



नेपाल सरकार वन तथा वातावरण मन्त्रालय

**मधेश प्रदेशको बारा र बागमती प्रदेशको मकवानपुर र चितवन जिल्लामा
प्रस्तावित पथलैया-हेटौडा-नारायणघाट सडक (१०० कि.मी.) स्तरोन्नतिको
वातावरणीय प्रभाव मूल्याङ्कन (EIA) प्रतिवेदन राय सुझावको
लागि आह्वान गरिएको सार्वजनिक सूचना**

प्रथम पटक प्रकाशित मिति: २०८२/१२/१५

प्रस्तावक श्री सडक विभाग आयोजना निर्देशनालय (ए.डि.बी.) द्वारा मधेश प्रदेशको बारा र बागमती प्रदेशको मकवानपुर र चितवन जिल्लामा पर्ने पूर्व-पश्चिम राजमार्गको पथलैया देखि नारायणघाट सम्मको १०० कि.मी. सडक खण्डको स्तरोन्नतिको लागि पथलैया-हेटौडा-नारायणघाट सडक (१०० कि.मी.) स्तरोन्नति आयोजनाको वातावरणीय प्रभाव मूल्याङ्कन (EIA) प्रतिवेदन श्री भौतिक पूर्वाधार तथा यातायात मन्त्रालयबाट स्वीकृतीका लागि सिफारिस साथ प्राप्त भएको छ। प्राप्त प्रतिवेदन अनुसार यो सडक श्री भरतपुर महानगरपालिका, हेटौडा उपमहानगरपालिका, जितपुरसिमरा उपमहानगरपालिका, खैरहनी नगरपालिका, रत्ननगर नगरपालिका, राप्ती नगरपालिका र मनहरी गाउँपालिका क्षेत्रमा पर्दछ। सडकको सुरु बिन्दु बारा जिल्लाको पथलैया र अन्तिम बिन्दु चितवन जिल्लाको गोन्द्राङ रहनेछ। यस आयोजना अन्तर्गत सडकको आफ्नै स्वामित्वमा रहेको ५० मी. अधिकार क्षेत्रमा अस्फाल्ट कीकटबाट निर्मित ४ लेनको सडक ३ मी. आइल्याण्ड सहित आवश्यकतानुसार सोलजर निर्माण गरिनेछ। सडकको संरचित गति ८० देखि १०० कि.मी. प्रतिघण्टा रहनेछ। यस सडक खण्डमा बन्नुजन्नु बाह्रपारका लागि १९ वटा बन्नुजन्नु निकास र २ स्थानमा भायाडकट निर्माण गरिनेछ। सडक स्तरोन्नतिको क्रममा ४१ वटा पुल र २४६ वटा कलभर्ट निर्माण गरिनेछन।

वातावरण संरक्षण नियमावली, २०७७ को नियम ९(६) बमोजिम यस प्रतिवेदनमा राय-सुझाव दिनेको लागि सर्वसाधारणले प्रतिवेदन अध्ययन वा उतार गर्न सकिने व्यवस्था रहेकोले यो प्रतिवेदन निम्न स्थानहरूमा तथा मन्त्रालयको वेबसाइट www.mofe.gov.np मा समेत सार्वजनिक गरिएको छ। प्रतिवेदनमा उपयुक्त राय-सुझाव प्राप्त भएमा, यस मन्त्रालयले उक्त प्रस्ताव कार्यान्वयनको लागि स्वीकृति दिने क्रममा ती सुझावहरूलाई समेत ध्यानमा राखिनेछ। उक्त प्रतिवेदन सम्बन्धी कुनै राय-सुझाव भएमा यो सूचना प्रकाशित भएको मितिले ७ (सात) दिनभित्र निम्न ठेगानामा पठाई विनु हुन यसै सूचनाद्वारा आह्वान गरिन्छ।

प्रतिवेदन अध्ययन वा उतार गर्न सकिने स्थानहरू:

- श्री भौतिक पूर्वाधार तथा यातायात मन्त्रालय, सिंहदरबार, काठमाडौं।
- श्री विभुवन विश्वविद्यालय केन्द्रीय पुस्तकालय, किराँतपुर, काठमाडौं।
- श्री पुस्तकालय, संसद सचिवालय, सिंहदरबार, काठमाडौं।
- श्री नेपाल आदिवासी जनजाति महासंघ (नेफिन) भिमसेनगोला, काठमाडौं।
- श्री जिल्ला समन्वय समितिको कार्यालय, बारा।
- श्री जिल्ला समन्वय समितिको कार्यालय, हेटौडा, मकवानपुर।
- श्री जिल्ला समन्वयको समितिको कार्यालय, चितवन।
- श्री भरतपुर महानगरपालिका, भरतपुर, चितवन।
- श्री हेटौडा उपमहानगरपालिका, हेटौडा, मकवानपुर।
- श्री जितपुरसिमरा उपमहानगरपालिका, सिमरा, बारा।
- श्री खैरहनी नगरपालिका, खैरहनी, चितवन।
- श्री रत्ननगर नगरपालिका, बकुलहर, चितवन।
- श्री राप्ती नगरपालिका, चितवन।
- श्री मनहरी गाउँपालिका, मकवानपुर।

**राय सुझाव पठाउने ठेगाना
वन तथा वातावरण मन्त्रालय**

सिंहदरबार, काठमाडौं।

फोन नं. ०१-४२११५६७, ४२११९४६ ईमेल: info@mofe.gov.np

ENVIRONMENTAL IMPACT ASSESSMENT (EIA)
FOR
UPGRADING OF PATHALAIYA-HETAUDA-
NARAYANGHAT ROAD (100 KM)

Bara, Makawanpur and Chitwan District, Madesh and Bagmati Province, Nepal



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December, 2025

SN	Comments / Suggestion MoPIT	Comments Incorporated
	Tree number as per present condition	23326 numbers
1	As mentioned here, 6. Study Methodology in executive summary section: “Altogether, 55 consultation meetings and 7 public hearing with the major stakeholders of the project area were conducted from 2028-1-6 to 2082-1 10, public notice was published on to obtain their opinions and suggestions. According to Rule 7(2) of EPR, 2077, what is 2028 -1-6 should be rechecked.	2028-1-6 is corrected as 2082-1-6
2	The proposed road alignment passes through Terai, Siwalik, and Dun vally. What is vally? should be rechecked	Corrected as valley
3	कार्यकारी सारांशमा वातावरणीय संरक्षण ऐन तथा वातावरणीय संरक्षण नियमावली भनेर उल्लेख छ, वातावरणीय भन्दा पनि वातावरण हुनु पर्ने हो	Corrected as वातावरण
4	कार्यकारी सारांशमा सडक खण्डमा पर्ने रुखविरुवाको मापनका लागि वातावरण संरक्षण नियमावली २०७७ अनुसार अवलम्बन गरेको भनेर उल्लेख छ, वातावरण संरक्षण नियमावलीमा त्यस्तो व्यवस्था छ र ?	Changes as Forest Rules (वन नियमावली २०७९)
5	As mentioned here: The SASEC Highway Improvement Project (SHIP) will upgrade 270.00 km of East West Highway including bridges among them PHN road section is approximately 100 km. so it would be better if you also clarified where the 270 km upgrade is being planned from.	Added (in chapter Background 2.1 and Executive summary) Kakarbhitta-Laukahi (120m) road section, Butwal Gorusinghe –road section 50 KM and Pathalaiya-Hetauda-Narayanghat (PHN) road section 100 km)
6	2.3, As mentioned here “PHN road crosses the Siwalik and Rapti Doon Valley. Is this road crosses rapti doon valley? I think it should be rechecked.	Corrected as dun valley Deleted Rapti (refer chapter 2.3)
7	Will this upgradation affect the raxaul – amalekhgunj petroleum pipeline? it should be clearly mentioned.	It will not affect during road widening and added in the report (refer chapter 2.3)
8	As mentioned in this report the project lies on Madesh and Bagmati province, so better to write Madhesh instead of Madesh.	Corrected as Madhesh
9	As mentioned here in salient features: Design speed a. In Plane and Dun Area 100 km/hr, plane or plain?	Corrected as Plain
10	It is mentioned that there are 35 bridges under 'Salient Features', but in the 'Scope' section it says 22, please recheck it thoroughly again.	Corrected as All Bridges (existing is 22 bridges and 19 additional during upgrading 41 new bridges (including box bridge) will be constructed The original scope included 22 bridges; however, during the study, an additional 19 number of Box bridges (replace of causeway, slab culvert) were designed based on their characteristics and discharge capacity, considering the effects of climate change. As a result, the total number of bridges has increased to 41, including the 22 bridges initially mentioned in the scope of works. (Refer Chapter 2.4)
11	As mentioned here Road Section Depending upon the development of the urban and market area along the roadside,	Mention in chapter 2.5, Figure 6 Hetauda Bazar will be 45.8m road

SN	Comments / Suggestion MoPIT	Comments Incorporated
	three types of cross section Urban area-50m width, however in Hetauda Bazar there will be different road width, better to mention the width near Hetauda and other urban areas as well.	width (<i>Figure 3, Figure 4 & Figure 5, and Figure 6</i>)
12	Does the environmental study of the bridges fall within the scope of this report, or does it need to be conducted separately? Should be mentioned clearly if it falls under this report then detail of the bridge should also be mentioned.	Yes it is covered the scope of bridges also, which is mentioned in the chapter 2.4, 2.5.1 and Separate EMP has been prepared for bridges (Annex IX)
13	In annex part C. Procedure and Cost of Compensatory Plantation According to EPR (2020), for a tree felled, a replenishment plantation has to be carried at a ratio of 1:10. A well fenced and managed/maintained plantation till 5 years before being handed over to the GON. Has been mentioned. Does EPR has provision for compensatory plantation? should be rechecked and reconfirmed	EPR has not provision for compensatory plantation it is mentioned in Forest Act and Regulation and corrected accordingly in whole report
14	Construction Materials: As mentioned here “The final locations of quarries and borrow areas will be determined at the implementation stage. This should be determined in this study stage because only after determining appropriate location the proper impact its mitigation and management plan can be prepared. Also give detail about the availability of construction materials. Electricity will be used at camp, and for other plant operation such as crusher plant, batching plant, asphalt plant. So, When using electricity, explain a bit more clearly where to bring it from, how to bring it, how much is needed, etc. Also here “Kerosene will be used for bitumen heating” has been mentioned. Even in this day and age, are we still using kerosene to heat bitumen? “Water from Rapti, Manahari, Lothar, Kair, Khageri river and its tributaries are likely to be used during the time of construction” so can you elaborate this by adding the amount and sources of water available in the area also the quality of water required during the construction?	16 locations is identified for construction materials. Guidelines for Quarry and Borrow operation plan is given in Annex XVIII. During the Project Preparation Period, the Consultant proposed 16 potential locations for quarrying construction materials. This does not imply that materials must be sourced from all the proposed sites during the implementation stage; however, the final selected quarry sites should be chosen from among the proposed locations. Water quality was measures and given in Table-39 The discharges of the Rapti, Manahari, Lothar, Kair, and Khageri rivers are presented in the Hydrological Study section of the Main Report. Compared to the required water quantity, the available volume of water in these rivers is significantly large.
15	Table 15: Possible locations of construction camp, material stockpiling site : so also clearly explain how many people can be accommodated in which specific locations of the mentioned sites.	Table 15: every proposed location more than 100 workers can be accommodated
16	Table 16: Possible locations of spoil disposal site: All the spoil disposal sites mentioned here appear to be located along river banks. Therefore, would it be better to choose alternative locations for this? Also, clearly mention the area covered by each proposed disposal site, and up to what height the spoil may reach when disposed of there.	Proposed locations are Ch 380+900/320, Ch 385+700/340, Ch 388+600, Ch 389+040, Ch 417+880, Ch 429+500 the locations are selected for where required filling, embankment improvement, and possible quantity to be dispose

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		in the each location is given in the Table-16
17	2.6.7 Crusher Plant and Asphalt Plant Sites: Clearly mention how many crusher plants will be installed, their specific locations, their capacities, and how much material they can crush per day.	This stage we can say only locations and area, Installation capacity will depend of the contractor.
18	3.5.2 Biological Environment, Methodology section: it is mentioned here that the information related to trees and forests has been taken as per the EPR. Is that really the case? Does the EPR say anything about forest area details and tree cutting? Plz recheck.	Corrected as Forest Regulations
19	Policies, act rules .. It is not necessary to include extensive details. It would be more appropriate to mention only the specific rules and regulations applicable to this project. A concise, to-the-point explanation will suffice.	Revised, NA
20	Geology and soil : alignment wise geological and landslide/stability information should be given	Chainage wise information is given in Table 31, Chapter 5.1.8 Slope instability, 5.1.9 Riverbank Erosion and Sedimentation
21	It would be better to provide alignment-wise detailed information about the potential risks that may arise when cutting or disturbing currently stable slopes	Chainages are given at Slope failure locations are given in chapter Baseline of Physical Environment Chapter 5.1.8 Slope instability, 5.1.9 Riverbank Erosion and Sedimentation
22	Better to give the brief hydrological information near the location of possible inundation and bridges sites.	There in low risk of inundation, due to further minimize any potential risk, the size and number of cross-drainage structures have been increased. For instance, all pipe culvert has been replaced by box culvert and bridges are increased from 22 to 41 numbers. Annex-IV-AA: Hydraulic Parameters of Bridges of PHN Section Details of the Hydrological Study are included in the Main Report. The study indicates that there is no risk of inundation. To further minimize any potential risk, the size and number of cross-drainage structures have been increased.
23	5.3.11 Affected Private Structures: 403 private structures (beside Hetauda Bazar) will be affected by the project along the alignment. This includes residential, resident cum commercial, commercial, sheds and others, including 2 structures of institution. Out of the 403 private affected structures, there are 46 residential structures, 116 residences cum commercial structures, 129 commercial structures and 112 others. Among the total affected households, 30 residential households (165 persons) and	Annex IV (A,B,C) and RP

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	28 commercial structures (154 persons) will be fully affected and needs to be vacated. The affected commercial structures have been used only for business purpose, temporarily; only 30 residential households of 165 persons and 28 residences cum business households of 154 persons will be physically displaced along the alignment. So, give detail information about this type of household, condition of household etc.	
24	Vegetation Clearance: As mentioned here "Sal and associated species of Sal forests in the Terai and inner Don Valleies" what does don valleies mean?	Corrected by Dun valley
25	As mentioned here: Reviewing the rate of traffic growth, it has been found that passenger cars have increased by 14.4%, buses by 9.6%, and 2-3 wheelers by 13% whereas truck has decreased by 3.7%. Due to improve road, the travel speed would improve about 30%. So, clearly mention the time period this data covers — from when to when.	The study period is 20 years from the traffic opening after the Improvement. Ie, 2047. Included in chapter- Existing traffic growth trend
26	Resettlement Action Plan (RAP) has been prepared to address and compensation on the affected households. Details of affected households are given in Annex VI-C. It would be better to include the gist of RAP information in this report as well.	Included in Socio-economic and Cultural Environment / EMP (<i>The RAP provides detailed information on compensation rate and relevant livelihood restoration activities. The objective of the plan is to improve or at least restore the income and livelihood conditions of the people to at least the pre-project level. The affected households will not only receive cash compensation for assets at prevailing rates for full replacement cost, but also additional assistance will be given for relocation and livelihood restoration. Overall, the RAP presents (a) socio-economic profile of the affected households; (b) type and extent of loss of assets; including land, structures, (c) principles and legal framework applicable for mitigation of these losses; (d) the entitlement matrix; (e) income and livelihood restoration program; (f) relocation and resettlement budget; (g) institutional framework for the implementation of the plan, including monitoring and evaluation).</i>
27	The EMP is not adequate and does not appear to follow the format provided in the EPR 2077, so it should be prepared accordingly."	Revised accordingly as per EPR 2077 refer Annex-IX
28	River training work has also been proposed, so a detailed description of that, along with the required construction materials	River Training Works with Chainage and proposed river

SN	Comments / Suggestion MoPIT	Comments Incorporated
	and related information, should be clearly mentioned.	training works is given in Annex IV-Z
29	It would be good to provide HFL and other relevant hydrological information at the locations where animal passes have been proposed.	HFL is given in Annex IV-A-1 and A-2: Hydraulic Parameters of Bridges of PHN Section Only Box Bridges located at 389+889.50 and 429+931.50 are proposed for dual purpose the HFL of first one is: 585.68 and second is 267.73
30	Information on various river crossings, transmission line crossings, etc., should also be included in the salient features.	NA, Provided in Table 75 under Chapter - Affected Roadside Public Utilities
31	Clearly explain what measures will be taken for movement during construction — whether any alternatives will be used or what else will be done	TMP will be prepared –refer Annex-XIV for guidelines Diversion and traffic management works shall be the responsibility of the Contractor. This requirement is clearly specified in the Specifications of Works, which form an integral part of the Contract.
32	The possible quarry sites mentioned here are likely already being used by nearby projects and local residents for construction materials. Therefore, sourcing additional materials from the same quarry sites for this project could lead to further impacts on those sites. It would be better to provide a detailed explanation regarding the availability of materials.	The estimated quantity of quarry materials is significantly higher than the required quantity. For example, while the total required aggregate is 1,025,891 m³ , the total proposed quarry capacity amounts to 3,369,000 m³ . A comparison between the two indicates a substantial surplus in the proposed quarry capacity. It is given in Table 44 and annex Annex IV-Ga
33	There should be a clearer explanation on how to manage electric poles, transmission lines (TL), and other religiously significant sites located within the Right of Way (RoW)	Mention under chapter-Impact Prediction and Mitigation Measures of Adverse Impacts (Table 85, pre-construction phase) The project will take necessary process for clearance, transfer of funds etc. to the respective utility service provider so as not cause any delays to the road construction schedule. Prior inform to public before shifting of the public structures, utilities.
34	It is mentioned that the bridge will be upgraded, but it is not clear whether the existing bridge will be upgraded, a new bridge will be constructed alongside it, or the old one will be dismantled and replaced. This should be clearly stated.	The existing functional bridges will be utilized as one carriageway since the proposed improvement involves a dual carriageway configuration.

SN	Comments / Suggestion MoPIT	Comments Incorporated
		An additional new two-lane bridge will be constructed parallel to each functional bridge. For bridges that are non-functional or additional (beyond the original scope of works), completely new twin two-lane bridges have been proposed. The bridges at Pakkipul, Sansare, Sayafot, and Lothar Branch are proposed to be dismantled. It is mentioned in Chapter 2.5, under sub-chapter: Bridge and Culvert
35	It is mentioned that some information is included in the Annex, but it would be better to include the gist of it in the main report as well.	Review and added in the main report also
36	Given that a fast track is being constructed near the proposed location, it is essential to critically evaluate the relevance and necessity of developing this road as currently planned. With the operation of the fast track, the traffic volume on this route is expected to decrease. Therefore, the justification for this project should be elaborated more clearly, taking these future developments into account	An extensive discussion was held among the Project Directorate, the ADB Technical Team, and the Mission regarding the traffic issue. At present, the Narayanghat–Mugling Road functions as a 2-lane highway, and both the Prithvi Highway (Mugling–Naubise section) and the Tribhuvan Highway (Naubise–Nagdhunga section) are being upgraded to 2 lanes. With the completion of the Fast Track, it is expected that goods vehicles from western Nepal, particularly multi-axle and large trucks, will prefer to use this route to access Kathmandu. Consequently, the previously estimated 39% reduction in normal traffic has not been applied, in accordance with the instructions from the Project Directorate and the ADB Technical Team.
37	It has been indicated that a transmission line (TL) may be affected by the project. If so, the capacity of the line, its type, and technical specifications should be clearly stated. Furthermore, the report should detail how the TL will be managed—whether it can be retained in its current alignment, relocated, or modified—while also assessing whether adequate space is available for such adjustments. A management plan for the transmission line should be included accordingly.	The transmission lines are not affected by the project; however, the low-tension (LT) and distribution lines will be relocated during project implementation. Sufficient funds have been allocated for the relocation of all utilities. <i>Refer Table 75</i> Budget was allocated and it will be prepared during implementation with coordination of NEA (as per practical procedures)-

EXECUTIVE SUMMARY

1. Background

East-West Highway (EWH) is the main domestic as well as international trade corridor of Nepal. The EWH is also part of the Asian Highway 2 (AH2). The South Asia Sub-Regional Economic Cooperation (SASEC) Highway Improvement Project (SHIP) will upgrade 270.00 km (Kakarbhitta-Laukahi (120m) road section, Butwal Gorusinghe –road section 50 KM and Pathalaiya-Hetauda-Narayanghat (PHN) road section 100 km) of East West Highway including bridges among them Pathalaiya-Hetauda-Narayanghat (PHN) road section is 100 km. The proposed project will be improved PHN road section from existing two lanes into four lanes including bridges. PHN road section passes through Bara district of Madhesh province and Makawanpur and Chitwan district of Bagmati province. The PHN Road will be upgraded to alleviate traffic congestion, increase ride quality, and improve road safety.

2. Proponent and Consultant

The proponent of the proposed Pathalaiya-Hetauda-Narayanghat (PHN) road is Project Directorate-Asian Development Bank (PD-ADB), Department of Roads (DoR), Ministry of Physical Infrastructure and Transport (MoPIT).

The address of project proponent

Project Directorate-Asian Development Bank (PD-ADB)

Department of Roads

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The proponent has assigned Soosung Engineering Co. in association with ERMCTSE, Baluwatar, Kathmandu, Nepal as a project preparatory consultant for SASEC Highway Improvement Project, to prepare detail engineering design and Environmental Impact Assessment (EIA).

3. Rationality of EIA

This project consists of 100 km road upgrading works including all bridges. As per the Environment Protection Act (EPA) 2076 B.S., and Environment Protection Rule (EPR), 2077(Addendum 2078) B.S.; Schedule 3, Rule 3, E (6); upgrading of national highway or feeder road if more than 50 km is mandatory to conduct an Environmental Impact Assessment (EIA).

The road passes through the core area of Parsa national Park (PNP) and Buffer Zone (BZ) of PNP, Chure Conservation area, BZ of Chitwan National Park (CNP) and Barandabhar Corridor Forest (BCF). According to Schedule 3 (A) List 12, pursuant to Rule 3 of EPR, 2077 B.S. it has been made

mandatory to conduct EIA to implement any project within a national park, wildlife reserve or hunting reserve.

As per EPR, 2077 (Addendum 2078) B.S.; Section 2, Rule 7, Sub-rule 8; if the project is funded by foreign agency the environmental assessment report can be prepared in Nepali or in English, this report is prepared in English language, as it is funded by ADB.

4. Objective of the EIA

The objectives of the EIA of this project are as follows:

- Collect the baseline information on physical, biological, socio-economic and cultural environment in the project affected areas,
- Analyze and determine the potential beneficial and adverse impacts due to the project on physical, biological, socio-economic and cultural environment and chemical environment,
- Propose practical and site-specific mitigation measures for adverse impacts and enhancement of positive impacts,
- Prepare environmental management plan and environmental monitoring plan,
- Provide information to the decision makers and concerned parties about environmental implications of proposed project,
- Provide an opportunity of public involvement in the all phase of the project, and
- Define the institutional framework required for the implementation of the project.

5. Project Description

Pathalaiya-Hetauda-Narayanghat (PHN) road section of EWH starts at Pathalaiya intersection at Ch 367+630 and ends at Gondrang (Bharatpur) at Ch 467+320. This road section is 100 km long. The existing road has 7 m (two lanes) carriageway width in most of the section and in urban area, there is found four lanes road also.

The right of way (RoW) of the road is 50 m (both sides 25 m from centre line) except Hetauda bazar area. RoW of EWH has already been gazatted under the jurisdiction of GoN/MoPIT.

The road alignment passes through mainly settlement, agriculture land, protected area, BZ, industrial area, forest areas. The road section starts from Pathlaiya (367+550) and end at Gondrang, Bharatpur (Ch 467+320). Major settlements along the PHN road section are Amlekhganj (Ch 376+000), Hetauda (Ch 396+500), Manahari (Ch 425+700), Lothar (Ch 436+960), Bhandara (Ch 447+000), Parsa (Ch 454+300), Tandi (Ch 459+700) and Bharatpur (Gondrang) (Ch 467+320). Hetauda and Bharatpur are busy junctions of the highway.

The alignment traverses through dense forest block from Pathlaiya to Amlekhgaunj (368+000 to 375+900) is also called Adhabhar Forests, the Siwalik Hill (380+000 to 392+300), Rajiya Forest

blocks are Ch 404+940 to Ch 406+540; and Ch 408+820 to Ch 410+840; Ch 412+740 to Ch 420+740 and Ch 426+750 to CH 439+900 (including Manohari-Lothar Forests) and others are sparse forest blocks. The road intersects Barandabhar Corridor Forest (BCF) from Ch 463+600 to Ch 467+320. From Ch 370+550 to Ch 374+000 lies in Parsa National Park (PNP) is known as wildlife corridor such as Wild Asian Elephant, Royal Bengal Tiger, One horned Rhinoceros and others wildlife. The BZ of PNP and CNP passes from Ch 367+630 to Ch 370+550, Ch 374+000 to Ch 375+900, Ch 374+000 to Ch 391+700; Ch 419+250 to Ch 432+200 and 463+420 to Ch 467+320.

Existing road and bridges will be upgraded to National Highway-II standard (or Asian Highway-2). The road width is designed as: i) 50 m in urban area, ii) 37.4 m in semi-urban area and iii) 24 m in rural and forest area. Road upgrading components include widening of 100 km length from 2 lanes into 4 lanes which includes: pavement upgrading, geometry improvement, junction improvements at 13 locations, service roads on both sides of the road, cycle lanes and footpaths in urban areas, pedestrian crossing (6 overhead bridges and 12 underpass), structures for potential wildlife crossings at 21 locations including 2 VIADUCT of length approximately 2 km each., retaining structures (4,526 cum gabion and 215,091cum RCC retaining/breast wall and 54,072sqm reinforced earth wall); civil engineering and bioengineering measures for slope protection and stabilization, construction of 41 new bridges (22 existing and 19 upgraded to box bridge) and 246 box culverts, 174,612 m RCC side drain for drainage improvement. The proposed bridges are designed for 100-year return flows, culverts are designed for 50-year and side drains are designed for 25-year return flows. The road upgrading works will be done within the RoW, additional land acquisition will not be required beyond the right-of-way.

Total project cost for construction of road and bridges has been estimated to NRs. 54,293,647,526. The project is planned to start on 2026 and completion is estimated on 3 years, 12 Month will be DLP period and 5 years will be PBM period.

6. Study Methodology

The study methodologies comprise desk study, field survey, interaction, consultation, impact identification using impact assessment matrix and secondary information. Prior to mobilize into the project areas, desk study was carried out. Secondary informations were collected from the detailed engineering design, inventory report of road alignment, secondary information on physical, biological and socio-economic environment, feasibility report of the project, profile of project affected districts and municipalities, maps such as road alignment map, topographic map, maps related to geomorphology, land use maps, and reviewed. Further, the EPR, 2021 , Environment and Social Management Framework (ESMF), 2023 of DoR, ADB's SPS 2009 and ADB's ESF 2024 , publications of Divisional Forest Office (DFO) of Chitwan, Bara and Makawanpur, Chure Development Board, and Parsa and Chitwan National Parks, reports of population data by National

Statistics Office, ADB TA report on Smart Infrastructure Planning and Design to Protect Natural Habitats and Biodiversity: Ecological Assessment of the PHN Road Upgrading, Forest Regulation, 2022, the prevailing plans, policies, acts, rules, regulations, guidelines etc were reviewed.

EIA team conducted field visit and survey in the project area for collecting/updating/verification of the baseline information on physical, biological, socio-economic and cultural environment of the proposed project from January to August of 2022, March to May of 2023 and November to December of 2024.

Topographical maps and satellite images have been analyzed along the road alignment together with field verification, analyzing direct and indirect impact zones in the project area. Data on temperature and precipitation and other climatic information of the project affected areas were collected from Department of Hydrology and Meteorology (DHM). Information on geology and hydrology was taken from detail design report of the PHN road. Baseline data on air quality and noise level were collected from 28 locations in the months of April and May 2023. Ground water samples of 3 locations and surface water of 9 major rivers were collected and analyzed.

Tree and plants along the alignment were measured using a Census approach, and sample plots laid for sapling, seedling, NTFPs/MAPs. During the time of field measurement important information regarding wildlife habitat, occurrence of rare and endangered flora and fauna species, NTFPs/MAPs etc. were collected through direct observation, field survey/mapping, secondary information, and concern stakeholders consultations.

Total tree volume, biomass, and total carbon stock has been estimated. Sign survey such as, pugmark, footprint hoof mark, scats, pellets, dung, and scratch on the tree trunks (mostly deer) were monitored and recorded during wild animal survey. For Avifauna diversity survey, a point count method was employed and designated 13 points for bird observation. Consultations, focus group discussions were made with different stakeholders such as Parsa National Parks (PNP), Chitwan National Parks (CNP), Divisional Forest Office and Sub- Divisional Forest Office (S/DFO), Forest Management Groups (LFMG -CFUG, BZCF) and another stakeholder regarding presence of wildlife, human wildlife conflict, and road crossing points of wildlife.

Household survey of 1867 households was carried from July to August, 2022 using survey format, questionnaire covering information about sources of annual income, occupation and age groups, education level, vulnerability status, and other relevant information of APs.

55 formal consultation meetings and 7 public hearing and several focus group discussions were conducted with the major stakeholders of the project area. Public hearing were conducted from 2082-1-6 to 2082-1-10, public notice was published on to obtain their opinions and suggestions. According to Rule 7(2) of EPR, 2077, notice requesting for written suggestions were affixed in notice board of

affected municipalities, ward offices, schools, health post and other public places of project affected wards. 7 days public notice was published in a national daily newspaper (Kantipur) on 2082-1-29 for suggestions. Recommendation letters were collected from affected municipalities and other concern stakeholders along with feedback and suggestions.

7. Existing Environmental Condition

Physical Environment

The proposed road alignment passes through Terai, Siwalik, and Dun valley. The elevation of alignment ranges from 178 m amsl (Pathalaiya) to 688 m amsl (Churiya mai) and elevation of end point (Gondrang) is 203 m amsl. 19.5 Km of road section lies in Bara district; 50.12 Km lies in Makawanpur district and 30.02 Km lies in Chitwan district. The average maximum temperature varies from 20.8 °C to 32.6°C and the average minimum temperature varies from 9.4 °C to 24.6 °C. The annual rainfall is 2,407 mm. Rainfall is more intensive during monsoon season (June – September), about 80% of the rainfall occurs in monsoon season.

In Siwalik section of the road is found coarse- to fine-grained sandstones, siltstones and mudstones. Soil found comprising gravels, sands, silts and muds. The project area falls in the moderate to high (3 to 5) seismic hazard zone Landslides, gully erosions and old scars have been found at Ch 382+180, Ch 405+940 – Ch 406+250, Ch 406+700, Ch 409+900 – Ch 410+300, Ch 412+250, Ch 414+000, Ch 414+150, Ch 415+000 – Ch 415+400, Ch 418+100 – Ch 418+500. Gully formation: Ch 385+370, Ch 385+300, Ch 386+423, Ch 386+000. Embankment erosion was noticed at bridge sites due to high embankment. High embankment has been found at Ch 401+300 - Ch 401+600, Karra bridge, Bothside of Mardar bridge Ch 444+271, Khageri bridge Ch 462+500, Ch 462+800.

The concentration of particulate matters (PM_{2.5} & PM₁₀) is influenced by location-specific activities, vehicular emissions, industrial areas and other local activities. PM_{2.5} was ranging from 35.61 µg/m³ at (Bridge No.3) to 91.46 µg/m³ (at Manahari Bridge) whereas PM₁₀ concentrations varied from 49.82 µg/m³ (at Gadyauli) to 163.86 µg/m³ (at Rajaiya). The average 24 hours noise level varies from 55 dB(A) to 73 dB(A) in day times and 30 dB(A) to 42 dB(A) in night. Drinking water samples were collected from 3 locations and compared with Nepal drinking water quality standard. Surface water samples were collected from 9 locations and comply with the generic effluent standards for inland surface water; however, E. coli exceeds 200 CFU/100mL in Lothar River, indicating localized pollution.

The daily traffic volume of different stations varies from 12,000 ~ 25,000 vehicle/day. The urbanized Narayanghat, Hetauda area shows more traffic than other sections. Roadside markets, small shops, grocery, hotels, restaurants, and teashops are the major source of waste generation, which are seen along the roadside. The road crosses 22 rivers. Karra, Rapti, Manahari, Lothar

are major rivers in the project area. Wetland like Rhino lake at Chainage Ch 466+500 (1600m far from the road RHS), Kalimati Lake (1800 m far from the road LHS), Chepang Lake (200m far from the road LHS) and Bishajari Lake (about 4 km far from the road) are situated in the Barandabar Corridor Forest. At many locations, irrigation canal cross and found along the road.

16 potential locations for sources of construction materials (stone, coarse aggregates, sand, subbase, base course, and asphalt concrete chips) has been identified. Further, final locations of quarries and borrow areas will be determined at the implementation stage. For the reduction of aggradation can also be used suitable locations of the river even fall in Chure area or BZ area. The extraction of materials will be done using equipment and labour (such as pick, shovel, excavator, loader, truck, labours etc.).

Biological Environment

PHN road traverses through Parsa National Park/ Adhabhar Corridor Forests (ACF), BZ of PNP, BZ of Chitwan National Park, Barandabhar Corridor Forest (BCF), and other forest. The forests of PNP begins from Pathlaiya and end at Amlekhgaunj. The road lies in tropical and sub-tropical vegetation zone, dominated by dense Sal forest in between Pathalaiya (Ch 368+00) to Amlekganj (Ch 375+900) and at Siwalik hill and Dun valley found Riverine forest type. Forest blocks distributed in Ch 404+940 to Ch 406+540; Ch 408+820 to Ch 410+840; Ch 412+740 to Ch 420+740; Ch 426+750 to Ch 439+900 is dominated by Sal forest. Manohari-Lothar Forests and BCF (Ch 463+600 to Ch 467+320) forests are also dominated by Sal forest.

Sal Forest is dominated by Sal species (*Shorea robusta*) and major associate species are Bhalayo (*Semecarpus anacardium*), Barro (*Terminalia bellirica*), Asana (*Terminalia allata*), etc. The Tree Census Survey (TCS) found 23,326 trees to be felled down during the construction of PHN road. In Bara district 9,646 trees, in Makwanpur 10,278 and in Chitwan 3,402 to be felled down. Total 404 numbers of Bar, Peepal and Sami trees also recorded for felled down during tree census survey. During survey recorded the species with medicinal values such as Jamun (*Syzygium cumuni*), Barro (*Terminalia bellirica*), Harro (*Terminalia chebula*), Tatari (*Dillenia pantoagyna*), Wild Guava (*Psidium guajava*), Chiure (*Aesandra butyraceae*), Amala (*Phyllanthus emblica*), etc. During field survey has identified Sal (*Shorea robusta*), Bijayasal (*Pterocarpus marsupium*) and Satisal (*Dalbergia latifolia*) as protected species which are banned from felling, transportation and export. Globally, Sal (*Shorea robusta*) and Bijayasal (*Pterocarpus marsupium*) are listed as least concerned and Satisal (*Dalbergia latifolia*) is vulnerable. Along the road, forests are managed under Community Forest Management Practice, Collaborative Forest Management Practice, Government and Private Forest Management Practices.

The PHN road passes through core areas of PNP (Ch 370+550 to Ch 374+000), Buffer Zone area of both PNP and CNP and BCF (Ch 463+600 to Ch 467+320), where the movement of wildlife is found relatively high. The project area is home to 59 species of mammals (Survey 2023/024). Wild Asian Elephant (*Elephas maximus*), Royal Bengal Tiger (*Panthera tigris tigris*), Great One Horned Rhinoceros (*Rhinoceros unicornis*), Terai Grey Lungur (*Semnopithecus hector*) and others species are found migrating (Clavenger 2022). During the study 4 (four) major wildlife movement corridors were identified. Adhabhar Corridor Forests (ACF) connecting Terai<>Terai, where Wild Asian Elephant, Royal Bengal Tiger, Great One Horned Rhinoceros, Terai Grey Lungur and others species were found crossing the highway. Another movement corridor was Rapti Wildlife Connecting Forests, connecting Terai <>Siwalik<>Mahabharat, where Royal Bengal Tiger and Chital were common. Similarly, Rajaiya Connectivity Network Forests, where species migrated to Mahabharat hill forests across the Rapti river. Series of crossing points have been identified. The Barandabhar Corridor Forest (BCF), Innerterai <> Mahabharat hill forests.

