of the richest natural resources of Sikkim. The total forest and tree cover of the State as per the latest India State of Forest (2019) is 3378.49 sq. km. (47.61% of the total geographical area of the state). Major forest type of the region ranges from tropical Dry Deciduous Forests with Sal and its associates in the valleys of Teesta and Rangeet to the Alpine Scrub and grasslands in high altitude.

Sikkim State Symbols

Red Panda
Ailurus fulgens
State Animal

Blood Pheasant
Ithaginis cruentus
State Bird

Nobile Orchid
Dendrobium nobile
State Flower

Rhododendron
Rhododendron niveum
State Tree

Common Mahseer (Katley)
Neolissochilus hexagonolepis
State Fish

Blue Duke
Bassarona durga
State Butterfly

Ecoregions and Biomes

163. The primary ecoregions and their corresponding biomes are:

- Terai-Duar savanna and grasslands of the tropical and subtropical grasslands, savannas, and shrublands biome,
- Eastern Himalayan broadleaf forests of the tropical and subtropical moist broadleaf forests biome,
- Himalayan subtropical pine forests of the tropical and subtropical coniferous forests biome,
- Eastern Himalayan subalpine conifer forests of the temperate coniferous forest's biome, and
- Eastern Himalayan alpine shrub and meadows of the montane grasslands and shrublands biome.

3.6.1 Protected Areas and Reserved Forests

164. The state's protected area network is comprised of seven wildlife sanctuaries and one national park. The largest of these is the Khanchendzonga National Park, which encompasses an area covering 1,784 sq. km. It is bounded in the north by the Tent Peak and the ridge of the Zemu glacier. The Khangchendzonga National Park is the only National Park in Sikkim which occupies 25.14 % of total geographical area of Sikkim *viz*. 78.30 % in North District, 18.32 % in West and 3.38 % South Districts. It is also a mixed World Heritage Site (under natural and cultural criteria). In addition, Sikkim has seven Wildlife Sanctuaries namely Pangolakha Wildlife Sanctuary, Fambong Lho Wildlife Sanctuary, Kyongnosla Alpine Sanctuary, Maenam Wildlife Sanctuary, Barsey Rhododendron Sanctuary and Shingba Rhododendron Sanctuary, and Kitam Wildlife Sanctuary.

165. All of these along with the Reserved Forests together constitute 47.69% of the total geographical area under forest and tree cover. Majority of protected areas have also notified their eco sensitive zones. ~~Recognizing the importance of this region as one of the four biodiversity hotspots in India, majority of the biodiversity rich areas of the state have been placed inside the protected area network system as national park and sanctuary.~~ The total area under the protected area network is 22.5 percent and that of under national parks is 19.6 percent. The details on the forest area, forest cover and area under protected areas is presented in the succeeding Table 5-19

166. There are 5 protected area that fall within 5 km periphery of the project roads. These protected areas have notified eco sensitive zones, which extend a maximum of 200m out from the protected area boundary.

Table 3-15::

Sl. No.	Name of Forest Area and Protected Area	Eco sensitive Zone/Boundary	Area in sq. km.	Co ordinates	
				Longitude	Latitude
A.	National Parks				
1	Khangchendzonga National Park	Notification# S. O. 2166 dated 27th August 2014 (Notifies an area up to 200 meters around the boundary of the Khangchendzonga National Park as the Eco-sensitive Zone)	1784	88º 03' to 88º 39'	27º 27' to 27º 53'
B.	Wildlife Sanctuaries				
1	Fambong lho Wildlife Sanctuary	Notification# S. O. 2171 dated 27th August 2014 (notifies an area up to 25 meters around the boundary of the Fambonglho Wildlife Sanctuary as the Eco-sensitive Zone)	51.76	88º 29' to 88º 35'	27º 10' to 27º 23'
2	Maenam Wildlife Sanctuary	Notification# S. O. 2170 dated 27th August 2014, (notifies an area up to 50 meters around the boundary of the Maenam Wildlife Sanctuary as the Eco-sensitive Zone.)	35.34	88º 21' to 88º 25'	27º 21' to 27º 25'
3	Kyongnosla Alpine Sanctuary	Notification# S. O. 2168 dated 27th August 2014 (notifies an area up to 200 meters around the boundary of the Kyongnosla Alpine Sanctuary as the Eco-sensitive Zone.)	31	88º 44' to 88º 45'	27º 22' to 27º 24'
4	Singba Rhododendron Sanctuary	Notification# S. O. 2169 dated 27th August 2014 (notifies an area up to 50 meters around the boundary of the Shingba Rhododendron Sanctuary as the Eco-sensitive Zone)	43	88º 43' to 88º 46'	27 43' to 27 48'
5	Barsey Rhododendron	Notification# S. O. 2172 dated 27th August 2014, (notifies an area up to 50 meters around the boundary of the Barsey Rhododendron Sanctuary as the Eco-sensitive Zone.)	104	88º 02' to 88 11'	27º 10' to 27 13'
6	Pangolakha Wildlife Sanctuary	Notification# S. O. 2173 dated 27th August 2014, (notifies an area up to 50 meters around the boundary of the Pangolakha Wildlife Sanctuary as the Eco-sensitive Zone.)	128	88º 35' to 88º 51'	27º 09' to 27º 22
7	Kitam Bird Sanctuary	Notification# S. O. 2167 dated 27th August 2014, notifies an area up to 25 meters around the boundary of the Kitam Bird Sanctuary as the Eco-sensitive Zone.	6	88º 20' to 88º 22'	27º 06' to 27º 07
C	Reserved Forest		5452.4		
D	Protected Forests		389		

Source: India State of Forest Report, 2021

167. Fauna: Faunal diversity includes more than 7,000 moths, 5,892 insects, 994 beetles, 689 butterflies, 568 birds, 144 mammals, 92 lizards/snakes, 50 amphibians, 48 fish, 40 bees, 33 reptiles and 16 frogs2. Many endangered mammal species in Sikkim are also present while, among bird species, 17 are threatened – including 1 Endangered, 3 Critically Endangered and 13 Vulnerable3.

Table 3-16: Faunal diversity

Sl. No.	Faunal Diversity	No. of species
1	Mammals	>144
2	Bees	30
3	Beetles	994
4	Birds	568
5	Butterflies	689
6	Moths	7000
7	Insects	5892

[2](http://sikenvis.nic.in/Database/ Biodiversity_776.aspx, accessed 14 March 2023).

[3] (http://sikkimforest.gov.in/Reports%20and%20Publications/Biodiveristy-ofSikkim/14%20Birds%20Bhoj_255-280%20web.pdf; accessed 14 March 2023).

Sl. No.	Faunal Diversity	No. of species
8	Fishes	48
9	Frogs	16
10	Lizards and Snakes	92
11	Reptiles	33
12	Amphibians	50
13	Mountain & Peaks	28

Information on the distribution of animal communities for the state is rather limited except for detailed observations on the birds by Salim Ali and on butterflies by Meena Haribal (Ali 1962; Haribal 1992). Attempts to collect ample information on the distribution of various faunal groups in the state (Lachungpa et al. 2003) have been made which have been incorporated in the State Biodiversity Strategy and Action Plan (SBSAP) of the state. Tambe (2007) conducted a detailed study on the ecology and management of alpine vegetation in Khangchendzonga National Park. A short study on the habitat uses and food selection by wild and domestic ungulates in Tso Lhamo plateau was conducted by Chanchani (2007).

Fauna alongside the projects immediate vicinity

168. Based on one year of systematic surveys, site visits, and consultations; using a range of industry standard field methods including camera trapping and eDNA surveys a number of species were identified. The details of all surveys and road/bridge specific detections has been presented in a CHA (Annexure 20). Importantly, Chinese pangolin (*Manis pentadactyla*), listed as Critically Endangered / Schedule I WPA were detected within the project immediate influence zones for E1, E4, S1, and BR4 based on camera trapping studies in 2024. Habitat mapping revealed the species likely occurs along other Project roads also.

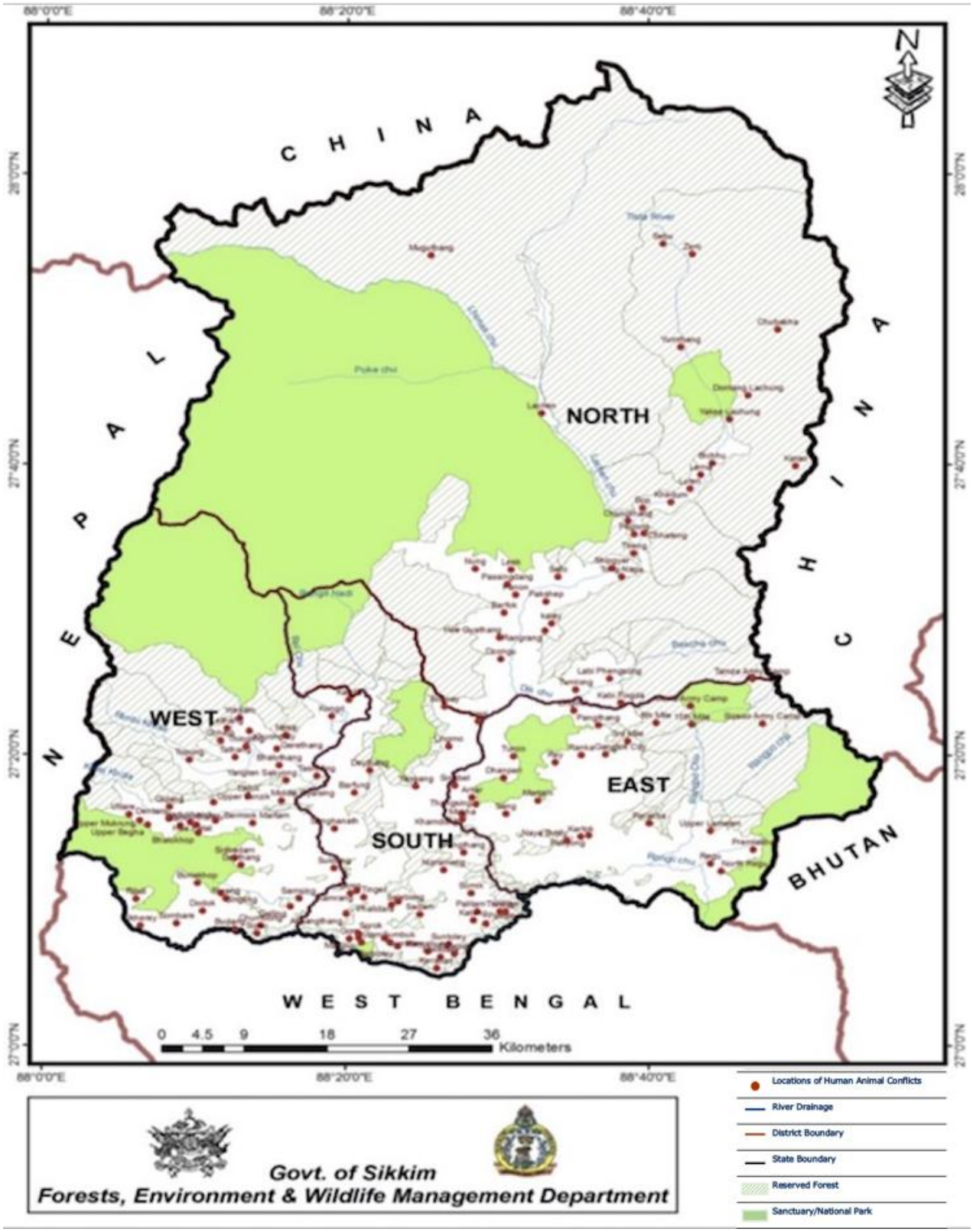
169. During field surveys, there were direct sightings of 16 other Schedule I WPA species and five mammal species listed as either Vulnerable or Near Threatened including: clouded leopard (*Neofelis nebulosa*) along E4, Himalayan Goral (Naemorhedus goral), Assamese macaque (*Macaca assamensis*), Marbled Cat (Pardofelis marmorata), Malayan giant squirrel (giant squirrel (*Ratufa bicolor*). Additionally, a range of reptile and amphibian species were detected including the Mountain cascade frog (Amolops monticola) listed as Endangered, Annandale's paa frog (Nanorana annandalii) NT, King Cobra (Ophiophagus Hannah) Vulnerable, Günther's Worm-Eating Snake (Trachischium guentheri) Vulnerable, and Walnut Kukri Snake (Oligodon juglandifer) Vulnerable. While none of the reptiles and amphibians triggered Critical Habitat criterion, the richness and diversity highlight the rich biodiversity present in Sikkims forests and streams. The Endangered Golden Mahseer (Tor putitora) was confirmed present in the Rangeet, Raman rivers and some tributaries along with other important fish species including snow trout, locally "Asala" (Schizothorax richardsonii) Vulnerable, both valued as a food source.

170. Other more common species were detected along the project roads including northern red muntjac (*Muntiacus vaginalis*), golden jackal (*Canis aureus*), wildpig (*Sus scrofa*), and common leopard (*Panthera pardus*) (Annex 20). Less common but still reported in the area are red panda (*Ailurus fulgens*) along E4 and Himalayan black bear (*Ursus thibetanus*). Significant instances related to human wildlife conflicts have been increasing particularly in respect of Himalayan black bear and Assamese macaque. Crop damage was observed along project roads by wild pigs and peafowl.

3.6.2 Human Wildlife Conflict in Sikkim

171. The state of Sikkim has a long-standing history of human-wildlife conflicts. Human–wildlife conflicts in Sikkim can be grouped into four categories: (1) attacks on humans, (2) livestock killing, (3) crop raiding and (4) wildlife straying in human dominated areas. There are a number of reasons for increasing conflicts, including the overlap of resource utilization by humans and animals. High altitudes have more incidences of yaks and cows killed by wild dogs, Himalayan black bears, and snow leopards.

172. The mid elevation areas suffer from incidences of cattle kill and crop damage by Himalayan Black Bear, wild pigs, and macaques. The lower elevation areas of the state suffer from attacks by wild pigs and birds like peacock. The number of Himalayan black bear attack increases before winter and in spring when they search for food out to the agricultural fields. In case of Himalayan black bear, crops like maize in the agricultural fields, has proven to be an attractant like in Lachung during month of August and September. A number of site specific, practical field-based solutions are being carried out like solar fencing in areas like Kitam WLS which will prevent wildlife from entering fields. The Forest Department also organizes frequent trainings on tranquilizing animals in Himalayan Zoological Park. A community-based insurance system which has been practiced in other Himalayan states has to be initiated in the state.



Source: Envis hub, Sikkim.

Figure 3-17: Human-wildlife conflict locations in Sikkim

3.6.3 Forest Types

173. The state is divided into three vegetation zones: tropical, temperate and alpine. The favourable rainfall, temperature and high humidity existing in the area have caused the vegetation to acquire the general characteristics of the northern tropical semi-evergreen forest. The territorial area under region extends from the forest hills of Eastern Himalayas (Bhutan hills) to the flood plain area of Brahmaputra valley. Because of diversified configuration pattern of the ground and varied rainfall pattern throughout the region, different types of forest associations are found. The project corridors S1, W10, E1, E4 fall under Eastern Himalayan broadleaf forests of the tropical and subtropical moist broadleaf forests biomes while N9 corridors fall under Eastern Himalayan wet temperate forest.

174. Based on the classification pattern envisaged by Champion and Seth (Revised Survey of Forests types of India), the different type of forests occurring in the region are indicated in the succeeding.

Table 3-17: Forest types in Sikkim

Sl. No.	Forest Types	Classification Codes
1	Eastern Sub- Mountain Semi-Evergreen Forest	2B/C1b
2	Sub-Himalayan light alluvial Semi-Evergreen Forest	2B/1S1
3	Eastern Alluvial secondary Semi-Evergreen Forest	2B/2S2
4	Sub-Himalayan secondary wet mixed Forest	2B/2S3
5	Moist Sal Savannah Forest	3C/DS1
6	East Himalayan moist mixed deciduous Forest 3C/CS3b	3C/CS3b
7	Low alluvial Savannah wood land	3/1S1
8	Eastern Hillock Forest (*Terminalia- Lagerstroemia*)	3/1S2(a)
9	Eastern Hillock Forest (*Terminalia Duabanga*)	3/1S2(b)
10	Eastern wet alluvial grass land	4D/1S2(b)
11	Khair Sissoo Forest	5/1S2

Source: India State of Forest Report, 2021.

175. The very moist Sal bearing forests found at low elevations along S1, BR8, and BR6 are rare for Sikkim. This forest class makes up only 1.1% of the forest cover in Sikkim based on a 2009 forest classification map developed by the Dept. of Forests in Sikkim. The 3C/ C3b East Himalayan Moist Mixed Deciduous Forest type found along five Project roads (E1, S1, S6, BR4) makes up 4.1% of the forest cover in Sikkim. These low elevation forests found along the Project roads are under severe anthropogenic pressure and are being converted to urban, bare land, and agricultural land cover types which indicates the conversion of Natural forest areas to modified human use and infrastructure (Kanda and John 2018). Furthermore, these low elevation areas are not present within the network of Protected Areas, with only Kitam Bird Sanctuary being found at low elevation.

District-wise Forest Cover

176. The forest area is divided into three categories which vary from Very Dense Forest to Open Forest. The district-wise forest cover is given below. The project corridors are falling in Moderately dense to very dense forest region. This project involves rehabilitating and upgrading 6 existing roads and rebuilding 3 new bridges located across four districts of Sikkim.

Table 3-18: The district-wise forest cover

District	Geographical area	Very Dense Forest and Moderate dense Mod. Dense		Open Forest	Total	% of GA
North	4226	410.36	586.04	285.91	1282.31	30.34
East	954	271.67	313.00	128.60	713.27	74.77
South	750	173.35	289.49	108.98	571.82	76.24
West	1166	246.85	363.03	164.02	773.90	66.37

District	Geographical area	Very Dense Forest and Moderate dense Mod. Dense		Open Forest	Total	% of GA
Total	7096	1101.96	1552.31	688.22	3342.49	47.11

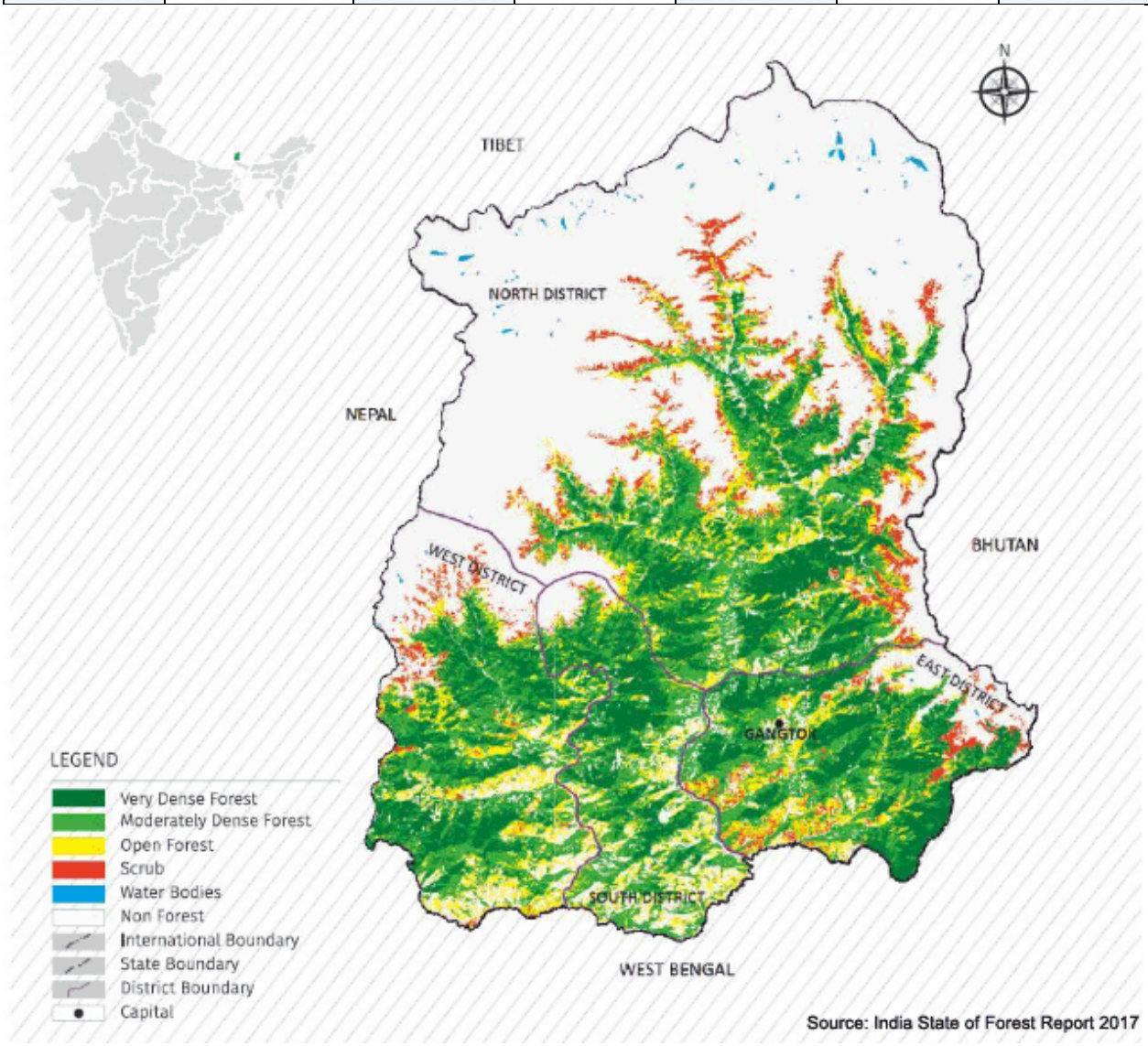


Figure 3-18: Forest Cover in Sikkim per India State of Forest Report

3.6.4 Forests in Project Corridors

177. The Project roads pass through portions of seven reserved forests including: Jhum, Melli, Payong, Pemayangtse, Ramaram, Salghari, and Suntaley. The list of roads and bridges with 5 km buffer zone and reserve forest proximity per GIS measurement and approximate shortest distances are presented in **Table 3-19**.

Table 3-19: Forest and Reserve Forest Proximity, Nearest Wildlife Sanctuary/National Park

Sl. No.	Name of Road	Reserve Forest Proximity *(Approx. Shortest Distance as per GIS measurement)*	Nearest Wildlife Sanctuary/ National Park *(Approx. Shortest Distance as per GIS measurement)*
1	N9 Mangan Bazaar to DAC	No RF	Kanchendzonga National Park (4.6 km)
2	S1 Melli - Phong via Rateypani	Melli RF Payong RF Sunatalay RF Ramam RF (CH 22+000 - CH 22+300). 8.9 km of the Project roads fall within the seven Reserve Forests, see Table 5-16 in LASA 2023.	Kitam Bird Sanctuary (7.7 km)
3	S6 Assangthang - Salghari to CCCT Nandugaon	No RF	Kitam Bird Sanctuary (3.6 km)
4	E1 Rorathang Rongli	No RF	Pangolakha W.S. (1 km)
5	E4 Khamdong-Lingzey- Tintek	No RF	Fambonglho Sanctuary (0.5 km);
6	W10 Geyzing to Sakyong	Pemayangtse RF	Barsey Rhodendron Sanctuary (5.7 km)
7	Br 04 Bhaley Khola Sirsiray - Kalung Dara	No RF	Maenam Sanctuary (3.0 km)
8	Br 06 Ramam River along Nayabazar Singla Road Km 0.0 to 1.0 Ch. 22	Jhum RF Salghari RF *RF areas are on approach roads* 2 kms of the approach road traverses through Reserved Forest	Kitam Bird Sanctuary (3.5 km)
9	Br 08 Bridge over Andheri Kholcha along Manpur Fatak to Jorethang Road	Bharikhola RF Manjhitar RF Salghari RF 3 kms of the approach road traverses through Reserved Forest.	Kitam Bird Sanctuary (2 km)

178. All six existing roads are within a generally forested landscape of natural to semi modified habitat. All but three projects have over 50% natural habitat along their length, with E1 being bordered by natural habitat along 96% of it's length. These roads, N9, BR4, and S6 have villages and agricultural lands classified as built area, range land and bare ground (Table 3-20).

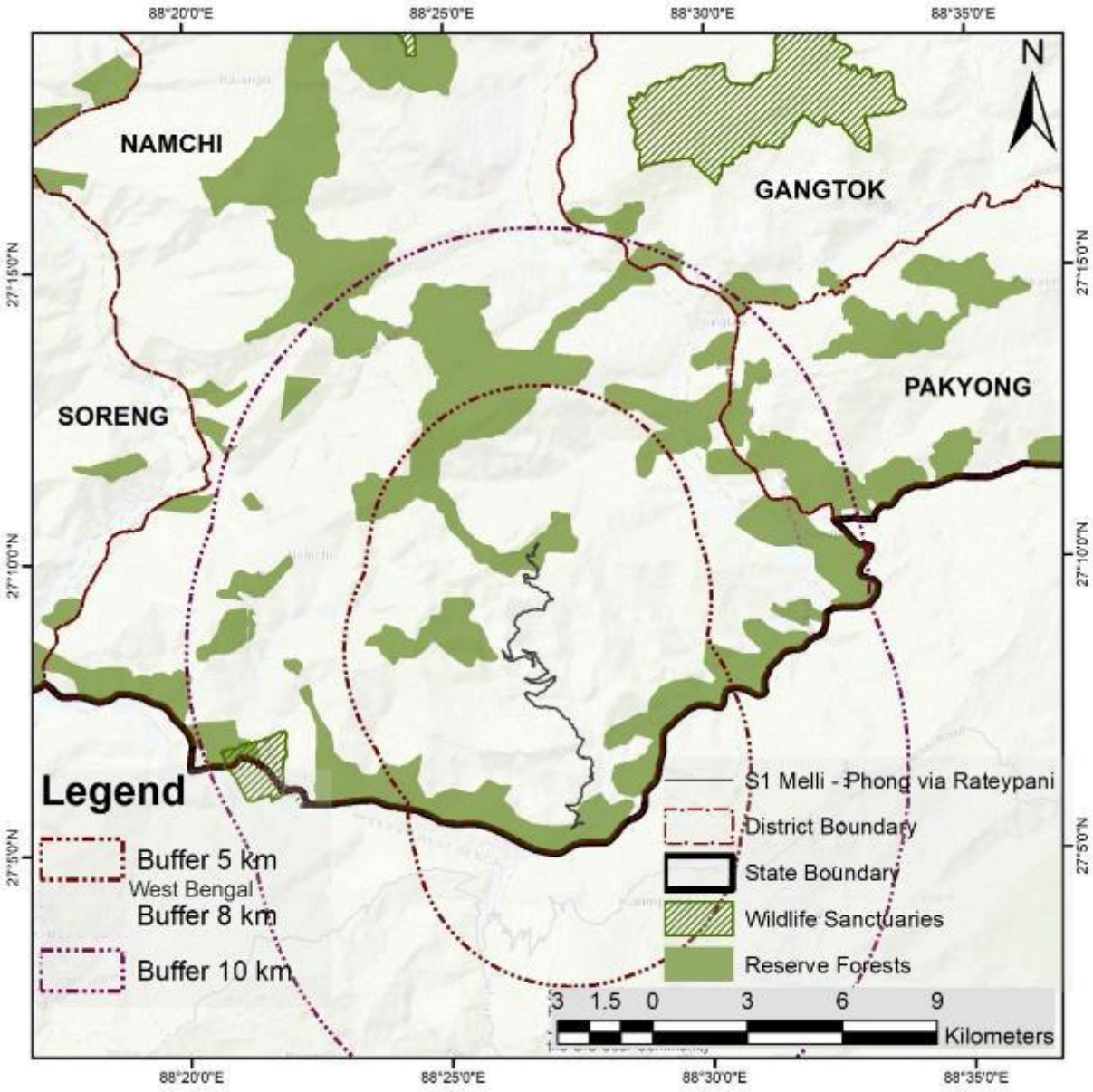
179. Three Project roads (S1, BR6, and BR8) are either fully or partially within the Lowland forests of South Sikkim Important Biodiversity Area (IBA). IBA are generally considered to function as Critical Habitat. Therefore, the areas of roads falling within the IBA were designated as Critical Habitat on a precautionary basis.

Table 3-20: Landcover within 10 M of each road reported in Hectares.

Natural (ha)			Modified (ha)						
Name	**Water**	**Trees**	**Bare Ground**	**Range land**	**Built Area**	**Total**	**% Modified**	**% Natural**	**Road length (km)**
N9	0	2.13	2.12	0	0.11	4.36	51.15	48.85	2.04
W10	0	9.18	3.44	0.74	0.29	13.65	32.75	67.25	6.12
BR8	0	7.03	0.28	1.75	0	9.06	22.41	77.59	4.23
BR4	0	4.27	0	4.97	0	9.24	53.79	46.21	4.38
S1	0	33.09	2.55	12.58	0.05	48.27	31.45	68.55	22.65
S6	0	8.28	3.24	18.8	1.14	31.46	73.68	26.32	14.80
BR6	0.13	6.68	1.35	0	0.5	8.66	21.36	78.64	4.05
E4	0	33.22	11.72	0.07	1.37	46.38	28.37	71.63	21.76
E1	0	18.22	0.76	0	0	18.98	4	96	8.89

S1 - MELLI - PHONG VIA RATEYPANI

180. The road is located in the Namchi district, formally known as south Sikkim district, of Sikkim. It connects Melli with Phong through Rateypani village. It starts at the junction going towards Phong on the left and Bhaniyang on the right. At Melli, it ends at the junction merging at SH-15. Between Melli and Phong the existing road runs for 22.65 km and passes through three Reserve Forests (hereafter addressed as RF) namely Melli RF, Payong RF and Suntaley RF from starting chainage and is in close vicinity (<2km) of Ramaram RF towards the end of chainage, respectively. The road also crosses one major and two minor streams, including a 120 m and two 25 m bridges over tributary streams. The nearest Protected area from the project road is Kitam Wildlife sanctuary located at 7 km from the road. Please refer Figure 3-19.

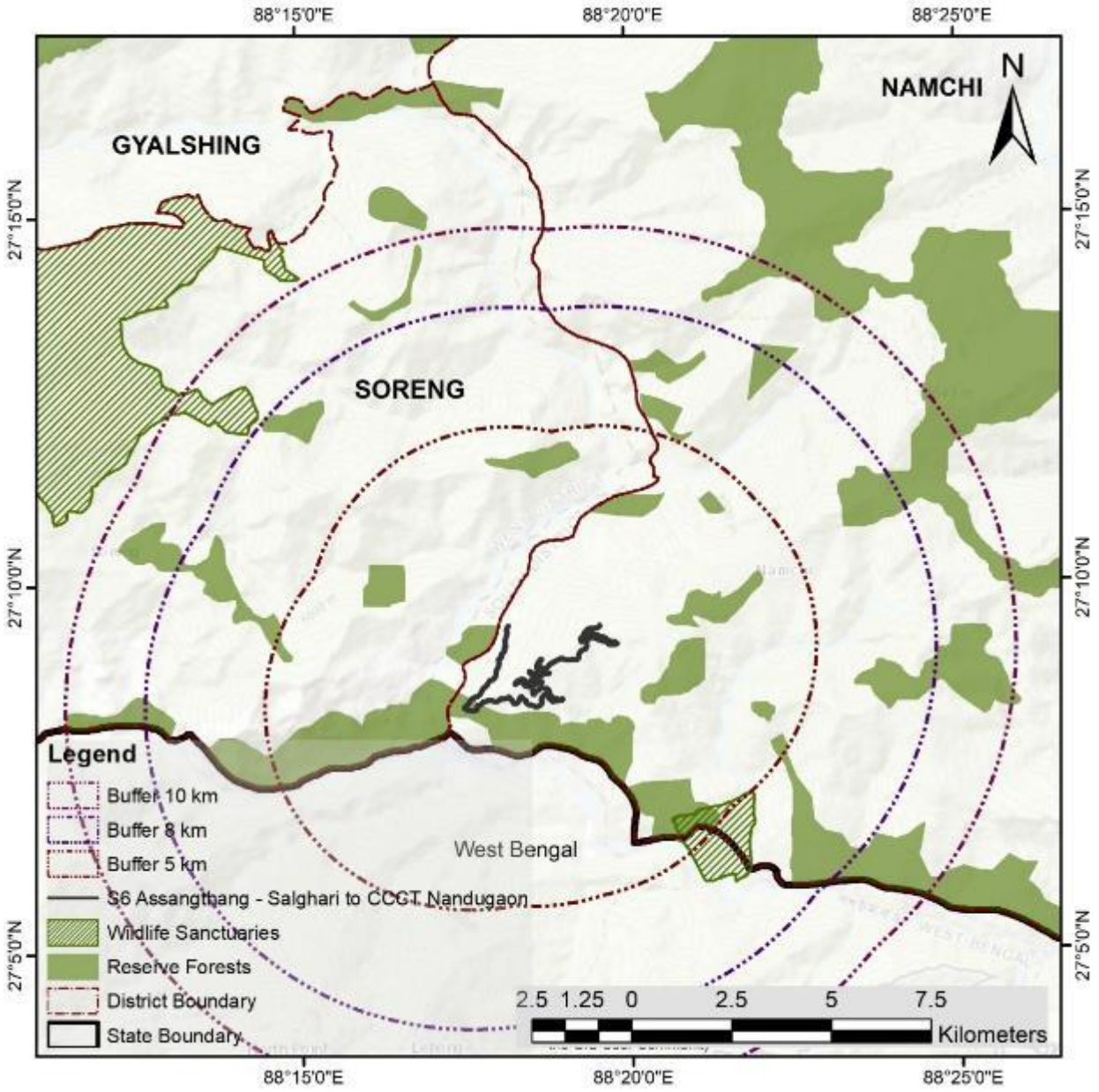


S6 - ASSANGTHANG - SALGHARI TO CCCT NANDUGAON

Figure 3-19: S1 road and Buffer of 5-10 km

181. The road is located in the south Sikkim district. It connects Namchi (Assangthang) with Nandugaon with the existing road running for 14.79 km. The project road is inhabited by human habitation and agricultural fields throughout its chainage with very few woodlands and private woodlots present along the roadside towards the end of the chainage. The project road passes the vicinity of two major RFs namely

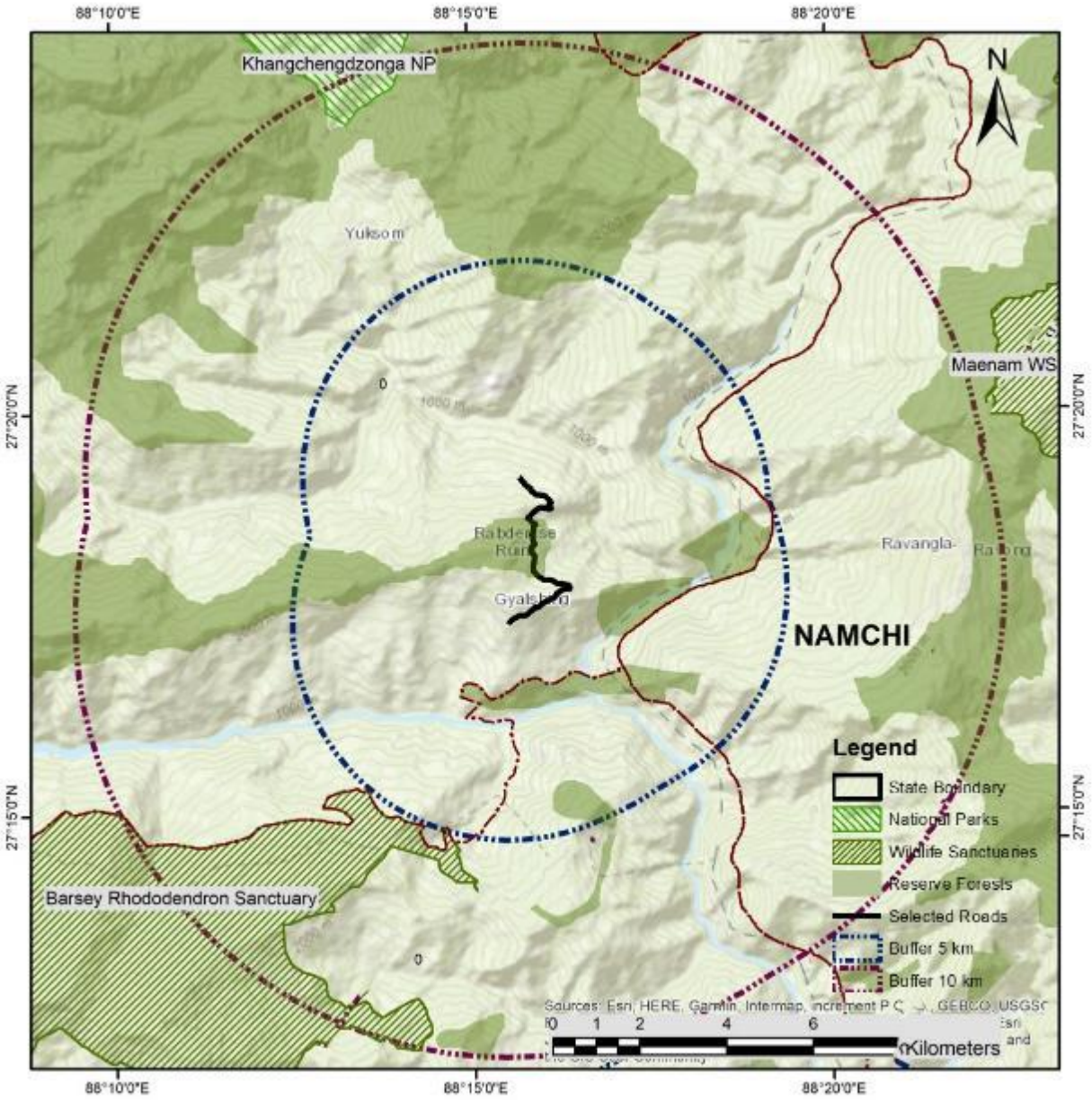
Namchi RF and Salgharhi RF with an aerial distance of less than 500 m from starting and mid-chainage, respectively. The nearest wildlife sanctuary is Kitam WLS located at 3.5 km from the project corridors.



W10 – GYALSHING TO SAKYONG

Figure 3-20: S6 road and Buffer of 5-10 km

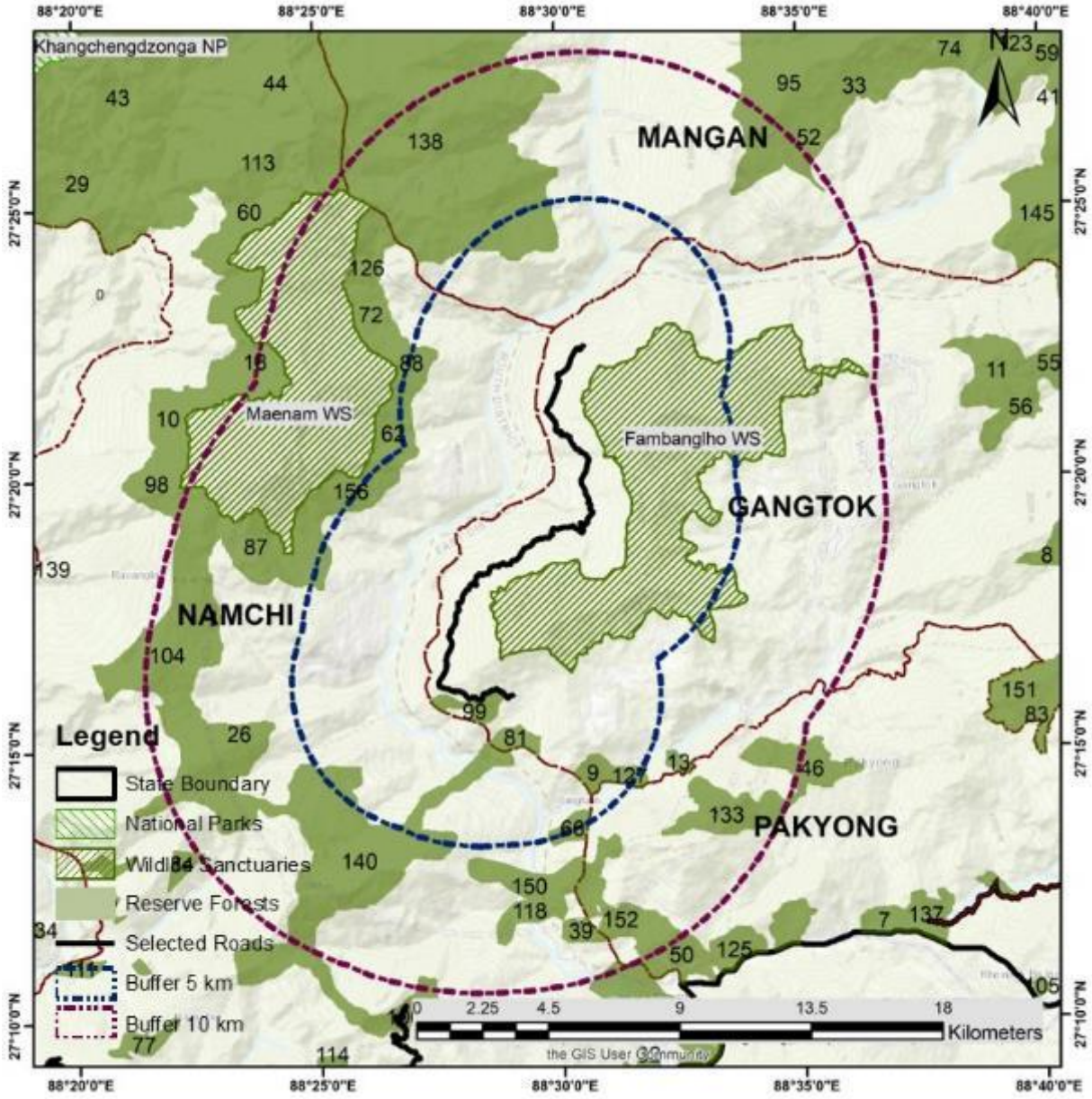
182. The road is located in the west Sikkim district. It connects Gaying with Sakyong with the existing road of 6.12 km. The project road is inhabited by human habitation through most of its chainage with many woodlands and forest patches present along the roadside or within 50 m distance from the roadside both upslope and downslope respectively. The project road passes the vicinity of three RFs namely Omchung RF on the downside and Pemayangtse and Sakyong RF on the upslope side from starting and mid-chainage, with an aerial distance of less than 300 m respectively. The nearest PA is Barsey Rhododendron WLS, located at 5.4 km from the project area.



E4 – KHAMDZONG - LINZEY - TINTEK

Figure 3-21: W10 road and Buffer of 5-10 km

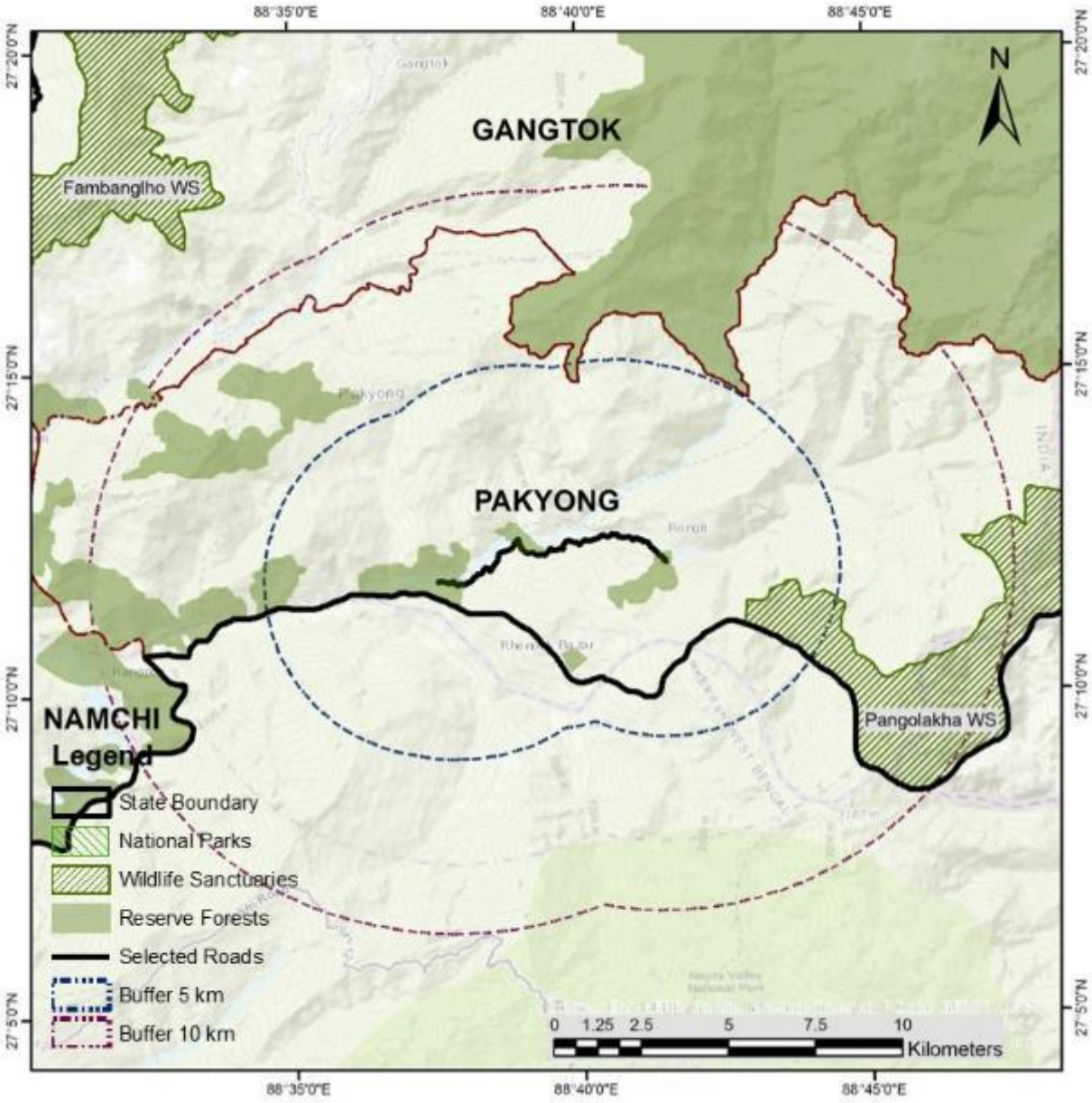
183. The road is located in the East Sikkim district and it connects Khamdzong to Tintek via Linzey. The existing road runs for 21.76 km and is inhabited by human habitation, agricultural fields and natural forest patches present alongside the road. Although the existing road does not pass through any existing PA in its entirety, three PA are within the close vicinity (less than 500 m) of the existing road namely Fambonglho wildlife sanctuary (hereafter referred to as WLS), Lingkhu RF and Ralap RF respectively while Maenam WLS is present withing aerial distance of the project road. The road also has about 10 minor bridges over many small tributary streams. The nearest PA is Fambanglo WLS, located at 400 m from the project area.



E1 – RORATHANG TO RONGLI

Figure 3-22: E4 road and Buffer of 5-10 km

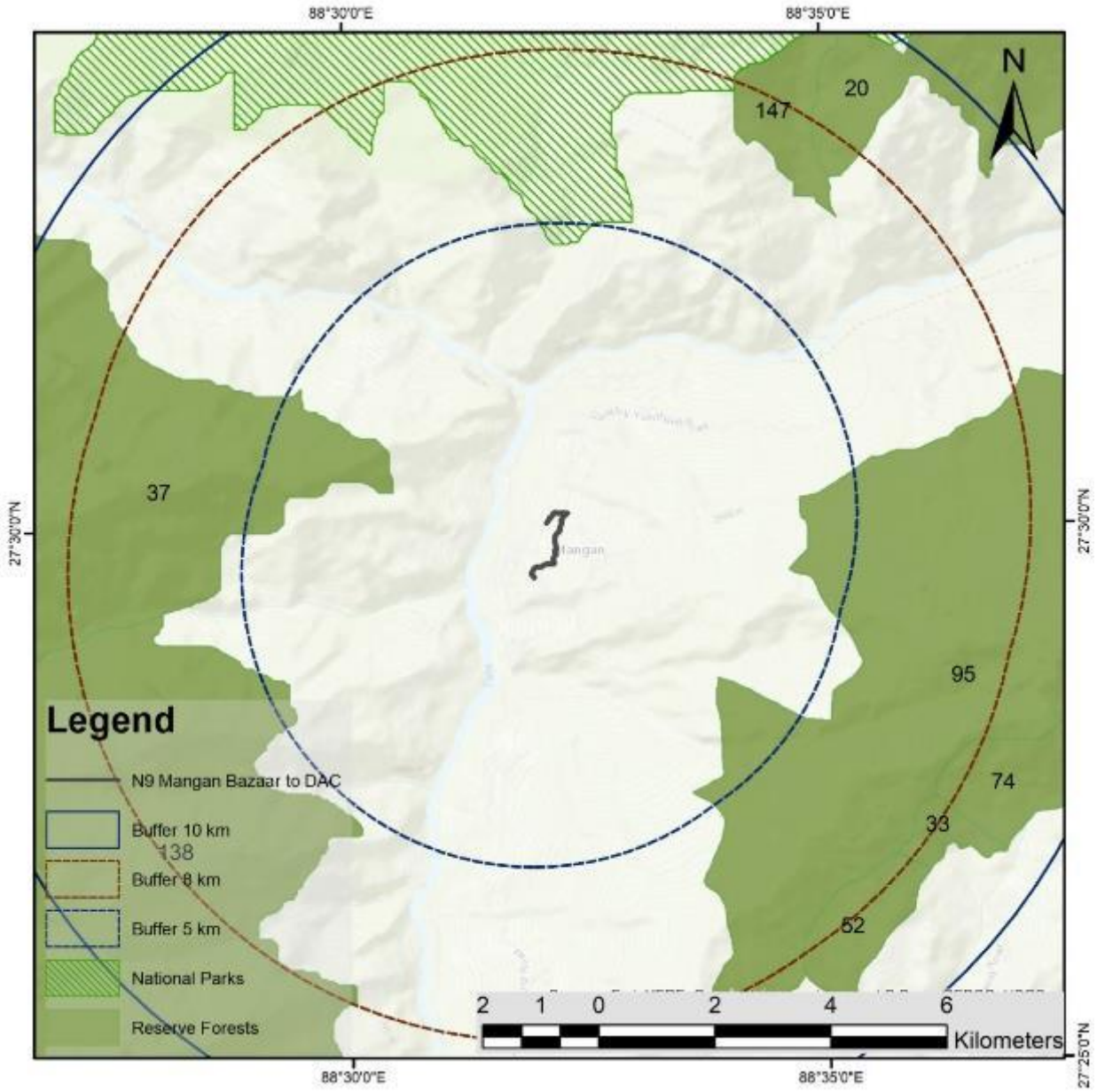
184. The road is located in the east Sikkim district and it connects Rorathang and Rongli. The existing road runs for 8.9 km. Natural Forest patches are present alongside the existing road in early chainage (from 00 to 850m) with very little human habitation present within the 50 m of the roadside and mid-chainage where a second natural forest patch is present (5700 to 7100m) with human habitation and agricultural fields dominating remaining road vicinity. The road also has about 3 minor bridges over small tributary streams. The nearest PA is Pangolakha WLS, located at 1.6 km from the project area.



N9 – MANGAN BAZAAR TO DAC

Figure 3-23: E1 road and Buffer of 5-10 km

185. The road is located in the north Sikkim district in Mangan city. The existing road is 2.1 km long and connects Mangan Bazaar to the DAC office. The entire road vicinity is inhabited by human settlements with no PA in the immediate vicinity. The nearest PA is Kanchendzonga National Park, located at 4.6 km from the project area.



BR 04 - BHALEY KHOLA SIRSIRAY - KALUNG DARA

Figure 3-24: N9 road and Buffer of 5-10 km

186. The BR 04 bridge is to be constructed over a running stream of Bhaley Khola between Sirsiray and Kalung Dare villages. The road leading to and away from the bridge is surrounded by moderately dense forest of East Himalayan Moist Mixed Deciduous Forest.

BR 06 - RAMAM RIVER ALONG NAYABAZAR SINGLA ROAD KM 0.0 TO 1.0 CH. 22

187. The bridge is present on Ramam river along Nayabazar Singla road. The bridge connects Sikkim and West Bengal. The road leading to and away from the bridge is surrounded by low hill Sal Forest in both Sikkim and West Bengal along with human habitation and agricultural lands on West Bengal side.

BR 08 - BRIDGE OVER ANDHERI KHOLCHA ALONG MANPUR FATAK TO JORETHANG ROAD

188. This bridge is to be constructed over Andheri Kholcha on highway connecting Manpur to Jorethang. The bridge lies some distance from Kitam Bird Sanctuary towards Jorethang. ().

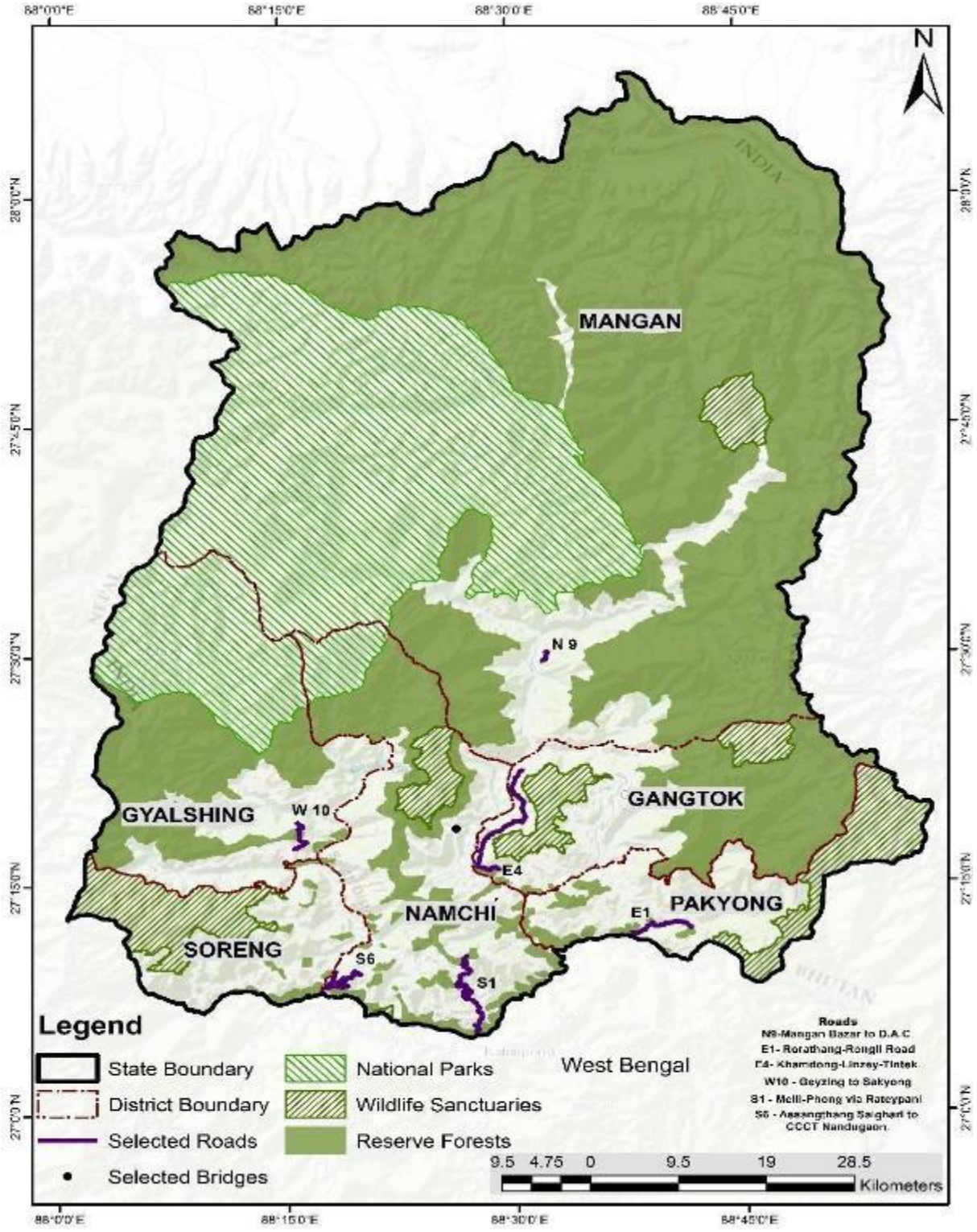


Figure 3-25: Map showing different Project roads and nearby important protected areas

Forest Diversion

189. Forest areas (reserve forests, Khasmal areas, gorucharan areas, khola etc) have been identified at some corridors. Forest diversion is required in five roads i.e., S1 Melli - Phong via Rateypani, S6 Assangthang - Salghari to CCCT Nandugaon, W10 Gyalshing to Sakyong, E4 Khamdzong-Linzey-

Tintek, E1 Rorathang Rongli. Any recorded Forest Land will require Forest Diversion as per FCA 1980. Gauchar (grazing lands), Khasmahal and other government lands also require forest diversion similar to reserved forests. All details such as locations, area to be diverted as per the existing surveys are given below.

Table 3-21: Forest Diversion

Corridor	Length of the Road	Approximate Forest Diversion in ha	Approvals
S1 Melli - Phong via Rateypani	22..65	0.21	Forest/tree felling Approval will be required
S6 Assangthang - Salghari to CCCT Nandugaon	14.79	0.033	Forest/tree felling Approval will be required
W10 Gyalshing to Sakyong	6.12	0.291	Forest/tree felling Approval will be required
E4 Khamdzong-Linzey- Tintek	21.76	0.086	Forest/tree felling Approval will be required
E1 Rorathang Rongli	8.9	0.138	Forest/tree felling Approval will be required
N9 Mangan Bazaar to DAC	2.1	NR	Forest Approval will not be required
Br 04		0.153	Forest/tree felling Approval will be required
Br 06		0.24	Forest/tree felling Approval will be required
Br 08		0.121	Forest/tree felling Approval will be required
Total		**1.280 ha in about 8 to 9 km of road is falling within RF.**	

Trees within Right of Way

190. The trees which are falling under proposed ROW of the project road, i.e., within 12-16m of ROW have been marked as impacted. Subsequently based on the verification of trees with forest department, the tree felling approval shall be applied under the project. Felling of non-forest trees falling within the project influence zone will be required to get permission from District Forest office as per Sikkim Private and Other Non-Forest Lands Tree Felling Rules, 2006. Similarly, permission for cutting of tree from forest notified area (RF/PF) will require approval from State Forest department under Forest Conservation Act 1980.

191. As part of compensatory afforestation scheme, tree plantation shall be done under the project in ratio of 1:2 of each tree impacted. Major trees species along the corridor are observed as Chilauney (*Schima wallichii Chois*), Siris (*Albizzia lebbeck*), Panisaj (*Terminalia myriocarpa*), Uttis (*Alnus nepalensis*), Gokul (*Ailanthus grandis* Prain), Simal (*Bombax ceiba*), Kainjal (*Bischofia javanica*), Pakhasaj (*Terminalia tomentosa*), Thekifal (*Cycas circinalis*), *Pinus roxburghii*, Ranichanp (*Michelia excelsa*), Kattus (*Chukrasia tabularis)* etc. None of the impacted tree species are Rare or Endangered.

192. List of tree species enumerated from the study shown in Table 0-XVI.

Table 3-22: Tree species along the corridors

Sl. No.	Scientific Name	Vernacular Name	IUCN Status
1	*Schima Wallichii* Chois	Chilauney	Least concern
2	*Albezzia Labbeck*	Siris	Least concern
3	*Terminalia Myriocarpa*	Panisaj	Least concern
4	*Alnus Nepalensis*	Uttis	Least concern
5	*Ailanthus Grandis* Prain	Gokul	Least concern
6	*Bombax Ceiba*	Simal	Least concern
7	*Bischofia Javanica*	Kainjal	Least concern
8	*Terminalia Tomentosa*	Pakhasaj	Least concern
9	*Cycas Circinalis*	Thekifal	Least concern
10	*Michelia Excelsa*	Ranichanp	Least concern
11	*Chukrasia Tabularis*	Kattus	Least concern
12	*Boehmeria rugulosa*	Dar	Least concern
13	*Gmelina arborea*	Khamari	Least concern
14	*Duabanga grandiflora*	Lampate	Least concern
15	*Albezia chinensis*	Kalo Siris	Least concern
16	*Toona ciliata*	Tooni	Least concern
17	*Eugenia operculate*	Jamun	Least concern
18	*Shorea robusta*	Sal	Near Threatened
19	*Cassia fistula*	Amaltas	Least Concern
20	*Jacranda mimosifolia*	Gulmohar	Least Concern
21	*Lagerstroemia speciosa*	Pride of India	Least Concern
22	*Mangifera* sp	Mango	Least Concern
23	*Melia azedarach*	Daiken	Least Concern
24	*Murraya* sp	NA	Least Concern
25	*Phonix* sp	Palm	Least Concern
26	*Spondia pinnata*	Amaro	Least Concern
27	*Lyonia ovalifolia*	Angeri	Least Concern
28	*Engelhardia spicata*	Mawa	Least Concern

Source: Primary Survey

3.6.5 Heritage Trees

193. Department of Forest Environment and Wildlife Management, Sikkim in the pursuance of Sikkim Forest (Preservation, Protection and Declaration) of Heritage Trees Rules, 2016, Sikkim Government has identified and listed 21 trees of girth class 25 ft and above and 32 trees of girth class 20 ft to 25 ft respectively under forest land across the state as “Heritage Trees” due to their historical and cultural importance. A tree is recognised as a 'Heritage Tree' if it has a historical significance to the human settlement in the area. Some of the trees identified include the locally found 'Bajrat', 'Tooni' and 'Rani Champ’. None of these trees are falling in immediate study area of the road.

194. A consultation with the forest department was conducted and they confirmed the absence of heritage trees within the project influence area. A survey of the impacted trees has been conducted. None of the listed heritage trees are located in the study area that includes the construction footprint.

A mapping exercise is provided in below map which finds none of these trees fall within the immediate vicinity of the project.