31 species of bird were found during the study. 23 herpetofauna species was recorded, including endangered Golden Monitor Lizards, Bengal Monitor Lizard, Numerous Snakes (such as Indian Rock Python, King Cobra, Nepalese Sand Boa), Frogs, and Geckos were also found in the project area. 15 fish species were recorded from the river during the study.

Socio-economic and Cultural Environment

PHN road section lies in Bara, Makawanpur and Chitwan districts. It covers one metropolitan city, 2 Sub-metropolitan cities, 3 municipalities and one rural municipality. Major settlements along the road are Pathalaiya (Ch 367+630), Amlekhgunj (Ch 376+000), Churiya Mai (Ch 386+780), Ratmate Bazaar (Ch 391+220), Hetauda (Ch 396+500), Newarpani (Ch 411+700), Manahari (Ch 425+700), Lothar (Ch 436+960), Mahadevtar (Ch 439+200), Bhandara (Ch 447+000), Parsa (Ch 454+300), Tandi (Ch 459+700), Bharatpur Gondrang (Ch 467+320). Total population of the project municipalities has 957,699.

1,867 HHs were surveyed for socio-economic survey and comprises 52.20% men and 47.80% women. Average household size was 5.4. The project area is predominantly inhabited by Brahmin/Chhetri (47.94%) followed by Indigenous People (40.06%). More than 90% of the surveyed populations were literate. Nearly 7.36% of the economically active populations were found in foreign employment and about 10.12% were involved in agriculture. Tap water with taps was found to be a primary source of drinking water and septic tank toilet is the most commonly used toilet in the project area.

The project affects 403 private structures (beside Hetauda bazar) belonging to 378 HHs. Out of the 403 private affected structures, 272 are fully affected and 131 are partially affected. Among the fully affected houses, 30 are residential and 113 are commercial houses. In total 180 community structures

will be affected by the project. The project area does not pass from cultural heritage sites. However religious temple like Bhimsen temple Ch 368+050 (out of RoW), Churiya Mai (Ch 386+780), Churiya mai Tunnel at Ch 387+160, Compound wall of Nava Durga Temple within CoI (Ch 394+360), Gorachheswor Temple at Ch 397+280, footsteps, Om Kareshwor Mahadev area at Ch 398+100, Krishmna Temple small Ch 411+800, Shiva Parbati temple at Ch 420+970, Jaleshwor Shiwalaya at Ch 421+320, Shiva temple at Ch 424+180, Babadham at Ch 424+740 etc. lies in the RoW. During the road widening, public utilities such as electric pole, access road, Ht. line, optical fibre cable, gate, fencing, overhead bridge, tap, telephone pole, water tank, water supply pipe, irrigation canal etc. will be affected.

8. Alternative Analysis

The alternative analysis includes alternatives of design, technology, implementation procedures, less forest option and no project alternative. Currently the road section is in operation as two lanes and the project is planned for upgrading as a four lanes so alternative of location is not considered. Other alternatives such as VIADUCT, alternative of Hetauda bazar also studied during the EIA.

9. Environmental Impacts and Mitigation Measures

9.1 Beneficial Impacts and Augmentation Measures of the Project

Environmental Impacts	Augmentation Measures
Beneficial Impacts	
<i>Construction Stage</i>	
Employment Opportunities and Increase Income Sources	One of the key benefits for the local population during the construction phase is the generation of employment opportunity. Based on the initial estimate, the project is expected to create approximately 854,181 person-days of skilled labor and 2,631,333 person-days of unskilled labor. On average, around 1,000 workers will be required daily to support construction activities. It is assumed that approximately 20 to 30% local people will get employment opportunities during construction. This project will help address local unemployment by offering unskilled and semi-skilled job opportunities.
Development of Enterprise and Commercialization	Due to influx of construction workers, demand of local products such as pulses, vegetables, fruits, etc. will increase, which will motivate for local production and marketing. This will contribute to increase in the local people's economy.
Skills Enhancement	Project will provide priority for use of local people for construction activities, which will facilitate the transfer of skills and technical knowledge in construction and related technical sectors. A considerable number of worker expected to upgrade their skills and transition into skilled labour roles in area such as masonry, gabion works, bar binding for bridge, and slope stabilization work such as bio-engineering works etc.
<i>Operation Stage</i>	

Environmental Impacts	Augmentation Measures
Improvement of Trade	The upgraded road will enhance connectivity along the East-West Highway and facilitate the trade with the neighboring countries via Birgunj Dry Port. Improved access will reduce the time taken of goods to reach their destination there by supporting regional economic integration.
Reduce Travel Time, Travel Cost	The road will be improved from 2 lanes to 4 lanes. An efficient and safe road transport system will reduce travel times, road accidents, fuel, vehicle operating and maintenance costs and transportation cost of goods. 45 to 60 minutes' time will be reduced after road improvement. This will lead to overall cost savings in the transportation of goods.
Traffic Management reduce traffic congestion and Road Accident	The road will be upgraded to four lanes and increases the road's capacity which contributes reducing congestion, and provide better traffic safety. Road safety measures are adequately provisioned. There is provision of VIADUCT and wildlife crossing at sensitive areas which will reduce the vehicle and wildlife collisions.
Women Empowerment	The project will create employment opportunities for women in roles such as laborers, technical and ensuring that women have equal access to employment and training opportunities. Training will be conducted focusing on women empowerment (such as GBV, skills enhancement etc.). The project will support to increase women's skills, awareness and confidence level.
Improved road infrastructure Reduce Green House Gas Emission	The improved road surface will reduce the wearing and tearing of vehicles parts and reducing the general costs for spare parts; increase the fuel efficiency and reduce vehicular emissions. The proposed plantation of roadside avenue trees will also support to consumption of CO ₂ and emission of oxygen in the surrounding atmosphere. Because of good riding condition, vehicles will use less gasoline as a result will reduce CO ₂ emissions and fuel consumption.
New Income Generation	The road connects with importance tourist destination places such as Parsa and Chitwan National Park, Sauraha, Churia Mai temple and Churia Mai Tunnel, etc. VIADUCT will be constructed for minimization on wildlife impact at BFC and PNP section. It is new concept in the country and will support to increase domestic and international tourist flow in this area. Shops, hotels will be increased along the road at Pathlaiya, Amlekhgunj, Hetauda, Ratmate, Tandi, Bbharatpur and create new income generation opportunities.
Enhancement of Social Services	Upgraded roads will enhance the overall quality of life nearby residents by providing better transportation facilities and reducing travel-related stress. Rural populations can easily travel to get government/public facilities (such as Ambulances, clinics and hospitals for regular checkups and treatments). Remote communities will easily connect to urban centers, local product can sell in nearby markets, which will support for local community livelihoods and well-being.
Enhancement to wildlife corridors	Reduce Wildlife-Vehicle Collisions: 21 potential underpass crossings including 4002m VIADUCT (2001m at BFC and 2001m at PNP) has been proposed. This will significantly reduce the chances of wildlife collisions. Increase Habitat Connectivity: Road upgrading with wildlife crossings and other mitigation measures help reconnect fragmented habitats. By allowing free move between habitats, these measures promote genetic exchange, increase access to resources.

9.2 Adverse Impacts and Mitigation Measures

Environmental Impacts	Mitigation measures
Physical Environment	
Construction Stage	
Change in Land Use Pattern	The road upgrading will convert approximately 245.64 ha of RoW land into asphalt road. The design of road is 50m in urban area, in forest area and rural area, 24 m and semi urban area 37.4m. The optimum road design reduces RoW land use change.
Air Pollution	For the control of fugitive dust, water sprinkling will be carried out throughout the construction period three times a day, cover the materials during transportation of soil and sand particularly during windy conditions, Personal protective equipment (PPEs) shall be provided to the construction workers. Periodic air quality monitoring will be carried out (Construction camp, asphalt plant, batching plant, crusher plant, settlements, School, Hospital, Forest area) to ensure compliance with national ambient air quality Standards and WHO Air Quality Guidelines. Possible locations are identified for crusher plants, asphalt and hot-mix plants (Ch 405+780, 428+800, 437+400) which are at least 500 m away from the nearest sensitive receptor (e.g. school, hospital and wildlife habitat (PNP/BFC) and at least 50m from a water body. Construction equipment and vehicles will be well maintained. Open burning of solid wastes (plastic, paper, organic matters) shall be prohibited, and with coordination and getting approval from Hetauda Sub-Metropolitan City, Bharatpur Metropolitan City landfill sites could be used for the disposal of waste.
Noise Pollution	Temporary construction facilities such as labour camps, vehicle maintenance workshop, crusher plant will be located away from settlements and sensitive receptors as far as possible. Noise sources such as stone crushers, asphalt plant shall shield with appropriate materials. Equipment and machinery with lower sound power levels shall be used for construction. Protection devices such as ear plugs/ or earmuffs shall be provided to the workers during operation of high noise generating equipment. Construction activities shall be carried out only day time to avoid disturbance to nearby settlement and wildlife corridor (BCF, PNP) at night. Temporary Noise barriers such as wall of wood/ metal shall be used, especially in the sensitive receptors (schools Ch 376+840, 379+180, 381+970, 400+810, 402+780, 414+400, 420+320, 426+260, 428+030, 434+850, 439+280, 441+740, 442+840, 444+400, 444+820, 462+680 and hospitals). Periodic noise quality monitoring will be carried out in the project area to ensure compliance with national noise level. Vegetative plantation will be done in the median and roadside.
Generation of Vibration	Old houses that pose a danger of vibration during the construction phase will be noted before work begins. Contractor shall aware the operator for careful handling of machines and equipment. The workers will be provided with Personal Protective Equipment (PPE) such as anti-vibration gloves, avoid continuous exposure by taking rest periods.
Deterioration on Water Quality	Prohibited to dispose excavated spoils and wastes into river/streams water, will be disposed in approved designated location or landfill side. All chemicals and oil shall be stored away from water and shall be stored in drum, concrete platform with catchments pits will be constructed at maintenance yard for spills collection. The Contractor shall arrange awareness programme to all equipment operators, drivers, on immediate response for spill contamination and eventual clean-up. Silt collection pond (two/three settling system) shall be constructed at batching plant,

Environmental Impacts	Mitigation measures
	crusher plant, asphalt plant for collecting sediments before letting them into the water body. All wastes arising from the construction sites shall be collected and disposed in a designated location. The wastes shall be collected, stored and transported at approved disposal sites. Bridge and cross drainage work at river/streams to be consider fish breeding time (May/June to August/September), not to be disturbed in river during this time. Surface and ground water quality monitoring shall be conducted.
Slope failure, river Bank Erosion	Soil erosion shall be stabilized by applying engineering as well as bioengineering techniques. At Siwalik area specials slope protection measures are proposed. 1,540,010 sqm hill slope and embankment, bridge embankment and river side slope protection will be done by applying bio-engineering technique (Grass plantation, Brush layering, and Tree/Shrub plantation) with combination of civil structures. Reinforced concrete wall and geogrid reinforced retaining wall, 4,526 cum gabion wall, 54,072 sqm reinforced earth wall will be constructed for hill slope and river bank protection. Excess spoil will be managed at designated locations to control erosion; river water flow will not be disturbed during construction.
Disruption of Natural Flow of Water due to Construction of Bridge and Cross Drainage Structures	Existing natural drainage system will not be disturbed by providing temporary measures (such as diversion/hume pipe), and construction near/inside rivers, streams will be limited during the rainy season. The excess spoil will be stockpile in designated location. The size of the drainage structures has been designed as per increasing volumes of water. During upgrading of road, 174,612 m³ RCC side drainage, 41 new major/minor bridges and 246 box culverts will be constructed to minimize flooding, inundation, and maintain natural flow. Construction will be limited during monsoon and fish spawning seasons in the perennial river like Lothar, Manahari, Rapti, Karra etc. and will be used silt curtains, sediment traps, fuel chemicals will be stored in bunded area or in sealed drums.
Generation of Waste (Hazardous, non-hazardous and liquid waste)	Before commencing the construction activities, the contractor to be prepared a Waste Management Plan. The plan will cover – management of hazardous material, storage, transport and disposal. Designated area to be allocated for temporary storage of hazardous waste in containers and no mixing of hazardous waste with any other waste shall be allowed. Staff to be trained for waste management practice. With coordination and getting approval from Hetauda Sub-Metropolitan City, Bharatpur Metropolitan City landfill sites could be used for the disposal of waste. No disposal sites will be established by the contractor.
Operation of Quarries and Burrow Pits	The contractor shall use the government-approved quarry sites, or to be obtained approval from concern authorities'/ local government, National Park. During the operation of quarry and borrow pit, coordination will be done with local government, National Park, DFO. 16 possible quarry/borrow pits locations are identified during study by design team and EIA team. Contractor shall prepare quarry and borrow pits operation and restoration plan. Mining activities will not be done at forest area, protected area or near sensitive areas. However, for the reduction of aggradation can be used suitable locations of the river even fall in Chure area or BZ area. The extraction of materials will be done using equipment and labour (such as excavator, loader, truck, labours). Does not disturb river water course during the operation of quarry, maintain a BZ of 5 to 10m between the low flow channel and the mining operations to minimize the downstream impacts and limit the excavation activities to the low flow season (non-monsoon). The contractor will restore the site as per restoration plan maintaining natural contours and

Environmental Impacts	Mitigation measures
	revegetation after use.
Establishment and Operation of Crusher Plant, Hot mix plant and Batching Plant	Before establishment the contractor will obtain permit from local stakeholder/Municipality. Stone crushing equipment / cement batching plant, asphalt plant shall be fitted with dust control devices and operated as per Manufacturer's Specification. The contractor will locate plant site away from sensitive receptors (500m), settlement, drinking water sources and water bodies. For the control of fugitive dust, water sprinkling will be done three times daily at the crusher plant during the operation of the crusher to minimize dust. The contractor to be constructed a siltation pond (two/three settling system) to regulate wastewater prior to its discharge into the drainage system, The plant shall be operated during day time only. The contractor will restore the site after use.
Stockpiling of Construction Materials	Stockpile shall not be located on water courses; shall not be within 50m of schools, hospitals or public standpipes; Possible locations are given in Table-15. The contractor will obtain written permission from landowners and local bodies for stockpiling on their land. Hard surface will be prepared for chemical hazard materials store to prevent the contamination/leakage in the soil. 8 possible locations are identified for stockpiling of construction materials.
Waste water discharge from construction sites	Sedimentation ponds of adequate size and capacity will be built for the treatment of wastewater discharges from the batching plants, asphalt plant and the crushing plants to allow the sediments to settle. The settled sediments will be periodically removed and will be disposed of at the designated spoil disposal sites. Wastewater treatment facilities, including a septic tank, soak pit, and site drainage, will be constructed at the camp Wastewater quality will be tested and monitored on a regular basis to ensure compliance with the standards.
Operation Stage	
Air and Noise Pollution	Regular maintenance of the road, maintenance of plants (approximately 16,666 plants will be planted and maintain at urban and semi urban area which act as air and noise absorbers). If require, additional information board will be installed, enforce for No Blowing of Horn Zones particularly in settlement areas, sensitive areas. Enforce Nepal vehicle mass emission standard. Air and noise monitoring shall be conducted during operation.
Water Pollution	Do not dispose directly soil, sludge, and other wastes in water bodies which generate from maintenance of road, drain and cross drainage, use designated spoil disposal locations; Prohibition of washings activities near water bodies.
Increase Road Accident, traffic management	Road safety features will be maintained properly so that they always remain functional. Enforcement of traffic rules, conduct on-site pilot safety campaigns with coordination local traffic police for drivers to prevent accidents (such as follow rules for keeping left, rules for overtaking, rules for motorists passing cyclists, rules for changing lanes, rules for merging, rules for making U-turns, rules for using overhead control signs, rules for making right turns left turns on multi-lane roads, follow rules for overtaking at the approaches to zebra pedestrian crossings, rules for keeping intersections clear off stop lines, rules on priority at zebra crossings etc).
Slope Instability and Blockage of Cross Drainage	Slope/Soil conservation activities through plantation will be promoted in hill slopes and embankment slopes. Routine and recurrent maintenance of roads like cleaning of cross drainage, drains and additional embankment protection structures will be carried out during maintenance to minimize blockage problem, flooding, inundation, and maintain natural flow. Deposition of sediment will be regularly removed and river channelization will be

Environmental Impacts	Mitigation measures
	maintained in the heavy sedimentation locations.
Chemical Environment	
Potential Hazards Caused by Bitumen and other Toxic Chemicals	Automated asphalt plants (Batching plant) will be used. All fuel, lubricants and chemicals, spill/oil will be stored in sealed drums in a secure place within the camp site. Bitumen mixing plant shall have in-built mechanisms for the absorption of gases. No bleeding of bitumen into the soil and nearby water bodies will be allowed. The area will be concrete floor facilities with provision to capture the spillage or chemicals.
Biological Environment	
Construction Stage	
Loss of Vegetation/trees (23,326 trees to be cleared from RoW)	In forest area, road width has been minimized width of road has been proposed 24m, which reduce significance number of tree clearance from RoW. Compensation of tree loss: The proponent will deposit funds in the "Forest Development Fund's Account" under MoFE in accordance with Forest Rules 2022, which will thereafter handle the Compensation Plantation. According to the Tree Census Survey (TCS), 23,326 trees will be felled during upgrading of en PHN. A total of 9,646 trees in the Bara district, 10,278 in Makwanpur district, and 3,402 in Chitwan district will be felled. A budget of NRs. 220,266,768 has been estimated for the compensatory plantation.
Use of Forest Products (NTFPs) by Construction Workers	Construction workers will follow the code of conduct during works in forest area. Worker's camps and construction facilities will not be constructed in the forest/protected area.
Loss of Protected Species of Flora	Significant number of Sal will be lost during construction. Compensatory plantation will have these species as priority species, for conservation status in the plantation and other indigenous species will have focus and will be planted.
Impacts on wildlife	Reduction in loss of forest area: In forest area road width has been minimized to 24m to avoid/reduce impact on forest and wildlife habitat. No clearance of forests or reduce clearing of forest will help naturalize wildlife habitat to the maximum. Structures for Wildlife Crossing Points: The wildlife survey, supplemented by camera trapping study, road kill survey (Clevenger et al 2022) identified 21 critical points dedicated to construct specific wild animals' friendly structure (GON 2022). When most of the crossings detected were under-passes, over ground. Over-ground wildlife crossing was very vibrant in Adhabhar Corridor Forests (ACF)/PNP and Barandabar Corridor Forests (BCF). Endangered species like Asian elephant and Bengal tiger were most common, compared to other forests of PHN and Asian elephant was found migrating in herds of 70 and above, in addition to distractive loaders indulging in smashing structures and even human. This size of elephant population is reported growing. VIADUCT at PNP and BCF has been proposed for a natural flow of these vulnerable species. VIADUCT is designed for all the mammals travelling across the Adhabhar (East <> West) and Barandabar (North <> South), overground. 2001 m long VIADUCTs are proposed at Adhabhar (373+496) and 2001m long at Barandabar (Ch 465+356). Similarly, 3 very large animal crossing structure (VLACS) are proposed at Ch 382+897, Ch 391+096 and Ch 420+178. Large animal crossing structure (LACS) will be built at Ch 413+160, Ch

Environmental Impacts	Mitigation measures
	418+550, Ch 419+539, Ch 419+733 and Ch 429+939. Of the 10 crossings proposed for Medium Sized Mammals (Ch 382+752, Ch 383+636, 405+622, Ch 409+100, Ch 418+168, Ch 419+026, Ch 429+350, Ch 429+717, Ch 432+968 and Ch 435+520). The small animal crossing is as well upgraded at Ch 415+190. The underpass structures will be successful in keeping the animals away from the road. Funnelling fencing: Solar or electrified funnelling fencing (EFF) are proposed to guide and use the structure efficiently. <u>About 14,000 m of EFF is proposed in PNP and about 4000 m in BCF.</u> Waterholes and salt lick: Two waterholes will be constructed, on either side of VIADUCT and source and supply of water has been identified. Rhino Lake in the Barandabar and Kamini/Bridge no 1 source will be maintained. One salt lick each will be constructed in the ACF and BCF. Increase Light Index: Further to enhance the light index, after increasing the size of box culverts, in design an opening/hole be made in the middle of the structure (in the median – opening size of 3 m x 3 m). VIADUCT: 2001m long VIADUCT at Parsa National Park and 2001m long at Barandabar Corridor Forest has been proposed. Light index: The one-way VIADUCT/Bridges will stand at least 8 m apart. Soundproof barriers: The soundproof barriers will be constructed to keep sound away/down and block light during the night time, to maximize natural flow and use of structure by wildlife in both the VIADUCTS. Culverts and Bridge improvement: Use of culverts were found natural and the wildlife were found using the culverts for underground movement and a very dynamic overground movements in Adhabhar and Barandabar Corridor forests area (Clavenger, et.al. 2022 – (5.3.2)). All pipe culvert will be replace by Box Culverts (BC). This will enhance the mobility as the BC ground mobility will be increased with one and two wildlife walking lanes in BCs greater than 1.5 m x 1.5 m size. Two Wildlife Walking Lanes (WWL) are proposed under the Very Large Wildlife Crossing Structure (VLWC) and Large Wildlife Crossing Structure (LWC) structures. The wildlife crossing structures will have animal trail and waterway designed. All the culverts will have an opening of 3 m X 3 m is placed in the median of the highway to improve the light index and increased use of the culvert by the wildlife. Size of the box culvert for large wildlife will be increased considering the standard openness index advised by the Guidelines for wildlife friendly structures of the Government of Nepal (GON 2022), The Under Bridge Surfaces: Under bridge surface of bridge no 1, bridge no 2, bridge no 3, bridge no 4, Gundo bridge, Churiya bridge, Pakkipul bridge, Sansare bridge, Sayafut bridge, Badahakim bridge, Rapti bridge, Manohari bridge and Lothar Bridges are improvised for animals walking tracts to cross the highway. Most large bridge will have RCC base (upto 3 m) and later naturalize as wildlife tract. Dual function of Box Culverts and bridges: The upgraded box culverts will have its base designed as underpass in addition to the waterway functions. Depending upon the size, there are one or two wildlife tracks. Large bridge floors will have riverside of under-bridge of Bridge no 1, 2, 3, 4, Badahakim, Rapti, Manohari and Lothar as well for the Very large

Environmental Impacts	Mitigation measures
	wildlife, large wildlife and others to walk through. Canopy Bridges for canopy movers: 24 canopy bridges will be built for these arboreal species to cross PHN road. There are wildlife using air/canopy to move around in the forests. Awareness increasing: warning sign, speed limit, display board of wildlife will be erected in the crossing areas. To minimize noise and disturbance to wildlife honking will be restricted at sensitive wildlife crossing locations. Awareness on wildlife co-existence and regulation of illegal wildlife hunting to the community residing will be conducted in the periphery of highway. Camera trapping: Cameras will be installed at different locations for effectiveness monitoring. Existing Forest Fence: Existing fencing will be reinstated.
Disturbance on Wildlife Movement/ Wildlife Vehicle Collision	21 wildlife crossing structures (including VIADUCT at PNP and BCF along the other forest), canopy bridges, fencing has been proposed to reduce wildlife vehicle collision. Speed reduction: Warning sign, speed limit, display board of wildlife will be erected in the crossing areas. Informatory signboards on the presence of wildlife and importance will be installed along the forest sections that have wildlife movement. Camera trapping: Cameras will be installed at different locations for effectiveness monitoring. Fencing will prevent wild animals approach the highway, thus reduce wildlife vehicle collision.
A chance meeting with wildlife working on the road passing through the national parks (PNP), BCF, BZ Workers and Wildlife Safety	A chance meeting with wildlife while working at passing through the national parks, BCF, Buffer zone. Dawn & Dusk and wildlife movement timing will be avoided to avoid a chance meeting with wildlife especially working in the National Parks (Work 8AM to 6 PM in Summer and 9AM to 5 PM in Winter). Inform Park management of construction schedules, coordination with concern Office. Camp will not establish in the sensitive area (PNP, BCF, BZ). Workers will be in groups while working. Safety awareness will be provided to the workers for self-protection in case of wildlife encounter before start the work. One person to be deployed as watchman. Emergency response plan to be prepared. There will not be any ditches left uncovered or unfilled after the work is halted for the day. This will be a standard practice conducted for the safety of wild animals and construction team members and others. Worker's camps and construction facilities will not be constructed in the forest area.
Impact on Avifauna	In forest area, the design of road width has been minimized to 24 m, which will reduce impact on forest clearance and bird habitat. No construction materials will be disposed in critical forests and wetland area. If vegetation clearance takes place within the bird (including vulture) breeding season (October –April), trees will be checked for nests of vulnerable raptors or other large birds prior to felling. If active nests are identified, an exclusion zone will be established around the nest to avoid disturbance until the young have fledged. Unnecessary sounds produced equipment during the construction work shall be regulated through regular awareness and traffic no-horn zones. Roadside plantations and plantations of affected area will be carried out as soon as the construction work is completed.
Impact on Aquatic	Rivers will be channelized without disturbing river regime as far as possible. Sand and

Environmental Impacts	Mitigation measures
Life	gravel will not be extracted unless is approved by concerned authority and excavation will only be done from the approved locations without affecting the river regime. All affected locations will be reinstated immediately after the construction activity in the rivers is completed. Water flow will be maintained providing hume pipes during bridge construction. All chemicals, bitumen, oil and fuel will be stored in drums on impervious floor so that no leakage or spillage will reach water bodies. Fishing will be prohibited by the construction workers. Bridge and cross drainage work at river/streams will not be initiated during the fish spawning time (May/June to August/September). No disturbances will be created in the river system, as far as possible, during this time. Construction activities will be limited/ to be considered during this period.
Operation Stage	
Impact on Flora and Fauna, Monitoring and Biodiversity impact/study mitigation efforts	Regular maintenance of VIADUCT/ Underpass of wildlife crossing, regular cleaning, clearing and maintenance of all culverts to reduce the chances of blocking. Camera trapping: Cameras will be installed at different locations for effectiveness monitoring of wildlife crossing. Roadkill study: Conduct monitoring by installing devices to monitor wildlife movement, use of structures by wildlife. Together with respective DFOs, to be maintained recording of road kill.
Disturbance to Wildlife Movement/ Wildlife Vehicle collision	Installation of additional measures to reduce collisions between animals and vehicles (e.g. use of signs to alert drivers where animals frequently cross; installation of additional fencing along the roadway to direct animals toward crossing structures; and use of reflectors along the roadside to deter animal crossings at night when vehicles are approaching) Regular cleaning and maintenance of all wildlife crossing structures to reduce the chances of blocking and facilitate animal movement;
Awareness increasing activities	Warning sign, speed limit, display board of wildlife will be erected in the crossing areas. To minimize noise and disturbance to wildlife honking will be restricted at sensitive wildlife crossing locations. Awareness on wildlife co-existence and regulation of illegal wildlife hunting to the community residing will be conducted in the periphery of highway. Wildlife information: Informative signboards on wildlife, their presence and their importance to be installed along the forest area where wildlife movement. Workshops for locals for awareness-raising on forest fire/management/coordination, wildlife protection, wildlife and their relation with waste dumping (from vehicles), Speed limit, and Potential collision/Roadkill.
Maintenance of crossing structures and others	Regular maintenance of VIADUCT/ Underpass of wildlife crossing, regular cleaning, clearing and maintenance of all culverts to reduce the chances of blocking/cluging and facilitate wildlife movement. Conduct monitoring by installing devices for the wildlife movement and use of wildlife crossing facilities for wildlife. Together with respective PNP, CNP, DFOs, maintain recording of road kill.
Socio-economic and Cultural Environment	
Construction stage	

Environmental Impacts	Mitigation measures
Private structure Acquisition (The project will affect a total of 403 private structures of 378 HHs)	A Resettlement Action Plan (RAP) has been prepared to address compensation on the affected households. The affected households will not only receive cash compensation of structures, additional assistance will be given for relocation and livelihood restoration also. Additional cash compensation will be paid to vulnerable households. Livelihood restoration measures will also be implemented in accordance with the RAP.
Disruption of Community Structure and Public Utilities (During the road widening 180 community structures will be affected)	Prior inform to public before shifting of the public structures, utility. Take necessary process for clearance, transfer of funds etc. to the respective utility service provider so as not cause any delays to the road construction schedule. • Community structures- Rebuilt with consultation of the local community, local authorities, the cost is allocated in project cost • Irrigation canal and water supply lines – contractor will relocate the irrigation canal, water pipelines – provision in the engineering costs • Electric poles and power lines – coordination with Nepal Electricity Authority for relocation • Telephone lines – Telecommunication / Nepal Telecom • Public toilet– Coordination with local government • Access roads – Realign the roads before demolition of the existing roads • Tube wells -new tube well before demolishing the existing one
Impacts from Labour Influx	The Contractors will be aware of the possibility and risks of miscommunications between local residents and workers, to reduce conflicts; this will be prevented by raising awareness and implementing a Code of Conduct for the workers. The Contractor shall develop a Worker Code of Conduct to govern the behavior of workers on-site, in camps, and in local communities. Awareness campaign will conduct to construction workforce on spreading of sexually transmitted diseases such as HIV/AIDS, GBV. Construction camps will be built in the designated areas, located away from the settlements.
Occupational Health and Safety Risks	The contractor will be required to prepare, obtain approval and implement an occupational health and safety (OHS) plan for all identified hazards under each work activities, and site-specific OHS hazard and risks during construction, and control and preventive measures. Conduct a 'job hazard analysis at the new construction site to identify potential hazards that may arise from the proposed works or working conditions to the project workers and implement necessary control measures. Conduct regular training program for workers on occupational health safety (daily/weekly toolbox talks). Provide personal protective equipment (PPE) for workers (such as safety boots, helmets, masks, gloves, body harness, protective clothing, goggles, fully face eye shields and ear protection). Facilities of firefighting, ambulance, medical and rescue shall be provided at the site for implementation of an emergency response. The construction camp will be built with all adequate facilities (safe drinking water and sanitation, kitchen, rest areas, etc.) including entertainment facilities so that there will be minimal interaction between them and local communities. First aid facilities will be made available at the worksites and in the camps. The contractors will engage qualified first aider(s). Separate toilet facilities will be provided to men and women workers followed DoR's policy, manuals, guidelines.
Community	Safety Hazards due to construction vehicles: The contractor will develop and implement

Environmental Impacts	Mitigation measures
Health and Safety	comprehensive traffic management plan with adequate measures such as proposing traffic diversion measures, alternate routes for local traffic, avoiding school hours, following speed limits, etc. The plan will be implemented with the aim of preventing unsafe situations, especially near schools, settlement, market areas, construction areas Community Exposure to Work Hazards: Barricade the work areas with hard fencing to prevent the entry of community in the construction areas. Placing of adequate information, install signboards and flagmen to divert the community away from the construction works. Community awareness programs will be conducted on construction-related hazards and risks to the nearby people.
Risk of Gender-Based Violence	Ensure the sensitization and enforcement of code-of-conduct by the Contractor employees and workers and all other parties that are involved in the project implementation. Conduct awareness training of supervision consultant, contractor, sub-contractor and service providers staff to sensitize them about SEA, and SH.
Impacts on Religious Sites	Prior inform to public before shifting of the affected structures. Community temple will be rebuilt with consultation of the local community, local authorities, the cost is allocated in project cost. Chance Finding: During the construction encountering any finding of physical cultural resources at sites, the Contractor will follow Chance Find Protocol.
Operation Stage	
Road Safety	Maintenance of safety furniture's, pedestrian crossing (preferably over or under, zebra crossing the roadway); Crossing locations should take into account community preferences, including those related to convenience or personal safety. As per requirement additional signs, signals, markings, and other devices will be installed; Establishment of traffic signals, CC cameras for monitoring in the highway. Road safety awareness trainings will be conducted with coordination of local traffic police to drivers and locals.
Community Health and Safety	Maintenance and additional signs, signals, markings, and other devices will be installed Additional crossing locations will be constructed as per community preferences for safety of community. Road crossing infrastructures will be as principal of universal access. Temporary bypass will be managed while maintenance of the road. Manage temporary bypass while maintenance the road. Conduct road safety awareness trainings to drivers and locals.
Enhancement of RoW	Project/DoR will conduct awareness to local about RoW encroachment. With coordination of local government, enforcement of law, Conduct coordination for combined efforts of various governmental agencies and awareness activities.
Workers Health and Safety	Establishment of work zones safety to separate workers from traffic, Closure of lanes and divert the traffic to the remaining lanes if the road is wide enough (e.g.re-routing of all traffic to one side of a multi-lane highway). Where worker exposure to traffic use of protective barriers to shield worker from traffic vehicles, or installation of channeling devices (e.g. traffic cones and barrels) to delineate the work zone, regulate traffic flow by warning lights, flaggers.

10. Environmental Management Plan and Environmental Monitoring Plan

The Environmental Management Plan (EMP) presents the set of mitigation and management measures to be taken its location, timeframe, cost for implementation and institutional arrangement to ensure that no significant adverse impacts results from the project intervention. A detailed EMP matrix has been prepared and presented in Annex. A separate Resettlement Plan has been prepared to address social and resettlement issues. In addition, an Environmental Monitoring Plan (EMoP) has been prepared to guide key monitoring activities to ensure effectiveness of EMP implementation. The Department of Road /Project Directorate under the Ministry of Physical Infrastructure and Transport (MoPIT) is the implementing agency for the project and will be responsible for the overall implementation of environment safeguards under the project. The Supervision Consultants (SC) including an environmental specialist will oversee environment safeguard activities to support DoR / Project Directorate. The cost for the proposed mitigation measures and enhancement measures on physical, biological, socio-economic and cultural environment of PHN road has been estimated NRs 12,461,929,581.

11. Environmental Auditing

Environmental Auditing will be carried out to examine and assess performances of the road project related to environment and its conservation and protection. Audit will be undertaken after two years from the project completion. Ministry of Forests and Environment is responsible for conducting environmental auditing.

12. Conclusion and Commitment

The proposed PHN road is an existing 2 lanes and will improve 4 lanes road including bridges and support capacity, quality and safety improvements of the road. Implementation of the proposal will have significant beneficial impacts on human life, income generation from employment, skill enhancement during the construction stage and increased income from improved access for market to agricultural products. The upgraded road will provide smooth, easy and quick access to traffic eliminating existing traffic congestion and reduction in roadway accidents. Most importantly the upgrading of the road will reduce travel time (60 minutes) and cost, running costs of vehicles such as fuel economy, reduction in wearing and tearing of vehicle parts, reduce greenhouse gas emission. After construction it is expected to reduce Wildlife-Vehicle Collisions: 4002m VIADUCT (2001m at BFC and 2001m at PNP) and 19 underpass crossing structures have been proposed for the PHN road.

Approximately 245.64 ha land use pattern of RoW will be changed into asphalt road. Construction activities will increase air, noise and water pollution thus adequate mitigation measures are proposed in order to minimize the pollution. In total 23,326 trees will be felled down from the RoW. The

alignment passes through PNP, BZ, BCF, and forest in different sections, which effect on wildlife movement during the construction period. The project has proposed 21 wildlife friendly structures including VIADUCT, canopy bridges, fencing. A RAP has been prepared to address 403 private structures (except Hetauda Bazaar area) of 378 households by the project. Out of the 403 private affected structures, 272 are fully affected and 131 are partially affected. Around 180 community structures and public utilities will be sifted coordination with local people, the local government and other concerned authorities. All affected private structures will be compensated as per resettlement plan (RP).

The project has prepared EMP and EMoP which includes detail mitigation measures to enhance and mitigate adverse impacts. NRs. 12,461,929,581 is proposed for environmental mitigation and enhancement cost. The proponent is committed to implement and monitored the proposed mitigations measures mentioned in the EIA/EMP.

कार्यकारी सांराश

१. पृष्ठभूमि

पूर्व-पश्चिम राजमार्ग नेपालको प्रमुख आन्तरिक तथा अन्तर्राष्ट्रिय व्यापारिक राजमार्ग हुनुका साथै एसियाली राजमार्ग - २ (AH-2) को खण्ड पनि रहेको छ। दक्षिण एसियाली उपक्षेत्रीय आर्थिक सहयोग (SASEC) सडक सुधार आयोजनाले पूर्व-पश्चिम राजमार्गमा पर्ने पुलहरूसहित २७० किमी सडकखण्ड स्तरोन्नति गर्दै छ, जसमध्ये काकरभित्ता-लौकाही सडकखण्ड- १२० कि मी, बुटवल – गोरुसिन्धे सडकखण्ड – ५० कि. मि. तथा पथलैया-हेटौँडा-नारायणघाट सडकखण्ड १०० किमी रहेको छ। यस प्रस्तावित आयोजनाले पथलैया-हेटौँडा-नारायणघाट सडकखण्डका सबै पुल पुलेसाहरूसहित २ लेनको सडकलाई ४ लेनमा स्तरोन्नति गर्ने छ। यो सडकखण्ड मधेश प्रदेशको बारा जिल्ला र बागमती प्रदेशको मकवानपुर र चितवन जिल्ला भएर गएको छ। पथलैया-हेटौँडा-नारायणघाट सडक, स्तरोन्नति पश्चात ट्राफिक जाम न्यूनीकरण, यात्रा गुणस्तर अभिवृद्धि तथा सडक सुरक्षामा सुधार ल्याउने छ।

२. प्रस्तावक र परामर्शदाता

प्रस्तावित पथलैया-हेटौँडा-नारायणघाट सडकको प्रस्तावक आयोजना निर्देशनालय-(ए.डी.बी.), सडक विभाग, भैतिक पूर्वाधार तथा यातायात मन्त्रालय रहेको छ।

प्रस्तावकको ठेगाना

आयोजना निर्देशनालय-(ए.डी.बी.)

सडक विभाग

विशालनगर, काठमाडौँ, नेपाल

टेलिफोन नं. ०१-४५३७४९२, ४५३७४९३

फ्याक्स नं. ०१-४५३७४८८ ; ईमेल : pdadb@dor.gov.np

यस आयोजनाका प्रस्तावकले आयोजनाको विस्तृत डिजाइन र वातावरणीय प्रभाव मूल्याङ्कन गर्नका लागि Soosung Engineering Co. र ERM-TSE, बालुवाटार, काठमाडौँलाई आयोजना तयारी परामर्शदाताको रूपमा नियुक्ति गरेको छ।

३. वातावरणीय प्रभाव मूल्याङ्कनको सान्दर्भिकता

यस आयोजनाअन्तर्गत १०० किमी सडक र सडकखण्डमा पर्ने सबै पुल पुलेसाहरूको स्तरोन्नति गरिने छ। वातावरण संरक्षण ऐन, २०७६ र वातावरण संरक्षण नियमावली, २०७७ (संशोधन २०७८)को अनुसूची ३, नियम ३, ड (६)मा गरिएको व्यवस्थाअनुसार ५० किमीभन्दा बढी लम्बाइको राष्ट्रिय राजमार्ग वा सहायक सडकको चौडाइ वृद्धि हुने गरि स्तरवृद्धि, पुर्नस्थापना वा पुर्ननिर्माण गर्दा वातावरणीय प्रभाव मूल्याङ्कन अनिवार्य रहेको उल्लेख छ।

यो सडक पर्सा राष्ट्रिय निकुञ्ज र यसको मध्यवर्तीक्षेत्र, चितवन राष्ट्रिय निकुञ्जको मध्यवर्तीक्षेत्र, बराण्डाभार कोरिडोरक्षेत्र र चुरे संरक्षणक्षेत्र हुँदै गएको छ। वातावरण संरक्षण नियमावली, २०७७ को नियम ३, अनुसूची ३(क)को सूची १२ अनुसार राष्ट्रिय निकुञ्ज, वन्यजन्तु आरक्षक्षेत्रमा कुनै आयोजना कार्यान्वयन गर्दा वातावरणीय प्रभाव मूल्याङ्कन अनिवार्य रूपमा गर्नुपर्ने व्यवस्था उल्लेख छ।

वातावरण संरक्षण नियमावली, २०७७ को नियम ७ को उपनियम (८)मा विदेशी लगानी भएको कुनै प्रस्तावको हकमा वातावरणीय अध्ययन प्रतिवेदन तयार गर्दा नेपाली वा अङ्ग्रेजी भाषामा तयार गर्न सकिने उल्लेख छ। यस आयोजना एसियाली विकास बैङ्क (ADB)को सहयोगमा सञ्चालन भएकाले सोही प्रावधानअनुसार वातावरणीय प्रभाव मूल्याङ्कन प्रतिवेदन अङ्ग्रेजी भाषामा तयार गरिएको छ।

४. वातावरणीय प्रभाव मूल्याङ्कनका उद्देश्यहरू

यस आयोजनाको वातावरणीय प्रभाव मूल्याङ्कन (EIA)का उद्देश्यहरू निम्नानुसार रहेका छन् :

- आयोजनाबाट प्रभावित क्षेत्रका भौतिक, जैविक, आर्थिक सामाजिक तथा सांस्कृतिक वातावरणसम्बन्धी आधारभूत जानकारी सङ्कलन गर्नु,
- आयोजनाका कारण भौतिक, जैविक, सामाजिक-आर्थिक, सांस्कृतिक तथा रासायनिक वातावरणमा पर्न सक्ने सम्भावित सकारात्मक तथा नकारात्मक प्रभावहरूको विश्लेषण तथा मूल्याङ्कन गर्नु,
- नकारात्मक प्रभावहरू न्यूनीकरण तथा सकारात्मक प्रभावहरू प्रवर्द्धन गर्नका लागि व्यावहारिक र स्थल विशेषका न्यूनीकरण उपायहरू प्रस्ताव गर्नु,
- वातावरणीय व्यवस्थापन योजना तथा वातावरणीय अनुगमन योजना तयार गर्नु,
- प्रस्तावित आयोजनाले वातावरणमा पार्न सक्ने प्रभावहरूका सम्बन्धमा निर्णयकर्ता निकाय र सरोकारवालाहरूलाई आवश्यक जानकारी उपलब्ध गराउनु,
- आयोजनाको सम्पूर्ण चरणहरूमा सार्वजनिक सहभागिताको अवसर प्रदान गर्नु,

- आयोजना कार्यान्वयनका लागि आवश्यक संस्थागत संरचना परिभाषित गर्नु।

५. आयोजनाको विस्तृत विवरण

पथलैया-हेटौंडा-नारायणघाट सडकखण्ड पूर्व-पश्चिम राजमार्गको पथलैया (चे ३६७+६३०)बाट सुरु भई भरतपुर गोन्द्राङ (चे ४६७+३२०)मा पुगेर टुङ्गिन्छ। पूर्व-पश्चिम राजमार्गअन्तर्गतको पथलैया-हेटौंडा-नारायणघाट सडकखण्डको लम्बाइ १०० कि.मी. रहेको छ। यस सडकखण्डको अधिकांश भागमा पुर्ववत क्यारिज वे (Carriage way) चौडाइ ७ मिटर (२ लेन) रहेको छ भने केही सहरी क्षेत्रमा चार लेनको रहेको छ।

हेटौंडा बजारबाहेक यस सडकको क्षेत्राधिकार केन्द्रबाट दुवैपट्टि २५ मिटर गरी कुल ५० मिटर रहेको छ। पूर्व-पश्चिम राजमार्गको क्षेत्राधिकार नेपाल सरकारको भौतिक पूर्वाधार तथा यातायात मन्त्रालयको अधिकार क्षेत्रभित्र रहेको राजपत्र प्रकाशन गरी कानुनी रूपमा घोषित गरिएको छ।

यो सडकखण्ड मुख्यतया अमलेखगन्ज (चे ३७६+०००), हेटौंडा (चे ३६९+५००), मनहरी (चे ४२५+७००), लोथर (चे ४३६+९६०), भन्डारा (चे ४४७+०००), पर्सा (चे ४५४+३००), टाँडी (चे ४५९+८००) र भरतपुर (चे ४६७+३२०) जस्ता बजार/वस्तीक्षेत्र, पर्सा राष्ट्रिय निकुञ्ज र यसको मध्यवर्तीक्षेत्र, बरण्डाभार कोरिडोर र कृषियोग्य जमिन र घना जङ्गल भएर गएको छ।

यस सडकखण्ड पथलैया देखि अमलेखगन्ज (चे ३६८+००० देखि चे ३७५+९००) सम्म आधाभार घना जंगल, सिवालेक (चे ३८०+००० देखि चे ३७५+९००), रजिया जंगल खण्डहरु (चे ४०४+९४० देखि चे ४०६+५४०), (चे ४०८+८२० देखि चे ४१०+८४०), (चे ४१२+७४० देखि चे ४२०+७४०) तथा (चे ४२६+७५० देखि चे ४३९+९००) मनहरी – लोथर बनक्षेत्रमा पर्दछ। बरण्डाभार कोरिडोरक्षेत्र चे ४६३+६०० देखि चे ४६७+३२० सम्म पर्दछ। यस सडकखण्डको चे ३७०+५५० देखि चे ३७४+००० पर्सा राष्ट्रिय निकुञ्जमा पर्दछ जसलाई जंगली एसिएन हात्ती, पाटेबाघ, एक सिँघे गैडा तथा अन्य जंगली जनावरहरुको आवतजावत गर्ने मुख्य बन्धन कुरिडोर रहेको छ र चे ३६७+६३० देखि चे ३७०+५५०, चे ३७४+००० देखि चे ३८७+२०० सम्म, चे ३८७+२०० देखि चे ३९१+७०० र चे ४१९+२५० देखि चे ४३२+२०० सम्म पर्सा राष्ट्रिय निकुञ्जको मध्यवर्तीक्षेत्र पर्दछ।

यस आयोजनाअन्तर्गत विद्यमान सडक तथा पुलहरू एसिएन राजमार्ग-II मापदण्डमा स्तरोन्नति गरिने छ। सडकको चौडाइ सहरी क्षेत्रमा ५० मी, अर्धसहरी (सहरोन्मुख) क्षेत्रमा ३७.४ मी. र ग्रामीण तथा वनक्षेत्रमा २४ मी. कायम गरिएको छ। सडक स्तरोन्नतिका अवयवहरूअन्तर्गत १०० किमीको सडकखण्डलाई २ लेनबाट ४ लेनमा स्तरोन्नति गर्ने, पेभमेन्ट स्तरोन्नति, ज्यामितीय सुधार, २० स्थानमा चोक सुधार, सडकका दुवै भागमा सर्भिस रोड, साइकल लेन, सहरीक्षेत्रमा फुटपाथ, पैदलयात्रु क्रसिङका लागि ६ स्थानमा आकासेपुल र १२ स्थानमा अन्डरपास, ४ किमीभन्दा बढी लम्बाइ भएको २ भायडक्ट (Vaiduct)सहित २१ स्थानमा वन्यजन्तु क्रसिङ स्ट्रक्चरहरु (जंगली एसिएन हात्ती, शाही बेंगल बाघ, एक सिँघे गैडा तथा अन्य जंगली जनावरहरु), टेवा वाल: ४,५२६ घन मिटर ग्याबिन वाल, २१५,०९१ घन मिटर आर.सी.सी. टेवा वाल तथा Earth Reinforced Wall ५४,०७२ वर्ग मिटर, स्लोप संरक्षण तथा स्लोप स्थिरिकरण को लागि सिभिल इन्जिनियरिङ साथै जैविक इन्जिनियरिङका उपायहरु अवलम्बन गरिएको छ, ४१ वटा (२२ वटा पूर्ववत तथा १९ वटा नया बक्स बृज) पुलहरू र २४६ बक्स कल्भर्ट निर्माण, ड्रेनेज सुधारका लागि १७४,६१२ मी. आर. सी. सी. साइड ड्रेन निर्माणका कार्यहरू रहेका छन्। प्रस्तावित पुलहरूका लागि १०० वर्ष रिटर्न फ्लो, कल्भर्टहरूका लागि ५० वर्ष रिटर्न फ्लो र साइड ड्रेनका लागि २५ वर्ष रिटर्न फ्लोमा डिजाइन गरिएको छ। प्रस्तावित स्तरोन्नतिका कार्यहरू सडकको ५० मी. क्षेत्राधिकारभित्र सम्पन्न गरिने भएकाले क्षेत्राधिकारभन्दा बाहिर स्थायी रूपमा थप जमिन आवश्यक पर्ने छैन।

सडक र पुल निर्माणका लागि कुल नेरु ५४,२९३,६४७,५२६ लागत लाग्ने अनुमान गरिएको छ। यो आयोजना २०२६ सालमा सुरु भएर ३ वर्षमा सम्पन्न हुने अनुमान गरिएको छ। यस आयोजनाको डी.एल.पी. (ट्रुटि सच्याउने अवधि) १२ महिना र पी. बी.एम. (कार्यसम्पादनमा आधारित मर्मत सम्भार) ५ वर्षको हुने छ।

६. अध्ययन विधि

अध्ययन विधिमा मुख्यतया सन्दर्भसामग्रीको अध्ययन, स्थलगत सर्वेक्षण, अन्तर्क्रिया र परामर्श समावेश छ र म्याट्रिक्स विधि साथै द्वितीय स्रोत बाट प्रभाव मूल्याङ्कन र पहिचान गरिएको छ। स्थलगत सर्वेक्षण पुर्व Desk Study गरिएको थियो। द्वितीय स्रोतहरु विभिन्न माध्यमहरुबाट संकलन गरिएको थियो। बिस्तृत इन्जिनियरिङ डिजाइन, Inventory Report of Alignment, भौतिक, जैविक तथा सामाजिक आर्थिकका द्वितीय जानकारी, संभाव्यता अध्ययन प्रतिवेदन, आयोजनाबाट प्रभावित जिल्लाहरूका जिल्ला पार्श्वचित्र तथा नगरपालिकाका पार्श्वचित्र, नक्साहरु जस्तै : सडक रेखाङ्कन नक्सा, स्थालाकृतिक नक्सा साथै भौगर्भिक तथा भू-उपयोगिय नक्साको पनि पुनरावलोकन गरिएको थियो। वातावरण संरक्षण नियमावली, २०७७, सडक विभागको वातावरण तथा सामाजिक व्यवस्थापन रूपरेखा ESMF, २०२३, एडिबीको Safeguard Policy Statement (SPS), २००९, एडिबीको ESF २०२४, डिभिजनल वन कार्यालय (चितवन, बारा, मकवानपुर), चुरे विकास बोर्ड, पर्सा तथा चितवन राष्ट्रिय निकुञ्जबाट प्रकाशित प्रतिवेदनहरू, राष्ट्रिय तथ्याङ्क कार्यालयबाट प्राप्त जनसङ्ख्या तथ्याङ्क, प्रभावित नगरपालिकाहरूको पार्श्वचित्र, साथै ADB TA रिपोर्ट : Smart Infrastructure Planning and Design to Protect Natural Habitats and Biodiversity: Ecological Assessment of the PHN Road Upgrading, वनसम्बन्धी नियमावली, २०२२, जैविक विविधता मूल्याङ्कन (WWF, २०१६, २०१७) लगायतका सम्बन्धित प्रकाशित प्रतिवेदनहरूको अध्ययन गरिएको थियो। यसैगरी, आयोजनासँग सम्बन्धित अन्य प्रचलित नीति, ऐन, नियम, निर्देशिका, मार्गदर्शन र प्रकाशित दस्तावेजहरूसमेतको समीक्षा गरिएको थियो। प्रचलित ऐन, नियम, नीति, नियमावली, निर्देशिका आदिको पुनरावलोकन गरिएको थियो।

आयोजनाक्षेत्रको भौतिक, जैविक र सामाजिक तथा आर्थिक वातावरणसम्बन्धी तथ्याङ्क सङ्कलन, अध्यावधिक र प्रमाणीकरणका लागि मिति २०२२ को अगस्ट, २०२३ को मार्चदेखि मे र २०२४ को नोभेम्बरदेखि डिसेम्बरसम्म वातावरणीय अध्ययन टोली आयोजनाक्षेत्र खटिएका थिए।

आयोजनाबाट प्रत्यक्ष र अप्रत्यक्ष रूपमा प्रभावित हुने क्षेत्रहरूमा सडक रेखाङ्कन नक्सा साथ साथै स्थलाकृतिकनक्सा र उपग्रह फोटोहरूको विश्लेषण तथा फिल्ड प्रमाणीकरणबाट पहिचान गरिएको थियो। आयोजनाक्षेत्रको तापक्रम, वर्षा र अन्य जलवायुसम्बन्धी तथ्याङ्कहरू जल तथा मौसम विज्ञान विभागबाट सङ्कलन गरियो। आयोजनाक्षेत्रको भूविज्ञानसम्बन्धी र जल बिज्ञान सम्बन्धि जानकारीहरू यस आयोजनाअन्तर्गत तयार पारिएको बिस्तृत आयोजना प्रतिवेदन बाट साभार गरिएको छ। वायुको गुणस्तर र ध्वनिको स्तर २०२३ साल अप्रिल र मे महिनामा यस सडकखण्डको २८ ओटा स्थानबाट सङ्कलन गरिएको थियो। त्यस्तै भूमिगत पानी तीन स्थानबाट र सतहको पानी प्रमुख ९ ओटा खोलाहरूबाट सङ्कलन गरी गुणस्तर मापन गरिएको थियो।

यस सडकखण्डमा पर्ने रुखबिरुवाहरूको मापनका लागि वन नियमावली २०७९ अवलम्बन गरियो साथै सिडलिङ, स्पापलिङ, गैरकाष्ठ वन पैदावार र औषधीजन्य बिरुवाका लागि सामुदायिक वनस्रोत सर्वेक्षण मार्गदर्शन, २०६१ बमोजिम प्लटहरू तयार गरियो। स्थलगत अध्ययनको समयमा वन्यजन्तुका वासस्थान, दुर्लभ र लोपोन्मुख रुख बिरुवाहरूसम्बन्धी तथ्याङ्क/जानकारीहरू प्रत्यक्ष अवलोकन, स्थलगत सर्वेक्षण/म्यापिङ, द्वितीय स्रोतहरू र अन्तर्वार्ताबाट सङ्कलन गरियो। वन नियमावली २०२२ मा तोकिएबमोजिम कुल बायोमास र कुल कार्बन स्टक मापन गरियो। जङ्गली वन्यजन्तु सर्वेक्षणको समयमा पगमार्क, पदचिन्ह, वडकुला, मलमुत्र, गोबर र रुखहरूमा नङ्गाचिन्ह पहिचान गरियो। चराचुरुङ्गीहरूको विविधताको अध्ययनका लागि पोइन्ट काउन्ट विधिको अवलम्बन गरियो जसअन्तर्गत चराचुरुङ्गीहरूको अवलोकनका लागि १३ स्थानहरू पहिचान गरियो। यसका साथै वन्यजन्तु, मानव वन्यजन्तु द्वन्द्व र वन्यजन्तुको सडक पार गर्ने क्षेत्रका सम्बन्धमा पर्सा रा.नि, चितवन रा.नि, डिभिजन तथा सब डिभिजन वन कार्यालय, स्थानीय वन व्यवस्थापन समूहका साथै लक्षित समूहहरूसँग पनि छलफल गरियो।

मिति २०२२ जुलाई १ देखि २०२२ अगस्ट ३० सम्म कुल १८६७ ओटा घरधुरीमा सर्वेक्षण गरियो। यस सर्वेक्षणमा परिवारको वार्षिक आम्दानी, पेसा र परिवारका सदस्यहरूको उमेर समूह, शैक्षिक योग्यता, जोखिमको अवस्था र आयोजना प्रभावितहरूको अन्य आवश्यक जानकारीहरू सङ्कलन गरियो।

यस आयोजनाक्षेत्रमा कुल ५५ (पचपन्न) ओटा परामर्श बैठकहरू, धेरै संख्यामा विभिन्न लक्षित समूहसंग छलफल सञ्चालन गरिएको थियो भने मिति २०८२ वैशाख ६ देखि २०८२ वैशाख १० गते सम्म ७ (सात) स्थानहरूमा सार्वजनिक सुनुवाइ सञ्चालन गरिएको थियो। सरोकारवालाहरूबाट राय सुझाव प्राप्त गर्न सार्वजनिक सूचना प्रकाशन गरिएको थियो। वातावरण संरक्षण नियमावली, २०७७ को नियम ७(२)अनुसार, लिखित सुझावका लागि प्रभावित पालिकाहरू, वडाकार्यालयहरू, विद्यालयहरू, स्वास्थ्य चौकीहरू तथा अन्य सार्वजनिक स्थानहरूमा सूचना टाँस गरिएको थियो। साथै, सुझाव सङ्कलनका लागि ७ (सात) दिनको सार्वजनिक सूचना राष्ट्रिय दैनिक पत्रिका 'कान्तिपुर'मा मिति २०८२ साल वैशाख २९ गते प्रकाशित गरिएको थियो। प्रभावित पालिकाहरू तथा अन्य सरोकारवाला निकायहरूबाट सिफारिस पत्रहरू सङ्कलन गर्नाका साथै प्राप्त सुझाव तथा प्रतिक्रिया पनि सङ्कलन गरिएको कार्यक्रम थियो।

७. विद्यमान वातावरणीय अवस्था

७.१. भौतिक वातावरण

प्रस्तावित सडक आयोजना तराई, चुरे र दुन उपत्यका भएर गएको छ। यो सडकखण्ड पथलैयाबाट सुरु भएर भरतपुरको गोन्द्राङमा पुगेर अन्त्य भएको छ। यो सडकखण्ड सामुद्रीसतहबाट १७८ मी. (पथलैया)देखि ६८८ मी. (चुरियामाई)सम्मको उचाइमा रहेको र अन्तिम बिन्दु (गोन्द्राङ)को उचाइ २०४ मी. छ। यस आयोजनाअन्तर्गत कुल सडक खण्डमध्ये १९.५२ किमी बारा जिल्लामा, ५०.१५ किमी मकवानपुर जिल्लामा र ३०.०२ किमी चितवन जिल्लामा पर्छ। आयोजना क्षेत्रको औसत उच्च तापक्रम २०.८ से. देखि ३२.६ से. सम्म र औसत न्यूनतम तापक्रम ९.४ से. देखि २४.६ से. सम्म रहेको छ। यस क्षेत्रको वार्षिक वर्षा २४०७ मिमी रहेको छ। यस सडकखण्डमा हुने वर्षाको करिब ८०% वर्षा मनसुन (जुलाई – सेप्टेम्बर) मा हुने गरेको पाइयो।

चुरेक्षेत्रमा खस्रो र नरम स्यान्डस्टोन, सिल्टस्टन र मडस्टोन रहेको छ । माटोको बनोट मा ग्रेगर, बालुवा तथा माटाका मसिना सप्प्रीसनहरू रहेका छन्। यो आयोजनाक्षेत्र मध्यमदेखि उच्च भूकम्पीय जोखिम (३-५) क्षेत्रमा पर्दछ। मनसुनको समयमा आयोजनाक्षेत्र नदी कटान र बाढीको जोखिममा पर्छ। आयोजनाक्षेत्र (पर्सा, टाँडी, मनहरी) मनसुनको समयमा नदी कटान तथा बाढीको जोखिममा पर्ने क्षेत्रहरू हुन्। पहिरो र भूक्षयहरू चे ३८२+१८०, चे ४०५+९४०-चे ४०६+२५०, चे ४०६+७००, चे ४०९+९००-चे ४१०+३००, चे ४१२+२५०, चे ४१४+०००, चे ४१४+१५०, चे ४१५+०००-चे ४१५+४००, चे ४१८+१००-चे ४१८+५००, स्थानहरू खोल्सी कटान चे ३८५+३७०, चे ३८५+३००, चे ३८६+४२३, चे ३८६+००० स्थानमा पहिचान भएको छ। High embankment चे ४०१+३००-४०९+६०० कर्रा पुल, मरदार पुल चे ४४४+२७९ को दुवैपट्टि, खगेरी पुल चे ४६२+५०० र चे ४४४+२७९ लगायतका अभिलेख गरिएको छ।

पी.एम. २.५ र पी.एम. १० को मात्रा मुख्यतया सवारीसाधनबाट निस्कने प्रदूषण, स्थान विशेष क्रियाकलाप र आयोजनाक्षेत्र वरिपरिका औद्योगिक क्षेत्रका कारण प्रभावित हुने गरेको छ। पी.एम. २.५ को मात्रा पुल नं ३ मा ३५.६९ $\mu\text{g}/\text{m}^3$ देखि मनहरी पुलक्षेत्रमा ९१.४६ $\mu\text{g}/\text{m}^3$ सम्म रहेको छ भने पी.एम. १० को मात्रा घडियाउलीमा ४९.८२ $\mu\text{g}/\text{m}^3$ देखि राजैयामा १६३.८६ $\mu\text{g}/\text{m}^3$ सम्म मापन भएको छ। औसत २४ घण्टाको ध्वनिको मात्रा दिउँसोको समयमा ५५ डिबी (ए)देखि ७३ डिबी (ए)सम्म र रातको समयमा ३० डिबी (ए)देखि ४२ डिबी (ए)सम्म रहेको छ। खानेपानीको लागि तिन स्थानबाट नमुना सङ्कलन गरिएको थियो । पानीको गुणस्तर नेपाल खानेपानी गुणस्तर

मापदण्ड संग तुलना गरिएको छ, जुन स्वास्थ्यको हिसाबले खानयोग्य पाइएको छ। सतही पानीको नमुना ९ स्थानबाट संकलन गरियो तथा सतही जलप्रवाह मापदण्डहरूसँग मिल्दोजुल्दो पाइएको छ। लोथर खोलामा E. coli २०० CFU/१००mL भन्दा बढी मापन भएकाले यसले स्थानविशेषमा प्रदूषण भएको सङ्केत गर्दछ।

यस सडकखण्डको विभिन्न स्टेसनहरूमा गरिएको गणनाअनुरूप प्रतिदिन करिब १२००० देखि २५००० सवारीसाधनहरू आवतजावत हुन्छन्। नारायणघाट, हेटौँडा लगायतका सहरीक्षेत्रमा अन्य ठाउँहरूको तुलनामा बढी सवारी रहेको छ। सडक किनारका बजारहरू, साना किराना पसलहरू तथा सब्जी पसलहरू, होटलहरू, रेस्टुराँहरू तथा साना चिया पसलहरू यस सडकखण्डमा उत्पन्न हुने फोहोरको स्रोतका रूपमा रहेको छ। यस सडकले २२ नदीहरू पार गर्दछ। कर्ना, राप्ती, मनहरी, लोथर आयोजनाक्षेत्रका प्रमुख नदीहरू हुन्। सीमसारक्षेत्र पानीको अर्को स्रोत हो। बरण्डाभार करिडोर वनमा राइनो ताल चे ४६६+५०० (सडकबाट १६०० मिटर टाढा), कालीमाटी ताल (सडकबाट देब्रे १८०० मिटर टाढा), चेपाङ ताल (सडकबाट देब्रे २०० मिटर टाढा) र बिसहजारी ताल (सडकबाट करिब ४ किलोमिटर टाढा) अवस्थित छन्।

निर्माण सामग्रीहरूका १६ सम्भावित स्रोतहरू/स्थानहरू (ढुङ्गा, गिट्टी, बालुवा, सब बेस, बेस कोर्स र असफाल्ट कन्क्रिट चिप्स) पहिचान गरिएको छ। उत्खनन क्षेत्रको निक्कौल कार्यान्वयन चरणमा निर्धारण गरिने छ। चुरेक्षेत्र, मध्यवर्तीक्षेत्र वा वनक्षेत्रमा पर्ने खोलाका जमाव वृद्धि (Aggregation) घटाउन संकलित निर्माण सामग्री प्रयोग गर्न सकिनेछ। उत्खनन कार्य गर्न उपकरण र श्रम (जस्तै- पिक, सावेल, लोडर, एक्साभेटर, ट्रक, श्रमिक इत्यादि) को प्रयोग गरिने छ।

७.२. जैविक वातावरण

पथलैया-हेटौँडा-नारायणघाट सडक पर्सा राष्ट्रिय निकुञ्ज/आधाबार कोरिडोर वनक्षेत्र, पर्सा राष्ट्रिय निकुञ्जको मध्यवर्तीक्षेत्र चितवन राष्ट्रिय निकुञ्जको मध्यवर्तीक्षेत्र, बरण्डाभार कोरिडोर संरक्षित क्षेत्र साथै अन्य वनक्षेत्र भएर गएको छ। पर्सा राष्ट्रिय निकुञ्जको वनक्षेत्र पथलैयाबाट सुरु भएर अमलेखगन्जमा टुङ्गिन्छ। यो सडक उष्ण र उपोष्ण वनक्षेत्र हुँदै गएको छ, जसमा पथलैया (३६८+०००) देखि अमलेखगन्ज (३७५+९००) बीच रहेका सालका रुखहरूको बाहुल्यता छन्। चुरे क्षेत्र र दुन क्षेत्रमा भने नदि किनारामा पाइने किसिमको वन पाइएको छ। ४०४+९४० देखि ४०६+५४० ; ४०८+८२० देखि ४१०+८४० ; ४१२+७४० देखि ४२०+७४० ; ४२६+७५० देखि ४३९+९०० लगाएत मनहरी – लोथर वनक्षेत्र र बरण्डाभार कोरिडोर वनहरूमा पनि साल प्रजातिका बाहुल्यता पाइएको छ।

सालको वनमा मुख्यतया सालका प्रजाति (*Shorea robusta*) र मुख्य सहयोगी प्रजातिहरूमा भलायो (*Anacardium*, बर्रो (*Terminalia Bellirica*), असना (*Terminalia Alacta*) को बाहुल्यता रहेका छन्। रुखहरू गणना सर्वेक्षण गर्दा आयोजना निर्माण चरणमा २३,३२६ रुखहरू काटनु पर्ने देखिएको छ। जसमध्ये बारा जिल्लाबाट ९,६४६ रुखहरू, मकवानपुर जिल्लाबाट १०,२७८ रुखहरू र बाँकी ३,४०२ रुखहरू चितवन जिल्लाबाट काटान गरिने छ। रुख गणना सर्वेक्षणका क्रममा ६,७६७ लाथा (Sapling) (१० dbh भन्दा कम)को रेकर्ड गरिएको थियो। रुखहरू गणना सर्वेक्षण गर्दा बर, पिपल र समि गरि जम्मा ४०४ ओटा रुखहरू काटनु पर्ने देखिएको छ।

सर्वेक्षण दौरान रेकर्ड गरिएको प्रजाति जामुन (*Syzygium cumuni*), बर्रो (*Terminalia bellirica*), हर्रो (*Terminalia chebula*), टाटरी (*Dillenia pentagyna*), अम्बक (*Psidium guajava*), चिउरी (*Aesandra butyraceae*), अमला (*Phyllanthus emblica*), जस्ता प्रजाति औषधीजन्य वनस्पतिहरू रहेका छन्। फिल्लि सर्वेक्षण दौरान पहिचान गरिएको रुखका प्रजातिहरूमा साल (*Shorea robusta*), विजयसाल (*Pterocarpus marsupium*) र सतिसाल (*Dalbergia latifolia*) लाई नेपाल सरकारले संरक्षित वनस्पतिका रूपमा राखेको छ। विश्वव्यापी रूपमा साल (*Shorea robusta*), र विजयसाल (*Pterocarpus marsupium*) र सतिसाल (*Dalbergia latifolia*) सङ्कटापन्न अवस्थामा रहेको वनस्पति हो। आयोजनाक्षेत्रका वनक्षेत्रहरू सामुदायिक वनव्यवस्थापन, साझेदारी वनव्यवस्थापन तथा निजी वनव्यवस्थापन (बस्तीभित्रका वन/रुखहरू) अभ्यासहरू अन्तर्गत सञ्चालनमा रहेका छन्।

यो सडक पर्सा राष्ट्रिय निकुञ्ज (चे ३७०+५५० देखि चे ३७४+०००), पर्सा राष्ट्रिय निकुञ्ज र चितवन राष्ट्रिय निकुञ्जको मध्यवर्तीक्षेत्र र बारण्डाभार कोरिडोर वनक्षेत्र (चे ४६३+६०० देखि चे ४६७+३२०)का मुख्य क्षेत्रहरूमार्फत जान्छ, जहाँ वन्यजन्तुको आवागमन उच्च रहेको छ। आयोजनाक्षेत्रमा ५९ प्रजातिका स्तनधारीहरूको (Survey 2023/024) वासस्थान रहेको छ। जंगली एसिएन हात्ती (*Elephas maximus*), पाटेबाघ (*Panthera tigris tigris*), एकसिङ्गे गैंडा (*Rhinoceros unicornis*), तराई ग्रे लंगुर (*Semnopithecus hector*) साथै अन्य प्रजातिका वन्यजन्तुहरू आवतजावत भइरहेको पाइयो। (Clavenger 2022). अध्यनका क्रममा ४ ओटा अत्यन्त सक्रिय जैविक मार्गको पहिचान गरिएको छ। तराई देखि तराई जोड्ने, आधाभार कोरिडोर वन भएर जंगली एसिएन हात्ती, पाटेबाघ, एकसिङ्गे गैंडा, तराई ग्रे लंगुर तथा अरु वन्यजन्तुहरूको राजमार्गलाई छिचोल्दै जैविक मार्ग बनाएको भेटियो। अर्को जैविक कोरिडोरमा राप्ती वन्यजन्तु जंगल पर्छ। जसले तराई – चुरे- महाभारतलाई जोड्दछ। त्यहाँबाट पाटेबाघ र चित्तलहरू आवतजावत गर्दछन्, त्यस्तै रजैया जंगल पनि वन्यजन्तु ओहोरदोहोर गर्ने मार्ग हो, जहाँ वन्यजन्तुहरू राप्ती नदीलाई पार गरेर महाभारततिर स्थानान्तरण गर्ने गरेको पाइयो। राजमार्गको विभिन्न स्थानहरूमा वन्यजन्तु वारपार गर्ने विन्दुहरू पहिचान गरियो। बरण्डाभार कोरिडोर वनले भित्रि तराई र महाभारतलाई जोड्छ।

अध्ययनका क्रममा ३१ प्रजातिका चराहरू फेला परेका थिए। आयोजनाक्षेत्रमा लोपोन्मुख गोल्डेन मोनिटर छेपारो, बेङ्गाल मोनिटर छेपारो, असङ्ख्य सर्पहरू (जस्तै- अजिङ्गर, राज गोमन, नेपाली स्यान्ड बोआ), भ्यागुता र छेपारो लगायतका २३ प्रजातिका सरीसृप तथा उभयेचर प्राणीहरू भेटिए। सर्वेक्षणका क्रममा आयोजना स्थलमा रहेका नदीहरूमा १५ प्रजातिका माछा भेटिएका छन्।

७.३. आर्थिक सामाजिक तथा सांस्कृतिक वातावरण

यो सडक बारा, मकवानपुर र चितवन जिल्लामा पर्दछ। यस खण्डमा १ महानगरपालिका, २ उपमहानगरपालिका, ३ नगरपालिका र १ गाउँपालिका समेटिएका छन्। सडकसँगै पर्ने प्रमुख बस्तीहरू क्रमशः पथलैया (चे ३६७+६३०), अमलेखगन्ज (चे ३७६+०००), चुरियामाई (चे ३८६+७८०), रातमाटे बजार (चे ३९१+२२०), हेटौँडा (चे ३९६+५००), नेवारपानी (चे ४११+७००), मनहरी (चे ४२५+७००), लोथर (चे ४३६+९६०), महादेओटार (चे ४३९+२००), भण्डारा (चे ४४७+०००), पर्सा (चे ४५४+३००), टौँडी (चे ४५९+७००) र भरतपुर गोन्द्राङ (चे ४६७+३२०) लगायतका रहेका छन्। आयोजनाको कार्यक्षेत्रभित्रका स्थानीय तहहरूको कुल जनसङ्ख्या ९५७,६९९ रहेको छ।

अध्ययनको क्रममा आयोजना क्षेत्रको १,८६७ घरधुरीहरूमा सामाजिक-आर्थिक सर्वेक्षण गरिएको थियो, जसमा पुरुष ५२.२% र महिला ४७.८% थिए। औसत घरधुरी आकार ५.४ जना रहेको पाइएको छ।

आयोजनाक्षेत्रमा ब्राह्मण/क्षेत्री (४७.९७%) र त्यसपछि आदिवासी जनजाति (४०.०६%)को बाहुल्यता रहेको छ। ९०% भन्दा बढी सर्वेक्षणका सहभागीहरू साक्षर पाइएको छ। करिब ७.३६% आर्थिक रूपले सक्रिय जनसङ्ख्या वैदेशिक रोजगारमा रहेको र करिब १०.१२% जनसङ्ख्या कृषिमा संलग्न रहेको पाइएको छ। स्वास्थ्य, सरसफाइ तथा खानेपानी सेवा समग्रमा सन्तोषजनक देखिएको छ। नलजडित धारो प्रमुख खानेपानीको स्रोत हो भने सेप्टिक ट्याङ्की जडित शौचालय यस क्षेत्रमा सबैभन्दा बढी प्रयोग हुने शौचालय प्रणाली हो।