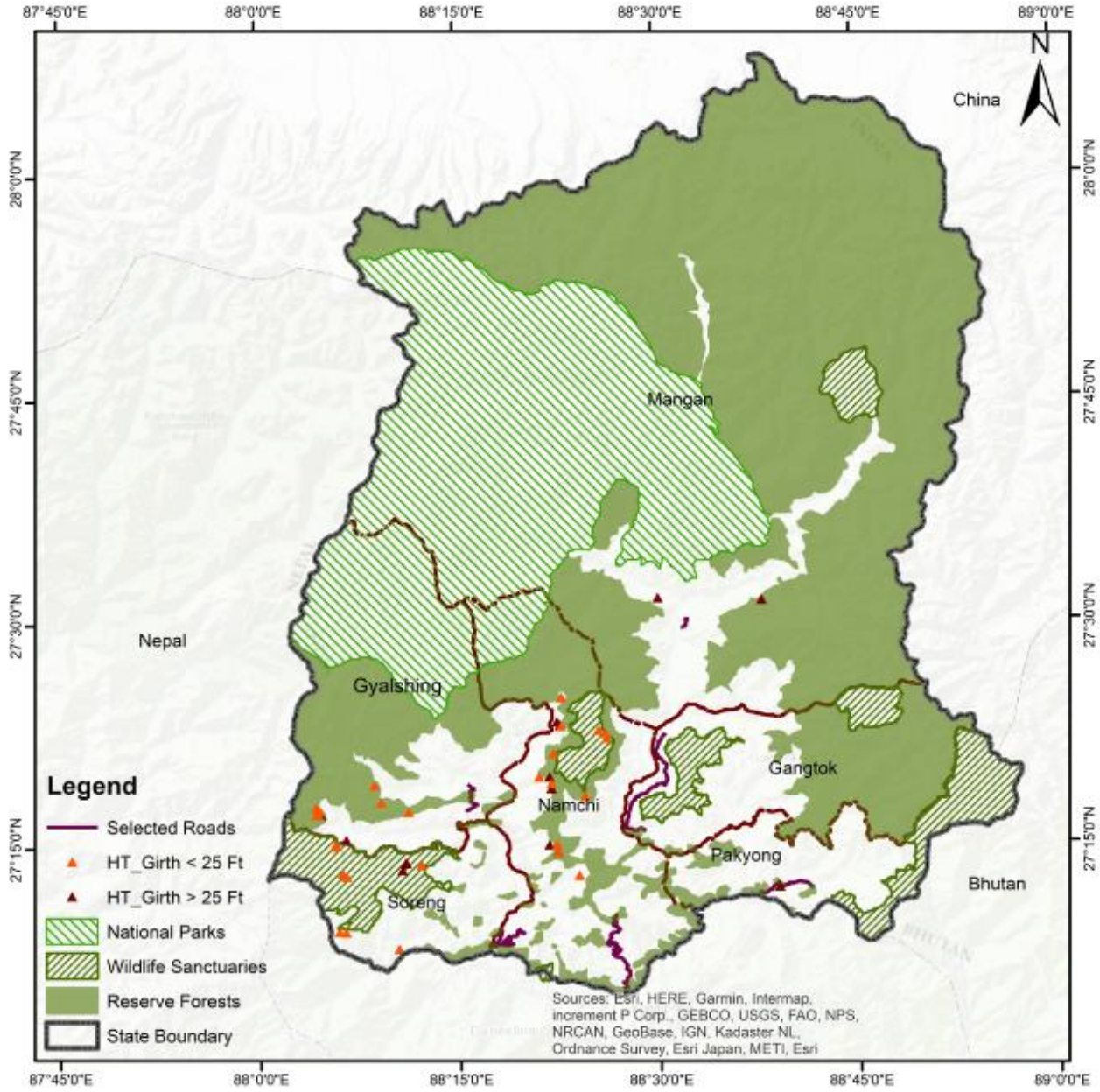


Figure 3-26: Heritage Tree

3.6.6 Plants

195. Floral Diversity: The State is endowed with rich floral biodiversity. Approximately state harbors species of 5500 flowering plants, 557 Orchids, 38 Rhododendrons, 16 Conifers, 28 Bamboos, 362 Ferns and its allies, 9 Tree Ferns, 30 Primulas, 11 Oaks, 1681 Medicinal plants. State has 1961 nos. of medicinal species from different varieties of plants.

Table 3-23: Floral diversity

Sl. No.	Biodiversity at a Glance	Nos. of species
1	Flowering Plants	5500
2	Orchids	557
3	Rhododendrons	38
4	Conifers	16
5	Bamboos	28
6	Ferns and Ferns allies	362
7	Tree Ferns	9
8	Primulas	30
9	Oaks	11
10	Lichens	506
11	Magnolia	12
12	Trees and Tall Bamboos	717
13	Small Grasses	257
14	Bushes	112
Source: ENVIS Sikkim		

196. Sikkim has exceptionally diverse orchids and it is also believed to be center of origin for Cymbidium. Contiguous riverine habitats along sub-tropical and warm temperate belts form congenial habitat for a variety of epiphytic as well as ground orchids. The sub-tropical belt has a number of tall trees which form excellent host for epiphytes such as *Shorea robusta, Duabanga sonneratioides, Gmelina arborea, Terminalia tomentosa, Schima wallichii, Toona ciliata, Engelhardtia spicata*, and *Machilus odoratissima* to name a few. The common genera of orchids in these forests include *Dendrobium, Ascocentrum, Aerides, Acampe, Vanda, Cymbidium, Bulbophyllum, Flickingeria, Smitinandia, Phalaenopsis* and *Porpax.*

197. Till date, approximately 187 rare, endangered, and threatened (RET) plant species have been reported from the Indian Himalayan region of which Sikkim comprises a significant part (http://gbpihedenvis.nic.in/PDFs/RET% 20Plants-2.pdf, accessed 14 March 2023).

198. Plants strictly endemic to Sikkim, Chatterjee (1939) made a detailed study on the endemism in the Indian flora. He observed the number of endemics in the Himalaya as 3165 out of a total of 6850 endemics in India, representing 46 percent of the total endemics. Several endemic species have been collected from Sikkim. It is estimated that about 3% of the plants known from Sikkim are endemic to the region. The genus like *Brachycaulos* is exclusively endemic to Sikkim. Other genera as *Aucuba, Bryocarpum, Gamblea, Lepidostemon, Sphaerosacme, Treutlera* are endemic to the eastern Himalaya and are represented in Sikkim also (Singh and Sanjappa, 2011). Some of the representative plant endemics are listed in table below.).

Table 3-24: Endemics of Sikkim

Sl. No.	Species	Family
1	*Astragalus zemuensis*	Fabaceae
2	*Berberis sikkimensis*	Berberidaceae
3	*Cacalia chola*	Asteraceae
4	*Calamus inermis*	Arecaceae
5	*Caragana spinifera*	Fabaceae
6	*Carex kingiana*	Cyperaceae
7	*Codonopsis affinis*	Campanulaceae
8	*Coelogyne treutleri*	Orchidaceae
9	*Cremanthodium palmatum subsp. Benthamii*	Asteraceae
10	*Crepis atropappa*	Asteraceae
11	*Juncus sikkimensis*	Juncaceae
12	*Jurinea cooperi*	Asteraceae
13	*Ligularia kingiana*	Asteraceae
14	*Ligularia pachycarpa*	Asteraceae
15	*Ligularia yakla*	Asteraceae
16	*Mahonia sikkimensis*	Berberidaceae
17	*Podophyllum sikkimensis*	Podophyllaceae
18	*Ranunculus sikkimensis*	Ranunculaceae
19	*Uvaria lurida var. sikkimensis*	Annonaceae

Table 3-25: Endemic plants of Sikkim

Sl. No.	Species	Family
1	*Agapetes incurvate*	Ericaceae
2	*Agapetes sikkimensis*	Ericaceae
3	*Dipsacus atratus*	Dipsacaceae
4	*Eriobotrya hookeriana*	Rosaceae
5	*Geum macrosepalum*	Rosaceae
6	*Lindera heterophylla*	Lauraceae
7	*Lloydia flavonutans*	Liliaceae
8	*Maddenia himalaica*	Rosaceae
9	*Meconopsis grandis*	Papaveraceae
10	*Meconopsis superba*	Papaveraceae
11	*Meconopsis villosa*	Papaveraceae
12	*Myricaria albiflora*	Tamaricaceae
13	*Primula whitei*	Primulaceae
14	*Rhododendron baileyi*	Ericaceae
15	*Rhododendron camelliaeflorum*	Ericaceae
16	*Rhododendron ciliatum*	Ericaceae
17	*Rhododendron glaucophyllum*	Ericaceae
18	*Rhododendron grande*	Ericaceae
19	*Rhododendron lanatum*	Ericaceae
20	*Rhododendron lindleyi*	Ericaceae
21	*Rhododendron wallichii*	Ericaceae
22	*Rhododendron wightii*	Ericaceae
23	*Saussurea conica*	Asteraceae

3.6.7 Terrestrial and Aquatic Biodiversity

Terrestrial

199. Specific and detailed field data were collected, which included camera trapping, fish, reptile, amphibian, bird surveys, and local person interviews. Field studies were initiated on 28th November 2023 and continued up to 30th December 2024. Most field work was suspended during monsoon season (**Figure 4**). Five primary datasets were collected including camera trapping, bird surveys, opportunistic roadkill and observations, night-time transects focused on reptiles and amphibians, and local person interviews. Additional specialized eDNA surveys were conducted by wildlife biologists from the Wildlife Institute of India (WII). Together these studies helped in establishing a baseline for species richness and distribution and evaluate the potential for Critical Habitat and plan mitigations to reduce the projects impacts. Data were amalgamated in a Geographic Information System (GIS) to conduct resulting analyses and to confirm or add detail to data gather from other published sources, government datasets, and information derived from literature review.

200. Camera traps recorded the presence of over 29 different species of wild mammals accounting for 1,010 detections. The most detections were recorded for northern red muntjac, which was also the most widespread, detected at 45 camera traps. The golden jackal was abundant and widespread. Other common species included the masked palm civet, Assamese macaque, Malayan Porcupine, and Yellow-throated Marten. Notably, Chinese Pangolin (*Manis pentadactyla*) (IUCN CR v. 2024-1), Clouded leopard (*Neofelis nebulosa*) (IUCN NT v. 2024-1), Assamese macaque (*Macaca assamensis*) (IUCN NT v. 2024-1), Himalayan Goral (*Naemorhedus goral*) (IUCN NT v. 2024-1), composed the Threatened or Near Threatened species detected via camera trapping.

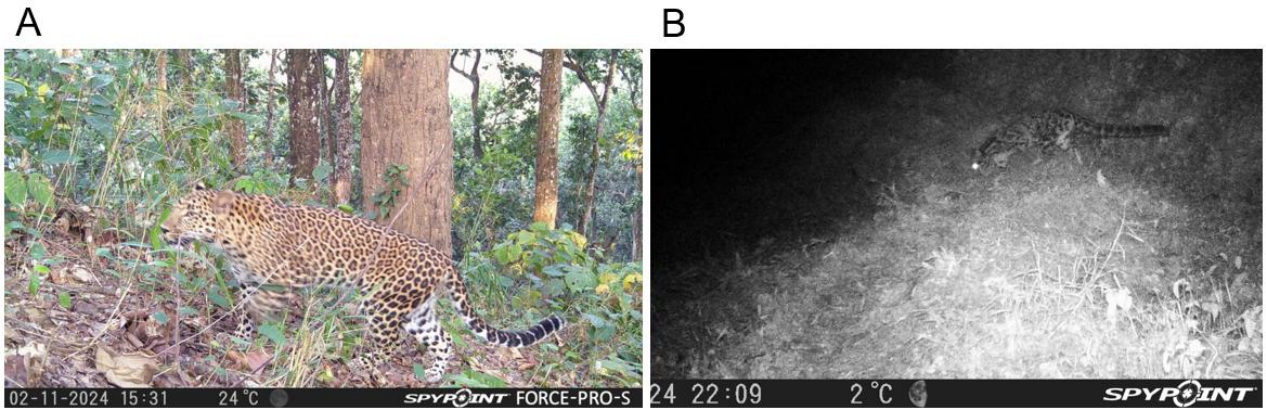


Figure 3-27. Carnivores detected by camera traps along Project roads included five species of cats (felids). A) common leopard B) clouded leopard.

201. After clusters of Chinese pangolin burrows were detected, camera traps were deployed at a subset of burrows that appeared active.

Figure 3-28. Camera traps were setup at Chinese pangolin burrows along BR04 and E1 to confirm species and establish a baseline for the species occupancy along Project roads.

Figure 3-29. Representative trap detections of Chinese Pangolin *(Manis pentadactyla*) recorded along the Project Roads (E1, BR04)

Table 3-26: Species recorded by camera traps

English Name	*Latin Name*	IUCN Status / India WPA Schedule	Detected	Unique Camera locations	% Total detected
Assamese Macaque	*Macaca assamensis*	NT / I	73	25	7.2
Chinese Pangolin	*Manis pentadactyla*	CR / I	5	5	0.5
Crab-eating Mongoose	*Herpestes urva*	LC / I	2	1	0.2
Golden Jackal	*Canis aureus*	LC / I	201	31	19.8
Himalayan Goral	*Naemorhedus goral*	NT / I	24	3	2.4
Jungle Cat	*Felis chaus*	LC / I	1	1	0.1
Large Indian Civet	*Viverra zibetha*	LC / I	49	13	4.8
Clouded leopard	*Neofelis nebulosa*	VU / I	1	1	0.1
Leopard	*Panthera pardus*	VU / I	1	1	0.1
Leopard Cat	*Prionailurus bengalensis*	LC / I	55	21	4.5
Malayan Porcupine	*Hystrix brachyura*	LC / I	71	22	7
Masked Palm Civet	*Paguma larvata*	LC / I	104	36	10.3
Northern Red Muntjac	*Muntiacus vaginalis*	LC / I	297	45	29.3
Pallas's Squirrel	*Callosciurus erythraeus*	LC / II	1	1	0.1
Small Indian Civet	*Viverricula indica*	LC / I	9	4	0.9
Wild Boar	*Sus scrofa*	LC / II	13	6	1.3
Yellow-throated Marten	*Martes flavigula*	LC / I	73	23	7.2
Birds					
Blue Whistling-thrush	*Myophonus caeruleus*	LC / II	4	4	0.4
Chestnut-headed Tesia	*Cettia castaneocoronata*	LC / II	1	1	0.1
Common Green Magpie	*Cissa chinensis*	LC / II	1	1	0.1
Orange-headed Thrush	*Geokichla citrina*	LC / II	2	2	0.2
Red Junglefowl	*Gallus gallus*	LC / II	1	1	0.1
Indian Peafowl	*Pavo cristatus*	LC / I	8	7	0.8
Kalij Pheasant	*Lophura leucomelanos*	LC / I	6	4	0.6
Domestic animals					
Domestic Cat	*Felid sp.*	NA / NA	20	3	2
Domestic Cattle	*Bos taurus*	NA / NA	18	5	1.8
Domestic Chicken	*Gallus gallus domesticus*	NA / NA	1	1	0.1
Domestic Dog	*Canis familiaris*	NA / NA	115	25	11.4
Domestic Goat	*Capra aegagrus hircus*	NA / NA	17	6	1.7
Unidentified Wildlife		NA / NA	107	46	10.6

Aquatic

202. The project corridors fall under Teesta and Rangeet River basins. Species identified within the rivers and streams intersecting the project roads included Golden mahseer (*Tor putitora*) through use of eDNA methods.

203. The Endangered Golden mahseer is an important migrant in Himalayan Rivers, which migrates from warmer plains to the high reaches in cold water regions. Mahseer is a true potamodromous migrating fish in Sikkim, travels a long distance from Teesta barrage (foothills) to Rangeet, Teesta and Rangpo Chu during the late summer to monsoon months for breeding. The water turbidity, temperature and nature of riverbed are considered to be important stimuli for the migration of mahseer. Most brooders of mahseer are found to prefer river Rangeet for spawning. The fingerlings and juveniles live in these rivers till next September to mid-October and descend to water of plains, while adults after spending whole summer and monsoon in these streams return to warmer waters. The Rangeet up to Jorethang has been identified as breeding grounds for mahseer while in the Teesta river, they are found up to Singtam.

204. Other locally important fish species detected include Katley (*Neolissocheilus hexagonolepis*) and Asala (*Schizothorax richardsonii*). *A*quatic surveys were conducted for the biodiversity assessment and by the State revealed a total of 10 species recorded during the study period. *Schizothorax richardsonii* emerged as the most widespread species (Table 4-XI).

Table 3-27: Fish Species found in Primary Survey

Local Name	Scientific name	S1	E1	E4	BR04	BR06	BR08
Golden mahseer	*Tor putitora*					✓	✓
Chuchay asala	*Schizothorax progastus*	✓	✓			✓	
Dothey asala	*Schizothorax richardsonii*	✓	✓	✓	✓	✓	✓
Khasray	*Barillus bendelensis*					✓	
Chirkay	*Barillus vagra*	✓				✓	✓
Bhitti	*Danio aequipinnatus*	✓					
Nakkatua Buduna	*Garra gotyla*	✓	✓				
Dothey Buduna	*Garra mcclellandi*		✓				
Gadela	*Noemacheilus sp.*	✓	✓				
Gadela	*Noemacheilius kangjupkhulensis*		✓				
Katley	*Neolissochilius hexagonolepis*	✓	✓				✓

205. Although, during a traditional Aquatic Survey conducted in March and April 2024 by the Sikkim State Fish Department in various water bodies around the project site, presence of Mahseer was not reported in any of the locations. These results can be attributed to recent flash flooding in the region (October 2023) and a number of factors causing reduced populations including barriers to movement and migration and unsustainable harvest techniques.

206. There has been a decline in the diversity of fish in the river Teesta (Das and Mukherjee 2005). Menon et al. (2008) described 19 threatened species of India which also inhabit Teesta waters in Sikkim. Of these 15 species are rare and 4 species viz. *Anguilla bengalensis, Puntius clavatus, Ompak bimaculatus* and *Pseudeutropius* are considered to be Endangered.

3.7 Habitat Assessment

207. The habitat conditions have been surveyed, analysed, and presented in the CHA (Annexure 20). The CHA also provides more detailed and site-specific information on terrestrial and aquatic biodiversity and ecosystem function.

208. The ADB Safeguard Policy Statement 2009 (SPS 2009) provides guidance on environmental safeguard requirements for projects falling within different types of habitat. The SPS 2009 provides guidance on how to identify three categories of land and water areas based on its condition and biodiversity value. Habitats can be classified as either natural or modified; ranging from pristine, undisturbed natural habitat at one end of the scale, through different degrees of modification or disturbance, up to highly modified or

degraded areas that support an artificial assemblage of plants and animals. Despite a habitat being modified, it may support valuable biodiversity, including endemic or threatened species. Subsets of these habitat types are Critical Habitats and legally protected areas, both of which more commonly consist of natural or slightly modified habitat (ADB 2012).

209. The SPS 2009 requires projects to achieve at least no net loss of biodiversity in Natural habitat and no measurable adverse impacts, or likelihood of such, on Critical Habitats which could impair its high biodiversity value or the ability to function. This includes, no "reduction in the population of any recognized Endangered or Critically Endangered species or a loss in area of the habitat concerned such that the persistence of a viable and representative host ecosystem be compromised", and mitigation of any lesser impacts.

210. The SPS underscores the importance of preserving habitats that are crucial for species survival and ecosystem integrity. Protected areas are generally considered Critical Habitat along with other areas recognized nationally or internationally for their biodiversity value (e.g. areas that meet the International Union for Conservation of Nature (IUCN) classification criteria, the Ramsar List of Wetlands of International Importance, and United Nations Educational, Scientific, and Cultural Organization (UNESCO) world natural heritage sites. However, the formal criteria are based on the biological significance and function of habitat areas regardless of their legal designation.

211. ADB policy defines Critical Habitat using six criteria including "…areas with high biodiversity value, including habitat required for the survival of critically endangered or endangered species; areas having special significance for endemic or restricted-range species; sites that are critical for the survival of migratory species; areas supporting globally significant concentrations or numbers of individuals of congregatory species; areas with unique assemblages of species or that are associated with key evolutionary processes or provide key ecosystem services; and areas having biodiversity of significant social, economic, or cultural importance to local communities."

212. The criteria are 'triggers' in that if an area of habitat meets any one of the qualifying criteria, it will be considered Critical Habitat irrespective of failing to meet any other criterion. In the absence of reliable population data, proxies such as potential/predictive habitat maps and species' distributions have been used to inform the Critical Habitat determination for criteria 1-3. Appropriate population surrogates including Extent of Occurrence ("EOO"), range, or known sites of occurrence, mainly derived from the IUCN Red List data have been used to assess Critical Habitat with respect to the global population (see IFC, 2019: Guidance Note 77).

213. This Critical Habitat Assessment also considered other international, national, and regional policies and agreements (e.g. India Wildlife (Protection) Act 1972; IUCN Redlist of Threatened species 2024; CITES 1973; IFC PS6 2009; Government of Sikkim Biodiversity Strategy and Action Plan 2012). In these assessments, ADB SPS advises a precautionary approach to be applied based on the best available information respecting local and international perspectives and policy.

3.7.1 Methods of CHA

214. In short, a literature review and a series of rapid biodiversity field surveys were conducted to provide the information required to inform CHA and BAP reports and actions. Based on initial survey data, literature, and consultation with the Dept. of Forests and Conservation Service Organizations (CSO), a subset of species were further considered as possibly triggering at least one of the critical habitat criterion.

Table 3-28: Species screened in for Critical Habitat Assessment

SN	Class	Scientific Name	Common Name	IUCN Status	IWPA Schedule
1	Aves	*Aythya baeri*	Baer's Pochard	CR	I
2		*Gyps bengalensis*	White-rumped Vulture	CR	I
3		*Sarcogyps calvus*	Red-headed Vulture	CR	I
4		*Aquila nipalensis*	Steppe Eagle	EN	I
5		*Haliaeetus leucoryphus*	Pallas's Fish-eagle	EN	I
6		*Aceros nipalensis*	Rufous-necked Hornbill	VU	I
7	Fish	*Amblyceps arunchalensis*	Indian Torrent Catfish	EN	NA
8		*Tor putitora*	Golden mahseer	EN	NA
9	Mammal	*Manis pentadactyla*	Chinese pangolin	CR	I
10		*Ailurus fulgens*	Red Panda	EN	I
11		*Cuon alpinus*	Dhole	EN	I
12		*Moschus chrysogaster*	Alpine Musk Deer	EN	I
13		*Moschus leucogaster*	Himalayan Musk Deer	EN	I
14		*Panthera tigris*	Tiger	EN	I
15		*Arctictis binturong*	Binturong	VU	I
16		*Neofelis nebulosa*	Clouded Leopard	VU	I
17		*Panthera pardus*	Leopard	VU	I
18	Reptile	*Indotestudo elongata*	Elongated Tortoise	CR	IV
19		*Amolops monticola*	Mountain cascade frog	EN	IV
20	Liliopsida	*Trillium govanianum*	Himalayan Trillium	EN	NA
21		*Trillium tschonoskii*	Keun-yeon-yeong-cho	EN	NA
22	Magnoliopsida	*Nardostachys jatamansi*	Indian Nard	CR	NA
23		*Aquilaria malaccensis*	Agarwood	CR	NA

Abbreviations: CR: Critically Endangered, EN: Endangered, VU: Vulnerable, NA: Not Assessed; IWPA: Indian Wildlife Protection Act.

215. An initial list of 23 candidate species was evaluated based on the findings of field surveys and available literature. These and other Open Data were amalgamated to evaluate the potential for Critical Habitat areas following ADB SPS 2009 and relevant Indian laws and policies (MOEF 2011, WPA 1972). Extensive data collection over a one-year period including camera trapping and eDNA methods.

216. Although the assessment was definitive for most species, emerging information on the rich herpetofauna in Sikkim continue to raise questions. Information emerging near the end of these studies highlight the dynamic understanding of the scientific community and IUCN threat categorizations for lesser known species. For example, the Mountain cascade frog (Amolops monticola) categorized as Endangered and range restricted by the IUCN is commonly regarded by expert herpetologists as widespread (pers comm. Das 2025). Based on these communications and emerging publications, it was concluded the IUCN status and Range Restricted designation does not fully align with peer reviewed literature and expert opinion (pers comm. Das 2025). Recent taxonomic reclassification of species in the Amolops monticola group further establish the general distribution of the species across the Himalayas including the northeastern parts of India, Nepal, including parts of Tibet - China assessment (Patel et al 2021). Regardless, the richness and local practices of hunting frogs for traditional medicine and protein highlight the need for additional scientific research and community engagement. As a result, the need for additional in-situ research and monitoring is prescribed in the Biodiversity Action Plan.

3.7.2 Conclusion of the CHA

217. There were six Critical Habitat qualifying biodiversity features, two are single species, one is an internationally recognized biodiversity area, one is an ecosystem service, and two are ecosystem processes. The species occurring along Project roads that met the Critical Habitat criteria included Chinese pangolin and Golden mahseer. These two species occurred along multiple Project roads and warranted tailored safeguards including road and bridge design modifications as well as compensatory measures aimed at ensuring no net loss to abundance and long-term persistence in the landscape surrounding the Project roads.

218. Habitat was mapped spatially for Chinese pangolin which revealed portions of the ROW along E1, S1, BR4, and W10 qualified as Critical Habitat. The areas considered Critical Habitat for Golden mahseer extended to the unobstructed reaches of the rivers and tributaries where the species was detected and those areas within the footprint of physical works. Two connectivity corridors were identified as Critical Habitat, which function to support the long-term persistence of both Endangered species and the ecosystem process of movement and dispersal for other species across the PA network. These corridors fall in a mixt of land tenures including private lands. These corridors provide for movement of a number of species between Fambong Lho and Maenam wildlife sanctuaries including Chinese pangolin, red panda, clouded leopard, and common leopard. Portions of the corridors were already identified as Critical Habitat based on habitat mapping described above for E4 and BR4 which highlights the importance of areas outside of protected areas for not only holding significant biodiversity but also supporting larger landscape scale ecosystem processes such as dispersal and migration. The boundaries nor the pinch points of these corridors were mapped, rather the findings were used to evaluate impacts and plan mitigations at an ecologically appropriate scale. The corridors were used to determine the locations of needed wildlife passage structures and other measures aimed at reducing wildlife mortality in corridors.

219. The Important Bird Area – Lowland forests of South Sikkim falling along BR6, BR8, and S1 were considered Critical Habitat on a precautionary basis due to its official designation, location within the Central Asian Flyway, and multiple data sets establishing the areas rich bird diversity. Together these data provided sufficient evidence that the area contains important concentrations of nationally or regionally listed EN or CR species.

220. Lastly, access to fresh water was identified as a critically important ecosystem service that should also be under a no net loss / net gain approach when developing mitigation and restoration plans. See Section 4.1.7.

221. Although the species and ecosystem components described above were rated as severe risks that in some cases are long-lasting or permanent, none are unprecedented, and all have been addressed using the mitigation hierarchy through established safeguard measures in the Biodiversity Action Plan (BAP; Annexure 21).

Table 3-29: Summary table listing roads and chainages where CH was designated.

Name	Length within CH (km)	Percent in CH	Chainage
BR4	1.71	39	1+700 to 3+400
BR6	2.08	51	0+000 to 2+000
BR8	4.23	100	0+000 to 4+727
E1	0.00	0	NA
E4	14.05	65	0+400 to 0+500;0+950 to 1+050; 2+400 to 3+200; 5+100 to 14+290 ;15+300 to 16+650; 19+100 to 21+386
S1	7.18	32	0+850 to 4+050; 18+780 to 22+318
W10	4.31	67	0+400 to 1+200; 1+400 to 3+000; 3+500 to 4+800; 5+400 to 6+000

Natural and Modified Habitat

222. Landcover was assessed based on the amount of modification, where ultimately areas were classified as Natural or Modified habitat based on the amount of human modification and levels of usage. The assessment was conducted at two spatial extents, a medium scale EAAA and a small scale EAAA (<1500 M and <10 M) representing direct and indirect impacts respectively. Within each EAAA and for each Project road, the amount of each landcover type was calculated. These distances were based on the physical footprint of the ROW, tree clearance, home range size of species detected, and published studies looking at the impacts of infrastructure on biodiversity (van der Ree 2002).

223. Regardless of the exact distance analyzed, the amount of natural habitat, primarily forests listed as "Trees" in Table 15 and Table 16, varies. When the smallest scale is evaluated, those areas within 10 M of the Project roads, "Trees", ranges between 30% to 96% of the area (**Table 5**). These data reveal the amount of Natural and Modified habitat vary. These same classifications were used when estimating the amount of CH. Areas with high disturbance, classified as modified, were removed from the CH area estimates.

Table 3-30. Landcover within medium scale EAAA (1500 M buffer) for each road reported in Hectares.

	Natural (ha)		Modified (ha)					
Name	**Water**	**Trees**	**Bare Ground**	**Rangeland**	**Built Area**	**Total**	**% Modified**	**% Natural**
N9	43.84	1002.85	10.71	165.69	0	1223.09	14.42	85.58
W10	1.36	1776.72	24.74	286.89	0	2089.71	14.91	85.09
BR-8	60.9	1402.53	49.31	48.34	0	1561.08	6.26	93.74
BR-4	39.96	1050.71	20.04	193	5.85	1309.56	16.71	83.29
S1	66.75	3703.61	10.39	109.24	3.33	3893.32	3.16	96.84
S6	64.53	1985.86	61.51	99.39	0	2211.29	7.28	92.72
BR-6	42.22	1153.67	47.78	55.65	0	1299.32	7.96	92.04
E4	9.61	5826.1	51.17	514.38	1.98	6403.24	8.86	91.14
E1	15.32	2673.44	33.85	174.04	0	2896.65	7.18	92.82

224. Land cover at the small scale EAAA varied significantly more between Project roads, due to some roads passing through small villages, classified as Built Area (Table 6). Also, at this small scale the raster resolution starts to impact the exact values because the pixels are 30 M. Regardless, this is the most efficient and repeatable way to begin estimating the amounts and types of habitat affected.

225. In total 910.5 ha of tree area exists within 10 M of the Project roads. Based on an estimate that the current roads are effectively 5 M wide (89 ha), the result is an estimated 821 ha of forested area being converted or degraded based on the DPR drawings.

Table 3-31. Landcover within small scale EAAA (10 M buffer) for each road reported in Hectares.

	Natural (ha)	Modified (ha)						
Name	**Trees & water**	**Bare Ground**	**Range Land**	**Built Area**	**Total**	**% Modified**	**% Natural**	**Road length (KM)**
N9	2.13	2.12	0	0.11	4.36	51.15	48.85	2.04
W10	9.18	3.44	0.74	0.29	13.65	32.75	67.25	6.39
BR-8	7.03	0.28	1.75	0	9.06	22.41	77.59	4.23
BR-4	4.27	0	4.97	0	9.24	53.79	46.21	4.38
S1	33.09	2.55	12.58	0.05	48.27	31.45	68.55	22.74
S6	8.28	3.24	18.8	1.14	31.46	73.68	26.32	14.80
BR-6	6.68	1.35	0	0.5	8.66	21.36	78.64	4.05
E4	33.22	11.72	0.07	1.37	46.38	28.37	71.63	21.75
E1	18.22	0.76	0	0	18.98	4.0	96.0	8.89

226. It is clear that the full impacts to forest and habitat loss due to construction in areas with significant slope (i.e. greater than 40°) are difficult to precisely accounted for. The amount of natural habitat along Project roads ranges from 0 to 11 Ha with a total of 122 ha. The extent of forest loss should also

estimate and areas of likely forest loss above and downslope of ROW clearing due to spillage and slippage of excess soil.

227. Slope instability and forest loss along road improvements in Sikkim is a well-established challenge. It is difficult to measure and may be most efficiently measured post construction via modern survey techniques including the use of small drones and photogrammetry.

Biodiversity No-net Loss and Net Gains

228. As business and development impact natural habitats, the concepts of "No Net Loss" and "Net Gain" have become vital strategies in conservation and sustainable development. No Net Loss (NNL) in biodiversity values aims to ensure that project does not lead to a decrease in the overall biodiversity value of the affected area. In short, the population size, distribution, or other indicators should remain stable during and after the Project's completion. Projects impacting critical habitats are required to implement measures, usually through a BAP, to achieve no-net loss or net gains for critical habitat qualifying biodiversity values. Net Gain (NG) is a stage where the losses have been compensated beyond the pre-impact conditions. For species, successful net gains would be recording population sizes higher than the baseline values. Achieving NNL or NG requires planning and collaboration with governments and conservationists. In the case of this Project, measures to achieve NNL and NG for the critical habitat triggering species, i.e., Chinese pangolin and Golden mahseer, must be implemented. Projects impacting critical habitats are required to implement measures, usually through a BAP, to achieve no-net loss or net gains for critical habitat qualifying biodiversity values. Net Gain (NG) is a stage Forestry is the major land cover in the State and nearly 83% of the total geographical area of the state is under the administrative control of the State Forest Department. The second dominant land cover is agriculture which was recorded as 17.63% (2017) as against 12.75% in 2008 due to traditional agro-forestry practices, horticulture, floriculture and animal husbandry which is widely practiced. Major land use along the corridors is open forest land /Agricultural land followed by built-up land use.

3.7.3 Landcover for respective corridors has been provided below:

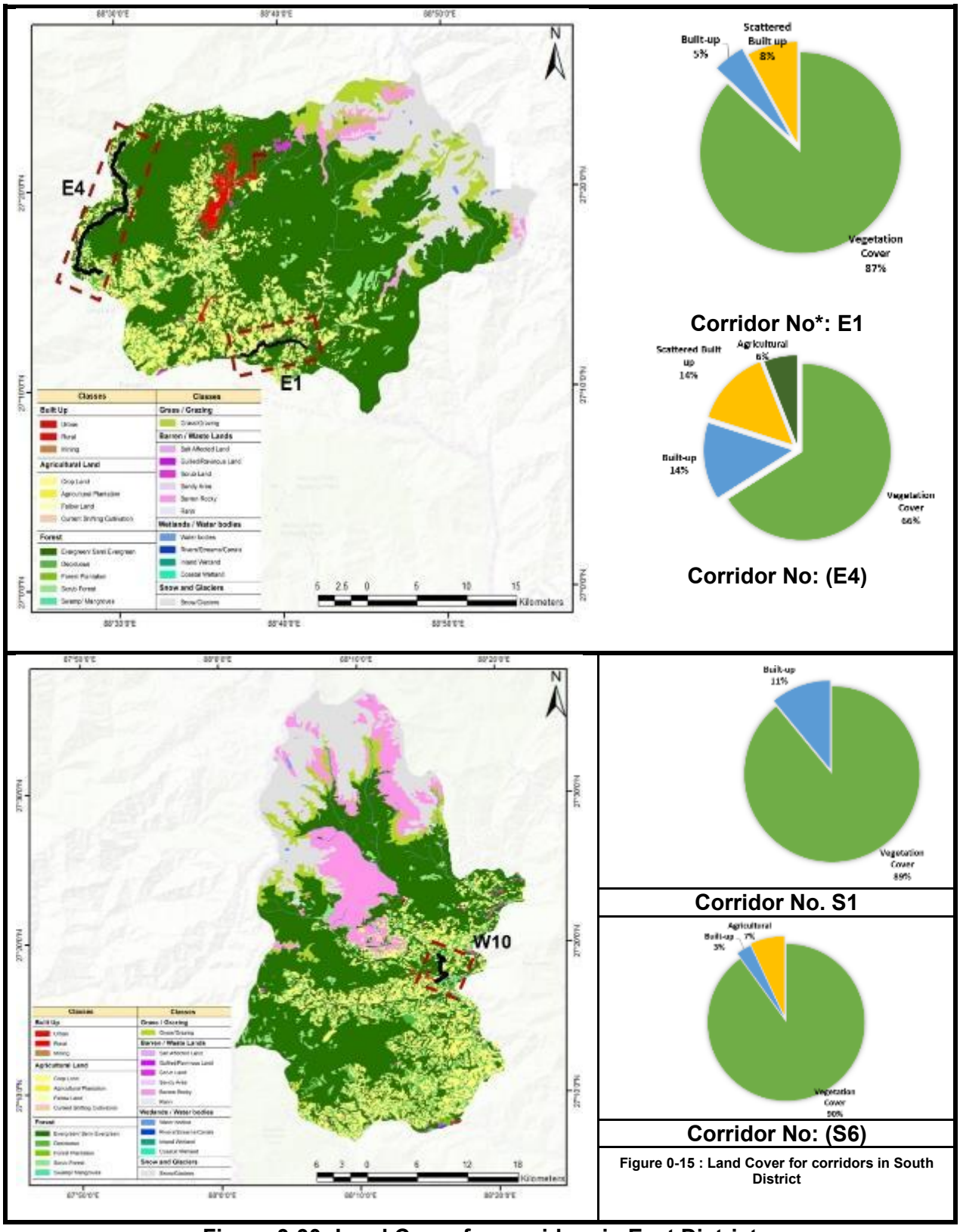


Figure 0-15 : Land Cover for corridors in South District

Figure 3-30: Land Cover for corridors in East District

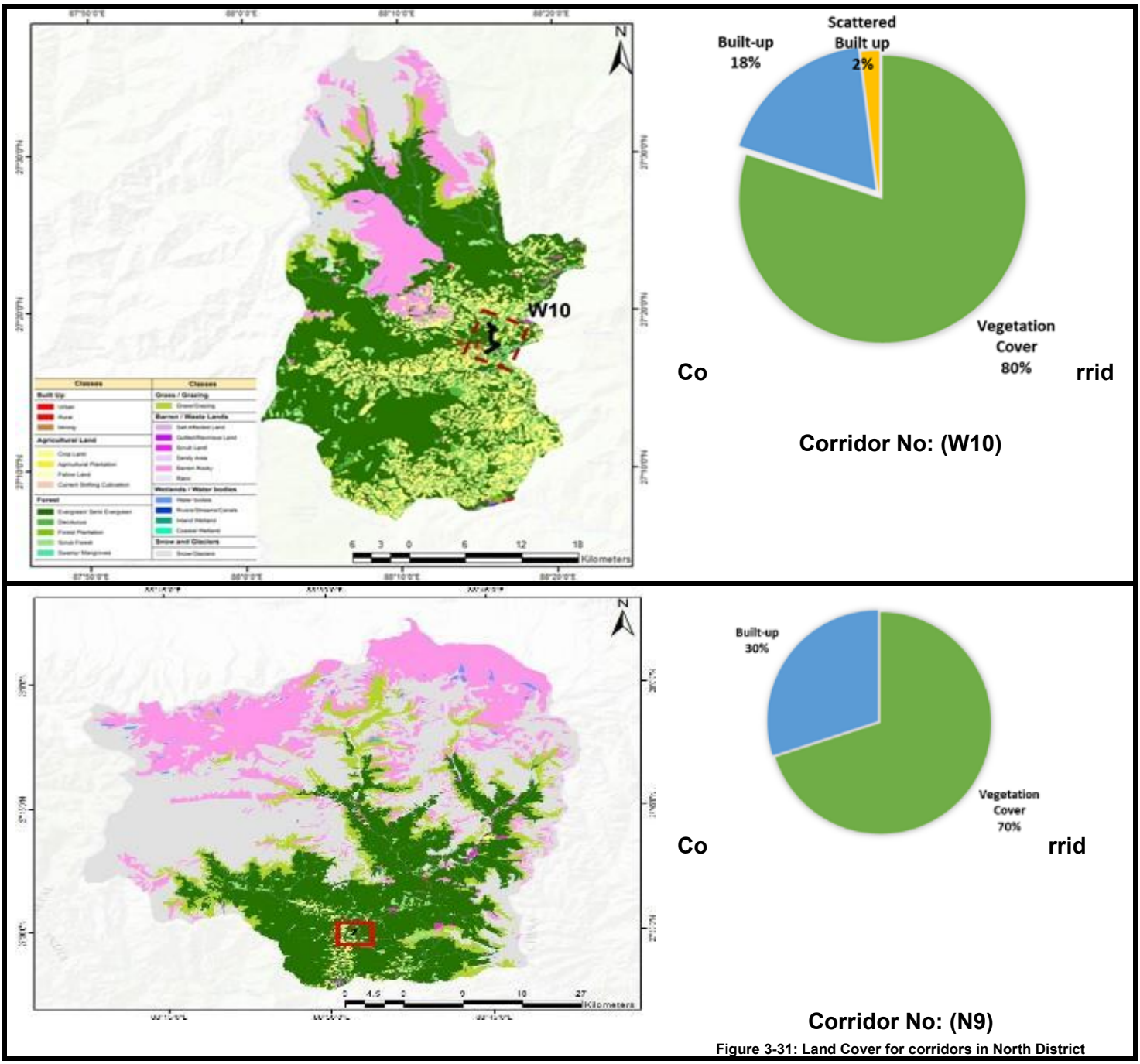


Figure 3-31: Land Cover for corridors in North District

Figure 3-32: Land Cover for corridors in West District

3.8 Archaeological Sites and Cultural Heritage

229. Sikkim's landscape is dotted with high altitude lakes, rolling green mountains, colourful rhododendron groves, azure rivers, milky waterfalls, beautiful monasteries and unparalleled views of Mt. Kanchenjunga. The ancient monasteries of Sikkim which stand today as famous center of Buddhism are Dubdi, Pemiongchi, Sancholling, Tashiding, Ralong, Rumtek, Enchey, Labrang, Phodong, Phensang, Ngadak, Thoung, Lingthem amongst many others. Apart from religious structures, secular and old architectural remains are none the less noteworthy including the remains of the first capital Tashi Tenka at Yuksam, the second capital Rabdentse at Pelling and third at Tumlong. The Dubdi Monastery and Rabdentse site of ancient capital of Sikkim are recognized under ASI. Being a tourism-oriented state, the project corridor development will give immense benefit to the state economy and livelihood upliftment of the region.

230. Cultural assets of local importance are available within the project right of way and adjacent to the right of way. These cultural assets are provided below.

Table 3-32: List of Cultural Resources

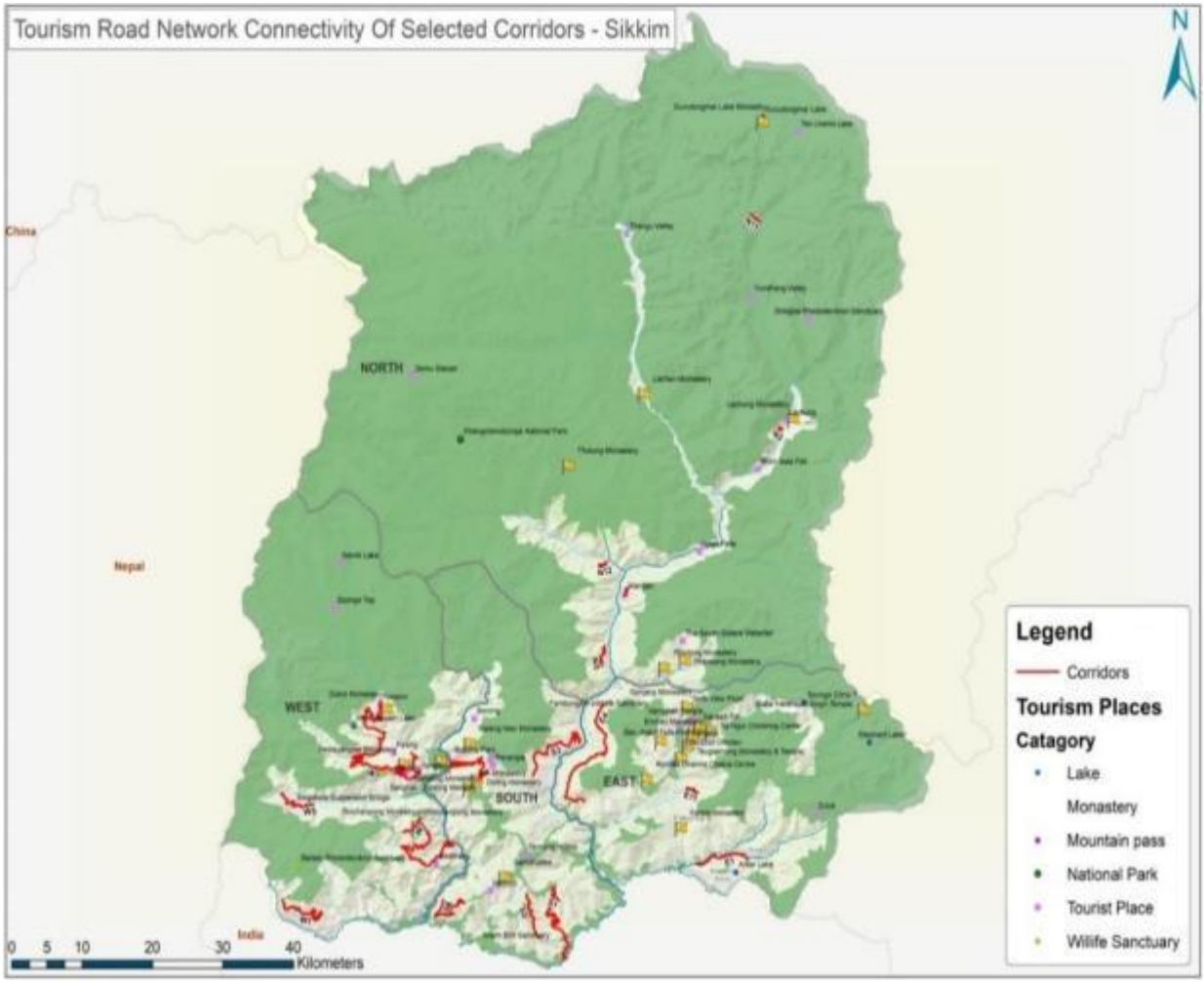
Project Road	Asset Type	Remarks
Road E04	A cremation ground, a shrine and local idols within the right of way. A church and a temple are located adjacent to the RoW	Cremation ground with stairs and shelters for the dead body. Non designated cultural heritage site of local importance.
Road S1	Road S1 has cremation ground at the upstream of the bridge and 3 churches near the ROW	Cremation ground is about 100 meters from the existing bridge.
N9	Two church adjacent to the right of way.	Church is located near the road but outside the RoW.
W10	A monastery near the RoW.	Monastery is located near the road but outside the RoW.
All Roads	Rivers / natural streams	The rivers hold cultural significance for the local community and are considered intangible cultural resources. As an expression of giving life, the community often releases fish into the rivers.

231. The project influence area does not have cultural assets of high value significance of conservation like UNESCO world heritage sites, internationally recognized sites, nationally protected sites, cultural heritage of regional value or intangible cultural heritage of affected community.

232. The map below shows the Cultural sites of Sikkim. These sites are not situated in the immediate vicinity of the current project road.

Table 3-33: ASI monuments of Sikkim

Sl. No.	Name of the monument / site	Location		District
1	Dubdi Monastery, Kheochod Phalvi,	Kheochod Phalvi	Located at 6 km from W10	West Sikkim
2	Coronation Throne of Norbugang near Yuksam, Kheochod Phalvi,	Kheochod Phalvi	1.35 km from W10	West Sikkim
3	Radbentse site of ancient capital of Sikkim, Forest area of Pemayongtse Monastery Estate, Forest area of Pemayongtse Monastery Estate	Pemayongtse Monastery Estate	800 m from W10	West Sikkim



Source: State of Environment 2007, Sikkim

Figure 3-33: Cultural Properties/ ASI monuments along the Corridors

3.9 Socio-Economic Conditions

233. Socio-Economic Profile of Project Districts. This sub-section gives an overview of the socio-economic characteristics of four districts which consists of the identified roads for the project. Such a profile gives an understanding about the project locations and helps to assess the impact of project on the population. The socio-economic profile of the project districts has been studied and brief findings are presented in the ensuing sub-sections.

234. Sikkim state has four districts which are named according to their regional location. The districts are:

i. North District
ii. South District
iii. East District
iv. West District

235. The demographic profile of the four districts of Sikkim is presented in the table below:

Table 3-34: Demographic Profile of Districts of Sikkim

Indicators	Project Districts			
	North	South	East	West
District Population	43,709	1,46,850	74,753	1, 36,435
Male	24,730	24,730	64,285	70,238
Female	18,979	18,979	58,202	66,197
Urban Population	4,644	21,199	1,22,487	5,248
Rural Population	39,065	1,25,651	1,61,096	1,31,187
Sex Ratio	767	915	849	942
Literacy rate (population aged 15 and above)	78.01	81.42	83.85	77.39
Labour force population	3,08,138	74,753	1,39,678	70,348
Scheduled Caste	982	6,053	15,305	5,935
Scheduled Tribe	65.70	41,392	78,436	57,817

3.9.1 North District

236. The north district is the largest of the four districts of Sikkim. The landscape is mountainous with dense vegetation upto the alpine altitude to desert scrub towards the northern tundra. The district has it's headquartered in Mangan. This district is the seventh least populous district in the country. Since 2002, the district is divided into three assembly constituencies:

- Kabi Longshot (BL)
- Django (BL)
- Lachen-Mangan(BL)

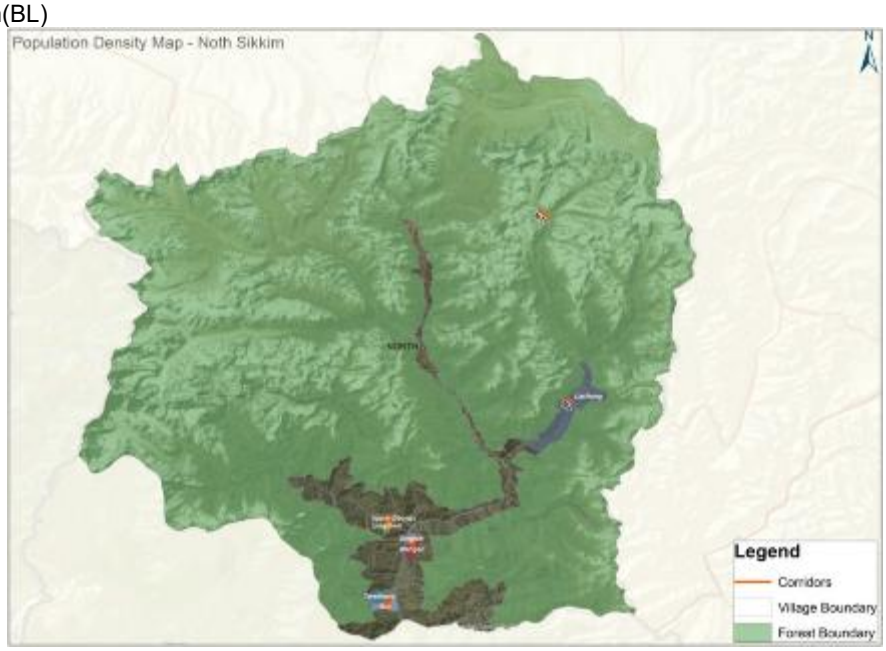


Figure 3-34: North district, Sikkim

237. The total area of the district is 4226 sq. mtr. The density of north district is 10 people per sq. km. Overall 55 villages and one town falls under north district. Out of these villages, 52 villages are inhabited. Out of the total 400 revenue blocks (villages) excluding 51 forest blocks (villages), 45 (11.25 per cent) revenue blocks are in the north district. In addition to this, out of the total population, 240 people (5.17 percent) reside in the slum area.

238. There is total 43,709 population in the north district which represents 7.15 percent of the state's population. Out of the total population, 89.38 percent people reside in rural area and 10.62 percent

reside in urban area. The population between the age group of 0 to 6 is 4, 677 which consists of 2, 425 male and 2, 252 females.

239. With regards to sex ratio, it stood at 767 per 1000 male compared to 2001 census figure of 752. Further, the total scheduled caste population is least in north district constituting proportion of 2.25 percent constitutes the highest proportion (65.69 percent) of scheduled tribe's population.

240. The literacy rate of the district is 78.01 percent which is lower than the State's literacy rate (81.42 percent). Out of the literate population, 83.30 percent of male and 70.97 percent of female are literate. Further, the district has 139 educational institutions, out of which majority are primary schools (43 numbers).

241. As per the Census 2011, the district has 8,753 numbers of households. The majority of the houses are made up of G.I./ metal/asbestos sheets (7, 796) followed by concrete (1, 788), grass/ thatch/ bamboo/ wood/ mud, etc. (932), stone/slate (268), plastic/ polythene (128), handmade tiles and burnt brick (31 each), machine made tiles (25) and others (18).

242. Health infrastructure is an important indicator to understand the healthcare delivery provision and mechanism. The district has 73 health institutions. Out of these institutions, majority are family welfare centers. However, a nursing home is 60 kms away and veterinary hospital is 15 kms away from the district. The crude birth rate in north district is 17.6 per 1000 population and crude death rate is 2.02 per 1000 population.

243. The total number of workers in north district is 23, 359, which is 53.44 percent of the total population of the district. This working population comprise of 39.39 percent of main workers and 14.05 percent of marginal workers. Among these working population, 24,730 are male and 18,979 are female. This was also observed that female working populations are more in main working population category (23.92 percent).

244. As per the Census 2011, out of the total working population of 23, 359, 31.39 percent are cultivators, 9.68 percent are agricultural labourers, 1.42 percent are engaged in household industry and remaining 57.59 percent of population is into other economic activities. Out of the total female working population, majority of the workers are cultivators.

245. As per Census 2011, the net sown area of the district is 8225 ha., the total irrigated land area is 1,421 ha. and the total un-irrigated land area is 6,803 ha. The district has 2,55,014.2 ha. of forest land, 2 ha. area under non-agricultural uses, 944 ha. is barren and un-cultivable land, 361 ha. is used for permanent pastures and other grazing lands, 7,020 ha. is for miscellaneous tree, crops etc. and 1 ha. is used as cultivable waste land.

246. The district has 2 national banks, 1 private commercial bank, 1, co-operative bank and 1 agricultural credit societies. The district does not have any non-agricultural credit societies.

247. As per the Census 2011, there are two sources of water which is tap water (treated/untreated) (52) and spring (52). The district has 2 community toilet including bath, 5 community toilet excluding bath and 2 community bio- gas or recycle of waste for productive use.

248. In case of connectivity, the district has 26 villages connected to State Highway (SH), 37 villages connected to Major District Road (MDR), 45 villages connected to others district road. Further, only 41 villages with Pucca roads. In addition to this, there are 44 taxis & vans and 7 buses plying in the district. The district has only one railway station which is in Siliguri. The Census 2011 record says that the district has 46 villages with electricity connection whereas 6 villages still lack access to electricity.

3.9.2 South District

249. South Sikkim lies at an altitude of 400 to 2000 meters and has a temperate climate for most of the year. Major urban centers include Namchi, Ravangla, Jorethang and Melli. The Melli check post is the entry point to South District from West Bengal. South district is also the most commercialized district of Sikkim. Temi Tea Garden distinguishes the South district for being among the leading tea producer of India. Ranging between the altitudes of 400 meters to 2000 meters, South Sikkim District observes temperate climate for most of the time. The district was previously divided into eight assembly constituencies.

- Barfung (BL)
- Poklok-Kamrang
- Namchi-Singhithang

- Melli
- Namthang-Rateypani
- Temi-Namphing
- Rangang-Yangang
- Tumen-Lingi (BL)

250. As per Census 2011 out of total population, 43.2% people live in urban areas while 56.8% lives in the rural areas. The average literacy rate in urban areas is 88.9% while that in the rural areas is 80%. Also, the Sex Ratio of Urban areas in East District is 905 while that of rural areas is 849.

251. The population of Children of age 0-6 years in East District is 27,984 which is 10% of the total population. There are 14,277 male children and 13,707 female children between the age 0-6 years. Thus, as per the Census 2011 the Child Sex Ratio of East District is 960 which is greater than Average Sex Ratio (873) of East District.

Literacy Rate

252. The total literacy rate of East district was 83.85% in 2011 which is greater than average literacy rate 81.42% of Sikkim. Population-wise, out of total 214,329 literates, males were 121,345 while females were 92,984. Also, the male literacy rate was 88.47% and the female literacy rate was 78.5% in East District.

Working Population

253. In East District out of total population, 139,678 were engaged in work activities. 79.5% of workers describe their work as Main Work (Employment or Earning more than 6 Months) while 20.5% were involved in Marginal activity providing livelihood for less than 6 months. Of 139,678 workers engaged in Main Work, 22,325 were cultivators (owner or co-owner) while 5,127 were Agricultural labourers.

Table 3-35: Working Population

Type of Workforce	Total	Male	Female
Main workers	111,058	79,311	31,747
Cultivators	22,325	13,135	9,190
Agriculture Labourer	5,127	3,025	2,102
Other workers	82,120	62,075	20,045
Marginal workers	28,620	13,040	15,580
Non-Working	1,43,905	59,081	84,824

Agriculture

254. The economy of Sikkim is linked with agriculture that serves as the source of livelihood and economic security of sizeable native population. The growth, however, has been restricted because of biotic and abiotic factors. It is estimated that over 80 per cent of the rural population depends on agriculture and allied sectors for economic, food, and nutritional security. The agriculture systems practiced in Sikkim are integrated in natures that have evolved through years of experimentation by the farmers. A marginal improvement in the lifestyle of the farmers has been witnessed with the adoption of modern technologies. Rice, Wheat, Maize, Finger Millet, Barley, Buckwheat, Pulses and Oil seeds are the major crops in the Sikkim.

255. Industries. Rorathang is a small town situated in the East District of Sikkim. Rorathang is one of the important Industrial hub of Sikkim, hosting many pharmaceutical companies like Cipla Pharmaceuticals, Golden Cross Pharmaceuticals, Lupin Pharmaceuticals, Zuventus Healthcare, Zydus Healthcare, Zydus Pharmaceuticals, Swiss Garnier Pharmaceuticals, Kingfisher Beer Factory, Indichem Pharmaceuticals, Alkem Laboratories, Gati Hydro Electric Power Project, Savi Healthcare, Northeast Pharma Packaging Company, Ideal Cures Private Limited, National Institute of Electronics & Information Technology, and Malu Electrodes Private Limited.

256. Cultural Resources. The state has great cultural value. Festivals and cultural activities are being celebrated throughout the year in the state. The department of cultural has taken various activities like promotion of art and culture, preservation of old and historical monuments. The state has great cultural value for Buddhism. There are 11 monasteries in the state. However, project road does not affect these places.

257. Energy and Electric Power Potential. Firewood is still a major source of energy in the state which is available in abundance. The state is generating hydro-power which contributes about 70% of installed capacity in the state and rest is by other means. The total installed capacity in Sikkim is 95.70 MW. The available hydro-power potential in the State5 is huge (5352.7 MW) and actions are being taken to capture it.

3.9.3 West District

258. West Sikkim is the second largest district in the Indian state of Sikkim. The headquarters of the district is at Gyalshing, also known as Geyzing. The town is connected to the capital Gangtok by a metaled road. Geyzing is also connected to the West Bengal towns of Darjeeling and Kalimpong via Jorethang. West Sikkim is divided into two sub-divisions:

- Gyalshing
- Soreng

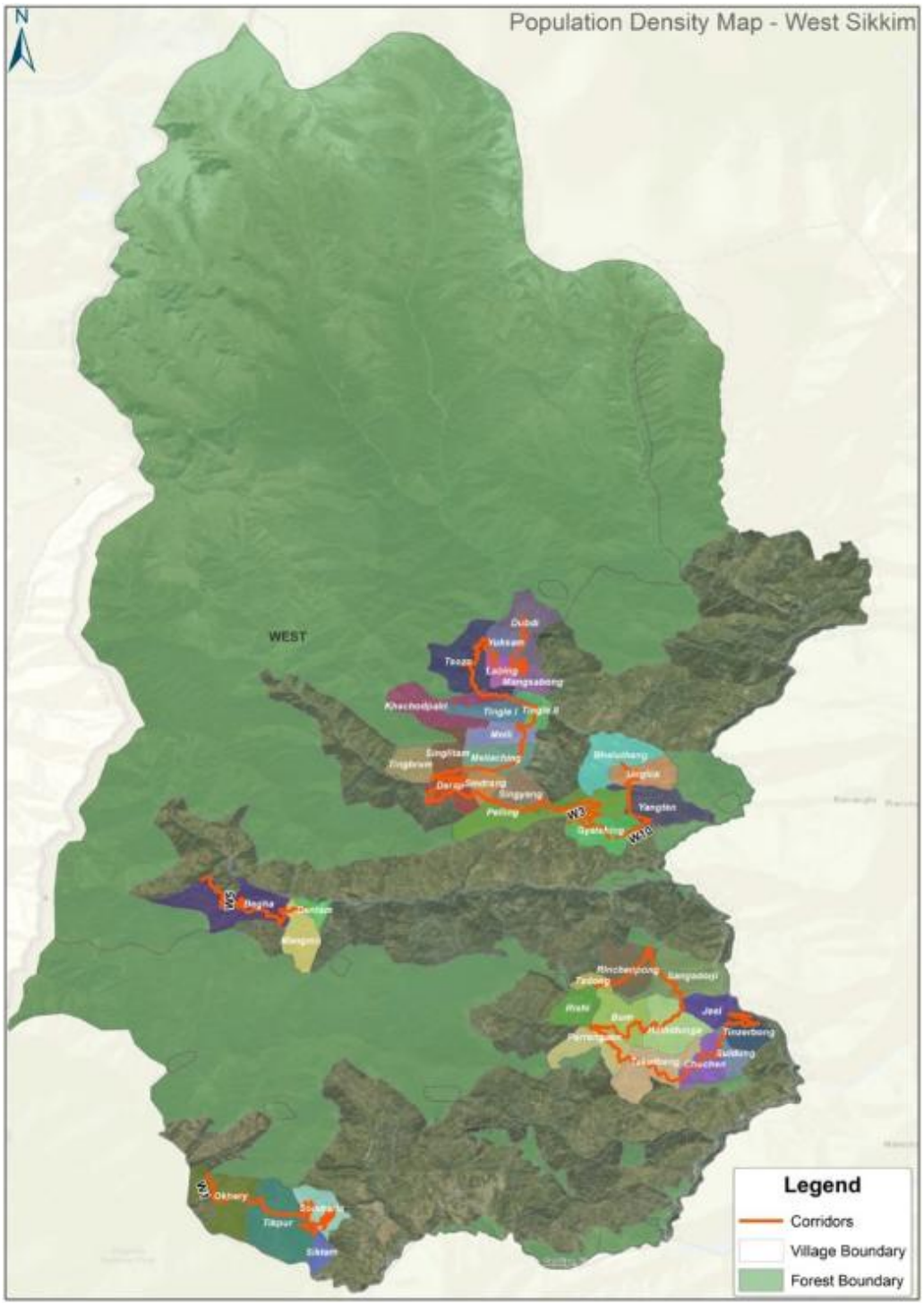


Figure 3-35: West district, Sikkim

259. The total area of the district is 1166.00 sq. mtr. The density of west district is 117 people per sq. km. Overall 125 villages and 2 towns fall under west district. Out of the total villages, 119 villages are inhabited and 6 villages are uninhabited. Out of the total 400 revenue blocks (villages) excluding 51 forest ocks (villages), 112 (28 percent) revenue blocks are in the west district. In addition to this, out of the total population, 1878 people (35.79 percent) reside in the slum area.