आयोजनाबाट हेटौँडा बजारबाहेक ३७८ घरधुरीका ४०३ ओटा निजी संरचनाहरू प्रभावित हुने छन्। तीमध्ये २७२ संरचना पूर्ण रूपमा र १३१ संरचना आंशिक रूपमा प्रभावित हुने छन्। पूर्ण रूपमा प्रभावित संरचनामध्ये ३० ओटा आवासीय र ११३ ओटा व्यापारिक/व्यावसायिक संरचना छन्। त्यस्तैगरी, आयोजनाको प्रभाव क्षेत्रभित्र पर्ने १८० ओटा सामुदायिक संरचनाहरू प्रभावित हुने छन्। यो आयोजना सांस्कृतिक सम्पदा स्थलहरू भएर गएको छैन। यद्यपि भीमसेनमन्दिर (चे ३६८+०५०, क्षेत्राधिकारबाहिर), चुरिया माई (चे ३८६+७८०), चुरियामाई सुरुङमार्ग (चे ३८७+९६०), नवदुर्गामन्दिरको कम्पाउन्ड पर्खाल (चे ३९४+३६०, प्रभाव क्षेत्रभित्र), गोरछेश्वरमन्दिर (चे ३९७+२८०), ओमकारेश्वर महादेवक्षेत्र (चे ३९८+१००), कृष्णमन्दिर सानो (चे ४११+८००), शिव-पार्वतीमन्दिर (चे ४२०+९७०), जलेश्वर शिवालय (चे ४२१+३२०), शिवमन्दिर (चे ४२४+१८०), बाबाधाम (चे ४२४+७४०) आदि आयोजनाको क्षेत्राधिकारमा अवस्थित छन्। आयोजनाबाट विद्युतीय पोल, पहुँच मार्ग, Ht लाइन, अष्टिकल फाइबर केबल, गेट, आकासेपुल, टेलिफोन पोल, पानी ट्याङ्की, खानेपानी पाइप, सिँचाई नहर आदि पनि प्रभावित हुने छन्।

८. विकल्पहरूको विश्लेषण

वैकल्पिक विश्लेषणअन्तर्गत प्रविधि, कार्यान्वयन प्रक्रिया, समयतालिका, वनक्षेत्र कम गर्ने विकल्पहरू अध्ययन गरिएको छ। हाल यो सडक सञ्चालनमा रहेको र स्तरोन्नतिका लागि प्रस्ताव गरिएकाले वैकल्पिक सडकको विकल्प विश्लेषण गरिएको छैन। यद्यपि, डिजाइनका क्रममा विभिन्न डिजाइन विकल्पहरू र वैकल्पिक निर्माण सामग्रीको मूल्याङ्कन गरिएको थियो। यस आयोजनाका लागि अपनाइएका विकल्पहरू वर्तमान परिस्थितिका लागि प्राविधिक, आर्थिक र वातावरणीय दृष्टिकोणले उत्तम विकल्पका रूपमा रहेका छन्। अन्य विकल्पको रूपमा VIADUCT तथा हेटौँडा बजार को बैकल्पिक मार्गको पनि अध्ययन गरिएको थियो।

९. वातावरणीय प्रभावहरू र न्यूनीकरणका उपायहरू

९.१. आयोजनाका सकारात्मक वातावरणीय प्रभावहरू र बढोत्तरीका उपायहरू

वातावरणीय प्रभावहरू	बढोत्तरीका उपायहरू
सकारात्मक प्रभाव	
निर्माणको चरण	
रोजगारीका अवसरहरू र आमदानीका स्रोतहरूमा वृद्धि	आयोजना निर्माणकार्य मुख्य फाइदामा यस क्षेत्रका स्थानीय वासिहरूलाई रोजगारीको अवसर सिर्जना पर्दछ। निर्माणकार्यका लागि ८,५४,१८२ व्यक्ति-दिन दक्ष र २६,३१,३३४ व्यक्ति-दिन अदक्ष कामदार आवश्यक हुन्छ। औसत प्रतिदिन करिब १००० व्यक्तिको आवश्यकता पर्दछ। निर्माणको चरणमा करिब २०-३०% स्थानीयलाई रोजगारीको अवसर सिर्जना अनुमान गरिएको छ। जसले गर्दा योजनाले दक्ष र अदक्ष रोजगारीको अवसर दीइ स्थानीय बेरोजगारि हल गर्न मद्दत गर्नेछ।
उद्यमशीलता तथा व्यावसायिकताको विकास	निर्माणकार्यले स्थानीयको आमदानीमा वृद्धि गर्नका साथै खाजाघर, चियापसल, स्थानीय उत्पादन, सब्जी पसलजस्ता साना व्यवसायको अवसर पनि सिर्जना गर्दछ। यसले स्थानीय अर्थतन्त्रमा टेवा पुऱ्याउँछ।
क्षमता विकास	आयोजना निर्माणकार्यका लागि अधिकतम स्थानीय वासिन्दाको आवश्यकता पर्दछ, जसबाट स्थानीयबासीहरूको प्राविधिक ज्ञान, सिप र क्षमता विकास हुने छ। स्थानीय कार्यदलहरूले मेसोनरी कार्य, ग्याबियन कार्य, पुलका लागि बार बाइन्डिङ, बायो इन्जिनियरिङ कार्यहरू भिर व्यवस्थापनजस्ता कामहरूमा आफूलाई दक्ष श्रमिकमा रूपान्तरण गर्ने छन्। प्रभावितलाई जीविकोपार्जन अभिवृद्धि तालिम पनि दिइने छ।
सञ्चालनको चरण	
व्यापारमा सुधार	प्रस्तावित सडकले पुर्व पश्चिम राजमार्ग र वीरगञ्ज सुक्खा बन्दरगाहमार्फत छिमेकी मुलुकहरूसँग व्यापार सुधार गर्न मदत गर्दछ। सामानहरू ठाउँ ठाउँमा पुग्न सहज हुने साथै क्षेत्रीय आर्थिक बिकासमा टेवापुग्नेछ।
यात्राको समय, लागत घटाउने	प्रस्तावित सडक २ लेन बाट ४ लेनमा स्तरोन्नति गरिनेछ। एक सुधारिएको तथा सुरक्षित सडक यातायात प्रणालीले गर्दा यात्रासमय (४५ देखि ६० मिनेट), सडक दुर्घटनाहरू, इन्धन, सवारी संचालन तथा मर्मत खर्च घट्ने छ। जसले गर्दा सम्पूर्ण सामानको ढुवानी लागत कम हुने छ।
ट्राफिक व्यवस्थापन र सडक दुर्घटना घटाउने	सडकलाई चार लेनमा स्तरोन्नति गरिने छ, जसले सडकको क्षमता वृद्धि गरी जाम घटाउँछ र ट्राफिक व्यवस्थापनमा सहयोग पुऱ्याउँछ। आयोजनामा प्रस्तावित सडक सुरक्षासम्बन्धी व्यवस्था गरिएको छ। संवेदनशील क्षेत्रमा VIADUCT र वन्यजन्तु क्रसिङको व्यवस्था छ, जसले सवारी साधन र वन्यजन्तुको टकरावलाई कम गर्ने छ।
महिला सशक्तीकरण	आयोजनाले महिलाहरूका लागि श्रमिक वा प्राविधिक भइ कार्य गर्न लैङ्गिक भेदभावबिना रोजगारी तथा तालिमको अवसर दिनेछ। तालिमहरू महिला सशक्तीकरणमा आधारित हुनेछन्। आयोजनाले महिलाहरूलाई क्षमता विकास, जागरुकता तथा आत्मविश्वासस्तर बडाउन सहयोग गर्नेछ।
सुधारिएको सडक संरचनाले हरितगृह ग्याँसको उत्सर्जनमा न्यूनीकरण गर्नेछ	सुधारिएको सडक सतहले सवारीसाधनका पार्टपुर्जाहरूमाथि पर्ने असर कम गरी स्पेयर पार्ट्समा लाग्ने खर्च घटाउने छ; इन्धनको दक्षता वृद्धि गराउने र सवारीसाधनबाट उत्सर्जन हुने प्रदूषण घटाउने छ। प्रस्तावित सडक छेउको वृक्षारोपणले पनि प्राकृतिक रूपमा कार्बनडाइअक्साइडको उपभोग तथा अक्सिजनको उत्सर्जनमार्फत वातावरणीय सन्तुलनमा योगदान पुऱ्याउने छ। आरामदायी राम्रो सवारीको कारणले, सवारीसाधन बाट निस्कने कार्बनडाइअक्साइडको उत्सर्जनमा उल्लेखनीय कमी आउने छ।
आयआर्जनका नयाँ स्रोतहरू	सुधारिएको सडक पहुँचले पर्यटकीय क्षेत्रहरू, जस्तै- पर्सा तथा चितवन राष्ट्रिय निकुञ्ज, सौराहा, चुरियामाईलगायत स्थानहरूमा स्वदेशी तथा विदेशी पर्यटकको आगमन वृद्धि गराई पर्यटन प्रवर्द्धनमा

वातावरणीय प्रभावहरू	बढोत्तरीका उपायहरू
	उल्लेखनीय योगदान पुर्याउने अपेक्षा गरिएको छ। यस सडकमा चितवन र पर्सा राष्ट्रिय निकुञ्ज खण्डमा वन्यजन्तुको प्रभावलाई न्यूनीकरण गर्न VIADUCT निर्माण गर्न प्रस्ताव गरिएको छ। यो देशकै नयाँ अवधारणा हो । पथलैया, अमलेखगञ्ज, हेटौँडा, रातमाटे, टाँडी, भरतपुरका सडकछेउमा पसल, होटल बढाएर आयआर्जनका नयाँ अवसर सिर्जना हुने छ ।
सामाजिक सुविधाहरूमा सुधार	स्तरोन्नति गरिएका सडकहरूले सो क्षेत्रका बासिन्दाको समग्र जीवनस्तरमा उल्लेखनीय सुधार ल्याउने अपेक्षा गरिएको छ। यस्ता सडकहरूले आवागमनका विकल्पहरू सजिलो बनाई यात्रासम्बन्धी तनाव घटाउने मात्र नभई, स्वास्थ्यसेवा, शिक्षा, सञ्चार तथा बजारसम्मको पहुँचलाई समेत प्रभावकारी रूपमा वृद्धि गर्ने छन्।
वन्यजन्तु कोरिडोरहरूमा सुधार	वन्यजन्तु-सवारी साधन दुर्घटना घटाउनुका लागि २१ ओटा अन्डरपास क्रसिङ प्रस्ताव गरिएको छ, जसमध्ये २, २ किमीको VIADUCT बरण्डाभार वन करिडोरमा र पर्सा निकुञ्जमा प्रस्ताव गरिएको छ र यसले वन्यजन्तु-सवारी साधन दुर्घटनाको सङ्ख्यामा उल्लेखनीय रूपमा कमी ल्याउने छ, बासस्थान (habitat) बढ्ने छ। जनावरका बासस्थान (habitat)को निरन्तरता (connectivity): वन्यजन्तु क्रसिङहरूसहित सडक स्तरोन्नतिले खण्डित वासस्थानहरू पुनः प्रतिस्थापन गर्न मदत गर्दछ। यसका साथै जनावरका बासस्थान (habitat)को पुनः निरन्तरता (connectivity) हुने छ। वन्यजन्तुहरूको आनुवंशिक आदानप्रदानलाई बढावा दिने छ र साथै स्रोतहरूमा पहुँच बढ्ने छ ।

९.२ नकारात्मक वातावरणीय प्रभावहरू र न्यूनीकरणका उपायहरू

नकारात्मक वातावरणीय प्रभावहरू	न्यूनीकरणका उपायहरू
भौतिक वातावरण	
निर्माणको चरण	
भू-उपयोगमा परिवर्तन	यस सडकको स्तरोन्नतिबाट सडकको क्षेत्राधिकार भित्र करिब २४५.६४ हेक्टर जमिन कालोपत्रे सडकमा परिवर्तन हुने छ। सडक डिजाइन सहरीक्षेत्रमा ५० मी., अर्ध सहरी (सहरोन्मुख) क्षेत्रमा ३७.४ मी. र वन तथा ग्रामीण क्षेत्रमा २४ मी. रहेको छ। यस डिजाइनले सडक क्षेत्राधिकारको भू-उपयोगमा परिवर्तन न्यूनीकरण गरेको छ।
वायु प्रदूषण	निर्माण अवधिभरि निर्माणका कारणले धुलो उड्न नदिन पटक, दिनको ३ पटक पानी छर्ने कार्य गरिनेछ ; तेज हावा चल्ने मौसममा माटो तथा बालुवा ढुवानी गर्दा त्यसलाई माथिबाट ढाकिने र कामदारहरूलाई व्यक्तिगत सुरक्षा उपकरणहरू (PPEs) प्रदान गरिने छ। निर्माण शिविर, आस्फाल्ट प्लान्ट, ब्याचिङ प्लान्ट, क्रसर प्लान्ट, विद्यालय, अस्पताल, वनक्षेत्रलगायतमा वायुको गुणस्तर NAAQS र WHO Air Quality Guidelines अनुरूप कायम गर्न नियमित रूपमा वायुको गुणस्तर मापन र नियमन गरिने छ । सम्भावित क्रसर प्लान्ट, आस्फाल्ट प्लान्टहरू (४०५+७८०, ४२८+८००, ४३७+४००)मा पहिचान गरियो जुन नजिकको संवेदनशील संरचना, जस्तै- विद्यालय, अस्पताल र वन्यजन्तुको वासस्थानबाट कम्तीमा ५०० मी.को दुरीमा र जलाशयबाट कम्तीमा ५० मी.को दुरीमा स्थापना र सञ्चालन गरिने छ।

नकारात्मक वातावरणीय प्रभावहरू	न्यूनीकरणका उपायहरू
	निर्माणकार्यमा प्रयोग हुने मेसिनरी उपकरण तथा सवारीसाधनहरूको नियमित मर्मतसम्भार गरिने छ । प्लास्टिक, कागज वा जैविक फोहोरको खुल्ला रूपमा जलाउने कार्य पूर्णतः निषेध गरिने छ। भरतपुर महानगरपालिका र हेटौँडा उपमहानगरपालिकासँगको समन्वय र स्वीकृतिमा त्यहाँको ल्यान्डफिल साइटमा फोहोरहरूको व्यवस्थापन गरिने छ।
ध्वनि प्रदूषण	अस्थायी निर्माण संरचनाहरू, जस्तै- श्रमिक शिविर, सवारी मर्मत कार्यशाला, क्रसर प्लान्ट, बस्ती र अन्य संवेदनशील क्षेत्रहरूबाट यथासम्भव टाढा स्थापना गरिने छ। ढुङ्गा क्रसर, सवारी आवागमन, ढुङ्गा खानी तथा Borrow Pit मा गरिने कार्यहरू उपयुक्त सामग्री प्रयोग गरी Shielding गरिने छ। कम ध्वनि उत्सर्जन गर्ने उपकरण तथा मेसिनहरूको छनोट गरी प्रयोग गरिने व्यवस्था मिलाइने छ। उच्च ध्वनि उत्पादन गर्ने मेसिनहरू सञ्चालन हुने समयमा कामदारहरूलाई कान थुनिने सुरक्षात्मक उपकरण, जस्तै- इयरप्लग वा इयरमफ उपलब्ध गराइने छ। नजिकको समुदाय र वन्यजन्तुमा पर्न सक्ने असर न्यूनीकरण गर्न दिनको समयमा मात्र निर्माणकार्य गरिने छ। विद्यालय, अस्पतालजस्ता संवेदनशील क्षेत्रमा काठ/जस्तापातालाई ध्वनि अवरोधकका रूपमा प्रयोग गरिने छ। (३७६+८४०,३७९+१८०,३८१+९७०,४००+८१०,४०२+७८०,४१४+४००,४२०+३२०,४२६+२६०,४२८+०३०,४३४+८५०,४३९+२८०,४४१+७४०,४४२+८४०,४४४+४००,४४४+८२०,४६२+६८० र अस्पताल) राष्ट्रिय स्तरको ध्वनी मापक स्तरलाई सुनिश्चितता दिई नियमित रूपमा ध्वनिको स्तर मापन आयोजना क्षेत्रमा गरिने छ। सडक किनार र मिडियनमा वृक्षरोपण गरिने छ।
कम्पन उत्पन्न	निर्माणकार्यपूर्व कम्पनको जोखिममा रहेका पुराना घरहरूको पहिचान गरिने छ। निर्माण व्यवसायीले प्रयोग गरिने मेसिन र उपकरणहरूको प्रयोगमा विशेष सावधानी अपनाउन अपरेटरलाई सजग गराउने छ। कामदारहरूको सुरक्षाका लागि Anti-Vibration Gloves जस्ता PPE प्रदान गरिने छ। निरन्तर कम्पन रोक्न आवश्यक विश्राम अवधिको व्यवस्था मिलाइने छ।
पानीको गुणस्तरमा हास	उत्खनन गरिएका माटो र फोहोरलाई नदी खोलाहरूमा फाल्न पूर्णतः निषेध गरिएको छ। फोहोरलाई निर्दिष्ट स्थानमा निस्तेज गरिने छ। सबै रसायन र तेलहरू पानीबाट टाढा राखिने छ र तिनलाई कन्क्रिट प्लेटफर्ममा राखिने छ, साथै लिकेजको सङ्कलनका लागि क्याचमेन्ट पिटको व्यवस्था गरिने छ। निर्माण व्यवसायीले सबै उपकरण सञ्चालन गर्ने व्यक्ति, सवारी चालकहरूलाई स्पिल (चुहावट), प्रदूषण तथा त्यसको तत्काल प्रतिक्रिया र सफाई प्रक्रियाबारे चेतनामूलक कार्यक्रमको व्यवस्था गरिने छ। ब्याचिङ प्लान्ट, क्रसर प्लान्ट तथा आस्फाल्ट प्लान्टमा पानीको मुहानमा जानुपूर्व सेडिमेन्ट सङ्कलन गर्न सिल्ट सङ्कलन पोखरी निर्माण गरिने छ। निर्माण स्थलहरूबाट निस्कने सबै फोहोरहरू तोकिएको स्थानमा सङ्कलन तथा भण्डारण गरी स्वीकृत फोहोर व्यवस्थापन स्थलसम्म ढुवानी गरिने छ। माछा प्रजनन समय (मे / जुन देखि अगस्त/सेप्टेम्बर)लाई ध्यानमा राखेर नदी वा खोल्साहरूमा हुने पुल तथा क्रस ड्रेनेजसम्बन्धी कार्यहरू गर्दा ध्यान पुर्यायर गरिने छ । सतही तथा भूमिगतजल गुणस्तरको अनुगमन गरिने छ।

नकारात्मक वातावरणीय प्रभावहरू	न्यूनीकरणका उपायहरू
स्तोप अस्थिरता, नदी किनारको अस्थिरता	माटो कटान नियन्त्रण गर्न इन्जिनियरिङ तथा बायोइन्जिनियरिङ प्रविधिहरू प्रयोग गरिने छ, जसले भूपरिस्थितिको स्थायित्व कायम राख्न सहयोग पुर्याउने छ। शिवालिक क्षेत्रमा स्तोप संरक्षणका विशेष उपायहरू प्रस्तावित छन्। १,५४०,०१० वर्गमिटर पहाडी स्तोप र तटबन्ध, पुल तटबन्ध र नदी किनारको स्तोप संरक्षणका लागि सिभिल संरचनाहरूको संयोजनसँग बायो-इन्जिनियरिङ प्रविधि (घाँस रोपण, ब्रस लेयरिङ र रुख/झाड रोपण) प्रयोग गरी गरिने छ। पहाडी स्तोप र नदी किनारको संरक्षणका लागि प्रबलित कङ्क्रिट पर्खाल र भौगोलिक प्रबलित पर्खाल, ४,५२६ घन मिटर ग्याबियन पर्खाल, ५४,०७२ वर्गमिटरको प्रबलित पर्खाल निर्माण गरिने छ। अधिक माटालाई निर्धारित स्थानहरूमा नदीको बहावलाई असर नपर्ने गरी व्यवस्थापन गरिने छ।
पुल र क्रस ड्रेनेज संरचनाको निर्माणका कारण पानीको प्राकृतिक प्रवाहमा अवरोध	निर्माणकार्यका क्रममा रहेको प्राकृतिक जलप्रवाहमा अवरोध नपुऱ्याउने गरी डाइभर्जन, ह्युम पाइपजस्ता अस्थायी व्यवस्था गरिने छ। साथै वर्षायाममा नदी, खोल्सा, ताल तथा पोखरीजस्ता जलस्रोतहरू भित्र वा नजिकको निर्माणकार्य वर्षायाममा कम गरिने छ। निर्माणकार्यबाट उत्पन्न हुने थैग्रानलाई पूर्वनिर्धारित स्थानहरूमा मात्र भण्डारण गरिने छ। बढ्दो जलप्रवाहलाई समेट्न सक्ने क्षमताका आधारमा जल निकासी संरचनाहरूको डिजाइन गरिएको छ। सडक स्तरोन्नति क्रममा बाढी, डुबान तथा प्राकृतिक बहावलाई सहज बनाइराख्न १७४,६१२ मी. साइड ड्रेन, ४१ ओटा साना तथा ठुला पुलहरू र २४६ ओटा बक्स कल्भर्टहरूको निर्माण गरिने छ। मनसुन तथा माछाको अण्डा पार्ने समयमा (spawning) ठुला नदीहरू (जस्तै लोथर, मनहरी, राप्ती र कर्ना) मा निर्माण कार्यमा सहजता अपनाइने छ र silt curtain, sediment tank हरु प्रयोग गरिनेछ साथै इन्धन केमिकलहरू बन्द ड्रम मा राखिने छ।
फोहोरमैला व्यवस्थापन (हानिकारक, गैर-हानिकारक तथा तरल फोहर)	निर्माणकार्य प्रारम्भ गर्नुअघि निर्माण व्यवसायीले फोहोरमैला व्यवस्थापन योजना तयार गर्नुपर्ने छ। यस योजनाअन्तर्गत हानिकारक फोहोरको व्यवस्थापन, भण्डारण, स्थानान्तरण र निस्तेजजस्ता विषयवस्तु समेटिएको हुनुपर्ने छ। हानिकारक फोहोरको अस्थायी भण्डारणका लागि निर्धारित स्थान र कन्टेनर तोक्नुपर्ने छ र त्यहाँ अन्य फोहोरसँग मिसाउन निषेध गरिने छ। श्रमिकहरूलाई फोहोरमैला व्यवस्थापनका सम्बन्धमा तालिम प्रदान गरिने छ। हेटौँडा उपमहानगरपालिका, भरतपुर महानगरपालिकासँगको समन्वय र स्वीकृतिमा ती पालिकाको ल्यान्डफिल साइटमा फोहोरमैलाको निस्तारण गरिने छ। निर्माण व्यवसायीद्वारा फोहोर निस्तारणक्षेत्र स्थापना गरिने छैन।
खानी र उत्खनन क्षेत्रको सञ्चालन	निर्माण व्यवसायीले सरकारद्वारा स्वीकृत गरिएका खानीहरू प्रयोग गर्नुपर्ने छ वा सम्बन्धित निकायहरू, स्थानीय सरकार, राष्ट्रिय निकुञ्जबाट स्वीकृति प्राप्त गरी प्रयोग गर्नुपर्ने छ। खानी तथा उत्खननक्षेत्र सञ्चालनका क्रममा स्थानीय सरकार, राष्ट्रिय निकुञ्ज, डिभिजन वन कार्यालयसँग समन्वय गरिने छ। डिजाइन टोली तथा वातावरणीय प्रभाव मूल्याङ्कन टोलीद्वारा अध्ययनका क्रममा १६ ओटा सम्भावित खानी तथा उत्खननक्षेत्र पहिचान गरिएको छ। निर्माण व्यवसायीले खानी तथा उत्खननक्षेत्र सञ्चालन तथा पुनःस्थापना योजना तयार गर्नुपर्ने छ। खानीजन्य गतिविधि वनक्षेत्र, संरक्षित क्षेत्र वा संवेदनशील क्षेत्रमा सञ्चालन गर्न पाइने छैन। यद्यपि, नदीको Aggradation कम गर्न चुरेक्षेत्र, मध्यवर्तीक्षेत्रमा पर्ने नदीबाट उत्खनन गर्न सकिने छ। निर्माण सामग्रीहरूको उत्खनन र ढुवानी एस्काभेटर, लोडर, ट्रकजस्ता मेसिनरी तथा श्रमिकहरूमार्फत गरिने छ। खानी सञ्चालनका क्रममा नदीको प्राकृतिक बहाव अवरोध गर्न निषेध गरिने छ। न्यून प्रवाह भएका नदीहरूको बफर जोन ५ देखि १० मिटर कायम गरिने र उत्खनन कार्य वर्षा यामबाहेकको समयमा मात्र सञ्चालन गरिने छ। उपयोगपछि साइटलाई पुनर्स्थापना योजनाअनुसार पुनर्स्थापना गरिने छ।

नकारात्मक वातावरणीय प्रभावहरू	न्यूनीकरणका उपायहरू
क्रसर प्लान्ट, आस्फाल्ट प्लान्ट र ब्याचिङ प्लान्टको स्थापना र सञ्चालन	संरचना स्थापनापूर्व निर्माण व्यवसायीद्वारा स्थानीय सरोकारवालाहरू र नगरपालिकाबाट अनुमति प्राप्त गर्नुपर्ने छ। क्रसर प्लान्ट, सिमेन्ट ब्याचिङ प्लान्ट र आस्फाल्ट प्लान्टमा धुलो न्यूनीकरण गर्ने यन्त्र जडान गरिने छ र उक्त संरचना निर्माताको विनिर्देशन अनुसार सञ्चालन गरिने छ। निर्माण व्यवसायीले यी प्लान्टहरू, बस्ती खानेपानीको स्रोत, खेतीयोग्य जमिन, जलाशय र संवेदनशील क्षेत्रभन्दा (५०० मी.) टाढा स्थापना गर्नुपर्ने छ। क्रसर प्लान्ट सञ्चालनको समयमा धुलो उत्सर्जन न्यूनीकरण गर्न दिनमा तीन पटक पानी छर्कनुपर्ने छ। निर्माण व्यवसायीले फोहोर पानीलाई ड्रिनेज प्रणालीमा मिसाउनुअगाडि सिल्टेसन पोखरी (दुइ/तिन सेटलिङ्ग प्रणाली) निर्माण गरी सञ्चालन गर्नुपर्ने छ। उपकरणहरू दिउँसोको समयमा मात्र सञ्चालन गरिने छ। निर्माण व्यवसायीले उपयोगपछि साइटलाई पुनर्स्थापना गरिने छ।
निर्माण सामग्रीको भण्डारण	भण्डारण स्थल जलाशय, विद्यालय, अस्पतालबाट ५० मी.को दुरिमा स्थापना गरिने छैन। सम्भावित स्थलहरू तालिका १५ मा उल्लेख गरिएको छ। निर्माण व्यवसायीले भण्डारण स्थल स्थापनाअघि जग्गाधनी र स्थानीय सरकारको स्वीकृति प्राप्त गर्नुपर्ने छ। रासायनिक सामग्रीको भण्डारणका लागि कडा सतहको निर्माण गरिने छ। निर्माण सामग्री भण्डारणका निम्ति कुल ८ ओटा सम्भावित स्थलहरूको प्रस्ताव गरिएको छ।
निर्माण क्षेत्रबाट फोहोर पानीको निष्काशन	ब्याचिङ प्लान्ट, आस्फाल्ट प्लान्ट र क्रसिङ प्लान्टबाट निस्कने फोहोर पानीको प्रशोधनका लागि पर्याप्त आकार र क्षमताका सेडिमेन्टेसन पोखरीहरू निर्माण गरिने छ। पोखरीमा थिग्रिएको सेडिमेन्टलाई नियमित रूपमा हटाइने छ र निर्धारित बिग्रन व्यवस्थापन स्थलमा विर्सजन गरिने छ। निर्माण स्थलमा फोहोर पानीको प्रशोधनका लागि सेप्टिक ट्याङ्क, सोक पिट र साइट ड्रेनेजको निर्माण गरिने छ। पानीको गुणस्तर तोकिएको मापदण्डअनुरूप कायम गर्न नियमित रूपमा पानीको गुणस्तर मापन गरिने छ।
सञ्चालनको चरण	
वायु र ध्वनि प्रदूषण	सडक तथा बिरुवाहरूको नियमित मर्मतसम्भार गर्न , ध्वनि अवशोषकको रूपमा करिब १६,६६६ बिरुवाहरू शहरी तथा शहुरुमुख क्षेत्रहरूमा रोपिने छ। यदी आवश्यक परेमा, वस्ती तथा संवेदनशील क्षेत्रमा No Horn Zone सूचना पाटी पनि राख्न सकिने छ। सञ्चालनको चरणमा वायु र ध्वनिको स्तर मापन निगरानी गरिने छ।
जल प्रदूषण	सडक, नाली र क्रस ड्रेनेजको मर्मतसम्भारबाट उत्पन्न हुने माटो र अन्य फोहोरलाई पानीको स्रोतमा फालिने छैन र तोकिएको स्थानमा मात्र फालिने छ। पानीका स्रोतहरूको नजिक सवारीसाधन धुनेजस्ता गतिविधिहरूमा पूर्ण प्रतिबन्ध लगाइने छ।
सडक दुर्घटना तथा व्यवस्थापनमा वृद्धि	सडक सुरक्षाका सुविधाहरू सहज कायम राखेमा सडक सुरक्षा कायमै हुनेछ ।ट्राफिक नियम प्रवर्तन गर्न , स्थानीय ट्राफिक प्रहरीसँगको समन्वयमा स्थानीय समुदायलाई दुर्घटनाबाट जोगाउनका लागि यातायात सुरक्षाबारे सचेतना कार्यक्रमहरू आयोजना गरिने छ। यी कार्यक्रमहरूले यात्रा गर्ने, ओभरटेक गर्ने, साइकल चालकलाई ओभरटेक गर्दा पालना गर्ने नियम, लेन परिवर्तन गर्ने नियम, युटर्न गर्ने नियम, नियन्त्रण चिह्नहरूको प्रयोग गर्ने, जेब्रा क्रसिङमा ओभरटेक नगर्ने, स्टप लाइन नजिक इन्टरसेक्सनलाई खुला राख्नेगायतका महत्त्वपूर्ण नियमहरूको पालना सुनिश्चित गर्ने छन्।
स्लोप स्थिरता र क्रस ड्रेनेजमा अवरोध	पहाडी तथा स्लोप क्षेत्रहरूमा वृक्षरोपणमार्फत स्लोप संरक्षण गरिने छ। बाटो, क्रस ड्रेनेज र साइड ड्रेनेजमा अवरोधको समस्या कम गर्न नियमिति रूपमा मर्मतसम्भार गरिने छ। जम्मा भएका सेडिमेन्टलाई नियमित रूपमा हटाइने छ तथा नदीको बहाव कायमै राखिने छ ।

नकारात्मक वातावरणीय प्रभावहरू	न्यूनीकरणका उपायहरू
रासायनिक वातावरण	
बिटुमेन र अन्य विषाक्त रसायनहरूबाट हुने सम्भावित खतराहरू	सडक निर्माणका लागि Automated Asphalt Plants प्रयोग गरिने छ। सबै इन्धन, लुब्रिकेन्ट तथा रासायनिक पदार्थहरूलाई निर्माण शिविरभित्र निश्चित, घेराबन्दी गरिएको सुरक्षित स्थानमा भण्डारण गरिने छ। Bitumen मिसाउने प्लान्टमा Gas Absorption प्रणाली अनिवार्य जडान गर्नुपर्ने छ। Bitumen माटामा वा नजिकका जलस्रोतहरूमा चुहिन दिइने छैन। भण्डारणक्षेत्र कङ्क्रिटको सतह भएको हुने छ, जसमा चुहावट नियन्त्रणका लागि आवश्यक संरचना Spill Containment System को व्यवस्था गरिने छ।
जैविक वातावरण	
निर्माण चरण	
वन तथा वनस्पतिमा हास (२३,३२६ रुखहरू RoW बाट हटाउनुपर्ने)	रुखहरूको कटान न्यूनीकरण गर्न वनक्षेत्रमा सडकको चौडाइ २४ मी. प्रस्ताव गरिएको छ। कटान गरिएको रुखको क्षतिपूर्ति : बन मन्त्रालय, बन नियमवाली २०७९ को अनुसार प्रस्तावकले कटान गरिएको रुखको क्षतिपूर्ति वापत “वन विकाश कोष” को खातामा रकम जम्मा गर्नु पर्नेछ। रुख गणना सर्भेक्षणअनुसार २३,३२६ रुखहरू निर्माण अवधिमा काटिने छन्। जसमध्ये बारा जिल्लामा ९६४६, मकवानपुर जिल्लामा १०२७८ र चितवन जिल्लामा ३४०२ रुखहरू काटिने छन्। जम्मा ४०४ ओटा बर, पिपल र समिक रुखहरू काटिने छन्। क्षतिपूर्ति वृक्षरोपणका लागि रु २२०,२६६,७६८ बजेट अनुमान गरिएको छ।
निर्माण श्रमिकहरू द्वारा बन उत्पादनहरूको उपयोग	निर्माण श्रमिकहरू द्वारा वन क्षेत्रभित्र वनको नियम पालन गर्नुपर्नेछ। श्रमिक क्याम्प तथा सुविधाहरू वन तथा निषेधितक्षेत्रहरूमा निर्माण गर्न पाइने छैन।
संरक्षित वनस्पतिमा हास	उल्लेख्य संख्यामा साल प्रजातिका रुखहरूको हास हुनेछ। क्षतिपूर्ति वृक्षरोपणका गर्दा यस प्रजातिका बिरुवाहरूलाई विशेष प्राथमिकता दिइनेछ।
वन्यजन्तुमा असर	वनस्पति तथा वन्यजन्तु वासस्थानमा पर्ने असरलाई न्यूनीकरण गर्न वनक्षेत्रमा सडकको चौडाइ घटाएर २४ मी. कायम गरिएको छ। वन्यजन्तु क्रसिंग बिन्दु संरचना : वन्यजन्तु सर्भेक्षण, क्यामरा ट्र्यापिंग, रोड किल सर्भेक्षण (Clevenger et al 2022) वन्यजन्तुको आवागमन सहज बनाउन २१ स्थानमा Dedicated क्रसिङहरू प्रस्ताव गरिएको छ। धेरै जस्तो क्रसिंगहरू अन्तरपास रहेका छन्। सतह क्रसिंगहरू पर्सा निकुन्जको आधाभार र चितवन निकुन्जको बरन्डाभारमा प्रस्ताव गरिएको छ। लोपोन्मुख प्रजातिका जस्तै एसियन हात्ती र बेंगल बाघ PHN सडकमा देख्न सकिन्छ। एशियाली हात्तीहरू ७० वा सोभन्दा बढी संख्याको बथानमा आवतजावत गर्दै गरेको अवस्थामा फेला परेका थिए, यसका अतिरिक्त, संरचना भत्काउने तथा मानवमाथि समेत आक्रमण गर्ने जस्ता विनाशकारी गतिविधिमा संलग्न हात्तीहरू देखिएका छन्। यति ठूलो आकारको हात्तीको जनसंख्या बढ्दो क्रममा रहेको रिपोर्ट गरिएको छ। यी संवेदनशील प्रजातिहरूको प्राकृतिक आवागमन सहज बनाउन २००१ मिटर लामो भायोडक्ट प्रस्ताव गरिएको छ। आधाभार (पूर्व-पश्चिम) र बरन्डाभार (उत्तर-दक्षिण) क्षेत्र हुँदै आवागमन गर्ने सबै प्रकारका स्तनधारी जनावरहरूको सहज आवत-जावतका लागि भायोडक्ट (VIADUCT) भुइँमाथि (ओभरग्राउन्ड) निर्माणको प्रस्ताव गरिएको छ। आधाभारमा (चैनज ३७३+४९६) २००१ मिटर लामो भायोडक्ट र बरन्डाभारमा (चैनज ४६५+३५६) पनि २००१ मिटर लामो भायोडक्ट प्रस्ताव गरिएको छ।