260. There is total 1, 36,435 population in the west district which represents 22.34 percent of the state's population. As per the Census 2011, the district has 27,913 numbers of households. Out of the total population, 96.15 percent people reside in rural area and 3.85 percent reside in urban area at Gyalshing (NP) and Nayabazaar (NBA). The population between the age group of 0 to 6 is 1 5,706 which consists of 7, 996 male and 7, 710 females. The sex ratio of the district is higher than the State sex ratio of (890).

261. Further, the total scheduled caste population constitutes proportion of 4.35 percent. The west district constitutes the proportion of 42.38 percent of scheduled tribe's population.

262. The literacy rate of the district is 77.39 percent which is higher than the State's literacy rate (81.42 percent). Out of the literate population, 83.53 percent of male and 70.86 percent of female are literate. Further, the district has 330 educational institutions, out of which majority are primary schools (108 numbers).

263. Health infrastructure is an important indicator to understand the healthcare delivery provision and mechanism. The district has 152 health institutions. Out of these institutions, majority are Family welfare centres (FWC) followed by 41 each primary health sub centre (PHS) & dispensary (D), 3 each primary health centre (PHC), maternity and child welfare centre (MCW) & T.B. clinic (TBC) and 3 veterinary hospitals (VH).

264. The total number of workers in west district is 70,348, which is 51.56 percent of the total population of the district. This working population comprise of 37.55 percent of main workers and 14.02 percent of marginal workers. Among these working population, 40, 772 are male and 29, 576 are female. This was also observed that female working populations are more in main working population category (27.15 percent).

265. As per the Census 2011, out of the total working population of 70, 348, 57.99 percent are cultivators, 11.45 percent are agricultural labourers, 1.99 percent are engaged in household industry and remaining 28.57 percent of population is into other economic activities. Out of the total female working population, majority of the workers are cultivators (63.04 percent).

266. As per Census 2011, 41122.3 ha. is forest land, 35.8 ha. is of land for non-agricultural uses, 2920.6 ha. is barren & un-cultivable land, 0.2 ha. are permanent pastures & other grazing lands, 3934.1 ha. is land under miscellaneous tree crops etc., 120.6 ha. is culturable waste land, 25464.8 ha. is net area sown, 2637.5 ha. total irrigated land and 22823.9 ha. is total un-irrigated land. The district has 6 commercial & co-operative, 1 ATMs and 74 agricultural credit societies.

267. As per the Census 2011, there is only one sources of water which is tap water (treated/untreated) in all the villages of the district. The district has 6 community toilet including bath, 23 community toilet excluding bath, 9 rural sanitary mart or sanitary hardware outlet and 7 community bio- gas or recycle of waste.

268. In case of connectivity, the district has 17 state highways (SH), 72 major district roads (MDR), 84 district roads, 95 Kuccha roads and 3 Water bounded macadam (WBM) roads. The district does not have any National Highway NH in addition to this, there are 51 bus service (public/private) and 111 Taxi & vans plying in the district. The Census 2011 record says that all the inhabited villages in the district have electricity connection.

4. Anticipated Environmental Impacts and Mitigation Measures

269. Road improvement projects are likely to bring several changes to the environment, both beneficial and adverse. This section presents identification and evaluation of anticipated impacts during pre-construction, construction and operational phases for all roads and bridges. The project interventions address impacts across all stages of construction and operation.

270. The subsequent sections address anticipated adverse impacts that would occur if not mitigated. Environmental impacts have been assessed based on information collected during project planning; including DPR preparation, screening & scoping of environmental attributes, and baseline data collection.

4.1 Category of Impact

271. The methodology of assessing environmental impacts from the project entailed clearly identifying the environmental components that will be impacted, type of impacts, assessment area where the impacts will be felt and defining the criteria for assessing the significance of each type of impact. After defining these aspects, a screening of project impacts during design and preconstruction, construction and operation stages of the project was carried out to identify the minor, moderate and major impacts to guide development of mitigation measures and ensure that there are no residual impacts.

Identification of impacts

272. This includes identifying the valued environmental components (VEC) of the physical, biological, and human environments that are at risk of being impacted by the project. The VECs for this project which are based on the environmental baseline are:

- **Physical environment** – air quality and greenhouse gas emissions, land and soil, and groundwater quality and quantity.
- **Biological environment** – terrestrial and aquatic vegetation, mammals, avifauna, fish, and ecologically important areas supporting ecosystem processes.
- **Human environment** – private land and buildings, public infrastructure including utility structures, noise and vibration levels, cultural/heritage buildings, and occupational health and safety for the construction workers and local community living within the vicinity of the project area.

273. The type of impact can be described as:

- **Positive**: Improvement in the quality of the VECs because of the project
- **Negative**: Degradation or reduction in the quality of the VECs because of the project
- **Neutral**: No noticeable change in VECs.

274. The Area of Impact Assessment was established for assessing direct and indirect impacts for a broad range of environmental phenomena. Furthermore, this EIA incorporates information from multiple reports and assessments which evaluated areas of impact at different distances and at different spatial resolutions. Below each category of impact reports the specific area evaluated.

275. These ranged from the direct area permanently converted to paved surface based on design drawings and spatial data to larger extents designed cautiously to ensure sensitive receptors and VECs were not overlooked. For example, the Critical Habitat Assessment alone used three separate areas of impact assessment to evaluate the severity of impacts for different species and ecosystem processes in the Ecological and Biological Environment sections. Please see the detailed descriptions in those sections for clarity. For simplicity, two general extents were used:

276. Direct Impact Area – Clearly, the direct impact area is based on the extent of physical works including borrow areas, batching plants, aggregate sourcing sites, worker camps, and the area cleared for construction and the eventual carriage way and ancillary structures. The CHA, evaluated the direct impact area based on DPR drawings and design data which reveals a 20 m wide corridor generally centred on the existing road center lines. For most other studies, a 500m radius was considered as the Direct Impact Area for mapping of sensitive receptors during field surveys and for undertaking baseline monitoring.

277. Direct Impact Area -– Clearly, the direct impact area is based on the extent of physical works including borrow areas, batching plants, aggregate sourcing sites, worker camps, and the area cleared for construction and the eventual An average of 1 km corridor (ROW) along the sub-project sections. This includes 500 m16 on either side studied for direct impacts. For most parameters, 500m radius was considered as core zone for mapping of sensitive receptors during the field surveys and for undertaking baseline monitoring. For CHA, the direct impact area was evaluated as a 20 m wide corridor centered on the planned centerline.

278. Indirect Impact Area - In addition, a 5 km buffer was studied for indirect impacts. For CHA, the indirect impact area was evaluated at 1500 m and 50 km based on the species and ecosystems determined to be of significance

shown in the figure below. Here the indirect impact area was referred to as the ecologically appropriate area of analysis aligned with wording in other guiding documents. Regardless of the nomenclature, these multiple extents are used to evaluate both small scale site specific and large scale regional and international environmental components that are based on the respective scientific fields.

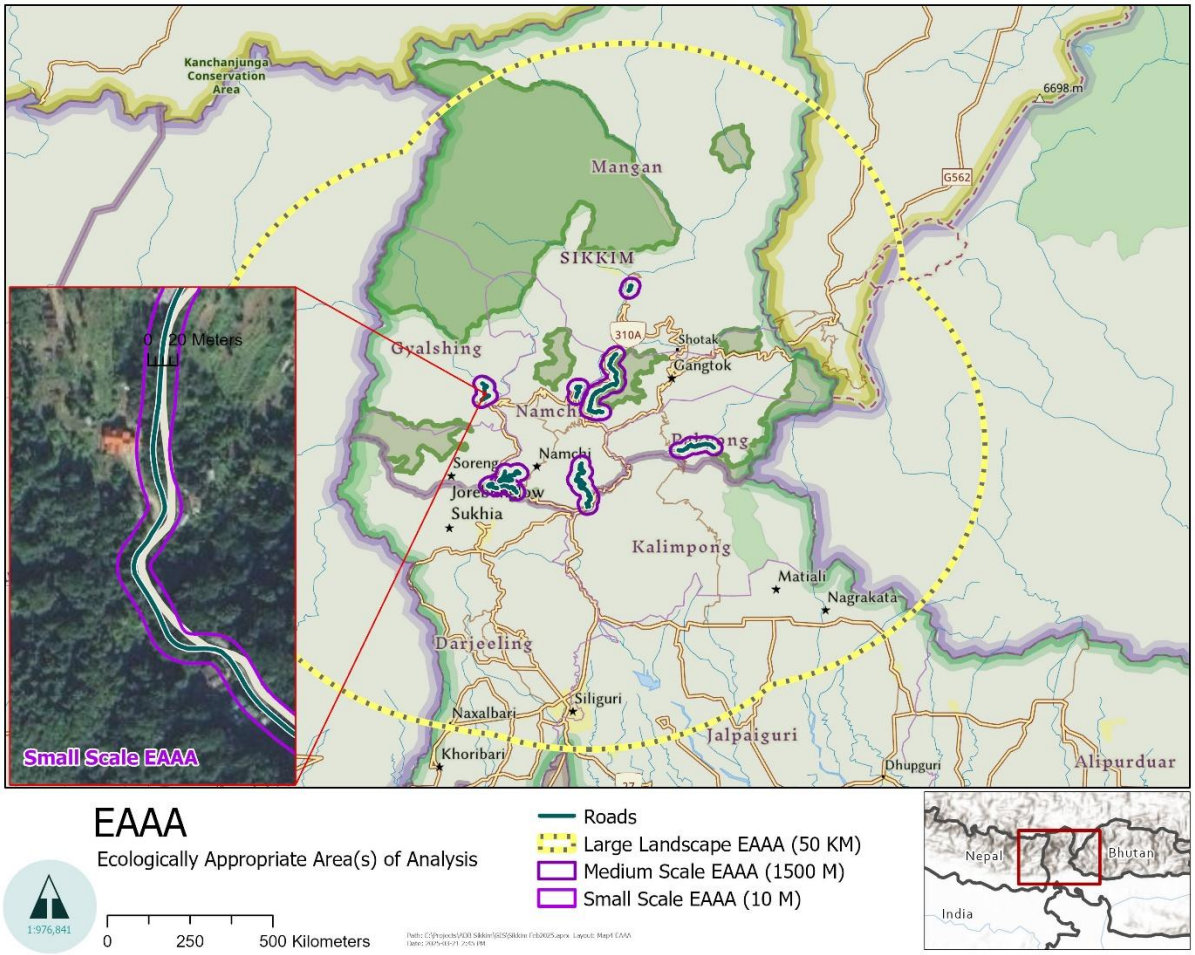


Figure 4-1. Ecologically Appropriate Areas of Analysis (study area) showing Protected Areas, Reserve Forests, Key Biodiversity Areas, and road network.

Duration of the impact

279. Duration means the time dimension of the impact on the VECs. The terms permanent, temporary and short-loved are used to describe the duration of impact:

- **Short-lived**: The impact disappears promptly
- **Temporary**: The impact is felt during one project activity or, at most, during the construction period of the project
- **Permanent**: The impacts are felt throughout the life of the infrastructure.

Assessment of Sensitivity of Receptors

280. Receiving parameter or receptor sensitivity was determined using information taken from the baseline description on the importance, significance, or value of the social or environmental component under examination. It is important to understand the sensitivity of the receiving parameter, as this is a measure of the adaptability and resilience of an environmental parameter to an identified impact. The following levels of sensitivity were applied to the assessment:

1. High: The environmental parameter/receptor is fragile, and an impact is likely to leave it in an altered state from which recovery would be difficult or impossible.
2. Medium: The parameter/receptor has a degree of adaptability and resilience and is likely to cope with the changes caused by an impact, although there may be some residual modification as a result.

3. Low: The parameter/receptor is adaptable and is resilient to change. The sensitivity of the receiving environment to changes caused by the Project was determined within each of the technical chapters using professional judgement, and existing information, where possible.
4. Low to Medium: The parameter/receptor is adaptable and is resilient to change, although there may be some residual modification as a result.
5. Medium to High: The parameter/receptor has a degree of adaptability, although an impact is likely to leave it in an altered state from which recovery would be difficult or impossible.

281. Based on the rating of duration, area and severity of impact as described above the overall significance of each impact as major, moderate or minor was determined as demonstrated in **Table 4-2**.

Table 4-2: Criteria for rating the significance of impacts

Significance	Duration	Area	Severity
Minor	Short lived or temporary	Limited or local or regional Low	Low
	Permanent	Limited	Low
Moderate	Temporary	Limited or local – construction specific or regional	Medium
	Permanent	Limited	Medium
Major	Permanent or temporary	Limited or local or regional	High
	Permanent	Local or regional	Medium

4.1.1 Loss of Land and Other Assets

Construction

Description

282. Since widening and improvement are confined to available ROW, extent of land acquisition is negligible. Land acquisition is required at blind hairpin bends. Private properties affected are either squatted or encroached. Impact on common property resources is also minimal. Though clearing ROW for the construction of road and establishing ancillary facilities will require the following:

283. Major activities to be considered at pre-construction stage:

- Loss of land for road construction within available ROW
- Diversion of forest areas at hairpin bend location/curves
- Design of Construction of road
- Impact on Livelihoods
- Disruption of access to clean drinking water and water for crops and livestock

284. Total land to be acquired or transferred to achieve encumbrance-free RoW is 1.398 ha. The land acquisition is to be done mainly on the hairpin bends, side treatment of the roads etc. The details of total land impacted at each individual corridor is mentioned in **Table 4-3**.

Table 4-3: Land Requirement

Corridor/Bridge	Total Area (sq. mtr.)	Total Area (ha)
E1	1843.7447	0.184
E4	1419.90	0.142
S1	2169.0271	0.217
S6	494.62	0.049
W10	2912.8297	0.291

Corridor/Bridge	Total Area (sq. mtr.)	Total Area (ha)
Br04	1531.1023	0.153
Br06	2399.999	0.240
Br08	1210.211	0.121
TOTAL	13981.4394	**1.398**

Assessment

285. Depending on the extent of land acquired and the socio-economic value of the land and diversion of forest, these impacts are significant but can be mitigated through fair compensation and resettlement for affected individuals, afforestation programs, and active community engagement to provide alternate livelihoods and afforestation on land on twice area of impacted and plantation of tree in 1:2 ratio.

286. For all other private assets, such as hand pumps, wells, etc., refer to the Resettlement Plans for E1, E4 and S6 corridors.

Table 4-4: Displaced Households, Affected Private Structures and CPRs (Affected)

Sl. No.	Corridor No.	Total Structures	Acquisition Area in Sq. mtr.	Acquisition Area in Hectares	Affected CPRs
1	E1	1	1843.74	0.1843	0
2	E4	0	1419.90	0.1419	5
3	S1	0	2169.02	0.2169	4
4	S6	0	494.62	0.0494	0
5	N9	0	0	0	2
6	W10	0	2912.82	0.2912	1
7	Br 04	0	1531.10	0.1531	0
8	Br 06	0	2399.99	0.2399	0
9	Br 08	0	1210.21	0.1210	0
Total		**1**	**13981.4**	**1.3977**	**0**

4.1.2 Impact on Forest and Flora

Construction Phase

Description

287. The assessment of natural and modified habitat is provided in section 2.21 of Annexure 20-CHA. The assessment acknowledged the discrepancies between estimates using different methods and the challenges given the very steep topography and down slope impacts of soil wasting, slippage, and construction stage slope instabilities. As a result, a case study approach estimated approximately 51.48 ha may be converted from natural habitat to modified. The true amount of natural habitat was recommended to be reevaluated after construction stage to set accurate forest and habitat restoration targets.

288. The Critical Habitat Assessment, Annexure 20, acknowledged the importance of these mid elevation forests.

289. According to ADB's SPS, "In an area of natural habitats, there must be no significant conversion or degradation, unless (i) alternatives are not available, (ii) the overall benefits from the project substantially outweigh the environmental costs, and (iii) any conversion or degradation is appropriately mitigated." The detailed analysis of alternatives is provided in Chapter 5. That assessment confirmed that no feasible alternatives are available. Each road section was screened against available right of ways, landslide risks, and habitation patterns. As a result, the final alignments were kept inside the existing RoW as much as possible. It is clear, alternative or new alignments would cause greater habitat loss, hence the least impact is to improve the current alignments.

290. Secondly, the project benefits clearly outweigh environmental costs as upgrading the all-weather roads will shorten travel time, reduce accidents and improve access for emergency and school transport bringing direct social benefits to the local community. The slope stabilisation and drainage measures will cut recurrent landslide risk, potential damages, and eventually reduce associated sediment loads in the downstream rivers, thus delivering co-benefits. The economic benefits are explained in section 4.1.18.

291. Importantly, appropriate mitigations have been described in the BAP to address the conversion and degradation of forest lands via compensatory plantation of 1:2 ratio, integration of wildlife passage structures, restoration of CH and corridors, rescue and recovery for Threatened species, and a number of other measures. These include mitigations for lesser impacts including suppression of dust, noise barriers at the sensitive receptors. The safeguard measures budgeted in the BAP, Annex 20, direct $310,500 towards mitigations for natural and critical habitat conversion or degradation.

Table 4-5. Landcover in Hectares within small scale EAAA (10 M buffer) for each road reported in Hectares.

	Natural (Ha)		Modified (Ha)						
Name	**Water**	**Trees**	**Bare Ground**	**Range land**	**Built Area**	**Total**	**% Modified**	**% Natural**	**Road length (KM)**
N9	0	2.13	2.12	0	0.11	4.36	51.15	48.85	2.04
W10	0	9.18	3.44	0.74	0.29	13.65	32.75	67.25	6.39
BR-8	0	7.03	0.28	1.75	0	9.06	22.41	77.59	4.23
BR-4	0	4.27	0	4.97	0	9.24	53.79	46.21	4.38
S1	0	33.09	2.55	12.58	0.05	48.27	31.45	68.55	22.74
S6	0	8.28	3.24	18.8	1.14	31.46	73.68	26.32	14.80
BR-6	0.13	6.68	1.35	0	0.5	8.66	21.36	78.64	4.05
E4	0	33.22	11.72	0.07	1.37	46.38	28.37	71.63	21.75
E1	0	18.22	0.76	0	0	18.98	4	96	8.89

Forest areas & Protected areas:

292. No project roads fall within the boundary of a Protected Area including Ecosensitive/Buffer zones. (e.g. Wildlife Sanctuary or National Park). No land will be required from any Protected Area for the implementation of the project. Although some National Parks/ Wildlife Sanctuary are located within a 5 km radius of the project roads, none of these overlap the Projects direct footprint nor intersect the smallest Ecologically Appropriate Area of Analysis evaluated in the Critical Habitat Assessment (Annex 20). Therefore no wildlife clearance shall be applicable under the project.

293. The diversion of forest land is regulated. Forest department prescribes a set of measures to be implemented by the user agency to ensure that there is no net loss incurred due to diversion of forest land, which include (i) payment of Net Present Value (NPV) (ii) allocation of at least equivalent or double degraded land for development of forest area, and (iii) compensatory afforestation. These are requirements for obtaining forest clearance.

294. Clearing and grubbing is the foremost impact to forests, flora, and fauna at the start of construction which will disturb a range of vegetative species and organisms ranging from large mature trees to plants and animals. The impacts due to clearing and grubbing include:

- Loss of vegetative cover ranging from large mature trees to small plants.

- Loss of natural and critical habitat, increased landscape fragmentation and barrier effects.
- Loss of productive topsoil.
- Changes to slope stability and hydrologic flows
- Dust generation which affects both human and environmental VECs.

295. Impact on Trees: A total of 5815 trees have been enumerated in proposed ROW that will be removed. The trees are common species within Sikkim and northeastern area of Himalayan region and none of them are rare, Endangered, or Threatened.

Assessment:

Table 4-6: Trees within ROW

Sl. No.	Name of Corridors	Total no of trees located within ROW
1	E1 (8.9 km)	524
2	E4 (21.76 km)	2225
3	S1 (22.65 km)	1635
4	S6 (14.79 km)	599
5	N9 (2.10 km)	10
6	W10 (6.12 km)	762
7	Br04	40
8	Br06	10
9	Br08	10

Table 4-7: Impacted Trees in Project Corridor

Name of Corridors	Total no. of trees located within ROW	Girth wise impacted trees*					
		Tree Ø300-600	Tree Ø600-900	Tree Ø900-1200	Tree Ø1200-1800	Tree Ø1800-2700	Tree Ø2700 - Onward.
E1 (8.9 Km)	524	44	91	230	119	36	4
E4 (21.76 km)	2225	78	925	749	395	73	5
S1 (22.65)	1635	139	411	623	266	179	17
S6 (14.79)	599	99	215	206	53	26	0
N9 (2.10)	10	-	-	-	-	-	-
W10 (6.12)	762	35	282	270	108	65	2

Trees less than Ø300 were not enumerated.




Trees within RoW @E1 **Trees @E4** **Trees @W10 road**


Trees @S6


Trees @S1


Trees @N1


Tree sampling

Figure -4-1. Trees within Row

296. Forest diversion is required for the sub-projects. The selected alignment (all six corridors) will involve diversion of 1.28 ha of Forest land as per the survey conducted for the designed road.

Table 4-8: Additional Area Required for Forest Clearance from under Forest Department

Name of Corridors	Lengths (km)	Non notified forest area (Khasmal, gaucher)[4] ha	Notified forest area (Reserve Forest)[5] ha
E1	8.9	0.139	0
E4	21.76	0.086	0
S1	22.65	0.217	0
S6	14.79	0.033	0
N9	2.04	0	0
W10	6.12	0.291	0
Br 04	-	0.153	0
Br 06	-	0	0.24
Br 08	-	0	0.12
Total		0.919	0.36

297. The notified and non-notified forest land is distinguished by its legal status and level of protection by the government. The notified forests are Reserved forest, Protected Forest, Wildlife Sanctuaries/ National Parks. The non-notified forest land include Khasmal and Gaucharan land. Khasmal forest is forest land settled and set aside by the Government for meeting the bonafide domestic need of timber, firewood and fodder of the residents of adjoining villages. The Gaucharan land is forest land used by the community for the purpose of grazing land.

298. The forest land has been verified with the forest maps of the forest department. The Reserved Forest boundaries are defined in the forest maps of Government of Sikkim. Same has been referred for the identification of the forest map. The clearance of the notified forest land and non-notified forest land is obtained from the forest department.

[4] The notified and non-notified forest land is distinguished by its legal status and level of protection by the government. The notified forests are Reserved forest, Protected Forest, Wildlife Sanctuaries/ National Parks. .

[5] The non-notified forest land include Khasmal and Gaucharan land. Khasmal forest is forest land settled and set aside by the Government for meeting the bonafide domestic need of timber, firewood and fodder of the residents of adjoining villages. The Gaucharan land is forest land used by the community for the purpose of grazing land.

299. In E4 (Khamdong Linzey – Tintek), the Fambong Lho Wildlife Sanctuary is within 400m but the project is falling outside the Eco sensitive zone boundary may have impact on natural habitat. Forest Clearance is not required for works within the existing Right of Way (ROW) but working permission will be required for S1. In S1 Melli-Phong via Rateypani, S6 Assangthang Salghari to CCCT Nandugaon, W10 (Geyzing to Sakyong) Tree cutting / Forest approval is likely required. The distances of all roads to the nearest protected areas have been verified based on spatial data provided by official sources (eg. Sikkim Forest Department). The findings are given below:

Table 4-9: Forest and Reserve Forest Proximity, Nearest Wildlife/National Park

Sl. No.	Name of Road	Length of road (km)	Road passes through Reserve Forest	Nearest Wildlife Sanctuary/ National Park *(Approx. Shortest Distance as per GIS measurement)*
1	N9 Mangan Bazaar to DAC	2.04	No RF	Kanchendzonga National Park (4.6 km)
2	S1 Melli - Phong via Rateypani	22.65	Melli RF Payong RF Sunatalay RF	Kitam Bird Sanctuary (7 km)
3	S6 Assangthang - Salghari to CCCT Nandugaon	14.79	No RF	Kitam Bird Sanctuary (4 km)
4	E1 Rorathang Rongli	8.9	No RF	Pangolakha W.S. (1.5 km)
5	E4 Khamdong-Lingzey- Tintek	21.76	No RF	Fambonglho Sanctuary (0.8 km);
6	W10 Geyzing to Sakyong	6.12	No RF	Barsey Rhodendron Sanctuary (5.8 km)
7	Br 04 Bhaley Khola Sirsiray - Kalung Dara	60	No RF	Maenam Sanctuary (3.0 km)
8	Br 06 Ramam River along Nayabazar Singla Road Km 0.0 to 1.0 Ch. 22	100	Jhum RF Salghari RF *RF areas are on approach roads*	Kitam Bird Sanctuary (3.5 km)
9	Br 08 Bridge over Andheri Kholcha along Manpur Fatak to Jorethang Road	60	Bharikhola RF Manjhitar RF Salghari RF	Kitam Bird Sanctuary (7.2 km)

Table 4-10: Impact and Severity of Forest Impacts

Aspect	**Impacts**	
Impact Description	**Impact on trees**	**Forest and protected area**
Receptor Importance/ Sensitivity	High	High
Extent	Core Zone	Core Zone
Duration	Permanent	Permanent
Frequency	Single event	Single event
Likelihood	Certain	Certain
Reversibility	Irreversible	Irreversible
Magnitude/ Severity	Small	Medium
Effect	Negative	Negative
Direct/ Indirect	Direct	Direct
Significance	Major	Major

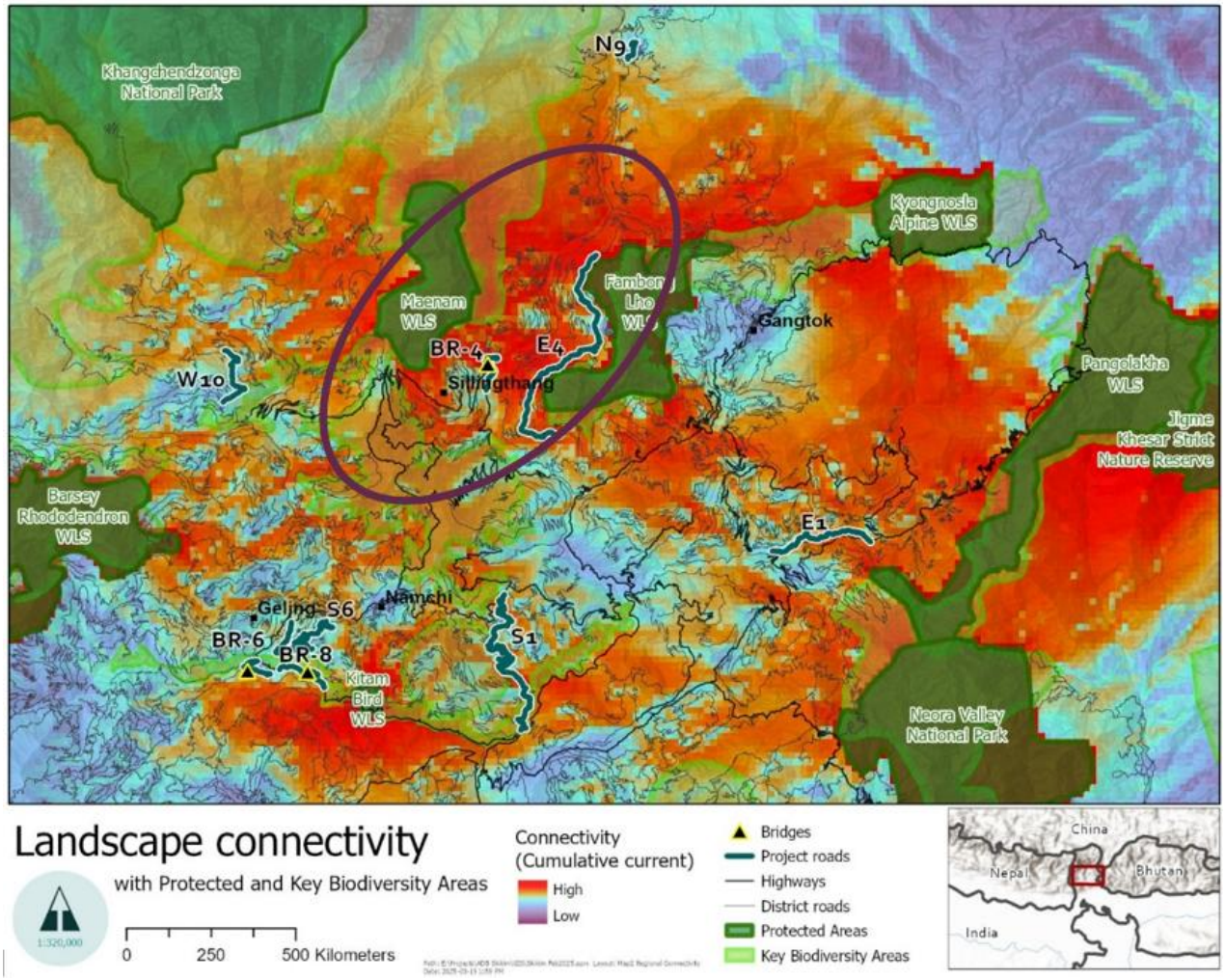
Aspect	Impacts	
Additional Mitigation (Y/N)	Y	Y
Residual Significance	Minimal	Nil

300. Regarding the significance of impacts to forests and flora, the mid to low elevation forests and riparian areas are not well represented in Sikkim's network of protected areas, making the species and habitats particularly vulnerable. Protected areas in the region are primarily centered on higher elevation zones such as the Khangchendzonga Biosphere Reserve. Only one protected area in Sikkim is found at low elevations (e.g. below 1,500 masl. Kitam Bird Sanctuary), whereas the Project roads fall between 180 and 1600 MASL (Appendix 20. Table 2).

301. The very moist Sal bearing forests found at low elevations along S1, BR8, and BR6 are rare for Sikkim. This forest class makes up only 1.1% of the forest cover in Sikkim based on a 2009 forest classification map developed by the Dept. of Forests in Sikkim. The 3C/ C3b East Himalayan Moist Mixed Deciduous Forest type found along a five Project roads (E1, S1, S6, BR4) makes up 4.1% of the forest cover in Sikkim. These low elevation forests found along portions of the Project roads are under severe anthropogenic pressure and are being converted to urban, bare land, and agricultural land cover types which indicates the conversion of Natural forest areas to modified human use and infrastructure (Kanda and John 2018). Furthermore, these low elevation areas are not contained within the network of Protected Areas, with only Kitam Bird Sanctuary being found at low elevation.

302. At the same time, information found below (see Biological Environment) supports the finding that the forests still hold the native plant and animal species including top predators and endemic species, and where humanactivity has not modified the area's ecological function, thus the areas have been classified as Natural habitat above are vulnerable to a number of impacts beyond simple forest conversion. These include habitat fragmentation and barrier effects (eg. foraging, dispersal, and migration).

303. It is estimated that habitat fragmentation may affect an area of 1,200 km² (based on a minimum convex polygon). While fragmentation impacts need to be minimized across landscapes, of particular concern are areas between protected areas and reserved forests. The road segments E4 and BR04 are aligned between Fambong Lho and Maenam WLS and intersect an east-west corridor connecting these two PAs ().



Mitigations:

1. Afforestation and reforestation programs to offset the loss of forest cover. Geometric adjustment till final design by the contractors will be made to minimize affected trees. Further, tree cutting will be restricted to toe line of the formation width without compromising road safety elements. The mandatory compensatory plantation will be done on 1:2 basis by the Forestry Department and cost will be charged under the NPV. No tree will be uprooted without prior approval of competent authority.
2. Necessary clearance as per prevailing regulatory provisions (FC act 1980) shall be taken under the project. Without prior clearance, no work shall be commenced in the forest notified areas. The necessary cost of afforestation, net present value and other additional cost of maintenance as suggested by forest department while in approval shall be submitted. The work will commence only when the diversion of forest land is granted by the Regional MoEF&CC office Shillong. The joint verification of the land is under process and after that forest diversion application shall be done.
3. NPV is monetary value of the ecological and environmental services that are lost when forest land is diverted for non-forest use. It is one-time payment made by the project proponent in this case it is R&BD as part of forest clearance under the Forest (Conservation) Act, 1980. This covers the loss of forest land and trees. The NPV is determined by the Nodal Officer of the Forest Department and R&BD department will pay the amount. Subsequently the forest department will carry out the mitigation measures.
4. The allocation of degraded forest land will be done by the forest department, and its cost will be charged under the NPV.
5. This report recommends specific design modifications to avoid and minimize impacts for a wide range of species. These modifications to the DPR designs include wildlife passage structures, traffic calming measures including speed reductions, and generic wildlife warning signs. Many of these modifications are located in corridors and areas holding populations of Endangered species (Table 4). These measures aim to minimize landscape fragmentation and mortality risks for Endangered species and local biodiversity.

6. These design changes are largely based on the guidelines established in India's Wildlife Friendly Infrastructure guide (WII 2016) and the Green Infrastructure Design Guidelines (ADB 2019), which establish minimum sizes and spacing for wildlife passage structures and recommend other mitigations where linear infrastructure development threaten biodiversity. From these guiding documents, the minimum size for cross drainage structures where Chinese pangolins are present is 2 m square, with a spacing based on an estimated home range of 1 km². The recommendations listed in Table 4 and figures 14 to 18 include minor changes to existing cross drainage structures but in two cases include the addition of small box culverts.

Operation Phase

Description

304. The tree species planted against trees cut will improve the canopy cover of the area. Only local species of trees will be planted under compensatory afforestation program. It will also improve the regional ecology and will provide habitats for avifauna and mammals.

305. All other impacts to Forest environment occur within Construction Phase.

Mitigations

None

4.1.3 Biological Environment (terrestrial)

Construction Phase

Description

306. Field studies documented species richness including 29 different species of mammals, 32 birds, 24 reptiles, 14 amphibian, and 8 fish species occurring along project roads. The richness is not surprising considering the entire area falls within the Himalayan biodiversity hotspot. The richness and diversity of fauna detected demonstrate the high biological intactness and integrity of the area.

307. Scientific reports, camera trap photos, and clusters of Chinese pangolin burrows established their general occurrence within the Project areas. The species was not found in high densities but rather clustered in specific locations. The species is very rare, cryptic and hard to detect. No global population estimates exist and estimating the species abundance was not feasible.

308. Therefore habitat modelling was used to delineate critical habitat areas occurring along five project roads were estimated to total 50.76 ha within the road rights of way. An indirect and induced impact area was estimated to extend out 1,500 m increasing the amount of critical habitat to 6,359.68 ha. A cautious estimate of the amount of deterioration of critical habitat due to indirect impacts was set at 10% based on recorded avoidance and additional mortality reported for other species (McLellan and Shackleton 1988; Forman et al., 2002; Gagnon et a., 2007). Thus 0.1 * 6359.68 = 635.968 ha which reveals the significance of accounting for road impacts after incorporating considerations of animal behaviour, changes in habitat near road edges, increased traffic and noise, increased human and domestic animal presence, and other effects commonly described as the road effect zone.

Assessment

309. During the construction phase, the heightened human activities and associated works are projected to cause disturbance to local wildlife. Two Critical Habitat qualifying species (Chinese pangolin and Golden mahseer) were detected along multiple road projects. It is expected that some direct mortality and displacement of Chinese pangolin and their burrows may occur due to the excavation, and other earth works. Areas currently occupied by Chinese pangolin intersect the ROW along E1, E4, S1, and BR04. An estimate of critical habitat for Chinese Pangolin is provided in Table 4-11.

Table 4-11: Critical Habitat estimates (Hectares) for Chinese pangolin within two Ecologically Appropriate Areas of Analysis based on Direct impacts and indirect impacts.

Name	Type	Rd. Length (M)	Small EAAA (<10 M) Ha	Medium EAAA (<1500 M) Ha
N9	Upgrade	2036.7	1.17	465.86
W10	Upgrade	6385.9	8.44	789.92
BR-8	Resurface	4233.9	0	0
BR-4	Resurface	4381.1	0	113.49
S1	Upgrade	22745	8.72	1210.1
S6	Upgrade	14795.6	7.11	537.47

BR-6	Resurface	4050.2	0	0
E4	Upgrade	21747.5	25.32	2752.44
E1	Upgrade	8888.9	0	490.4
Total		**89,264.80**	**50.76**	**6,359.68**

310. Based on habitat mapping for Chinese pangolin, the most significant construction stage impact will be the conversion of 50.76 ha of Critical Habitat to highly modified road surface, ROW, and other disturbed areas resulting in unsuitable habitat. Individual animals may still occasionally occur or move through these zones but with greatly increased mortality risk. Reduced movement and increased mortality falling along road projects between protected areas was also identified as a direct impact where mitigations were needed (e.g. along E4 and BR04).

311. These results are based on a detailed landcover and connectivity analyses presented in Annex 20, which determined that the project will affect the ground and canopy cover of an area at least twice as large as the existing road. The area of 1.280 ha reported above is only for notified reserved forest lands as described in table 4-6. The natural habitat and Critical Habitats that are adjacent to the Project roads include private lands and Non-notified Forests.

312. These assessments considered both the direct impact area, including the footprint of construction activities where losses will be permanent as well as road verges where some of the impact will be temporary.

313. Satellite images of recently completed road projects nearby were analysed to determine the amount of habitat converted. It was found that the area disturbed by construction was twice as large as the final paved surface. The extent of visible disturbance extending outwards was due to road design details including increased roadbed and slope treatments. Disturbance to natural habitat was further exacerbated by the extremely steep topography and excess soil originating from hill cutting for road construction. Muck disposal methods also appear to contribute to the amount of additional ground and forest area impacted.

314. The 50.76 ha of Critical Habitat loss estimated represents the best available estimate prior to construction. Final amounts of habitat affected should be updated after clearing and grubbing have been completed. Final determination of habitat area affected is not possible due to construction practices, topography, slope instabilities, and debris/ muck disposal realities at the site level.

315. Furthermore, roads cause habitat degradation indirectly to the functionality and quality of habitats at distances extending outwards from the roads' physical footprint. The area impacted was estimated based on the species and biophysical characterises to include areas within 1,500 M of the project road centrelines. This area of indirect impacts, often referred to as the road effect zone was used to estimate the amount of habitat affected for Chinese pangolin.

316. The amount of reduced effectiveness in habitat quality inclusive of increased mortality risk for Chinese pangolins was estimated to be 10% (McLellan and Shackleton 1988; Forman et al., 2002; Gagnon et a., 2007). This number was used to calculate an area impacted 0.10 x area within 1500 M of project roads classified as Critical habitat. The 10% deterioration rate was determined based on an analysis of various indirect impacts such as changes in animal behaviour, habitat alterations near road edges, increased traffic and noise levels, heightened human and domestic animal presence, and other effects associated with the road effect zone. This rate is aimed to cautiously estimate the overall impact on critical habitats. While it is intended to be conservative, it incorporates multiple aspects based on both the civil works designs, projected traffic volume, and wildlife behaviour.

317. The estimate is a cautious worst-case scenario developed to ensure thorough impact assessment and a full accounting.

Figure 4-2. Chinese pangolin detected 30 M from S1 Project Road in October 2024

Table 4-12: Habitat loss fauna

Criteria	Particulars
Habitat Quantity	**50.76 ha** of Critical Habitat within forest habitat areas shall be impacted due to the implementation of the proposed project. This is the area expected to be highly modified resulting in unsuitable habitat for qualifying species. Individual animals may occur or move through these zones but with increased mortality risk.
Duration/phase	Permanent/Construction phase.
Reversibility	Irreversible
Magnitude	Severe
Overall degree of impact	Severe

318. The presence of workers, food, and construction waste may attract some wildlife species (e.g. macaque, wild pig, and others), leading to habituation, human-wildlife conflict, and mortalities. Effective waste management practices, worker training, and wildlife protection measures are essential to mitigate these impacts.

319. ADB's SPS states "Do not implement project activities in areas of critical habitats, unless (i) there are no measurable adverse impacts on the critical habitat that could impair its ability to function, (ii) there is no reduction in the population of any recognized endangered or critically endangered species, and (iii) any lesser impacts are mitigated." The environmental assessment confirmed that the project roads have been designed so avoid and minimize the likelihood the project would cause a reduction in the population nor impair the functionality of the habitat. Given the mitigation plan, the stretches that overlap with Critical Habitat will continue to function. Compensatory measures including rescue/recovery, in-situ conservation, and population recovery related research is detailed in the BAP with budgeting related to the amount of habitat and number of individuals potentially affected. Habitat suitability and landscape connectivity modelling identified corridors linking Fambong Lho and Maenam Wildlife Sanctuary where forest restoration and community lead conservation measures are prescribed to ensure corridors remain functional. The area of impact is small relative to the potential across the Himalayan foothills and thus measurable functional loss of corridor connectivity is very unlikely. Modification of culverts have been incorporated to facilitate movement and reduce the likelihood of roadkills for a range of species including Critical Habitat qualifying species. Consequently, no reduction in population of either Endangered or Critically Endangered species is anticipated.

320. Thus the project satisfies ADB SPS by i) avoiding any measurable adverse impact on critical-habitat functionality through alignment optimization and ecological supervision during construction and operation; ii) preventing population declines of recognized species via species-specific BAP; and iii) fully mitigating lesser, short-term impacts through compensatory afforestation, twice-area forest offsets, and long-term monitoring as per BAP/EMP.

Mitigation Measures:

1. About 11,630 trees shall be planted for loss of 5,815 trees. Compensatory afforestation by plantation will be carried out by twice the number of trees cut/removed. The forest department shall check for suitability of such land. Young trees will be uprooted and will be replanted in the identified area.
2. For safe traffic operation, vertical clearance between the crown of the carriageway and lowest part of overhang of the tree available across the roadway shall conform to the standards laid down in IRC: SP: 21-2009. The pit size, fencing, watering, and manuring requirements shall also conform to the above standard.
3. Clearance of vegetation
    a. Reference to Solid Waste Management Rule, 2016, Air (Prevention and control of Pollution) Act, 1981 and National Green Tribunal landmark order in 2017, a complete prohibition on open burning of waste (including leaves / crop residue) on land throughout country. Violators are liable for environmental compensation. So, the vegetation clearance or any disposal of waste shall not be done by burning anywhere in the project. However, it will be disposed at the identified dumping location.
4. To protect pangolin burrow clusters, construction activities will avoid areas identified as critical habitats where Chinese pangolin burrows are detected. This includes taking precautions during excavation to prevent disturbing these areas. Consultation during site visits indicated that there is an awareness about burrow locations.
5. The project design incorporates the provision of widened culverts which will serve as corridors to facilitate the safe movement of pangolins, across roads. These corridors are aligned with the landscape connections between Fambong Lho and Maenam Wildlife Sanctuaries. They serve as key dispersal routes for wildlife, ensuring that pangolins and other species can move freely without the risk of mortality or habitat fragmentation.
6. Studies to monitor pangolin activity and habitat use throughout the construction phase and post-construction periods is needed. The monitoring will include camera trapping and other field methods to track pangolin presence, distribution, and behaviour along the project roads.
7. Contractors and workers will receive education and awareness training which includes a chance find reporting procedure due to the conservation significance of species likely occurring along the Project Roads.
8. Bird surveys, specifically nest surveys should be conducted in the year of and prior to forest clearings.
9. Joint training should be held between the Forest Department and Labors to handle forest fire, if so happens.
10. The LPG gas should be provided in the labor camps for cooking of food, and for other domestic usage. No fire wood should be allowed inside the labor camps.
11. The Telephone/Mobile number for DFO, Ranger, and Forest Guard should be with the supervisor or should be written on notice boards, so that if young of animals are reported or trapped, they are intimated to the concern officers.
12. No nighttime construction works or aerial lighting should be allowed. No uncontrolled blasting should be carried out.
13. If wildlife are detected along the construction works, they should be allowed to continue their natural movements without any intervention.
14. The labor should not discard any waste material of food items near the construction site, as this mayattract animals and consumption of plastic may lead to death. The contractor should take care that proper dustbins be provided near the construction site and are carried away from the labor camps . The discarded food materials and households' items should not be discarded in the low-lying area or near the workers camps.
15. Labor camps and other construction sites should not be established within areas designated as Critical Habitat, Reserved Forests, or other sensitive areas identified herein or as advised by the Sikkim Department of Forests.
16. No D.G. sets or operation will be allowed within 500 M of Critical habitats, Reserved Forests, or other sensitive areas identified herein or as advised by the Sikkim Department of Forests. The Silence Zone noise level standard be maintained during night.
17. Safety zones of at least one km should be maintained for establishment of Hot Mixed Plant, Ready Mix Plant, staking yard and machinery storage area.

18. Construction works should be suspended during monsoon season on riverbanks, streams, and surface water bodies. The over burden should be removed before the onset of monsoon seasons. These and other measures should be reasonably conducted to prevent runoff spoil soil, silt, and other pollutants from entering river systems.
19. Silt fencing should be installed during construction phase of the project roads at locations of perennial steams. Silt fencing should be maintained to prevent direct run-off from construction areas into surface water bodies.
20. The avenue plantation is not part of the cross sections of the road improvements, and it will be determined depending on the availability of right of way.
21. Specific design modifications to avoid and minimize impacts for a wide range of species have been incorporated into the projects design. These modifications include construction of wildlife passage structures, traffic calming measures to reduce vehicle speeds, and wildlife warning signs in Critical Habitat areas and movement corridors between Protected Areas. (see Annex 20, Table 4).

Operation Phase

Description

321. During operation phase, highway traffic and human movements will negatively affect wildlife through increased roadkill and disruption of movements. Together these two forces are often referred to as barrier effects which incorporates the impact of roadkill on successful wildlife movements although roadkill are a separate and additive impact.

322. Roadkill currently is uncommon and primarily limited to small mammals, reptiles, and amphibians. Road improvements resulting in increased speeds and traffic volumes will result in increased roadkill. Threatened and Endangered species moving across project roads falling between protected areas will be at increased roadkill risk (e.g. red panda, Chinese pangolin).

323. The road segments E4 and BR04 are aligned between Fambong Lho and Maenam WLS and intersect an east-west biological corridor connecting these two protected areas. Corridors were modelled with the goal of identifying areas that support large-scale movement of mammals (e.g. red panda, clouded leopard, leopard, Himalayan goral, and others) known to occur in otherwise isolated protected areas.

324. The nearby protected areas and the reserved forests serve as core habitat areas and source populations for numerous Threatened species living in and moving through the unprotected areas. Corridors and connectivity are key components of healthy functioning ecosystems. They enable wildlife to forage, breed, and disperse across large areas interspersed between protected areas.

325. The road projects falling between these corridor areas creates both perceived and real barriers. Perceived barriers because wildlife are wary and thus will not cross areas with traffic. As well physical barriers including concrete retaining walls and vertical rock cuts as tall as 6 M create challenges for some species to move across the planned roads. Additionally, real mortality risk from both vehicles and other anthropogenic risks (e.g. hunting, feral dogs) pose a danger and inhibit wildlife movement. Together these factors negatively affect the populations for multiple species by compounding both increased mortality and genetic isolation.

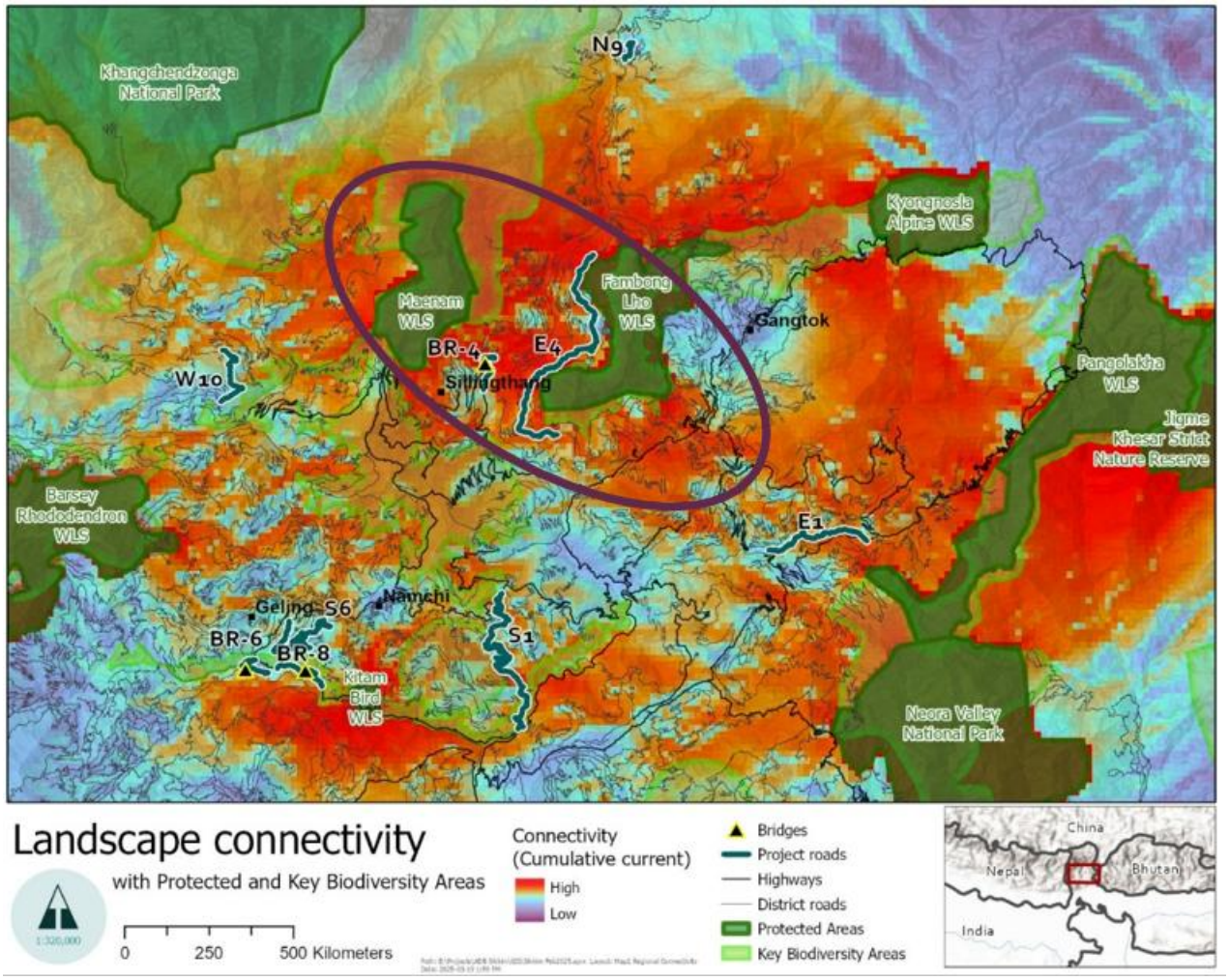


Figure 4-3. Connectivity between protected areas based on landcover and elevation developed using Circuitscape. The purple circle denotes the corridor affected by BR4 and E4.

Table 4-13: Impact on biodiversity during operation phase

Aspect	Impacts
Impact Description	**Road mortality and reduced connectivity**
Receptor Importance/ Sensitivity	High
Extent	Regional to international spatial extent
Duration	Permanent
Frequency	Single event
Likelihood	Likely
Reversibility	Reversible
Magnitude/ Severity	Low
Effect	Negative
Direct/ Indirect	Direct / Indirect
Significance	Moderate
Additional Mitigation (Y/N)	Y
Residual Significance	Low

Mitigations

1. The location of afforestation works should be as much as possible within the Critical Habitats and corridors identified in this report.
2. The location of forest restoration should consider the regional connectivity between protected areas and reserved forests to support regional corridor restoration. The location of forest compensation should be identified in collaboration with the Forest Department, Government of Sikkim with the caveat that they target functional corridors at mid to low elevations outside protected areas in Sikkim.
3. To account for the increased risk of roadkill and to evaluate the effectiveness of structural mitigations, a statewide roadkill monitoring project will be supported via App development, reporting, and data management.
4. Design modifications to the DPR include wildlife passage structures, traffic calming measures including speed reductions, and wildlife warning signs. These modifications are located in corridors and areas holding populations of Endangered species (Annex 20, Table 4). These measures aim to reduce the barrier effects and mortality risks for Endangered species and local biodiversity.
5. Not all impacts, including habitat loss, could be mitigated via structural solutions, therefore compensatory programs have been developed to provide for any remaining residual impact. These programs and projects include:
    5.1. The location of forest restoration works should be within Critical Habitats and corridor areas. The location of forest restoration should consider the regional connectivity between protected areas and reserved forests to support regional corridor restoration.
    5.2. Habitat restorations should target mid to low elevation areas highlighted in Figure 4, which are under-represented in the protected areas in Sikkim.
    5.3. Provide funding support to wildlife rescue and rehabilitation via facilities existing in NE India, for example Assam, veterinary specialists, training, and providing transport equipment.
    5.4. Fund *in situ* conservation and research on Chinese pangolins in Sikkim.
    5.5. Support community awareness and education programs for Threatened species, road effect on wildlife, and reporting roadkills to enable long-term state-wide conservation.

4.1.4 Aquatic Environment

326. The construction of roads particularly when adjacent to riparian zones (eg. rivers and streams) can significantly impact fish spawning areas. This can be due to potential damage and disruption to the stream bed, movement of rocks and vegetation, as well as inputs of gravel, soil, and other spillage which reduces habitat for aquatic life. See **Table 4-15** discussing the aspect impact on spawning is presented below.

Table 4-14: Impact on biological environment during construction phase

Aspect	**Impacts**
Impact Description	**reduced habitat quality and quantity**
Receptor Importance/ Sensitivity	High
Extent	Primarily downstream, watershed to regional spatial extent
Duration	Permanent
Frequency	Single event
Likelihood	Certain
Reversibility	Reversible
Magnitude/ Severity	Low
Effect	Negative
Direct/ Indirect	Direct / Indirect
Significance	Moderate
Additional Mitigation (Y/N)	N
Residual Significance	Low

Mitigation Measures:

Assessment

327. To maintain the aquatic balance of hydraulic flow and maintain the natural drainage system, a number of culverts, bridges and minor bridges will be implemented in the Project. Additionally, the following measures will be implemented:

- No construction work during monsoon season
- Care should be taken that all the cutting and digging work should be carried out during the lean month of the year, when water volume and flow is minimum.
- Before start of work on the river bed a cofferdam should be installed, this will prevent increase in siltation load in river bed.
- The labours should not be allowed to install gill traps or fish gears to trap fishes on the river bed near construction site.
- No vehicles washing should be allowed in the river bed. This will result in river water pollution.
- PWRD will participate in development of a conservation management strategy for Golden mahseer and aquatic biodiversity. The work would identify the roads and important river stretches in the Sikkim that may require specialized engineering solutions or instream works to maintain or restore fish habitat and stream connectivity.
- The project corridors fall under Teesta and Rangeet River basins. Species identified within the rivers and streams intersecting the project roads included Golden mahseer (*Tor putitora*) through use of eDNA methods.
- The Endangered Golden mahseer is an important migrant in Himalayan Rivers, which migrates from warmer plains to the high reaches in cold water regions. Mahseer is a true potamodromous migrating fish in Sikkim, travels a long distance from Teesta barrage (foothills) to Rangeet, Teesta and Rangpo Chu during the late summer to monsoon months for breeding. The water turbidity, temperature and nature of riverbed are considered to be important stimuli for the migration of mahseer. Most brooders of mahseer are found to prefer river Rangeet for spawning. The fingerlings and juveniles live in these rivers till next September to mid-October and descend to water of plains, while adults after spending whole summer and monsoon in these streams return to warmer waters. The Rangeet up to Jorethang has been identified as breeding grounds for mahseer while in the Teesta river, they are found up to Singtam.
- Other locally important fish species detected include Katley (*Neolissocheilus hexagonolepis*) and Asala (*Schizothorax richardsonii*). *A*quatic surveys were conducted for the biodiversity assessment and by the State revealed a total of 10 species recorded during the study period. *Schizothorax richardsonii* emerged as the most widespread species (Table 4-XI).

Table 4-15: Fish Species found in Primary Survey

Local Name	Scientific name	S1	E1	E4	BR04	BR06	BR08
Golden mahseer	*Tor putitora*					✓	✓
Chuchay asala	*Schizothorax progastus*	✓	✓			✓	
Dothey asala	*Schizothorax richardsonii*	✓	✓	✓	✓	✓	✓
Khasray	*Barillus bendelensis*					✓	
Chirkay	*Barillus vagra*	✓				✓	✓
Bhitti	*Danio aequipinnatus*	✓					
Nakkatua Buduna	*Garra gotyla*	✓	✓				
Dothey Buduna	*Garra mcclellandi*		✓				
Gadela	*Noemacheilus sp.*	✓	✓				
Gadela	*Noemacheilius kangjupkhulensis*		✓				
Katley	*Neolissochilius hexagonolepis*	✓	✓				✓

328. Although, during a traditional Aquatic Survey conducted in March and April 2024 by the Sikkim State Fish Department in various water bodies around the project site, presence of Mahseer was not found in any of the locations. These results can be attributed to recent flash flooding in the region (October 2023) and a number of factors causing reduced populations including barriers to movement and migration and unsustainable harvest techniques.

329. There has been a decline in the diversity of fish in the river Teesta (Das and Mukherjee 2005). Menon et al. (2008) described 19 threatened species of India which also inhabit Teesta waters in Sikkim. Of these 15 species are rare and 4 species viz. *Anguilla bengalensis, Puntius clavatus, Ompak bimaculatus* and *Pseudeutropius* are considered to be Endangered.

4.1.5 Community Safety

Operation

Description

330. With increased traffic volume, communities including road users may be at risk due to road crashes in absence of adequate safety provisions such as crash barriers at accident prone areas. Safety provisions in accordance with IRC guidelines will be implemented under the Project. These include (i) speed breakers in habitat areas to regulate speed, (ii) retro-reflective warning signboards near schools, hospitals, and religious places, (iii) proper sidewalks/pedestrian zones along roads in habitat areas and near schools, hospitals, and religious places, and (iv) compliance with IRC codal provisions for state highways regarding curvature and grading. These measures are incorporated in the preliminary design and will be further reviewed and finalized during the detailed design stage by the EPC contractor. Provision of safety kerb at all bridges will also be implemented. The design should attempt to equalize cut and fill. R&BD is mandated to adhere to IRC guidelines and embed the requirements in the road design.

Assessment

331. Increase in economic activities results in ribbon development along highways. This may cause congestion to road users and increase in accidents. With increased traffic volume, communities including road users may be at risk due to road crashes in absence of adequate safety provisions such as crash barriers at accident prone areas.

Table 4-16: Aspect Impact table of Community Health & Safety – Construction Stage

Aspect	Impacts
Impact Description	Impact of road accidents on road users including local community
Receptor Importance/ Sensitivity	Medium-High
Extent	Core Zone
Duration	Temporary
Frequency	Regular
Likelihood	Certain
Reversibility	Reversible
Magnitude/ Severity	High
Effect	Adverse
Direct/ Indirect	Direct
Significance	Major
Additional Mitigation (Y/N)	Y
Residual Significance	Moderate

Mitigation Measures

332. Safety provisions in accordance to IRC guidelines which includes provision of (i) speed breakers in habitat areas to regulate speed, (ii) retro-reflective warning signboards near schools, hospitals, and religious places, (iii) proper sidewalks/pedestrian zones along the road near habitat areas, schools, hospitals, and religious places are included in preliminary design which will be further reviewed during detailed design by EPC contractor, and (iv)

compliance with IRC codal provisions of state highway for curvature and grading. Provision of safety kerb at all bridges will also be implemented. The design should attempt to equalize cut and fill. PWD shall explore options like avenue plantation and/or fencing and initiating regulatory provisions to stop encroachment of ROW.

- The location and type of crash barrier and curbs are determined as per the IRC:119-2015 Guidelines for Traffic safety Barriers.
- The fencing and regulatory provisions like notices to prevent encroachments like notice boards are determined at the time of operation.

Operation

Description

333. Lack of proper maintenance may deteriorate the road condition over the years resulting into numerous problems such as rise in accidents, disruption of transportation services, tree survival.

Table 4-17: Aspect Impact table of Community Health & Safety – Operation Stage

Aspect	Impacts
Impact Description	Impact of road accidents on road users including local community
Receptor Importance/ Sensitivity	Medium-High
Extent	Core Zone
Duration	Long Term
Frequency	Regular
Likelihood	Certain
Reversibility	Reversible
Magnitude/ Severity	High
Effect	Adverse
Direct/ Indirect	Direct
Significance	Major
Additional Mitigation (Y/N)	Y
Residual Significance	Moderate

Mitigation Measures

~~334.~~ PWD/PIU must allocate adequate resources and logistics to ensure that the road is being maintained and intended benefits are generated thereof.

4.1.6 Utility Shifting, Aesthetic and Visual

Construction

Description

335. Delay and unplanned shifting of public utilities like telephone and electrical poles, water pipelines, and OFC cables causes disruption of utility services to local community. Digging, shifting, and re- establishment of poles may also impair the view of community areas.

336. Of note are water pipes which have been built by local communities and individuals along Project roads where they pass under and at road grade. Water pipes have been constructed to pass overhead across the road via posts and trees as well as across the road via unofficial trenches dug into the road surface and subsurface. Generally, water utilities both official and unofficial were ubiquitous along all Project roads. An inventory of water pipes revealed a minimum of 139 locations where freshwater resources were being diverted across the road rights of way to human habitations. See detailed location of all water pipes in Appendix 20, Table 16. The surveys and interviews reveal that numerous springs, small streams and rivers are used by local peoples for irrigation, personal household drinking water, and livestock.