नकारात्मक वातावरणीय प्रभावहरू	न्यूनीकरणका उपायहरू
	गरिएको छ। त्यसैगरी, अत्यन्त ठूला जनावरहरूका लागि ३ वटा अति ठूला जनावर क्रसिङ संरचना (Very Large Animal Crossing Structure – VLACS) चेनज ३८९+८९७, ३९१+०९६ र ४२०+१७८ मा प्रस्ताव गरिएको छ। ठूला जनावर क्रसिङ संरचना (Large Animal Crossing Structure – LACS) चेनज ४१३+१६०, ४१८+५५०, ४१९+५३९, ४१९+७६० र ४२९+९३९ मा निर्माण गरिनेछ। मध्यम आकारका स्तनधारी जनावरहरूका लागि प्रस्तावित १० वटा क्रसिङहरू चेनज ३८२+७५२, ३८३+६३६, ४०५+६२२, ४०९+१००, ४१८+१६८, ४१९+०२६, ४२९+३५०, ४२९+७१७, ४३२+९६८ र ४३५+५२० मा रहनेछन्। साथै साना जनावरहरूका लागि क्रसिङ संरचना चेनज ४१५+१९० मा स्तरोन्नति गरिएको छ। यी अन्डरपास संरचनाहरूले जनावरहरूलाई सडकबाट टाढा राख्न प्रभावकारी हुने अपेक्षा गरिएको छ। फनेलिङ फेन्सिङ: संरचनाको प्रभावकारी उपयोग सुनिश्चित गर्न तथा जनावरहरूलाई मार्गदर्शन गर्न फनेलिङ फेन्सिङ (FF) प्रस्ताव गरिएको छ। दुई वटा पानीपोखरी तथा नुनिलो माटो (साल्ट लिक्) भायोडक्टको दुवै तर्फ निर्माण प्रस्ताव गरिएको छ र पानीको स्रोत तथा आपूर्ति पहिचान गरिएको छ। बरन्डाभारस्थित राइनो ताल तथा कामिनीपुल नम्बर १ को पानी स्रोतलाई निरन्तर रूपमा संरक्षण तथा व्यवस्थापन गरिनेछ। साथै, एसीएफ (ACF) र बीसीएफ (BCF) क्षेत्रमा पनि एक एक वटा नुनिलो माटो (साल्ट लिक्) निर्माण गरिनेछ। लाइट इन्डेक्स वृद्धि: लाइट इन्डेक्सलाई अझ वृद्धि गर्न बक्स कल्भर्टको बीच भाग (मेडियनमा) ३ मि को खुला भाग/प्याल (ओपनिङ) बनाउने व्यवस्था गरिएको छ। भायोडक्ट (VIADUCT): पर्सा राष्ट्रिय निकुञ्जमा २००१ मिटर लामो भायोडक्ट तथा बरन्डाभार करिडोर वन क्षेत्रमा २००१ मिटर लामो भायोडक्ट प्रस्ताव गरिएको छ। लाइट इन्डेक्स भायोडक्टहरूको बिचमा कम्तीमा ८ मिटरको दूरी रहने व्यवस्था गरिएको छ। ध्वनि नियन्त्रण पर्खालहरू दुवै भायोडक्टमा वन्यजन्तुहरूको प्राकृतिक आवागमन र संरचनाको अधिकतम उपयोग सुनिश्चित गर्न, ध्वनि नियन्त्रण गर्न तथा रातको समयमा प्रकाश अवरुद्ध गर्न ध्वनि नियन्त्रण पर्खालहरू निर्माण गरिनेछ। कल्भर्ट तथा पुल सुधार: आधाभार र बरन्डाभार करिडोर वन क्षेत्रहरूमा कल्भर्टहरूको प्रयोग स्वाभाविक देखिएको छ र वन्यजन्तुहरूले भूमिगत आवागमनका लागि कल्भर्ट प्रयोग गरिरहेको तथा भुईँमाथि पनि अत्यन्त गतिशील आवागमन भइरहेको तथ्य फेला परेको छ (Clavenger, et al., 2022 – धारा ५.३.२) । सबै पाइप कल्भर्टहरूलाई बक्स कल्भर्ट (BC) द्वारा प्रतिस्थापन गरिनेछ। यसले आवागमन क्षमता वृद्धि गर्नेछ, किनकि १.५ मि × १.५ मि भन्दा ठूलो आकारका बक्स कल्भर्टहरूमा एक वा दुई वटा वन्यजन्तु हिँड्ने लेन रहने व्यवस्था गरिनेछ, जसले सतहको आवागमन सहज बनाउनेछ। अत्यन्त ठूला वन्यजन्तु क्रसिङ संरचना (Very Large Wildlife Crossing Structure – VLWC) र ठूला वन्यजन्तु क्रसिङ संरचना (Large Wildlife Crossing Structure – LWC) अन्तर्गत दुई वटा वन्यजन्तु हिँड्ने लेन (Wildlife Walking Lanes – WWL) प्रस्ताव गरिएको छ। यी वन्यजन्तु क्रसिङ संरचनाहरूमा जनावरहरूको ट्रेल (animal trail) तथा जलमार्ग (waterway) समेत डिजाइन गरिनेछ। लाइट इन्डेक्स सुधार तथा वन्यजन्तुहरूले कल्भर्टको प्रयोग बढाउन सबै कल्भर्टहरूको हाइवे मेडियनमा ३ मि आकारको खुला भाग (ओपनिङ) राखिनेछ। ठूला वन्यजन्तुका लागि बक्स कल्भर्टको आकार नेपाल सरकार (GON) को <i>वन्यजन्तु मैत्री संरचना सम्बन्धी मार्गनिर्देशन, २०२२</i> मा सिफारिस गरिएको मानक ओपननेस इन्डेक्सलाई आधार मानी वृद्धि गरिनेछ। पुलमुनिको सतह (अन्डर ब्रिज सर्फेस): राजमार्ग पार गर्न वन्यजन्तुहरूका लागि हिँड्ने मार्ग (walking tract) उपलब्ध गराउने उद्देश्यले अमलेखगन्जपुल- १, अमलेखगन्ज पुल नम्बर- २, अमलेखगन्ज पुल नम्बर ३, अमलेखगन्ज पुल नम्बर ४, गुन्डो पुल, चुरिया पुल, पक्कीपुल, सन्सारे पुल, सयफुट पुल, बडाहाकिम पुल, राप्ती पुल, मनहरी पुल तथा लोथर पुलका

नकारात्मक वातावरणीय प्रभावहरू	न्यूनीकरणका उपायहरू
	पुलमुनिका सतहहरू सुधार गरिएको छ। धेरैजसो ठूला पुलहरूमा ३ मिटर सम्म आरसीसी (RCC) आधार निर्माण गरिनेछ र त्यसपछि सो सतहलाई वन्यजन्तु आवागमनका लागि प्राकृतिक मार्गको रूपमा रूपान्तरण (naturalize) गरिनेछ। बक्स कल्भर्ट र पुलको दोहोरो कार्य: स्तरोन्नत बक्स कल्भर्टहरूमा पानीको मार्ग (waterway) कार्यसँगै अन्डरपासको रूपमा पनि आधार डिजाइन गरिनेछ। आकारअनुसार एक वा दुई वटा वन्यजन्तु मार्ग (wildlife tracks) रहनेछन्। ठूला पुलहरूको तलको सतहमा (under-bridge floors) अमलेखगन्ज पुल नम्बर १, २, ३, ४, बडाहाकिम, राप्ती, मनोहरी र लोथर पुलको नदी किनारतर्फको भाग पनि अत्यन्त ठूला वन्यजन्तु, ठूला वन्यजन्तु तथा अन्य जनावरहरूका लागि हिँड्ने मार्गको रूपमा उपलब्ध गराइनेछ। क्यानोपी पुल ; PHN राजमार्ग पार गर्न जंगली रुख उपरी प्रजातिहरू (arboreal species) का लागि २४ वटा क्यानोपी पुल निर्माण गरिएको छ। वन्यजन्तुहरूले जङ्गलमा आवतजावत गर्न क्यानोपी मार्गको प्रयोग गरिरहेका छन्। सचेतना अभिवृद्धि: क्रसिङ क्षेत्रहरूमा चेतावनी संकेत (warning sign), गति सीमा (speed limit) र वन्यजन्तु सम्बन्धी जानकारी दिने प्रदर्शन बोर्ड (display board) राखिनेछ। वन्यजन्तुहरूमा आवाज र असुविधा कम गर्न संवेदनशील क्रसिङ स्थानहरूमा हर्न बजाउने कार्य (honking) प्रतिबन्धित गरिनेछ। राजमार्गको छेउछाउ बसोबास गर्ने समुदायलाई वन्यजन्तु सहअस्तित्व (co-existence) र गैरकानुनी शिकार नियन्त्रण सम्बन्धी सचेतना कार्यक्रम सञ्चालन गरिनेछ। क्यामेरा ट्र्यापिङ : प्रभावकारिता निगरानीका लागि विभिन्न स्थानहरूमा क्यामेरा जडान गरिनेछ। हालको अवस्थित वन फेन्सिङ : पुनः स्थापना गरिनेछ।
वन्यजन्तु आवागमनमा बाधा / -वन्यजन्तु सवारी साधन टकराव	वन्यजन्तु-सवारी साधन टकराव न्यूनीकरणका लागि २१ वटा वन्यजन्तु क्रसिङ संरचना (PNP र BCF भायोक्टसहित अन्य वन क्षेत्रहरूमा), क्यानोपी पुलहरू तथा फेन्सिङ प्रस्ताव गरिएको छ। गति न्यूनीकरण: क्रसिङ क्षेत्रहरूमा चेतावनी संकेत (warning sign), गति सीमा (speed limit) र वन्यजन्तु सम्बन्धी सचेतनात्मक प्रदर्शन बोर्ड राखिनेछ। वन्यजन्तु आवागमन हुने वन क्षेत्रहरूमा वन्यजन्तुको उपस्थिति र महत्वबारे जानकारी दिने सूचना बोर्डहरू पनि स्थापना गरिनेछ। क्यामेरा ट्र्यापिङ: प्रभावकारिता निगरानीका लागि विभिन्न स्थानहरूमा क्यामेरा जडान गरिनेछ। फेन्सिङ: फेन्सिङले वन्यजन्तुलाई राजमार्गतर्फ आउनबाट रोक्नेछ, जसले वन्यजन्तु-सवारी साधन टक्कर घटाउन सहयोग पुऱ्याउनेछ।
राष्ट्रिय निकुञ्ज (NP), बरण्डाभा र करिडोर वन (BCF) र बफर जोन (BZ) हुँदै जाने सडकमा काम गर्ने क्रममा वन्यजन्तु	राष्ट्रिय निकुञ्ज (NP), बरण्डाभा र करिडोर वन (BCF) र बफर जोन (BZ) हुँदै काम गर्दा अनपेक्षित रूपमा वन्यजन्तुसँग आमनेसामने हुने जोखिमलाई ध्यानमा राख्दै तलका सुरक्षा उपायहरू लागू गरिनेछन्: - वन्यजन्तु सक्रिय हुने बिहान र साँझको समय (Dawn & Dusk) मा, विशेष गरी राष्ट्रिय निकुञ्जमा, काम नगर्ने। ग्रीष्मकालमा काम ८:०० बिहान देखि ६:०० साँझ र जाडोमा ९:०० बिहान देखि ५:०० साँझसम्म सीमित गरिने। - निर्माण तालिका पार्क व्यवस्थापनलाई जानकारी गराइने र सम्बन्धित कार्यालयसँग समन्वय गरिने। - कर्मचारीहरूको शिविर संवेदनशील क्षेत्रमा (NP, BCF, BZ) स्थापना नगरिने। - काम गर्दा कर्मचारीहरू समूहमा रहने। - काम सुरु गर्नु अघि वन्यजन्तु भेटिएमा आफूलाई जोगाउने सुरक्षा सचेतना प्रशिक्षण प्रदान गरिने। - एक जना व्यक्तिलाई प्रहरी/वार्डनको रूपमा नियुक्त गरिने। - आपतकालीन प्रतिक्रिया योजना (Emergency Response Plan) तयार गरिने।

नकारात्मक वातावरणीय प्रभावहरू	न्यूनीकरणका उपायहरू
सँग अनपेक्षित भेट कर्मचारी तथा वन्यजन्तु सुरक्षा	अन्य सुरक्षा उपायहरू: - काम रोकिएपछि कुनै खाल्डो/खालि स्थान ढाकिएको हुनेछ। यो वन्यजन्तु र निर्माण टोलीका सदस्यहरूको सुरक्षाका लागि अनिवार्य अभ्यास हुनेछ। - कर्मचारीहरूको शिविर र निर्माण सुविधा वन क्षेत्रमा निर्माण नगर्ने।
पन्छीवर्गमा पर्ने असर	वन क्षेत्रमा, सडकको चौडाइ २४ मिटरमा सीमित गरिएको छ, जसले वन सफाई र पन्छीको आवासमा पर्ने प्रभाव घटाउनेछ। महत्वपूर्ण वन तथा सिमसार (wetland) क्षेत्रमा कुनै निर्माण सामग्री जम्मा गरिने छैन। यदि पन्छी (गिद्धसमेत) को प्रजनन समय (अक्टोबर-अप्रिल) भित्र वनस्पति सफाई गर्नुपर्ने अवस्था आएमा, ढुङ्गा/रुख काट्नु अघि संवेदनशील बाज वा अन्य ठूला पन्छीहरूको गुँड (nest) जाँच गरिनेछ। सक्रिय गुँड फेला परेमा, त्यहाँ वरिपरि निषेध क्षेत्र (exclusion zone) स्थापना गरिनेछ र साना पन्छीहरू उडेर जान नपाउँदासम्म कुनै बाधा वा असुविधा पुऱ्याइने छैन। निर्माण कार्यको क्रममा अनावश्यक आवाज उत्सर्जन गर्ने उपकरणको प्रयोग नियमित सचेतना र “नो-होर्न” (No-Horn) क्षेत्रमार्फत नियन्त्रण गरिनेछ। सडक छेउ र प्रभावित क्षेत्रमा बोटबिरुवा रोपण कार्य निर्माण समाप्त हुनासाथ सम्पन्न गरिनेछ।
जलीय जीवहरू तथा उभयचरहरूमा पर्ने असर	नदीको प्रवाह (river regime) यथासंभव बाधा नपुऱ्याउँदै (canalization) गर्ने। बालुवा (sand) र गिट्टी (gravel) को उत्खनन केवल सम्बन्धित निकायबाट स्वीकृति प्राप्त स्थानमा मात्र गरिनेछ र नदीको प्रवाह प्रभावित नहुने गरी मात्र उत्खनन गरिनेछ। नदीमा निर्माण कार्य सम्पन्न भएपछि प्रभावित सबै स्थान तुरुन्तै पुनर्स्थापित गरिनेछ। पुल निर्माणको क्रममा पानीको सतत प्रवाह सुनिश्चित गर्न ह्यूम पाइप (hume pipes) प्रयोग गरिनेछ। सबै रासायनिक पदार्थ, बिटुमेन, तेल र इन्धन ड्रममा र अभेद्य (impervious) सतहमा राखिनेछ ताकि कुनै चुहावट वा फैलावट पानीमा पुग्न नपाओस्। निर्माण कार्य गर्ने कर्मचारीहरूले माछा मार्ने काम नगर्ने व्यवस्था मिलाइने छ। पुल तथा क्रस-ड्रेनेज कार्य नदी/नाला क्षेत्रमा माछा प्रजनन समय (मे/जुनदेखि अगष्ट/सेप्टेम्बर) मा सुरु नगर्ने। यस अवधिमा नदी प्रणालीमा कुनै बाधा सिर्जना नगर्ने प्रयास गरिनेछ। निर्माण गतिविधिहरू यस समयमा सीमित गरिने वा विशेष ध्यानमा राखी सञ्चालन गरिनेछ।
सञ्चालनको चरण	
वनस्पति तथा वन्यजन्तुमा प्रभाव निगरानी र जैवविविध	क्यामेरा ट्र्यापिङ: प्रभावकारी निगरानीका लागि विभिन्न स्थानहरूमा क्यामेरा जडान गरिनेछ। वन्यजन्तु क्रसिङ नियमित रूपमा अनुगमन गर्न क्यामेरा प्रयोग गरिनेछ। रोडकिल अध्ययन (Roadkill Study): वन्यजन्तुको आवागमन र संरचनाहरूको प्रयोग अनुगमन गर्न उपकरणहरू जडान गरी निगरानी सञ्चालन गरिनेछ। सम्बन्धित वन कार्यालय (DFO) सँग मिलेर सडकमा मरेका जनावरहरूको रेकर्ड राखिनेछ।

नकारात्मक वातावरणीय प्रभावहरू	न्यूनीकरणका उपायहरू
ता प्रभाव /न्युनिकरण प्रयास	वन्यजन्तु-सवारी साधन टक्कर न्यूनीकरणका थप उपायहरू: - जहाँ जनावरहरू प्रायः क्रस गर्छन् त्यहाँ चालकलाई सचेत गराउन संकेत (signs) प्रयोग। - सडक किनारमा फेन्सिङ जडान गरी जनावरहरूलाई क्रसिङ संरचनातर्फ मार्गदर्शन। - रातिको समयमा सवारी साधन आउँदा जनावरहरूलाई क्रस गर्नबाट रोक्न सडक छेउमा रिफ्लेक्टरहरूको प्रयोग। अन्य व्यवस्थापन: वन क्षेत्रमा जडान गरिएका पानीका स्रोत/पोखरी र फेन्सिङको नियमित निरीक्षण र मर्मतसम्भार गरिनेछ।
वन्यजन्तु आवागमनमा बाधा / -वन्यजन्तु सवारी साधन टक्कराव	वन्यजन्तु-सवारी साधन टक्कराव घटाउन थप उपायहरूको व्यवस्थापन: - जहाँ जनावरहरू प्रायः क्रस गर्छन् त्यहाँ चालकलाई सचेत गराउन संकेत (signs) प्रयोग गर्ने। - सडक किनारमा अतिरिक्त फेन्सिङ जडान गरी जनावरहरूलाई क्रसिङ संरचनातर्फ मार्गदर्शन गर्ने। - राति सवारी साधन आउँदा जनावरहरूलाई क्रस गर्नबाट रोक्न सडक छेउमा रिफ्लेक्टरको प्रयोग। अन्य व्यवस्थापन: - सबै वन्यजन्तु क्रसिङ संरचनाहरूको नियमित सफाई र मर्मतसम्भार गरिने, जसले अवरोध घटाएर जनावरहरूको सहज आवागमन सुनिश्चित गर्नेछ।
सचेतना अभिवृद्धि गतिविधिहरू	क्रसिङ क्षेत्रहरूमा चेतावनी संकेत (warning signs), गति सीमा (speed limits) र वन्यजन्तु सम्बन्धी प्रदर्शन बोर्ड (display boards) स्थापना गरिनेछ। संवेदनशील वन्यजन्तु क्रसिङ स्थानहरूमा आवाज र असुविधा कम गर्न हर्न बजाउन प्रतिबन्ध लगाइनेछ। राजमार्गको छेउछाउ बसोबास गर्ने समुदायलाई वन्यजन्तुसँग सहअस्तित्व र गैरकानुनी शिकार नियन्त्रण सम्बन्धी सचेतना कार्यक्रम सञ्चालन गरिनेछ। वन्यजन्तु जानकारी: वन्यजन्तुको उपस्थिति, महत्व र संरक्षण सम्बन्धी जानकारी दिने सूचना बोर्डहरू वन क्षेत्रका आवागमन हुने स्थानहरूमा स्थापना गरिनेछ। स्थानीयहरूका लागि कार्यशालाहरू: - वन डढेलो व्यवस्थापन र समन्वय - वन्यजन्तु संरक्षण - वन्यजन्तु र फोहोर व्यवस्थापन (सवारी साधनबाट फोहोर नफाल्ने सम्बन्ध) - गति सीमा - सम्भावित टक्कराव / सडकमा मरेका जनावर (Roadkill) यी कार्यशालाहरू स्थानीय समुदायमा सचेतना अभिवृद्धि गर्ने उद्देश्यले सञ्चालन गरिनेछ।
क्रसिङ संरचनाहरूको मर्मतसम्भार	भायाडक्ट/अन्डरपास र अन्य क्रसिङ संरचनाहरूको नियमित मर्मतसम्भार: - वन्यजन्तु क्रसिङका भायाडक्ट र अन्डरपासहरूको नियमित मर्मतसम्भार गरिनेछ। - सबै कल्भर्टहरूको नियमित सफाई, अवरोध हटाउने कार्य र मर्मतसम्भार गरिने, जसले अवरोध/ब्लकिङ घटाएर वन्यजन्तुहरूको सहज आवागमन सुनिश्चित गर्नेछ। - वन्यजन्तु आवागमन र क्रसिङ संरचनाको प्रयोग अनुगमन गर्न उपकरणहरू जडान गरी निगरानी सञ्चालन गरिनेछ। - सम्बन्धित राष्ट्रिय निकुञ्ज (PNP, CNP) र वन कार्यालय (DFOs) सँग मिलेर सडकमा मरेका जनावरहरूको रेकर्ड कायम राखिनेछ।

नकारात्मक वातावरणीय प्रभावहरू	न्यूनीकरणका उपायहरू
सामाजिक आर्थिक तथा सांस्कृतिक वातावरण	
निर्माण चरण	
निजी संरचनामा प्रभाव (परियोजनाले 378 HHs को कुल 403 निजी संरचनाहरूलाई असर गर्ने छ।)	प्रभावित घरधुरीहरूमा पर्ने असरलाई सम्बोधन गर्न तथा न्यूनीकरण गर्नका लागि पुनःस्थापना कार्ययोजना तयार गरिएको छ। यस योजनाको उद्देश्य प्रभावित व्यक्तिहरूको आय र जीविकोपार्जनको अवस्थालाई आयोजनापूर्वको अवस्थामा कायम राख्ने वा सुधार गर्ने हो। प्रभावित घरधुरीहरूलाई उनीहरूको सम्पत्तिको पूर्ण प्रतिस्थापन लागतका आधारमा प्रचलित दरअनुसार नगद क्षतिपूर्ति प्रदान गरिने छ। साथै, पुनःस्थापना र जीविकोपार्जन पुनःस्थापनाका लागि थप सहायता समेत उपलब्ध गराइने छ। व्यवसायमा परेको असरको क्षतिपूर्ति सम्बन्धमा प्रभावित घरधुरीहरूलाई उनीहरूको गुमेको आयका आधारमा (पुनर्वास योजना) RAP अनुसार प्रदान गरिने छ। साथै, जोखिममा रहेका घरधुरीहरूलाई थप नगद सहायता प्रदान गरिने छ। जीविकोपार्जन पुनःस्थापनाका उपायहरू पनि RAP अनुरूप कार्यान्वयन गरिने छ।
सामुदायिक संरचना तथा सार्वजनिक उपयोगितामा अवरोध (सडक विस्तारको क्रममा १८० वटा सामुदायिक संरचनाहरू प्रभावित हुनेछन्)	सार्वजनिक संरचनाहरू स्थानान्तरण गर्नुपूर्व सार्वजनिक जानकारी प्रदान गरिने छ। स्थानान्तरणकार्य ढिलो नहोस् भन्ने सुनिश्चित गर्न सम्बन्धित सेवा प्रदायक संस्थाहरूसँग समन्वय गरी पूर्वतयारी, आवश्यक स्वीकृति प्रक्रिया तथा कोश हस्तान्तरण आदि अग्रिम रूपमा गरिने छ। सामुदायिक संरचनाहरू- स्थानीय समुदाय, स्थानीय अधिकारीहरूको परामर्शमा पुनर्निर्माण, लागत परियोजना लागतमा विनियोजन गरिएको छ। - सिँचाई नहर र खानेपानी आपूर्ति लाइनहरू- निर्माण व्यवसायीले सिँचाई नहर, पानीका पाइपलाइनहरू स्थानान्तरण गरिने छ यसका लागि इन्जिनियरिङ लागतमा प्रावधान गरिएको छ। - बिजुलीका पोल र बिजुली लाइनहरू- स्थानान्तरणका लागि नेपाल विद्युत् प्राधिकरणसँग समन्वय गरिनेछ। - टेलिफोन लाइनहरू- दूरसञ्चार/नेपाल टेलिकमसँग समन्वय गरिनेछ। सार्वजनिक शौचालय- स्थानीय सरकारसँग समन्वय गरिनेछ। - पहुँच सडकहरू- अवस्थित सडकहरू भत्काउनुअघि सडकहरू पुनः व्यवस्थित गरिने छ। - ट्युबवेलहरू- हालको ट्युबवेल भत्काउनुअघि नयाँ ट्युबवेल उपलब्ध गराइने छ।
कामदारहरूको आवागमन बाट पर्ने प्रभाव	निर्माण व्यवसायीले स्थानीय बासिन्दा र कामदारबिच सम्भावित गलत सञ्चार र त्यसबाट उत्पन्न हुन सक्ने द्वन्द्वका जोखिमबारे सचेत रहनुपर्ने छ। यसरी उत्पन्न हुने द्वन्द्वलाई कम गर्न जनचेतना कार्यक्रम सञ्चालन गरी र कामदारहरूको आचारसंहिता लागु गरी नियन्त्रण गरिने छ। निर्माण व्यवसायीले निर्माणस्थल, शिविर तथा स्थानीय समुदायमा कामदारहरूको व्यवहार व्यवस्थापनका लागि स्पष्ट आचारसंहिता तयार गर्ने छ र त्यसको पालना सुनिश्चित गर्ने छ। कामदारहरूलाई यौनरोगहरू, जस्तै- एचआइभी एड्स, लैङ्गिक हिंसासम्बन्धी सचेतना अभिवृद्धि गर्ने अभियान सञ्चालन गरिने छ। निर्माण शिविरहरू तोकिएका क्षेत्रहरूमा मात्र बनाइने छ र बस्तीक्षेत्रबाट टाढा राखिने छ।
पेसागत स्वास्थ्य र सुरक्षा	निर्माण व्यवसायीले प्रत्येक कार्यगतिविधिअन्तर्गत पहिचान गरिएका सबै जोखिमहरू तथा निर्माण अवधिमा स्थल-विशेष व्यावसायिक स्वास्थ्य तथा सुरक्षा (OHS) सम्बन्धी जोखिम र खतराहरूका लागि OHS योजना तयार गर्ने, स्वीकृति प्राप्त गर्ने र कार्यान्वयन गर्नुपर्नेछ। साथै नियन्त्रण तथा रोकथामका उपायहरू लागू गर्नुपर्नेछ। नयाँ निर्माण स्थलमा प्रस्तावित कार्यहरू वा कार्य परिस्थितिका कारण परियोजनाका कामदारहरूलाई हुन सक्ने सम्भावित जोखिमहरू पहिचान गर्न 'कार्य जोखिम विश्लेषण' (Job Hazard Analysis) सञ्चालन गरी आवश्यक नियन्त्रण उपायहरू

नकारात्मक वातावरणीय प्रभावहरू	न्यूनीकरणका उपायहरू
	लागू गरिनेछ । कामदारहरूका लागि व्यावसायिक स्वास्थ्य तथा सुरक्षासम्बन्धी नियमित तालिम कार्यक्रम सञ्चालन गरिनेछ (दैनिक/साप्ताहिक टुलबक्स टक) । कामदारहरूलाई आवश्यक व्यक्तिगत सुरक्षा उपकरण (PPE) उपलब्ध गराइनेछ (जस्तै: सेफ्टी बुट, हेल्मेट, मास्क, पञ्जा, बडी हार्नेस, सुरक्षात्मक कपडा, चस्मा, पूर्ण अनुहार ढाक्ने आँखा-सिल्ड तथा कान संरक्षण उपकरण) । आपतकालीन प्रतिकार्य कार्यान्वयनका लागि स्थलमा आगो निभाउने उपकरण, एम्बुलेन्स, चिकित्सकीय तथा उद्धार सुविधाहरू उपलब्ध गराइनेछ । निर्माण शिविर सबै आवश्यक सुविधासहित (सुरक्षित खानेपानी तथा सरसफाइ, भान्सा, विश्राम कक्ष आदि) निर्माण गरिनेछ । साथै मनोरञ्जनसम्बन्धी सुविधाहरू पनि उपलब्ध गराइनेछ, जसले गर्दा कामदारहरू र स्थानीय समुदायबीचको अन्तरक्रिया न्यून रहनेछ । कार्यस्थल तथा शिविरहरूमा प्राथमिक उपचार सुविधा उपलब्ध गराइनेछ । ठेकेदारले योग्य प्राथमिक उपचारकर्ताहरू नियुक्त गर्नेछ । सडक विभागको नीतिअनुसार पुरुष तथा महिला कामदारहरूका लागि छुट्टाछुट्टै शौचालय सुविधा उपलब्ध गराइनेछ ।
सामुदायिक स्वास्थ्य र सुरक्षा	निर्माण सवारीसाधनका कारण हुने सुरक्षा जोखिमहरू: निर्माण व्यवसायीले यातायात व्यवस्थापनसम्बन्धी विस्तृत योजना तयार गरी कार्यान्वयन गर्नेछ, जसमा यातायात मोड्ने व्यवस्था, स्थानीय यातायातका लागि वैकल्पिक मार्गहरूको व्यवस्था, विद्यालय समयको व्यवस्थापन, गति सीमाको पालना गर्ने आदि जस्ता पर्याप्त उपायहरू समावेश गर्नेछ । यो योजना विशेष गरी विद्यालय, बस्ती, बजार क्षेत्र तथा निर्माण क्षेत्र नजिक असुरक्षित अवस्था उत्पन्न हुन नदिन कार्यान्वयन गरिनेछ । कार्यसम्बन्धी जोखिममा समुदायको सम्पर्क: निर्माण क्षेत्रमा समुदायको प्रवेश रोक्न कडा बार (हार्ड फेन्सिङ) प्रयोग गरी कार्य क्षेत्र घेराबन्दी गरिनेछ । निर्माण कार्यबाट समुदायलाई टाढा राख्न पर्याप्त सूचना प्रदान गरिनेछ तथा संकेत बोर्डहरू जडान गरिनेछ र ट्राफिक/सुरक्षा कर्मी (फ्ल्यागम्यान) खटाइनेछ । नजिकका बासिन्दाहरूलाई निर्माणसम्बन्धी जोखिम तथा खतराबारे जानकारी दिन समुदाय सचेतना कार्यक्रमहरू सञ्चालन गरिनेछ ।
लैङ्गिक हिंसा	ठेकेदारका कर्मचारी तथा कामदारहरू र परियोजना कार्यान्वयनमा संलग्न सबै पक्षहरूबाट आचारसंहिता (Code of Conduct) को सचेतना र कडाइका साथ कार्यान्वयन सुनिश्चित गरिनेछ । पर्यवेक्षण परामर्शदाता, निर्माण व्यवसायी/ उप- निर्माण व्यवसायी तथा सेवा प्रदायक संस्थाका कर्मचारीहरूलाई यौन शोषण तथा दुर्व्यवहार (SEA) र यौन उत्पीडन (SH) सम्बन्धी विषयमा संवेदनशील बनाउने उद्देश्यले सचेतनामूलक तालिम सञ्चालन गरिनेछ ।
धार्मिक क्षेत्रमा पर्ने प्रभाव	प्रभावित संरचनाहरू सार्नुअघि सार्वजनिक रूपमा जानकारी प्रदान गरिने छ। सामुदायिक मन्दिरहरू स्थानान्तरणपछि स्थानीय समुदाय र सरोकारवाला निकायहरूसँगको परामर्शमा पुनःनिर्माण गरिने छ, जसको लागत आयोजना लागतभित्र समावेश गरिएको छ। निर्माणका क्रममा साइटहरूमा भौतिक सांस्कृतिक स्रोतहरू फेला पर्दा निर्माण व्यवसायीले मौका खोजी (Chance Finding) प्रोटोकल पालना गर्ने छ ।
सञ्चालनको चरण	
सडक सुरक्षा	सडक सुरक्षा सामग्री (Road Furniture) हरुको नियमित मर्मतसम्भार गरिनेछ तथा पैदलयात्री क्रसिङ (सम्भव भएसम्म ओभरपास वा अन्डरपास, सडक सतहमा जेब्रा क्रसिङ) को व्यवस्था गरिनेछ । क्रसिङका स्थानहरू समुदायको चाहना तथा प्राथमिकतालाई ध्यानमा राखी (सुविधा र व्यक्तिगत सुरक्षासम्बन्धी पक्ष सहित) निर्धारण गरिनेछ । आवश्यकताअनुसार

नकारात्मक वातावरणीय प्रभावहरू	न्यूनीकरणका उपायहरू
	थप संकेत चिन्ह, ट्राफिक सिग्नल, सडक चिन्हाङ्कन तथा अन्य उपकरणहरू जडान गरिनेछ । राजमार्गमा निगरानीका लागि ट्राफिक सिग्नल तथा सीसी क्यामेरा जडान गरिनेछ । स्थानीय ट्राफिक प्रहरीसँग समन्वय गरी सवारी चालक तथा स्थानीय बासिन्दाहरूका लागि सडक सुरक्षा सचेतना तालिमहरू सञ्चालन गरिनेछ ।
सामुदायिक स्वास्थ्य र सुरक्षा	मर्मतसम्भारका साथै आवश्यकताअनुसार थप संकेत चिन्ह, सिग्नल, सडक चिन्हाङ्कन तथा अन्य उपकरणहरू जडान गरिनेछ । समुदायको सुरक्षाका लागि समुदायको चाहना तथा प्राथमिकताअनुसार थप सडक क्रसिङ स्थानहरू निर्माण गरिनेछ । सडक क्रसिङ-सम्बन्धी पूर्वाधारहरू सार्वभौमिक पहुँच (Universal Access) को सिद्धान्तअनुसार निर्माण गरिनेछ । सडक मर्मतसम्भारको समयमा अस्थायी बाइपास मार्गको व्यवस्था गरिनेछ । सवारी चालक तथा स्थानीय बासिन्दाहरूका लागि सडक सुरक्षा सचेतना तालिमहरू सञ्चालन गरिनेछ ।
सडकको क्षेत्राधिकारको सुधार	आयोजना/सडक विभागले सडक संरचनाको अधिकारक्षेत्रमा अतिक्रमणबारे स्थानीयवासीमा सचेतना कार्यक्रम सञ्चालन गर्ने छ। यसका लागि स्थानीय सरकारसँग समन्वय गरी कानून कार्यान्वयन गरिने छ। विभिन्न सरकारी निकायहरूको संयुक्त प्रयास र सचेतना कार्यक्रमहरूको समन्वय पनि गरिने छ।
कामदारको स्वास्थ्य र सुरक्षा	कामदारहरूलाई सडकसवारी बाट अलग राख्न कार्य क्षेत्रको सुरक्षा सुनिश्चित गरिनेछ । यदि सडक पर्याप्त चौडा छ भने लेनहरू बन्द गरी बाँकी लेनहरूमा सवारी मोडिनेछ (जस्तै, बहु-लेन राजमार्गको सबै यातायातलाई एकतर्फी मार्गमा पुनर्निर्देशन) । कामदारहरूको सवारीसँग सम्पर्क कम गर्न सुरक्षा बारियर्स प्रयोग गरिनेछ वा कार्य क्षेत्र स्पष्ट पार्न च्यानलिङ उपकरणहरू (जस्तै ट्राफिक कोन र ब्यारेल) जडान गरिनेछ । यातायात प्रवाहलाई नियन्त्रण गर्न चेतावनी बत्ती र फ्ल्यागरहरू प्रयोग गरिनेछ ।

१०. वातावरणीय व्यवस्थापन योजना र वातावरणीय अनुगमन योजना

यस प्रतिवेदनअन्तर्गत वातावरणीय व्यवस्थापन योजना (EMP) तयार गरिएको छ, जसमा न्यूनीकरण उपायहरू, तिनको कार्यान्वयनको समयावधि, स्थान, लागत, जिम्मेवार कार्यान्वयन निकायहरू र अनुगमन गर्ने निकायहरू उल्लेख गरिएको छ। आयोजनाबाट उत्पन्न सामाजिक असरहरू समाधान गर्न छुट्टै पुनर्वास योजना (Resettlement Plan) पनि तयार गरिएको छ। साथै, EMP कार्यान्वयनको प्रभावकारिता सुनिश्चित गर्नका लागि आवश्यक प्रमुख अनुगमन गतिविधिहरूको मार्गदर्शन गर्न वातावरणीय अनुगमन योजना (EMoP) पनि तयार गरिएको छ।

यस आयोजनाको कार्यान्वयन निकायका रूपमा भौतिक पूर्वाधार तथा यातायात मन्त्रालय (MoPIT) अन्तर्गतको सडक विभाग (DoR)/आयोजना निर्देशनालय रहने छ र आयोजनाअन्तर्गतका सबै वातावरणीय सुरक्षात्मक उपायहरूको कार्यान्वयनको समग्र जिम्मेवारी यसै निकायले वहन गर्ने छ। सुपरभिजन परामर्शदाता (SC) टोली, जसमा वातावरण विज्ञसमेत रहने छन्, जसले सडक विभाग आयोजना निर्देशनालयलाई सहयोग गर्दै वातावरणीय सुरक्षात्मक कार्यहरू अनुगमन र सुपरिवेक्षण गर्ने छन्।

यस सडकखण्डअन्तर्गतका भौतिक, जैविक, सामाजिक-आर्थिक र सांस्कृतिक वातावरणमा प्रस्तावित न्यूनीकरण तथा प्रवर्धन उपायहरूको कार्यान्वयनका लागि अनुमानित लागत ने.रु. १२,४६१,९२९,५८१ रहेको छ।