Assessment

337. With respect to project corridors, Waterpipe line, OFC, Telephone line, Transformer and Electric lines are affected along the project roads of E1, E4, S1, S6, W10 and N9.

Table 4-18: Aspect Impact of Utility Shifting, Aesthetic and Visual Impact

Aspect	Impacts
Impact Description	**Utilities, Aesthetics and Visual Impacts**
Receptor Importance/ Sensitivity	High
Extent	Buffer Zone
Duration	Temporary
Frequency	Single event
Likelihood	Certain
Reversibility	Reversible
Magnitude/ Severity	High
Effect	Negative
Direct/ Indirect	Direct
Significance	Negligible
Additional Mitigation (Y/N)	Y
Residual Significance	-

Mitigation Measures

338. All efforts shall be made to reduce the duration of utility shifting impact and restore the disturbed facilities and access. Clearly, drinking water is a vital life sustaining component of infrastructure. All utilities should be shifted before start of construction. Necessary permission and payments should be made to relevant utility service agencies and individuals to allow quick shifting and restoration of utility services. Visual barriers are to be provided, as necessary, on active construction zones. Consultation with affected people prior to the start of utility shifting, presenting construction timelines and guidelines should be conducted. Local people must be informed through appropriate means about the time of shifting of utility structures and potential disruption of services, if any.

4.1.7 Loss of access to drinking water and water resources

Description

339. Water pipes have been built by the local communities along Project roads where they pass under the road via bridges or culverts. Water pipes have also been constructed to pass overhead across the road via posts and trees as well as across the road via unofficial trenches dug into the road surface and subsurface. Generally, water utilities both official and unofficial were ubiquitous along all Project roads (**Figure 27**).

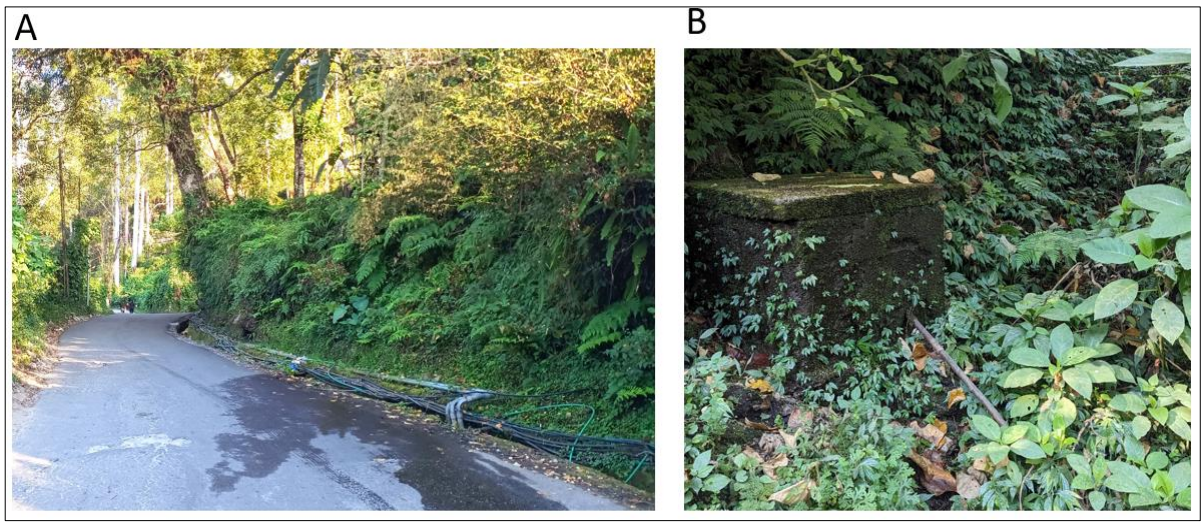


Figure 4-4. Examples of freshwater services established along the road the E4 ROW.

340. Fresh water has been piped along, under, across, and over Project roads with up to 20 pipes in some locations, while in adjacent forest areas cisterns and catchments have been built to ensure continuous water supply. Here A) shows many separate water lines installed by local communities and residents to divert water to home(s). While B) shows an example water catchment installed to provide siltation and continuous flow to a single water line.

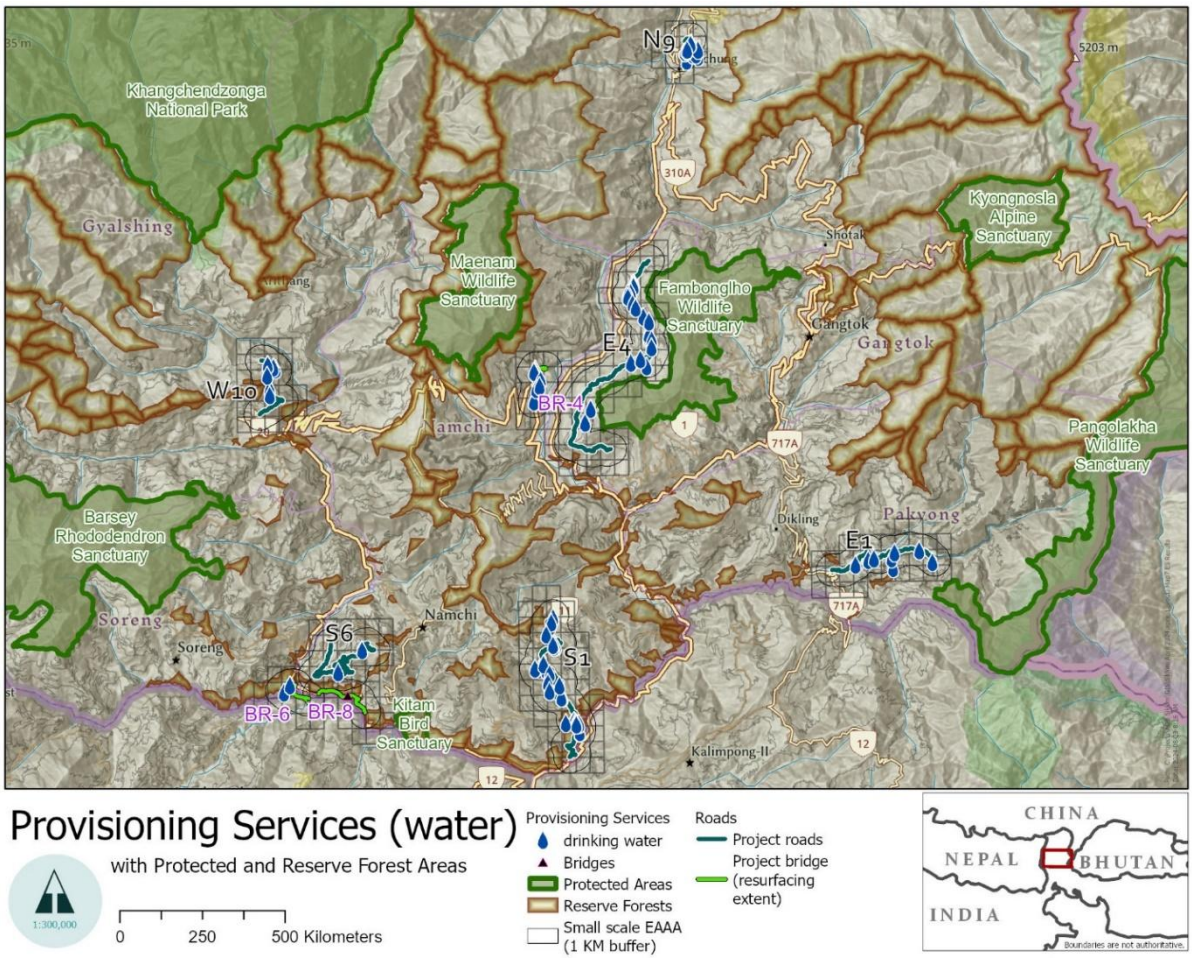


Figure 4-5. Map showing the locations and distribution of water lines crossing or effected by the Project. Detail maps available here: https://tinyurl.com/8kfrcns6

Table 4-19. Summary Table Water distribution lines, and water distribution features shown in Annex 20. Figure 21.

ID	Subproject Road	Minimum number of water lines crossing project roads
1	BR-4	10
2	BR-6	3
3	E1	0
4	E4	8
5	N9	73
6	S1	11
7	S6	26
8	W10	2

Assessment

341. The loss of access to water for households and farms along the project roads is potentially a severe negative impact. All water access will be restored or improved for locals residing along the Project by using a “like for like or better” approach during the construction phase. Approximately 139 fresh water supply lines cross Project roads and thus need to be restored, the mapping is provided in Table 16 of Appendix 20.

Table 4-20: Impact and Severity of Water Supply

Aspect	Impacts			
Impact **Description**	**Physical displacement of local communities or loss of livelihood for those dependent on the land**	**Loss of vegetation and wildlife habitat**	**Cultural impacts if land holds religious or cultural significance**	**Loss of access to water for drinking, crops, and livestock**
Receptor Importance/ Sensitivity	High	High	Medium	High
Extent	Core Zone	Core Zone	Buffer Zone	Core Zone
Duration	Permanent	Permanent	Permanent	Permanent
Frequency	Single event	Single event	Single event	Single event
Likelihood	Certain	Certain	Certain	Certain
Reversibility	Irreversible	Irreversible	Irreversible	Reversable
Magnitude/ Severity	High	High	Medium	High
Effect	Adverse	Adverse	Adverse	Adverse
Direct/ Indirect	Direct	Direct	Direct	Direct
Significance	Major	Major	Moderate	Major
Additional Mitigation (Y/N)	Y	Y	Y	Y
Residual Significance	Moderate	Moderate	Low	Low

Mitigation Measures

1. Compensation and Resettlement for affected individuals, ensuring that it is fair and timely in manner. Adequate compensation and rehabilitation assistance has been provided for affected households consistent to ADB's involuntary resettlement policy and GOI's Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act (RFCTLARR), 2013.
2. Income restoration measures for vulnerable/resource poor sections and other affected persons shall be implemented. All impacted CPRs will be relocated in consultation with the local communities under the project cost.
3. Restoration of access to water usage crossing roads and along drainage structures.
4. Afforestation with monitoring to ensure successful regeneration and effective implementation of land compensation to the impacted people.
5. Temporary Measures During Construction to ensure uninterrupted access to drinking water and water resources for affected households and farms during construction, the following temporary measures will be implemented:
    a. Temporary water supply arrangements will be established in areas where access may be disrupted. This includes using private water tankers to supply water to households and farms when necessary.
    b. The contractor will coordinate with local communities to identify critical water points prior to commencement of construction activities. This will help in planning the preservation of access during the construction phase.
    c. Surface flow shall be diverted or construction activities will be isolated from the surface flow in a manner acceptable to PIU/PMU to mitigate direct impacts on water resources.
6. Contractor Requirements:
    a. Provide Temporary Water Supply: The contractor is required to provide temporary water supply arrangements in areas where access is disrupted. This ensures households and farms have continuous access to water.

b. Coordinate with Local Communities: Coordination with local communities is essential to identify critical water points prior to construction. Consent for usage of water needs to be taken in writing from Village Council Presidents to address local water sources.

c. Monitor and Report Water Access Conditions: The contractor will monitor and report on water access conditions throughout the construction phase. Regular assessments will be conducted to ensure there are no disruptions and that mitigation measures are effective.

7. Community Communication Protocol:

a. To mitigate potential disruptions, a community communication protocol will be established, including:

i. Informing residents in advance of any temporary disruptions and available alternatives.

ii. Conducting community participation and engagement programs for constant guidance.

iii. Providing upfront information on potentially detrimental impacts on local communities.

342. **Residual Impact:** Despite these measures, residual impacts, such as reduced or altered forest cover along the ROW and slight changes in private land/community structure, water usage and subsequent health of people, livestock and crops could persist if not mitigated in responsible manner.

Monitoring Residual Impacts Post-Construction: After the construction phase, residual impacts on water usage and health will be monitored through environmental monitoring processes. This includes:

i. Maintaining photographic records to provide useful environmental monitoring tools.

ii. Ensuring compliance with environmental standards for water quality.

iii. Long-term support and follow-up actions to address any ongoing issues relating to water usage and health.

iv. Conducting regular community consultations to ensure sustained access to water resources and addressing any emerging concerns.

4.1.8 Heritage and Archaeology

Construction

Description

343. The cultural resources identified within the RoW and outside the ROW have been assessed for environmental impacts.

Table 4-21: Locations of Heritage Assets

Road E04	A cremation ground, a shrine and local idols within the right of way. A church and a temple are located adjacent to the RoW	Cremation ground with stairs and shelters for the dead body. These are undesignated cultural assets that has insignificant archaeological, architectural, spiritual or cultural importance.
Road S1	Road S1 has cremation ground at the upstream of the bridge and 3 churches near the ROW	Cremation ground is about 100 meters from the existing bridge.
N9	Two churches are adjacent to the right of way.	Church is located near the road but outside the RoW.
W10	A monastery near the RoW.	Monastery is located near the road but outside the RoW.
All Roads	Rivers/ natural streams	The rivers hold cultural significance for the local community and are considered intangible cultural resources. As an expression of giving life, the community often releases fish into the rivers.

Assessment

Ancient Monuments and Archaeological Site Remains Act, 1958 is also not applicable. However, the responsibility has been designated for the contingency purpose in case of the chance find.

Road R04

- The access to the cremation ground and shelter will be required to be demolished for the construction of bridge. This will be a temporary impact. The alternative access will be provided during the construction phase.
- The church and temples are outside the right of way will be preserved.
- Idols available within the right of will require shifting.

Road S01

- Three churches are closer to the right of way, but construction will have temporary impact on the access to the churches.
- The cremation ground is away from the project site but the access to the cremation ground will be impacted. During the construction stage, an alternative access will be provided.

Road N09

- Two churches are available near the right of way, there will not be a direct impact, but indirect impacts include damages to the access.

Road W10

- There is a monastery close the road. The impacts will be indirect due to construction work of emission of air pollution and noise. The impacts will be temporary and of low significance.
- No Archaeological sites as listed under the provisions of the AMASR Act, 1958 protects monuments of National importance and listed under the State protected monuments are reported within one km from the PROW. 3 numbers of protected monuments exist within 5 km radius of the project road W10.

Rivers and Streams

- The rivers and natural streams hold cultural significance for the local community and are considered intangible cultural resources. As an expression of giving life, the community often releases fish into the rivers. There will not be any construction work in the riverbed. However, the access to the rivers may be impacted during the construction stage.

344. Though the project areas are not rich in historical and archaeological resource, digging for various road construction purposes may unearth chance artifacts.

345. With respect to project, ASI monuments are identified only in 5-10 km periphery of W10 road. The closest monument from the W10 corridor is the Radbentse site which was the ancient capital of Sikkim, Forest area of Pemayongtse located 800 m west from the corridor. Please refer **Figure 4-6**

None of the project corridor (E1, E4, S1, S6, W10 and N9) are falling within 300m regulated zone of ASI monuments, thus approval from ASI is not anticipated.

Figure 4-6.

Table 4-22: Aspect Impact table of Heritage and Archaeology

Aspect	**Impacts**
Impact Description	**Impact on cultural Heritage**
Receptor Importance/ Sensitivity	Medium
Extent	Buffer Zone
Duration	Permanent
Frequency	Single event
Likelihood	Certain
Reversibility	Irreversible
Magnitude/ Severity	Medium
Effect	Negative
Direct/ Indirect	Direct
Significance	Moderate
Additional Mitigation (Y/N)	Y
Residual Significance	Minor

Mitigation Measures

346. The mitigation measures include

i. Conduct a heritage/archaeological field surveys before start of the construction work. If surveys find resources, map them and define buffers/avoidance.

ii. Implementation of Chance Find Procedure including standard “stop-work — secure — notify — assess — conserve or salvage” sequence: stop work if finds occur, cordon off, notify competent authorities and project authorities, assess significance, implement approved conservation/salvage or reburial, document finds, then resume works only after clearance.

iii. Relevant provisions of Ancient Monuments and Archaeological Sites and Remains Act (1958) should be implemented, to include: i) consultation with the Sikkim Archaeology Department, ii), demarcation of the

discovery site, iii) chance finds report, iv) arrival and actions of cultural authority, and v) suspension/non-suspension/further suspension of work.

iv. Any shifting of cultural assets like idols of local importance will be done in consultation with the local community.

4.1.9 Physiography and Land use

Construction

Description

347. Sikkim is located in the high-risk seismic zone IV of the Indian Seismic Zoning Map. The state is spread-out on the Himalayan Mountain range with two main thrust faults, the Main Boundary Thrust (MBT) and Main Central Thrust (MCTO) crossing the state.

348. The Himalayan orogenic belt is one of the most seismically active continents–continent collision zones in the world, where the Indian Plate continues to under thrust the Eurasian Plate6. The region is close to the epicenter of the great 1934 Bihar – Nepal earthquake. Sikkim has experienced moderate seismicity in the past and the region is designated under zone IV in the seismic zonation map of India.

Assessment

349. In the hilly section, hill cutting will also be required for widening of roads to the desired configuration resulting physiographic changes. The baseline study revealed that steep slopes. Borrow earth will be required in the project road for filling and will be obtained from cut and fill within the right of way or from the existing approved borrowing areas. If the C&D waste generated are not reused as construction material, improper disposition of the waste may be carried out by contractor which can have many impacts.

350. Construction activities of the subproject road will bring permanent changes in the local level topography and appearance of the project road. At susceptible site of landslide, retaining and breast wall will be implemented in order to minimize risk of landslides.

Table 4-23: Potential Effects on Topography by the Proposed Road Sections Upgrading

Sl. No.	Construction activity	Potential effect on topography and appearance	Mitigation
1	Clearing of vegetation for widening of the road	Scarring of landscape from cutting and potential erosion (short term and long term) may be caused. There may be minor permanent changes in the landscape.	Cut material should be used to widen the road or disposed of at proper disposal sites. Cut slopes should be re vegetated immediately after widening activities
2	Stone quarrying	Scarring of landscape and potential landslides (rockslides/falls). There may be permanent changes in the landscape.	Stone quarrying should be undertaken from the selected lotions in Table 2-XIII or legally approved areas. Controlled and environmentally friendly quarrying should be carried out to minimize landslides and erosion.
3	Earthwork from borrow areas	Scarring of landscape due to unearthing activities. Minor but permanent changes in landscape.	As soon as construction activities are complete, they should be rehabilitated as per the owner's requirement in case any other approved borrow area is used.
4	Waste disposal	Disposal of cut soils and debris at improper locations which will make the area look untidy and unattractive.	Cut off material should be used to widen the road or disposed of at proper disposal sites.
5	Establishment of labour camps	Disposal of waste and litter at improper locations and deforestation for fire-wood will make the area look dirty and unattractive.	Provision and allocation of proper waste disposal bins and sites are required. A supply of cooking gas should be provided by the contractor to eliminate the use of firewood.

351. This could lead to increased soil erosion and other considerable impacts on natural drainage courses, and siltation to runoff during rains. Likely impact on the geological resources may also occur from the extraction of construction materials like borrow of earth, granular sub-base and aggregate for base courses, culverts and bridges.

352. During construction phase, the project activities are unlikely to create localized flood related issues. Nevertheless, various construction activities could temporarily worsen the flooding problem due to improper drainage

[6]Pinki Hazarika et al., Attenuation character of seismic waves in Sikkim Himalaya' Geophys. J. Int. (2013) 195, 544–557

conditions on account of the contractor's poor engineering practices and negligence. If the high intensity rainfall continues for many days a number of sections along the project road could develop flooding situation.

Table 4-24: Aspect Impact table of Physiography and Land Use

Aspect	Impacts
Impact Description	**Impact on Physiography**
Receptor Importance/ Sensitivity	High
Extent	Core Zone
Duration	Permanent
Frequency	Single event
Likelihood	Certain
Reversibility	Irreversible
Magnitude/ Severity	High
Effect	Negative
Direct/ Indirect	Direct
Significance	Major
Additional Mitigation (Y/N)	Y
Residual Significance	Moderate

Mitigation

1. Most of the excavated materials from existing roads will be reused as construction materials. The contractor must manage all hazardous and non-hazardous waste as per respective solid waste management rules.
2. As per the existing surveys, the project will require 1.398 Ha land. Out of the total 1.398 Ha, 1.280 ha is forest land that includes 0.36 ha is notified Forest land and 0.919 ha non notified forest land comprising of Khasmal/ Gaurachar area shall be required for the project is impacted. Village wise details of land required for road construction is given in RFP Report. This land utilization has a direct impact and will persist throughout the life of project. This land will be used for various purposes like construction of road and establish site office, construction-labour camp, and other facility area. Temporary leasing of private land can be seen as an alternative to land acquisition for construction for store house, ware-house and labours camps.
3. The indirect impact will be reduced agricultural production/ forest land, grazing land due to land acquisition. It will induce higher pricing of agricultural products and increase in dependence on nearby area. The other induced impact will be clearing of vegetation, hill cutting, increase in debris outcome/ its disposal and change in landscape of an area.
4. The landuse pattern of the project corridor is majorly forest land, green vegetation, mountainous land. Forest land diversion of impacted land will involve development of degraded forest land or allocation of twice amount of non-notified forest as forest land.
5. In terms of agriculture land, compensation of land as per RFCTLR 2013 shall be provided under the project.
6. Maximum of the cut material (debris generated) will be used in road widening or will be disposed in identified area.
7. The cut slope will be re-vegetated after construction activity under the project.
8. Trees plantation will be carried out in the proposed landscape area and abandon slope protection area to restore the canopy cover loss.
9. Total 1.28 ha land shall be diverted subject to approval of Forest Department. The compensatory afforestation shall be carried out by the Department of Environment and Forests, Government of Sikkim on twice the area diverted, identified by revenue department on degraded land in the same locality or in same district.
10. All cross-drainage structures and bridges on the project road need to consider the seismic coefficients with regards to the seismic energy propagation along the fragile geological/lithological strata. The road and bridge design shall follow (IS: 1893-Part 1, 2016 and IS: 1893-Part 3, 2014). The other codes for reference are (a) IRC 6: 2000, (b) IRC 112: 2011 and (c) IRC 78: 2014, that will also be followed.
11. The opening of new borrow area is highly unlikely. However, the borrowing of earth of the required specification is the responsibility of the contractor. In case the earth is borrowed from the outside the RoW, it

will be sourced from approved borrow area only. New borrow area will not be opened. In case hill cutting does not fulfil the requirement, the contractor will borrow earth from approved locations only.

4.1.10 Impact on Soil

Construction

Description

353. Analysis of land use on either side of the existing road shows that predominant land use is vegetation land (more than 70%), which will be permanently changed for road construction and widening.

Assessment

354. **Change in land use and loss of productive soil:** It is estimated that at least 1,90,000 cum topsoil shall be generated from proposed right of way (including all phase 1 DPR roads S1, S6, E1, E4, N9, W10). If this huge quantity of topsoil is not preserved, it will get wash out with run off and increase turbidity of the surface water bodies and settle at any location at downstream on the bed of surface water bodies. It is one of the most important environmental losses, as generation of topsoil takes very long time.

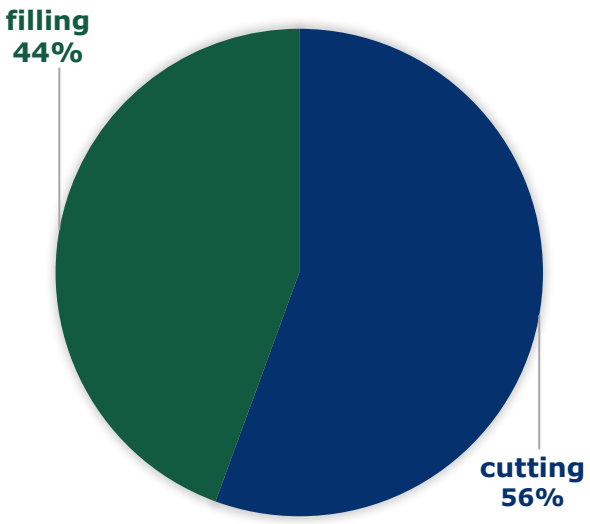
355. The productive top soil formation is slow process and takes years by gradual weathering of rocks. In the project area top soil is limited resource and need to be conserve and need to be utilized for plantation purpose. Following sets for mitigation measures will be implemented to conserve the productive top soil.

356. **Soil Erosion:** Erosion of top-soil can be considered as moderate, direct and have a long-term negative impact resulting from the construction of existing road along with curve improvements for the roads. The potential of soil erosion is pervasive during the construction stage and earth work on the existing alignment. Starting with clearing and grubbing, vegetation will be stripped away, exposing raw soil. Earth works and embankment will also prone to erosion during rains. Soil erosion will add siltation to the runoff during the monsoon season.

357. Soil erosion negatively impacts agriculture by reducing crop yields and quality, increasing water flow, and removing organic matter and essential plant nutrients. It also reduces biodiversity and water quality. Soil erosion downstream of culverts can lead to sedimentation in water bodies, water pollution, changes in hydrology, habitat disruption, and land degradation. Culverts are structures designed to allow water to pass beneath structures, but erosion downstream can cause sedimentation, water pollution, and land degradation. To mitigate these effects, effective erosion control measures like vegetation planting, riprap installation, and sedimentation basins are essential. Proper land use planning and management strategies are also crucial to prevent and mitigate the adverse effects of erosion.

Analysis of the design shows that out of total length of 41.200 km of package-I phase-IA, 11,78 km length passes though cut section, 0.380 km length will be fill section and cut and fill is 29.040 km length only fill.

358. Inventory and analysis show that Project Road E1, E4, S1, S6 is having LHS valley and RHS hill section throughout the road, while N9 & W10 road is having opposite condition left side hill and right-side valley. Based on the quantum of cutting and filling estimated tentatively in BOQ, it is perceived that approximately 50-60% area would be in cutting and 30-40% would be in filling. Locations were identified for borrowing soil for constructing embankment. The details of test result are presented in 'Volume-III: Material Report' of DPR. The slopes of the embankments and cut sections are prone to erosion and uncontrolled erosion may further lead to landslide. This brings risks of erosion to the exposed ground and topsoil. The soil erosion in construction stage may take place at the slope of the embankments, construction sites of cross drainage structures, at borrow areas and at construction sites which will be cleared. Accumulated eroded soil will result to siltation, embankment damage, and drainage problem. Loss of soil due to run off from earth stock-piles may also lead to siltation in natural drains and rivers nearby.



359. Soil erosion from the construction work may negatively impacts agriculture by reducing crop yields and quality, increasing water flow, and removing organic matter and essential plant nutrients. It also reduces biodiversity and water quality. Soil erosion downstream of culverts can lead to sedimentation in water bodies, water pollution, changes in hydrology, habitat disruption, and land degradation. Culverts are structures designed to allow water to pass beneath

structures, but erosion downstream can cause sedimentation, water pollution, and land degradation. This however can be mitigated through implementation of the mitigation measures listed below:

360. **Quarries and Borrow Areas**: Need for opening borrows areas and quarries are not anticipated as abundant material will be available from hill cutting. However, if requirement emerges, it may cause some adverse impacts if left un-rehabilitated. It may pose risk to people, particularly children and animals of accidentally falling into it as well as become potential breeding ground for mosquitoes and vector born disease. Illegal quarrying may lead to unstable soil condition; destroy the landscape of the terrain, air and noise pollution.

361. Opening of new quarries is not envisaged. Quarry material will be sourced from existing licensed quarries. The dredging and use of dredged material, if involved, may have its impact in terms of localized sedimentation level increase and dispersion of pollutants present in the dredged material in the river water.

362. The excavation of quarries and borrow pits used for obtaining aggregate materials and soil for road construction can cause direct, and indirect long-term major adverse impacts on the environment. While loss of productive soil is the most direct negative impact from borrow areas, other significant indirect negative impacts can also occur. Since most of the construction materials would be available from existing quarries nearby, relatively no new borrow areas may be required.

363. **Generation of Debris:** The major source of debris generation is dismantling of existing cross drainage structures, scarifying of bitumen from carriageway and removal of existing road for up gradation.

364. **Contamination of Soil**: Contamination of the soil may take place from the following activities at the construction zones, construction labor camps, construction plant sites and other auxiliary facilities required for the construction are through Scarified bitumen wastes, Debris generation due to dismantling of structures, Runoff from muck disposal area, Maintenance of the machinery and operation of the diesel generator sets on site, Oil spill from the operation of the construction machineries, maintenance and diesel storage and diesel generator sets, spillage bitumen from operation of hot mix plant, Wastes from the residential facilities for the labour and officers at camp site, and Storage and stock yards of bitumen.

Table 4-25: Aspect Impact table of Soil Environment

Aspect	**Impacts**		
Impact Description	**Soil Erosion**	**Loss in productivity**	**Soil contamination**
Receptor Importance/ Sensitivity	Medium	Medium	Medium
Extent	Core Zone	Core Zone	Core Zone
Duration	Permanent	Permanent	Temporary
Frequency	Single event	Recurring	Single event
Likelihood	Certain	Certain	Certain
Reversibility	Reversible	Reversible	Reversible
Magnitude/ Severity	Medium	Medium	Low
Effect	Negative	Negative	Negative
Direct/ Indirect	Direct	Direct	Direct
Significance	Moderate	Moderate	Minor
Additional Mitigation (Y/N)	Y	Y	Y
Residual Significance	Minor	Minor	Negligible

Mitigation Measures

365. Slope protection measures such as Random Rubble Stone masonry wall 5,989.00 rate rm, Seeding and Mulching by Preparing of seed bed on previously laid top soil, furnishing and placing of seeds, fertilizer, mulching material, fixing jute netting, Providing Soil Nailing for slope restoration and protection at the rate of 3,856.16 running meter, turfing/grassing will be provided to counter soil erosion. Discharge of the hill side slopes has been calculated and dimension of the road side drains will be implemented accordingly. Line drain will be provided for entire section of the proposed road. Tentatively approximately 32% cost has been taken as drainage, slope protection including Retaining wall cost in total project civil cost.

1. The green belt will be developed simultaneously along with construction activities to control the erosion process.

2. In addition, gabion and apron concrete will be installed at the outlet of culverts to avoid soil erosion due to water runoff.
3. Bank protection measures shall be taken at erosion prone areas.
4. Provision of side drain to guide the water to natural outfalls.
5. Retaining walls with parapets and breast walls have been included in the design to check erosion.
6. When soil is spread on slopes for permanent disposal, it shall be buttressed at the toe by retaining walls.
7. IRC: 56 -1974 recommended practice for treatment of embankment slopes for erosion control shall be taken into consideration.
8. Borrow areas if required, shall not be located near forest areas. The edges of borrow sites shall be no closer than 3 metres from any fence line or boundary. Adequate clearance shall be provided for the construction of catch drains. Borrow sites shall have adequate drainage outlets unless the relevant landowner has agreed that the borrow area is to create a permanent tank or dam. Cut batter slopes shall not be steeper than 3 to 1 and shall be left by the Contractor in a tidy and safe condition to the satisfaction of the Engineer. Written clearance from the land owner/village head shall be obtained before leaving a site.
9. Obtain statutory approval from competent authority as detailed in chapter II (recent policy initiatives on mining of minor mineral)
10. Borrow pits shall be selected from barren land/wasteland to the extent possible. Borrow areas should not be located on cultivable lands except in the situations where land owners' desires to level the land. The top soil shall be preserved and depth shall be restricted to the desired level.
11. Borrow areas should be excavated as per the intended end use by the owner. The Indian Road Congress (IRC):10-1961 guideline should be used for selection of borrow pits and amount that can be borrowed.
12. The dredged material from the river bank shall be tested for presence of heavy metals and other pollutants before its reuse.
13. The depths in borrow pits to be regulated so that the sides shall not be steeper than 25%, to the extent possible, borrow areas shall be sited away from habituated areas. Borrow areas shall be levelled with salvaged material or other filling materials which do not pose contamination of soil.
14. Fuel and lubricants shall be stored at the predefined storage location. The storage area shall be paved with gentle slope to a corner and connected with a chamber to collect any spills of the oils.
15. Unavoidable waste shall be stored at the designated place prior to disposal. To avoid soil contamination at the wash-down and re-fueling areas, "oil interceptors" shall be provided. Oil and grease spill and oil-soaked materials are to be collected and stored in labelled containers (Labelled: WASTE OIL; and hazardous sign be displayed) and sold off to SPCB/ MoEF&CC authorized refiners.)
16. Movement of construction vehicles, machinery and equipment shall be restricted to the designated haulage route.
17. Approach roads shall be designed along the barren and hard soil area to reduce the compaction induced impact on soil.
18. The productive land shall be reclaimed after construction activity.
19. Septic tank or mobile toilets fitted with anaerobic treatment facility shall be provided at construction camp.
20. Domestic solid waste at construction camp shall be segregated into biodegradable and non-biodegradable waste. Non-biodegradable and non-saleable waste shall be disposed off to authorised land fill site. If land fill site not available then burial of the waste in a secured manner shall be ensured.
21. The contractor during cutting should take care that the cut material is not pushed down hill to save labour and transportation cost.
22. PIU of R&BD Sikkim to monitor the contract and weekly report should be submitted. It the contractor does not follow the IRC norm for hilly terrain. He should be fined by the PWD on environmental issues.
23. The contractor should start cutting form the top point within the PROW by the Pokland Machine and dump the cut material in the PROW. After dumping, spreading and pressing the cut material, the excess left over material will be dumped at identified dumping site.
24. No cut over burden will be allowed to be dumped outside the PROW or hill slope side to save the transportation and labour cost.
25. It will be Contractor's responsibility to ensure that spoil material does not spill in valley or any unwanted location. Contactor will have to dump spoil material at the approved dumping site. If loss to orchard, agricultural land causes due to Contractor's action, Contractor shall compensate such loss from his own cost.

Dumping locations are given in EMP and guidelines has been provided for identification of dumping sites in EMP.

26. The top soil (25cm depth) from the productive land shall be preserved and reused for plantation purposes. It shall also be used as top cover of embankment slope for growing vegetation to protect soil erosion.
27. It will be ensured that the land taken on lease for access road, borrow areas, construction camp is restored back to its original land use.

4.1.11 Impact on Water Environment

Construction

Description

366. Road construction in general can generate a significant amount of pollution to nearby waterways as construction often involves extensive clearing, grading, and embankment formation, which exposes soil to erosion. It can result in the deposition of sediment that can be harmful for aquatic habitats and clog waterways. The sedimentation of soil on waterbodies resulting in poor water quality is likely caused due to:

- Excavation, cut-and- fill operations, and removal of vegetation accelerate erosion. Exposed soils easily wash into nearby rivers, lakes, and reservoirs.
- Disturbance of existing vegetation area can aggravate the poor water quality.

367. The impact on water environment due to construction activities include reduced water clarity, affecting photosynthesis in aquatic plants, harming fish and invertebrate populations. It also will reduce storage capacity of ponds and reservoirs due to silt deposition.

Assessment

368. **Water Pollution, drainage alteration**: In the proposed roads, during the construction of new culvers, some amount of drainage alteration and downstream erosion/siltation is anticipated. Some of these alterations may be because of construction of temporary traffic detours/diversion. Except for these temporary works, in almost all cases there should be an improvement in the drainage characteristics of the surrounding area due to improved design and added culvert/ditch capacity.

369. **Significance**: The proposed project roads does not intersect with river, though streams and natural drains exists. Proximity of rivers with the project corridors are – Rangpo river at 67 meters from CH 1+245 for corridor E1, Teesta River at 680 meters from Ch 3+200 for corridor E4, Teesta River at 860 meters from Ch 0+000 for corridor N9, Teesta River at 60 meters from Ch 0+000 for corridor S1, Rangeet River at 904 meters from Ch 14+750 for corridor S6 and Rangeet River at 1.03 km from Ch 4+910 for corridor W10. These are further connected to main streams which leads into seasonal and perennial rivers.

370. **Magnitude**: Siltation and water quality deterioration of rivers will be minimal since no piling is involved. Open foundations, steel truss bridge will be provided for the bridges. The temporary pollution of water bodies from spillage of chemicals and oil at construction sites and waste from construction camps may occur. Accidental oil and chemicals spills can contaminate the ponds close to alignment. Following activity may add on the water pollution during construction stage if not managed properly.

Anticipated Impacts from construction phase

- Discharge from untreated sewage, canteen, etc. from construction camp may pollute surface water bodies.
- Spillage of spoil material in or vicinity of water bodies may cause stagnation/ diversion of natural drainage as well as increase in turbidity.
- Water after washing vehicles from washing bay, vehicle repairing workshop, transit mixer, rotary mixer, aggregate batching plant may pollute surface water bodies.
- Erosion from the outfall of culverts at valley may slide. This eroded material may increase turbidity of surface water bodies.
- Demolition of unwanted culverts and minor bridge, construction of culverts, minor and major bridges at the natural water flow channel will definitely pollute the surface water bodies unless special care is taken to mitigate and minimize these impacts.
- Ancillary construction site such as quarries, borrow areas would also affect water bodies.

371. The contamination of water and siltation may occur if any streams running parallel to the project alignment due to various construction activities including excavation, stalking of materials, machines (Oil spillage etc.,).

372. During inventory, it is observed that typical cross section of the existing project roads is a combination of carriageway and earthen shoulder at valley side and paved shoulder at hills side. Hence, there is lot of scope for

horizontal and vertical geometry improvement due to the present deficiency in the existing project road. The project road traverses through mountainous terrain. Hence, a significant number of hair pin bends are found along the project corridor without provision of extra widening and with restricted width of carriageway. The same can be negotiated with proper horizontal geometry improvement. During inventory, few stretches of water-logged area and water submergence area are found due to the deficiency of longitudinal profile and existing cross fall of the project road. Similarly, at many locations sharp turns are encountered, and hence horizontal alignment may need to be improved.

373. **Water Usage and conflicts**: Drawing of water for construction camps for domestic use from local water sources like village hand pumps and water supply network if existing will result in competitiveness for existing water resource between the migrant labour and resident locals. In Sikkim, Himalayan mountains spring provide the main water source to the State. Over the years some of these springs have dried up or become seasonal and the discharge during the lean seasons is declining. Surface water source will be use for the construction phase. The contractor shall consult the local people to avoid disruption/disturbance to other water users; the contractor shall extract water from fixed locations.

374. It is expected that 150-200 labours will be engaged during the construction phase comprising skilled, semi-skilled and unskilled labours at each corridor wise. The construction may be done in stages from corridor to corridor. Major portion (75%) of the labours will be unskilled and will be hired from the local community. They will be daytime labours. The remaining 25% will be from outside area, who will be stayed in the labour's camps.

375. The daily water requirement for daytime labours as per Table 2-12 will be 15 Lpcd7. For residential labours (50) will be 35 gallon8/day or 132.5 Lpcd or say 135 Lpcd as per MoEF& CC construction manual. Hence the total water requirement for residential labours will be 6750. Therefore, the daily total water requirement for domestic usage will be 9750 LPCD or approximately 10 Kld.

376. Downstream water user and aquatic life at the downstream may be impacted due to extraction from surface water. The source of water for construction water requirement and for dust suppression can be met by approved water tanker, development water harvesting structure and check dams on seasonal rivers. The construction of rainwater harvesting or water retention points will be social benefits for the locals as this structure after construction phase will be handed over to local communities. This can be good alternative as the area receives 2000-3000mm rainfall annually. Other source can be withdrawing water from two perennial rivers crossing the PROW. Prior permission will to be taken form the concern government department and in consultation with the local community.

Table 4-26: Aspect Impact table of water environment for construction phase

Aspect	**Impacts**		
Impact Description	**Impact on water quality and siltation**	**Impact due to drainage alteration**	**Impact due to water conflicts**
Receptor Importance/ Sensitivity	Medium	Medium	High
Extent	Buffer Zone	Buffer Zone	Buffer Zone
Duration	Temporary	Temporary	Temporary
Frequency	Single event	Single event	Single event
Likelihood	Certain	Certain	Certain
Reversibility	Reversible	Reversible	Reversible
Magnitude/ Severity	Medium	Medium	Medium
Effect	Negative	Negative	Negative
Direct/ Indirect	Direct	Direct	Direct
Significance	Moderate	Moderate	Moderate
Additional Mitigation (Y/N)	Y	Y	Y
Residual Significance	Minor	Minor	Minor

Mitigation Measures

- The water supply pipeline was observed running all along the corridor at each road, this can be used for time being. Consent for usage of water need to be taken in written from the Village Council Presidents.

[7] WHO/SEARO Technical Note for Emergencies for domestic uses.
[8] Temporary Labor Camps — OSHA Standard 1910.142

- The other source for domestic water requirement can be met through private water tankers during construction phase.
- Contractor shall ensure that no spillage of spoil material in surface water bodes directly or indirectly.
- Precast pipe culverts shall be installed wherever applicable
- Surface flow shall be diverted or construction activates shall be isolated from the surface flow in a manner acceptable to ESMU /PMU.
- Retaining walls will be constructed on hill slopes and breast walls on down slopes to prevent erosion of road embankment.
- Install temporary silt traps or sedimentation basins along the drainage leading to the water bodies;
- No construction camp within 500m of any water body.
- Contractor shall ensure that no untreated discharge should enter into surface water bodies. Any discharges into environment should follow environmental standard
- Contractor shall ensure that construction material such as concrete, aggregate, shuttering material etc. does not spill over surface water
- Any diversion / bund/isolation constructed for bridge/culvert work shall be removed by Contractor as soon as utility of those are over.
- Silt fence will be provided for arresting of silt/construction material before entering into surface water bodies.
- Oil and grease interceptor will be installed into construction camp.
- Sock pit and septic tank will be provided to be constructed by the Contractor at Camp and plant site.
- Contractor shall prepare impervious surface at fuel refilling station, work shop area and material storage area. The fuel refilling station and workshop area should be provided with shed for sun and rain
- Contractor shall obtain permission for withdrawal of surface water and consult with the community and ensure that villager's user right is protected.
- Ensure Public Health and Engineering Department in mutual consent with Sikkim R&BD for relocation of their utilities before commencement of the construction so that villagers are not suffered due to lack of water supply.

Sustainable Water Practices

- Assessment of Water Quality:
    - Ensuring that any water source chosen complies with the drinking water standards set by local health authorities and agencies.
    - Regular testing of the water for contaminants, including microbial, chemical, and physical impurities.
- Sustainable Water Practices:
    - Selecting sources that have a proven and reliable supply of water, avoiding over-extraction that would deplete the natural source.
    - Implementing water-saving technologies and practices within the camp to minimize wastage.
- Community Collaboration:
    - Working collaboratively with local communities and authorities to manage and monitor the water sources sustainably.
    - Ensuring that the use of these water sources does not negatively impact the local community's access to water.
- Alternative Water Sources:
    - Identifying and invest in alternative sources of water such as rainwater harvesting and recycled greywater systems to reduce dependence on primary sources.
- Infrastructure and Maintenance:
    - Developing infrastructure that supports sustainable water use, such as efficient leak-proof pipelines and storage tanks.
    - Regularly maintain water extraction and storage equipment to prevent wastage and contamination.

- Education and Training:
    - Educating and training labour camp residents on the importance of water conservation and sustainable practices.
    - Promoting measures like using water responsibly and reporting any leaks or issues promptly.

Operation

Description

377. The operation phase of roads will likely impact the surface water sources near the project primarily from run off contaminants carrying accidental oil spillage, washing of vehicles, used engine oils etc. Expansion joints and drainage spouts may be choked due to silt and vegetation growth. However, it can be noted that the deterioration of water quality during operation phase is very less when compared to construction phase. Impacts on groundwater during the operation stage of the Project are limited to potential contamination from the spill of contaminants, usually as a result of vehicle accidents. Ground water can also be impacted by the discharge of black water from toilets situated along the stretch of the Project. Toilets installed will also consume water which would be likely extracted from the groundwater sources which will also impact the water resources along the Project stretch.

Assessment

378. The impact from surface run-off will be minimal as accidents would be a rare scenario and with the presence of proposed paved shoulders, and stabilized slopes, the extent of pollution will be contained within the Project stretch. Water is needed during maintenance works and for public restrooms. The impact on groundwater quantity and quality due to blackwater discharge and abstraction will be insignificant.

Table 4-27: Aspect impact table of water environment during operation phase

Aspect	**Impacts**			
Impact Description	**Contamination of surface water due to spillages**	**Contamination of ground water due to spillages**	**Contamination of ground water due to blackwater**	**Impact on Quantity due to ground water abstraction**
Receptor Importance/ Sensitivity	Medium	Medium	Medium	Medium
Extent	Core Zone	Buffer Zone	Buffer Zone	Buffer Zone
Duration	Short term	Short term	Long term	Long term
Frequency	Single Event	Single Event	Recurring	recurring
Likelihood	Likely	Likely	Likely	Likely
Reversibility	Reversible	Reversible	Reversible	Reversible
Magnitude/ Severity	Minor	Minor	Low	Low
Effect	Negative	Negative	Negative	Negative
Direct/ Indirect	Direct	Direct	Direct	Direct
Significance	Negligible	Negligible	Minor	Minor
Additional Mitigation (Y/N)	N	N	Y	Y
Residual Significance	-	-	Negligible	Negligible

Mitigation Measures

- To prevent runoff and surface waters from entering agricultural fields or infiltrating the ground, the drainage (including the toe drains) system shall be kept in good condition as part of pre-monsoon maintenance. The connections to the rainwater harvesting structures will be maintained for effective trapping of contaminants and increasing ground water recharge.
- Rejuvenation of the drainage system by removing encroachments/ congestions will be regularly conducted.
- The surface discharges and effluent from the contractor's activities shall not exceed the values indicated in the employer's requirements and shall not exceed the values prescribed by applicable laws and approvals.
- Water meters shall be installed at all the water discharge locations, and records shall be maintained.

- Installation of slit fencing with planting vegetated swales at the mouth of the nearest natural drain to prevent any residual sediments from entering the water body.

4.1.12 Impact on Air Environment

Construction

Description

379. Road projects do have a significant impact on the air environment. During construction phase, due to the disturbance of soil from excavation, and other activities such as earthmoving and material handling, particulate matters such as PM 10 and PM2.5 will likely be suspended in air. Additionally, diesel generated machinery, generators and vehicles will likely emit greenhouse gases such as CO2, NOx, CO and other VOCs. Impact on air environment will have a likely impact on neighbouring communities, in the form of respiratory health issues and cardiovascular stress.

380. During the construction activities, dust will be emitted sporadically and temporarily thus affecting air quality. The impacts are localized and time limited. Dust will likely be deposited on nearby structures and vegetation/crops. The dust can have negative impacts including reduced air quality, aesthetics, and reduced plant photosynthesis thus subsequently hamper the growth of the plants.

Assessment

381. During the baseline study in the project area, it has been found threat the air quality is fairly good.

382. During construction phase, there will be two main sources of air emissions i.e., mobile sources and fixed sources. Mobile sources are mostly vehicles involve in construction activities while emissions from fixed sources include diesel generator set, construction equipment and excavation/grading activities those produce dust and gaseous emissions.

383. Certain amount of dust and gaseous emissions will be generated during the construction phase from excavation machines and road construction machines. Pollutants of primary concern include Particulate Matter (PM2.5) and Particulate Matter (PM10). However, suspended dust particles may be coarse and will be settled within a short distance from construction area. Therefore, anticipated impact on ambient air quality will be temporary and restricted within the closed vicinity of the construction activities along the project road and allied activities area such as camp site, plant site, borrow areas etc.,

384. Considerable number of emissions of carbon monoxide (CO), unburned hydrocarbon, sulfur di-oxide, particulate matters, nitrogen di-oxide (NO2), etc., will be generated from the hot mix plant and may cause air pollution problem in nearby areas.

385. During the construction phase, the activities related to earthwork/rock excavation, borrow area operations, transport of material, storage and handling of construction materials, quarrying and/or stone crushing operations, movement of construction vehicles on unpaved roads, Hot-mix plant, handling of cement in batching plants, among others would contribute to the increased dust levels in terms of PM10, PM2.5, and other air pollutants like SO2, and NOx, and carbon monoxide levels. The details of the construction machinery can be found in section 3.9.

386. Key activities that would result in air pollutant emission during construction phase have been identified as follows:

- Cutting of hill side and loading of unsuitable hill cut material for dumping
- Dumping of unsuitable hill cut material
- Crushing of rocks and preparation of aggregate
- Movement of construction vehicle
- Stockpiling of construction material
- Transportation of construction material and accidental spillage of material
- Preparation of road embankment, sub-base and base.
- Operation of hot mix plant
- Operation of the DG Sets
- Operation of different construction vehicle, equipment and plants will lead to generation of air pollutants. Release of air pollutants has to take place. Key pollutants identified are PM10 and NOx.

387. Summarily, generation of dust is likely due to: Site clearance and use of construction vehicles and machinery, etc., Transport of raw materials, borrow and quarry materials to construction sites, Earthworks, Stone crushing operations at the crushers, Handling and storage of aggregates at the asphalt plants, Concrete batching plants, and Asphalt mixing plants due to mixing of aggregates with bitumen.

388. Generation of dust is a critical issue and is likely to have adverse impact on health of workers and vegetation in surrounding areas. Generation of exhaust gases is likely due to movement of heavy machinery for clearance of the RoW for construction. High concentration of HC and NOx are likely from hot mix plant operations. Toxic gases are released through the heating process during bitumen production. Although the impact will be much localized, it can be dispersed downwind depending on the wind speeds.

389. The aspect impact table for air environment is as follows

Table 4-28: Aspect impact table of air environment during construction phase

Aspect	**Impacts**	
Impact Description	**Impact due to particulates, oxides of sulphur, oxides of nitrogen and hydrocarbons from vehicular movement and diesel generators**	**Impact due to particulate matter suspension from dust**
Receptor Importance/ Sensitivity	High	High
Extent	Core Zone	Core Zone
Duration	Short term	Short term
Frequency	Recurring	Recurring
Likelihood	Likely	Likely
Reversibility	Reversible	Reversible
Magnitude/ Severity	Medium	Medium
Effect	Negative	Negative
Direct/ Indirect	Direct	Direct
Significance	Minor	Minor
Additional Mitigation (Y/N)	Y	Y
Residual Significance	Negligible	Negligible

390. Sensitive receptors for Air pollution are Locations of sensitive receptors are as follows –

Table 4-29: Air and Noise sensitive receptors within 500 m of project corridor

Sensitive receptors within 500 m						
Corridor	**Receptor**	**Chainage**		**Corridor**	**Receptor**	**Chainage**
N9	Market/Commercial Area	0 + 000		E1	Mulukay Kingfisher Beer Factory	2 + 200
N9	Glorious Church	0 + 000		E1	Playground	4 + 700
N9	Himalayan Free Church	0 + 000		E1	Block Administrative Centre, Regu	7 + 900
N9	North Sikkim medical centre	0 + 000		E1	Petrol Pump Rongli	8 + 700
N9	Canara Bank	0 + 000		W10	Gyalshing Bazar	0 + 000
N9	Mangan Police Station	0 + 200		W10	Yangley School	3 + 300
N9	Mangan Public Ground	0 + 700		W10	Govt. Senior Secondary	5 + 150
N9	Government Senior Secondary School	0 + 700		W10	Ugyencholing monastery	6 + 100
N9	Mangan Community Hall	0 + 890		W10	Government Junior High School Tathang	6 + 100

Sensitive receptors within 500 m						
Corridor	**Receptor**	**Chainage**		**Corridor**	**Receptor**	**Chainage**
N9	North DAC	2 + 035		S6	Assangthang Govt. Secondary	0 + 100
N9	Mangan District Hospital	2 + 035		S6	Namchi Helipad	0 + 300
S1	Melli Bazar area	0 + 100		S6	Lower Assangthang primary	3 + 200
S1	Melli Dazom Cinema	0 + 100		S6	Multipurpose co-operative society	6 + 800
S1	Govt. Sr. School	0 + 200		S6	Salghari Panchayat Bhawan	10 + 700
S1	Volleyball Ground	0 + 700		S6	State Institute of Rural Development & Panchayati Raj	12 + 500
S1	Passi Govt. Junior School	9 + 000		S6	Centre for Computers and Communication Technology	13 + 850
S1	Mother Teresa Memorial School	11 + 600		E4	Government Senior Secondary School	0 + 100
S1	Lower Rateypani ICDS Centre	13 + 630		E4	St john Mary Church	1 + 100
S1	Govt. Sr. School Rateypani	15 + 400		E4	Block Administrative Centre	3 + 400
S1	Avlon Pentecostal Church	16 + 800		E4	Sonamoti Memorial Govt. School	3 + 860
S1	Bikmat Pentecostal Church	19 + 100		E4	Village Community Center	9 + 400
S1	Bikmat Senior Secondary School	19 + 450		E4	Govt. Primary School, Subithang	9 + 450
S1	Evangelical Presbyterian Church	22 + 500		E4	Village Administrative Center	15 + 210
E1	Golden Cross Pharma	0 + 000		E4	Tumin Panchayat Bhawan	15 + 255
E1	Swiss Garnier	0 + 800		E4	Sadguru Kabir Mandir	17 + 530

Mitigation Measure:

Dust Control Measures – Contractor shall sprinkle water to suppress dust as per site condition. However, settlement areas, schools, markets shall be given preference. Contractor shall cover material by tarpaulin during transportation.

- Contractor shall install wet scrubber or any other suitable pollution control mechanism for Hot Mix Plant and ensure that flue gas passes through the wet scrubber before releasing into ambient air. Contractor shall also ensure that wet scrubber or other filter is always in operational stage when HMP is in operation.
- Contractor shall install water sprinkler at different point of crusher operation such before feeding into hopper, transportation at conveyor belt and before screening so that emission of dust is minimized.
- Debris Handling – contractor shall sprinkle water before handling debris to minimize generation of dust as per requirement of the site.

- Maintenance of the existing road and haul road – Contractor shall maintain existing road and haul road so that vehicle can pass easily and ensure that generation of dust is minimized.
- Storage sites of top soils shall be covered with grass and separated with bund. Water should be sprinkled to facilitate growing of grass.
- Storage area should be located downwind of the habitation area.
- Hot mix plant should be located at least 1 km from the nearest habitation, school, hospital, forest, river, streams, lakes, 500m from ponds, and national highways, 250m from state highways. Hot mix plant shall be fitted with stack of adequate height as may be prescribed by SPCB to ensure dispersion of exit gases.
- If HMP, Crusher plant is not meeting offset condition from sensitive area, then fencing with 6 height GI sheet barricading around the plant should be done.9
- LPG should be used as fuel source in construction camps instead for woods.
- Vehicles and machinery shall be maintained regularly and PUC certificate shall be obtained by the Contractor regularly.
- Ambient air quality shall be monitored by Contractor as per Environmental Monitoring Plan to ensure that air quality parameter is within permissible limit.
- Contractor shall follow Generic Guidelines for Environment Friendly Construction Methodology appended in EMP.
- Good management practices10 (refer Best Practicable Means for Cement Works (Concrete Batching Plant) BPM 3/2 to be followed.

Operation Phase

Description

391. Infrastructure projects like roads and highways are important for country's economic and social growth. Indian cities, in general, are characterized by the high motor vehicle population as they are excessively dependent on their road network for freight and passenger traffic movements. Road transport is a critical contributor to air pollution in the Indian city context because of excess use of diesel as fuel and non-availability of environment-friendly fuel like CNG gas in many Indian cities. Most of the cities are overly reliant on-road transportation, and the majority of motor vehicles are running with diesel and petrol as clean fuel like compressed natural gas (CNG) is yet to be available in most of the cities. The motor vehicle stock in Indian cities has grown steadily in the past. It is expected to continue with the momentum in the future due to the increase in population, migration, and economic growth. However, incremental and unchecked development may lead to innumerable environmental and economic losses. Development of new or expansion of existing road/highway project adds to existing traffic which in turn to air pollution, on human establishments etc. along the road corridor. In case of road and highway projects, vehicular traffic is the main source of air pollution and responsible for poor air quality along the road/highway corridor. Well maintained and new engine technology-based vehicles causes less pollution as compared to old technology and ill maintained vehicles. Concentration of pollutants depends not only on traffic volume but on other factors also. Estimation of pollution emission rate is complex process especially when traffic is heterogeneous in nature.

392. Air quality modelling due to traffic was carried out for the base year (2025) and also for the projected years (2030, 2035 and 2040). The following analysis is that of corridor S6 provided as a sample. Detailed analysis of remaining corridors has been provided in the Annexure 3 of the report.

Assessment

393. The air quality parameter is the most common environmental feature, which is being affected by any infrastructure projects. The pollutants of concern (recognized by by the Central Pollution Control Board (CPCB) as potentially damaging to human health) for the Project are the substances emitted by the traffic plying on the road stretch. The main pollutants of concern that may be generated from vehicular emission are nitrogen dioxide (NO_2), sulphur dioxide (SO_2), Carbon Monoxide (CO), particulate matter (PM) as PM10 and PM2.5, Ammonia (NH_3), Ozone (O_3), Lead (Pb), Arsenic (As), Nickel (Ni), Benzo(a)pyrene (BAP) and Benzene. The intensity of air pollution is linked with inadequate vehicle maintenance, load of vehicles, speed of vehicle and use of adulterated fuel in vehicles. Additionally, DG sets installed when operated will add emissions on the ambient air affecting air quality in the vicinity of toll plazas.The aspect impact table for air environment for operational phase is discussed in the table below.

Table 4-30: Aspect Impact of Ambient Air Quality in Operation Stage

[9] CPCB guideline of Hotmix, Crusher plants
[10] http://www.epd.gov.hk/epd/english/environmentinhk/air/guide_ref/guide_best_pract.html

Aspect	Impacts	
Impact Description	**Impact due to vehicular movement**	**Impact due to use of DG sets and other maintenance work.**
Receptor Importance/ Sensitivity	Low	Low
Extent	Core Zone	Core Zone
Duration	Short term	Short term
Frequency	Recurring	Recurring
Likelihood	Likely	Likely
Reversibility	Reversible	Reversible
Magnitude/ Severity	Low	Low
Effect	Negative	Negative
Direct/ Indirect	Direct	Direct
Significance	Minor	Minor
Additional Mitigation (Y/N)	Y	Y
Residual Significance	Negligible	Negligible

394. During operation phase of the road project, air quality impact assessment study was carried out considering traffic as major air pollution sources and its potential air environment impact was assessed using the American Meteorological Society (AMS)/Environmental Protection Agency (EPA) Regulatory Model AERMOD – Version 21112. AERMOD is the state-of-the-science, steady-state Gaussian air dispersion model based on planetary boundary layer theory. Atmospheric dispersion modelling is a mathematical simulation of how air pollutants disperse in the ambient atmosphere. It is performed with computer programs that solve the mathematical equations and algorithms which simulate the pollutant dispersion. The dispersion models are used to estimate or to predict the concentration of air pollutants emitted from sources on the desired impact area. Such models are important to governmental agencies tasked with protecting and managing the ambient air quality. The models are typically employed to determine whether the ambient air quality level due to proposed project will compliance with the National Ambient Air Quality Standards (NAAQS) or not. Over and above models also serve to assist in designing of effective control strategies to reduce emissions of harmful air pollutants.

395. Traffic inventory consist of 24-hour traffic volume, traffic composition as per vehicle type (2 wheelers, Auto, Taxi & Car, Bus, LCV, 2-Axle Truck, 3-Axle Truck, and MAV) representative of vehicular fleet on the Assangthang Salghari to CCCT Nandugaon - corridors was taken for study.

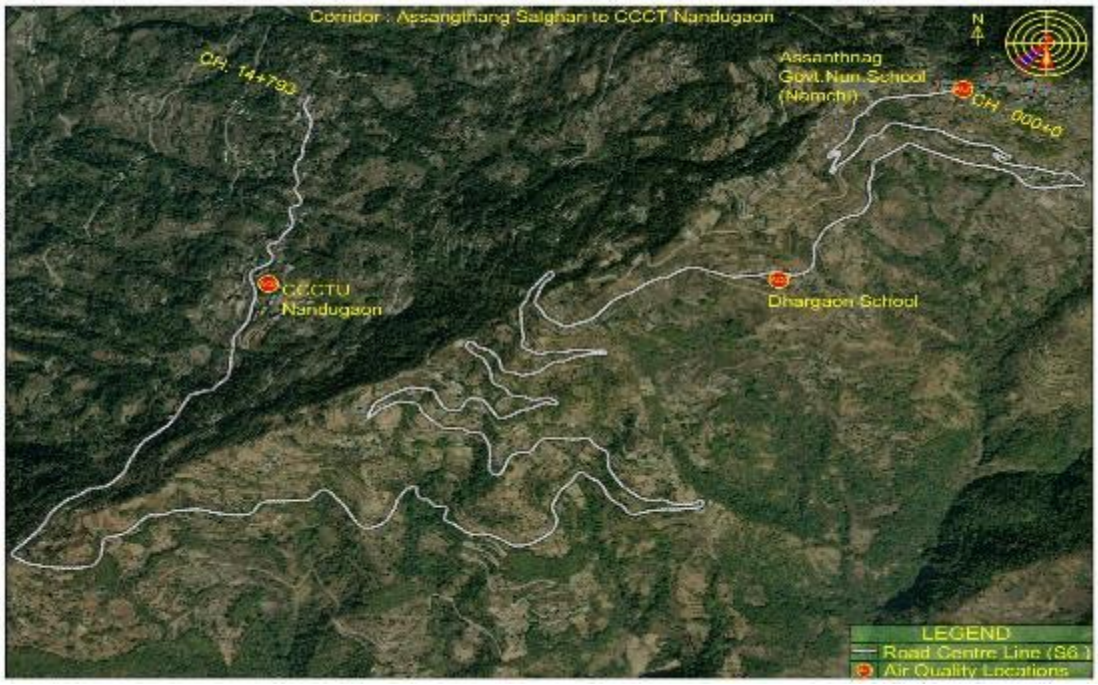


Figure 4-7: S6 Base Map

Table 4-31: base year projected traffic vehicle/day on Assangthang Salghari to CCCT Nandugaon

Vehicle Type	2025	2030	2035	2040
Two wheelers	65	900	1182	1552
Autorickshaw (3w)	0	0	0	0
7-seater (3w) / Maxi Cabs	0	0	0	0
Taxi	47	389	510	670
Car/Jeep/Van (Other than Taxi)	122	1081	1420	1864
Mini Bus	0	8	11	14
Govt. Bus	0	0	0	0
Bus Pvt	0	0	0	0
School/Institutional Bus	0	0	0	0
LCV-3 Wheeler	0	0	0	0
LCV-4 Wheeler	16	243	320	420
LCV-6 Wheeler	0	0	0	0
2-Axle Truck	12	49	64	84
3-Axle Truck	0	0	0	0
MAV (Truck Trolly)	0	0	0	0
Tractor-Trolly	0	0	0	0
Tractor	0	0	0	0
Cycle	0	0	0	0
Cycle Rickshaw	0	0	0	0
Animal Drawn	0	0	0	0
Total	**262**	**2670**	**3506**	**4604**

396. During operation phase, vehicular emissions are one of the major ambient air quality impact sources. However, the extent of these impacts, at any given time will depend upon the rate of vehicular emission within a given stretch of the road; and the prevailing meteorological conditions. Hourly emissions rates have been calculated as function of emission factor and vehicular activity data for each road segment. To assess the air quality impact quantitatively Gaussian plume dispersion model (AERMOD) was simulated with observed discussed meteorological conditions to predict the maximum ground level concentrations (GLCs). Air quality modelling due to traffic plying on the Assangthang Salghari to CCCT Nandugaon was carried out for the base year (2025) and also for the projected years (2030, 2035 and

2040). Three (03) desired receptor locations AQ1, AQ2 and AQ3 along the corridors were selected at per-identified receptor locations at a distance of 16 m, 32 m and 57 m respectively from the centerline of road alignment to assess the air quality quantitatively at these desired receptors locations using modelling technique. Spatial variation of model simulates predicted incremental ground level PM, NOx and CO criteria pollutants concentration due to the traffic in the base year 2025 on modelling grid scale 100 m x 100 m on appropriate impact zone considering the same meteorological conditions as observed in the year 2022-23 are shown in Figures 2.4-2.12 with reference to each receptor locations (AQ1, AQ2 & AQ3). Incremental maximum GLCs of modelled pollutants PM, NOx and CO due to traffic plying on the road segment with reference to each receptor location. Maximum incremental GLCs on applicable average is expected to occur near the road alignment. Variation in predicted maximum ground level concentrations may be attributed to road geometry and prevailing meteorological condition.