११. वातावरणीय परीक्षण

सडक आयोजनासँग सम्बन्धित वातावरणीय संरक्षण र व्यवस्थापनका पक्षहरूको मूल्याङ्कन तथा परीक्षण गर्न वातावरणीय परीक्षण गरिने छ। आयोजना सम्पन्न भएको दुई वर्षपछि परीक्षण सञ्चालन गरिने छ। वातावरणीय परीक्षणको जिम्मेवारी वन तथा वातावरण मन्त्रालयले वहन गर्ने छ।

१२. निष्कर्ष र प्रतिबद्धता

प्रस्तावित आयोजनाले हालको दुई लेन सडकलाई चार लेनमा स्तरोन्नति गर्ने छ, जसले सडकको क्षमता, गुणस्तर र सुरक्षामा उल्लेखनीय सुधार ल्याउने छ। यसले सवारी आवागमन सहज, सरल र छिटो बनाउने छ, वर्तमान ट्रफिक जाम हटाउने, सडक दुर्घटनामा कमी ल्याउने, यात्राको समय र लागत घटाउने, सवारी साधन सञ्चालनखर्च, जस्तै- इन्धन खपतमा सुधार ल्याउने, सवारीका पुर्जा बिग्रने दर घटाउने र राम्रो सवारी गुणस्तरका कारण हरितगृह ग्याँसको उत्सर्जनमा कमी ल्याउने अपेक्षा गरिएको छ। जैविक विविधता, वन्यजन्तु क्रसिङका दृष्टिले अत्यन्तै संवेदनशील रहेका पर्सा राष्ट्रिय निकुञ्ज र बरण्डाभार कोरिडोर वनक्षेत्रबाट जाने सडकलाई विशेष ध्यान दिई भायोडक्ट निर्माण गरी अन्य पहिचान भएका वन्यजन्तु क्रसिङ स्थानमा वन्यजन्तु क्रसिङ संरचना निर्माण गरिने छ।

पहिचान गरिएको प्रभावहरू महत्त्वपूर्ण भएपनि प्रायः स्थानीय र अस्थायी प्रकृतिका छन्। करिब २४५.६४ हेक्टर सडक अधिकारक्षेत्रको भूउपयोगको स्वरूप परिवर्तन भई कालोपत्रे सडकमा परिणत हुने छ। निर्माणकार्यको कारण वायु, ध्वनि र पानी प्रदूषणमा वृद्धि हुने भएकाले त्यसलाई न्यून पार्न पर्याप्त न्यूनीकरण उपायहरू प्रस्ताव गरिएको छ।

जम्मा २३,३२६ ओटा रुखहरू सडक अधिकारक्षेत्रबाट कटान गरिने छ। सडक पर्सा राष्ट्रिय निकुञ्ज र यसको मध्यवर्तीक्षेत्र, चितवन राष्ट्रिय निकुञ्जको मध्यवर्तीक्षेत्र, बरण्डाभार कोरिडोर वनक्षेत्र र अन्य सामुदायिक वन तथा अन्य वनक्षेत्रहरू हुँदै जाने भएकाले निर्माणकार्यको समयमा वन्यजन्तुहरूको आवागमन प्रभावित हुन सक्छ। सो असर न्यून पार्न वन्यजन्तु मैत्री संरचनाहरू, जस्तै- विशेष वन्यजन्तु क्रसिङ, भायोडक्ट, क्यानोपी ब्रिज, फेन्सिङजस्ता संरचनाहरूको प्रस्ताव गरिएको छ। आयोजनाले (हेटौँडा बजारबाहेक) ३७८ घरधुरीहरूसँग सम्बन्धित ४०३ निजी संरचनालाई प्रभावित पार्ने छ। ती प्रभावित निजी संरचनाहरूमध्ये २७२ ओटा पूर्ण रूपमा प्रभावित छन् भने १३१ ओटा आंशिक रूपमा प्रभावित छन्। प्रभावित हुने सबै निजी संरचना र सामुदायिक संरचनाहरूलाई पुनर्वास योजना (RP)बमोजिम र विद्यमान कानूनको पालना गरी क्षतिपूर्ति दिइने छ। स्थानीय सरकार र अन्य सरोकारवाला निकायसँगको समन्वयमा करिब १८० सामुदायिक संरचना र सार्वजनिक सुविधाहरूको पुनर्निर्माण वा निश्चित ठाउँमा सारिने छ।

आयोजनाबाट हुने प्रतिकूल असरहरू न्यूनीकरण गर्न विस्तृत न्यूनीकरण उपायहरू प्रस्ताव गरिएको छ, जुन वातावरणीय व्यवस्थापन योजना र वातावरणीय अनुगमन योजनामा पूर्ण रूपमा समावेश छन्। ने.रु. १२,४६१,९२९,५८१ लागत न्यूनीकरण तथा प्रवर्धनका कार्यहरूका लागि प्रस्ताव गरिएको छ। प्रस्तावकले वातावरणीय प्रभाव मूल्याङ्कन र वातावरणीय व्यवस्थापन योजनामा उल्लेख गरिएका न्यूनीकरण उपायहरू कार्यान्वयन गर्ने र तिनको निगरानी गर्ने प्रतिबद्धता व्यक्त गर्दछ।

ABBREVIATION/ACRONYMS

AASHTO	American Association of State Highway and Transportation Officials
ACF	Adhabhar Corridor Forests
ADB	Asian Development Bank
AGB	Above Ground Biomass
AH	Asian Highway
AIDS	Acquired Immunodeficiency Syndrome
amsl	Above Mean Sea Level
AP	Affected People
APHA	American Public Health Association
BCF	Barandabhar Corridor Forest
BCFW	Barandabhar Corridor Forest and Wetland
BES	Brief Environmental Study
BMS	Boulder Mixed Soil
BZ	Buffer Zone
BZCF	Buffer Zone Community Forest
BZCFUG	Buffer Zone Community Forest User Group
BZMC	Buffer Zone Management Community
CC	Climate Change
CCKP	Climate Change Knowledge Portal
Ch	Chainage
CF	Community Forest
CFUG	Community Forest Users Group
CHAL	Chitwan Annapurna Landscape
CITES	Convention on International Trade of Endangered Species of Flora and Fauna
CMQ	Clustered Mosaic Quadrants
CNP	Chitwan National Park
CoI	Corridor of Impact
CRCP	Climate Risk Country Profile
Cum	Cubic Meter
dB	Decible
DBH	Diameter at Breast Height
DCC	District Coordination Committee

DCID	Development Cooperation Implementation Division
DFO	Divisional Forest Office
DHM	Department of Hydrology and Meteorology
DIA	Direct Impact Area
DIZ	Direct Impact Zone
DLP	Defect Liability Period
DoF	Department of Forest
DNPWC	Department of National Parks and Wildlife Conservation
DoR	Department of Roads
DS	Downstream
EC	Electrical Conductivity
EFF	Electrified Funneling Fence
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
EMoP	Environmental Monitoring Plan
EPA	Environment Protection Act
EPR	Environment Protection Rules
ERMC	Environment and Resource Management Consultant
ESA	Environmental and Social Assessment
ESMF	Environmental and Social Management Framework
EWB	East West Highway
FA	Forest Act
FAO	Food and Agriculture Organization
FF	Funneling Fence
FGD	Focused Group Discussions
FR	Forest Regulations
GBV	Gender Based Violence
GESU	Geo-Environment and Social Unit
GESI	Gender Equality and Social Inclusion
GIS	Geographic Information System
GoN	Government of Nepal
GPS	Global Positioning System
GRID	Green, Resilient, and Inclusive Development
Ha	Hectare

HFT	Himalayan Frontal Thrust
HH	Household
HIV	Human Immunodeficiency Virus
HWC	Human Wildlife Conflict
IBA	Important Bird Area
IIZ	Indirect Impact Zone
INGO	International Non-Governmental Organization
IP	Indigeneous People
IPC	Incrementally Prestressed Concrete
IRC	Indian Road Congress
IUCN	International Union for Conservation of Nature
KII	Key Informant Interview
km	Kilometer
KML	Keyhole Markup Language
KSFT	Khair-Sissoo Forest Type
LAeq	Equivalent Sound Level
LC	Least Concern
LF	Leasehold Forest
LFMG	Local Forest Management Groups
LHS	Left Hand Side
LPG	Liquefied Petroleum Gases
LT	Low Tention
m	Meter
MAP	Medicinal and Aromatic Plants
mm	Milimeter
MoFE	Ministry of Forests and Environment
MoPIT	Ministry of Physical Infrastructure and Transport
MS	Microsoft
MSW	Municipal Waste Management
MT	Metric Ton
NAAQS	Nepal Ambient Air Quality Standard
NASQS	National Ambient Sound Quality Standard
NDWQS	National Drinking Water Quality Standard
NGOs	Non-Governmental Organizations

NHP	Narayanghat Hetauda Pathalaiya
Nos.	Numbers
NSO	National Statistics Office
NT	Near Threatened
NTFPs	Non-Timber Forest Products
NTU	Nephelometric Turbidity unit
PBM	Performance Based Maintenance
OHS	Occupational Health and Safety
PD	Project Directorate
PHN	Pathalaiya-Hetauda-Narayanghat
PIU	Project Implementation Unit
PM	Particulate Matter
PNP	Parsa National Park
PPE	Personal Protective Equipment
ppm	parts per million
PSC	Prestressed Concrete
RAP	Resettlement Action Plan
RB	Root Biomass
RCC	Reinforced Cement Concrete
RCP	Representative Concentration Pathway
RHS	Right Hand Side
Rm	Running Meter
RM	Rural Municipality
RoW	Right of Way
SAARC	South Asia Association for Regional Cooperation
SASEC	South Asia Sub-regional Economic Cooperation
SC	Supervision Consultant
SD	Scoping Document
SDFO	Sub-Divisional Forest Office
SDFT	Subtropical Deciduous Forest Type
SEA	Sexual Exploitation and Abuse
SH	Sexual Harassment
SHIP	SASEC Highway Improvement Project
SPS	Safeguard Policy Statement

sq.km	Square Kilometer
sqm	Square Meter
STDs	Sexually Transmitted Diseases
TA	Technical Assistance
TAL	Terai Arc Landscape
TCS	Tree Census Survey
ToR	Terms of Reference
TSE	Tech Studio of Engineering
TSP	Total Suspended Particles
US	Upstream
VEC	Valued Environment Components
VES	Visual Encounter Survey
VU	Vulnerable
WHO	World Health Organization
WWF	World Wildlife Fund
ZoI	Zone of Influence

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1 NAME AND ADDRESS OF THE INSTITUTION PREPARING THE REPORT

1.1 Proponent

The proponent of the proposed Pathalaiya-Hetauda-Narayanghat (PHN) road is Project Directorate-Asian Development Bank (PD-ADB), Department of Roads (DoR), Ministry of Physical Infrastructure and Transport (MoPIT).

The address of project proponent

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1.2 Consultant

The proponent has assigned Soosung Engineering Co. in association with ERMCTSE, Baluwatar, Kathmandu, Nepal as a project preparatory consultant for SASEC Highway Improvement Project (SHIP), to prepare detail engineering design and Environmental Impact Assessment (EIA).

The address of consultant

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The Scoping Document (SD) and Terms of Reference (ToR) of the proposed project was approved by Ministry of Forests and Environment (MoFE) on 2081-06-11 BS (27 September 2024) and approval letter was issued on 2081-06-21 BS (7 October, 2024). The approval letter of ToR and SD is attached in Annex I-A and EIA study consent from President Chure Terai Madhesh Conservation Development Committee is attached in Annex I-B. The approved ToR is attached in Annex I-C. The team of experts involved in EIA along with self-signed declaration form is attached in Annex II.

1.3 Rationality of Conducting EIA

The project is service delivery type (transportation service) for upgrading/widening of existing road and bridges of the national highway from present two-lane road into four lanes from Pathalaiya (EWH: Ch. 367+630) to Narayanghat (EWH: Ch. 467+320). The rationality is to evaluate and

address the potential environmental, social, and economic impacts of the proposed development and to check regulatory requirements.

Environment Protection Rule (EPR), 2077 (Addendum 2078) B.S.; Schedule 3, Rule 3, E(6) have clearly outlined rationality for conducting the EIA study for this project. This project consists of approximately 100 km road upgrading works including all bridges. As per the Environment Protection Act (EPA) 2076 B.S., and Environment Protection Rule (EPR), 2077 (2078) B.S.; Schedule 3, Rule 3, E (6); upgrading of national highway or feeder road if more than 50 km is mandatory to conduct an Environmental Impact Assessment (EIA).

The road passes through the core area of Parsa national Park (PNP) and Buffer Zone (BZ) of PNP, BZ of Chitwan National Park (CNP), Barandabhar Corridor Forest (BCF) and Chure (Siwalics) area. Schedule 3 (A) List 12, pursuant to Rule 3 of EPR, 2077 B.S. has made it mandatory of conducting EIA to implement any project within a national park, wildlife reserve, hunting reserve or other conservation areas.

As per EPR, 2077(Addendum 2078); Section 2, Rule 7, Sub-rule 8; if the project is funded by foreien agency the environmental assessment report can be prepared in Nepali or in English; this report is prepared in English language, it is funded by ADB.

The scope of EIA in terms of project components includes 100 km road including all bridges, VIADUCT for wildlife and project facilities (such as camps, storage yards, operation of crusher plant, borrowing and quarrying, batching plant, asphalt plant etc).

1.4 Objective of the EIA

The objectives of the EIA of this project are as follows:

- Collect the baseline information on physical, biological, socio-economic and cultural environment in the project affected areas,
- Analyze and determine the potential beneficial and adverse impacts due to the project on physical, biological, socio-economic and cultural environment and chemical environment,
- Propose practical and site-specific mitigation measures for adverse impacts and enhancement of positive impacts,
- Prepare environmental management plan and environmental monitoring plan,
- Provide information to the decision makers and concerned parties about environmental implications of proposed projects,
- Provide an opportunity of public involvement in the all phase of the project, and
- Define the institutional framework required for the implementation f the project.

1.5 Limitation of the EIA

The study is limited to one-time data collection. Further, socio economic survey of household was conducted as sample of 20% household of impact zone. Findings of wildlife study and road kill data is taken from secondary sources. Biodiversity baseline data are supplemented by ADB TA report (Asian Development Bank, (TA-9461, 2022), “Smart Infrastructure Planning and Design to Protect Natural Habitats and Biodiversity: Ecological Assessment of the NHP Road Upgrading” and other secondary source. Tree counting was conducted in year 2022 and verification was done by 2025, however, there could be variation in number and size of trees during the implementation period. The data on biodiversity baseline is limited to winter season (December -January 2024-2025), movement of the reptiles/herpetofauna was at its lowest. VIADUCT has been proposed as per recommendation of ADB TA report and MoFE/Department of National Parks and Wildlife Conservation and as per decision (minute of meeting) of sacratory level (MOFE and MOPIT).

2 INTRODUCTION OF PROJECT

2.1 Background

East-West Highway (EWH) is the main domestic as well as international trade corridor of Nepal. It was constructed about 50 years ago with single-lane bituminous carriageway width and has been rehabilitated/up-graded to the double lane during different periods in between 1998-2005. The EWH is also part of the Asian Highway 2 (AH2).

The SASEC Highway Improvement Project (SHIP) will upgrade 270.00 km (Kakarbhitta-Laukahi (120m) road section, Butwal Gorusinghe –road section 50 KM and Pathalaiya-Hetauda-Narayanghat (PHN) road section 100 km) of East West Highway including bridges among them PHN road section is approximately 100 km. The PHN Road section will be improved from existing two lanes into four lanes including all bridges. The PHN Road will enhance to reduce the traffic congestion, improve the riding quality, and safety of the road after improvement.

The improvement of the road and bridges may have impact on the environment depending on the project's scope, location, scale. Environmental assessment has been carried out to identify and mitigate the impacts. The Environmental Impact Assessment (EIA) has been carried out in accordance with the stipulations of the Environment Protection Act, 2076 B.S. and the Environment Protection Rules, 2077 B.S. (addendum of 2078 B.S.) of the Government of Nepal.

2.2 Relevancy of the Project

Pathalaiya-Hetauda -Narayanghat Road section is a part of East-West (Mahendra) highway which is further a part of Asian Highway. It connects Nepal with India and Bangladesh. This highway has been playing the major role in trade enhancement of the country along with regional connectivity and possible transit corridor. Pathalaiya locates near the dry port of Birgunj and Indian border. It is important for cross-border trade and the movement of goods between Nepal and India. The PHN Road supports trade and commerce facilities between the Kathmandu Valley and the Terai Region also. As a part of the East-West Highway, it serves as a critical route for both local and long-distance traffic, connecting southern Nepal to Kathmandu, and beyond. Pathlaya, Hetauda, and Narayanghat are raising cities and also have been increasing industries day by day that depend on the road to carry both raw materials and finished goods. This road is important for the economic development of the region. At present, most of the road section is 2 lanes and most of the bridges are bottle neck creating traffic nuisances. Further, the road condition of different sections of the road is deteriorated and has developed potholes. Hence, Pathalaiya-Hetauda -Narayanghat Road is crucial for upgrading for the transportation, economic activity, and overall development of Nepal, while also contributing to national and international accessibility. It is proposed to upgrade from existing 2 lanes to 4 lanes National Highway Standard-II (Asian Highway Standard).

2.3 Description of the Project (Road)

Pathalaiya-Hetauda-Narayanghat (PHN) road section of EWH starts at Pathalaiya intersection at Ch 367+630 and ends at Gondrang (Bharatpur) at Ch 467+320. This road section is approximately 100 km long. The existing road has 7 m (two lanes) carriageway width in most of the section and in urban area, there is found four lanes road also. The right of way (RoW) of the road is 50 m (both sides 25 m from centre line) except Hetauda bazar area. RoW of EWH has already been gazated under the jurisdiction of GoN/MoPIT. Generally, the road pavement has flexible pavement. However, from Pathalaiya to Hetauda some section found rigid pavement.

The road alignment passes through mainly settlement, agriculture land, protected area, buffer zone, forest areas. Major settlements along the PHN road section are Amlekhganj (Ch 376+000), Hetauda (Ch 396+500), Manahari (Ch 425+700), Lothar (Ch 436+960), Bhandara (Ch 447+000), Parsa (Ch 454+300), Tandi (Ch 459+700) and Bharatpur (Gondrang) (Ch 467+320). Hetauda and Bharatpur are one of the busy junctions of the highway. Longitudinal drains were built at many settlement areas. At some places, the in-let and out-let of the cross-drainage structures are closed, mainly due to construction of building by local people. Interconnected cracks, routing, undulation and maintained potholes were observed in many locations.

The road intersects the Parsa National Park (PNP) from Ch 370+550 to Ch 374+000 and this section is corridor of the wildlife (Elephant, Tiger, Rhinoceros and others wildlife). The BZ of PNP passes from Ch 367+630 to Ch 370+550, Ch 374+000 to Ch 387+200, Ch 387+200 to Ch 391+700, and Ch 419+250 to Ch 432+200. The alignment traverses through dense forest block from Ch 368+000 to Ch 375+900, from Ch 380+000 to Ch 392+300 is the Siwalik block, Ch 426+750 to Ch 439+900 and Barandabhar Corridor Forest (BCF) from Ch 463+600 to Ch 467+320. BCF connects the Inner Terai and Mahabharat hills and important wildlife habitat.

The road passes through Siwalik/Chure area from Amlekhgunj to Hetauda. The Churiya Mai area has a stretch having huge box cutting and retaining structures are provided on both side of the road for protection. This section is more fragile and unstable. In the river from Ch 379+800 to Ch 390+800, there is minimum free board in the bridges due to siltation and deposition of debris. From Hetauda to Bharatpur, the road passes through the foothills of Siwalik and plain Terai area.

This road passes from close to Petroleum Pipeline (Raksaul - Pathalaiya - Amlekhjung), and Hetauda industrial area (Ch 392+200 - Ch 394+000). During the road widening petroleum pipeline will not be affected.

There are 22 existing bridges along the road. The bridge types are RCC T-Beam, PSC T-Beam, and solid slab. Among 22 bridges, Karra (Ch 394+572), Rapti River (Ch 397+510), Manahari River (Ch 425+497) and Lothar River (Ch 437+230) are more than 100 m in length. A huge number of cargo and petroleum products carrying vehicles were observed along the road. The passenger and freight

traffic has increasing day by day because of connection with Birgunj dry port and India boarder. The daily traffic volume of different stations varies from 12,000 - 25,000 vehicles/day. The urbanized Bharatpur and Hetauda area shows more traffic than other sections. This road and bridges is proposed for upgrading from 2-lanes to 4-lanes road under SHIP.



Figure 1: Existing Road Condition of Pathalaiya-Hetauda-Narayanghat (PHN) Road

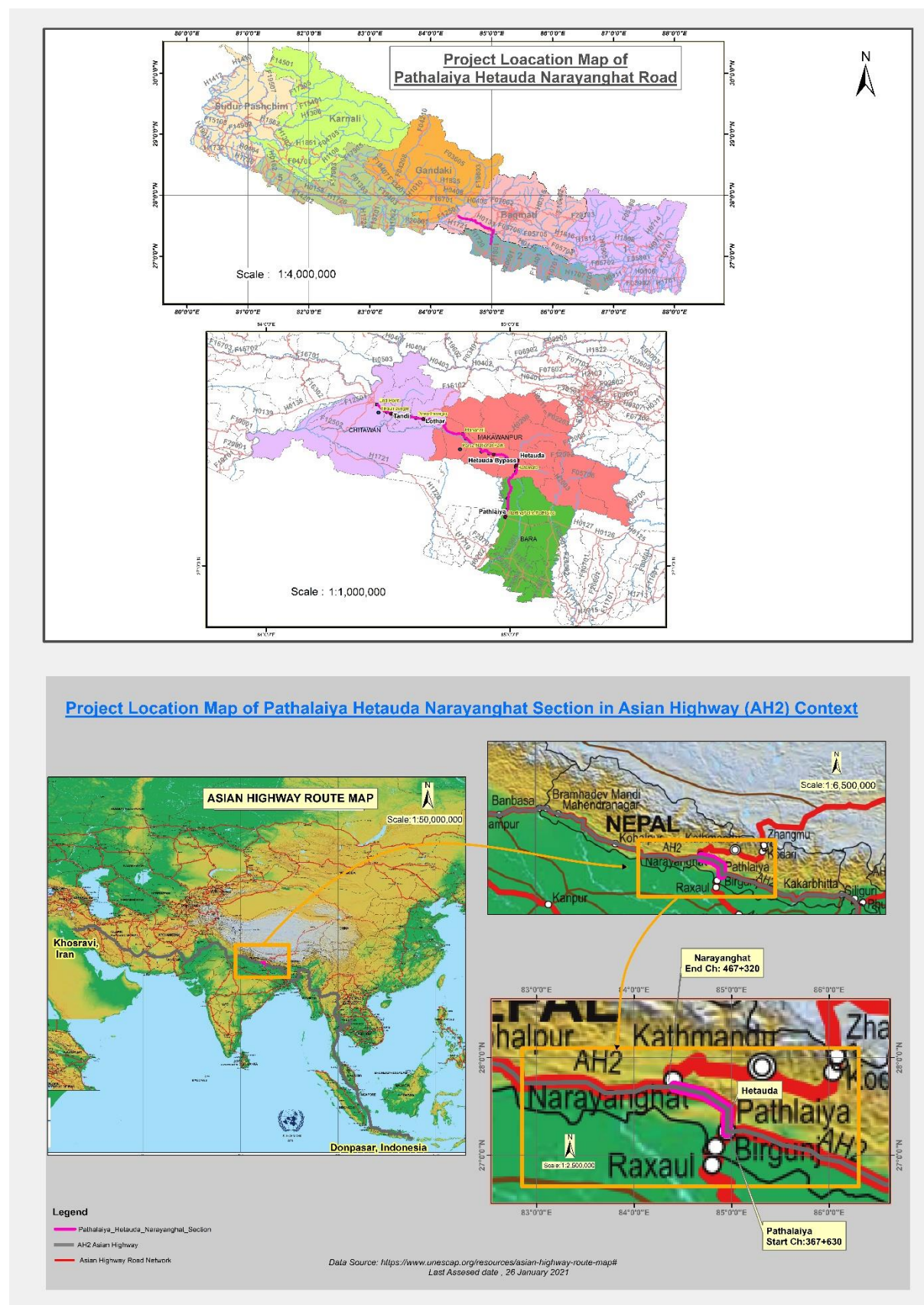


Figure 2: Location Map of PHN Road

2.3.1 Project Location and Accessibility

The project alignment lies between 27°11'57.66" North latitude and 84°58'50.75" East Longitude (at Pathalaiya) to 27°39'36.80" North Latitude and 84° 27'15.18" East longitude (at Gondrang). The road passes through one metropolitan city, two sub-metropolitan cities, three municipalities and one rural municipality. The details are given in Table 1. The location of the proposed road alignment is shown in Figure 2. Topographic map and google map of the project area is attached in Annex III.

The project area is accessible from Kathmandu via Prithivi Highway (100 km) and Mugling-Narayanghat Highway (36 km). The project area is also accessible through Tribhuvan Highway and by air: Kathmandu-Simara and Kathmandu-Bharatpur.

Table 1: Coverage with Administrative Districts and Local Bodies

Provinces	Districts	Local Government	Length (km)
Madhesh	Bara	Jitpursimara Sub-Metropolitan City	19.5
Bagmati	Makawanpur	Hetauda Sub-Metropolitan City, Manahari Rural Municipality	50.12
	Chitwan	Rapti Municipality, Khairahani Municipality, Ratnanagar Municipality, Bharatpur Metropolitan City	30.02

Source: Field Survey, 2024

2.3.2 Salient Features of the Project and Project Components

The salient features of the proposed road are given in the Table 2.

Table 2: Salient Feature of the Project

Name	Particular
Name of the project	SASEC Highway Improvement Project (SHIP)
Name of the road	Pathalaiya - Hetauda - Narayanghat Section of East-West highway (Ch 367+630 ~ Ch 467+320)
Start Point	Pathalaiya, 27°11'57.66"N North latitude and 84°58'50.75" East Longitude, Ch 367+630
End Point	Gondrang (Bharatpur) way to Bishajari Tal 27°39'36.80" North Latitude and 84° 27'15.18"East longitude, Ch 467+320
Districts	Bara, Makawanpur and Chitwan
Provinces	Madhesh, Bagmati
Affected Municipalities	Jitpursimara Sub-Metropolitan city, Hetauda Sub-Metropolitan city, Manahari Rural Municipality, Rapti Municipality, Khairahani Municipality, Ratnanagar Municipality, Bharatpur Metropolitan City

Name	Particular
Major Markets	Amlekhganj (Ch 376+000), Hetauda (Ch 396+500), Manahari (Ch 425+700), Lothar (Ch 436+960), Bhandara (Ch 447+000), Parsa (Ch 454+300), Tandi (Ch 459+700) and Bharatpur (Ch 467+320)
Geography	Terai Plain, Dun Valley and Chure Range
Climate	Tropical and Subtropical
Rainfall	2,407 mm (Annual)
Altitude	Minimum 178.000m amsl (Pahtalaiya), Maximum 687.800 m amsl (Churiyamai)
	Altitude of start point (Ch 367+630): 178.000 m amsl
	Altitude of end point (Ch 467+320): 204.793 m amsl
Road Classification	National Highway-II
Existing Surface	Blacktop
Proposed Surface	Asphalt Concrete
Road Length	100 Km (99.69 Km)
Geometric Design	
Design Speed Km/hr	a. In Plane and Dun Area 100 km/hr
	b. In Siwalik Range 80 km/hr
Roadway Width	In Urban case: 50m
	In Semi urban case: 37.40m
	In Rural case: 24m
Roadway Elements	In Urban case:
	Carriageway 4-lane- 2x7.5m
	Paved Shoulder- 2x2.50m (with Rumble Strip as required)
	Central Median - 3.00m,
	Service lane-2 x 6.5 m with 1.50 m Side Median and
	Foot Path-2 x 5.5m.
	In Semi urban case:
	Carriageway 4-lane- 2x7.5m
	Paved Shoulder- 2x2.50m (with Rumble Strip as required)
	Central Median- 3.00m
	Additional Lane -2 x 5.50 m additional lane (upgradable to 6.50m) with 2x1.2 m lane separator and drain.
	Verge: 0.50 m
	In Rural case:
	Carriageway 4-lane- 2x7.50m
	Paved Shoulder- 2x2.50m (with Rumble Strip as required)
	Central Median - 3.00m.
	Verge -2 x 0.50m

Name	Particular
Camber	Carriageway: 2%
	Shoulder: 3%
Right of Way (RoW)	50.00 m
Stopping Sight distance	190m-design speed of 100km/hr
	130m for design speed of 80 km/hr
Super-elevation	7%
Min. Radius for Horizontal Curves	Plain Terrain - 375 m (100km/hr)
	Rolling Terrain - 240 m (80 km/hr)
Ruling Gradient	5-6% Minimum Gradient 0.50 %
Bridge	41 Nos
Longitudinal Drain	174,612m
Box Culvert	246Nos
Wildlife crossing	Small Wildlife Crossing- 1 No (3 x 2.5 m) Medium Wildlife Crossing- 10 No (8x 3 m) Large Wildlife Crossing -5 No (15 x 4.5 m) Very Large Wildlife Crossing -3No (15 x 6.5 m) Viaduct - 2 No (2001 x 7.0 m) (Viaduct at Adhabhar Corridor Forests of PNP and at Barandabhar Corridor Forest)
Earthwork	
Cut (m ³)	2,499,538
Fill (m ³):	2,905,549
Project Cost (NRs.)	54,293,647,526
Environmental Mitigation Cost (NRs.)	12,461,929,581, (22.95% in relation to Total Project Cost)
Cost per km (NRs.)	544,624,812
Total Construction Period	Construction period 3 years, 12 Month DLP and PBM 5 years

Source: Detail design report of PHN road, 2025

2.4 General Description of Bridges

There are 22 nos of existing bridges in the PHN road. The types of bridge are RCC T-Beam, PSC T-Beam, and solid slab. Among 22 bridges, Karra (Ch 394+572), Rapti River (Ch 397+510), Manahari River (Ch 425+497) and Lother River (Ch 437+230) are more than 100 m in length. During the study, an additional 19 number of bridges (replace of causeway, slab culvert) have been proposed based on their characteristics and discharge capacity, considering the effects of climate change. As a result, the total 41 new bridges will be constructed. The salient features of bridges are presented in Table below and Annex IV-A.

Table 3: Salient Features of Bridges of the Project

Sn	Name of Bridge	Existing Bridge Parameter					New Proposed Bridge Parameter									Remarks
		Bridge ID	Type of Bridge	Span			Bridge ID	Design Chainage	Span			Height	Chainage		Type of Bridge	Upstream (US)/ Down stream (DS)/ Twin
				No	Span	Length			No	Span	Length		Starting	End	Structure ID	
1	Amelek gunj - 1	33 / HOO1 / 215_B	RCC Girder	3	20.3	60.90	33 / HOO1 / 215_A	378+024	3	21.00	63.00		377+991.43	378+056.57	RCC	US
2	Amelek gunj - 2	33 / HOO1 / 216_B	RCC Girder	4	20.33	81.32	33 / HOO1 / 216_A	379+882	2	42.00	84.00		379+838.78	379+925.22	PSC	US
3	Amelek gunj - 3	33 / HOO1 / 217_A	RCC Girder	2	29.87	59.74	33 / HOO1 / 217_B	381+807	2	32.00	64.00		381+773.78	381+840.22	PSC	US
4	Amelek gunj - 4	33 / HOO1 / 218_A	RCC Girder	2	30	60.00	33 / HOO1 / 218_B	382+184	2	35.00	70.00		382+147.78	382+220.22	PSC	DS
5	Badahakim Bridge	33 / HOO1 / 219_A	RCC Slab	5	5.54	27.70	33 / HOO1 / 219_B	383+999	1	30.00	30.00		383+983.40	384+014.60	PSC	US
6	Box Bridge						33 / HOO1 / 219-1_AB	384+220	2	4.00	8.00	3.75	384+216.00	384+224.00	BOX	Twin (New)
7	Box Bridge		RCC Slab	1	7	7.00	34 / HOO1 / 219-2_AB	384+719	2	4.00	8.00	6.00	384+715.00	384+723.00	BOX	Twin (New)
8	Gundo bridge	33 / HOO1 / 220_A	RCC Girder	12	5.65	67.80	33 / HOO1 /	384+982	2	35.00	70.00		384+945.78	385+018.22	PSC	US

Sn	Name of Bridge	Existing Bridge Parameter					New Proposed Bridge Parameter									Remarks
		Bridge ID	Type of Bridge	Span			Bridge ID	Design Chainage	Span			Height	Chainage		Type of Bridge	Upstream (US)/ Down stream (DS)/ Twin
				No	Span	Length			No	Span	Length		Starting	End	Structure ID	
							220_B									
9	Box Bridge						33 / HOO1 / 220-1_AB	385+981	2	5.00	10.00	5.30	385+976.00	385+986.00	BOX	Twin (New)
10	Churiya Bridge	31 / HOO1 / 221_A	RCC Girder	2	30.00	60.00	31 / HOO1 / 221_B	387+653	2	30.00	60.00		387+621.78	387+684.22	PSC	US
11	Pakkipul Bridge	31 / HOO1 / 222	RCC Slab	2	9.00	18.00	31 / HOO1 / 222_AB	387+943	1	19.00	19.00		387+933.15	387+952.85	RCC	Twin (New)
12	Sansare Bridge	31 / HOO1 / 223	RCC Slab	2	6	12.00	31 / HOO1 / 223_AB	388+144	1	15.00	15.00		388+136.15	388+151.85	RCC	Twin (New)
13	Sayafut Bridge	31 / HOO1 / 224	RCC Slab	5	4.85	24.25	31 / HOO1 / 224_AB	388+325	1	25.00	25.00		388+312.15	388+337.85	RCC	Twin (New)
14	Box Bridge_VLAC						31 / HOO1 / 224-1_AB	389+897	1	15.00	15.00	6.50	389+888.15	389+905.85	RCC_VLAC	Twin (New)
15	Box Bridge		Causeway				31 / HOO1 / 224-2_AB	390+749	2	4.00	8.00	2.65	390+745.00	390+753.00	BOX	Twin (New)

Sn	Name of Bridge	Existing Bridge Parameter					New Proposed Bridge Parameter									Remarks
		Bridge ID	Type of Bridge	Span			Bridge ID	Design Chainage	Span			Height	Chainage		Type of Bridge	Upstream (US)/ Down stream (DS)/ Twin
				No	Span	Length			No	Span	Length		Starting	End	Structure ID	
16	Box Bridge_VLAC						31 / HOO1 / 224-3_AB	391+096	1	15.00	15.00	6.50	391+087.15	391+104.85	RCC_VLAC	Twin (New)
17	Karra Bridge	31 / HOO1 / 225_B	RCC Girder	3	36	108.0	31 / HOO1 / 225_A	394+572	3	36.00	108.00		394+516.16	394+627.84	PSC	DS
18	Rapti Bridge	31 / HOO1 / 226_B	RCC Girder	7	30	210.0	31 / HOO1 / 226_A	397+510	7	30.00	210.00		397+395.55	397+624.45	PSC	DS
19	Box Bridge		Box Culvert	3	2.5	2.50	31 / HOO1 / 226-1_AB	404+357	2	5.00	10.00	5.50	404+352.00	404+362.00	BOX	Twin (New)
20	Box Bridge		Box Culvert	2	3	3.00	31 / HOO1 / 226-2_AB	405+622	2	4.00	8.00	5.20	405+618.00	405+626.00	BOX	Twin (New)
21	Box Bridge		Slab Culvert	1	6	2.20	31 / HOO1 / 226-3_AB	408+081	2	5.00	10.00	6.00	408+076.00	408+086.00	BOX	Twin (New)
22	Box Bridge		Slab Culvert	2	3	3.00	31 / HOO1 / 226-4_AB	409+100	2	4.00	8.00	3.10	409+096.00	409+104.00	BOX	Twin (New)

Sn	Name of Bridge	Existing Bridge Parameter					New Proposed Bridge Parameter									Remarks
		Bridge ID	Type of Bridge	Span			Bridge ID	Design Chainage	Span			Height	Chainage		Type of Bridge	Upstream (US)/ Down stream (DS)/ Twin
				No	Span	Length			No	Span	Length		Starting	End	Structure ID	
23	LAC / Bridge			1	7.00	1.30	31 / HOO1 / 226-5_AB	413+160	1	15.00	15.00	4.50	413+151.15	413+168.85	RCC_LAC	Twin (New)
24	LAC/ Bridge			1	7.00	1.30	32 / HOO1 / 226-6_AB	418+550	1	15.00	15.00	4.50	418+541.15	418+558.85	RCC_LAC	Twin (New)
25	VLAC / Bridge						33 / HOO1 / 226-7_AB	420+178	1	15.00	15.00	6.50	420+169.15	420+186.85	RCC_VLAC	Twin (New)
26	Manohari Bridge	31 / HOO1 / 227_B	RCC Girder	8	30	240.0	31 / HOO1 / 227_A	425+497	8	28.82	230.56		425+376.75	425+617.26	RCC	DS
27	Box Bridge		Causeway	1	2	3.00	31 / HOO1 / 227-1_AB	427+217	2	5.00	10.00	5.30	427+212.00	427+222.00	BOX	Twin (New)
28	Box Bridge		Causeway	1	2	3.00	31 / HOO1 / 227-2_AB	427+982	2	4.00	8.00	4.60	427+978.00	427+986.00	BOX	Twin (New)
29	BOX BRIDGE_LAC		Causeway	1	7.00	1.30	31 / HOO1 / 227-3_AB	429+939	1	15.00	15.00	4.50	429+930.15	429+947.85	RCC_LAC	Twin (New)

Sn	Name of Bridge	Existing Bridge Parameter					New Proposed Bridge Parameter									Remarks
		Bridge ID	Type of Bridge	Span			Bridge ID	Design Chainage	Span			Height	Chainage		Type of Bridge	Upstream (US)/ Down stream (DS)/ Twin
				No	Span	Length			No	Span	Length		Starting	End	Structure ID	
30	Box Bridge		Slab Culvert	1	5	2.60	31 / HOO1 / 227-4_AB	431+284	2	4.00	8.00	6.50	431+280.00	431+288.00	BOX	Twin (New)
31	Box Bridge		Slab Culvert	1	10	1.80	31 / HOO1 / 227-5_AB	433+167	2	5.00	10.00	5.00	433+162.00	433+172.00	BOX	Twin (New)
32	Lothar Bridge	31 / HOO1 / 228_B		5	30	150.0	31 / HOO1 / 228_A	437+230	5	28.82	144.10		437+154.85	437+305.15	RCC	DS
33	Lothar Branch Bridge	35 / HOO1 / 229_B	RCC Slab	1	7.2	2.00	35 / HOO1 / 229_AB	438+525	2	4.00	8.00	3.80	438+521.00	438+529.00	BOX	Twin (New)
34	Martal Bridge	35 / HOO1 / 230_B	RCC Girder	2	22.75	45.50	35 / HOO1 / 230_A	444+270	2	22.20	44.40		444+246.58	444+293.43	RCC	DS
35	Pampha Bridge	35 / HOO1 / 231_B	RCC Girder	2	22.75	45.50	35 / HOO1 / 231_A	449+164	2	22.00	44.00		449+141.29	449+186.71	RCC	DS
36	Box Bridge		Box Culvert	3	3	2.50	35 / HOO1 / 231-3_AB	453+377	3	6.00	18.00	6.50	453+368.00	453+386.00	BOX	Twin (New)
37	Ladari (Budi Rapti)	35 / HOO1 / 232_A	RCC Girder	3	20.83	62.49	35 / HOO1 / 232_B	455+349	3	22.00	66.00		455+314.93	455+383.07	RCC	US

Sn	Name of Bridge	Existing Bridge Parameter					New Proposed Bridge Parameter									Remarks
		Bridge ID	Type of Bridge	Span			Bridge ID	Design Chainage	Span			Height	Chainage		Type of Bridge	Upstream (US)/ Down stream (DS)/ Twin
				No	Span	Length			No	Span	Length		Starting	End	Structure ID	
	Bridge															
38	Kair Bridge	35 / HOO1 / 233_A	RCC Girder	3	20.5	61.50	35 / HOO1 / 233_B	457+996	3	22.00	66.00		457+961.93	458+030.07	RCC	US
39	Budhi Bridge	35 / HOO1 / 234	RCC Slab	3	5.5	16.50	35 / HOO1 / 234	459+885								
40	Khageri-2 Bridge	35 / HOO1 / 235_A	RCC Girder	4	16.5	66.00	35 / HOO1 / 235_B	462+521	2	33.00	66.00		462+486.79	462+555.21	PSC	US
41	Khageri-1 Bridge	35 / HOO1 / 236_A	RCC Girder	2	19.5	39.00	35 / HOO1 / 236_B	462+634	1	40.00	40.00		462+613.40	462+654.60	PSC	US

Source: Detail design report of PHN road, 2025

2.5 Upgrading Activities

Existing road and bridges will be upgraded from existing 2 lanes to 4 lanes (National Highway-II standard). The road width is designed as i) 50 m in urban area (However at Hetauda Bazar there will be 45.8m road width), ii) 37.4 m in semi-urban area and iii) 24 m in rural and forest area. Road upgrading components include widening of 100 km road and all bridges which comprises: pavement upgrading, geometry improvement, junction improvements, service roads on both sides of the road, cycle lanes, footpaths in urban areas, pedestrian crossing (overhead bridges/underpass), viaduct, wildlife crossing, construction of new bridges, drainage improvement, retaining structures; slope protection and stabilization, other off-road works, bus bays/lay byes and installation of adequate road safety measures and compensatory plantation etc. Parallel to the existing bridges, additional major and minor bridges with footpaths will be constructed to meet 4 lanes standard.