Table 4-32: base year projected traffic vehicle/day on Assangthang Salghari to CCCT Nandugaon

Pollutants	Receptors		
	Road Segment for AQ1	Road Segment for AQ2	Road Segment for AQ3
PM	0.12	0.09	0.10
NO_x	15.39	11.67	12.94
CO	68.52	52.29	59.75

Figure 4-8: spatial distribution of 24-hour average PM conc. (ug/m3): traffic (2025): aq1

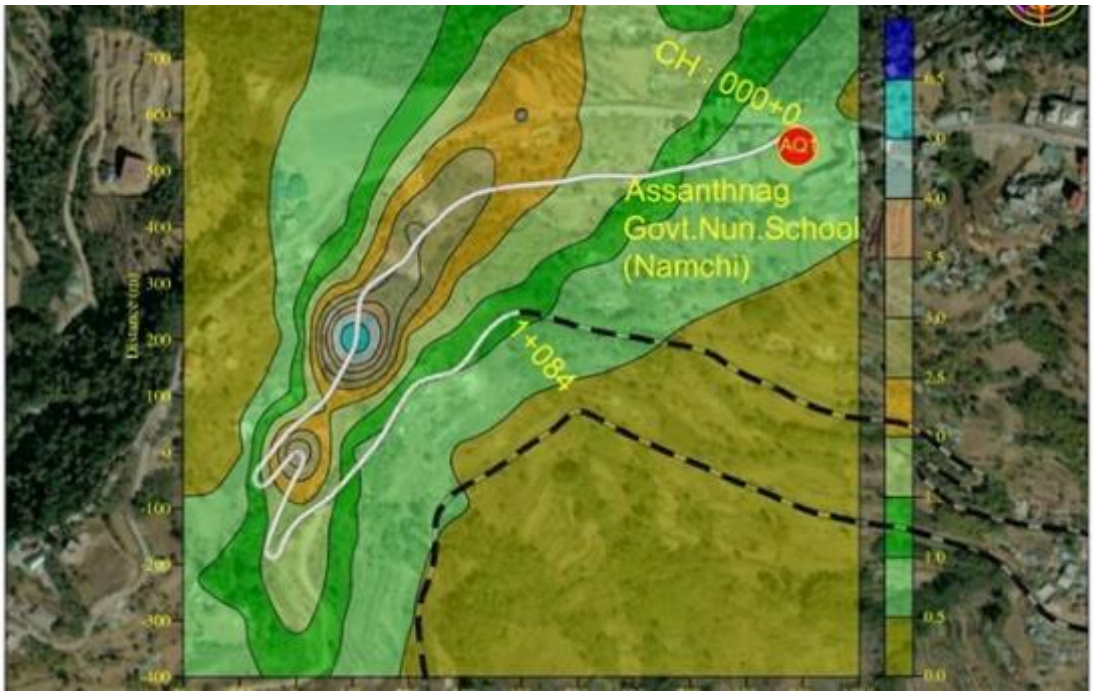


Figure 4-9: spatial distribution of 24-hour average NOx conc. (ug/m3): traffic (2025): aq1

Figure 4-10: spatial distribution of 8-hour average CO conc. (ug/m3): traffic (2025): aq1

Figure 4-11: spatial distribution of 24-hour average PM conc. (ug/m3): traffic (2025): aq2

Figure 4-12: spatial distribution of 24-hour average NOx conc. (ug/m3): traffic (2025): aq2

Figure 4-13: spatial distribution of 8-hour average CO conc. (ug/m3): traffic (2025): aq2

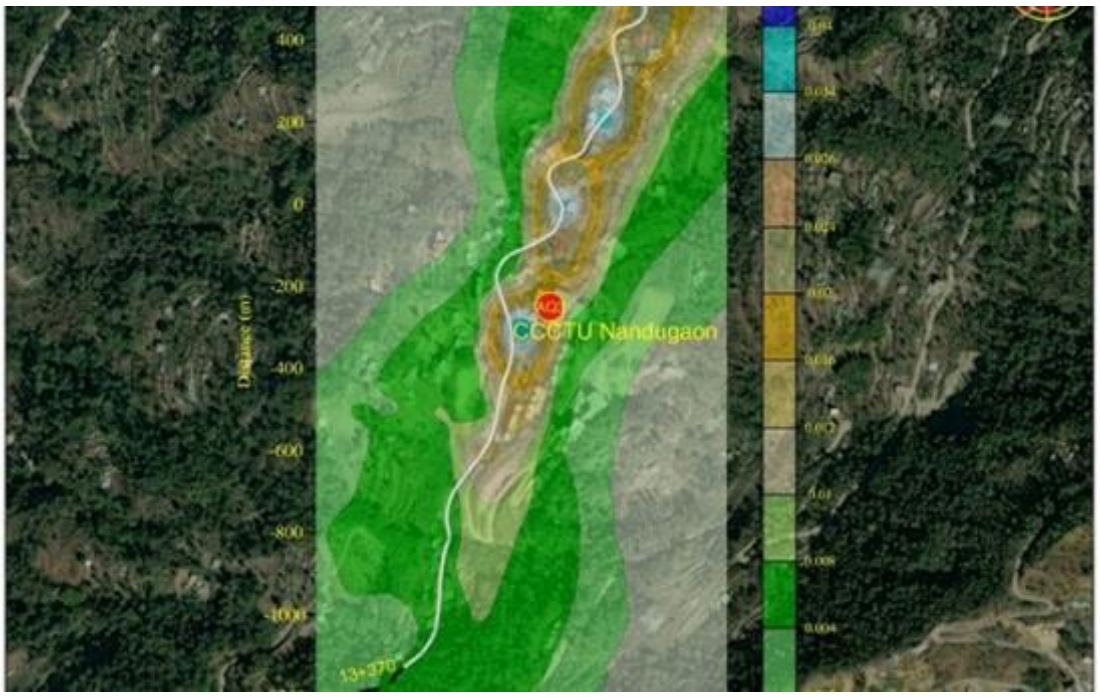


Figure 4-14: spatial distribution of 24-hour average PM conc. (ug/m3): traffic (2025): aq3

Figure 4-15: spatial distribution of 24-hour average NOx conc. (ug/m3): traffic (2025): aq3

Figure 4-16: spatial distribution of 24-hour average CO conc. (ug/m3): traffic (2025): aq3

397. Predicted maximum incremental ground level PM, NOx and CO concentrations (GLCs) at three interested receptor's locations is presented in Table 2.4 reflects that the highest maximum ground level concentrations are expected to occur at receptor AQ3. Highest concentration may be attributed to road geometry around the receptor location and prevailing meteorological condition.

Table 4-33: predicted max. ground level coc. (µg/m3) at receptors locations: year 2025

Pollutants	Receptors		
	AQ1 Assanthang Govt. Nun. School (Namchi)	AQ2 Dhargaon School	AQ3 CCCTU Nandugaon
PM	0.0102	0.0097	0.0363
NOx	1.2610	1.1947	4.4743
CO	8.2656	5.6977	20.2907

398. Further, ambient air environment impact was also assessed with reference to projected traffic volume in the years 2030, 2035 and 2040. Predicted incremental concentration of criteria pollutants PM, NOx and CO at these three desired receptor's locations in projected years along with base year 2025 due to projected traffic are presented below.

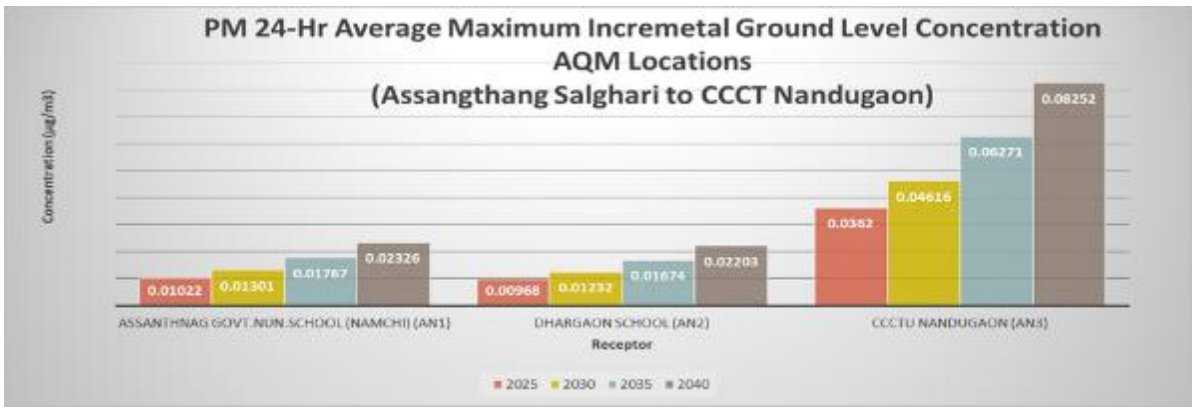


Figure 4-17: predicted 24-hour average PM max. conc. (ug/m3) at receptors locations (2025-2030-2035-2040)

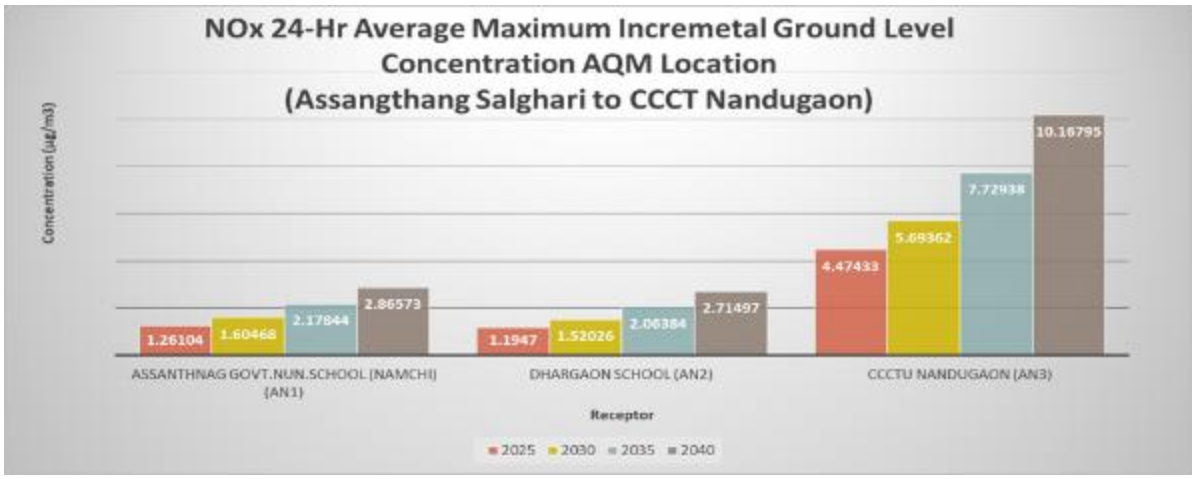


Figure 4-18: predicted 24-hour average NOx max. conc. (ug/m3) at receptors locations (2025-2030-2035-2040)

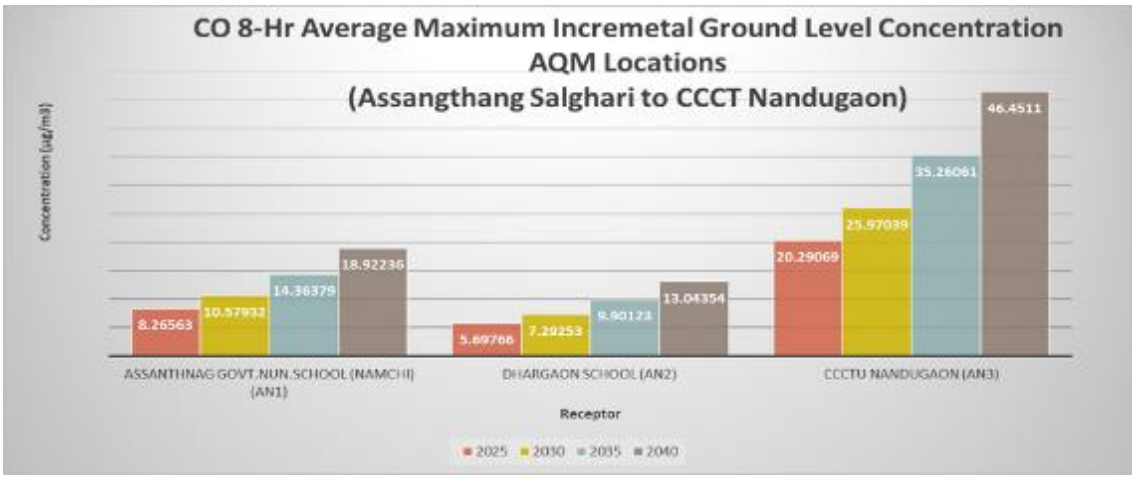
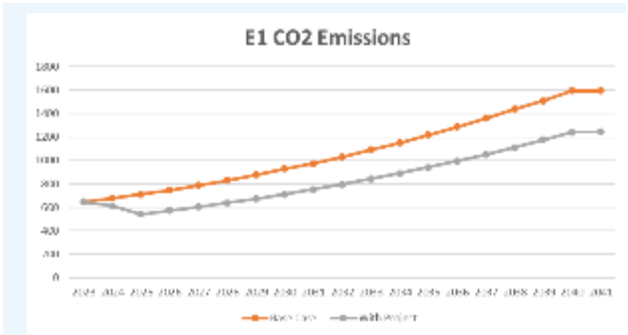
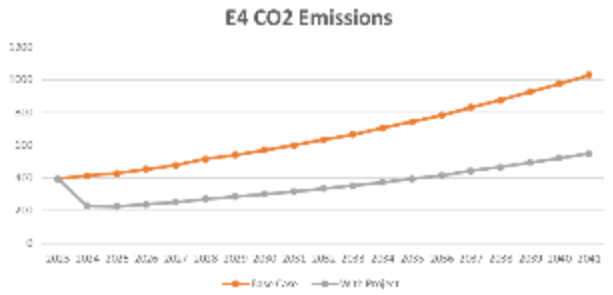


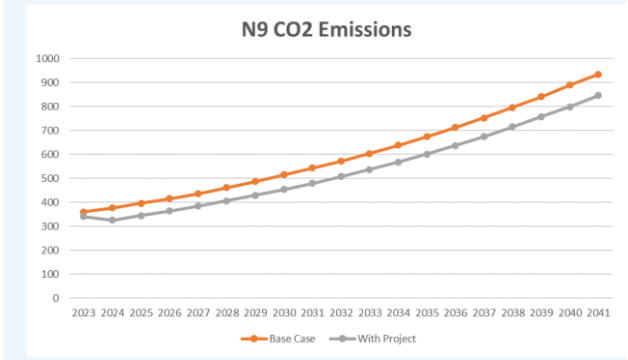
Figure 4-19: predicted 8-hour average PM max. conc. (ug/m3) at receptors locations (2025-2030-2035-2040)

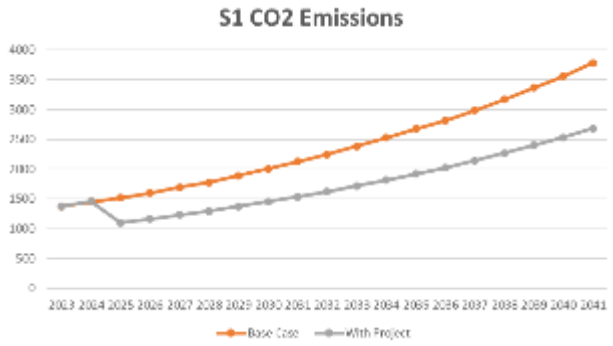
399. Modelling study of Air pollution prediction has been attached in Annexure 3.

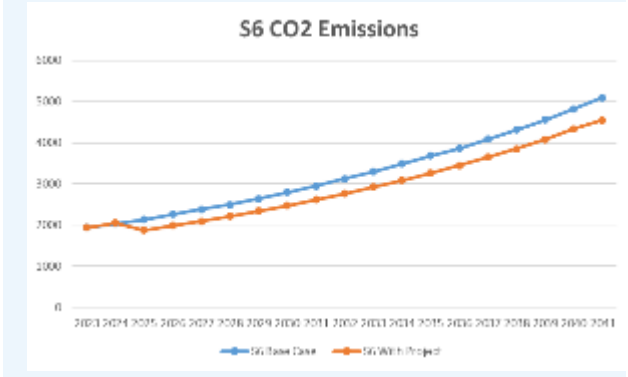
400. It is observed for all project corridors there is substantial reduction in Carbon Dioxide emission thereby resulting in carbon reduction at the end of 2042.











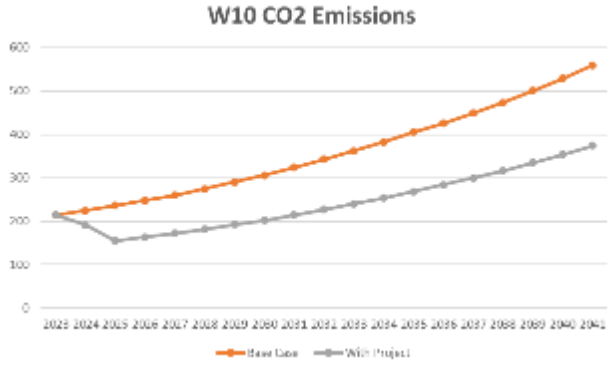


Figure 4-20: Analysis of CO2 emission in all project corridors

401. The mitigation measures to control the emissions in air environment includes:

- Regularly clean and maintain unpaved shoulders, service roads, and medians to minimize dust.
- Develop green belts or roadside plantations to act as biological air filters for pollutants like PM2.5, PM10, NO_2 , SO_2, and CO.
- Implement measures to reduce congestion and idling times, such as intelligent traffic signals or dedicated lan es.
- Road (main carriage way) damage to be promptly rectified with proper road repair and maintenance work to avoid dust emission.
- Explore the use of vehicles which use cleaner fuel types (CNG and EVs) for operation (patrolling) purpose.

4.1.13 Impact on Noise Environment

Construction

Description

402. Construction activities significantly increase local noise levels, affecting workers, nearby residents, wildlife, and structural integrity, with potential health and social consequences. The sources of noise will be mainly from heavy machineries such as excavators, bulldozers, and cranes, power tools such as jackhammers, drills and saws, noise from trucks while transporting construction materials and from crusher and mixing plants on-site.

Assessment

403. With regards to noise related impacts, construction phase is a difficult stage. During this period noise impacts will be high due to operation of construction machineries and the conflict with the regular traffic requiring more honking of vehicle horns and more stop and go (acceleration and deceleration process).

404. All temporary noise related impacts in the immediate vicinity of the project roads will occur during the construction activities. This will be occurred along the construction zones as well as construction camps, hot mix plants, WMM plants, crusher and quarry sites (if required).

405. During Baseline study on noise level along the Project Road it has been found that the noise level varied between daytime (Leq) in the range of 55 dB (leq) to 50 dB (leq) and similarly night time 45 (leq) to 40 db.

Table 4-34: Standards in Respect of Noise

Category of Area	Limits in dB(A) Leq	
	Day Time	Night Time
Industrial Area	75	70
Residential Area	55	45

406. Typical noise levels associated with highway construction is given in Table 6-8. The magnitude of impact will depend upon the specific types of equipment to be used, the construction methods employed and the scheduling of the work.

Table 4-35: Typical noise levels of principal construction equipment's (Noise Level in dB (A) at 50 Feet)

Activities/ Operation of Equipment	Noise Level dB(A)	Activities/ Operation of Equipment	Noise Level dB(A)
CLEARING AND GRUBBING		**STRUCTURE CONSTRUCTION**	
Bulldozer	80	Crane	75-77
Front end loader	72-84	Welding generator	71-82
Jack hammer	81-98	Concrete mixer	74-88
Crane with ball	75-87	Concrete pump	81-84
		Concrete vibrator	76

Activities/ Operation of Equipment	Noise Level dB(A)	Activities/ Operation of Equipment	Noise Level dB(A)
EXCAVATION & EARTH MOVING		Air compressor	74-87
Bulldozer	80	Pneumatic tools	81-98
Backhoe	72-93	Bulldozer	80
Front end loader	72-84	Cement and dump trucks	83-94
Dump truck	83-94	Front end loader	72-84
Jack hammer	81-98	Dump truck	83-94
Scraper	80-93	Paver	86-88
GRADING AND COMPACTING		**LANDSCAPING AND CLEAN-UP**	
Grader	80-93	Bulldozer	80
Roller	73-75	Backhoe	72-93
		Truck	83-94
PAVING		Front end loader	72-84
Paver	86-88	Dump truck	83-94
Truck	83-94	Paver	86-88
Tamper	74-77	Dump truck	83-94
Source: U.S. Environmental Protection Agency. Noise From Construction Equipment and Operations. Building Equipment and Home Appliances. NJID. 300.1. December 31. 1971,			

407. At the moment, noise level is within the desired level. The noise level will be increased during construction period, which have significant impact for a limited period on the surrounding environment. The noise levels in the working environment are compared with the standards prescribed by Occupational Safety and Health Administration (OSHA-USA) which in-turn are being enforced by Government of India through Model rules framed under the Factories Act. The acceptable limits for each shift being of 8-hour duration, the equivalent noise level exposure during the shift is 90 dB(A). Hence noise generated due to various activities in the construction camps may affect workers, if equivalent 8-hour exposure is more than the safety limit. ACGIH (American Conference of Government Industrial Hygienists) recommends an 8-hour Leq limit of 85 dB(A). Exposure to impulses or impact noise should not exceed 140 dB(A). The workers in general are likely to be exposed to an equivalent noise level of 80-90 dB(A) in an 8-hour shift for which all statutory precautions as per laws should be taken into consideration. Noise limits for different working environment are provided in Table 4-36: Noise Limits for different working Environment

Table 4-36: Noise Limits for different working Environment

Location/ Activity	Equivalent Level LAeq,8h	Maximum LA max, fast.
Heavy Industry (no demand for oral communication)	85dB (A)	110dB (A)
Light industry (decreasing demand for oral communication)	50-65dB(A)	110 dB(A)
Open offices, control rooms, service contours of similar	45-50 dB(A)	
Individual offices (no disturbing noise)	40-45dB(A)	
Classrooms lecture halls	35-40 dB(A)	
Hospital	30-35 dB(A)	40 dB (A)

Noise sources identified are:

- Construction activities such as demolition of structures, clearing and grubbing, hill cut, excavation & earth moving, grading and compacting, structure construction
- Transportation of construction material/debris/spoil through heavy vehicles
- Operation of hydraulic rigs for piles

Sensitive Receptor: Six settlements exist along the existing road. Proposed road has bypassed all the 4 villages. There Noise receptors are presented in Table 4-28 and in Ch-5. Noise receptors for the construction work are:

- Residential, Religious Places, Educational Institute, Hospital etc.
- Construction worker who are engaged at construction site
- Workers who are engaged in operation of plants such as crusher, aggregate batching plant, quarry etc.

Various construction activities (section 8.7.1) will generate temporary noise impacts in the immediate vicinity of the construction site. Typical noise levels associated with various construction activities and various construction equipment's are presented in Table 4-28. The noise generated by construction activities is a temporary phenomenon and is limited to construction phase only.

- Sources of vibration – Compaction activities are the significant sources of noise during construction phase. Compaction activities may damage properties adjacent to the RoW.
- Contractor shall be responsible for preservation of properties (MoRTH Clause 201.2), which are not to be disturbed.

408. The aspect impact table for the construction phase of noise environment is presented below.

Table 4-37: Aspect impact table for noise environment during construction phase

Aspect	**Impacts**
Impact Description	**Impact due to noise from heavy machinery, power tools, crusher and mixing plants and transportation of heavy vehicles.**
Receptor Importance/ Sensitivity	High
Extent	Core Zone
Duration	Short term
Frequency	Temporary
Likelihood	Likely
Reversibility	Reversible
Magnitude/ Severity	Medium
Effect	Negative
Direct/ Indirect	Direct
Significance	Minor
Additional Mitigation (Y/N)	Y
Residual Significance	Negligible

409. The high noise levels may cause discomfort to local residents and workers. Following mitigation measures shall be adopted to keep the noise and vibration levels under control.

- The plants and equipment used for construction will strictly conform to Central Pollution Control Board (CPCB) noise standards. Vehicles, equipment and construction machinery shall be monitored regularly with particular attention to silencers and mufflers to maintain noise levels to minimum;
- Workers in the vicinity of high noise levels must wear ear plugs, helmets and should be engaged in diversified activities to prevent prolonged exposure to noise levels of more than 85-90dB(A);
- In construction sites within 150 m of human settlements, noisy construction will be stopped between 10 PM and 6 AM except in case of laying of cement concrete pavement for which lower working temperature is a requirement;
- Hot mix plant, batching or aggregate plants shall not be located within 500 m of sensitive land use as schools and hospitals;

- Near to the sensitive receptors such as hospitals and schools, noise barriers such as earth, concrete, wood, metal or double-glazing of windows for façade insulation shall be used;
- Phase demolition, earthmoving and ground-impacting operations so as not to occur in the same time period. Unlike noise, the total vibration level produced could be significantly less when each vibration source operates separately
- Construction machinery will be located away from the settlements;
- Careful planning of machinery operation and scheduling of operations can reduce the noise levels. Use of equipment, emitting noise not greater than 90 dB(A) for the eight-hour operations shift and locating of construction yards at a distance of at least 500 m from any residential areas can be adhered to;
- Use of noise shields to construction machinery and provision of earplugs to the heavy machine operators are some of the mitigation measures, which should be followed by the contractors during the civil works;
- The noise control measures include limitations on allowable grades. Open-graded asphalt and avoidance of surface dressings to reduce tire noise in sensitive areas. Maintenance of proper road surface repairs also helps in reducing noise levels;
- Use of air horns should be minimized on the highway during nighttime. During daytime use of horns should be restricted at few sensitive locations. This can be achieved through the use of sign boards along the roadside;
- Periodic medical hearing checks should be performed on workers exposed to high noise levels.
- Future development along the road should follow correct land use norms so that sensitive receptors are not located along the road, specifically along the bypasses; and
- Development of greenbelt along the main road can also bring about considerable reduction in noise levels. The area available on both sides of the road should be used to develop green belt comprising selected species of trees with high canopy to provide added attenuation of noise.

Table 4-38: OSHA Daily Permissible Occupational Noise Level Exposure

Sl. No.	Duration per day, hours	Sound level dB(A)
1	8	90
2	6	92
3	4	95
4	3	97
5	2	100
6	1 and ½ or 1.5	102
7	1	105
8	½	110
9	14 or less	115

Operation

Description

410. Noise level is likely to increase due to increased traffic. Effective traffic management and good riding conditions shall be maintained to reduce the noise level throughout the stretch and speed limitation, and honking restrictions may be enforced near sensitive locations. The effectiveness of noise mitigation should be monitored and if need be, solid noise barrier shall be placed.

Assessment

411. During the operation stage of the project, there would be vehicular engine and honking noise as a result of traffic movement Additionally, noise will be generated from maintenance activities as well. The aspect impact table for the noise environment for operational phase is as follows.

Table 4-39: Aspect impact of noise environment during operational phase

Aspect	Impacts	
Impact Description	**Impact due to noise from vehicle movement**	**Impact due to maintenance activities**
Receptor Importance/ Sensitivity	Medium	Low
Extent	Core Zone	Core Zone

Aspect	Impacts	
Duration	Permanent	Permanent
Frequency	Permanent	Permanent
Likelihood	Likely	Likely
Reversibility	Reversible	Reversible
Magnitude/ Severity	Medium	Low
Effect	Negative	Negative
Direct/ Indirect	Direct	Direct
Significance	Minor	Neglibible
Additional Mitigation (Y/N)	Y	N
Residual Significance	Negligible	-

Noise Impact Analysis Using SoundPlan 5.0

412. The impacts of traffic noise have been calculating noise model SoundPlan5.0. the detailed report of noise modelling is provided in the Annexure 25 and the summary is provided below.

413. The source of noise generated in linear projects is generally from vehicles, junctions, and congestion. Topography, vegetation, and atmospheric factors can affect the rate of sound attenuation. A hard site exists where sound travels away from the source over a generally flat, hard surface such as water, concrete, or hard-packed soil. When ground cover or normal unpacked earth is present between the source and receptor, the ground becomes absorptive to sound energy and is called a soft site. All project roads being in soft ground sites generally does attenuate a certain amount of noise. However, there are places where the sound produced is greater than the national permissible limits. This is due to the traffic flow of the respective road stretches. The noise monitoring results obtained from EIA is mentioned in the table below.

Table 4-40: Background Ambient Noise Level

	S6		E1		E4		N9		S1		W10	
Scenario	**Day**	**Night**	**Day**	**Night**	**Day**	**Night**	**Day**	**Night**	**Day**	**Night**	**Day**	**Night**
Sampled Noise Level in 2022	53.8	42.3	53.1	43.1	53.6	42.1	56.8	44.8	55.1	44.4	54.8	42.3

414. These results were sampled in the year 2022 and it can be noted that most of the values are very close to the national permissible limit for day (55db) and night (45db). The possibility of widening these road stretches will positively increase the traffic flow thus resulting in increased noise levels. The results obtained from projected scenario of 2026 without noise protection measures is presented in the table below.

Table 4-41: Project Noise Level

	S6		E1		E4		N9		S1		W10	
Scenario	**Day**	**Night**	**Day**	**Night**	**Day**	**Night**	**Day**	**Night**	**Day**	**Night**	**Day**	**Night**
Projected Noise Level of Scenario 2 (2026)	52.7	48.3	54	51.2	53.6	46.8	59.5	48.6	61	52.1	56.6	47.8

415. It can be observed that most of the values are exceeding the national permissible limits for both day and night. Therefore, noise protection measures are in priority need for all project roads. Out of the many mitigation measures which can be used for linear projects, noise berm/ earth berm, vegetative barriers, speed restriction, improved flow of traffic, signages at noise sensitive area are optimal measure for this topography. Noise berms can be an effective way to help lower sound levels from the linear project. The following table provides the projection of all the road projects for the year 2026 with noise protection measure. The noise protection used here is noise/earth berm.

Table 4-42: Project Noise Level with Noise Protection Measure

	S6		E1		E4		N9		S1		W10	
Scenario	**Day**	**Night**	**Day**	**Night**	**Day**	**Night**	**Day**	**Night**	**Day**	**Night**	**Day**	**Night**
Projected Noise Level of Scenario 3 (2026)	49.5	44	50.5	45.6	44.6	37.6	54.4	43.2	46.7	37.3	49.4	40.4

Noise Impact Analysis using Calculation of Road Traffic Noise (CRTN)

416. Impact from traffic noise on the proposed road corridors were investigated using traffic noise model (Calculation of Road Traffic Noise (CRTN)) developed by UK Department of Transport. CRTN method is an appraised model being used worldwide to predict traffic noise, especially in highways and roads of urban centre. Procedure for determining the level of noise from the corridors based on the traffic parameters, the propagation distance and conditions between the roadway and receiver. The noise model was used to calculate noise levels within the noise study area, at a height of 5 m above local ground at the desired receptor's locations from the centerline of the roads segment for the base year (2025) and also for projected years (2030, 2035 & 2040 with the assumption of full view angle. The CRTN procedures assume typical noise propagation scenarios which are consistent with moderately adverse wind velocities in all directions. The speed of the vehicle on the roadway was assumed 20 kmph for all type of vehicles. The road surface was assumed to be paved and no sound absorption by soil was considered for conservative estimation of noise level at the desired receptor location. The predicted daytime (Ld) (7:00-22:00 Hrs.) noise level, Nighttime (Ln) (22:00-7:00 Hrs.) noise level and day night time (Ldn) noise level due to hourly traffic flow on the dedicated corridor are presented in **Table 4-43**

417. The detail noise modelling results show that noise level will not be expected to be increased significantly between the base year (2025) and project year (2040) and may be expected to be increased by 1-8 dB(A) during night time. Further, how noise level from the traffic noise may be expected to attenuate with distance from the road alignment during daytime, night time and day night time are Presented in the Annexure-3 respect to each desired noise receptor location along the road corridors. Traffic Noise Model (TNM) simulated results envisages that noise level meets the environmental noise standards with respect to daytime Noise standards 55 dB(A) and Nighttime 45 dB(A) within 100 m from the centerline of the roadway alignment. As per results it was observed that in the year 2025 S6 (NQ1), S1 (NQ1, NQ2, NQ3, NQ4), E1 (NQ1), W10(NQ1, NQ2) would have significant increase in noise due to traffic during night time arising from increased usage of road. Additionally in the subsequent years by 2040 S6 (NQ1), S1 (NQ1, NQ2, NQ3, NQ4), E1 (NQ1, NQ2), E4 (NQ1, NQ3), N9 (NQ1), (W10(NQ1, NQ2) would also see a rise in the traffic during night time. During day time none of the roads will face any significant increase.

Table 4-43: Predicted noise level (dB(A)) at the receptor's locations (2025-2030-2035-2040)

Road S6: Assangthang Salghari to CCCT Nandugaon									
Year	**NQ1 Assanthang Govt. Nun. School (Namchi)**			**NQ2 Dhargaon School**			**NQ2 CCCTU Nandugaon**		
	Ldn	Ln	Ld	Ldn	Ln	Ld	Ldn	Ln	Ld
2025	52	**46**	44	49	42	40	46	39	37
2030	53	**46**	44	49	43	41	46	40	38
2035	53	**47**	45	50	44	42	47	40	38
2040	54	**48**	46	51	44	42	48	41	39

Road S1: Melli-Phong via Rateypani												
Year	**NQ1: 25 m (Melli PHC)**			**NQ2: 10 m (Passi)**			**NQ3: 21 m (Phong (Govt. Si. Sec. School)**			**NQ4: 9 m (Near Precbyterian Church)**		
	Ldn	Ln	Ld	Ldn	Ln	Ld	Ldn	Ln	Ld	Ldn	Ln	Ld
2025	52	**46**	44	56	**50**	48	53	**46**	44	57	**50**	48
2030	53	**46**	46	57	**51**	49	54	**47**	45	57	**51**	49
2035	55	**48**	46	59	**52**	50	56	**49**	47	59	**53**	51
2040	55	**49**	47	60	**53**	51	56	**50**	48	60	**54**	51
Road E1: Rorathang-Rongli												

Year	NQ1: 16 m (Rorathang)			NQ2: 61 m (Rongli BDO Office)		
	Ldn	Ln	Ld	Ldn	Ln	Ld
2025	56	**50**	48	49	43	41
2030	57	**51**	49	50	44	42
2035	58	**52**	50	52	45	43
2040	59	**53**	51	52	**46**	44

Road E4: Khamdong Lingzey-Tintekugaon

Year	NQ1 (32 m) (Birkuna Junior School)			NQ2 (49 m) (Lingzey Junior School)			NQ3 (23 m) (Samdong PHC)		
	Ldn	Ln	Ld	Ldn	Ln	Ld	Ldn	Ln	Ld
2025	48	42	40	46	40	38	50	44	42
2030	51	44	42	49	42	40	52	**46**	44
2035	52	**46**	44	50	44	42	54	**48**	46
2040	54	**48**	46	52	45	43	56	**49**	47

Road N9: Mangan Bazar to D.A.C. (Mangan) (Dr. Lobzang Tenzing Marg)

Year	NQ1: 93 m Mangan (Fire Brigade)		
	Ldn	Ln	Ld
2025	48	42	40
2030	50	44	42
2035	51	45	43
2040	52	**46**	44

W10: Geyzing to Sakyong

Year	NQ1: 11 m (Gayzing Near Taxi Stand)			NQ2: 10 m (Near Panchayet Bhawan)		
	Ldn	Ln	Ld	Ldn	Ln	Ld
2025	55	**49**	47	55	**49**	47
2030	57	**51**	49	57	**51**	49
2035	59	**52**	50	59	**53**	50
2040	60	**53**	51	60	**54**	52

As per CPCB Guidelines, permissible limit are as follows:

Category of Area	Limits in dB(A) Leq	
	Day Time	Night Time
Industrial Area	75	70
Residential Area	55	45

*Red marked cells denote breach of permissible limit

Mitigation measures

418. The mitigation measures for Noise Impacts based mitigation hierarchy is given below.

i. **Traffic Management:**

- Speed Regulation: Implementing and enforcing speed limits to reduce vehicle noise, particularly from heavy trucks.
- Vehicle Restrictions: Restricting the movement of heavy vehicles during night hours or in certain sensitive areas will reduce noise levels.
- Vegetation : Planting trees and shrubs along roads serves as natural buffers, reducing the perception of noise.
- Mitigating the impact of increased noise levels at the sensitive receptor locations includes posting of signs prohibiting the use of horns, constructing a sound insulating barrier and, to the extent possible, planting appropriate trees to serve as green noise barriers.

ii. Road Design and Construction:

419. A community consultation was conducted on 27 and 28 November 2025 where the proposal of Noise wall and Noise Berms were disclosed, which the stakeholders did not prefer sighting following reason.

- The noise wall/ berms will restrict access to the road as the right of way is limited.
- The area is highly seismic so, putting additional load on the slop may case failure of slops and trigger land slide.

420. So, it was recommended to provide vegetative noise barrier. The noise model has been re-run with the vegetative barrier. It was found 1 meter width of combination of grass, shrubs and coniferous trees of minimum height 10 meters mitigates the noise to the acceptable limit. The noise modelling at the sensitive receptors has been conducted with the options of vegetative barrier. The scenario of post mitigation measures meets the national noise standards and are provided in Table No 7-3 of Annexure 25. The technical specifications of the mitigation measures are also provided in Table No 7-1 and 7-2 of Annexure 25.

421. The cumulative length of all sixes roads where vegetative noise barrier is required is 1700 meters. The species of grass, shrubs and trees are provided in the Annexure 25.

- Noise Barriers: constructing vegetative noise barriers the road can help reduce the impact of traffic noise on nearby residences and sensitive areas.
- Pavement Materials: Using noise-reducing pavement materials can help minimize the sound produced by vehicle tires.
- Optimizing Road Alignment: Adjusting road alignment to avoid high population density areas and sensitive zones like schools and hospitals can reduce noise exposure.

422. Provision of noise barriers along the road will reduce the noise significantly. The characteristics of the noise barriers for each road stretch are provided in the table below.

Table 4-44: Vegetative Noise barrier characteristics for each road stretch

SN	Road Name	Start Chainage	End Chainage	Length of road	Provision of vegetative barrier in LHS/RHS	Length of the vegetative barrier considered	Maximum Tree height
1.	E1 Rorathang Rongli	0+ 500	0+ 700	200 m	LHS and RHS	LHS: 200 m RHS: 200 m	LHS:10m
2.	E4 Khamdong-Lingzey-Tintek	+0.000	+0.200	200 m	LHS	LHS :200 m	LHS: 10 m

SN	Road Name	Start Chainage	End Chainage	Length of road	Provision of vegetative barrier in LHS/RHS	Length of the vegetative barrier considered	Maximum Tree height
3.	S1 Melli - Phong via Rateypani	+0.000	+0.200	200 m	LHS and RHS	LHS: 200 m RHS: 100 m	LHS: 15m RHS: 10m
4.	S6 Assangthang – Salghari to CCCT Nandugaon	+0.000	+0.200	200 m	LHS and RHS	LHS: 200 m RHS: 200 m	LHS: 20m RHS: 15m
5.	W10 Geyzing to Sakyong	4+ 700	5+000	200 m	LHS	LHS: 200 m	LHS: 10m
6.	N9 Mangan Bazaar to DAC	+0.000	+0.200	200 m	LHS	LHS: 200 m	LHS: 10 m
Total Length						**1,700 meter**	

4.1.14 Impact on Socio-Economy

Construction

Description

423. Construction phase of road projects opens a wide array ofsocio-economic impacts. This phase creates immediate jobs for skilled and unskilled labor, engineers, project managers, and machinery operators. Wages paid to local workers stimulate local economies by increasing purchasing power. Ancilliary industries such as material suppliers, equipment rentals etc grow within the region as a multiplier effect. There will be increased activities on public utilities and retail services.

Assessment

424. Although the construction contractors are likely to use un-skilled labour drawn from local communities, use of specialized road construction equipment will require trained personnel not likely to be found locally. Sudden and relatively short-lived influxes of construction workers to communities along the project will have the potential to 'skew' certain demographic variables and the traditional social coherence.

It is anticipated that the construction labor inputs for the construction of the project road will be in the order of about 50 to 60 persons per day. However, this number will fluctuate and the number in any particular activities will be lower.

425. Construction and operation phases of the project road will have some beneficial impact on social environment. Some increase in income of local people is expected as some local unskilled, semiskilled and skilled persons will gain direct or indirect employment during construction phase. Since the immigration of work force during construction phase is likely to be very small, the social impacts on literacy, health care, transport facilities and cultural aspect are expected to be insignificant.

426. Impact on Public Utility: The preliminary design identified impact on a number of public utilities. These include water supplies, drainage system, telecommunication infrastructure and electricity supply poles and transformers. The Detailed Project Report (DPR) clearly mentions the designs to be taken up for the existing public utilities within the RoW and accordingly the budget and plans for relocation or redesign of these existing affected utilities has been considered.

427. Impacts on Access and Mobility: Mobility and access of people using the road for commuting, will be temporarily impacted due to civil works of the Project. The contractors shall ensure that no inconvenience is caused to the commuters. Temporary traffic delays are envisaged during construction period.

428. The contractors will ensure that the construction related activities would be minimal and temporary at any one location along the road. Contractors would also keep community members apprised of construction schedules in readily accessible public locations. A traffic management plan will also be prepared for this purpose as part of the EMP. The contractor has to identify the impacts and address them during the construction.

429. The impacts of the construction of the project road on the socio-economic environment are systematically discussed under the following categories:

- Influx of construction workers,
- Economic impacts,
- Relocation of community structures within the proposed ROW.
- Influx of Construction Workers.

430. The relatively short-lived economic impacts of the construction phase are likely to be experienced in local communities for the duration of construction, as workers will make everyday purchases from local traders. This is likely to give a short-lived stimulus to these traders that will disappear as soon as the construction is complete. Wider, flow-on economic impacts will be experienced in other sectors of economy as a result of purchase of construction materials and the payment of wages and salaries. The aspect impact table for construction phase of scio-economic impact is as follows.

Table 4-45: Aspect impact table of socio economic impact for construction phase

Aspect	**Impacts**	
Impact Description	**Impact due to local employement**	**Impact on public utilities**
Receptor Importance/ Sensitivity	Medium	High
Extent	Buffer Zone	Buffer Zone
Duration	Temporary	Temporary
Frequency	Temporary	Temporary
Likelihood	Likely	Likely
Reversibility	Reversible	Reversible
Magnitude/ Severity	Low	Medium
Effect	Positive	Negative
Direct/ Indirect	Indirect	Direct
Significance	Neglibible	Minor
Additional Mitigation (Y/N)	N	Y
Residual Significance	-	Negligible

431. Project Road E1 will decrease drive time to Pangolakha Wildlife Sanctuary and E4 provides access to Fambong Lho Wildlife Sanctuary via a secondary (western) entrance road. Although neither project road is directly connected to the wildlife sanctuaries, they are part of the road network leading to these protected areas and thus make it more efficient to travel there. Visitation is a key component of fostering public education, understanding, and appreciation for protected areas and natural resource conservation thus it was considered a positive environmental impact. All protected areas in Sikkim have a total reported visitation under 100,000 per year and thus were not considered to be in a state of over-tourism (Gachuiwo et. al. 2025). Importantly, in 2011, Sikkim developed an ecotourism plan and policy, which contains specific plans regarding “Strategies for Infrastructure.

432. Development and Carrying Capacity”. The plans and policies address the direct and indirect impacts associated with the increased visitation by providing policy for tour operators, park management, and infrastructure development.

433. Therefore, the Sikkim ecotourism policy was considered sufficient to prevent negative impacts and no further conservation management planning was required due to the clarity and comprehensiveness of identified measures and plans currently in place by the Department of Forest, Environment and Wildlife Management, Government of Sikkim.oAs and when ecotourism plans are updated, funds from these conservation action plans could be used to support updated ecotourism planning in conjunction with other funding sources.oAn increase in road traffic volumes is expected post construction, and this may lead to enhancement in road-induced injury/mortality for which appropriate measures have been included in the BAP. These measures include supporting the state in developing a roadkill monitoring App to help evaluate and identify roadkill hotspots, trends in sightings and mortalities and thus support a broad range of adaptive management including ecotourism planning.

Operation

Description

434. The socio-economic condition of the region where the road projects are will likely have a positive effect due to the presence of enhanced road connectivity between urban and rural areas facilitating faster travel time for residents, tourists and commercial transport.

Assessment

435. The operation of the road projects will benefit local and regional economies due to easier transport of goods, materials, and services, reducing logistics costs for businesses. Increased accessibility often attracts commercial investment, industrial developments, and retail expansion, generating permanent jobs and diversifying the economy. Property values along the road stretch will also appreciate. The roads will also support tourism by linking and reducing drive times between Gangtok and local protected areas.

436. The negative effects on socio-economic aspects include increased traffic congestion leading to increased travel time for travellers and creating unfavourable conditions to communities living along the road stretch. Increased accidents or safety hazards may emerge, resulting in healthcare expenditures and social distress. Road operation generates air pollution, noise, and vibration impacts, contributing to respiratory illnesses, cardiovascular diseases, and diminished community well-being. The following table details the socio-economic impacts due to the operation of upgraded roads.

Table 4-46: Aspect impact table of socio economic impact on the operational phase

Aspect	**Impacts**	
Impact Description	**Positive impact due to improved road condition**	**Negative impact due to improved road condition**
Receptor Importance/ Sensitivity	High	High
Extent	Buffer Zone	Buffer Zone
Duration	Permanent	Permanent
Frequency	Permanent	Permanent
Likelihood	Likely	Likely
Reversibility	Irreversible	Irreversible
Magnitude/ Severity	Medium	Medium
Effect	Positive	Negative
Direct/ Indirect	Indirect	Indirect
Significance	Minor	Minor
Additional Mitigation (Y/N)	-	Y
Residual Significance	-	Negligible

Mitigation Measures

437. The mitigation measures include:

- Continuous engagement with local communities, vulnerable groups, and business owners to assess ongoing risks and impacts.
- Provision of clear, timely information about project operations, changes in accessibility, or maintenance sched ules that could impact the community.
- Implement intelligent traffic management systems and rerouting strategies to minimize congestion in surround ing neighborhoods.
- Ensure uninterrupted access to schools, healthcare, markets, and religious or cultural centers by planning ope rational traffic and service layouts.
- Incorporate features accommodating elderly, disabled, and marginalized populations in road-related infrastructure.

4.1.15 Labour/ Workforce Required for the Project

Construction

Description

438. The construction phase of road projects involves complex coordination of skilled, semi-skilled, and unskilled labor. The impacts on the labor force manifest across multiple dimensions from productivity, costs, timelines, safety, and social dynamics.

Assessment

439. It is expected that 35-315 labours will be engaged during the construction phase comprising skilled, semi-skilled and unskilled labours at each corridor wise. The construction may be done in stages from corridor to corridor. Major portion (75%) of the labours will be unskilled and will be hired from the local community. They will be day time labours. The remaining 25% will be from outside area, who will be stayed in the labour camps. Details of the amenities to be provided in the labour camp provided in the Annexure 6.

440. The contractor will ensure that, at the beginning of the working relationship, project workers are provided with written contracts and/or other forms of information and documentation that contain clear and understandable terms and conditions of their employment. The contracts, information, and/or documentation will set out in the OHS plan to be prepared by the contractor. The hiring is to be done in an unbiased gender-neutral manner providing equal opportunity to all.

441. Generally, villagers are employed under the GOI's scheme 'MNREGA (The Mahatma Gandhi National Rural Employment Guarantee Act, 2005)', which mandate 100 days of wage employment in a financial year to the rural household, whose adult member volunteer to do unskilled manual work. Apart from this the local laborers/communities are also engaged in other productive activities like sessional agriculture work, craft work, motor driving/mechanic and petty shops etc. The available labors in the villages are within the reach of the project area. This additional project work will help them to generate more income and support their family by raising their standard of living. By employing the workers from locally available labor pool, will help the contractor in reducing the labor cost, as they do not have to provide a large number of labor camps and facilities.

442. The baseline survey discovered that the educational institutions and health care facilities present in the project villages are catering to the requirements of the people to an extent but the inclusion of labors from outside villages can create problems for the host communities.

443. Positive and Negative Impacts of Project Induced Labour Influx in the Project Area

444. The labour influx might have adverse positive and negative social impacts on the host community. Given below are the following:

Positive impacts of labour influx on host communities can be:

- Increased economic opportunities through improved communication, transport links, economic linkages, monetization of rural economies and new markets for local products and services.
- Individual, household, and community empowerment and capacity enhancement through increased training and employment opportunities, wealth accumulation, purchasing power and network building.

445. Labour influx likely have a wide range of negative impacts on the host community's resident within the project area of influence including negative impacts on the environment, public infrastructure, services and utilities, the local and regional economy, livelihood strategies and public health, the social and cultural environment, and legacy issues. These community level impacts have the potential to directly and indirectly affect the project. Table 4-47 below shows the predictable negative social impact of the project induced labour influx on the host community and their mitigation measures.

Table 4-47: Potential Mitigation Measures of Expected Adverse Impact

Sl. No.	Expected Adverse Impact	Description	Mitigation Measure
1	Negative impact on health and burden on local health services	• Increased pollution (air, water, dust, noise, traffic) • Increased incidence of accidents and fatalities associated with project traffic (Delivery of supplies for construction work and movement of workers) • Proliferation of communicable diseases (including sexually transmitted diseases (STDs), respiratory infections, waterborne diseases) • Local health and rescue facilities will be overwhelmed and/or ill-equipped to address the accidents that can occur in the construction site (insufficient number of health centers, staff and medical supplies) • Insufficient public hygiene facilities • Return of migrant workers to their home communities may lead to the further spread of communicable diseases, such as sexually transmitted infections.	• Preparation and implementation of a traffic management plan • Road safety training for staff • Vaccination to project workers against common and locally prevalent diseases • Assigning an HIV service provider to be available on-site • Conducting education and awareness programs on HIV/AIDS • Conducting Information campaigns on STDs among the workers and local community; • Provision of condoms (condom vending machine at important transit place)
2	Negative impact on social dynamics of the community	• Impacts on traditional beliefs, damage to cultural heritage of the host community • Dilution of social cohesion and cultural disruption (separation of households and communities) • Changing relationships between groups (gender, age, socioeconomic status, ethnicity) • Possible marginalization of women, ethnic minorities, and other vulnerable group • Chances of loss of local identity • Increased incidence of social ills, including alcoholism, drug abuse, prostitution, gambling • Increased ethnic tension and violence (competition for limited services and utilities may threaten the health and welfare of both local and migrant communities, can aggravate relations between locals and in-migrants, and may lead to increasing resentment and social unrest).	• Association with civil society organizations to create integrative action plans • Provision of upfront information on potentially detrimental impacts on local communities • Conducting community participation and engagement program for constant guidance
3	Negative Impacts on Infrastructure, Services and Utilities	• Increased use of/ demand for existing roads, transportation, water, electricity etc. systems • Increased pressure on education and health services • Increased pressure on waste management systems • Increased use of / demand for community, religious, and recreational facilities	• Workers' camp to include wastewater disposal and septic systems • Identification of authorized water supply source and prohibition of use from other community sources • Separate service providers for community and workers' camp/construction site • Capacity building program of local public service providers

Sl. No.	Expected Adverse Impact	Description	Mitigation Measure
4	Risk of social conflict	• Chances of conflict between host community and project workers on religious, ethnic or cultural differences or simply on the completion for utility of resources or conflict between the workers itself • Ethnic and regional conflicts may be aggravated if workers from one group are moving into the territory of the other.	• Providing cultural sensitization training for workers regarding engagement with local community • Consultations with and involvement of local communities in project planning and implementation • Conducting awareness programs among local community and workers
5	Increased risk of illegitimate behavior and crime	• Chances of increase in the rate of crime (theft, physical assaults, substance abuse, prostitution and human trafficking)	• Payment of adequate salaries to the workers in their bank account rather than cash to reduce enticement for theft • Creation of supervised leisure areas in worker's camp • Strong sanctions (e.g., dismissal) for workers involved in criminal activities • Provision of substance abuse prevention and management programs • Police monitoring to prevent drug trafficking • Sensitization campaigns for workers and local communities.
6	Additional population (followers)	• Opportunistic, family members of the workers, traders, suppliers and also sex workers (especially in the arears where local capacity to provide goods and services is limited. • Illegal and unsafe development may occur • Orderly accommodation of all in open spaces	• Already workers are first recruited from the project areas in order to limit the followers, therefore only few in comparison will be dealt with. • Explore options for organized accommodation on open space that can be supervised by law enforcement.
7	Gender based violence	• Construction workers are mostly either single male or married male, outside the habitual sphere of social control • Inappropriate and criminal behavior (sexual harassment of women and girls, exploitative sexual relations, and illicit sexual relations with minors from the local community etc.) can take place • Chances of exploitative sexual relationships and human trafficking whereby women and girls are forced into sex work deriving from the dramatic rise in the men, money, movement (influx), and mixing (i.e., social interaction).	• Compulsory and regular training for workers on required lawful conduct in host community (specifically women) and legal consequences for failure to comply with laws • Making them aware about the national laws for sexual harassment and gender-based violence • Reinforcing local police to the project area for constant surveillance • Deploying female officers in the project area if possible • Partnership with local NGO to report workers misconduct and complaints/reports on gender-based violence or harassment through the GRM • Provision of opportunities for workers to take advantage of entertainment opportunities away from rural host

Sl. No.	Expected Adverse Impact	Description	Mitigation Measure
			communities and to regularly return to their families for short-term visits.
8	Child labor leading to school dropout	• Children from host community in order to sell goods and services to the labors, indulge in child labor, which in turn leads to enhanced cases of school dropout.	• Ensuring that no child is involved in project activities or in selling of any goods and services • Certain criteria should be laid down for the hiring process (minimum age etc.) • Strong sanctions for people forcing children for child labor
9	Local Inflation of prices	• Labor influx led to significant increase in the demand in the prices of goods and services which results in local price hikes and crowding out of local consumers	• Suitable mix of locally and non-locally procured goods to allow local project benefits at the same time reducing risk of crowding out of and price hikes for local consumers. • Monitoring of local prices
10	Accommodation to the workers	• Project induced workers require accommodation in the project area until their work is over. If proper accommodation facility will not be provided, then this might lead to unplanned and uncontrolled development of squatter settlements.	• The contract should include funding for workers accommodation • Proper camps with all the facilities should be provided to the workers, so that they do not damage or exploit the environment.
11	Illegal waste disposal	• Influx of large number of workers will generate large amount of waste. The area with small number of community population won't have sufficient local waste management capacities for the increased population which will lead to improper disposal practices.	• Providing waste disposal arrangements • Educating the workers with sound practices of waste disposal
12	Increased deforestation and ecosystem degradation	• Land or forest conversion for formation of workers camp will lead to deforestation.	• Avoidance of deforestation around the camp area • Minimized land use change and use of other natural resources. • Use of wood for fuel should be prohibited • Monitoring of impact on natural resources

446. Recommendations: In the public consultation in the respective host communities, it was noticed that everyone in the villages want to work in the civil construction during the project execution. However, it is not possible to recruit 100% worker strength from the locally available labour pool, but the contractor through transparent and fair process also assures it to employ at least 75 % of the workers from the same.

447. The village council is empowered in the host communities with NGOs (active in the region). These will be consulted while recruiting the labour force for the project. They will guide the contractor in the recruitment process suggesting eligible, desirable and appropriate labours for the task.

448. Construction Guidelines and Health and Safety Plan

449. The objective of the preparation of the construction guidelines is to ensure the mitigation of the issues mentioned above by the contractor during construction. The guidelines will broadly cover the following aspects:

450. The contractors should recruit the labour through transparent and free process and with constant consultation with the Village council etc. For this below mentioned guidelines should be followed by the contractors:

- Compliance with the provisions of the labour laws applicable to construction industry;
- Awareness on HIV/AIDS/ sexual health;
- Ensuring prohibition of the engagement of child labour;
- The terms and conditions of a worker's employment should be specified in an appropriate, verifiable, and easily understandable manner, ensure that workers are paid at least the wages due to them as per the amount fixed by the government under the provisions of the Minimum Wages Act, 1948. Written contracts should be in a language which the worker can understand;
- In the case of migrant workers also, written contracts should be in a language which the worker can understand, and should be provided sufficiently in advance of departure from the region of origin;
- Ensure that an abstract of the relevant labour laws is displayed in English and Hindi and in the language spoken by the majority of workers in such forms as may be approved by appropriate authority at the construction site
- Workers should have access to grievance and other dispute resolution mechanisms in cases of alleged abuses in the recruitment process or any other issues among the labours and between labours and community;
- Ensure that workers are not working in excess of the maximum mandated number of hours and receive at least one specified interval in a normal working day and one day off per week per day as fixed under the Minimum Wages Act, 1948;
- Promotion of efficiency, transparency and protection for workers in the recruitment process, such as mutual recognition of skills and qualifications;
- Effective law enforcement;
- Contractors should ensure that the conditions of work and life are those that recruited workers have been promised;
- Maintenance of registers and records giving particulars of persons employed, the work performed by them, the wages paid to them, the deductions made from their wages (fines) and such other particulars;
- Timely and complete payment for work accomplishment;
- Suitable clean, hygienic and separate residential accommodation for women and men is provided to all labours, including migrant labours;
- Sanitation facility, cooking gas, cleans hygiene, first aid box, other essential lifesaving aids, mosquito net, portable drinking water, protective clothing etc. should be provided free of charge at the worksite;
- Ensure that sufficient toilet arrangements are made for construction labour, separately for women and men;
- Ensure that no workman is carrying weights above the maximum prescribed under the building and other construction workers (Regulation of Employment and conditions of Service) Act 1996 and Cess Act 1996.
- Ensure that in case of personal injury to a workman arising out of and in course of the employment, which results in total or partial disablement or occupational disease or death, compensation is paid in accordance with the Workman's Compensation Act, 1923
- Adequate lighting of all worksite through natural and/or artificial lighting;
- Regular training should also be given to the workers on rules and guidelines, safety and security measures
- Notices showing rates of wages, hours of work, wage period, dates of payment, names and addresses of the inspector should be displayed in the project villages and copy of it is sent to the inspector;
- Pass Book is issued to all workers in Hindi and English and the language of the worker, with a photograph of the worker. The Pass Book would contain the name and place of the establishment, period of employment, rate and mode of payment of wages, and deductions, if any. For interstate migrant workers, additionally, the

Pass Book would contain the displacement allowance and return fare payable to the workman on expiry of the period of employment.

- Deductions from payment of wages will only be made as specified in the Terms and Conditions of written contracts or if allowed by the National and State applicable laws, and the contractor will ensure that project workers are informed of the conditions under which such deductions will be made.
- Workers should be provided with a Grievance Redressal Mechanism system, where complaints on issues related to wages, working conditions etc. may be recorded and addressed.

451. Special Provisions Relating to Females and Child Labour

- Female labour should be paid wages 'equal' to male labour for the same kind of work.
- Provisions of the Maternity Benefit Act, 1961 are followed in respect of female labour. This is applicable before and after delivery, in case of miscarriage, medical termination of pregnancy and tubectomy. Statutory benefits include provision for requisite compensation, nursing breaks, medical bonus, and prohibition of discharge or dismissal.
- Crèches should be provided for children of women workers
- Women workers should be carrying restricted loads in accordance with the provisions of Building and other construction workers (Regulation of Employment and Conditions of Service) Act 1996
- Female labour should not be employed by contractor before 6 a.m. or after 7 p.m. except for those engaged in pit head baths, crèches, canteens and medical establishments;
- Female labour should be provided with separate washing and screening facilities at the site;
- Provisions relating to sexual harassment of women as per the Sexual Harassment of Women at the Workplace (Prevention, Prohibition and Redressal) Act, 2013 and for children as per the Protection of Children from Sexual Offences Act, 2012 should be followed;
- No children should be employed in the construction activities, temporary or permanent. Any such employment should be reported.

452. To implement the health and safety aspects in the project various measures are presented below

453. Table 4-19. The responsibility of organizing these activities lies with the implementing agencies.

Table 4-48: Health and Safety Aspects

Sl. No	Activities	Target Groups	Responsibility
1	Awareness **programme on Labour health and Safety Aspects in Construction**	Contractors / Construction labours	PIUs/PMU
		Engineers of PWD	PIUs/PMU
2	Develop I.E.C. materials on labour issues	Officials of line department /contractors / construction labours	PIUs/PMU
3	Display in important locations		PIUs/PMU
4	Engage NGOs	Project intervened area with labour engagements	SMU/Contractor
5	M&E	All the project activities with engagement of labours	SMU/ M & E Consultant/PIUs

4.1.16 Workers Health and Safety

454. Poor siting and layout of workers camp may cause (i) loss of agricultural produce if sited on cultivable land, (ii) health hazard to workers and nearby community, (iii) surface water pollution in case sited near water bodies, (iv) local drainage problem (v) wear and tear to haul routes if material is transported via village roads, and (vi), fire, electrical and other safety risks.

455. The location, layout and basic facility provision of each labor camp will be submitted to Authority Engineer (AE) and PIU prior to their construction. All camps should maintain minimum distance from habitation, water bodies, and through traffic routes as prescribed by SPCB and other applicable local guidelines. The construction shall commence only after approval of PIU. Contractors shall prepare solid waste management plan that includes collection, storage, and disposal subject to the review and approval of the AE. Settlement along road chainage wise has been presented in Annexure 9.

456. The occupational health and safety risks to workers due to inadequate housekeeping and unsafe work practices at work sites. Health problems to workers due to inadequate sanitation and un-healthy environment at labor camps/plant sites.

457. Major health and safety issues summarized given below:

Table 4-49: Health and Safety Activities

Sl. No.	Activities	Type of Risk	Health Issues
1	Operation of Hot mix Plant, Stone Crusher Plant, Batching Plant, material stockyards)	Exposure to dust and gaseous emissions	Health hazards, Respiratory problems
		Accident Risks	Injury/ death
2	Operation of vehicles and machineries	Accident Risks	Injury/ death
3	Excavation and Earth works	Dust generation	Health hazards, Respiratory problems
4	Concreting and masonry works	Exposure to concrete and cement	Skin Problem, respiratory problem
5	Paving works	Gaseous emission Heat generation	Health hazards, Respiratory problems Burning injury
6	Bridge works	Falling from height Accident risks	Injury due to fall from height
7	Electrical works	Electrocution	Electric shock and injury
8	Welding	Eye injury	Eye injury
9	Handling of hazardous chemicals and waste	Exposure to hazardous chemicals	Chemical injury
10	Operation of Camp site	Unhygienic condition	Water borne diseases, vector diseases, snake bites
11	Working near DG sets	Exposure to Noise Pollution	Health hazards
12	Waste generation	Health hazards	Health problems

Table 4-50: Aspect impact on work camp

Aspect	**Impacts**
Impact Description	**Impacts due to poor siting of workers camps**
Receptor Importance/ Sensitivity	High
Extent	Core Zone
Duration	Temporary
Frequency	Single event
Likelihood	Certain
Reversibility	Irreversible
Magnitude/ Severity	Medium
Effect	Negative
Direct/ Indirect	Direct
Significance	Major
Additional Mitigation (Y/N)	Y
Residual Significance	Moderate

Mitigation Measures

- Camps should be strategically located to minimize exposure to dust, noise, and hazardous operations, id eally separated from active construction zones.
- Adequate space must be provided for residential areas, storage facilities, sanitation, recreation, and emer gency exits.
- Temporary structures must adhere to structural safety standards, preventing collapse or fire risks.
- Green belts or vegetation buffers may be established around camp perimeters to control dust and air poll ution.
- Provision of adequate toilets, sewage treatment systems, and waste collection facilities.
- Domestic wastewater should be treated or transported to approved disposal sites.
- Hazardous and non-hazardous waste must be handled per environmental safety standards to prevent contamination of soil and water.

- Safe drinking water must be available at all times.
- Food storage and preparation follow hygiene and safety guidelines to prevent food-borne illnesses.
- Fuel, flammable liquids, and chemicals stored in bunded, well-ventilated areas away from living quarters.
- Spill containment systems and fire-fighting equipment must be accessible.
- Workers trained in fire safety and evacuation procedures.

4.1.17 Economic Cost of Environmental Damage

The economic cost of environmental damages in the absence of mitigation measures is provided below.

- Unstable cut slopes, improper drainage, unplanned disposal of excavated materials, deforestation results economic cost of emergency restoration after major slides, closure of access results loss of trades in local market.
- Loss of vegetation, lack of slope protection, poor debris disposal results in sediment deposition in rivers and drainage that reduces the capacity hence higher risk of flooding.
- Clearing forest land for widening, quarrying, and camps results in loss of ecosystem services (carbon sequestration, water regulation, NTFP). Loss of biodiversity can lead to reduced tourism appeal.
- Improper cross-drainage structures and disposal of spoil into rivers result into frequent desilting and replacement, Flood damage to downstream infrastructure and Increased road maintenance due to waterlogging and subgrade damage.
- Landscape scars, debris dumping, visual pollution, unsafe conditions will result into reduced tourist arrivals and loss of hotel/transport revenue and local jobs.
- Roads with high environmental damage risk attract Higher insurance premium and Government relief expenditures after disasters.

4.1.18 Economic Benefit from Direct Positive Impacts

- Improved accessibility: Entire length of the project road is not accessible throughout the year. Specially April to September of every year, accessibility becomes limited through the rainy seasons especially due to landslides. The project will enable the villagers of the project influence area to utilize the project road for transportation throughout the year.
- Saving in Construction Cost vs new alignment / greenfield road.
- About 31% reduction in length of the project road which will reduce project cost of Rs 15011
- Reduction in number of accidents
- Enhancement in safety of the road user:
- Metal beam crash barrier, guard post, cautionary sign post such as sharp curve, speed limit etc. shall be installed to enhance of the road user.
- Reduction in Vehicle Operating Cost (VOC): Rs 492.85 million12.
- Net economic benefit due to the implementation of the project Rs 513.620 million.
- Benefit due to reduction in accident Rs 0.31 million13. Savings in fuel consumption

Savings of emission of tCO_2

458. CO2 emission for ‘base case’ i.e., without project scenario is in total 12,996.99 tones and with project scenario is 10,240.60 tonnes thus suggesting that this project will bring a reduction of 2756.39 tonnes at the end of 2042. Hence per year carbon reduction incentive is INR 2.3 million.

5. Analysis of Alternatives

5.1 Introduction

459. This chapter discusses the analysis of alternatives that have been considered for the upgradation of Phase 1 roads and bridges in Sikkim. It also includes discussions on the “With” and “Without” project scenarios. The minimization of environmental impacts by considering design alternatives determines the extent of mainstreaming of the environmental components. An evaluation of the various alignment options has been done for arriving at the most promising alignment of the project road.

5.2 With and without project alternatives

5.2.1 Without Project Scenario

460. The roads have settlements, and the traffic flow is impacted by severe conflicts between the local and the through traffic on the road. This is further compounded by the various land use conflicts, in terms of uncontrolled development along the road and the encroachments onto the ROW.

461. The population growth, increase in traffic volumes and the economic development along the project road would continue to occur and will worsen the already critical situation on the road. The existing unsafe conditions and the adverse environmental consequences in terms of the environmental quality along the road would continue to worsen in the absence of the improvements measures provided in the project. Moreover, if it is decided not to proceed with the project, then the associated reduced socioeconomic development of this remote, relatively poorly connected area cannot be justified.

462. Therefore, the no-action alternative is neither a reasonable nor a prudent course of action for the project road, as it would amount to failure to initiate any further improvements and impede economic development.

5.2.2 With Project Scenario

463. The ‘with project scenario’ is found to have a positive impact in the long run on social, environmental, economic and financial aspects.

464. This scenario includes the up gradation/widening to upgradation from single lane to Intermediate carriageway +1m earthen shoulders at valley side+1.5 m paved shoulder at hill side+ Side drains of the existing stretch as envisaged in the project objectives.

465. The scenario is economically viable and will improve the existing conditions. It, would thereby, contribute to the development goals envisaged by the Government of Sikkim and enhance the growth potential of the area.

466. The potential impacts on the various environmental components can be avoided through good environmental practices and implementation of mitigation measures. Wherever avoidance of negative impact has not been possible, appropriate mitigation and enhancement actions will be worked out to effectively offset the environmental impacts inflicted due to the project. A Comparative assessment of the “with and without” project scenarios along with anticipated benefits with project scenario are presented in Table 5-1.

Table 5-1: With and Without" Project Scenarios - A Comparative Assessment

Component	With Project Scenario	Without Project scenario
Highway Geometrics	Intermediate carriageway +1m earthen shoulders at valley side+1.5 m paved shoulder at hill side+ Side drain (based on the road section)	Single Lane
Design Speed	Speed restriction shall be envisaged at all built-up sections.	Presently no speed limit signs are posted along the project road nor any speed brakers noticed at major settlements and intersection. .
Congestion in Settlements	Free flow of traffic due to widened carriageway and improved geometry	Congestion in urban/rural areas due to mixing of local, pedestrian and through urban and rural areas.
Felling of road side trees	Felling of trees located near the road edge as these trees shall become a road hazard. Triple the number of new young and healthy trees to be planted in compensation.	No felling of trees. The trees close to carriageway may become a safety hazard to the road users.
Pedestrian safety	Along the settlement stretches with significant pedestrian traffic, provision of pedestrian (zebra) crossings and footpath has been kept in urban sections.	Pedestrian safety an issue of major concern especially along the settlements and congested sections
Road Safety Measures	Provision of proper road markings, zebra crossings, crash barriers and improvement of geometry to enhance road safety and to reduce accidents.	Accident incidents shall rise with an increased traffic volume.
Environmental Quality	Development of road and realignment in urban settlements will improve environmental quality due to lowered pollution levels and relieving of congestion of traffic. Besides tree plantation shall not only provide aesthetics but also improve the quality of air.	Poor due to congestion and high emission levels because of slow movement of traffic. A further deterioration is expected due to increase in traffic volumes and further congestion.
Drainage	Will be improved due to reconstruction/additional new construction of culverts/causeways, BOX culvert, Chute	These issues remain unaddressed without the project.
Slope Protection	Retaining wall, Breast wall, Top soil: Nailing and shotcrete. Surface and sub surface Rockfall netting, crib wall, vegetative palisade, Jute Geotextile (JGT) Netting shall be provided as landslide and slope protection measure	These issues remain unaddressed without the project.
Road Side Amenities	Appropriate road side amenities to be provided at various locations along the project road.	Continue to remain inadequate
Better Transportation Facilities	Reduction in time and fuel consumption for easy and fast movement through the major towns and villages. Better Access to markets.	Increased vehicle operating costs due to reduced speeds
Environmental Enhancement	Enhancement of water bodies, community and cultural properties and also water front in an aesthetic manner.	No enhancement proposal for without project scenario.
Development	Higher potential for development due to improvement in access and consequent increase in connectivity.	Development activities will be greatly hampered by the gross inadequacy.
Financial and Economic Analysis	The cost of operation and maintenance, Vehicle Operating Cost (VOC) and other ancillary cost are moderate to low.	The cost of maintenance while catering to the projected higher traffic, accident cost, Vehicle
Loss of vegetative cover	Vegetative cover will be removed within corridor of Impact. Compensatory plantation will enhance vegetative cover of area after 3-4 years.	No such impact in without project scenario
Access to basic facilities such as Markets, schools, Hospitals etc.	Easy access to basic facilities due to fine road	Difficulty in accessing the basic facilities due to heavy traffic and congestion under
Biological and Biodiversity	Wildlife friendly infrastructure design standards have been used to adjust civil works to provide for wildlife passage and reduce roadkill risk in areas where wildlife and critical habitats exist and structural measures were found feasible. Actions and compensations support both site specific biodiversity and regional net gains through monitoring and	Wildlife at risk or roadkill in areas where crossing due to lack of designated passage structures and speed reduction measures.
Terrestrial and Aquatic Connectivity	The action plan (Appendix 21) calls for forest restoration works within Critical Habitat areas and corridor areas. The location of forest restoration should consider the regional connectivity between protected areas and reserved forests to support regional corridor restoration. Habitat restorations should target mid to low elevation areas highlighted in Figure 4, which are under-represented in the protected areas in Sikkim.	

467. By looking at the above table, “with” project scenario, with its minor adverse impacts is more acceptable than the “without” project scenario which would mean an aggravation of the existing problems. The potential benefits of the road improvements are substantial and far-reaching both in terms of the geographical spread and time. Hence, it is clear that the implementation of the project will have definite advantage to area in development of its economy and progress for its people.

5.3 Environmental Considerations

468. The various avoidance measures for minimizing the extent of environmental impacts and avoiding sensitive environmental features have been worked out. A description of the measures has been presented in the Table 5-2.

Table 5-2: Alternative considerations for Minimization of Environmental Impacts

Environmental and social considerations	Provisions considered in project road design
Maintaining Design Speed for through traffic on the road	Improved geometrics
Improvement of Road Safety	Intersection improvements; geometric improvements at curves, road safety signage etc.,
Adequate drainage	Provisions of longitudinal drains and CD Structures
Reduction of Air and Noise Pollution	Intersection improvements; site specific attenuation measures; tree plantations, Implementation of EMP
Avoidance of contamination due to Siltation / spillage	Silt Fencing, Oil Interceptor
Minimization of Tree Loss	Maximum effort shall be given to avoid avoidable tree felling
Minimization of Direct Impact on Sensitive Receptors, cultural and religious properties	Trees plantation and appropriate /site specific EMP
Minimization of Property Acquisition	Realignments; Concentric widening to minimize social impacts and SIA & RAP
Displacement of Commercial Properties	Concentric widening to minimize social impacts and SIA & RAP
Minimization of Loss of Utility Lines	Centre line alterations to minimize shifting requirements
Erosion control and Stabilization of Slope	Turfing / Pitching Plantation measures
Avoid roadkills and barrier effects to biodiversity	Applied wildlife friendly design measures including wildlife passage structures and other solutions as needed.

5.4 Analysis of Alternative Alignments

469. After having examined the feasibility of the road-improvement in the existing alignment, it is concluded that there is no requirement of alternative alignment even though critical stretches are experiencing congestion, encroachment of RoW and poor geometry.

470. **Habitations.** There are no realignment options to minimize the impact on settlement due to project. Effort has been taken to avoid disturbance to Wildlife Sanctuaries, National Parks, Reserve Forest and other Eco Sensitive zones under the project.

471. **Alternatives considered for minimization of tree cutting and forest land diversion.** The major impact in this project on flora involves the removal of trees to permit construction and to provide clear zone for safety of the road users. Existing roadside vegetation and trees were recorded during the field survey. Some of the native trees will be cut down due to the upgrades. The final design of each road, utilized cross sectional profiles that minimized tree cutting, provided for optimal slop stability, required the least land diversion. After applying all alternatives to minimize tree removal, overall 5815 trees will be felled for the road construction works. Afforestation measure in 1:2 ratio has been considered under the project as per State Forest rule of the Sikkim.

472. **Alternatives considered for minimization of Critical and Natural Habitat loss.** The range of alternatives considered included: no upgrade/no action, upgrade existing alignment with mitigations (recommended), horizontal or vertical realignments, and decommissioning. To assess these alternatives, a simple scoring matrix comparing the alternatives across six criteria (scores: 1 = least favorable, 5 = most favorable):

Alternative	*Cost*	*Biodiversity Impact*	*Social Impact*	*Technical Feasibility*	*Climate Resilience*	Score
No Action	5	1	5	5	2	18

Alternative	*Cost*	*Biodiversity Impact*	*Social Impact*	*Technical Feasibility*	*Climate Resilience*	Score
Upgrade Existing Alignment	4	3	5	5	5	**22**
Horizontal Realignment	3	2	3	1	4	**13**
Vertical realignments eg. Tunnels or viaducts	1	5	4	1	4	**15**
Decommissioning	3	5	1	5	5	**19**

473. Based on the analysis, upgrading the existing alignment with integrated biodiversity mitigation measures (wildlife crossings, fencing, and climate mitigations) is recommended. This option balances technical feasibility, cost-effectiveness, and compliance with safeguard requirements while minimizing residual impacts.

474. Alternative alignments would either minimally avoid natural and Critical Habitats or result in significantly more loss due to need for greenfield road construction. Due to the nature of those areas mapped as CH for Chinese pangolin and the natural habitat, the cost of vertical and horizontal realignments was considered least favourable. Decommissioning and no action alternatives were assess to be slightly more favourable, primarily due to their biodiversity impact but come with high social consequences. Some Critical Habitat areas and projects could score sufficiently high to justify the full range of options evaluated here.

5.5 Alternative Materials and Technologies

475. Increasing demand for natural material for other construction activities e.g., building construction, urban development projects has put pressure on the exiting natural resources e.g., aggregates, sand, soil. Procuring natural construction material for the road construction has thus not only become difficult due to increased competition from other sectors but also escalated both time and money required for procuring them. Increased regulatory compliance requirements have also made availability difficult. Added to this is the increase lead distance because at times these materials have to be procured from quarries away from the construction site thus not only increasing transport costs but also increasing the carbon-footprint of the project.

476. The use of alternate materials for construction focuses on the management and reuse of alternate material including waste materials locally available in the project area or generated by the project itself.

5.6 Use of Alternate Recycled Material or Waste in Road Construction

477. **Use of Fly ash in Construction.** In tandem with the IRC Guidelines for promoting the use of fly ash in road embankments (IRC: SP:58-2001), MoEF&CC issued an amendment to their fly ash notification which made it mandatory for road construction within a radius of hundred kilometers of thermal power plant to undertake construction or approve design for construction of roads or flyover embankment with fly ash as mentioned in the IRC specification No. SP: 58.

6. Information Disclosure, Consultation and Participation

478. The consultations are necessary steps to obtain the views of people who may be affected by development projects or may otherwise have an interest in their outcomes and to inform them about changes that could affect them. Such feedback assumes greater significance in the case of people who may be adversely affected. Since these stakeholders usually do not have a direct role in decisions about projects that affect them, consultations are an important mechanism to ensure that their concerns are taken into account while decisions are made.

6.1 Stakeholders Identification &Analysis

479. As a part of participatory process, different stakeholders have been identified who could be involved in the process of identification of critical issues, identification of impacts, resettlement and rehabilitation project planning, execution, monitoring and evaluation. The stakeholders have been classified as primary and secondary stakeholders. The project has a public purpose and therefore, needs multiple stakeholder involvement for its success. This requires a participatory process from the beginning of project initiation. People in common have been considered as primary stakeholders and others include the service providers, authorities who have a say in the project etc. The details of the identified stakeholders are described below.

Primary Level Stakeholders

- Directly affected people
- Indirectly affected people
- Project road side villagers prone to air and noise pollution, accidents, communicable diseases, etc.
- Agencies having local knowledge to contribute
- Village Panchayat

The Concerned Authorities

- Forest Department
- Revenue Department
- Electricity Department
- District Collector and Magistrate
- Land Acquisition officer at the district level
- Concerned Taluka Officers
- Irrigation Department/water resource department
- State Pollution Control Board

Secondary Stakeholders

480. The secondary stakeholders are mostly government institutions who are expected to play a role in the project execution. They are as follows:

- Forest Department officials
- Village Heads
- Planning Department
- Police Department
- Revenue Department.

6.2 Public Consultations

6.2.1 Public Consultation

The public consultation as part of the preparation of EIA are summarised below.

Table 6-1: Public Consultation - Jorethang

The Roads and Building Department organized a series of public consultations in collaboration with the DPR consultant, M/S LASA. These consultations were held separately for different road sections to address specific concerns and gather localized feedback. Project information was shared with the local community through verbal communication, and feedback was actively collected from participants. The minutes of the meetings were systematically recorded. Key findings from all the consultations are outlined below. Detailed information regarding the consultations can be found in the Annexure 24.Project Name: BR06 Ramam River along Nayabazar Singla Road Km 0.0 to 1.0 Ch. 22

Participants: Public Repræsentatives	Date: 15-07-2025	Location: Roads and Bridges Department, Jorethang

Topic	Findings	Recommendations and Compliance
Grievance Redressal Committee	Members were informed about the upcoming establishment of this committee, which aims to address concerns and resolve disputes through multiple channels including in-person, written, telephonic, and online submissions	GRM structure is provided in Chapter 7 and same will be established in the Project.
Reaction to Bridge Construction Project	Panchayat members expressed strong interest in the new bridge, noting the deteriorating condition and limited capacity of the existing suspension bridge. They emphasized the new bridge's potential to transform the route into a vital corridor connecting the state to key destinations in West Bengal, such as Darjeeling	Three new bridges will be constructed and existing bridge. One bridges each on S1 and E1 will be replaced in this project.
Challenges During Construction	The potential short-term disruptions to livelihoods due to temporary access impediments were discussed sensitively. Efforts were made to document local knowledge about existing approach roads, highlighting sections prone to landslides, subsidence, waterlogging, and frequent accidents	EMP in Chapter 8 has been prepared for mitigating any construction related impacts.
Infrastructure Improvements	The area currently lacks the necessary infrastructure to support strategic connectivity. The new bridge and upgraded route are expected to significantly improve mobility, reduce travel time, and provide a dependable transit option. This initiative is also expected to stimulate economic growth, enhance regional accessibility, and strengthen inter-state linkages	No recommendation
Approach Roads	The condition of the existing roads was found to be poor due to erosion and inadequate stormwater drainage. Safety risks are heightened by damaged road surface and water logging due to runoff	EMP in Chapter 8 has been prepared to address the storm water drainage, and water logging.
Access and Construction Quality	There was an emphasis on ensuring full functionality of the existing suspension bridge and improving approach roads before construction starts. This would help minimize disruptions and ensure better connectivity during construction	Three new bridges will be constructed and existing bridge. One bridges each on S1 and E1 will be replaced in this project.

Table 6-2: Public Consultation – Jorethang Bridge location

Project Name: BR08 Bridge over Andheri Kholcha along Manpur Fatak to Jorethang Road		
Participants: Local villagers	Date:10-07-2025	Location: Bridge Location

Topic	Findings	Recommendations and Compliance
Interest and Support	The local Panchayat members expressed strong interest and support for the bridge development project. They recognized the severely eroded condition of the existing roads, which are impacted annually by landslides and mudflows, obstructing access	Three new bridges will be constructed and existing bridge. One bridges each on S1 and E1 will be replaced in this project.6 locations of Landslide have been identified and mitigation measure are provided.
Potential Benefits	The construction of the bridge is viewed as a transformative project that will improve connectivity and resilience against natural disruptions. It is anticipated to serve as a vital alternative corridor for the region	Three new bridges will be constructed and existing bridge. One bridges each on S1 and E1 will be replaced in this project.
Community Engagement	The stakeholders emphasized the importance of inclusive engagement and requested active involvement in planning and execution to ensure the project aligns with local needs. They assured full cooperation and pledged to facilitate coordination across all phases of implementation	Continued Consultation in the project construction and operation stage. Plan for consultation has been provided in the EMP in Chapter 8.
Environmental Sensitivities	Environmental considerations were addressed by documenting local knowledge concerning landslide-prone sections, areas susceptible to subsidence, stretches affected by waterlogging, and locations with a history of frequent accidents. Inquiry about the presence of rare, endemic, or exotic species was also conducted to ensure ecological sensitivities are duly accounted for.	Biodiversity action plan and environmental management plan has been prepared it will address the concerns raised in the consultation (See Appendix 20 and 21).
Grievance Redressal	Information on the establishment of a Grievance Redressal Committee was shared, intended to serve as a formal mechanism for addressing concerns and resolving disputes. Multiple channels for lodging complaints or grievances were discussed, ensuring transparent avenues for stakeholders to voice their issues	Establishing grievance redressal mechanism as given in Chapter 7.
Desired Outcomes	The community broadly supported the bridge development project, recognizing its long-term value and transformative potential. They requested a swift project timeline to maximize the benefits of improved connectivity, enhanced economic opportunities, and strengthened social infrastructure	Three new bridges will be constructed and existing bridge. One bridges each on S1 and E1 will be replaced in this project.

Table 6-3: Public Consultation at Dumping SIte

Project Name: E1 Rorathang Rongli		
Participants: Villagers of Tarpin, Mulukey, Dalapchand and Sudunglakha	Date:03-07-2025	Location: Dumping Ground

Topic	**Findings**	**Recommendations and Compliance**
Anticipation and Support	The local community has shown strong anticipation for the road project due to the current deteriorated condition of the existing road, which suffers from deep potholes and significant maintenance neglect over the past decade. The project is expected to enhance road safety, reliability, and potentially boost tourism in the region	No recommendations. The project design includes safety measures as per the IRC codes.
Concerns About Property Damage	There were concerns regarding the anticipated width of the road after widening, as it might result in potential damage to private property. Addressing these individual concerns about asset loss is crucial	Environmental management plan in Chapter 8 has been prepared to address such issues and moreover Grievance Redressal Mechanism in Chapter 7has been established.
Temporary Disruptions	Stakeholders were informed about possible short-term disruptions to livelihoods for business owners due to temporary impediments to access during the construction phase	Resettlement Plan has been prepared for any livelihood loss.
Grievance Redressal Mechanism	The establishment of the Grievance Redressal Committee was delineated, providing multiple channels for residents to lodge complaints or grievances, ensuring accessible and transparent avenues for addressing concerns	Grievance Redressal Mechanism has been established in Chapter 7.
Surface Condition Improvement	The enhanced road, once completed and improved, is expected to address issues tied to the poor surface condition, notably waterlogging during rainy seasons, thereby significantly improving mobility and safety	The road design address the issues of poor surface and water logging on the road.

Table 6-4: Public Consultation - Simik Lingzey GPU, Khamdong

Project Name: E4 Khamdong-Lingzey- Tintek		
Participants: Villagers of Khamdong, Khamdongbeng, Dungdung, Aritar, Lingzey	Date:09 July 2025	Location: Simik Lingzey GPU, Khamdong

Topic	**Findings**	**Recommendations and compliance**
Community Support and Concerns	Local residents overall support the road widening project, provided key concerns are addressed. These concerns particularly highlight the need to minimize impacts on private properties	Environmental management plan has been prepared to mitigate any impacts of the construction.
Pertaining Issues in the Road Corridor:	Stormwater drainage and waterlogging are major issues. Excess rainfall causes water runoff into residences, leading to deteriorating road conditions due to a large number of streams and lack of cross drains	Side drains have been provided in the road design that will address the issues of water logging.
Community Involvement	All future surveys should involve close coordination with local stakeholders, including panchayat members and residents likely to be affected by the project. Design reports must be transparently shared with elected representatives, and public notifications should be issued regarding their availability	The reports will be available at the PMU office, and it will also be disclosed on the website of the PRWD.
Environmental and Biodiversity Considerations	The consultations highlighted the need to address human-wildlife conflicts arising from road development activities	Biodiversity action plan has been prepared and it will be implemented to avoid any impacts on the local wildlife.
Reaction to the Road Project	The community acknowledges the importance of the road project for improving safety and reliability. Despite some sections undergoing resurfacing, residents understand that a properly widened road with effective drainage systems is essential for its long-term durability	Parallel drains are provided in the road design and environmental management plan has been prepared to address any safety risk associated with construction.

Table 6-5: Public Consultation - Mayal Hotel, Pentok, Mangan

Project Name: N9 Mangan Bazaar to DAC		
Participants: Villagers of Singhik and Zimchung	Date:27-06-2025	Location: Mayal Hotel, Pentok, Mangan

Topic	Findings	Recommendations and compliance
Reaction to the Road Project	The local community is supportive of the road project, particularly due to ongoing drainage issues that residents have been facing. They are optimistic that the project will result in safer and more reliable road travel, contingent on properly addressing identified concerns such as stormwater drainage and waterlogging during heavy rains	Side drains have been included in the design of the road. That will drain storm water.
Consultation Purpose	The consultations aimed to formally disclose details about the proposed road widening, the dimensions of the finished road, and potential impacts on the surrounding area. Residents were also informed about the establishment of a Grievance Redressal Committee to address concerns and disputes, with multiple channels available for lodging complaints, including in-person, writing, telephone, and online platforms	Environmental management plan has been prepared to address potential environmental impacts. A Grievance Redressal Mechanism will be established under the project.
Anticipated Challenges	The discussions highlighted possible challenges during the construction phase, including temporary disruptions to business owners' livelihoods due to access impediments and the potential impact on temporary tin structures near the road	Environmental management plan has been prepared that will address the impacts of the construction. Any loss of the livelihood will be addressed as per the Resettlement Plan
Design and Drainage Concerns:	Residents stressed the importance of an appropriate road design that incorporates adequate slope and effective drainage measures to ensure a durable, long-lasting road	No recommendation

Table 6-6: Public Consultation - Passi School Area

Project Name: S1 Melli - Phong via Rateypani		
Participants: Villagers of Passi village	Date:04-07-2025; 10:00 AM	Location: Passi School Area

Topic	**Findings**	**Recommendations and compliance**
General Community Reaction	Overall support was expressed for the project, contingent on addressing key concerns such as minimal impact to private properties and ensuring high-quality road construction	No recommendation
Specific Concerns	Residents emphasized the importance of addressing potential impacts on private properties and temporary structures near the road They remarked that ensuring a durable and quality road was essential for community approval and satisfaction	Environmental management plan has been prepared to address construction related impacts. Any loss to the livelihood will be addressed through resettlement plan. A continued consultation has been planned in the EMP in chapter 8 for community involvement.
Current Road Conditions	The community highlighted the poor condition of the existing road, which has deep potholes, inadequate drainage leading to frequent waterlogging, and significant surface damage. These issues have caused travel difficulties and safety risks	The improved road will address the travel difficulties. Side drains have also be provided in the design to address storm water.
Anticipated Benefits	Upon completion, the upgraded road is expected to significantly improve safety, reliability, and connectivity. It is seen as a crucial corridor linking South Sikkim with Central and Eastern regions, thereby enhancing regional access and economic opportunities	No recommendations

Table 6-7: Public Consultation - Salghari GPU

Project Name: S6 Assangthang – Salghari to CCCT Nandugaon		
Participants: Villagers of Salhari village	Date:08-07-2025; 10:00 AM	Location: Salghari GPU

Topic	**Findings**	**Recommendations and compliance**
General Support for the Project	Residents expressed their overall support for the road project, emphasizing the need for minimal impact on private properties and high-quality road construction to ensure a durable and long-lasting infrastructure The community is eagerly awaiting the commencement of the project due to the deteriorated state of the current roadway, which is crumbling and riddled with deep potholes	Environmental management plan has been prepared to address impacts of construction during the construction stage. Moreover a Grievance Redressal Mechanism will also be established to address any complaints of the community.
Environmental and Safety Concerns	Ensuring minimal impact on private properties and maintaining high-quality construction standards were highlighted as essential to achieving a durable and satisfactory roadway. The local community's support hinges on addressing these key concerns	Environmental management plan has been prepared to address construction time impacts.
Temporary Disruptions	Potential short-term disruptions to business livelihoods due to temporary access impediments were acknowledged and communicated sensitively during the discussions	EMP has been prepared to address construction related impacts and any livelihood related issued will be address as per the resettlement plan

Table 6-8: Public Consultation - Yangtey GPU

Project Name: W10 Geyzing to Sakyong		
Participants: Villagers of Yangten & Sakyong	Date:12-07-2025; 11:00 AM	Location: Yangtey GPU

Topic	Findings	Recommendations and compliance
Interest and Concerns	The local community showed interest in the upcoming road project, mainly due to the deteriorating state of the current stretch. However, there were concerns regarding the planned road widening and its potential impact on private properties along the route	Environmental management pan has been prepared for the addressing construction related environmental impacts.
Community Engagement	It was crucial to engage the affected residents in meaningful dialogue and ensure fair compensation through a transparent and just process	A continued consultation will be conducted int eh construction and operation stage.
Potential Challenges	The rationale and anticipated benefits of the project were explained to the stakeholders, along with possible challenges during the construction phase, including limited disruptions to livelihoods for business owners and impacts on temporary tin structures near the road	Environmental impact assessment has been caried out and environmental management plan has been prepared to address the construction stage environmental impacts.
Information Disclosure	Finalized design reports will be shared transparently with elected representatives and made publicly accessible. Critical on-site activities and construction processes should involve local landowners and community members to foster transparency and ownership	Reports will be disclosed on the website and consultation with the community will continue in the construction and operation stage.
Compensation Issues	Previous development initiatives in the area saw inadequate compensation distribution, which affected public trust and enthusiasm for future projects. Fair compensation is essential to prevent worsening living conditions	A resettlement plan as per the SPS 2009 has been prepared that will address the compensation issues.
Grievance Mechanisms	Establishing a Grievance Redressal Committee was highlighted to handle concerns and disputes. Multiple avenues for lodging complaints were provided to ensure accessible and transparent mechanisms for addressing grievances	A Grievance Redressal Mechanism will be established to address complaints of the community.

6.2.2 Focussed Group Discussion

481. Consultations and Focus Group Discussions (FGDs) were conducted with various groups to understand the views and suggestions of the people on the project intervention. Total 26 consultations were conducted, 45 participants in 4 districts.

Table 6-9: District wise details of consultations

#	FGD Groups	Name of Locations	Outcome
1	North District **Number of Consultations:** 2 **Number of**	Community people (Lepcha tribe of Gor village and Lingthem village)	These people are engaged in economic activities similar to other population sections. Most of the households are engaged in Cardamom (Elachi) farming. The poor road connectivity has restricted the selling of their products in the market which otherwise could have reached a bigger market by now. Tribes engaged in Maize and cardamom farming carries the products

#	FGD Groups	Name of Locations	Outcome
	Participants: 20		through local taxi to Singtham Market. The improved road connectivity will help traders from various other regions to reach them for buying their products.
2	South District **Number of Consultations:** 7 **Number of Participants:** 16	Community people (Bhangyang, Melli, Tashiding village, and Salghari village) Farmer in Tashiding village Milk Society Fair Price Shop (FPS) owner	NIT, Sikkim is located at 0+700 chainage of the roads. Students from all over India study in NIT and they need good road connectivity. The community serves a huge number of tourists as the famous seven Mirror Lake and Doling monastery is located here. The tourist spots could bring more opportunities to the community. They are expecting that the road will increase number of visitors and also it will bring more business opportunities Farmers from Tashiding village are majorly engaged in paddy and maize farming. They carry products to Ravongla market located in 17 km away for selling purpose. During monsoon it is very difficult for them to access the market through road which effect their earning as well the production gets waste. They expressed immediate proper road facility. An FPS owner intimated hurdles in transporting the goods and the poor road connectivity has lea to unnecessary rise in price for transportation. He believes that the improved road connectivity would help them commute well and also reduce the transportation cost. Transportation of the product and the cost of transportation are high due to the present road condition. They expect that improved road will help the females specifically in terms of transportation and it will be beneficial to the community people in other aspects too.
3	East District **Number of Consultations:** 6 **Number of Participants:** 18	Community people (Beng Khamdong village and Lower Tarpinkhare village) Village Administrative Centre (VAC) of Beng Khamdong village Akta and Kesari Self Help Groups (SHGs) (Lower Tarpinkhare and Kadamtam village) Milk society (Assam Lingzey village)	People expressed their difficulties in transporting the goods from the godown of Food Cooperation of India due to poor road condition. Transportation cost and maintenance also high due to poor road connectivity. During monsoon it becomes difficult for the Below Poverty Line (BPL) to commute through roads to buy ration from FPS. Poor road conditions have also led to road accidents. Absence of street lights makes the travel quite unsafe. SHGs in Kadamtam village runs a shop located beside the proposed road. Poor road connectivity always creates barrier in their business development plan. During monsoon season it becomes challenging for the community people to access to the milk society and vice versa. Around 80-90 households of the village are dependent on this milk society. All were hopeful about the road up gradation as it will provide easy and safe accessibility to market area. People are hoping that the improved road will reduce their struggles. SHGs are also hopeful that the road upgradation will help them run the business well and they can also expand it.
4	West District **Number of Consultations:** 11 **Number of Participants:** 17	Community people (Sombarey, Kurumpangphe Tribal Village, Yuksom, Sapsi village, Reshi village, Uttaray village) Shop owner (Geyzing and Rinchenpong village)	People expressed that the existing road condition limits their market accessibility as well as it is very difficult at times for vehicles to cross by as the road width is narrow. The village has a primary school facility but for higher studies the students need to travel to Jorthang which is again challenging for them. The existing road has witnessed many accidents especially during night time. Some residential structures are likely to be impacted during the construction work due to cutting of rock and falling of particles on the other side of the road. A family practicing dairy farming had 13 cows, producing 40 ltr. of milk per day. Nearby households are dependent on him for milk supply. He expressed that poor road condition during monsoon makes it difficult for him to supply milk to the households. Agricultural area of Kurumpangphe Tribal village where Limbu tribe resides might face temporary impact due to rock cutting. The Ex-Zila Parishad member who belonged to the Lepcha tribe expressed his happiness about the road works being planned and also

#	FGD Groups	Name of Locations	Outcome
			advised to discuss with the tribal community during later stages. Community people also intimated about the accidents being witnessed due to poor road condition. Singshore Bridge in Uttarey is a significant tourist attraction point and the local people are being benefitted by running some road side shops. People intimated that the poor road connectivity has reduced the scope of revenue generation. They have expressed their happiness for taking up the road for up gradation as it will attract more tourists and their village will be developed. Further, other community people were also happy towards the intervention as it would benefit the community people and will make easy and safe accessibility to work. Suggestion was provided by the community to consider safety measures for the curves.

Table 6-10: Schedule of Meeting held and Details of the Participants

Situation Assessment	Suggestions from Consultations	Pictures
Road- Rorathang-Rongli **(E1) Venue-**Lingthem **Group- Heterogenous Village Community ;** **Date- 17th January 2023** **No. of Participants- 09 (6 males, 3 Females)**		
PIC interacted with primitive tribe people who resides in the village Lingthem Most of the households are engaged in Cardamom (Elachi) farming and allow these years the poor road connectivity has restricted the market value the cardamom from their farm could have reach otherwise. Although there are many other factors responsible for that but they believe that improved road connectivity will help them reach out the global market faster.	Community suggested for better road. Good quality protection wall along with road is also required. They also mentioned about proper compensation for land acquisition and alternate options for livelihood for the shopkeepers.	 
Road- E4 Rorathang-Rongli; **Venue-** Khamdong (E4) **Group-** Shop owner, Heterogenous Village Community people **Date-** 20 . 01. 2023 **No. of Participants-**09 (5 males, 4 Females)		
PIC consulted an FPS owner He expressed his difficulties transporting the goods from FCI Godown, transportation cost is also high due to poor road connectivity During monsoon it is difficult for the BPL families who all are dependent on his FPS in commuting to his shop for buying. They are hopeful about the road up gradation Community has informed that Black bear used to reported in the vicinity area of road generally during harvesting time. No injury, animal human conflicts reported, villagers used to inform forest beat officers/rangers for the rescue of bear. Other that monkey used to reported regularly in the area	Improve the goods value. Community suggested for better road. Black top road with proper culverts has been suggested by the community. Community expressed their willingness for the project. Community suggested to hire local workers in the project from nearby area rather than from outside.	 
Road- E4 Rorathang-Rongli; **Venue-** Khamdong (E4) **Group-** Shop owner, Heterogenous Village Community people **Date-**24 . 01. 2023 **No. of Participants-**09 (6 males, 3 Females)		
The village has 5 Gram Panchayat Units. Agriculture, dairy and poultry farming practised in the village. Friday market is 15 to 20 kms away from the village. Gender BV cases are filed. Either matter is resolved at the VAC level or else reported in the police station. Bad road condition has led to more investment on vehicles for maintenance.	People expressed that, road enhancement and improvement will be beneficial for the people as it would be safe, less time consuming and easily accessible. Community wants safe access road with street lights.	

Many accidents have taken place due to bad road condition. Further, absence of street lights worsens the situation more by making it unsafe. Road enhancement and improvement will be beneficial for the people as it would be safe, less time consuming and easily accessible. Self Help Groups are very active in Sikkim. Women are empowered and aware due to the SHGs interventions. No injury, animal human conflicts reported, villagers used to inform forest beat officers/rangers for the rescue of bear. Other that monkey used to reported regularly in the area		
Road- S1 Melli-Phong via Rateypani ; **Venue**-Tashiding **Group-** Farmer, villagers **; Date**-22nd December 2022 **No. of Participants**-09 (3 Males, 6 Females)		
Interaction with the farmers from Lower Gor village The village community belongs to primitive tribe They are engaged in mainly Maize and cardamom farming apart from paddy and ginger cultivation. • They carry the products through local taxi to Singtham Market • The improved road connectivity will help traders from various other regions to reach them for buying their products. • No animal human conflict is reported from road influence villages of S1.	Community suggested for better road.	 
Road – S6 Assangthang Salghari to CCCT Nandugaon **Group -** Heterogenous village community**;** **Date** -13th January 2023 **No. of Participants** - 08 (4 Males, 4 Females)		
	Residents of the area have expressed concerns over road construction activities and allied maintenance routines. Due to irregularity of maintenance routines the residents have faced several problems over the years. They are hopeful that the new project provides for better drainage system which would remove water logging issues in certain areas. The present villagers are more or less aware on road management and maintenance, further providing suggestions for improvement. They have requested for construction of adequate drainage system for the road expressing that due to lack of proper drainage the surface runoff flows towards their properties/ houses. Cross drainage work is required at regular intervals.	

Road – W10 Geyzing to Sakyong **Group -** Heterogenous village community**;** **Date** -18th December 2022 **No. of Participants** - 12 (4 Males, 8 Females)		
	The local people are more or less aware on road management and maintenance. Mostly people are satisfied since good network and safe communication occur due to road. The road facilities improve the connectivity thus transportation which helps in socio economic development in the particular area by connecting from villages to basic necessities like hospital, school, market etc. The participants welcome the project as they understand the importance of access to education and the enhancement of social status of women that it brings. oParticipants have expressed that quality of road construction must be maintained along with structure of proper road side barrier for safety purpose. oConstruction work needs to start at the earliest so that benefits of road access reach the participants at the earliest. Landslide prone area and dropping zone should be protected for safety purpose.	
Road – Br04 Bhaley Khola Sirsiray – Kulung Dara **Group –** Women Group; **Date** -23rd December 2022 **No. of Participants** - 10 (10 Females)		
	Participants have raised concerns over frequent landslides and subsidence due to local geomorphological conditions. Participants have stated that in previous scenarios of infrastructure development proper compensations have not been paid to the affected thus pointing out that if their land or structure gets affected, they should be paid their worth, as many of the people are unemployed.	

482. Public consultation meetings were held with various stakeholders of the project to garner their views/opinions/ thought process/problems. The issues/concerns/suggestions raised by the people of the concerned are given below.

Table 6-11: Matrix on Key Issues Raised, Responses Provided and Suggestions Incorporated, If Any

Environment and Social Issues/Concerns/suggestions	Addressable in the Project
Proper Compensation shall be given for the structures affected	provided as per the provisions of the New Act and Rules of Land Acquisition
The existing road in the hill section requires to be standardized for heavy vehicle movements.	The section of hill roads is to be improved as per the standards for movement of heavy traffic
Poor Geometrics of Hill Road	Improvements of nonstandard curves & Hairpin bends and provision of safety measures in Hill roads will be implemented.
Number of houses will be dismantled due to construction of the road along the road side	Resettlement plan has been provided for the project affected persons
Fair compensation on the basis of impact assessment of houses (on market rate) Facilities for issue of free House site Pattas and Construction of Houses for the affected houses to be given.	Adequate compensation will be provided for the land and structure getting affected on market rate as per the RFCTLARR 2013 act

Environment and Social Issues/Concerns/suggestions	Addressable in the Project
Impact on water supply/Drainage system and units such as hand pump, bore - well, well and water pathway	As far as possible has been avoided, else will be replaced
Impacts due to/ during shifting of electric transmission lines	Public inconvenience will be avoided
Fair compensation for land (on market rate) and to the affected household	Will be provided as per the provisions of the New Act and Rules of the State
Impact on shop and commercial structure in government land	Will be provided assistance to restore income levels.
Risk of accidents of children and animal due to widening of the road	Sign boards warning vehicles in built up sections, school zones and pedestrian crossing places will be provided. Road safety awareness will be undertaken.
Pollution and health related problems at the time of construction work Impact on rural water and drain system due to construction work	Necessary mitigation measures provided in the EMP Will not affect, only after utility shifting the civil work will start
Impact on religious structures and compensation	Impact will be assessed, structures valuated and compensation will be provided at replacement cost for rebuilding at a suitable place
Provision of Zebra crossing at school zones and Provision for irrigation water flow from one side to the other	Zebra crossing at pedestrian crossing will be provided and any such existing facilities for water flow will be maintained
Participation of local leaders or public representative in compensation	The compensation will be determined as per the new LA Act and the Joint Collector will be the competent authority
Payment of compensation amount before starting the construction work	Yes, all compensation will be paid before civil work commences
Creation of employment for local people during the construction of the road	Provision has been made in the contract to engage local labors
Loss of Many trees in plain as well as in Forest area	Compensatory afforestation will be implemented by the Forest Department.
Negative Impacts on environment due to the construction materials	Eco friendly materials will be used for construction
Safety measures for Noise pollution during and after construction work	Noise barriers will be provided and mitigation measures will be taken especially in school and hospital zones
Disposal of effluents during construction	Waste shall be disposed using different methods of waste management
Timeline of the civil work starting and ending	All details will be shared before implementation
Bus traffic will transverse their village even after the completion of proposed bypass road works	Public transport routes will remain same after the road works completion. The bus stops will remain at the same locations.

6.2.3 Consultations Involving ADB Project Team

483. Consultations with community in the presence of ADB project team iwas convened in two phases of (i) early stage of EIA preparation and (ii) consultation at the at the Draft EIA stage.

A. Consultation with stakeholders
    a. Consultation with Community and Civil Society Organisation.
    b. Workshop with various expert of the Environmental and Biodiversity
B. Consultation with Stakeholders at the Draft EIA report is Ready.

6.2.3.1 Early Stage Consultation with Stakeholders and Non-Governmental Organisations

484. A Series of Consultation with the community was organised during 15 to 24 November 2023. The following persons were present in the meeting.

i. ADB TA's Environmental Specialist
ii. ADB TA National Biodiversity Specialist
iii. ADB TA International Biodiversity Specialist
iv. Representative of Roads and Bridges department of Government of Sikkim
v. Environmental Specialist of DPR consultant
vi. Community Persons

485. The findings of the consultations are given below.

Table 6-12: Key Finding of the Consultation with Community

Sl No	Road Section, Location and date	Key Findings	Recommendation and Compliance
1.	E-4, Chainage 5+600 on 17 November 2023	• The villages encountered land slide frequently. However, the last land slide was about one year ago. • The road condition is very poor and it poses serious threat to the patients and pregnant women for the transportation to Gangtok.	• The road improved includes measures of slop stabilisation to prevent landslide in Chapter 2. • The road condition will be as per the standards that will address the road conditions issues. Please refer Chapter 2.
2.	E-4, Nr Chainage km 12+800	• Farming, cow rearing are main occupations of the villagers. • Bear, fox, monkey and peacock are found in these regions. • Crop damages caused by wild animals and peacock are reported frequently. • The community members have complained about the truck transportation for the Power Grid Project being constructed on the hill side. • Community also complained the drains of the road have cracks and water percolates through the cracks and seep to the house in the valley side.	• Environmental management plan in Chapter 8 will address the construction time heavy vehicle movements. • The upgraded road will have drainage system that channelise water to streams and prevent percolation.
3.	E-1 Chainage 1+900	• The respondent in this consultant was brother of the house owner, and this family is project affected family. • There are 6 members in the family and the village has about 6-8 families, • Hospital, schools, Panchayat Bhawan are about 1.5 km to 7 kms from the village. • The responded informed about a cultural heritage location Darpan Dunga. • He informed, this is a stone covered with trees and shrubs.	• Resettlement Plan has been prepared to address any resettlement impacts, if any.
4.	E-1, Chainage 1+400	• Discussion at this location was focused on the Darpan Dunga. • The location was shown from the road but the access was not walkable. • The site is abandoned and people rarely visit the site.	• EMP addresses impact on any cultural assets. A chance find procedure has been developed in Annexure 15.
5.	BR-06, Vill. Bharikhola Nursury,	• About 8-10 houses are located downstream of the proposed bridge. • Landslide is frequent in this area.	• No negative impact on the downstream is anticipated. However it will have positive impact after getting access.

Sl No	Road Section, Location and date	Key Findings	Recommendation and Compliance
		• There is a forest nursery downstream of the proposed bridge.	• Landslide mitigation measures of slip stabilisation has been included in the design.
6.	S1, Village – Passi, South Sikkim	• A temple is located about 500 meters from the road. • About 2-3 shops are operational on the proposed bridge site. • About 50-60 families are living in the Pasi village. • There is a crematorium available about 100 meters upstream of the existing bridge. • The main occupations in the village are farming, piggery, poultry and cow rearing.	• EMP addresses impact on any cultural assets. Any relocation will be done in consultation with community.
7.	S1 Near orange farming	• The main occupation of the villagers are farming related to vegetable and oranges. • The nearest markets are Namchi and Gangtok. • Deer, Peacock and Monkey are found in this area and are involved in damaging the crops. • No cultural heritage site is present in the project area.	• No action is recommended.
8.	BR-04, Village Baram and Kalunglara	• The community members informed the river is perennial and road is closed in the monsoon season due high flood level. • The main occupation of the villagers is farming. • The nearest school and hospital are about 1 km from the proposed bridge site. • There is no cultural site in the project influence area. • The last bear siting was 2 years before. • Deer and monkeys are sighted frequently.	• No action is recommended.

6.2.3.2 Workshop Organised by the ADB in Gangtok

486. A two days workshop was organised by the ADB on 14 and 15 June 2025, where various expert from different organisation participated and information and knowledge were exchanged. The following agenda were discussed among various experts.

1. Introduction to ADB CHA & Biodiversity and SPS, 2009 Requirements
2. Biodiversity Baseline Assessment for Sikkim Road Project
3. Environmental DNA (eDNA) Study in Sikkim Rivers
4. Pangolin Conservation in Mountain Landscapes
5. Understanding Cumulative Impacts and Connectivity relative to Linear Infrastructure Development
6. Critical Habitat Analysis for Sikkim Road Project
7. Integrating Traditional Knowledge into Ecosystem Service Valuation for Climate-Resilient Conservation

8. Nature-based Solutions (NbS) for Maximizing Conservation Outcomes
9. Biodiversity Action Plan for Sikkim Phase I Roads & Bridges Project
10. Greening Transportation Infrastructure in Mountain Landscapes
11. Developments in Power Sector: Implications for Biodiversity Conservation
12. Good Practice Application of the Mitigation Hierarchy to Address Biodiversity Impacts
13. Integration of Biodiversity Baseline Surveys (e.g., roadkill) for Mitigation Planning
14. Investment Risks and Biodiversity Safeguards in Private Sector Projects
15. GIS Tools and Technologies for Screening, Surveys, and Mitigation Planning
16. Linear Infrastructure Developments and Wildlife Mitigation

487. The experts from the following organisation were invited.

- Biodiversity and GIS Experts
- Wildlife Institute of India (WII)
- ATREE (Ashoka Trust for Research in Ecology and the Environment)
- Environmental DNA (eDNA) Studies
- Power Sector Developments
- Mitigation Hierarchy for Biodiversity Impacts
- GIS Tools and Technologies
- Private Sector Project Risks and Biodiversity Safeguards
- Climate Change Impacts on Wildlife
- Bird/Bat Collision Risks Monitoring
- Financing Biodiversity Action Plans (BAPs)
- Traditional Knowledge in Ecosystem Valuation
- Nature-based Solutions (NbS)

6.2.3.3 Consultation with Stakeholders at the Draft EIA Stage

488. Consultation with Stakeholders were organised on 27 and 28 November 2025. As part of ADB's environmental and social safeguards, and given the project's categorization as Category A, two community consultation sessions were convened on the Khamdong–Tintek road (E4) on 27 November 2025 and two sessions were convened on the Melli-Phong via Rateypani (S1) road on 28 November 2025.

489. The consultations aimed to inform communities about the development project, gather feedback, identify environmental and social sensitivities, and address potential impacts on local structures and cultural properties. The presence of officials from the Roads and Bridges Department helped provide detailed project information and address community queries. Efforts were made to document concerns about landslide-prone areas, road safety issues, and environmental impacts.

E4 Consultation Summary

Consultation-1 Highlights:

Date: 27 November 2025, 11:00 AM

Venue: Simik Lingzey GPU (Aritar)

Participants: 27

Table 6-13 : Consultation with Community at Simik Lingzey Road No E4

Sl No	Topic	Key Findings	Recommendations and Compliance
1	Wildlife presence (monkeys, deer, wild boar)	Locals reported monkeys, deer, and wild boar; a bear incident was recalled uphill from the corridor. Mahseer was not reported in the local streams. The community requested	One year baseline biodiversity assessment described these species and noted their tendance to cause some human-wildlife coexistence /

		conservation of seasonal streams, or Sumer Khola. No social forestry was reported along the corridor by the local public.	conflicts. Although the major interaction related to roads is the interface for increased habituation and conflict with Assamese macaque – addressing that challenge is outside of the scope of these works. The road projects may see post construction conflict with Assamese macaques and for that monitoring and adaptive management is provided for in the BAP – both programmatically and with funding. The conservation of seasonal streams is addressed in the BAP with a build back better approach agreed to by all parties.
2	Landslide-prone sections confirmed	The public confirmed landslide prone sections within the corridor. Residents stated that speed related accidents are uncommon and that most accidents are human induced (for example, driving under the influence).	The location of land slide has been identified and provided in in Annexure 7. Slope protection measures are provided in the design.
3	Cultural sites identified (Kalikhola and Tanakkhola rocks, Rangshang Khola cremation site)	Two rocks of religious/cultural importance were identified at Kalikhola and Tanakkhola, and a cremation site at Rangshang Khola. Locals said any relocation would require broad community consultation and requested advance public notice and wider inclusion. A school was confirmed within the corridor as a sensitive receptor.	The impact assessment has been provided in Section 4.1.8 of Chapter 4. The religious Assets under impact have been identified. The asset available outside the carriage way will be protected.
4	Ethnic groups (Lepcha and Bhutia	Lepcha and Bhutia were identified as local ethnic groups. Festivals are observed but are few; the community requested that any decision on construction timing during festivals be made in consultation with practitioners.	A26 of EMP provides the contractor will identify the schedule of local festivals and schedule the construction work accordingly.
5	Timing for public hearings preferred mid-January	Locals preferred the public hearing after December, preferably mid January, and asked for prompt construction of the road. No further local considerations were raised.	A24 and B28 provides the consultation timing will be selected for local suitability.

Consultation-2 Highlights:

Date: 27 November 2025, 01:00 PM

Venue: Tintek GPU (Rakdong Tintek BAC)

Participants: 49

Table 6-14 : Consultation with Community at Tintek GPU of Road E4

Sl No	Topic	Key Findings	Recommendations and Compliance
1	Regular project updates requested	**Previous Consultations and Information Disclosure:** Locals requested regular project updates and coordination during future surveys.	An information disclosure plan is provided in section 6.5 of Chapter 6.
2	Concerns on compensation clarified	Compensation Concerns and Resettlement Plan: Residents raised concerns about potential structure damage and sought clarity on compensation, including for assets outside the road reserve. The community was informed that a Resettlement Plan has been prepared, listing affected persons and structures.	A separate resettlement plan has been prepared for the affect structure and impact PAPs.
3	Utility Shifting	Utility Shifting: Locals highlighted concerns about utilities such as water pipelines; R&BD confirmed that a utility-shifting plan is part of the DPR	A separate Utility shifting plan has been prepared as part of the DPR.
	Noise Impact	Noise Impacts: R&BD discussed noise impacts and possible mitigation such as vegetative barriers and berm sound barriers.	Noise modelling has been conducted to predict the noise and vegetative barrier has been found to mitigate the impact and same has been provided as mitigation measures.
4	Wildlife presence (monkeys, foxes, deer, bears)	Residents reported wildlife such as monkeys, foxes, deer, and bears, including one past bear attack	One year baseline biodiversity data has been generated in the assessment described these species and noted their tendance to cause some human-wildlife coexistence / conflicts. Although the major interaction related to roads is the interface for increased habituation and conflict with Assamese macaque – addressing that challenge is outside of the scope of these works. The road projects may see post construction conflict with Assamese macaques and for that monitoring and adaptive

			management is provided for in the BAP – both programmatically and with funding. The conservation of seasonal streams is addressed in the BAP with a build back better approach agreed to by all parties.
5	Cultural property relocation	Discussions included cultural and religious structures, with relocation acceptable if proper rituals are conducted. R&BD confirmed that newly constructed temples were included in the recent verification visit.	Clarification provided. The cultural structure relocation is included in the EMP in chapter 8 of the EIA.

S1 Consultation Summary

Consultation-1 Highlights:

- **Date**: 28 November 2025, 11:00 AM
- **Venue**: Rateypani GPU (Lower Rateypani)
- **Participants**: 43

Table 6-15 : Consultation with Community at Rateypani GPU of Road S1

Sl No	Topic	Key Findings	Recommendations and Compliance
1	Impacts on Structures	Residents identified possible impacts on individual assets, including a water tank, kitchen canteen, and shop. R&BD explained that a Resettlement Plan listing all affected persons has been prepared and will be shared with the Panchayat, with provision for grievance redress.	Clarification provided in the consultation meeting.
2	Cultural/Religious Structures	No significant cultural or religious structures were reported along the road. Participants highlighted the importance of local water sources and requested careful handling of pipelines.	The impacts and mitigation measures are provided in section 4.1.8 and its relocation will be done as per the provisions provided in the EMP.
3	Roadside amenities	Female participants requested public toilets and garbage bins; R&BD noted that waiting sheds with kiosks are included in the design.	The roadside amenities like toilets, solid waste bin are neither the scope of the project nor within the scope of the Road and Building Department. Rather these services are provided by the local government panchayat or municipality. They will provide these amenities after the road construction is complete.
4	Wildlife Presence	Locals reported monkeys, peacocks, and confirmed the sighting of a pangolin	One year baseline biodiversity assessment described these species and noted their tendance to cause some

			human-wildlife coexistence / conflicts. Although the major interaction related to roads is the interface for increased habituation and conflict with Assamese macaque – addressing that challenge is outside of the scope of these works. The road projects may see post construction conflict with Assamese macaques and for that monitoring and adaptive management is provided for in the BAP – both programmatically and with funding. The conservation of seasonal streams is addressed in the BAP with a build back better approach agreed to by all parties. Critical Habitat Analysis for Pengolin and Golden Mahaseer has been conducted. Accordingly, Biodiversity Action Plan has been prepared and part of this EIA. Please refer to Annexure 20 and 21 of EIA.
5	Safety measures near sensitive receptors (schools, health centers) assured	Residents sought structural (e.g., retaining walls) and non-structural (e.g., signage, crossings) safety features near schools and health centers. R&BD assured inclusion of measures with special consideration of these areas as sensitive receptors	The safety measures as per the IRC code have been included in the design that includes signages, zebra crossing will be provided.

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Consultation-2 Highlights:

Date: 28 November 2025, 01:00 PM

Venue: Upper Passi (near Suspension bridge - Rabi Khola Bridge)

Participants: 33

Table 6-16 : Consultation with Community at Upper Passi of Road S1

Sl No	Topic	Key Findings	Recommendations and Compliance

1	Impacts on structures (shops, cowshed, septic tank)	ADB sought information on affected households; several participants reported potential impacts including shops, cowshed, septic tank, and property damage due to hill cutting.	Resettlement Plan has been prepared for the impacted structures and PAPs.
2	Presence of Scheduled Tribes	The community reported the presence of Lepcha, Bhutia, and Tamang populations, with Tamang being the predominant group.	The presence of scheduled tribe and its screening has been addressed in the settlemen
3	Wildlife Observations	The public reported frequent sightings of monkeys. An incident of pangolin sighting was also confirmed. Some participants acknowledged the presence of Mahseer in the nearby stream.	One year baseline biodiversity assessment described these species and noted their tendance to cause some human-wildlife coexistence / conflicts. Although the major interaction related to roads is the interface for increased habituation and conflict with Assamese macaque – addressing that challenge is outside of the scope of these works. The road projects may see post construction conflict with Assamese macaques and for that monitoring and adaptive management is provided for in the BAP – both programmatically and with funding. The conservation of seasonal streams is addressed in the BAP with a build back better approach agreed to by all parties. Critical Habitat Analysis for Pengolin and Golden Mahaseer has been conducted. Accordingly, Biodiversity Action Plan has been prepared and part of this EIA. Please refer to Annexure 20 and 21 of EIA.

6.3 Institutional Consultations

Table 6-17: Stakeholder Consultation

MINES AND GEOLOGY DEPARTMENT, SIKKIM **Date – 2nd June, 2023** **Contact – K.K. Luitel, Joint Director (Geology)**	

A consultation was conducted with the Mines and Geology Department concerning their feedback on the project and stone quarries summarized as following –

With regards to quarry (stone), the concerned department is only involved in the feasibility study, wherein any new quarry will be studied upon by the department before being handed over to the Forest Department for the subsequent authorization and licensing activity.

With respect to licensing from the forest department, the concerned official is the DFO (T) of each individual district.

With respect to quarrying of sand on river banks, the official stated rivers as such lie within the authority of the forest department.

As such the official had positive feedback on the project overall and stated that their involvement in the project would be nil as such due to the forest department overseeing quarrying aspects.

The official also stated that in case we the consultants would require any documents such as hazard mapping in terms of landslide then the department is ready to provide their joint study with Geological Survey of India which has been done on a scale of 1:5000.

Consultation with Mr. K.K. Luitel, Joint Director (Geology), Mines and Geology Department

WATER RESOURCES DEPARTMENT, SIKKIM

Date – 2nd June, 2023

Contact 01 – B.S. Niraula, Chief Engineer, Water Resource & River Development Department

Contact 02 – Phintso Gyatso, Junior Engineer (Planning), Water Resource & River Development Department

A consultation was conducted with two officials from the Water Resource Department concerning their feedback on the project and matters involving state boundaries and river jurisdiction summarized as following –

As per the officials, currently for all matters related with rivers, the correspondence for rivers with the central government lies with the Water Resources & River Development department, but in reality, the Forest Department actually governs most aspects related to jurisdiction of natural rivers.

The Water Resource Department is concerned mostly with irrigation channels and waste water.

Regarding rivers on state boundaries, the official stated that the boundaries are not fixed and may shift if the river course changes. Also, the permissions involved depends on the location of the river bank and as such would require respective permission. As such the project should not face any issues due to the presence of state boundary.