Pre-Construction Phase

- Clearing of RoW (acquisition of private structure, shifting, relocation of public structures and utilities, tree felling approval from the concern ministry)
- Temporary land acquisition for construction and ancillary facilities

Construction Phase

- Earthwork excavation, Cutting-filling works, and formation of embankment,
- Construction of structures including retaining structures, embankment protection, slope protection and drainage structures,
- Traffic safety structures,
- Bridge construction,
- Culvert and side drain construction,
- Bio-engineering,
- Road pavement works,
- Roadside plantation, median plantation, compensatory plantation,
- Construction of VIADUCT, underpass, fencing, wetland development for wildlife,
- Operation of quarry/burrow sites, camps (Labour/Contractor), Asphalt plant, Concrete Batching plant, crusher plant,
- Road marking and establishment of traffic sign,etc,

Operation and Maintenance Phase

- Decommissioning of ancillary facilities,
- Maintenance of road and drainage structures,
- Maintenance of bio-engineering sites, slope protection,
- Maintenance of roadside plantation and wildlife crossing structures etc.

Road Section

To improve the current two-lane road into a four-lane road, three types of cross-sections are proposed: 50 meters wide in urban areas (however the road width in Hetauda Bazar will be 45.8 meters); 37.4 meters wide in semi-urban areas; and 24 meters wide in rural/forest areas.

All types of cross section are shown in the Figure 3, Figure 4 & Figure 5, and Figure 6. Chainage wise road alignment section is given in Table 4.

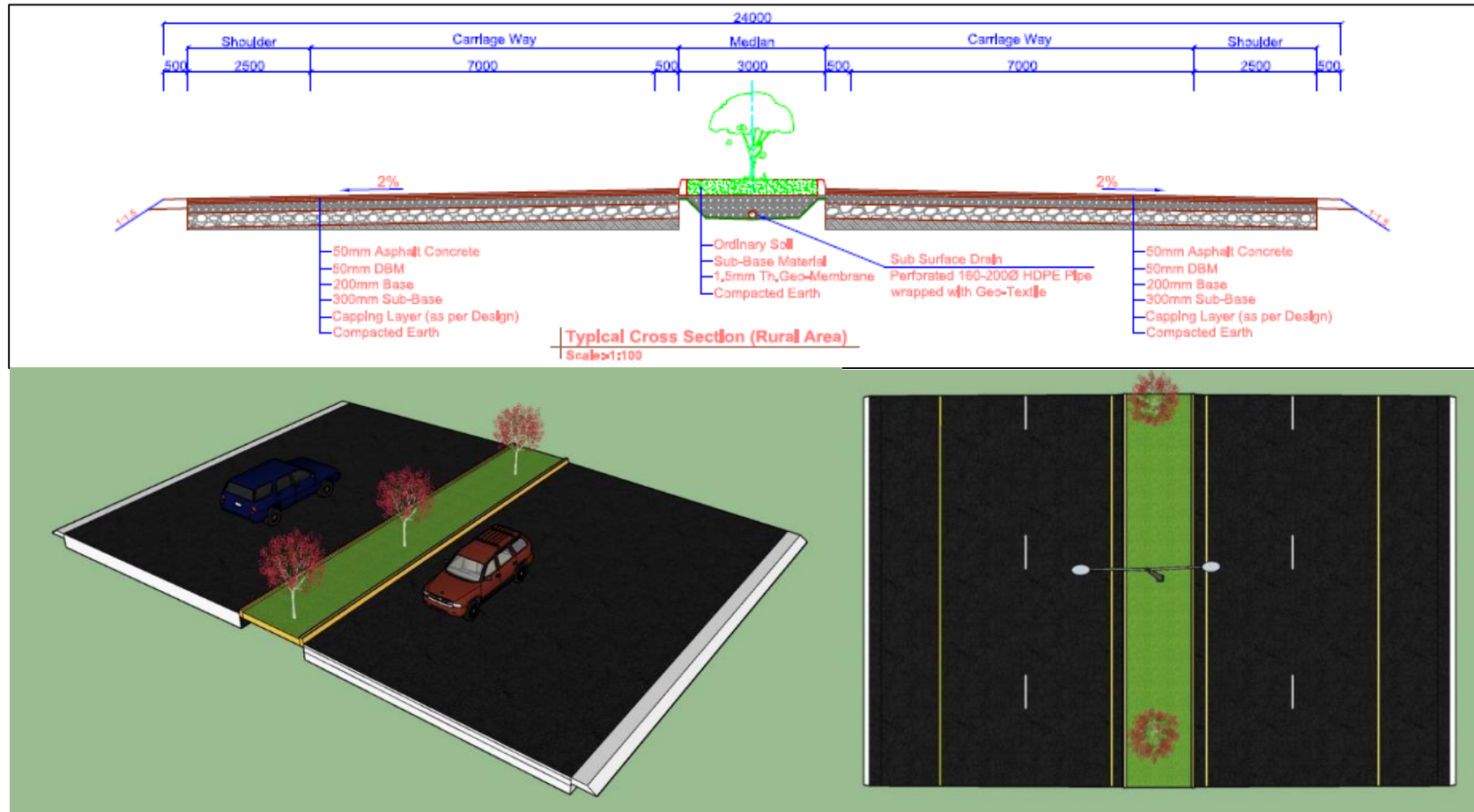


Figure 3: Typical design of road alignment section in rural area (4 lane road)

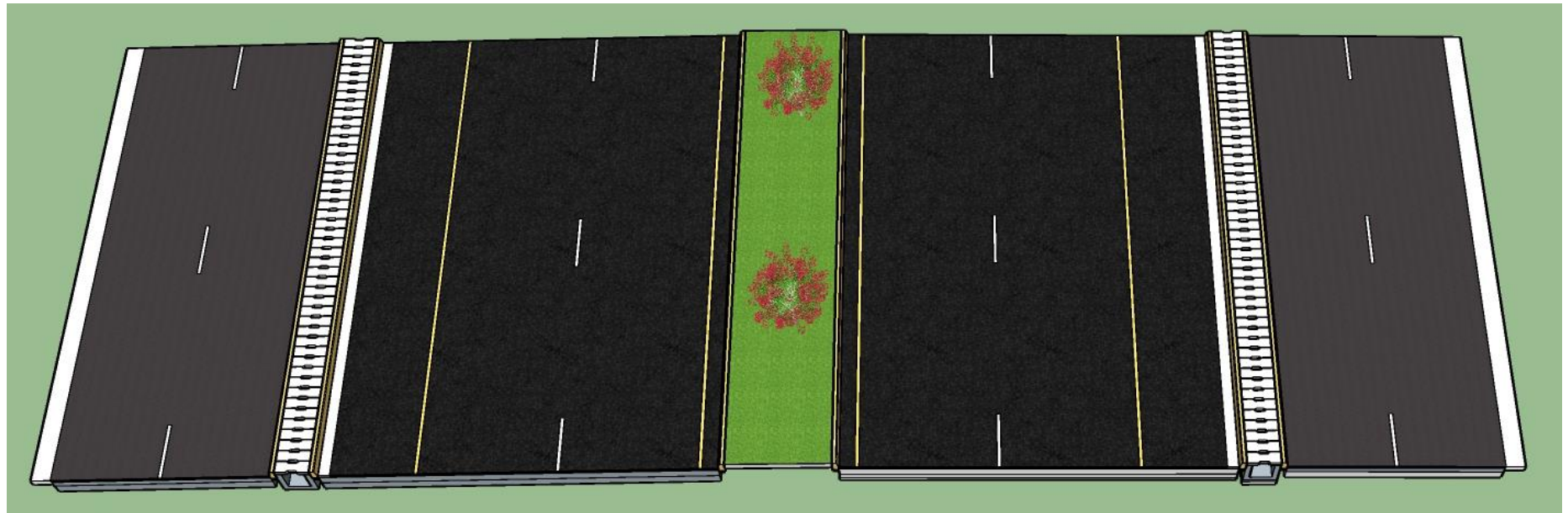
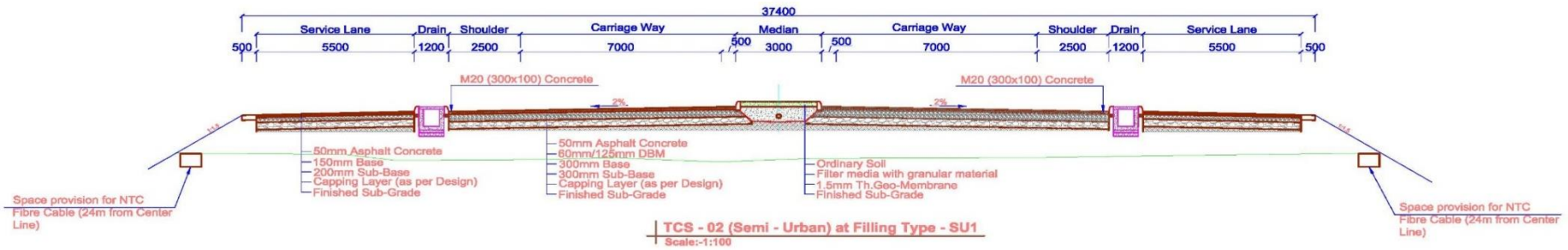


Figure 4: Typical design of road section in semi-urban area (Intermediate Lane)

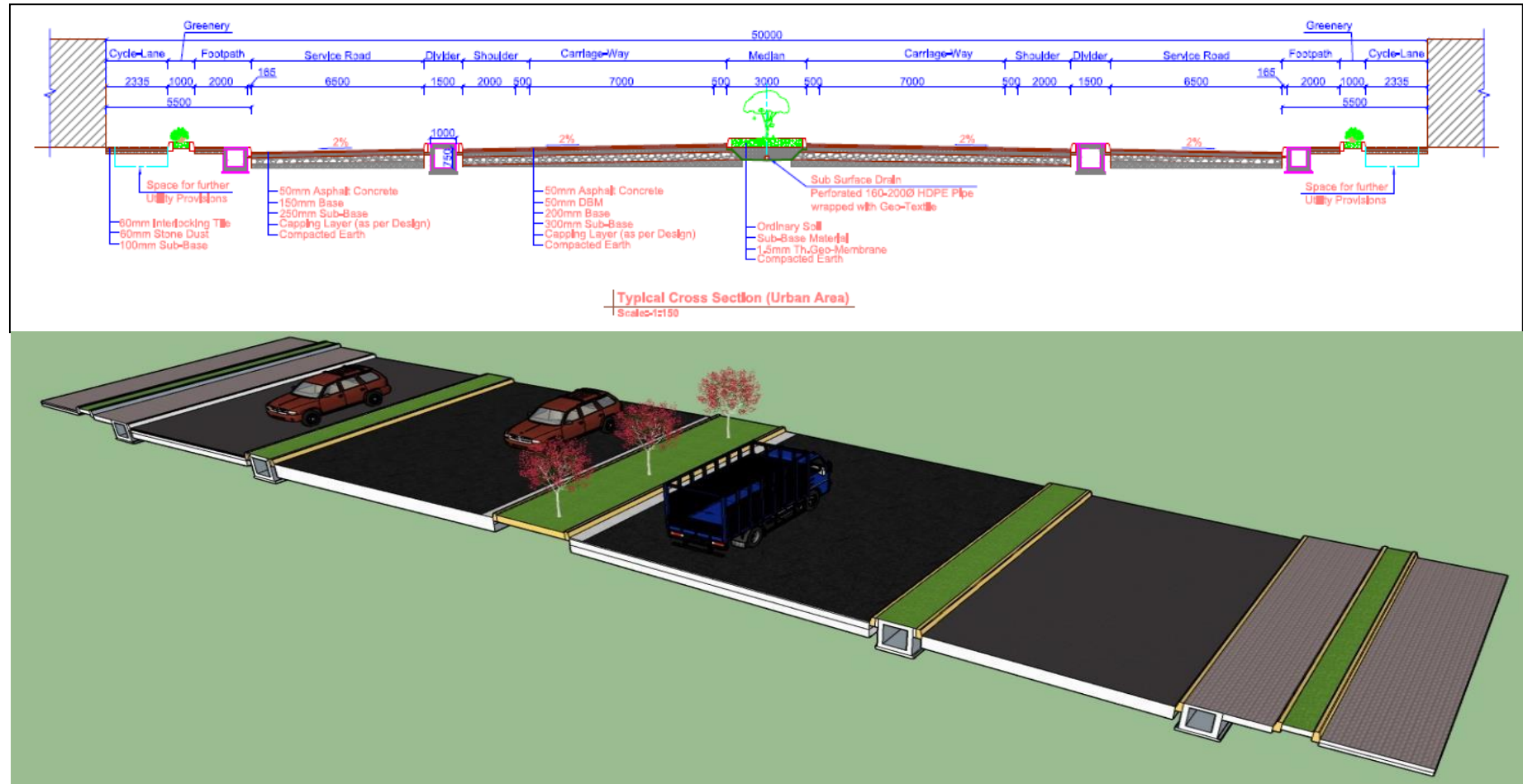


Figure 5: Typical design of road section in urban area

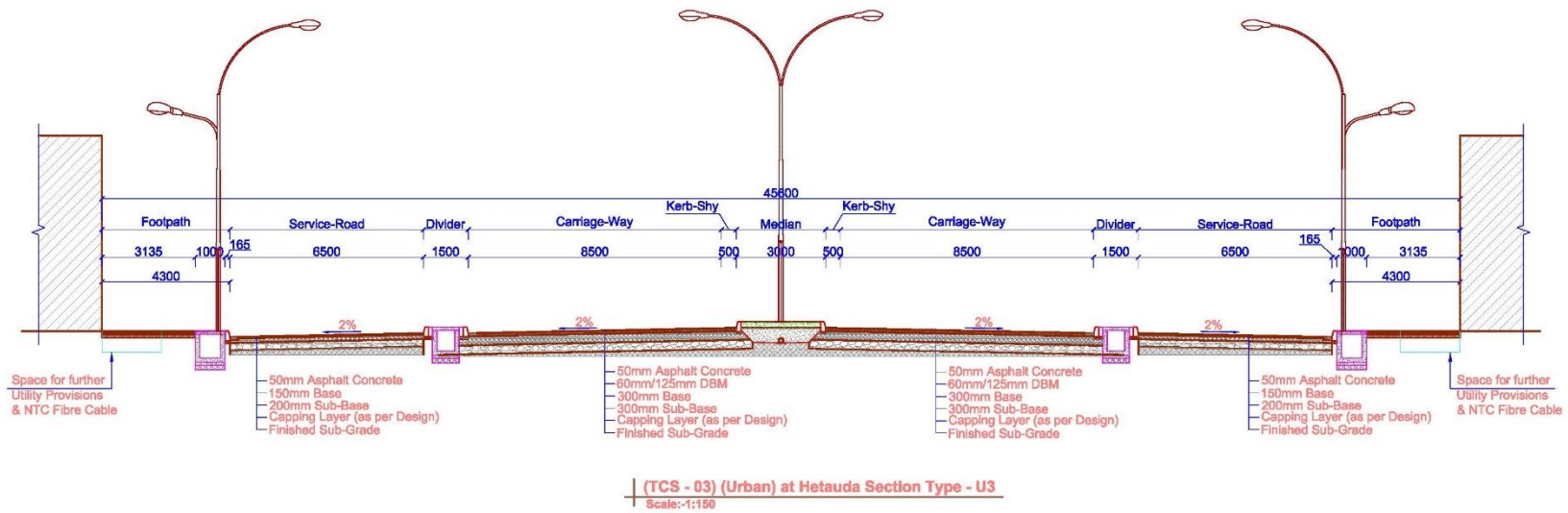


Figure 6: Typical design of road alignment section in urban area of Hetauda Bazaar

Table 4: Detail chainage wise road section

S.No	Chainage		Length (m)		
	From	To	Rural	Semi Urban	Urban
1	367+630	368+015			385.00
2	368+015	374+497	6,482.00		
3	374+497	374+710	213.00		
4	374+710	377+370		2,660.00	
5	377+370	387+175	9,805.00		
6	387+175	392+430	5,255.00		
7	392+430	393+650		1,220.00	
8	393+650	394+720	1,070.00		
9	394+720	397+300			2,580.00
10	397+300	397+700	400.00		
11	397+700	403+100			5,400.00
12	403+100	408+150		5,050.00	
13	408+150	413+090	4,940.00		
14	413+090	420+350	7,260.00		
15	420+350	425+200		4,850.00	
16	425+200	425+750	550.00		
17	425+750	428+300		2,550.00	
18	428+300	436+450	8,150.00		
19	436+450	437+100		650.00	
20	437+100	437+225	125.00		
21	437+225	437+440	215.00		
22	437+440	438+890		1,450.00	
23	438+890	440+580	1,690.00		
24	440+580	443+680		3,100.00	
25	443+680	449+040			5,360.00
26	449+040	449+280	240.00		
27	449+280	450+750			1,470.00
28	450+750	455+220			4,470.00
29	455+220	455+560	340.00		
30	455+560	457+835		2,275.00	
31	457+835	458+200	365.00		
32	458+200	459+885			1,685.00
33	459+885	462+420			2,535.00
34	462+420	463+420	1,000.00		
35	463+420	464+356	936.40		
36	464+356	466+357	2,001.00		
37	466+357	467+320	962.60		
Total Length			52,000.00	23,805.00	23,885.00
Total Length of Road			99.69 Km		

Source: Detail design report of PHN road, 2025

2.5.1 Bridge and Culvert

The existing bridges were 22 nos. However, during the study, an additional 19 number of bridges (replace of causeway, slab culvert) have been proposed based on their characteristics and discharge capacity, considering the effects of climate change. As a result, the total number of bridges has increased to 41 numbers. The existing functional bridges will be utilized as one carriageway since the proposed improvement involves a dual carriageway configuration. An additional new two-lane bridge will be constructed parallel to each functional bridge. The bridges that are non- well functional are proposed to be dismantled (beyond the original scope of works), new twin two-lane bridges have been proposed (such as at Pakkipul, Sansare, Sayafot, and Lothar Branch). The proposed type of substructure of bridges has RCC, solid and two lanes with sidewalks. Different types of superstructures of bridges have been proposed for design such as RCC T Beam, PSC Girder, IPC Girder, PSC Box Girder, Steel Deck, etc. DoR Nepal Bridge Standards 2067 is the main guideline for the design of bridges. All bridges have designed considering a discharge of 100 yrs. return period. For the calculation of design discharge empirical formulas has been used. All bridges have been designed as per IRC loadings or AASHTO loadings. The detail of bridge list is given in Table 3. Typical drawing is given in below.

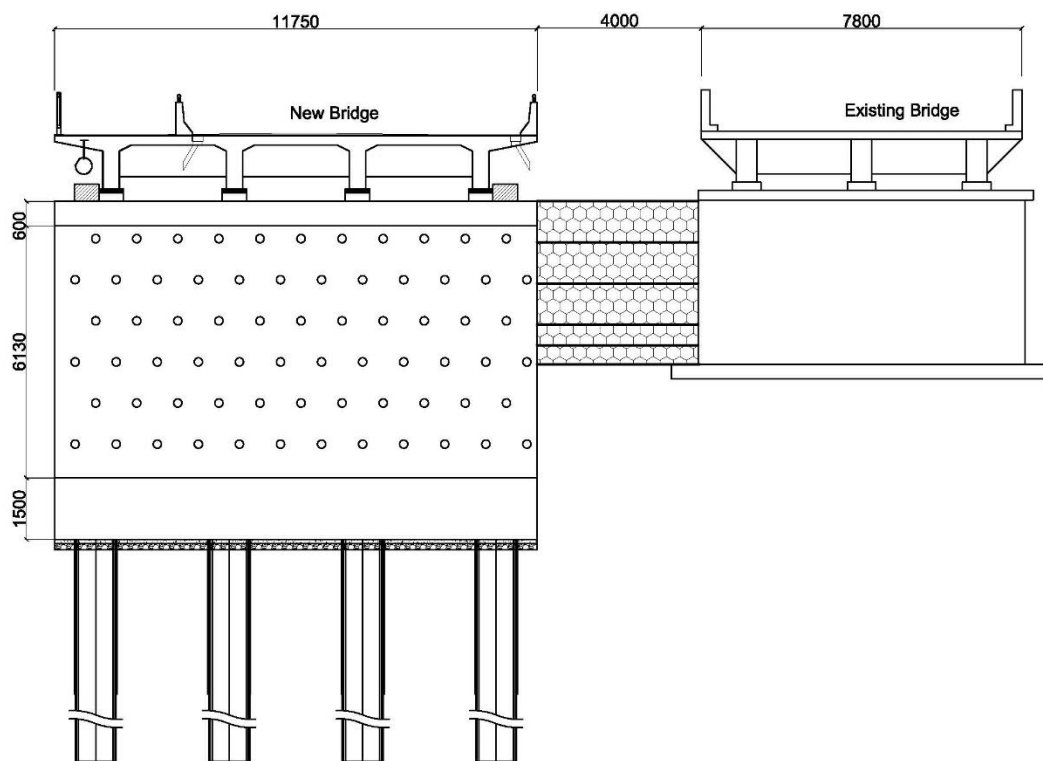


Figure 7: Bridge design for rural area

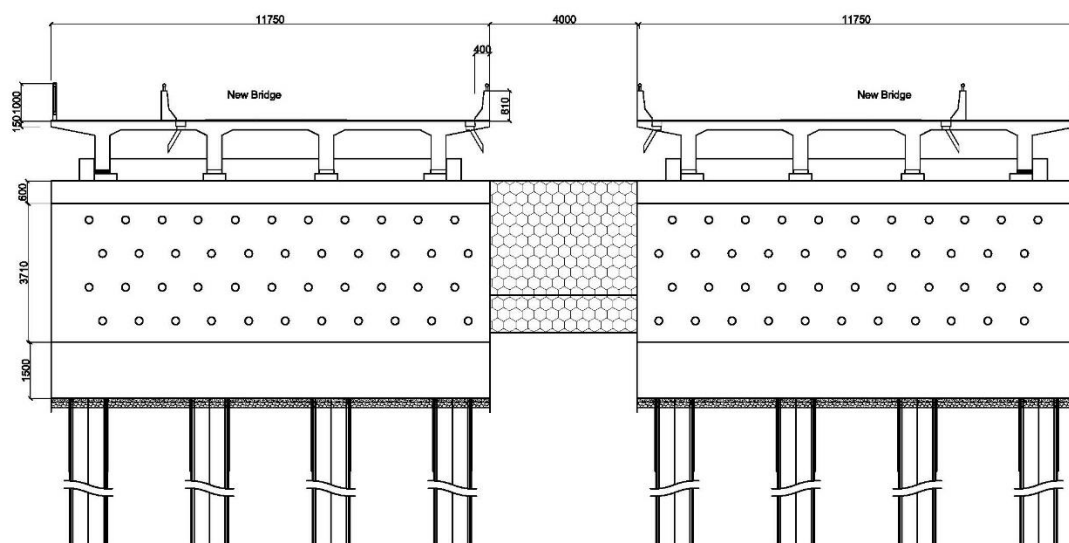


Figure 8: Twin bridges design for rural area.

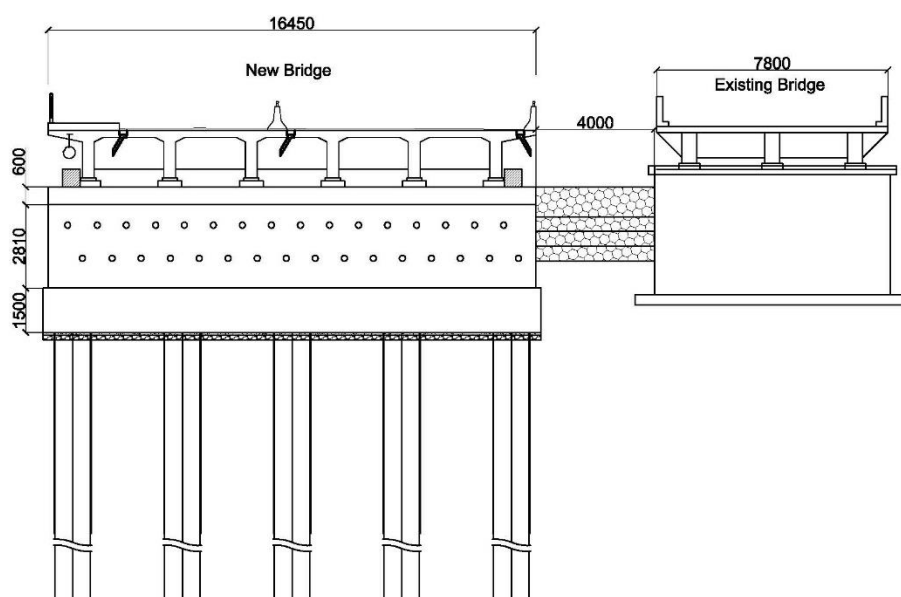


Figure 9: Bridge design for urban area

Culverts: There were 132 existing pipe culverts, 104 slab/box culverts and 8 causeways. All existing pipe culverts and causeway will be replaced by new RCC Box Culvert. In total, 246 box culverts will be constructed. New culverts have been designed for 50 years return period of flood. The detail size, length and chainage of box culverts are given in Annex IV-B and summary is given in Table below.

Table 5: Summary of box culverts

Sn	Size (L x H) m	Total No of Culvert			Total No of Box for Wild Life Crossing	Total No of Box for Pedestrian Crossing	Total No
		Rural	Semi-Urban	Urban			
1	1.5 x 1.5	67	15	4	12	-	98
2	2.0 x 1.5	18	5	3	-	-	26
3	2.0 x 2.0	20	4	1	-	-	25
4	3.0 x 1.5	6	3	6	-	-	15
5	3.0 x 2.0	9	6	0	-	-	15
6	3.0 x 3.0	5	1	-	-	12	18
7	4.0 x 1.5	4	1	6	-	-	11
8	4.0 x 2.0	5	2	1	-	-	8
9	4.0 x 2.5	2	2	-	-	-	4
10	4.0 x 3.0	3	1	1	-	-	5
11	5.0 x 2.0	5	1	1	-	-	7
12	5.0 x 2.5	1	1	-	-	-	2
13	5.0 x 3.0	-	-	1	-	-	1
14	6.0 x 1.5	-	-	1	-	-	1
15	6.0 x 2.0	4	-	-	-	-	4
16	6.0 x 2.5	1	-	1	-	-	2
17	6.0 x 3.0	2	-	2	-	-	4
	Total	152	42	28	12	12	246

Source: Detail design report of PHN road, 2025

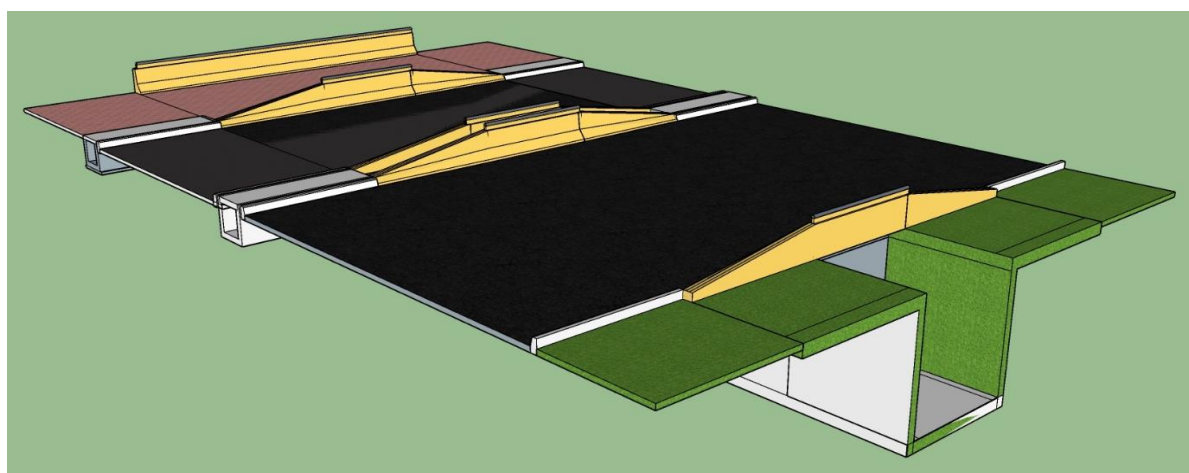


Figure 10: Design of culvert

2.5.2 Side Drain

Type and size of side drain has been designed on the basis of 25 years return period of flood. During upgrading of road, additional 174,612m side drain will be constructed. Type of drain and length is provided in Annex IV-C.

2.5.3 Retaining Structures

As per site condition, different types of retaining structures have been proposed in the design of road such as gabion wall, stone masonry wall, reinforced concrete wall and geogrid reinforced retaining

wall. 4,526 cum gabion and 172,495 cum RCC retaining / breast wall and 52,815 sqm reinforced earth wall will be constructed.

2.5.4 Slope Protection

Civil engineering and bioengineering measures will be applied for slope protection. 1,540,010 sqm for hill slope and road embankment slope protection, including bridge side and river side slope protection will be carried out.

2.5.5 Wildlife Crossing

Wildlife crossings are proposed in 21 locations including VIADUCT (Very Small Wildlife Crossing- 1, Medium Wildlife Crossing- 10 nos, Large Wildlife Crossing -5nos, Very Large Wildlife Crossing - 3nos Viaduct – 2nos). Viaduct of length 4002 m is proposed in Adhabhar Corridor Forests of Parsa National Park (Ch 372+496 to Ch 374+497) and Bharandabhar Corridor Forest (Ch 464+356.40 to Ch 466+390.75). The summary of proposed wildlife crossing is shown in Table below. List of default crossings which will enhance for animal crossing purposes is mentioned in Annex IV-D & Annex IV-E. Typical design of wildlife crossing for large animal (Figure 11) and very large animal (Figure 12) is illustrated below. Canopy bridges are proposed at different locations such as Ch 368+800, Ch 369+950, Ch 370+700, Ch 371+950, Ch 381+075, Ch 383+550, Ch 384+950, Ch 385+375, Ch 385+725, Ch 386+150, Ch 386+300, Ch 413+700, Ch 419+950, Ch 429+950 and Ch 429+950. Typical design of canopy structure is given in figure 12A.