Consultation with Mr. B.S. Niraula, Chief Engineer Water Resource & River Dev. Department

Consultation with Mr. Phintso Gyatso, Junior Engineer (Planning), Water Resource & River Dev. Department

STATE POLLUTION CONTROL BOARD, SIKKIM

Date – 2nd June, 2023

Contact – B.K. Chettri, Chief Scientific Officer, SPCB, Sikkim

A consultation was conducted with the State Pollution Control Board Department concerning their feedback on the project and matters involving dumping practices summarized as following –

As such there are no identified dumping grounds and current dumping practices involve person to person dealing with identified lands for dumping. The land has to identified as degraded with steep slope and thereafter can be used after negotiation with the land owner.

As such no particular mastic is banned.

For dumping grounds, it is essential that they are not located in close proximity to the river so as to prevent loose soil from spilling through runoff.

The official has positive feedback on the project but has advised that all Hotmix, Coldmix, cement mixing plants, DG sets etc. require permission from the State Pollution Control Board.

To prevent dust, while back cutting, water has to be regularly used.

Consultation with Mr. B.K. Chettri, Chief Scientific Officer, SPCB, Sikkim

FOREST & ENVIRONMENT DEPARTMENT

Date – 2nd June, 2023:

Contact – DFO (T) East, Sikkim, Forest and Environment Department

A consultation was conducted with the Forest and Environment Department concerning their feedback on the project and matters involving dumping practices summarized as following –

Quarries identified in East Sikkim are all forest department owned. Every year forest department floats tender for quarries and most are owned by forest department. However private quarries also exist outside the legal limits.

ROW of individual roads is not based on one document but various acts under which road reserve limits can be found, e.g., for PMGSY roads its PMGSY act.

DFO (T) has stated that diversion requires at least 1 year.

Diversion of forest will be under Forest Conservation Act 1980.

Forest Department has its own survey demarcation team and hence for joint survey it is important to include Forest Department.

Consultation with DFO(T), East

Lingmoo Territorial Forest Range Office

Discussion with Blen T. Targain, Joint Director, FCA Cell; 21.12.2022

Any recorded Forest Land will require Forest Diversion as per FCA 1980.

Gauchar (grazing lands), Khasmahal and other government lands also require forest diversion similar to reserved forests.

Data for Gauchar (grazing lands), khasmahal and other government lands remains with Land revenue department.

Application to be written to DFO Territorial for proposed construction, for joint survey/inspection comprising of R&BD, Land Revenue Department and Forest officials.

With respect to acquisition of reserve forest lands above 40 ha, New Delhi office gets involved otherwise approval will come from regional office, i.e., Kolkata which will take approximately 100 days.
- Mr. Wasim Director and Mr. Sanoj Date: 07.05.2023 Wildlife SOS D-210, Defence Colony, New Delhi-110024
The existing profile and behaviours of animal and their rescue operation have been discussed. The project background, area of work and interest with respect to avoid animal human conflict in the project region and potential area has been discussed. Director and Rescue coordinator advised that based on animal behaviour the rescue operation is different. Through survey of potential biodiversity area, wildlife movement area should be surveyed in various seasons. The management plan for each animal like bear, giant squirrel would be different for various areas. Porcupine is not a problematic animal and not very sensitive, but this scheduled species, need some management measure and awareness during and operation of the project. The area of operation should not be located within restricted area of wildlife sanctuary, eco sensitive zone or national park. The restricted zones are strictly monitored by forest department so wildlife NGOs might be helpful in getting training awareness and rescue operations in non-regulated zones of the wildlife areas.

6.4 NGO Consultation

490. On August 27, 2024, a detailed discussion was held with Sunita Pradhan and Sailendra Dewan from the Ashoka Trust for Research in Ecology and the Environment (ATREE). The conversation centered around ATREE's ongoing projects and their significant contributions to biodiversity conservation, sustainable livelihoods, and climate change research in the Eastern Himalayas, particularly in Sikkim.

491. Sunita Pradhan, a Wildlife Ecologist based in ATREE's Eastern Himalaya Northeast Regional Office in Gangtok, Sikkim, provided insights into her work on Chinese pangolins. Her efforts focus on combining ecological research with outreach and public engagement to mitigate changes to land use and the illegal pangolin trade.

492. During the discussion, the possibility of collaboration with ATREE during project implementation was explored. ATREE suggested arranging a meeting with NGOs operating in the state to understand how they can collectively contribute to the successful implementation of projects in the region. The collaboration would focus on raising awareness about wildlife conservation, with contractual and financial support from the project to facilitate these efforts.

493. ATREE expressed willingness to support monitoring – with expected budgetary needs for consultation and support to ATREE to conduct the monitoring. Monitoring extends across all construction stages. – with a maximum up to 3 yrs. Post construction.

494. The follow up meeting. Consultations have been provided in A24, B28 and D5 of EMP in Table No 8.17. The budgetary provision has been made in Item no 7 of Table No 8-11I. The collaboration with be done for the measures provided in the BAP.

6.5 Information Disclosure

495. To keep more transparency in planning and for further active involvement of affected persons (APs) and other key stakeholders the project information including IEE report will be disclosed on the Website of Sikkim Road development department.

Table 6-18: Summary of the issues discussed

Major Consultation outcomes	Suggestions and inputs
The community expressed satisfaction regarding the project as it will improve commercial connectivity and promote tourism. During consultation it was highlighted that improvement of the road will lead to high traffic flow which will likely increase in the risk of accidents. Consideration of proper road safety measures was requested by the community. The community suggested that Hill Cutting should be minimized and retaining structures & crash barriers for valley side should be provided for road safety. During rainy season landslides occur frequently blocking the major access roads to nearby towns. Identification and stabilization of potential landslide prone areas was requested by the community. It was also informed that wild animals like bear, porcupine and deer are often sighted (sometimes once in year or two year) in the villages along the corridor. During construction the labours may come in contact with wild animals.	Proper road safety measures are incorporated in the project design. Special measures like signage, speed breakers at schools, hospitals and marketplaces will be provided by the project Hill Cutting will be minimized and retaining structures & crash barriers for valley side will be considered. Landslide prone locations will be identified, and proper protection measures will be considered at design. Proper coordination will be carried out with Joint Forest Management Committees, Eco during construction stage of the project. Development Committees, as well with the local forest authorities to avoid conflict with wild animals during construction. Sensitivity regarding Eco sensitive zone and wild animal shall be done at project level and workers. Corridors having wild animal reporting should be identified and proper safety measures/ awareness will be incorporated in the design.

496. The document disclosure plan is provided in the following table. The Draft EIA has already been disclosed on ADB website on 17th November 2025. In North Sikkim, the predominant languages are Lepcha and Bhutia; in West Sikkim, Nepalese is most widely spoken; and in South Sikkim, both Sikkimese and Nepalese are common. English is also widely used across the state and serves as a language understandable to affected persons and other stakeholders.

Table 6-19 : Document disclosure Plan

Documents	format	Language	Disclosure platform	Timeframe	Responsible party
Environmental Impact Assessment Report[14]	Electronic version of PDF	English	Draf EIA has been disclosed on ADB website. It will be disclosed on Website of Sikkim Road and Building Department[15] and PMU office in January 2026.	January 2026	PMU
Executive Summary	Electronic version of PDF	English, Nepalese, Sikkimese (Bhutia), Lepcha.	website of Sikkim Road and Building Department	January 2026	PMU
Quarterly Environmental Monitoring Report (from the date of project effectiveness until	Electronic version of PDF	English	Website of Sikkim Road and Building Department	Every quarterly within 1 week after ADB clearance of the report	PMC/AE

[14] The draft EIA (in English) has already been shared with the community through. https://www.adb.org/sites/default/files/project-documents/52159/52159-002-eia-en.pdf .
[15] https://www.adb.org/sites/default/files/project-documents/52159/52159-002-eia-en.pdf

Documents	format	Language	Disclosure platform	Timeframe	Responsible party
the issuance of ADB's Project Completion Report.)					
Semi-annual External Environmental Monitoring Report (including External Biodiversity monitoring report)	Electronic version of PDF	English	Sikkim Road and Building Department	Within one week after ADB clearance of the report	ESMU- PMU
In person community consultation	Disclosure of project details to the illiterate persons and those who cannot access the reports will be done in person community consultation meetings	Local language	In person meetings near the project site.	One in pre-construction stage and other during construction stage.	ESMU and PIU

7. Grievance Redressal Mechanism

497. The project will put in place a common grievance redress mechanism (GRM) to receive, evaluate and facilitate the resolution of social, environmental or any other project -related grievances. The GRM will aim to provide a time-bound and transparent mechanism to voice and resolve all project related concerns. The public awareness campaign will generate awareness of the project and its grievance redress procedures. The campaign will ensure that all stakeholders including the vulnerable community also know about the GRM.

498. The GRM will provide an accessible, inclusive, gender-sensitive and culturally appropriate platform for receiving and facilitating the resolution of impacted persons' grievances related to the project. The three-tier GRM for the project is outlined below, each tier having time-bound schedules and with responsible persons identified to facilitate and address grievances at each stage. Corridor-wide public awareness campaigns will ensure that awareness of grievance redress procedures is generated through the campaign. The Environmental and Social Management Unit (ESMU), supported by PMU, will be responsible for timely grievance redress.

499. **Information to the stakeholders about the GRM:** Stakeholders, including affected persons, will be informed about the project's three-tier GRM and the state-level grievance redress system through public consultations, information disclosures, and the distribution of Project Information Booklets (PIBs) in the local vernacular language. For illiterate affected persons (APs), this information will be communicated verbally during consultation meetings. All relevant documents, including contact details (phone numbers, email addresses, and office addresses) of the PMU, Competent Authority for Land Acquisition (CALA) and designated grievance redress personnel, will be made publicly available. This information will be widely disseminated across the project area by safeguard officers of the PMU, with support from the Project Management Consultant (PMC) or Authority Engineer.

500. **Who can complain:** A complaint can be registered by stakeholders directly or indirectly affected by the project. A representative can register a complaint on behalf of the affected person or group, provided that the affected person or group identifies the representative and submits evidence of the authority to act on their behalf.

501. **What the Grievance/ Complaint should contain:** Any comments, complaints, queries and suggestions pertaining to safeguard compliance - environment, involuntary resettlement, and indigenous people, design-related issues, compensation, service delivery, civil construction, access, damage to structures or any other issues or concerns related to the project. The complaint must contain the complainant's name, date, address/contact details, location of the problem area, and the problem. A sample grievance registration form is provided in **Annexure 28.**

502. **Where and how to file a Complaint:** Complaints can be submitted offline at multiple locations, including the contractor's site office, divisional offices, or the offices of the Project Management Unit (PMU), Environmental and Social Management Unit (ESMU) and CALA. Complaint registers and forms are available at the offices of the Project Management Unit (PMU) and CALA to facilitate this process. Additionally, grievances, suggestions, or queries can be submitted via phone or email, or by dropping written complaints into grievance boxes placed at the offices of the PMU and CALA. The CALA will also assist complainants in drafting their petitions, if needed.

503. **Grievance redress/Problem solving through participatory Process:** The ESMU and PMU must make efforts to resolve the problems and conflicts amicably through a participatory process with the community. In case of immediate and urgent grievances in the complainant's perception, the contractor and supervision personnel from the PMU will provide the most easily accessible or first level of contact to resolve grievances quickly. Contact phone numbers and names of the concerned staff and contractors will be posted and displayed at all construction sites.

504. **Grievance Redress Committee:** The GoS will establish the grievance redressal committees at the site and district level to provide a mechanism to mediate conflict and disputes concerning compensation payments, displacement, loss of livelihood and any other grievance related to the project, and cut down on lengthy litigation. The following will be the composition of the GRCs.

505. **Site Level GRC (1st Level):** When a grievance arises—whether written or verbal—the complainant may initially approach the subproject field-level staff of the contractor, site engineers, or the Land Acquisition (LA) department. Each subproject will have a site-level grievance redress mechanism in place, with the objective of resolving complaints within 15 working days. Upon receipt, the grievance must

be recorded in the register maintained at the concerned office and the responsible personnel must inform the CALA on the same day. The CALA will assist the affected person or community in articulating their grievance and ensure that it is addressed by the appropriate authority—be it the LA department, contractor, Project Management Consultant (PMC) or Authority Engineer. CALA will also maintain comprehensive records of all grievances received and the actions taken for their resolution.

The site level (first level) GRC will comprise of the:

- Site/ Junior Engineer
- CALA
- Contractor's representative
- Representative from PMC/ Authority Engineer
- Surveyor/ Amin
- Representative from the scheduled tribe/indigenous people community (if the complaint is related to any concerns of the indigenous people)

506. **District Level GRC (2nd Level):** The complainant may contact sub project level offices to file complaints on non - resolution at the subproject site level. The address and contact number of the District level Grievance Officers' office will be provided in the project information leaflet. The District Level officer is the second level of GRM which offers the fastest and most accessible mechanism for resolution of grievances. The District Level Officer will be designated as the key officers for grievance redress. Resolution of complaints will be done within 15 working days. At this stage, the CALA will inform the PMU for additional support and guidance in grievance redress matters, if required. Investigation of grievances will involve site visits and consultations with relevant parties (e.g., persons, community, contractors, traffic police etc.). Grievances will be documented and details of the complainant (name, address, date of complaint, etc.) will be included, unless anonymity is requested. The District Level GRC will meet as necessary when there are grievances to be addressed. The GRC will suggest corrective measures at the field level and assign clear responsibilities for implementing its decision within fifteen (15) working days. The contractor will have observer status on GRC. **The District level (second level) GRC will comprise of the:**

- District Collector or Deputy Commissioner or designated representative, above the rank of Sub-Divisional Officer
- District level Resettlement Officer
- District Environmental Officer
- A representative from local person of repute and standing in the society or elected representative from Panchayet /Zilla Parishad/District Council.
- Representative from PMC/ Authority Engineer
- Women representative from a relevant agency which could be from the government or local community
- A representative from Vulnerable Affected Persons
- A representative of the local Deputy Commissioners office (land), if the grievance is of land acquisition related issues
- A representative of local Pollution Control Authority (for environmental issues related grievances)
- A representative from IP community for IP related issue, if any.

507. **PMU Level GRC (3rd Level):** The Resettlement Officer and the Environmental & Social Management Unit of the PMU will activate the third level of the Grievance Redress Mechanism (GRM). The District Resettlement Officer, will refer unresolved issues—along with written documentation—to the PMU. Complainants may also directly submit their grievances to the PMU. The PMU, with support from the PMC/ Authority Engineer, will investigate the complaints. Any unresolved grievances will be presented before the Grievance Redress Committee (GRC), where the affected person or their representative may also present their concerns, if needed. The process aims to facilitate resolution through mediation.

The PMU level (third level) GRC will comprise of the:

- Project Director, R&BD or any authorized representative, who should not be below the rank of Chief/Executive Engineer.
- Nodal Officer/ Executive Engineer PMU– Member Secretary
- Resettlement Officer, PMU assisted by PMC/ Authority Engineer
- Environmental Officer, PMU assisted by PMC/ Authority Engineer

- Representatives from local person of repute and standing in the society or elected representative from Panchayat/ Zilla Panchayat/ District Council
- Representative from the District GRC
- A representative from IP community for IP related issue, if any
- Representative from local forest authority, if grievances of forest aspects
- Representative from Pollution Control Board, if grievances of environmental aspects Representative of the Land Revenue department if grievances of land related issues

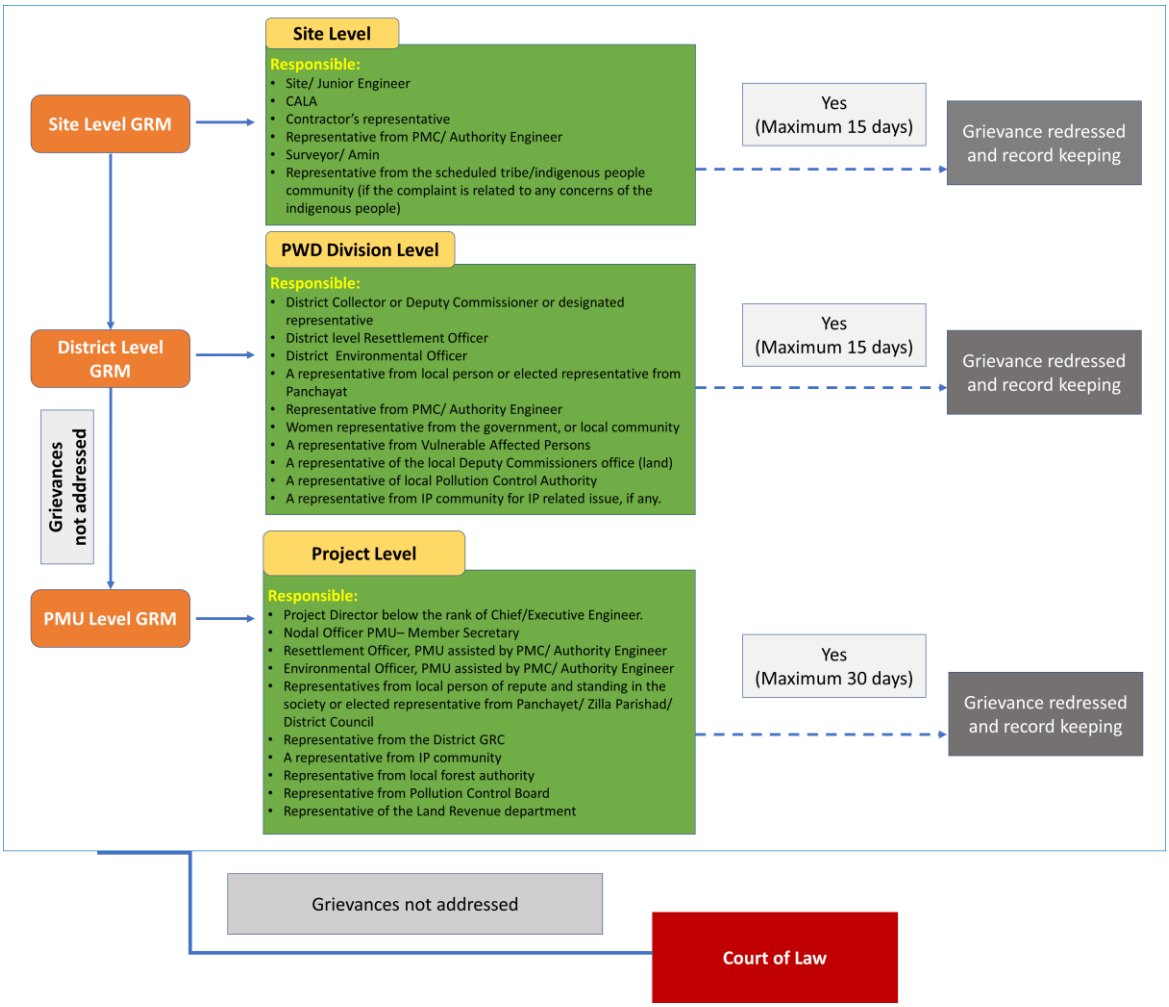
508. The complainant will be informed in writing about the resolution of their complaint or the decision of the grievance redress committees. The complainants are free to approach the court of law at any time of their own will at any stage, and accessing the country's legal system can run parallel to accessing the GRM and is not dependent on the negative outcome of the GRM.

509. **Additional grievance management**. In addition to the project-level grievance [redress] mechanism provided by the borrower [executing agency] [implementing agency], people who are, or may in the future be, adversely affected by the project have a range of forums available to them for purposes of raising their complaints, grievances, and concerns. These include applicable judicial or administrative forums and ADB through the resident missions and the ADB project teams. The borrower [executing agency] [implementing agency] will help ensure that project-affected people are made aware of these forums to address their complaints, grievances, and concerns. The borrower [executing agency] [implementing agency] should provide the applicable ADB contact details as part of stakeholder consultations and information disclosure, including in response letters to a complaint where appropriate, so that project-affected people know how to reach out to ADB.

510. **Court of Law**: Under the project specific GRM, an aggrieved person shall have access to the country's legal system at any stage and accessing the country's legal system can run parallel to accessing the GRM and is not dependent on the negative outcome of the GRM. However, as none of the impacts are complex, long-term or significant in nature, it is unlikely that there will be any unresolved issues after the first three stages. The PMU will submit resettlement plan/due diligence report EMP/SEMP implementation report to ADB's review and will ensure that affected persons will receive compensation and other assistances as per entitlement matrix prior to impact / displacement and before commencement of civil works. The issues relating to the environment will be redressed as per the guidance provided in EMP/SEMP.

511. **ADB's Accountability Mechanism.** The people who may /are in future be, adversely affected by the project may submit complaints to ADB's Accountability Mechanism. The Accountability Mechanism provides an independent forum and process whereby people adversely affected by ADB-assisted projects can voice, and seek a resolution of their problems, as well as report alleged violations of ADB's operational policies and procedures. Before submitting a complaint to the Accountability Mechanism, affected people should make an effort in good faith to solve their problems by working with the concerned ADB operations department. Only after doing that, and if they are still dissatisfied, should they approach ADB accountability mechanism.

Figure 21: Grievance Redress Mechanism



512. **Documentation:** ESMU, with the support of PMU, will be responsible for the timely registration of grievances, related disclosure, and communication with the aggrieved party. ESMU will also ensure that all the details from submission to resolution are well recorded and documented.

513. **Record-keeping:** PMU will keep records of grievances received, including contact details of complainant, date the complaint was received, nature of grievance, agreed corrective actions and the date these were affected and final outcome. The number of grievances recorded and resolved, and the outcomes will be displayed/disclosed in the ESMU office, and PMU offices.

514. **Periodic review and documentation of lessons learned.** The Project Director, PMU will periodically review the functioning of the GRM in each district and record information on the effectiveness of the mechanism, especially on the project's ability to prevent and address grievances.

515. **Costs.** All costs related to resolution of grievances (meetings, consultations, communication and reporting/ information dissemination as well as costs incurred by impacted persons to attend GRC meetings, if any) will be borne by PMU.

8. Environmental Management Plan

8.1 Introduction

516. The Environmental Management Plan (EMP) has been prepared with a focus on managing site specific environmental components, project activities, and anticipated impacts.

517. The EMP helps the responsible contractors, Project Management Unit and Authority Engineer (Divisional Engineer) to implement the project in an environmentally sustainable manner where contractors understand the potential environmental impacts arising from the project and take appropriate actions to properly manage all environmental impacts.

518. The EMP provides guidance to ensure environmentally sound construction of the project road and ensure efficient lines of communication and co-ordination between the PMU, Contractors, and the Roads & Bridges (R&B) Department, Government of Sikkim (GoS's). The EMP has been organized into three stages based on project road construction activities i.e., (i) Pre-construction Stage; (ii) Construction Stage; and (iii) Operation Stage. EMP for the phase-1 roads and bridges have been prepared and presented in Annexure 1. Various guidelines, checklists and reporting formats for implementation of EMP are given as Annexures 10.

519. Budgetary provisions for implementation of EMP shall be integrated into bid/construction contracts in the form of technical specifications and environmental performance requirements. The costs to be incurred on implementation of EMP shall be incidental to the civil works and therefore no separate environment budget/cost will be provided to the contractor for implementation of EMP.

520. The contractor will ensure effective implementation of EMP during pre-construction, construction and operation stages. EMP for operation stage will be implemented by PIU.

521. The Contractor is deemed not to have complied with the EMP if, i), within the boundaries of the project site/ancillary sites, site extensions and haul/access roads, (ii) there is evidence of contravention of clauses, (iii) if environmental damage ensues due to negligence, (iv) the contractor fails to comply with corrective action measures or other instructions issued by the PMU within a specified timeframe, and (v) the Contractor fails to respond adequately to complaints from the public.

8.2 Institutional Arrangements for Environmental Management

8.2.1 Existing Institutional Arrangement

522. The Executing Agency (EA) for the project is Roads & Bridges Department (R&BD), GoS. A Project Management Unit (PMU) under R&BD is the implementing agency for the project. The PMU is headed by a Project Director (PD) in the position of Additional Chief Engineer who is preceded by a Nodal Officer in the position of Chief Engineer. The PMU also comprises of one (01) Superintending Engineer (SE), one (01) Divisional Engineer (DE) and two (02) Assistant Engineer (AE) supported by four (04) Junior Engineers. The PMU is responsible for the implementation of loan and is also responsible for the overall coordination among ADB, R&BD and any other stakeholders involved and oversee the EMP implementation.

8.2.2 Institutional Arrangement for the Project

523. A dedicated unit, such as the Environmental and Social Management Unit (ESMU), will be established and provided adequate training on international best practices and climate-resilient road improvement initiatives. The dedicated ESMU will be headed by an officer at the rank of Divisional Engineer or Executive Engineer and will be responsible for all activities related to environmental management, resettlement and rehabilitation The PMU will have overall responsibility of the project, who will be assisted by Divisional Engineer (DE). The Divisional Engineer will be assisted by an Environmental Specialist and a Social Specialist or trained officers in the rank of Assistant Engineers. ESMU shall be housed at R&BD headquarters in Gangtok. Junior Engineers at each field divisions forming the Project Implementation Unit (PIU) will be responsible for E&S activities.

524. Description of key responsibilities of various agencies and parties for implementing safeguards are provided below: The roles and responsibilities of the officials are:

Table 8-1: Implementation Agencies and Key Responsibilities

Key Agency	Responsibility
Project Management Unit (R&BD)	The PMU is headed by a project director and supported by an assistant chief engineer, deputy engineer, two focal safeguards officers, and a contract administration consultant. Field offices will be established under the PIU to support the PMU operation. Each field office is headed by a superintending engineer and supported by executive engineers, deputy engineers and accounts officers. The executive engineer will serve as the social and environmental safeguards focal at the site level. The PMU and field offices will be responsible for ensuring the timely processing of environmental, wildlife and forestry clearances, tree cutting permits, and other similar clearances and permits required for the project. They will also ensure timely and effective planning and implementation of resettlement and social development activities. The PMU and the field offices will conduct at least bi-monthly site visits and ensure the reports submitted by the contractor and AE are consistent with site conditions. The PMU with the support of the PMSC will review all social and environmental monitoring reports prepared by the contractor and the AE. The PMU will ensure that environmental monitoring reports are submitted (**Table 6-19**).
Project Implementation Unit	The project implementation unit will be responsible for supervising implementation of the environmental management plan (EMP), Biodiversity Action Plan (BAP) environmental monitoring plan (EMOP) by the contractor through the following: • Review all sub-plans identified in the EMP to be prepared by the Contractor to include camp layout, waste/debris management plan, borrow area management plan, traffic management plan with guidance from the PMC; • Review environmental monitoring reports prepared by the • Contractors Environmental Focal Person (EFP); • Conduct monthly site and follow-up inspection to ensure the veracity of the submitted monitoring reports and enforce the EMP , BAP and EMOP; • Conduct compliance conference with the Contractor to discuss non-compliance and agree on corrective measures with guidance from the PMC and PMU.
ESMU headed by divisional engineer or executive engineer supported by field Assistant Engineer and Environmental and Social Specialists.	• Environmental Specialist and Social Specialist will be recruited full time for entire duration of the project in ESMU. These persons will be national experts. • National Biodiversity Specialist (for External Monitor role) will be hired by the ESMU for supervision of implementation of BAP. • Provide technical support and advise to the IAs in the implementation of the RP specifically for addressing complaints and grievances and participate in resolving issues as a member of the GRC • Provide technical advice and on the job training to the contractors as necessary • Review of environmental monitoring reports based on the monitoring checklists and submission to PIU by Authority Engineer and External Monitors
Project Management Consultancy	• Project implementation support, including safeguards implementation, will be provided to the PMU by the PMC. The PMC team will include an environmental specialist whose role will be to support the PMU in monitoring the implementation of environmental safeguards under the project and the review of environmental monitoring reports submitted by the AE and contractor. The PMC will also carry out capacity building activities on the implementation of social and environmental safeguards through training workshops and on-site training for the PMU,AE, and contractor, as necessary. Responsibilities of PMC are precisely outlined below. • Conduct environmental site induction training workshops to all contractors IE/AE and PIUs to ensure understanding of the EMP, BAP and domestic environmental laws and regulations requirements particularly on the required clearances and permits, training on occupational and community health and safety, • Ensure timely mobilization of the Contractor's EFP • Review and verify revised EMPs,BAP and sub-plans submitted by the contractor and advise the PMU on adequacy; • Conduct monthly site inspections to check the contractor's compliance with the EMP,BAP and EMOP • Participate in public consultations on issues concerning the project and facilitate addressing environment related grievances that maybe submitted to the project GRM • Ensure contractors secure necessary permits and clearances; • Prepare environmental due diligence reports on EMP implementation needed for the processing of subsequent tranches; • Prepare an environmental monitoring report template for contractors self-monitoring reports; • Design monthly compliance assessment checklists for PIU/PMU to be used for monitoring EMP and BAP implementation during pre-construction stage, construction stage, post construction stage and status of statutory clearances and permits

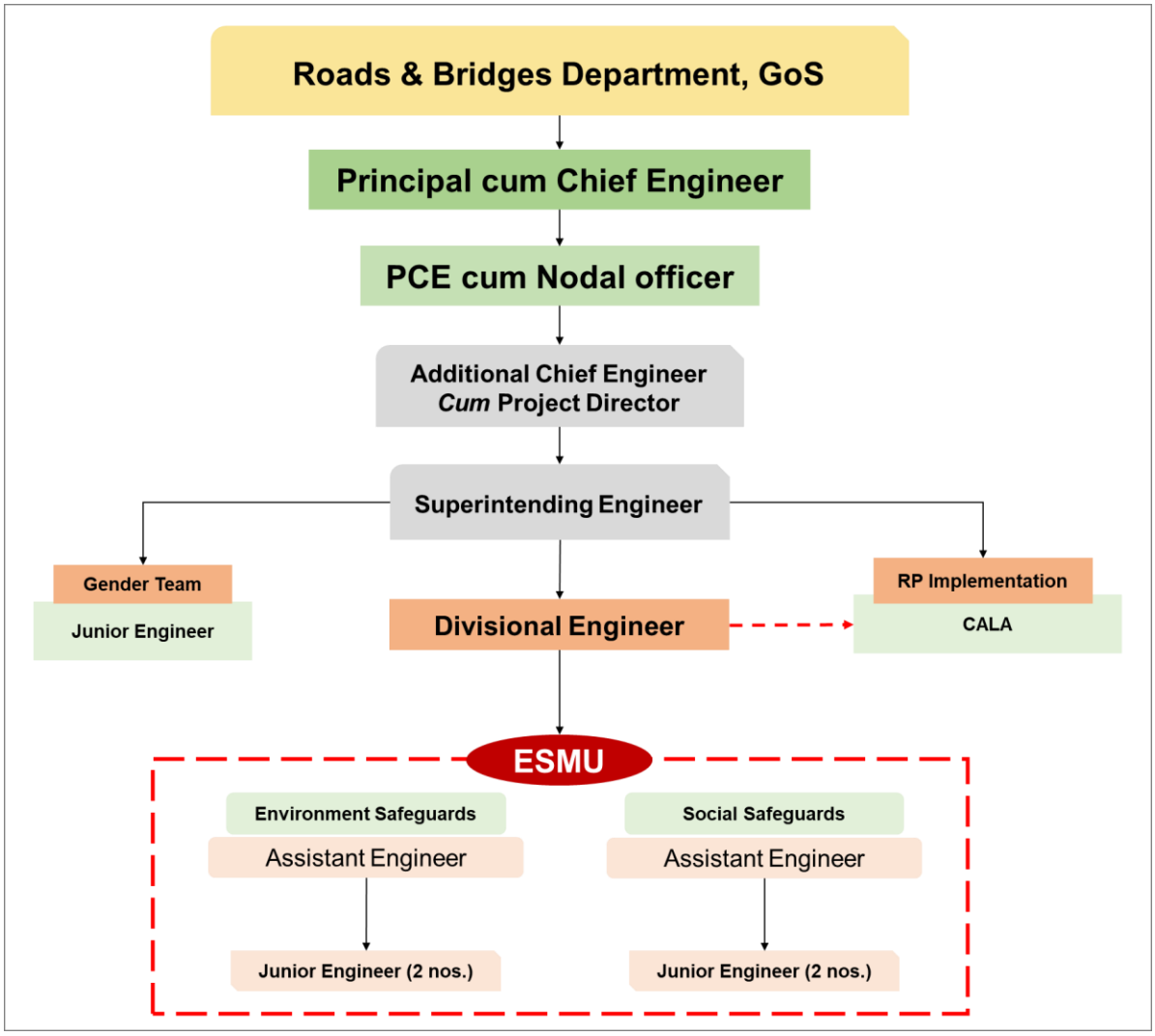
Key Agency	Responsibility
	• Prepare environmental monitoring reports (**Table 6-19**) based on the monthly environmental self-monitoring reports prepared by the Contractor's EFP and site observations for the review and of PIUs/PMU and approval by PMU; • Prepare environmental monitoring reports (**Table 6-19**) for approval by PMU (copy to PIU,IE/AE) and further submission to ADB for public disclosure; • Advise the Contractor through the PMU and PIUs on how to comply with requirements and address non-compliances; and • Report apparent unanticipated impacts and recommend mitigation measures to the • PMU for advising IE/AE to issue necessary instructions to the respective contractor • Update the EIA/EMP report in situations of unanticipated impacts when deemed necessary
Authority Engineer	Authority Engineer will be engaged under the project and will be responsible for approving and supervising implementation of the EMP, BAP and EMOP by the contractor. Each AE will include an environmental specialist who will be responsible for at least fortnightly site level supervision and monitoring. All subplans such as the construction camp layout, waste management, borrow area management, traffic management, tree plantation, and others prepared by the contractor will be reviewed and approved by the AE. The AE will also provide guidance to the contractor on corrective measures that must be taken and monitor their compliance. The environmental expert will review and verify all environmental reports prepared by each of the contractors. Based on site inspections and environmental reports from the contractors, he/she will assist the PMC in preparing environmental monitoring reports for submission to the PMU for their review and endorsement for further submission to ADB (**Table 6-19**). More specific role of AE in implementing EMP and BAP are: • Review the EIA, EMP and BAP to understand the background environmental issues of the respective subproject • Review and approve the revised EMP and other required sub-plans such as traffic management plan, health and safety plan, waste management plan etc. prepared by the contractor. • Conduct regular site inspections and monitor implementation of the EMP, BAP and EMOP by the contractor • Provide on-site training and technical guidance to the contractor workers as necessary • Review the monthly/quarterly/annual reports prepared and submitted by the contractor. • Prepare monthly reports on monitoring activities, training and other environment safeguard activities implemented • Where necessary, identify the need for corrective actions and issue official notices to the contractor to implement the corrective actions with clear timeline • If there are any complaints or grievances, facilitate consultations with the respective complainant and ensure the grievances are addressed in accordance with the GRM • Regularly convene meetings to discuss progress or issues on environment safeguards to ensure that all parties (contractor, PMC, PIU, R&BD) are on the same page on requirements and milestones for environment safeguards
EPC Contractor	The Contractor is the principal agent to implement the EMP , BAP and EMOP. The contractor will prepare and implement site-specific EMP and EMOP attached to the bidding documents. Qualified environmental health and safety experts will be recruited within 30 days of contract signing. These personnel will have presence in all construction and campsites and ensure proper day-to-day implementation of the EMP. The contractor will cooperate with the AE, PMC and PIU to implement environmental corrective actions and corrective action plans, as necessary. Specifically, the contractor will: • Participate the site induction workshop to be organized by the PMSC; • Obtain necessary environmental license(s), permits etc., from relevant agencies for associated facilities for project road works viz. borrow areas, quarries, hot-mix plant etc. prior to commencement of civil works contracts; • Implement all mitigation measures in the EMP,BAP and activities in the EMOP; • Pollution monitoring for air, water, noise/vibration, soil will be done on a quarterly basis through third-party laboratories and as approved by the AE. • Other EMOP items will be monitored on a monthly basis. o Monitoring reports must include wildlife movement/sightings and incidence of collision if any for the sub-projects located in proximity to wildlife sanctuary o Submit monthly monitoring reports for approval to the IE/AE and further submission to PIU and PMC for final submission to PMU; o Ensure that all workers, site agents, including site supervisors and management participate in training sessions delivered by PMC; o Acquire all environmental statutory requirements (permits, NOCs etc.) and fulfill contractual obligations;

Key Agency	Responsibility
	○ Collect the baseline data on environmental quality before the start of physical works and continue collection as given in the EMOP during construction and operation; ○ Participate in resolving issues as a member of the GRC; Respond promptly to grievances raised by the local community or any stakeholder and implement environmental corrective actions or additional environmental mitigation measures as necessary;
External Monitor-National Biodiversity Specialist	Monitor the implementation of the Biodiversity Action Plan (BAP) by the respective contractors and supervision consultants. • Provide technical guidance and feedback to the respective contractors and R&BD. Monitor operational stages and residual impacts, if any during project implementation. • The Independent Biodiversity Specialist will be engaged for the 5-year during construction and operation period for the implementation of BAP. • The monitoring report to be prepared by the Independent Biodiversity Specialist shall provide details of the methodology used; findings (result of desk review, site observations, and consultations/interview); recommendations; and other relevant information to support the findings (Minute of meetings, photo-documentation, etc.). • The Independent Biodiversity Specialist will also report on the functioning of the Grievance Redress Mechanism (GRM) regarding wildlife/biodiversity concerns, if any. Submit half-yearly BAP monitoring reports to R&BD and ADB from the start of monitoring date/period.
External Monitor-Overall	The PWD/ESMU will engage an Independent/ Third Party with the project approval of Asian Development Bank for half yearly environmental monitoring of the projects under construction and annually during operation stage. The primary purpose of an independent third-party monitoring is to provide an objective assessment of the borrower's (or client's) compliance with ADB's SPS 2009 and the effectiveness of their Environmental Management Plans (EMP) and Biodiversity Action Plan. This includes verifying the accuracy of monitoring information submitted by the borrower. The independent monitoring helps identify any gaps or deficiencies in safeguard implementation, allowing for timely corrective actions and preventing or minimizing negative environmental and social consequences. The external monitoring will also monitor the ESMU's monitoring work of compliances with the conditions of the Forest Clearance. This also includes verification of plantation survival, area coverage, and compliance with Stage-II approval conditions and provide in its report. The ESMU needs to coordinate with institutions at: • Local level viz., local office of Forest and Environment Department, Land Revenue & Disaster Management Department, The Water Resources & River Development Department, Commerce & Industries Department, Tourism & Civil Aviation Department, Rural Development Department. • Provincial/regional level viz., Sikkim State Disaster Management Authority (SSDMA), State Level Environment Impact Assessment Authority (SEIAA) Sikkim, State Level Expert Appraisal Committee (SEAC) Sikkim, State Forest Development Agency, (SFDA), State Pollution Control Board (SPCB) Sikkim, Sikkim Biodiversity Board, Social Welfare Department and Directorate of Economics, Statistics & Monitoring and Evaluation, Labour Department, Women, and Child Development Department, and Skill Development Department; and • National level viz., Ministry of Environment, Forest and Climate Change (MoEFCC), Ministry of Tribal Affairs, Ministry of Development of North Eastern Region, Ministry of Labour and Employment, and Ministry of Skill Development and Entrepreneurship.
District level officials	• Provide any existing socioeconomic information, maps and other related information to DPR Consultant prior to the field data/information collection activities. • Act as the local focal point of information dissemination • Execute land acquisition process
Forest Department	• Forest depart is regulator for the permission of diversion of forest land, tree on the forest land, wildlife. • Role of the Forest Department is stipulated below. • Forest Clearance – Scrutiny of the forest clearance proposal, recommendation to state government for the clearance, providing stage-1 clearance and provide report on compliance with the conditions to the State Government/ MoEFCC, Implementation Monitoring and Reporting. • Sikkim State Forest Department - The State Forest Department (Territorial or Social Forestry Division) — responsible for planning, implementation, and monitoring of compensatory plantation works. • Nodal officer/ Regional office of MoEFCC - Nodal Officer (Forest Conservation Act), in the State Forest Department. Regional Office of MoEFCC, which conducts periodic review and field verification
Community Based Organizations	• Ensure the community participation at various stages of the project • Coordination with stakeholder organizations • Assist in Monitoring of the project

Key Agency	Responsibility
	• Providing indigenous knowledge as required

525. Proposed institutional arrangement has been illustrated below through a flow in **Figure 22**.

Figure 22: Institutional Arrangement for Resettlement and Rehabilitation



8.2.3 Capacity Building

526. Project Management Unit (PMU), Roads and Bridges Department (R&BD), GoS has some of the experienced project staff having some basic knowledge of social safeguards, with knowledge and experience of ADB social safeguard policies and their implementation. However, some staff and the new candidates/ recruits as safeguards officers will require training in project preparation and implementation of this Project. The Social Specialist in ESMU, will be responsible for training the PMU safeguards focal (environmental and social), and PMUs engineers and the engineers and staff of Divisional/Field Offices, the Project Management Consultants (PMC)/ Authority Engineer and contractors. The RP/ RIPP includes indicative training modules on safeguards. The ESMU will coordinate with PMUs and Division/ Field Office, PMC/ Authority Engineer and Contractors on specific capacity development program which may include but is not limited to:

i. Sensitization on ADB's Policies and guidelines on social safeguards (ADB's Safeguard Requirement 2 and 3: Involuntary Resettlement and Indigenous Peoples) including meaningful consultations, GRM and accountability mechanism;

ii. Introduction to the assessment of involuntary resettlement and mitigation measures, including best practices, in the design, construction, operation and maintenance of water supply, sewerage, and drainage projects;
iii. Preparation and review of RPs/ DDRs based on detailed design, and documents have been updated based on the final design;
iv. Effective communication with stakeholders including elected representatives, media and general masses;
v. Improved coordination within nodal departments;
vi. Disbursement of compensation, consultation; and
vii. Monitoring and reporting requirements.

527. Indicative details of training needs placed in **Table 8-2.**

Table 8-2: Indicative Training Needs Assessed

Description	Target Participant and Venue	Source of Funds
1. Introduction and Sensitization to Social/ Resettlement/ Indigenous Peoples Issues (1 day) - ADB Safeguards Policy statement (SR 2 and SR 3) - Government of India and Sikkim applicable social safeguard acts - Incorporation of social/resettlement components under EMP/SEMP into the project design and contracts - Monitoring, reporting and corrective action	All staff and consultants involved in the project. At PMU in Gangtok	PMU, R&BD cost
2. RIPP implementation (1 day, twice during implementation with interval of six months) - Roles and responsibilities - Resettlement plan components and stages in implementation - Construction schedules and timelines - Public relations - Consultations - Grievance redress	All staff and consultants involved in the project. All contractors prior to award of contract	PMU, R&BD cost
3. Monitoring and corrective action planning - Reporting and disclosure - Timely documentation	At each PMU, Division/District level	PMU, R&BD cost
4. Experiences and best practices sharing (1 day) - Experiences on RP/ RIPP implementation - Issues and challenges - Best practices followed	All staff and consultants involved in the project All contractors. At PMU, State level	PMU, R&BD cost

ADB = Asian Development Bank, EM = Entitlement matrix, PMU = Project Management Unit

528. ESMU Officers are required to be conversant with ADB safeguards policy along with the national and state laws. Environmental and social safeguards are a cornerstone of ADB's support for inclusive economic growth and environmentally sustainable growth. Approved by ADB's Board of Directors in July 2009, the Safeguard Policy Statement (SPS) builds upon the three previous safeguard policies on the environment, involuntary resettlement, and indigenous peoples, and brings them into a consolidated policy framework that enhances effectiveness and relevance. The SPS applies to all ADB-supported projects reviewed by ADB's management after 20 January 2010. ADB works with borrowers to put policy principles and requirements into practice through project review and supervision, and capacity development support. The SPS also provides a platform for participation by affected people and other stakeholders in project design and implementation.

529. ESMU Officers along with ADB Environmental Safeguards Policy should also be aware of the DRAFT of the proposed Sikkim Forest, Water Courses, and Road Reserve (Preservation and Protection) Act, 2020.

530. The above shall help to build the technical capacity of ESMU officers to review the Initial Environmental Examination (IEE)/ Environmental Impact Assessment (EIA) and Environmental Management Plan (EMP) of any project, prepared by consultants, and oversee the suggestions in EMP being implemented by the contractors and overseen by Environmental Specialist of ESMU. Till now the department officers were only able to provide technical inputs.

531. Functionaries at Project level. The EE will ensure that all project activities are complied with as per the EMF and EMP.

532. Finally, for the project road, a Project Site Team (PST) or PIU will be responsible. The PST, to be headed by Executive Engineer, will oversee day to day implementation of environment, health and safety plan, including on issues pertaining to tree cutting, plantation works, utility relocation and worksite safety management.

533. The Environmental and Safety Officer and dedicated Ecology Biodiversity expert on the Contractor's team must ensure compliance with the environmental contractual clauses and will report on progress or challenges to the Construction Supervisory team, as per the requirements/obligations stated in the Contract Document.

534. The ESMU will oversee the quality including environment management, health and safety related aspects. This will determine whether the project is complying with regulatory performance standards. It entails a systematic, documented and periodic review of project implementation and could be a useful tool to improve project management performance on EHS aspects.

535. **Clause for Nonconformity to Environmental Management Plan (EMP) – Protection of the Environment.** The Contractor shall implement necessary mitigation measures for which responsibility is assigned to him as stipulated in the EMP. Any lapse in implementing the same shall attract the damage clause as detailed below:

536. Any complaints of public, within the scope of the Contractor, formally registered with the PIU and communicated to the Contractor, which is not properly addressed within the time period intimated by the PIU shall be treated as a major lapse.

537. Non-conformity to any of the mitigation measures like unsafe conditions, non-collection of excavated material (during laying of drainage pipes) regularly and other unattended Health, Safety &Environment (HSE) issues, as stipulated in the EMP Report (other than stated above) shall be considered as a minor lapse.

538. On observing any lapses, PIU shall issue a notice to the Contractor, to rectify the same.

539. Any minor lapse for which notice was issued and not rectified, first and second reminders shall be given after ten days from the original notice date and first reminder date respectively. Any minor lapse, which is not rectified, shall be treated as a major lapse from the date of issuing the second reminder.

540. **Environmental Monitoring Plan.** The monitoring programme consists of performance indicators, reporting formats and necessary budgetary provisions. The contractors monitoring plan should be in accordance with the baseline environmental monitoring, locations provided in the Environmental impact assessment report.

541. The monitoring plan has the following objectives:

- To ensure effective implementation of EMP
- To evaluate the performance of mitigation measures provided in the EMP
- To comply with all applicable environmental, safety, labour and local legislation
- To ensure that public opinions and obligations are taken into account and respected to the required satisfaction level
- To modify the mitigation measures or implementing additional measures, if required.

542. The monitoring requirement for the different environmental components have been prepared is presented in **Table 8-3** below.

8.3 Performance Monitoring Indicators

543. Environmental components identified of significance in affecting the environment at critical locations have been suggested as Performance Indicators. For example, near the construction site, a thick layer of dust over the nearby vegetation/leaf is an indication that the dust control measures are not effective. The performance indicators will be evaluated under three heads as mentioned below:

- Environmental condition indicators to determine efficacy of environmental mitigation measures for controlling air, noise and water pollution.
- Environmental management indicators to determine compliance with the suggested environmental management measures.
- Operational performance indicators have also been devised to determine efficacy and usefulness of the the mitigation measures provided for the project road.

544. The performance indicators and monitoring plan prepared for the project road are presented in Table 8-3. Details of the performance indicators parameters for each of the component have to be identified and reported during all stages of the implementation. The contractor must ensure that the mitigation measures comply with the requirements of organizations like the IFC and WHO for pollution prevention and occupational health and safety management at the project site. The prepared monitoring plan aligns with the standards set by the MOEF&CC, CPCB, IFC, and WHO.

Table 8-3: Performance Indicators and Monitoring Plan

Sl. No.	Description of Item	Indicator	Stage	Responsibility
1	Verification and identification of earth borrow areas and stone quarries	Compliance of site selection Criteria	Pre-construction	Contractor
2	Identification of locations for construction camp and construction plant sites	Compliance of site selection Criteria	Pre-construction phase	Contractor
3	Progress on Tree removal	Tree cutting	Pre-construction phase	PIU
4	Location of the temporary storage areas for excavated materials to be reused in road construction, embankment and sub grade	Storage of excavated materials	Pre-construction phase	Contractor
5	Implementation of mitigation measures specified in the EMP	Prevention/ Control of Pollution	Construction phase	Contractor
6	Environmental monitoring as per the conditions stipulated in the consents/ as described in environmental monitoring plan	Environmental Conditions at Construction Sites/Plants/ Camps	Construction phase	Contractor
7	Environmental monitoring in accordance with the frequency and duration of monitoring as well as the locations as per the Monitoring plan. Before the onset of monsoon all the debris/ excavated materials will be cleaned from the work sites and disposed of temporarily stock piled debris for final disposal properly away from the water bodies	Ambient Air Quality, Ambient Noise Level, Ground and Surface Water Quality, Silting of Water Bodies.	Construction phase	Contractor through external agency and will be supervised by the Environment Specialist of Authority Engineer/ PIU
8	Monitoring work zone safety	Use of PPE and signages	Construction phase	Contractor and will be supervised by the Environmental Specialist of Authority Engineer / PMC
9	Implementation of the enhancement measures suggested for the pond redevelopment areas,	Enhancements/ Earth works	Construction phase	Contractor

Sl. No.	Description of Item	Indicator	Stage	Responsibility
	cultural/community properties and oxbow land development			
10	Reporting of accidents at worksites/road construction sites	Accidents Reporting	Construction phase	Contractor
11	Plantation of shrubs and grass in high embankment/ enhancement sites and incidental spaces	Land scaping	Construction and Defect Liability Period	Contractor
12	Compensatory tree plantation and Reporting of the Survival Rate. The survival rate should be monitored and reported on quarterly basis	Tree Plantation and survival rate	Construction and Operation Stage	Forest Department and PIU
13	Verification of the borrow area redevelopment as specified in the redevelopment plan and Satisfaction of the owners/IRC guidelines	Status borrow area	Construction and operation stage	Contractor and PIU
14	De-mobilization of Camps and Plant on completion of works	Clean-up and restoration of the site	De-Mobilization	Contractor and will be supervised by the Environmental Specialist of Authority Engineer/ PIU

PIU = project implementation unit

8.4 Monitoring Plans for Environment Conditions

545. For each of the environmental components, the environmental monitoring plan specifies the parameters to be monitored including location and duration. The monitoring plan also specifies the applicable standards, implementation and supervising responsibilities. The monitoring plan for the various environmental condition indicators of the project in construction stages is presented in Table 8-5. Monitoring plan does not include the requirements arising out of regulatory provisions such as obtaining consent for plant site operation.

Table 8-4: Brief Description of Measures

Sl. No	Locations of worksite	Site safety measures
1	Construction site	Caution boards, Safety Cones, Delineators
2	Deep cutting	The construction zone shall be barricaded with G.I. Sheet or arrangement to be made as per plan approved by the PIU [Provide Safety Sign Boards and Safety Barriers marked with reflective tapes]
3	Temporary diversion (If any)	Diversion Board, Barricading [Provide 'Diversion Ahead' boards at 50m, 100m and 150m ahead of diversions with reflective tape for illumination at night at all diverted locations]
4	Safety of the workers	Helmets, Safety-Shoes, Goggles, Dusk mask. Etc.

546. Furthermore, periodic site monitoring shall be carried out by the Environmental Expert of PIU for surveillance and monitoring of road safety during the road construction. The brief description of measures has been given in Table 8-5.

Table 8-5: Monitoring Parameters

Attribute	Timing	Parameter	Standards	Frequency	Duration	Location	Implementation
Ambient Air	Pre - construction			Two samples for one week (on non-consecutive days)		As Indicated in table 11.4 & places designated for Construction labour camps, plants sites and settlements along the work zones in downwind direction as decided by Environmental Expert of Authority Engineer/PMC	Contractor
	Construction	PM2.5, PM10, SO2, NO2 and CO	National Ambient Air Quality Standards (NAAQM) 2009	Two samples for one week (on non-consecutive days) for in winter and summer seasons (six monthly)	24 Hours Sampling, 2 Samples in on Week	Construction labour camps, plants sites and settlements along the work zones in downwind direction (Locations will be decided by Environmental Expert of Authority Engineer/PMC	Contractor
	Operation			Once every season except monsoon season for 5 years after completion of construction		As Indicated in table 11.4	Contractor
Ground water	Pre - construction	Organoleptic and Physical, Chemical and Bacteriological Parameters	Potable Water Standards (IS 10500: 2012)	Once before commencement of construction	Grab Sampling Once	Places designated for Construction labour camps, plants sites and settlements along the work zones in downwind direction as decided by Environmental Expert of Authority Engineer/PMC	
	Construction			Winter and Summer Seasons	Grab Sampling Once	Construction labour camp, plants sites, settlements along the work zones (locations will be decided by Environmental Expert of Authority Engineer /PMC)	Contractor
Surface wate	Pre - construction	[16](i) pH, BOD, COD, TDS, TSS, Pb, DO Oil and Grease for Surface	Indian Standards (IS:2296-1982) for inland surface waters	Once before commencement of construction	Grab Sampling Once	Places designated for Construction labour camps, plants sites and settlements along the work zones in downwind direction as decided by Environmental Expert of Authority Engineer/PMC	

[16] These parameters along with parameters suggested in EIA Guidance Manual for Highways should be included. However, deletion or addition of any other parameters during construction phase shall be decided by Environmental specialist of ESMU.

Attribute	Timing	Parameter	Standards	Frequency	Duration	Location	Implementation
	Construction	Water (ii) pH, TDS, Total Hardness, Sulphate, Chloride, Fe, Pb, As, for Ground Water		Winter and Summer Seasons	Grab Sampling Once	Construction labour camp, plants sites, River and Ponds (locations will be decided by Environmental Expert of Authority Engineer/PMC)	Contractor
Noise	Pre - construction	Level Equivalent L Day and L Night based on hourly Noise Measurements	Ambient Noise Standards, MoEF Noise Rules, 2000	Once before commencement of construction	Hourly noise measurements for one day	As Indicated in table 11.4 and places designated for Construction labour camps, plants sites and settlements along the work zones in downwind direction as decided by Environmental Expert of Authority Engineer/PMC	
	Construction			Winter and Summer Seasons	Hourly noise measurements for one day in winter and summer seasons	Construction labour camp, plants sites, settlements along the work zones (locations will be decided by Environmental Expert of Authority Engineer/PMC)	Contractor
	Operation	Equivalent noise levels using an integrated noise level meter kept at a distance of 15 from edge of pavement			Hourly noise measurements for one day in winter and summer seasons for 5 years after construction completion.	At potential abutting traffic detours and traffic diversions and major intersection near habitations.	Contractor
Soil	Pre - construction	As suggested in section 4.2 of EIA Guidance Manual for Highways.	Threshold for each contaminant set by IRIS database of USEPA until national standards are promulgated	During the Pre monsoon and Post monsoon season each year for the entire construction period	Grab Sampling	At productive agricultural lands abutting traffic detours and traffic diversions and major intersection.	Contractor
	Construction				Grab Sampling	At productive agricultural lands abutting traffic detours and traffic diversions and major intersection.	Contractor

Table 8-6: List of Monitoring Stations

Attributions	Stage	Location
Air	**Construction**	**Receptor location:** N9 - North Sikkim Administration Centre, CH 0 +000 S1 - Melli PHC, CH 0 + 500; Settlement (Near Passi), CH 8 + 630; Govt. Senior Secondary School Settlement, CH 15 + 530; (Near Evangelical Presbyterian Church of Sikkim,Suiram), CH 22 + 460 S6 - Assangthang Government Junior School, CH 0 + 000; Govt Primary School Dhargaon, CH 3 + 530; Centre for Computers and Communication Technology, CH 13 + 830 E1 – Settlement (Near Swiss Garnier), CH 0 + 560; BDO Office, CH 7 + 930 E4 - Birkuna Junior High School, CH 0 + 50; Lingzey Junior School, CH 7 + 020; Samdong PHC, CH 18 + 700 W10 - ATM Near Geyzing Market, CH 0 + 000 ; Panchayat Bhawan near Unglok, CH 4 + 960 Br04 - Settlements near bridge site Br06 – Settlements near bridge site **Plant and Equipment site:** Aggregate Crusher site Aggregate Batching Plant location Asphalt Hot Mix plant
	Operation	**Receptor location:** West Lungdar Lengte Hreichuck
Noise	**Construction**	**Receptor location:** N9 - North Sikkim Administration Centre, CH 0 +000 S1 - Melli PHC, CH 0 + 500; Settlement (Near Passi), CH 8 + 630; Govt. Senior Secondary School Settlement, CH 15 + 530; (Near Evangelical Presbyterian Church of Sikkim,Suiram), CH 22 + 460 S6 - Assangthang Government Junior School, CH 0 + 000; Govt Primary School Dhargaon, CH 3 + 530; Centre for Computers and Communication Technology, CH 13 + 830 E1 – Settlement (Near Swiss Garnier), CH 0 + 560; BDO Office, CH 7 + 930 E4 - Birkuna Junior High School, CH 0 + 50; Lingzey Junior School, CH 7 + 020; Samdong PHC, CH 18 + 700 W10 - ATM Near Geyzing Market, CH 0 + 000 ; Panchayat Bhawan near Unglok, CH 4 + 960 Br04 - Settlements near bridge site Br06 – Settlements near bridge site **Plant and Equipment site:** Aggregate Crusher site Aggregate Batching Plant location Asphalt Hot Mix plant Operation of construction equipment
	Operation	**Receptor location:** West Lungdar Lengte Hreichuck
Water	**Construction**	At all corridors, rivers within 5 km upstream and downstream along with streams along project corridors
		Construction Camp Sites for drinking water as frequently EO as feels required. Immediately when change in source concerned.
Soil	**Construction**	at productive agricultural lands close to intersections or along sensitive land uses (3 locations) any accident or spill locations involving bulk transport carrying hazardous materials
It is noted that locations are indicative. It will finally be decided by Environmental Officer of ESMU during construction phase and by PIU, R&BD during operation phase.		

8.5 Monitoring Parameters and Standards

547. The environmental monitoring parameters and National Ambient Air Quality Standards are discussed below:

548. The ambient air quality parameters viz: Sulphur Dioxide (SO2), Nitrogen Dioxide (NO2), Carbon Monoxide (CO), Particulate Matter (PM10, PM2.5), shall be monitored once in six months/half yearly at identified locations from the start of the construction activity. The ambient air quality

parameters shall be monitored in accordance with the National Ambient Air Quality Standards as given in Table 8-7. The duration, the pollution parameters to be monitored, and the responsible institutional arrangements are detailed out in the Environmental Monitoring Plan.

Table 8-7: National Ambient Air Quality Standards

Sl. No.	Pollutant	Time weighted Average	Concentration in Air		
			Industrial, Residential, Rural and others	Ecologically sensitive area	Methods of Measurement
1	Sulphur dioxide (SO^2), µg/m3	Annual* 24 hours**	50 80	20 10	Improved West and Geake Ultraviolet fluorescence
2	Nitrogen Dioxide, (NO^2) µg/m3	Annual* 24 hours**	40 80	30 80	Modified Jacob & Hochhieser (Na-Arsenite) Chemiluminescence
3	Particulate Matter (size less than 10µm), or PM10, µg/m3	Annual* 24 hours**	60 100	60 100	Gravimetric TOEM Beta attenuation
4	Particulate Matter (size less than 2.5µm), or PM2.5, µg/m3	Annual* 24 hours**	40 60	40 60	Gravimetric TOEM Beta attenuation
5	Carbon Monoxide (CO), µg/m3	8 hours* 1hours**	02 04	02 04	Non-Dispersive Infra-Red (NDIR) spectroscopy

**Annual arithmetic means of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform intervals*
***24 hourly or (8 hourly or 01 hourly monitored values, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.*

8.6 Noise Quality Monitoring

549. The noise levels shall be monitored at designated locations in accordance with the Ambient Noise Quality standards given in Table 8-8. The duration and the noise pollution parameters to be monitored and the responsible institutional arrangements are detailed in the Environmental Monitoring Plan.

Table 8-8:National Ambient Noise Quality Standards

Sl. No.	Category of Zones	Limits of Leq in dB (A} Day*	Night*
A	Industrial	75	70
B	Commercial	65	55
C	Residential	55	45
D	Silence Zone	50	50

**Daytime shall mean from 6:000m to 10:00 pm and Night shall mean from 10:00 pm to 6:00 am*
***Silence zone is defined as an area up to 100 meters around premises of hospitals, educational institutions and courts, use of vehicles horns, loud speakers and bursting of crackers are banned in these zones.*

8.7 Water Quality Monitoring

550. Water quality parameters such as pH, BOD, COD, DO coliform count, total suspended solids, total dissolved solids, Hardness, Conductivity etc. shall be monitored at all identified locations during the construction stage as per standards prescribed by Central Pollution Control Board specifications presented in

551. **Table** 8-9. The duration, the pollution parameters to be monitored, and the responsible institutional arrangements are detailed out in the Environmental Monitoring Plan.

Table 8-9: Surface Water Standards

Sl. No.	Parameter	Unit	IS: 10500:2012	
			Desirable Limit	Permissible limit
1	Colour	Hazen Unit	5	15
2	Odour		Agreeable	Agreeable
3	Taste		Agreeable	Agreeable
4	Turbidity	NTU	1	5
5	pH		6.5 – 8.5	No relaxation
6	Conductivity	µmhos/cm	-	-
7	Free residual chlorine	mg/L	0.2	1
8	Total Dissolved Solids	mg/L	500	2000
9	Mineral oil	mg/L	0.5	No relaxation
10	Total Hardness (as $CaCO_3$)	mg/L	200	600
11	Total Alkalinity (as $CaCO_3$)	mg/L	200	600
12	Chloride (as Cl)	mg/L	250	1000
13	Sulphate (as SO_4)	mg/L	200	400
14	Nitrate (as NO_3)	mg/L	45	No relaxation
15	Fluoride (as F)	mg/L	1	1.5
16	Calcium (as Ca)	mg/L	75	200
17	Magnessium (as Mg)	mg/L	30	100
18	Sulphide (as S)	mg/L	0.05	No relaxation
19	Cyanide (CN)	mg/L	0.05	No relaxation
20	Phenol (as C_6H_5OH)	mg/L	0.001	No relaxation
21	Boron (as B)	mg/L	0.5	2.4
22	Copper (as Cu)	mg/L	0.05	1.5
23	Barium (as Ba)	mg/L	0.7	No relaxation
24	Iron (as Fe)	mg/L	1	No relaxation
25	Manganese (as Mn)	mg/L	0.1	0.3
26	Zinc (as Zn)	mg/L	5	15
27	Nickel (as Ni)	mg/L	0.02	No relaxation
28	Chromium (as Cr)	mg/L	0.05	No relaxation
29	Lead (as Pb)	mg/L	0.01	No relaxation
30	Cadmium (as Cd)	mg/L	0.003	No relaxation
31	Aluminium (as Al)	mg/L	0.03	0.2
32	Silver (as Ag)	mg/L	0.1	No relaxation
33	Molybdenum (as Mo)	mg/L	0.07	No relaxation
34	Selenium (as Se)	ppb	10	No relaxation
35	Arsenic (as As)	ppb	10	No relaxation
36	Mercury (as Hg)	ppb	1	No relaxation
37	Ammonia (as NH_3-N)	mg/L	0.5	No relaxation
38	Anionic detergents	mg/L	0.2	1
39	Chloramine	mg/L	4	No relaxation
40	Pesticides	mg/L	*	No relaxation
41	Polychlorinated biphenyls	mg/L	0.0005	No relaxation
42	Polynuclear aromatic Hydrocarbon (PaH)	mg/L	0.0001	No relaxation
43	Trihalomethanes	mg/L	**	**

8.8 Supervision and Monitoring of Biodiversity Action Plan

552. Sikkim Road and Building Department through ESMU will mobilise a National Biodiversity Specialist for the supervision and monitoring of implementation of Biodiversity Action Plan (BAP).

Table 8-10: Supervision and Monitoring of Biodiversity Action Plan

Sl No	Supervision and Monitoring Parameters	Implementation and Monitoring Responsibility	Monitoring Responsibility	Frequency	Method of monitoring and Corrective actions
1	Supervision and Monitoring of BAP as per BAP prepared and provided in Annexure 21	National Biodiversity Specialist	ESMU of Sikkim Road and Bridge department	monthly	The National Biodiversity Specialist will supervise the implementation of BAP regularly and provide monthly reporting to the ESMU.

8.9 Monitoring of Forest Compliance

The conditions of the forest clearance will be implemented by the forest department. The monitoring for the compliance of conditions will be performed the user agency. The monitoring plan is provided Table 8-9 below.

Table 8-11: Monitoring of Conditions of Compliances of Conditions of Forest Clearance

Sl No	Monitoring Parameters	Implementation Responsibility	Monitoring Responsibility	Frequency	Method of monitoring and Corrective actions
1	Compensatory Plantation and compensatory afforestation	Sikkim Forest Department	ESMU of Sikkim Road and Bridge department	monthly	ESMU will have physical verification and documentary verification. In case of delays or non-compliance, suitable action will be recommended and escalated to the competent authority.

8.10 Environmental Reporting System

553. The environmental reporting system for the suggested monitoring programme will function at two levels:

554. **Reporting for environmental condition indicators and environmental management indicators.** Reporting for operational performance indicators at the Project level. Environmental monitoring involves of the works. It provides the necessary feedback for the project management to keep the programme on schedule for achieving the expected outcomes.

555. Reporting overall environmental and social monitoring right from project to apex level shall be done in the following order as per ADB's SPS.

556. The Contractor, Authority Engineer shall operate the reporting system for environmental conditions and environmental management indicators. The reporting system is presented in Table 8-12. The reporting schedule for contractors has been prepared, which are on the basis of the implementation of EMP by the Contractor and monitoring by the Authority Engineer/ PMU. The reporting system will start with the Contractor who is the main executor of the implementation EMP activities.

557. The Contractor will report to the Authority Engineer, who in turn will report to the Project management Unit/ESMU. The reporting system will comprise the following:

- The contractor shall submit monthly environmental compliance reports along with formal monthly project progress report to the Authority Engineer.
- The Authority Engineer shall submit separate quarterly environmental monitoring reports to Project Management Unit/ESMU
- Authority Engineer shall be responsible for the preparation of the targets for identified non compliances for the EMP compliance
- Solutions for further effective implementation may also emerge as a result of the external environmental reports.
- Project Management Unit/ESMU will submit the Quarterly Report to ADB for the entire pre-construction and construction period of duration about 24 months and initial operation phase.
- PMU will disclose these report on their website and keep one copy on the report in each office of PMU for the easy access to the community. The language of the report will be English.

558. The photographic records shall be kept to provide useful environmental monitoring tools. All material sources points, disposal locations, plant's locations, camp locations, crusher locations etc. shall be photographed and kept as a record. A full record of construction activities and EMP implementation shall be kept as part of normal contract monitoring system. The Reporting and Monitoring Systems for various stages of construction and related activities have been provided in Table 8-12 for the implementation.

Table 8-12: Environmental Reporting System

Item	Contractor	Construction Supervision by the Authority Engineer		PMU/ESMU	
	Implementation and Reporting to Authority Engineer	Reporting	Reporting to PMU	Oversee Compliance Monitoring	Report to ADB
Pre-Construction Stage					
Sites of camps and Plants	Weekly	Weekly	Monthly	Monthly	Quarterly
Location of borrow area	Weekly	Weekly	Monthly	Monthly	Quarterly
Location of stone quarry	Weekly	Weekly	Monthly	Monthly	Quarterly
Shifting of Community/ Cultural Structures (If Any)	Weekly	Weekly	Monthly	Monthly	Quarterly
Tree cutting and Clearing of Vegetation	Weekly	Weekly	Monthly	Monthly	Monthly
BAP Implementation	Monthly	Monthly	Monthly	Monthly	Semi annual
Construction Stage					
Monitoring of construction site and construction Camp	Regular	Regular	Monthly	Monthly	Quarterly
Establishment of BP/HMP	Monthly	Monthly	Quarterly	Half Yearly	Quarterly
Pollution Monitoring	Six Monthly	As required	In Monthly report	In quarterly report	In quarterly report
Monitoring of Enhancement	Weekly	Weekly	Monthly	Monthly	Quarterly
Top soil Preservations	Weekly	Weekly	Monthly	Monthly	Quarterly

Item	Contractor	Construction Supervision by the Authority Engineer		PMU/ESMU	
	Implementation and Reporting to Authority Engineer	**Reporting**	**Reporting to PMU**	**Oversee Compliance Monitoring**	**Report to ADB**
Borrow area/ quarry area/ debris disposal area	Weekly	Weekly	Monthly	Monthly	Quarterly
Tree Plantation	Monthly	Monthly	Monthly	Monthly	Quarterly
Accident Report	As and when take place	Monthly	Quarterly	Quarterly	Quarterly
BAP Implementation	Monthly	Monthly	Monthly	Monthly	Semi annual
Demobilization of Plants					
Clean-up of plants & camps sites and Restoration of Sites	Monthly	Monthly	Monthly	Monthly	Quarterly
Operation Stage					
Environmental monitoring report till the issuance of ADB's project completion report.	None	Annually	Annually	Annually	Annually
Project Completion Report	At the completion of project	At the completion of project	At the completion of project	At the completion of project	At the completion of project

Capacity Building and its needs

Need for training

To enable the R&BD in integrating the social and environmental issues in its day-to-day operation and in internalizing the environmental and social issues in the existing and future road development projects training is conceived. To achieve this goal, the R&BD, needs training on road development and environment management and the effective implementation of the environmental issues.

Targets of planned training

The training programme will equip the environmental personnel of R&BD, Sikkim to implement and supervise the EMP and expose senior members of the R&BD to environmental and social issues associated with the highway projects. Such a group of senior staff can then be given the responsibility of active dissemination of the culture of environmental/social consciousness and ethics within the rest of the organisation. Further this will also include the ESMU deputed under the project.

Once the environmental staff of R&BD & ESMU have received training and have gained experience through the implementation of the EMP, they should be ready to resume leadership role within the organization in providing training and in implementing future projects. In order to disseminate environmental experience gained by the ESMU, each staff would be required to maintain good records and prepare dissemination notes on specific issues and problems encountered and resolved, and how the experience gained could be integrated in future road projects.

Planned training components

The environmental training aspects of the environmental personnel of R&BD will encompass the following:

Understanding of the relevant environmental regulations and their application to the project.

Environmental management practices in hill roads upgradation and maintenance

Main impacts of the project on the environment.

Mitigation measures as given in the EMP and their implementation through incorporation in the design, construction supervision and monitoring.

Duties and responsibilities of the Contractors, Authority Engineer and the R&BD

Public/community consultation and its role during the implementation of the project.

Liaison with other departments and relevant agencies (such as Forestry).

Supervision of the implementation of the EMP and social issues during construction and operation. Resolution of environmental and social issues and their reporting.

Monitoring during construction and operation.

Weekly, monthly and quarterly report preparations and submission.

Preparation of dissemination notes, holding of workshops, and training of other staff in R&BD.

The training modules to be worked out for the project need to be of relevance to the specific context of the roads in Sikkim focussing on the following issues:

Conservation of biodiversity

Slope stability and vulnerability to landslides

Siting criteria for identification of dumping sites

Harnessing water resources, including rain water harvesting

Concepts of bio-engineering and application of bio-engineering techniques for slope protection

Social management , gender inclusiveness

Labour Management

Session on SEA/SH risks mitigation

Stakeholder engagement

Grievance Redress Mechanism

Any other as per projet's requirement pertaining to E&S monitoring

Training of Contractor's Personnel

The Contractor shall provide appropriate training to relevant Contractor's Personnel on Environmental Social (ES) aspects of the Contract, including appropriate sensitization on prohibition of Sexual Exploitation and Abuse (SEA) and Sexual Harassment (SH), and health and safety training.

As stated in the Specification or as instructed by the Engineer, the Contractor shall also allow appropriate opportunities for the relevant Contractor's Personnel to be trained on ES aspects of the Contract by the Employer's Personnel. rThe Contractor shall provide training on SEA and SH, including its prevention, to any of its personnel who has a role to supervise other Contractor's Personnel.r

8.11 Environmental Management – Budget

559. Table 8-13 presents the total budget provided in the civil works contract and Sikkim R&BD budget to implement the EMP and EMoP. The total cost for implementing EMP is estimated to be about₹147 million. All items distributed further under different heads/source is provided in Table 8-13.

560. The estimated cost may increase considering the inclusion of additional noise barrier and vibration monitoring.

Table 8-13: Environmental Budget for the Contractor

Sl. No.	Corridor Name	Length(km)	Total Project Cost (in Cr)	Environment Mitigation Cost (INR)		
				Mitigation Measures	Pollution Monitoring	Total
1	N9 Mangan Bazaar to DAC		13.53	19,72,996	24,504	19,97,500
2	S1 Melli - Phong via Rateypani	22.65	14.69	47,91,735	92,000	48,83,735
3	S6 Assangthang – Salghari to CCCT Nandugaon	14.79	10.18	28,62,255	58,500	29,20,755
4	E1 Rorathang Rongli	8.90	12.85	18,94,437	49,000	19,43,437
5	E4 Khamdong - Lingzey - Tintek	21.76	13.07	38,60,919	82,500	39,43,419
6	W10 Geyzing to Sakyong	6.12	11.11	10,32,536	49,000	10,81,536
7	Br 04 Bhaley Khola Sirsiray - Kalung Dara	Span 60 M	0.93	-	21,500	21,500
8	Br 06 Ramam River along Nayabazar Singla Road Km 0.0 to 1.0 Ch. 22	Span 100 M	0.38	-	21,500	21,500
9	Br 08 Bridge over Andheri Kholcha along Manpur Fatak to Jorethang Road	Span 60 M	0.33	-	21,500	21,500
10	Total	301.26	77.07	1,64,14,878	4,20,004	1,68,34,882

Table 8-14I: Environmental Budget for R&BD/ PMU

Sl No	Item	Cost
1	Forest Clearance – cost in terms of NPV includes - Compensatory Plantation - Forest land diversion - Maintenance of plants	The NPV is determined by the nodal officer of the forest department, and the cost will be paid by R&BD. The recipient of the cost is forest department.
2	ESMU – Environmental Officer – salary for 36 months	INR 72,00,000
3	Procurement of External Monitor (refer Table No -	INR 12658800
4	BAP (Refer Table No. 6)	INR 8808825
5	Public Consultations (2 consultation per sub-projects @ INR per consultation)	INR 900000
7	Consultation with CSO/ NGO as part of the BAP (3 number of consultations)	INR 150,000
8	Capacity Building (lumpsum cost)	INR 10,00,000
9	Hiring of National Biodiversity Specialist	Cost also included in BAP budget below INR 7,650,000

Table 8-15II: Estimated Budget for implementation and Monitoring of Biodiversity Action Plan

Compensation/ Mitigation measure	Road project	Responsibility	Activity	Units	Unit cost (USD)	Total cost (USD)	Duration
Quantify forest loss and disturbance.	All project roads	ADB and PWRD	evaluate forest loss post construction using commercial satellite imagery, drones, or traditional survey methods.	7 days	$600/day	$4,200	2+ years
	All project roads	PWRD and Contractor	Forest compensation / corridor restoration planning. Stakeholders in State management and policy	2 years	$7,500/ year	$15,000	2 years
	All project roads	External contractor	Survey for nest trees prior to tree clearing, includes field surveys and reporting.	8	315	$2,500	2 years
Chinese pangolin compensation program	BR4, E1, E4, and S1	PWRD and Dept. of Forests and Wildlife	Pangolin rescue and rehabilitation via facility support, training, and providing transport equipment.	3 years	$5,000	$15,000	3 years
	BR4, E1, E4, and S1	Dept. of Forests and Academic partner	Fund *in situ* conservation and research on Chinese pangolins in Sikkim.	3 years	$20,000	$60,000	3 years
	BR4, E1, E4, and S1	PWRD and Dept. of Forests and Wildlife	Support community involvement through awareness and education programs	3 years	$5,000	$15,000	3 years
Support statewide roadkill monitoring by supporting roadkill App development.	All project roads	PWRD through Authority	Customize Roadkill App, provide	1	$8,000	$8,000	5 years

Compensation/ Mitigation measure	Road project	Responsibility	Activity	Units	Unit cost (USD)	Total cost (USD)	Duration
		Engineer (AE) and Contractor (in support from State Wildlife Department/ CSO) and ADB	training, communications, and information dissemination tools				
Refine understanding of uniqueness of herpetofauna occurring along project roads	All project roads	Dept. of Forests and Wildlife NGO	Morphological and genetic identification of potential range restricted and Threatened herpetofauna	3	$10000	$30,000	3 years
Monitor use of biological corridors between Fambong Lho and Maenam WLS.	BR4 and E4	PWRD through Authority Engineer (AE) and Contractor	Camera trapping and wildlife surveys, inclusive of reporting and communications.	3 years	$7,500	$15,000	3 years
Golden mahseer and aquatic biodiversity, Construction stage disturbance	BR-04, BR-06, BR-08	PWRD through Authority Engineer (AE) and Contractor	eDNA monitoring for golden mahseer and reporting	2	1400	$2,800	3 years
	BR-04, BR-06, BR-08	PWRD through Authority Engineer (AE) and Contractor (in support from State Fisheries Department/ CSO)	Participate in development of a conservation management strategy for golden mahseer	1	5000	$5,000	2 years
Revise engineering design to incorporate wildlife friendly structural mitigation plan and recommendations*	All project roads	PWRD through Authority Engineer (AE) and Contractor	Revise engineering design to incorporate wildlife friendly structural	1	NA	NA	Completed

Compensation/ Mitigation measure	Road project	Responsibility	Activity	Units	Unit cost (USD)	Total cost (USD)	Duration
			mitigation plan and recommendations*				
Restore small pipes and water conduit pipes. *	All project roads	PWRD through Authority Engineer (AE) and Contractor	Restore small pipes and water conduit pipes.	140	Unknown	Unknown	Construction phase
Implement Green Infrastructure construction practices and employee training. *	All project roads	PWRD through Authority Engineer (AE) and Contractor					
Engage an Independent National Biodiversity Specialist for Supervision of BAP Implementation	All project roads	PWRD	Supervision of implementation of BAP	1 person	3000	$90,000	1 person with intermittent input for 5 years till the implementation of BAP
Engage an External Monitor on Biodiversity	All project roads	PWRD, AE & Contractor	Engage a Biodiversity External Monitor through	5 years	30000	120,000	5 years
All Biodiversity Safeguards					**Grand Total**	**$382,500**	

*Costs of structural mitigations will be included in the contractors' bill of quantities and civil costs.

*Costs of structural mitigations will be included in the contractors' bill of quantities and civil costs.

Table 8-16: Cost Estimates for External Environmental Monitor

Items	Remarks	Quantity	Units	Rate in INR	Amount in INR	Amount in USD
Remuneration	For each monitoring cycle	54	Working days	25,000	1350000	15402.17
Per-diem allowance	For each monitoring cycle	18	Calaneder days	2,500	45000	513.41
Air Travel	For each monitoring cycle	2	Round Trips	20,000	40,000	456.36
Land Transport	For each monitoring cycle	9	days	8000	72,000	821.45
Sub Total					1,507,000	17193.39
Contingency of 5% of total cost					75350	859.67
Total for each bi-annual monitoring					1582350	USD 18053.06
Total number of estimated monitoring is 6 numbers (4 monitoring in construction stage and 2 monitoring in operation stage)					9,494,100	USD 108,318.36

Table 8-17: EMP Items Considered Under Different Heads/source

Sl. No.	Description	Source
1	Environmental Monitoring for air, water, noise and soil during construction and operation phase as per EMOP	Included as EMP Implementation Cost (Contractor's Quote)
2	Avoiding dust suppression in haul roads and material storage location (₹2,000 per tanker; 4 tankers a day for 240 days)	Included in Civil Items
3	Providing solid waste management facility in construction camp (dustbins, transportation, compost pit, inoculum etc.)	Included in Civil cost
4	Providing Training to officials and workers of Contactors	Authority Engineer Cost
5	Tree Plantation in the ratio 1:2 with respect to trees cut with 5yrs maintenance	Included under Road Arboriculture cost (Contractor's Quote)
6	Tree cutting	Included in Civil cost
7	Additional Roadside Plantation (Arboriculture)	Included in civil cost
8	Rainwater Harvesting structures	Included in civil cost
9	Signages for safety near sensitive locations, built up sections and forest sections	Included in civil cost
10	Noise barriers for sensitive locations	Contingencies as per Requirement
11	Forest diversion for acquisition of Forest Land	Sikkim Roads and Bridges Department
12	Cost for Climate resilience and protection work	Included in civil cost

561. The environmental budget for the various environmental management measures provided for construction and operation of the project road is detailed in Table 11-12. There are several other environmental issues that have been addressed as part of good engineering practices, the costs for which have been accounted for in the engineering cost. In the given the road wise number of samples during the construction and operation phase.

Table 8-18: Number of samples

Monitoring	N 9	S 1	S 6	E 1	E 4	W 10	Br 04	Br 06	Br 08
No. of Monitoring Stations									
Air	1	4	3	2	3	2	1	1	1
Noise Monitoring	1	4	3	2	3	2	1	1	1
Water Quality Monitoring (GW)	1	3	2	2	3	2	-	-	-
Surface water quality Monitoring	1	3	2	2	3	2	2	2	2
Soil Quality Monitoring	1	3	2	2	3	2	-	-	-

562. Budget of Vegetative Noise Barrier of all six roads are provided in Table No 8-17.

Table 8-19: Budget of Plantation Vegetative Noise Barrier

Plantation of Grass, Shrubs and Trees for Noise Attenuation	Rate	Cost
Land development, grass turfing, labour and transportation	lumpsum @INR 200/sq meter	340,000
Plantation of dense shrub for noise barrer	lumpsum @ 2000/sq meter	3,400,000

Plantation of coniferous trees	lumpsum cost of INR 2000/trees	1,700,000
Total Cost of plantation		**5,440,000**

563. The estimated maintenance budget of vegetative noise barrier is provided in Table No 8-18

Table 8-20: Budget of Maintenance of Vegetative Noise Barrier

Annual Maintenance cost	**Rate**	**Cost**
Grass	lumpsum INR 90 /sq meter	153,000
Shrubs	lumpsum INR 200/sq metrer	340,000
Trees	lumpsum INR 450/trees	255,000
Annual Maintenance cost		**748,000**

Table 8-21: EMP Budget

Particulars	Unit Cost	E1	E 4	S1	S6	N9	W10	Bridge 04	Bridge 06	Bridge 08
		8.90 km	**21.76 km**	**22.65 km**	**14.79 km**	**2.10 km**	**6.12km**	**60 m span**	**100 m span**	**60 m span**
Air quality Monitoring	9,500	171,000	85,500	342,000	256,500	85,500	171,000	85,500	85,500	85,500
Noise Monitoring	1,000	18,000	22,500	67,500	67,500	22,500	45,000	9,000	9,000	9,000
Surface Water Quality Monitoring	7,500	135,000	67,500	202,500	270,000	67,500	135,000	135,000	135,000	135,000
Ground Water Quality Monitoring	7,500	135,000	67,500	202,500	202,500	67,500	135,000	67,500	67,500	67,500
Soil Quality Monitoring	6,000	108,000	54,000	162,000	108,000	54,000	108,000	54,000	54,000	54,000
Travel and Transportation of Monitoring team (Lump sum Amount)	100,000	100,000	50,000	100,000	100,000	50,000	50,,000	100,000	100,000	100,000
Noise barrier	40,000	160,020	320,000	320,000	320,000	320,000	320,000			
Silt fencing total	600 rm	180,000						1,200,000	1,200,000	1,200,000
Sanitation at construction camp (LS)	100,000	200,000	500,000	500,000	500,000	500,000	500,000	500,000	500,000	500,000
Sub Total		**1,207,020**	**1,167,000**	**1,896,500**	**1,824,500**	**1,167,000**	**1,464,000**	**2,151,000**	**2,151,000**	**2,151,000**
Afforestation Cost										
Compensatory Plantation @1500 INR/per tree (10 times of the number of affected trees) for trees existing on Revenue Land (including PWD Land) -540 nos of impacted trees	1500	8,100,000	33,375,000	24,525,000	8,985,000	150,000	11,070,000	600,000	15,0000	150,000
Net Present Value for affected forest land Ha., (eco class VI as per Hon'ble Supreme Court Order dated 28.03.2008- 0.18 ha	897,000**	116,610	35,880	167,739	0	0	0	8970	107640	8970
Total Cost (Forest & tree approval)		**8,216,610**	**33,410,880**	**24,692,739**	**8,985,000**	**150,000**	**11,070,000**	**608,970**	**257,640**	**158,970**
Cost for operation phase										
Air quality Monitoring	9,500	114,000	57,000	228,000	171,000	57,000	114,000	57,000	57,000	57,000
Noise Monitoring	1,000	12,000	15,000	45,000	45,000	15,000	30,000	6,000	6,000	6,000
Surface Water Quality Monitoring	7,500	90,000	45,000	135,000	180,000	45,000	90,000	90,000	90,000	90,000

Particulars	Unit Cost	E1	E 4	S1	S6	N9	W10	Bridge 04	Bridge 06	Bridge 08
		8.90 km	**21.76 km**	**22.65 km**	**14.79 km**	**2.10 km**	**6.12km**	**60 m span**	**100 m span**	**60 m span**
Ground Water Quality Monitoring	7,500	90,000	45,000	135,000	135,000	45,000	90,000	45,000	45,000	45,000
Soil Quality Monitoring	6,000	72,000	36,000	108,000	72,000	36,000	72,000	36,000	36,000	36,000
Training & orientation (at site level workshop, contractor level)	50,000	50,000	100,000	100,000	100,000	100,000	100,000			
Training at PMU and ESMU level (two time in total project period) including construction & operation	200,000									
Travel and Transportation of Monitoring team (Lump sum Amount)	50,000	50,000	50000	100,000	100,000	50,000	50,000	100,000	100,000	100,000
Dust suppression in haul roads and material storage location	Lum sump	150,000	150000	150,000	150,000	150,000	150,000	150,000	150,000	150,000
Cost for operation phase		**628,000**	**498,000**	**1,001,000**	**953,000**	**498,000**	**696,000**	**484,000**	**484,000**	**484,000**
Total Cost		10,051,630	35,075,880	27,590,239	11,762,500	1,815,000	13,230,000	3,243,970	2,892,640	2,793,970
Contingency 5%		502,581.5	1,753,794	1,379,511.95	588,125	90,750	661,500	162,198.5	144,632	139,698.5
Sub Total Cost,		10,554,212	36,829,674	28,969,751	12,350,625	1,905,750	13,891,500	3,406,169	3,037,272	2,933,669
Total EMP Budget										**113,878,620**

8.12 Consolidated Environmental Management Plan for the Roads and Bridges

564. The consolidated Environmental Management Plan for the Roads and Bridges has been provided in Table No Table 8-22

Table 8-22: Consolidated Environmental Management Plan for the Project Roads and Bridges

S.No	Environmental Issues	Environmental Mitigation Measures	Sub-project/ Location		Responsibilities	
				Reference	Planning & Execution	Supervision/ Monitoring
A	**Preconstruction stage**					
A 1i	Forest Clearance for diversion of Forest Land and Wildlife permission.	Submit application of forest clearance based on the joint varificaiton data of forest land. The estimated area of forest land in DPR is 1.28 ha.	E1, E4, Br 04, Br 06, Br 08, S1, S6, W10	Forest Conservation Act, 1980	PMU	R&BD Sikkim
A 1ii	Tree Cutting	Trees are likely to be felled for bridge construction/ upgradation. Prior permission shall be obtained for cutting trees. Tree felling approval from forest department. Trees impacted as per the bridge alignment and those growing within the designed toe line (bottom of formation) will need to be removed.	E1, E4, Br 04, Br 06, Br 08, S1, S6, N9, W10	FCA 1980 & Sikkim Private and Other Non-Forest Lands Tree Felling Rules 2006	Contractor	Authority Engineer/ ESMU
A 2i	Loss of fauna	A thorough pre-inspection should be conducted, involving collaboration with professional bird and wildlife experts. Their role will be to identify and flag any nest trees. In some limited situations they may safely capture and relocate wildlife present at the site to a nearby suitable and secure environment. This proactive measure will minimize the risk to both the animal population and human personnel, ensuring a balanced approach to site development while maintaining ecological integrity.	Corridor of Impact area	Wildlife (Protection) Act, 1972; State rules for wildlife protection	Contractor	Authority Engineer

S.No	Environmental Issues	Environmental Mitigation Measures	Sub-project/ Location		Responsibilities	
				Reference	Planning & Execution	Supervision/ Monitoring
		Records of surveyed and rescued animals shall be maintained by a dedicated Environmental expert of the Contractor.				
A2ii	Impacts to critical habitats	Measures to achieve NNL and NG of biodiversity values that triggered the critical habitat for Chinese pangolin and Golden mahseer must be implemented. These involve development of metrics to monitor use and survival within the critical habitat areas. The progress towards the NNL/NG targets must be monitored regularly.	EAAAs designated as critical habitats	IFC PS 6	PMU, Contractor	Authority Engineer/ ESMU
A 3	Loss of land and properties	Conduct surveys and provide compensation as per the Resettlement Action Plan.	Br 04, Br 06, Br 08, E1, E4, S1, S6, W10	Respective RAP	PMU	PMU
A 4	Temporary diversion	Provide 'Diversion Ahead' boards at 50m, 100m, and 150m ahead of diversions with reflective tape for illumination at night at all diverted locations.			Contractor	PMU/ Authority Engineer
A 5	Noise barriers for sensitive locations	Adequate barricading and safety measures shall be provided and ensured to protect from dust pollution and noise impacts on sensitive receptors like schools and religious places etc., due to vehicle movement prior to the start of work and their effectiveness shall be checked during construction.		The Noise Pollution (Regulation and Control) Rules, 2000; WHO guideline for Noise rules 2002; MoST 111.13; MoST 111.1; MoST 111.6	Contractor	Authority Engineer/ ESMU

S.No	Environmental Issues	Environmental Mitigation Measures	Sub-project/ Location		Responsibilities	
				Reference	Planning & Execution	Supervision/ Monitoring
A 6	Pedestrian and Vehicular Traffic Movement Management	Detailed traffic control plans shall be prepared and submitted to the PIU for approval one week prior to commencement of works. The traffic control plans shall contain details of temporary diversion, details of arrangements for construction (road stretches, timing and phases). Construction itinerary shall be provided in advance so that the road users can use alternative routes.	All along the Project Corridor	MORT&H" Clause 112.4 Refer Guidelines-: Generic guidelines for environment friendly Construction methodology, Section – 5 & 6.	Contractor	Authority Engineer
A 7	Joint Field Verification	ESMU and Contractor will carry out joint field verification of the EMP. The efficacy of the mitigation/ enhancement measures suggested in the EMP will be checked.	All locations where mitigation/enhancement/ monitoring measures are provided for the implementation	EMP and Contract Document	Contractor, ESMU, Authority Engineer	ESMU and Authority Engineer
A 8	Modification of the Contract Documents	ESMU will propose modification/inclusion of the EMP and Contract documents if required.	All locations where changes in mitigation/enhancement/ monitoring measures are felt necessary	EMP and Contract Document	Contractor, ESMU, Authority Engineer	ESMU and Authority Engineer
A 9	Consent to Establish	Consent must be obtained from relevant authorities before construction begins.	Entire project		Contractor	Authority Engineer
A 10	Orientation of implementation agencies	Organize orientation sessions, including on-site training sessions for project staff and contractors.	Training sessions at PMU and contractors convenience location.	EMP, RAP	PMU	Authority Engineer/ ESMU

S.No	Environmental Issues	Environmental Mitigation Measures	Sub-project/ Location		Responsibilities	
				Reference	Planning & Execution	Supervision/ Monitoring
A 11	Procurement of Machinery, Crushers, Batching Plants etc	Comply with emission control legislations. Select suitable locations for plants.	Suitable locations for plants, as identified and provided by the contractor.	Water (Prevention and Control of Pollution) Act, 1974 + Air (Prevention and Control of Pollution) Act, 1981; Contract, MoRTH: 111.1, 121.2	Contractor	Authority Engineer
A 12	Replacement of Common Property Resources (CPRs)	Evaluate impact on CPR; provide alternate access; compensate as per guidelines.	E1, E4, S1, S6, N9, W10		Contractor	Authority Engineer
A 13	Construction Camp Locations - Selection, Design & Layout	Select camp locations to avoid inconvenience to local population; provide basic amenities and sanitation facilities.	Should be finalized by the contractor and submitted to the PMU.	Relevant labor laws; Camp management guidelines	Contractor	Authority Engineer
A 14	Arrangement for Construction water	To avoid disruption to other water users, the contractor shall extract water from designated locations only after consulting local stakeholders. Groundwater extraction is permitted only if surface water sources are unavailable and must be authorized by relevant authorities. Records and permits should be maintained according to guidelines regulating water extraction.	Sourcing should be from Surface water bodies in the project area. Boring of any tube wells shall be drilled only after obtaining necessary permission from Central Ground Water Authority.	Guidelines to regulate and control ground water extraction in India (24-Sep-2020 & amendment)	Contractor	Authority Engineer

S.No	Environmental Issues	Environmental Mitigation Measures	Sub-project/ Location		Responsibilities	
				Reference	Planning & Execution	Supervision/ Monitoring
A 15	Sand (all riverbeds used directly or indirectly for the project)	Procurement of sand and other materials shall be from approved sources. If sourcing from third parties, valid lease agreements must be submitted before procurement. Environmental clearances must be obtained if new quarries or borrow areas are opened for the project.	If the contractor is intended to open a new quarry then EC for stone quarry and borrow area shall be obtained from DEIAA/SEIAA	Vendor should have prior approval for sand mining under Amended EIA notification dated 15th January, 2016. S.O 141 (E)	Contractor	Authority Engineer
A 16	Stockyard/ Storage of Construction Materials	The contractor, in consultation with project authorities, shall identify suitable sites for storage that do not inconvenience local populations or traffic. Sites must be selected based on environmental considerations, including stormwater management and health and safety regulations. Proper storage practices, training, and awareness programs must be carried out to mitigate risks associated with hazardous substances.	Stockyard location	MoRTH: 111.1	Contractor	Authority Engineer
A17i	Labour related licenses	i. Labour licence ii. BOCW Licence iii. Workmen Compensation Insurance		Factory Act, 1948; The Building and other Construction Workers' (Regulation of Employment and Conditions of Service) Act, 1996	Contractor	Authority Engineer

S.No	Environmental Issues	Environmental Mitigation Measures	Sub-project/ Location		Responsibilities	
				Reference	Planning & Execution	Supervision/ Monitoring
A 17ii	Labor Requirements	Contractors shall prioritize hiring unskilled/semi-skilled labour locally to benefit the community and reduce stress on local facilities. All labour regulations must be followed, and necessary facilities provided under applicable labor laws. The contractor shall oversee sub-contract labor management and ensure compliance with safety standards.	Project site	The Building and other Construction Workers' (Regulation of Employment and Conditions of Service) Act, 1996., Factory Act 1948	Contractor	Authority Engineer
A 18	Information Dissemination and Communication Activities	Inform local community about traffic route diversions and pedestrian access arrangements.	All along the project site/ road	MoRTH Clause 112.4; Generic guidelines for environment-friendly construction methodology	Contractor	Authority Engineer
A 19	Fly ash	Fly ash from thermal power plants must be utilized if such plants are located within a 300 km radius of the project site. Utilize fly ash from nearby thermal power plants where feasible.	Identified Power Plants include - Farakka Super Thermal Power Station (West Bengal), Nabinagar Super Critical Thermal Power Project (Bihar), Meja Thermal Power Station (West Bengal), Kahalgaon Super Thermal Power Station (Bihar), Barh Super Thermal Power Station (Bihar), and Bhartiya Rail Bijilee Company Limited (BRBCL) (Bihar).	MoEF&CC Notification of January 25, 2016	Contractor	Authority Engineer

S.No	Environmental Issues	Environmental Mitigation Measures	Sub-project/ Location		Responsibilities	
				Reference	Planning & Execution	Supervision/ Monitoring
	Natural Hazards and Climate Change risks					
A 20	Damage to pavement integrity like Rutting, embrittlement, softening and migration of liquid asphalt. Thermal expansion in bridge expansion joints and paved surfaces	Asphalt binder specifications based on viscosity-grade specifications as per IS 73-2013 guidelines and IS 15462 2004 for rubber modified binder and polymer modified binders.	All along the project road and Bridge Structure.	IRC:37-2018,	Contractor	Authority Engineer
A 21	Earthquake	Relevant IS codes shall be adopted in designing the structures to sustain the magnitude of earthquake corresponding to Seismic zone of the project area.		The road and bridge design shall follow (IS: 1893-Part 1, 2016 and IS: 1893-Part 3, 2014). The other codes for reference are (a) IRC 6: 2000, (b) IRC 112: 2011 and (c) IRC 78: 2014, that will also be followed	Contractor	Authority Engineer
A 22	Land slides	Slope of the hill side cut shall be as per guideline in those suggested for bioengineering, turfing and engineering protection measures.	E1, E4, S1, S6, W10	Design Report, DPR	Contractor	Authority Engineer
A23	Relocation of cultural resources and impacts on the access to the cultural resources	Before start of the construction, a consultation with the community will be organised to inform and get the consent of the local community. The relocation of the cultural assets present with the right of way will be done in consultation with the local community.	E4, S1, N9, W10 and all roads crossing the rivers/ Streams.	EIA	Contractor	Authority Engineer

S.No	Environmental Issues	Environmental Mitigation Measures	Sub-project/ Location		Responsibilities	
				Reference	Planning & Execution	Supervision/ Monitoring
		The impacts on the access to the culrural resources will be identified and it will be informed to the community.				
A24	i. Consultation with Civil Society organisation (CSO)/ NGOs working in the biodiversity in Sikkim specifically for Chinese Pangolin as part of BAP ii. Consultation with community	Pre-project consultation with the CSO/NGO on biodiversity specifically the Pangolin as part of BAP. Community consultation as par the EIA/EMP. A neutral location for the consultation will be selected for maximum participation and time will be selected for the local suitability and maximum participation	All projects	BAP/CHA EIA	ESMU environmental officer along with biodiversity team	Authority Engineer
A25	Disclosure of EIA in English and Executive Summary in English, Nepalese, Sikkimese (Bhutia) and Lepcha as per Table 6.15 of Section 6.5	Disclosure on the website.	On R&B Website	Disclosure plan as per Table 6.15 of Section 6.5	R&BD, Sikkim	Authority Engineer
A26	Cultural Events – Festivals and cultural events of Bhutia and Lepcha like Losoong, TendonMuk zek Ding etc	The schedule of the local festival will be identified, and construction work will be scheduled to avoid any conflict.	All Project	EIA	Contractor	Authority Engineer
B	**Construction Stage**					

S.No	Environmental Issues	Environmental Mitigation Measures	Sub-project/ Location		Responsibilities	
				Reference	Planning & Execution	Supervision/ Monitoring
B 1	Safety of the workers	Helmets, Safety-Shoes, Goggles, Dusk mask. Etc. Periodical site monitoring shall be carried out by an Environmental Expert of ESMU for surveillance & monitoring of road safety during the road construction.	Labour camp and construction site	The Building and other Construction Workers' Act, 1996., Factory Act 1948	Contractor	Authority Engineer
B 2	Site Clearance (Clearing and Grubbing)	Remove vegetation from the construction zone only if required.	Bridge location, approach road ROW and within proposed ROW	Design MoRTH 201 111.15.1, Sub clause 111.15.4	Contractor	Authority Engineer
B 3	Dismantling of Culverts/Bridge Work	During the dismantling of culverts and bridge work, all necessary measures should be taken to prevent earthwork, stonework, and materials from impeding cross-drainage at streams, water canals, and existing irrigation and drainage systems.	At locations were bridge works and culverts are provided.	MoRTH 202.2, C&D Rule 2016 and its further amendment thereafter	Contractor	Authority Engineer
B 4	Stripping and Stocking of Topsoil	Strip topsoil to a depth of 150 mm and store in stockpiles, covering and protecting it from erosion. Utilize topsoil for covering disturbed areas and slopes.	Throughout Project site and corridor, where clearing and grubbing shall be carried out.	MoRTH 301.3.2; MoRTH 305.3.3	Contractor	Environmental Specialist of ESMU
B 5	Procurement and Management of Construction Materials	No borrow area should be opened without permission. Borrowing operations should follow guidelines. Rehabilitation of borrow areas should follow the approved redevelopment plan. Quarries and crushers should operate with necessary consents from regulatory authorities, and the contractor should submit quarry approval applications along with permissions obtained.	Project site	MoRTH Clause 111.2; IRC 36: 2010; MoRTH Clause 305.2.2.2; MoRTH 111.3	Contractor	Environmental Specialist of ESMU

S.No	Environmental Issues	Environmental Mitigation Measures	Sub-project/ Location		Responsibilities	
				Reference	Planning & Execution	Supervision/ Monitoring
B 6	Generation and Disposal of Debris	Debris generated from hill cut sections and existing road dismantling should be reused in the construction work, with appropriate reuse and disposal methods, including filling borrow areas with approval.	Project site	Construction & Demolition Rule 2016	Contractor	Environmental Expert of ESMU
B 7	Occupational Health and Safety of Workers	Comply with EHS Guidelines; develop OHS Plan; regular training to workers; maintain records.	Labour camp and construction site	EHS Guidelines, World Bank Group; statutory norms of construction safety	Contractor	Authority Engineer
B 8	Accessibility	Provide safe passage for vehicles, pedestrians, and livestock from roadsides and property accesses connected to the project road by providing temporary connecting roads.	All along the project corridor	MoRTH 112.1; MoRTH 112.4; MoRTH 112.2; MoRTH 112.5	Contractor	Authority Engineer
B 9	Potable Water	i. Assessment of Water Quality: • Any water source chosen complies with the drinking water standards set by local health authorities and agencies. • Regular testing of the water for contaminants, including microbial, chemical, and physical impurities. ii. Sustainable Water Practices: • Approved sources that have a proven and reliable supply of water, avoiding over-extraction that would deplete the natural source. • Implementing water-saving technologies and practices within the camp to minimize wastage. iii. Community Collaboration: • Working collaboratively with local communities and authorities to manage and monitor the water sources sustainably.	Construction camp, working sites, quarry, crusher etc. locations	IS 10,500 (2012); BOCW 2006	Contractor	Authority Engineer

S.No	Environmental Issues	Environmental Mitigation Measures	Sub-project/ Location		Responsibilities	
				Reference	Planning & Execution	Supervision/ Monitoring
		• Ensuring that the use of these water sources does not negatively impact the local community's access to water. iv. Alternative Water Sources: • Identifying and investing in alternative sources of water such as rainwater harvesting and recycled greywater systems to reduce dependence on primary sources. v. Infrastructure and Maintenance: • Develop infrastructure that supports sustainable water use, such as efficient leak-proof pipelines and storage tanks. • Regularly maintain water extraction and storage equipment to prevent wastage and contamination. vi. Education and Training: • Educating and training of labour camp residents on the importance of water conservation and sustainable practices. • Promoting measures like using water responsibly and reporting any leaks or issues promptly.				
B 10	Traffic Diversions and Detours	Construct temporary diversions with approval. Prepare and maintain detailed traffic control plans, ensuring dust control and community communication.	Project site	MoRTH 112.1; MoRTH 112.4; MoRTH 112.2; MoRTH 112.5	Contractor	Environmental Specialist of ESMU
B 11	Blasting Operations	Conduct blasting during fixed hours with danger signals displayed, handled by experienced personnel with necessary permissions.	All blasting and Pre-splitting Sites.	MoRTH Clause 302	Contractor	ESMU
B 12	Loss of Damage to Vegetation	Vegetation should be removed from the construction zone before commencement. Damage to flora not identified for cutting	Project site	Indian Forest Act 1927; Forest (Conservation)	Contractor	Authority Engineer

S.No	Environmental Issues	Environmental Mitigation Measures	Sub-project/ Location		Responsibilities	
				Reference	Planning & Execution	Supervision/ Monitoring
		should be minimized. Ground cover/shrubs impinging on works should only be removed with prior approval. No debris/waste should be disposed within the forest area, and tree cutting beyond diverted forest land is not allowed.		Act 1980; Forest (Conservation) Rules; Sikkim Private and Other Non-Forest Lands Tree Felling Rules, 2006		
B 13	Damage to forest	Contractors should submit an Environmental Management Action Plan and follow approved measures. Permission from the Forest & Wildlife Department is necessary for movement in reserved forest areas. Extracting earth materials from forest areas is prohibited. Camps and stockyards must maintain a 1 km distance from reserved forest boundaries. Construction should be limited to daytime hours. Bitumen mixing should be outside forest areas to prevent fire risks. Mother trees and heritage trees should not be felled or disturbed.	Project site	Indian Forest Act 1927; Forest (Conservation) Act 1980; Forest (Conservation) Rules; Van (Sanrakshan Evam Samvardhan) Rule 2023; Sikkim Private and Other Non-Forest Lands Tree Felling Rules, 2006	Contractor	Authority Engineer
B 14	Loss, Damage or Disruption to Wild Animals	Precautionary measures should minimize disruption to fauna during construction. Hunting and unauthorized fishing should be prohibited. Sensitize workers to protect natural resources and fauna; avoid disruption to wild animals; adhere to Wildlife Protection Act and state rules. Illegal poaching prevention measures should be enforced. Wildlife incidents should be reported and include a chance find reporting tool. The workforce should be oriented not to feed monkeys and to calmly walk away if wild animals are sighted.	Project site	Wildlife Protection Act 1972; Sikkim Private and Other Non-Forest Lands Tree Felling Rules, 2006	Contractor	Authority Engineer

S.No	Environmental Issues	Environmental Mitigation Measures	Sub-project/ Location		Responsibilities	
				Reference	Planning & Execution	Supervision/ Monitoring
B 15	Air Pollution	Ambient Air Quality Monitoring based on identified locations (carbon monoxide, particulate matter, etc.). Reports to be generated periodically and submitted to ESMU. Dust suppression using water tankers. Machinery should meet pollution control norms.	Project site	MoEF&CC/CPCB /Sikkim Pollution Control Board	Contractor	Authority Engineer
B 16	Water Pollution from Construction Wastes	The contractor shall take all precautionary measures to prevent entering of wastewater into streams, water bodies or the irrigation system during construction. Contractor will avoid construction works close to the Streams or water bodies during monsoon. Contractor shall not wash his vehicles in river water and enter riverbed for that purpose. Any type of construction wastes shall not be disposed in rivers or water bodies.	Project road and project bridge locations	The Honorable National Green Tribunal Eastern Zone Bench Kolkata O.A. 26/2023/EZ	Contractor	Authority Engineer
B 17	Silt fencing	The Contractor shall construct silt fencing at the base of the embankment construction for the entire perimeter of any water body (including wells) adjacent to the project road and around the stockpiles at the construction sites including ancillary sites close to water bodies. The fencing shall be provided prior to commencement of earthwork and continue till the stabilization of the embankment slopes on the particular sub-section of the road. Contractor shall ensure that construction materials containing fine particles are stored in an enclosure such that sediment-laden water does not drain into nearby watercourse.	Project site	All discharge standards promulgated under Environmental Protection Act, 1986	Contractor	Authority Engineer

S.No	Environmental Issues	Environmental Mitigation Measures	Sub-project/ Location		Responsibilities	
				Reference	Planning & Execution	Supervision/ Monitoring
B 18	Drainage and Flood Control	The Contractor shall ensure that no construction materials/debris shall block the water flow or create water lodging at the work site. The Contractor shall take remedies to remove accumulated water (if any) from the construction sites, camp sites, storage yard, excavated areas, etc. Construction works shall be planned well in advance prior to on-set of monsoons to avoid water-pool besides providing temporary cross drainage systems. The contractor shall take all adequate precautions to ensure that construction materials and excavated materials are enclosed in such a manner that erosion or runoff of sediments is controlled.	Project site	MoRTH Clause CLAUSE 111 201.4, 202.5; In the Hon'ble National Green Tribunal Eastern Zone Bench, Kolkata O.A. No. 26/2023/EZ	Contractor	Authority Engineer
B 19	Emission from Construction Vehicles, Equipment and Machineries	The contractor shall ensure that all vehicles, equipment and machinery used for construction works are regularly maintained and conform that pollution emission levels comply with the requirements of CPCB and/Motor Vehicles Rules. The contractor shall submit Pollution under Control (PUC) certificates for all vehicles used in the project. DG set shall be provided with chimney of adequate height as per CPCB guidelines (Height of stack in meter = Height of the building + 0.2 $\sqrt{}$KVA). The environmental monitoring shall be conducted as per the monitoring Plan.	Project Site	MoRTH Clause 111, Air (Prevention and Control of Pollution) Act, 1981	Contractor	Authority Engineer
B 20	Noise Pollution from Construction Vehicles and Equipment	Use of equipment conforming to noise standards. Maintenance of vehicles and machinery. DG sets to have acoustic enclosures. Vehicles fitted with mufflers. Regular maintenance and servicing.	Project Site	Air (Prevention and Control of Pollution) Act, 1981 MoEF&CC/CPCB /Sikkim Pollution	Contractor	Authority Engineer

S.No	Environmental Issues	Environmental Mitigation Measures	Sub-project/ Location		Responsibilities	
				Reference	Planning & Execution	Supervision/ Monitoring
				Control Board noise standards		
B 21	Chance Finding of Archaeological Property	Fossils, coins, and articles of antiquity discovered should be considered Government property and handled per relevant legislation. Contractors should prevent damage and notify the PIU upon discovery. Work should stop until direction from the Archaeological Survey of India is received.	Project site, no ASI Monument in the indirect influence area at 5 km radius		Contractor	Authority Engineer
B 22	Impacts on Cultural Properties	Necessary measures should minimize impacts on cultural properties. Relocation and enhancement should follow design and local community consultations. Access to these properties should be maintained clear and clean.	Project site		Contractor	Authority Engineer
B 23	Labour camp and Project site management	Engage local labour force. Provide resources to migrant labourers to avoid pressure on social infrastructure. Labour camps should have proper project information boards, electrical safety measures, and maintained housekeeping.	Labour camp	BOCW Act, 1996 The Contract Labour (Regulation & Abolition) Act, 1970 Factory Act 1948	Contractor	Authority Engineer
B 24	Labour Influx	Educate labour contractors on labour laws and management through IEC process.	Labour Camp	Labour Management Plan	Contractor	Authority Engineer
B 25	Burning of wastes	Burning of wastes at construction sites and camps not allowed. Segregated waste collection and appropriate disposal.	Labour Camp	ILO- Safety and health in construction, Factory Act 1948, BOCW 2006, Water Act 1974, Solid Waste	Contractor	Authority Engineer

S.No	Environmental Issues	Environmental Mitigation Measures	Sub-project/ Location		Responsibilities	
				Reference	Planning & Execution	Supervision/ Monitoring
				Management Rules 2016		
B 26	Environmental Monitoring Construction Stage	Monitoring of ambient air quality, noise levels, and water quality.	Project sites near sensitive receptors, Construction Camp, Crusher plant etc..	MoEF&CC/CPCB /Sikkim Pollution Control Board	Contractor	Authority Engineer
B 27	Compensatory Plantation	Loss of trees should be compensated by planting at a 1:2 ratio or greater. Regular monitoring of plantation along the project road should be conducted. Suitable species such as Silver Oak, Ashoka tree, Dhupi, and others should be used for compensatory afforestation.	Project site	FCA 1980; Indian Forest Act 1927; Sikkim Private and Other Non-Forest Lands Tree Felling Rules, 2006; State Compensatory Afforestation Fund Act, 2016	Contractor	Authority Engineer
B28	i. Consultation with Civil Society organisation (CSO)/ NGOs working in the biodiversity in Sikkim specifically for Chinese Pangolin as part of BAP ii. Consultation with community	Pre-project consultation with the CSO/NGO on biodiversity specifically the Pangolin as part of BAP. Community consultation as par the EIA/EMP. A neutral location for the consultation will be selected for maximum participation and time will be selected for the local suitability and maximum participation	All projects	BAP/CHA EIA	ESMU environmental officer along with biodiversity team	Authority Engineer
B29	i. Temporary arrangement of water supply during relocation of water supply pipelines.	Temporary Measures During Construction to ensure uninterrupted access to drinking water and water resources for affected households and farms during construction, the following temporary measures will be implemented: • Temporary water supply arrangements will be established in areas where access may be disrupted. This includes using private	All Projects	EIA and BAP	Contractor	Authority Engineer

S.No	Environmental Issues	Environmental Mitigation Measures	Sub-project/ Location		Responsibilities	
				Reference	Planning & Execution	Supervision/ Monitoring
		water tankers to supply water to households and farms when necessary. • The contractor will coordinate with local communities to identify critical water points prior to commencement of construction activities. This will help in planning the preservation of access during the construction phase. • Surface flow shall be diverted or construction activities will be isolated from the surface flow in a manner acceptable to PMU to mitigate direct impacts on water resources. Contractor Requirements: • Provide Temporary Water Supply: The contractor is required to provide temporary water supply arrangements in areas where access is disrupted. This ensures households and farms have continuous access to water. • Coordinate with Local Communities: Coordination with local communities is essential to identify critical water points prior to construction. Consent for usage of water needs to be taken in writing from Village Council Presidents to address local water sources. • Monitor and Report Water Access Conditions: The contractor will monitor and report on water access conditions throughout the construction phase. Regular assessments will be conducted to				

S.No	Environmental Issues	Environmental Mitigation Measures	Sub-project/ Location		Responsibilities	
				Reference	Planning & Execution	Supervision/ Monitoring
		ensure there are no disruptions and that mitigation measures are effective. Community Communication Protocol: • To mitigate potential disruptions, a community communication protocol will be established, including: • Informing residents in advance of any temporary disruptions and available alternatives. • Conducting community participation and engagement programs for constant guidance. • Providing upfront information on potentially detrimental impacts on local communities.				
A30	Disclosure of internal and external environmental monitoring reports as per Table 6-19 of Section 6.5	Disclosure on the website.	On R&B Website	Disclosure plan as per Table 6.15 of Section 6.5	PMU	PMU/ Authority Engineer
C	**Demobilisation Stage**					
C 1	Clean-up Operations, Restoration, and Rehabilitation	The contractor shall prepare project and labour camp site restoration plan, which shall be approved by the ESMU / Environmental Expert. The clean-up and site restoration operations are to be implemented by the contractor prior to demobilization from construction site and labour camp. The contractor shall clear all temporary structures, debris, construction wastes, garbage, night soils, etc. in an environmentally sound manner. All disposal pits or trenches shall be filled in and effectively sealed off.	Project site, All construction camp, sites	Forest Department and PMU	Contractor	Environmental Specialist of Authority Engineer/ PMU

S.No	Environmental Issues	Environmental Mitigation Measures	Sub-project/ Location		Responsibilities	
				Reference	Planning & Execution	Supervision/ Monitoring
C 2	Demobilization of Camps and Plant	Demobilization of camps and plant on completion of works. Clean-up and restoration of the site. All construction places including camp and any other area used/affected due to the project operations shall be left clean and tidy at the contractor's expense to the entire satisfaction of the PMU.	Project site, All construction camp, sites		Contractor	Authority Engineer
C 3	Land Rehabilitation	Hardened surfaces due to construction activities should be ripped and imported materials removed. Rubbles should be removed to approved disposal sites; burying rubble on site is prohibited. Surfaces should be checked for waste products from activities like concreting or asphalting and cleared as approved by the Engineer. Embankments should be trimmed, shaped, and replanted to the satisfaction of PMU.	Project site	MoRTH: 111.2	Contractor	Authority Engineer
D	**Post Construction stage**					
D 1	Environment Monitoring Post Construction stage	Post-construction environmental monitoring for ambient air quality, noise levels, and water quality should be carried out as per the environmental monitoring plan and instructions from the Environmental Specialist of PMU.	Near Sensitive receptors	EMP	PMU	PMU/ Authority Engineer
D 2	Monitoring of Afforested and Landscape areas	Continuous monitoring of plantation and landscape areas should be done to assess performance and survival rate. Plantations should be properly guarded, with provision for scheduled manure application and watering.	Along the Road landscape, exposed surface near the bridge, culverts, and area allocated under CA by Forest Department under the project	FCA 1980 & Sikkim Private and Other Non-Forest Lands Tree Felling Rules, 2006	PMU, Forest department, Contractor	PMU/ Authority Engineer

S.No	Environmental Issues	Environmental Mitigation Measures	Sub-project/ Location		Responsibilities	
				Reference	Planning & Execution	Supervision/ Monitoring
D 3	Soil erosion and monitoring of Borrow areas	Visual monitoring and inspection of soil erosion at borrow areas, quarries (if closed and rehabilitated), embankments, and other places prone to erosion should be carried out once every three months.	-	MoRTH: 111.2	PMU	PMU / Authority Engineer
D4	Encroachment on the carriage way or in the right of way.	Provide fencing and regulatory provisions like notices to prevent encroachments.	All sub-projects		PMU	PMU/ Authority Engineer
D5	i. Consultation with Civil Society organisation (CSO)/ NGOs working in the biodiversity in Sikkim specifically for Chinese Pangolin as part of BAP ii. Consultation with community	Pre-project consultation with the CSO/NGO on biodiversity specifically the Pangolin as part of BAP. Community consultation as par the EIA/EMP	All projects	BAP/CHA EIA	ESMU environmental officer along with biodiversity team	PMU
D6	Residual Impact: Despite these measures, residual impacts, such as reduced or altered forest cover along the ROW and slight changes in private land/community structure, water usage and subsequent health of people, livestock and crops could persist if not mitigated in responsible manner.	Monitoring Residual Impacts Post-Construction: After the construction phase, residual impacts on water usage and health will be monitored through environmental monitoring processes. This includes: • Maintaining photographic records to provide useful environmental monitoring tools. • Ensuring compliance with environmental standards for water quality. • Long-term support and follow-up actions to address any ongoing issues relating to water usage and health. • Conducting regular community consultations to ensure sustained access to water resources and addressing any emerging concerns.	All projects	BAP/CHA EIA	PMU	ESMU/PMU

8.13 Conclusion and Recommendation

565. The selected project roads have an existing single lane and these will be improved to intermediate lane with paved shoulder and drains. These roads will support capacity, quality, and safety improvements of the local community. 6 roads and 3 bridges have been selected for improvement for Phase 1 of the project. The improvement proposals are made based on the detailed field surveys and investigations and subsequent design following guidelines of manual, key decisions received from Authority with respect to improved facilities and project standards.

566. This project has been screened and categorized as Category 'A' and Environmental Impact Assessment (EIA) has been conducted. However, the project area does not fall under any national park, wildlife reserve, and conservation area, buffer zone and world heritage site of nationally historical, archaeological significance.

567. The nearest cultural site is Rabdentse site located at about 800 meters from the right of way of W10. Other two site Coronation Throne of Norbugang and Dubdi Monastery are present about 1.3 km and 6 kms respectively.

568. Cultural features of local importance are available within the ROW and adjacent to the ROW. Road E4 has a cremation ground, a shrine and local idols within the right of way. A church and a temple are located adjacent to the RoW. Road S1 has cremation ground at the upstream of the bridge and 3 churches near the ROW. Road N9 has two church adjacent to the right of way. Road W10 has a monastery near the RoW.

569. Potential environmental impacts identified are: i) pre-construction phase: permanent loss of trees, disturbance of IUCN Critically Endangered and nationally protected species, increased road crashes from inadequate road alignment and design, and localized flooding from inadequate drainage design; ii) construction phase: loss of productive soil from new borrow areas, dust emissions, generation of noise, risks of accident from improper management of borrow areas, and inadequate clean-up operation, restoration and rehabilitation prior to decommissioning.

Mitigation Measures

570. Selected alignment of the project corridors has been finalized in such a manner to ensure improvement proposal may fit within existing right of way to avoid land acquisition as far as possible.

571. Most of the project corridors are passing through land slide and erosion prone areas and specific remedial measures has been provided to stabilize hill and valley slopes during construction as well as after implementation of the improvement proposal.

572. During construction phase, adequate guidance and resources are provided by Sikkim Roads and Bridges Department to the Contractor to comply with the borrow area management requirements, dust suppression measures. .

573. Residual impacts are compensated through mandatory compensatory plantation.

574. Meaningful consultations have been conducted during the project preparation stage and all concerns of the affected persons and stakeholders have been incorporated in the EIA and the EMPs. These consultations were represented by key informant's, roadside communities, and related government organizations.

575. In all the stages, due mitigation measures related to community health and safety impacts, socio-economic impacts, biological environment impacts, soil environment impacts, air pollution, noise pollution and water pollution shall be taken by executing agency as per the prepared plans and existing national and international standards.

Grievance Redressal Committee

576. It is suggested that the Department of Roads and Bridges formulates a Grievance Redress Committee (GRC) to hear and resolve project-related grievances, particularly from project affected parties The process will promote the settlement of disputes and reduce litigation. GRC shall be set up at the site and district level and will be headed by local Panchayat Member and District Collector respectively.

Environment Management Plan (EMP) and Environment Social Management Unit (ESMP)

577. Environmental Management Plan (EMP) has been prepared which is mainly centered on understanding the interactions between the environmental settings, project activities and the assessment of the anticipated impacts.

578. The environmental management requirements/guidelines/plans are needed to be applied and implemented at all stages of the project. This requires an institutional mechanism to deal with various processes and requirements at each stage. Within the institutional framework provided for the project, preparation, implementation, supervision and monitoring of environment functions, particularly the Environment Management Plans, a dedicated unit, viz., Environmental and Social Management Unit (ESMU), shall be formulated. The dedicated ESMU shall ideally be headed by an officer at the rank of Divisional Engineer or Executive Engineer and shall be responsible for all activities related to environmental management, resettlement and rehabilitation. Project Director (ADB-Project) shall have overall responsibility of the project, who will be assisted by Divisional Engineer (DE). The Divisional Engineer will be assisted by an Environmental Specialist and a Social Specialist or trained officers in the rank of Assistant Engineers. ESMU shall be housed at R&BD headquarters in Gangtok. Junior Engineers at each field divisions will be responsible for E&S activities. The road-specific EMPs and associated costs is part of the bidding documents. This EIA report is disclosed on the ADB and Government of Sikkim, Roads and Buildings Department websites.

579. The EMP and other safeguard requirements (including any conditions stipulated in the government clearances and permits) will be included in bidding documents and civil works contracts. The bidders will be required to submit, as part of their bids, the expected costs of implementing the EMP to ensure that sufficient resources are allocated for EMP implementation.

580. The Contractor will be required to prepare Contractor's EMP (CEMP) outlining how it will implement the EMP. The description of the precise locations of the required mitigation/monitoring, the persons responsible for the mitigation/monitoring, the schedule and reporting methodology will be included in the CEMP. The Contractor(s) will be required to submit the CEMP to the R&BD/PMU for approval before taking possession of any work site. No access to the site will be allowed until the CEMP is approved by the PMU/ Authority Engineer.

581. The PMU will have the right to suspend works or payments if the Contractor(s) are in violation of any of his obligations under the EMP and CEMP.

582. Following requirements of ADB SPS, R&BD will apply pollution prevention and control technologies and practices consistent with international good practice as reflected in internationally recognized standards such as the World Bank Group's Environment, Health and Safety Guidelines. When Government regulations differ from these levels and measures, R&BD will achieve whichever is more stringent. If less stringent levels or measures are appropriate in view of specific project circumstances, R&BD will provide full and detailed justification for any proposed alternatives that are consistent with the requirements presented in ADB SPS.

583. This EIA will be updated if unanticipated environmental impacts become apparent based on results of detailed engineering design and of any additional baseline monitoring as required (e.g., air, noise, water quality, biodiversity, forest impacts, etc.) and will be submitted to ADB for clearance and disclosure at ADB website.

584. Compensatory afforestation will be carried out in accordance with the *Forest Conservation Act (1980)*. The afforestation is expected to be completed before the end of the construction period. In the event of non-compliance, the ESMU will raise the matter with the Principal Chief Conservator of Forests and Head of Forest Force, Government of Sikkim. Should afforestation not be completed as scheduled, extension of the loan closing will be considered to ensure full implementation of this mitigation measure.