Table 6: Details of wildlife crossing locations

Sn	Type of Structure	Chainage at Center	Chainage		Proposed Size		Existing Structure	Recommended By
			From	To	Length / Span	Height		
1	Viaduct at PNP	373+496.5	372+496	374+497	2001	7	-	ESSA / MoPIT / MOEF
2	Middium Wild Life Crossing		382+752		8	3	Pipe Culvert-900	ESSA
3	Middium Wild Life Crossing		383+636		8	3	Slab Culvert - 2.5 x 2.3	ESSA
4	Very Large Wild Life Crossing	389+897	389+889.50	389+904.5	15	6.5	Slab Culvert - 7.0 x 2.50	PNP
5	Very Large Wild Life Crossing	391+096	391+088.50	391+103.50	15	6.5	Slab Culvert - 5.80 x 4.30	PNP
6	Middium Wild Life Crossing	405+622	405+618	405+626	8	5.2	Box Culvert 2-3.0 x 3.0	ESSA
7	Middium Wild Life Crossing	409+100	409+096	409+104	8	3.1	Box Culvert 2-3.0 x 3.0	ESSA
8	Large Wild Life Crossing	413+160	413+151.15	413+168.85	15	4.5	Pipe Culvert-900	ESSA / PNP
9	Small Wild Life Crossing		415+190		3	2.5	Pipe Culvert-600	ESSA
10	Middium Wild Life Crossing		418+168		8	3	Slab Culvert 1.5 x 2.5	ESSA
11	Large Wild Life	418+550	418+541.15	418	15	4.5	Slab Culvert	PNP

Sn	Type of Structure	Chainage at Center	Chainage		Proposed Size		Existing Structure	Recommended By
			From	To	Length / Span	Height		
	Crossing			+55 8.85			2.0 x2.5	
12	Middium Wild Life Crossing		419+026		8	3	Pipe Culvert-900	ESSA
13	Large Wild Life Crossing	419+539	419+530.15	419+547.85	15	4.5	BC- 2.0 x 2.50	ESSA
14	Large Wild Life Crossing	419+760	419+751.15	419+768.85	15	4.5	Pipe Culvert-900	ESSA
15	Very Large Wild Life Crossing	420+178	420+169.15	420+186.85	15	6.5	Pipe Culvert-900	ESSA / PNP
16	Middium Wild Life Crossing		429+350		8	3		ESSA
17	Middium Wild Life Crossing		429+717		8	3		ESSA
18	Large Wild Life Crossing	429+939	429+930.15	429+947.85	15	4.5	Slab Culvert - 7.0 x 1.30	PNP
19	Middium Wild Life Crossing		432+968		8	3		ESSA
20	Middium Wild Life Crossing		435+520		8	3		ESSA
21	Viaduct at PNP	465+356.9	464+356.4	466+357.4	2001	7	-	ESSA / MoPIT / MOEF

Source: Detail Design Report of PHN Road, 2025

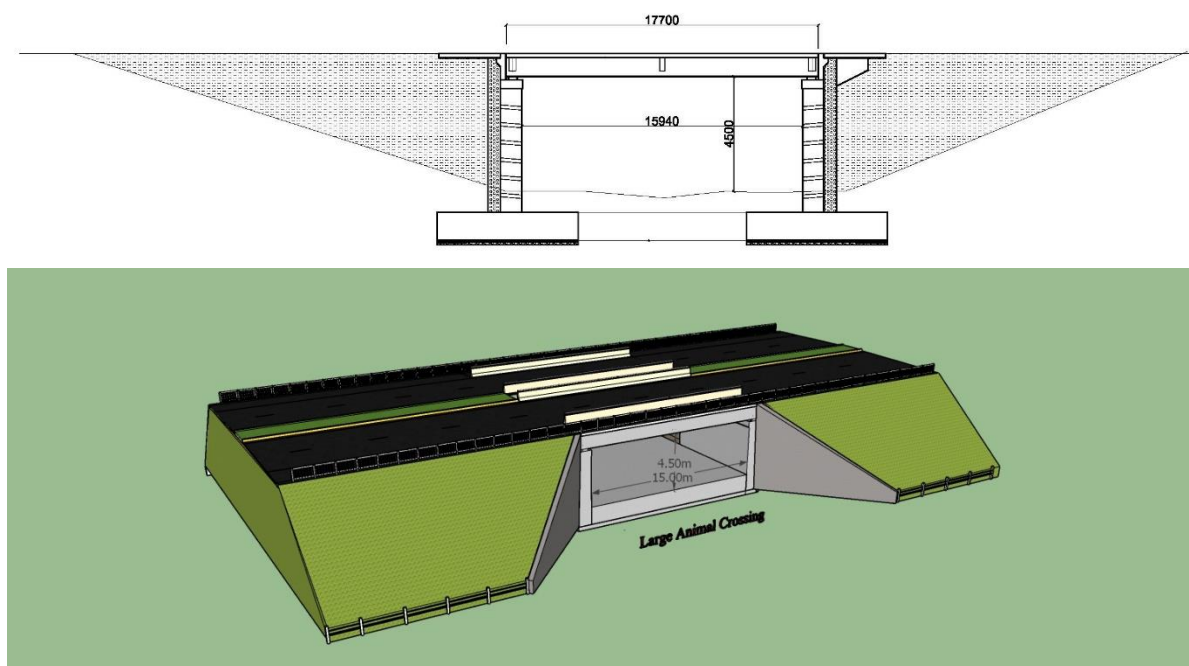


Figure 11: Typical design of large animal crossing

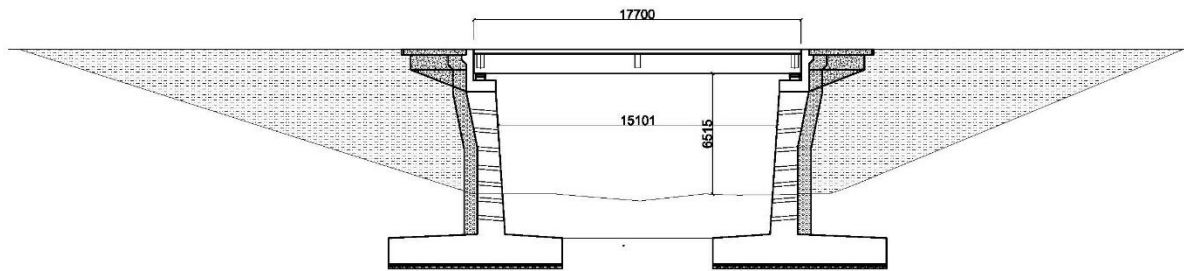


Figure 12: Typical design of very large animal crossing

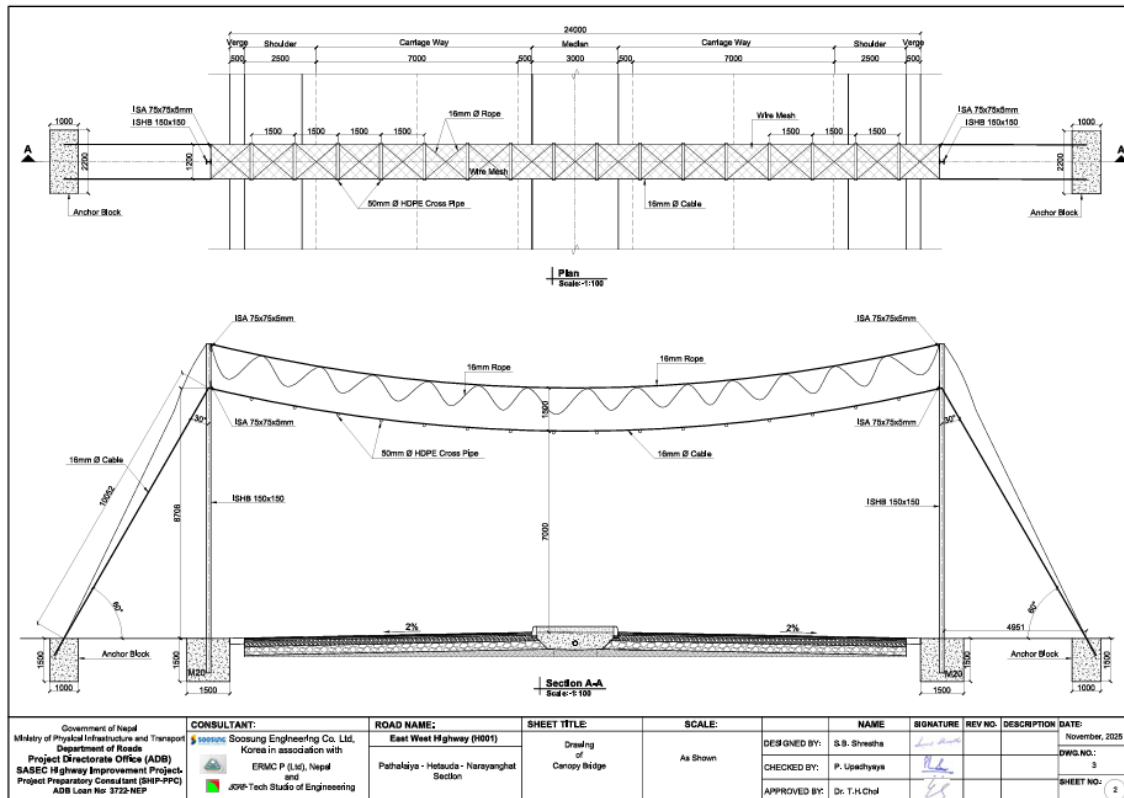


Figure 13: Typical design of canopy bridge

2.5.6 Design of Viaduct

A viaduct must be streamlined with the elements of the road cross section. The main carriageway width has been designed as 8.0m (7.5 m + 0.5 m curb-shyness width). Footpath is provided at one side (outer side) with a clear width of 2.75 m. The viaduct including footpath and crash barrier has been designed 11.75 m width. Next to footpath, the raised bar will be mounted with the Sound and Light Proof Bar across. The cross-section parameters are shown in the Figure 14.

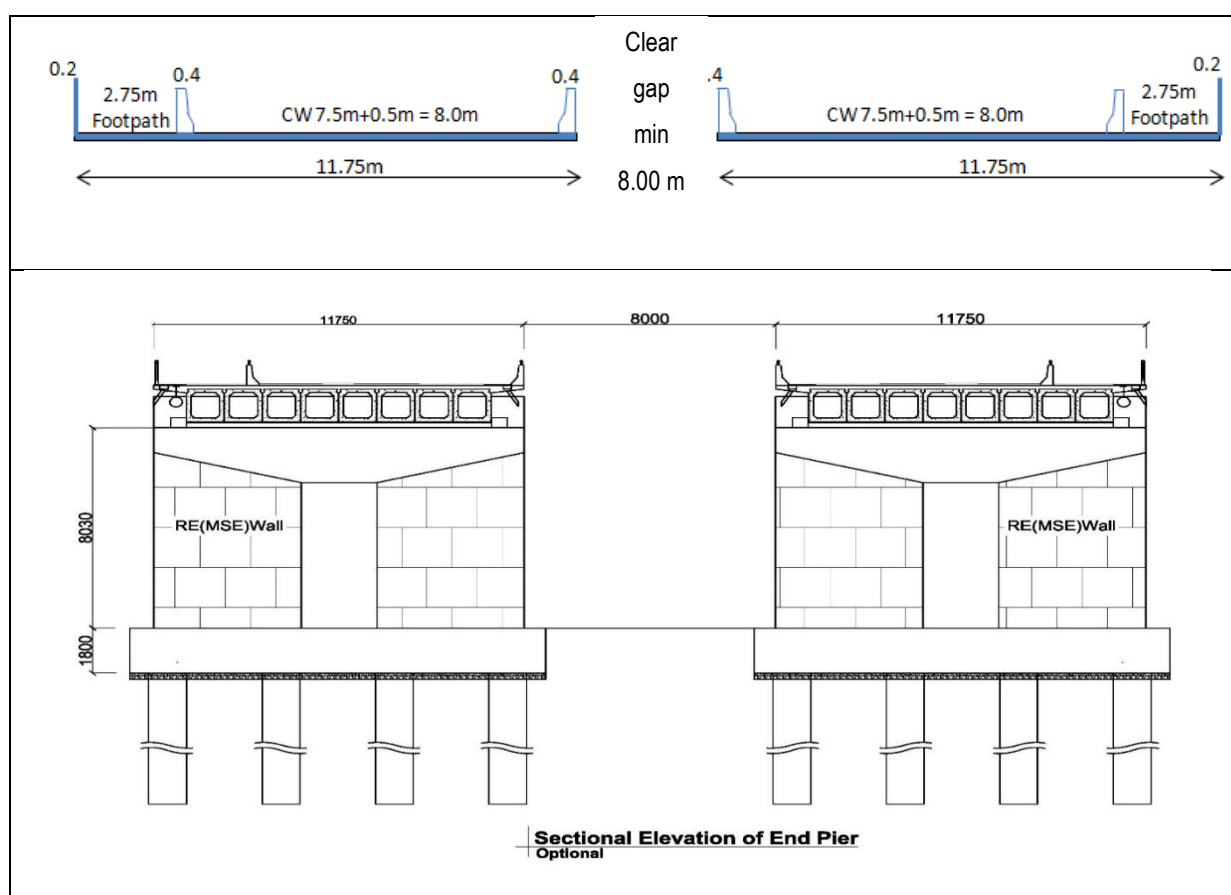


Figure 14: Design of VIADUCT

2.5.7 Road Safety Measures

This includes provision of pedestrian footpaths and cycle lanes in urban areas, in all major intersections installation of traffic lights with zebra crossings and road humps, traffic signs, overhead sign, barriers and road markings, minor realignment at identified black spots etc. The project has proposed for installation of traffic signs 4,667 nos, streetlight 2,214 nos, Reinforced Cement Concrete Crash Barrier 29,915 Cum, Metal Beam Crash Barrier “W” 9225 Rm, Metal Beam Crash Barrier “THRIE” 11,360 Rm, Road Studs 9,145 nos, Footpath Railing 32,865 Rm, 20 Junctions improvement, Edge Rumble Strip 106,542 Rm, Zebra Crossing at 76 locations etc. Bus bays, bus stop additional lanes has been provisioned in market areas; provide guard barriers at bridge approaches and where horizontal curves are sharp and where embankments are greater than 3.00 m in height; provide appropriate interchange mechanism at intersections; provide sufficient road furniture including road

safety elements including signs, delineator posts etc. and additional signs where there are high pedestrian activities and a high possibility of accidents in order to make the road safer. The detail is presented in the Table below.

Table 7: Proposed road safety measures

Sn	Description of Items	Quantity	Unit	Remarks
1	Junction	20.00	No	
2	Footpath Railing	32,865.00	Rm	
3	W Beam	9,225.00	Rm	
4	Thrie Beam	11,360.00	Rm	
5	Delineator Post	3,183.00	No	
6	RCC Bridge End Block	94.00	No	
7	RCC Barrier	29,915.00	Rm	
8	Road Studs	9,145.00	No	
9	Transverse Rumble Strip	226.00	No	
10	Edge Rumble Strip	106,542.00	Rm	
12	Zebra Crossing	76.00	No	
13	Traffic Island (Non Pedestrian)	50.00	No	
14	Traffic Island (Pedestrian)	19.00	No	
15	Traffic Light Junction			
	Cross Junction	2.00	No	
	T-Junction	2.00	No	
16	Sign Post			
	Regulatory	237.00	No	
	Warning	518.00	No	
	Informatory	715.00	No	
	Lane control sign TULL-Truck Use Left Lane	370.00	No	
	Route / Other Sign	165.00	No	
	Speed Sign	610.00	No	
	Chevron Sign	1,893.00	No	
	Hazard Plate	98.00	No	
	Emergency Board	61.00	No	
	<i>Total</i>	<i>4,667.00</i>	<i>No</i>	
17	Street Light	2,214.00	No	
18	Light for Underpass	18.00	No	
19	Over Head Sign	14.00	No	
20	Signalized Pedestrian Crossing	9.00	No	
21	Wombat Crossing Pavement	5.00	No	
22	Overhead Pedestrian Crossing	6.00	No	

2.5.8 Pedestrian Crossing

Pedestrian crossing has been planned and designed for pedestrian safety aspect. Zebra crossing, overhead bridges and underpass has been designed to cross the road for pedestrian safety aspects. Potential pedestrain crossings have been identified such as schools, colleges, hospitals and in other areas where there are high pedestrian movements. The proposed location of overhead bridges (Table 8), underpasses (Table 9), and zebra crossing (Table 10) are given in table below.

Table 8: Overhead bridge for pedestrian crossing

S.No	Chainage	Location
1	393+490	Hetauda Industrial District
2	394+780	Karra Chowk
3	396+060	Hetauda Commercial
4	402+850	School / Industry
5	407+560	Shree Nirmal HS School
6	425+750	Manahari

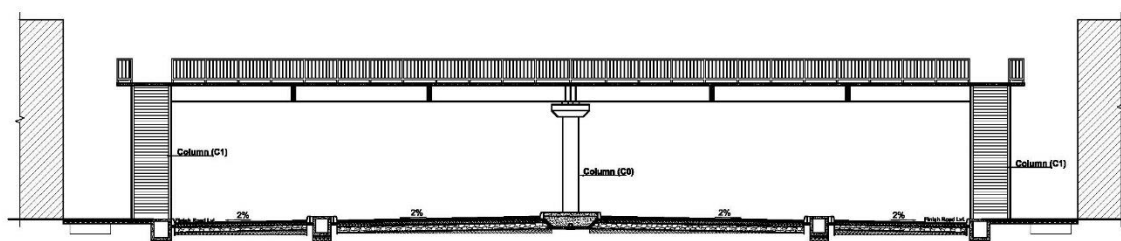


Figure 15 : Design of Overhead Bridge

Table 9: Underpass for Pedestrian Crossing

S.N	Chainage	Width	Height	Settlement Name
1	396+720	3	3	Hetauda
2	397+150	3	3	Hetauda
3	452+154	3	3	Bairahani
4	452+355	3	3	Bairahani
5	452+887	3	3	Khairahani
6	453+088	3	3	Khairahani
7	454+205	3	3	Parsa
8	454+405	3	3	Parsa
9	458+472	3	3	Shanti Chowk
10	458+672	3	3	Shanti Chowk
11	461+198	3	3	Nipani Chowk
12	461+398	3	3	Nipani Chowk

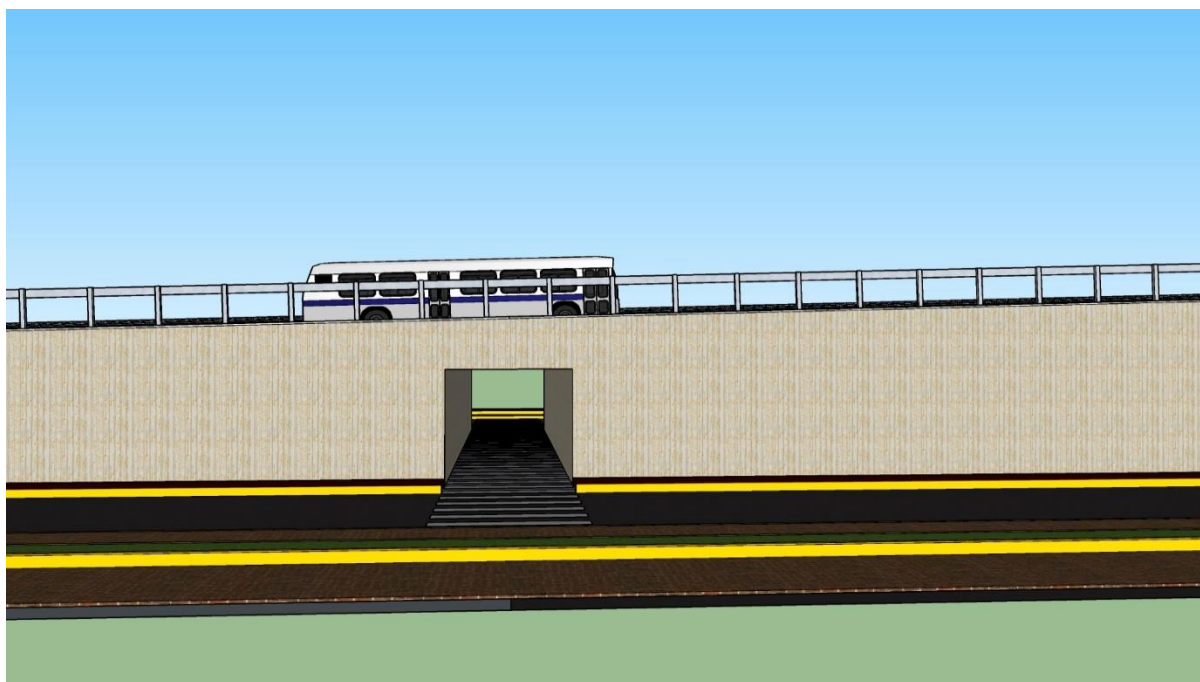


Figure 16: Design of pedestrian underpass

Table 10: Location of Zebra Crossing for Pedestrian

S. No.	Locations	Measurement		
	From	No.	Avg length	Breadth
1	375+930	1.00	37.40	3.5
2	376+185	1.00	24.00	3.5
3	376+685	1.00	30.00	3.5
4	379+410	1.00	24.00	3.5
5	391+230	2.00	24.00	3.5
6	393+765	1.00	24.00	3.5
7	394+090	2.00	24.00	3.5
8	394+850	1.00	24.00	3.5
9	395+380	2.00	50.00	3.5
10	395+610	1.00	40.00	3.5
11	395+830	2.00	50.00	3.5
12	396+470	3.00	40.00	3.5
13	396+720	1.00	50.00	3.5
14	396+920	1.00	50.00	3.5
15	397+150	1.00	50.00	3.5
16	398+590	1.00	50.00	3.5
17	399+935	2.00	50.00	3.5
18	400+670	1.00	50.00	3.5
19	402+190	1.00	50.00	3.5
20	403+350	1.00	40.00	3.5
21	405+000	1.00	40.00	3.5

S. No.	Locations	Measurement		
	From	No.	Avg length	Breadth
22	414+340	1.00	24.00	3.5
23	416+260	1.00	24.00	3.5
24	420+450	1.00	24.00	3.5
25	426+200	3.00	33.00	3.5
26	436+785	2.00	24.00	3.5
27	437+340	1.00	24.00	3.5
28	441+870	1.00	24.00	3.5
29	442+590	1.00	24.00	3.5
30	444+980	2.00	50.00	3.5
31	446+755	3.00	50.00	3.5
32	449+870	1.00	50.00	3.5
33	450+490	3.00	50.00	3.5
34	452+155	1.00	50.00	3.5
35	452+260	1.00	50.00	3.5
36	452+355	1.00	50.00	3.5
37	452+890	1.00	50.00	3.5
38	452+990	1.00	50.00	3.5
39	453+090	1.00	50.00	3.5
40	454+200	1.00	50.00	3.5
41	454+310	1.00	50.00	3.5
42	454+400	1.00	50.00	3.5
43	455+085	3.00	50.00	3.5
44	456+315	3.00	33.00	3.5
45	457+670	1.00	33.00	3.5
46	458+470	1.00	50.00	3.5
47	458+580	1.00	50.00	3.5
48	458+670	1.00	50.00	3.5
49	459+500	1.00	50.00	3.5
50	459+950	1.00	50.00	3.5
51	460+080	2.00	50.00	3.5
52	460+485	3.00	50.00	3.5
53	461+200	1.00	50.00	3.5
54	461+310	1.00	50.00	3.5
55	461+400	1.00	50.00	3.5
56	461+870	1.00	50.00	3.5
		76.00		

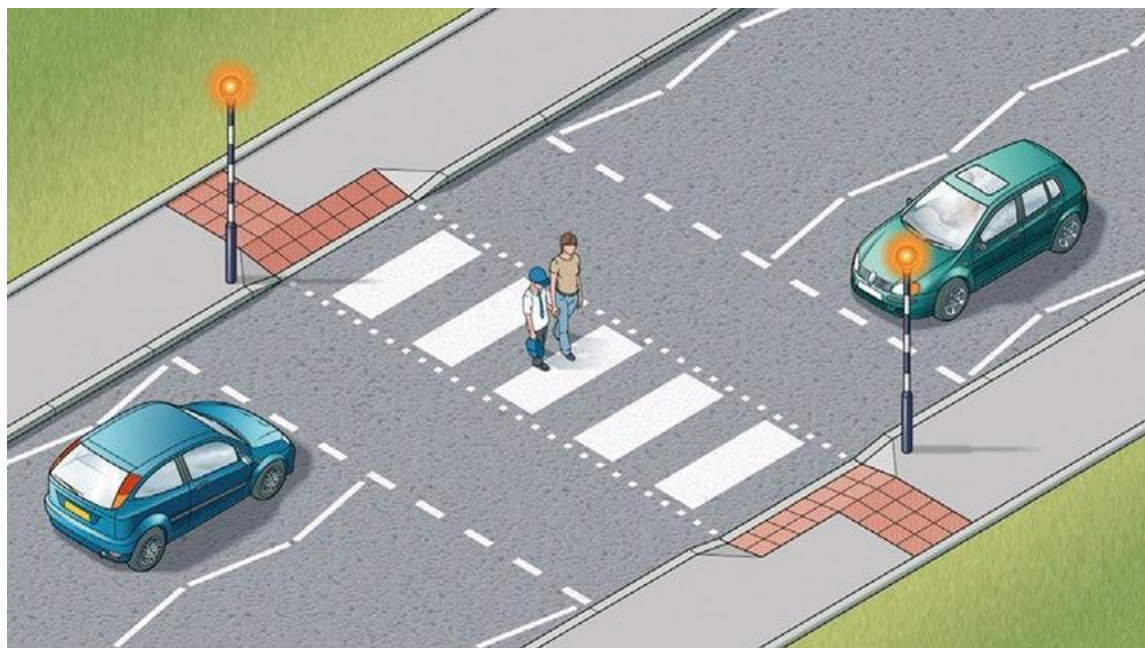


Figure 17: Proposed disable friendly zebra crossing

Table 11: Locations of vehicular underpass

SN	Type of Structure	Chainage		Span	Remarks
		From	To		
1.	Vehicular Under Pass	396+903	396+916	13.0	Hetauda
2	Vehicular Under Pass	452+248	452+261	13.0	Simaltandi Bus Bisauni Chowk
3	Vehicular Under Pass	452+981	452+994	13.0	Khairahani
4	Vehicular Under Pass	454+298	454+311	13.0	Parsa
5	Vehicular Under Pass	458+565	458+578	13.0	Shanti Chowk
6	Vehicular Under Pass	461+291	461+304	13.0	Nipani chowk

Source: Detail design report of PHN road, 2025

2.5.9 Road Junction Improvement

20 junctions will be improved for free flow of high-speed vehicles and to facilitate different access to main 4-lane carriage way. Different types of intersections are designed and proposed (Figure 18).

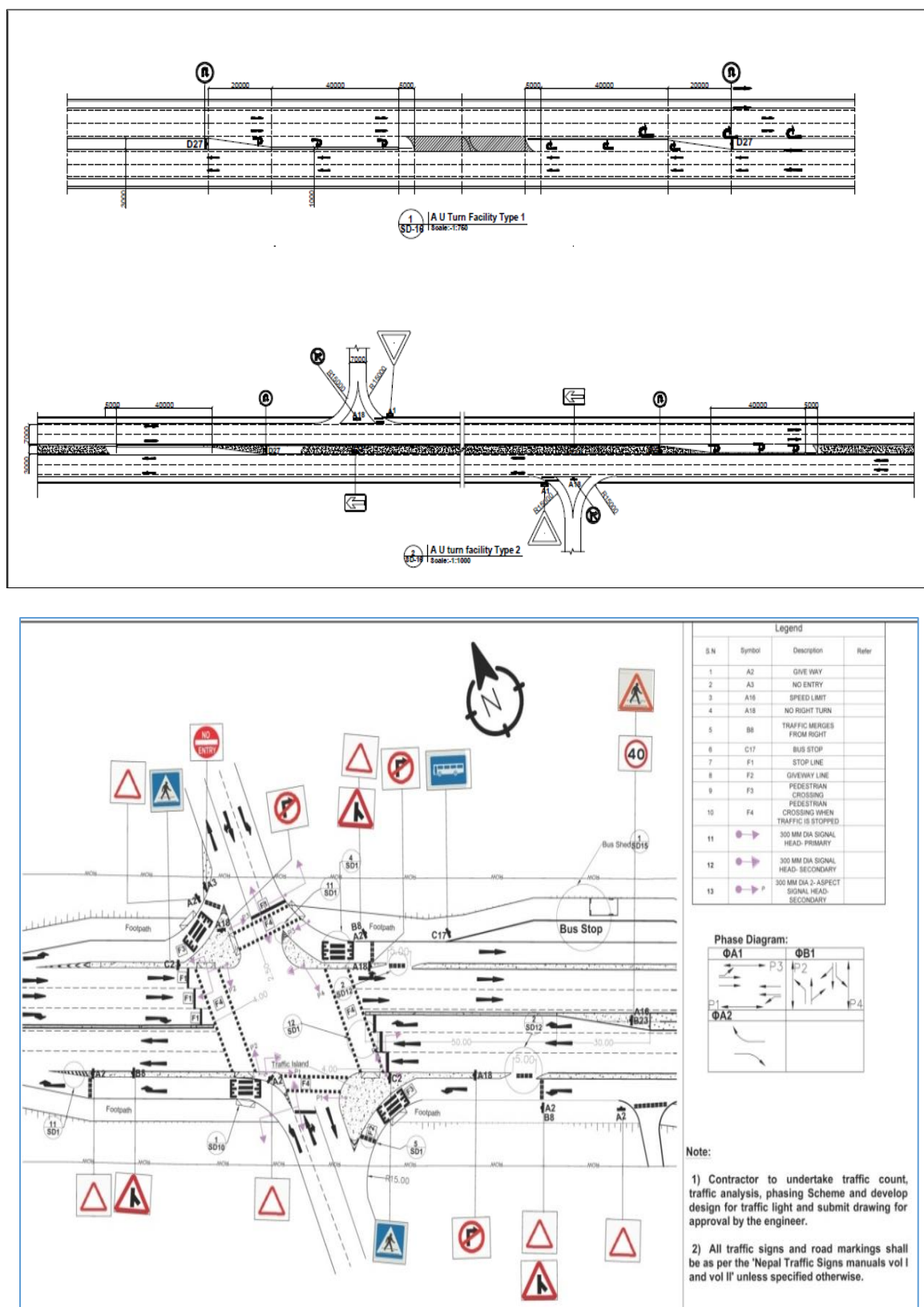


Figure 18: Figure of Road Junction Improvement

The locations and type of intersections improvement are tabulated below.

Table 12: Location of the different types of intersections at major junctions

S. No.	Chainage	Type	Location	Remarks
1	376+165	Channelized 3 Way	NOC Entrance, Jitpursimara-21	
2	376+670	Channelized 4 Way	Amlekhgunj, Jitpursimara-21	
3	391+220	Channelized 3 Way	Ratamate Checkpost, Hetauda-15	
4	393+500	Channelized 3 Way	Hetauda Industrial District, Hetauda-9	
5	394+105	Channelized 3 Way	Gumba Chowk, Hetauda -9	
6	394+870	Channelized 3 Way	Prithivi Marg, Hetauda-4	
7	395+360	Channelized 3 Way	Rajat Stamba Marg, Hetauda-4	
8	395+845	Signalized 3 Way	Hetauda Bypass	Traffic Light
9	396+470	Signalized 4 Way	Hetauda Buddha Chowk	Traffic Light
10	402+830	Channelized 4 Way	Hetauda Municipality Ward No-3 Office	
11	407+630	Channelized 4 Way	Bastipur, Hetauda-19	
12	446+765	Channelized 4 Way	Bhandara Chowk, Rapti-5	
13	449+870	Channelized 4 Way	Birendranagar Chowk, Rapti-7	
14	450+505	Channelized 4 Way	Khurkhure Chowk, Rapti-8	
15	455+070	Channelized 4 Way	Khairahani, Khairahani-8	
16	456+300	Channelized 4 Way	Jyamire, Khairahani-1	
17	459+690	Signalized 4 Way	Tandi Bazar, Ratnagar-2	Traffic Light
18	460+075	Signalized 3 Way	Sauraha Chowk, Ratnanagar-2	Traffic Light
19	460+465	Channelized 4 Way	Bakulahar Chowk (Ratnanagar Municipality Office), Ratnanagae – 1	
20	461+880	Channelized 4 Way	Bhanu Chowk, Ratnanagar- 10	

Source: Detail design report of PHN road, 2025



Figure 19: Proposed design of bus shed

2.6 Materials Required for Project Construction

2.6.1 Construction Material

Construction materials such as stone, coarse aggregates, sand, subbase, base course, and asphalt concrete chips are available in locally and others will be sourced from local market. The required major construction materials are given in Table below and the potential source of construction materials are given in Annex IV-G.

Table 13: Estimated quantities of construction materials

SN	Types of Construction Materials	Unit	Quantity Required
1	Cement	Mt	287,323
2	Sand	Cum	347,226
3	Aggregate	Cum	1,023,795
4	Stone	Cum	223,933
5	Bricks	No	607,500
6	Geotexttile	Sqm	90,755
7	Precast kerb Block	No	1,528,188
8	600 mm dia RCC Pipe	Rm	280.00
9	900 mm dia RCC Pipe	Rm	850.00
10	Interlocking Tile	Sqm	167,380
11	Gabion Box	Sqm	319,117

SN	Types of Construction Materials	Unit	Quantity Required
12	Reinforcement	Mt	74,291
13	Steel Structural	Mt	1,554
14	Strands (Tendon)	Mt	2,986
15	Filling Material	Cum	3,699,070
16	Subbase	Cum	1,176,366
17	Base	Cum	896,450
18	Bitumen	Mt	33,522

Source: Detail design report of PHN road, 2025

16 potential locations of construction materials sources (stone, coarse aggregates, sand, sub base, base course, and asphalt concrete chips) are identified. The final locations of quarries and borrow areas will be determined at the implementation stage. The extraction of materials will be done using equipment and labour (such as pick, shovel, excavator, loader, truck/tractors, labours etc.). The final locations of quarries and borrow areas will be finalised during construction phase of the Project. During extraction of construction materials, the contractor will coordinate with local bodies, if necessary and will obtain necessary approval from concern municipalities. As far as possible, approved locations of municipalities will be used for extraction of construction materials. In order to reduce aggradation, appropriate river locations—including those in Chure or BZ areas—can be used. A permissible benchmark (Quantity, extraction area and depth) for acceptable extraction shall be fixed.

2.6.2 Use of Energy during Construction

Equipment such as Concrete Mixture, Dozer, Excavator, Tractor, Grader, Roller, Loader, Truck / Tripper, Bitumen Distributor, Boiler, Generator, Batch Mix, Paver, Crane, Wet Mix, Plant Broomer, Air Compressor, Back Hoe, Plate Compactor, Pilling Rig etc. will be used during the construction. Gasoline and electrical energy will be used during the construction phase of the project to prevent pressure on natural forests of the project area. Contractor will avoid using fuelwood for cooking purpose in labour camps. Electricity will be used at camp, and for other plant operation such as crusher plant, batching plant, asphalt plant. Mainly kerosene and diesel will be used during construction. Diesel will be used for material transportation vehicles. Kerosene will be used for prime works. All energy will be supplied by the local supplier. The required quantity is given in Table below.

Table 14: Type and quantity of fuel required

Type of fuel	Quantity (litre)
Diesel	8,147,137
Kerosene	3,194,262

Source: Detail design of PHN road, 2025

Water is required during construction mainly for the following purposes.

- Water for mixing or curing cement concrete, mortar, or grout.
- Water for planting or care of vegetation.
- Water for earthwork, pavement courses, dust control, and incidental construction

Water will be required approximately 500-700 cum per km. Water from Rapti, Manahari, Lothar, Kair, Khageri river and its tributaries are likely to be used during the time of construction.

2.6.3 Construction Camp and Material Stockpiling Site

Detailed criteria for siting of construction camps and establishment of facilities are given in the Environmental Management Plan (Annex IX). The contractor will provide following basic facilities in the construction camps:

- Adequate ventilation facilities
- Safe and reliable water supply. Hygienic sanitary facilities and sewerage system.

Treatment facilities for sewerage of toilet and domestic wastes

- Storm water drainage facilities;
- Sick bay and first aid facilities

There is availability of the land near the existing road which can be used for the camp and stockpiling of the construction materials. The possible locations/chainages are given in the following table. The nearby houses can also be rented for small group of construction crew. However, the contractor will identify possible locations during the construction period.

Table 15: Possible locations of construction camp, material stockpiling sites

SN	Location/ Chainage	Construction Camp /Material Stockpiling	Land use
1	379+000	Possible location of Construction Camp/Material Stockpiling	RHS, Private land (Small) settlement
2	405+780	Possible location of Material Stockpiling, AMP, BP	LHS, Open space (Small)
3	418+500	Possible location of Material Stockpiling	Near roadside
4	421+000-421+300	Possible location of Construction Camp and Material Stockpiling	LHS, Agriculture land
5	428+800	Possible location of Construction Camp and	LHS, Agriculture land, Open

SN	Location/ Chainage	Construction Camp /Material Stockpiling	Land use
		Material Stockpiling, AMP/CP/BP	space
6	435+800	Possible location for BP/Material Stockpiling	LHS, Degraded Agriculture land
7	437+400	Possible location of Construction Camp and Material Stockpiling, AMP/CP	LHS, Agriculture land
8	444+270	Possible location of Construction Camp and Material Stockpiling	LHS, Private land

Source: Field survey, 2023

2.6.4 Spoil Management Site

Approximately 2,499,538 cum of spoil from the slope cutting likely to be generated and 2,905,549cum filling material will be required for the upgrading. Most of the cut material can be used as fill material for embankment construction and can be used as base or subbase or for backfilling of retaining structures. Excess spoil materials will be disposed safely at following locations.

Table 16: Possible locations of spoil disposal site

SN	Location/Chainage	Land use	Quantity (cum)	Remark
1	380+900/320	LHS, Near Riverbank	326,408.00	With protection of gabion wall
2	385+700/340	LHS, Riverbank	91,055.00	With protection of gabion wall
3	388+600	LHS, Riverbank	45,680.00	With protection of gabion wall
4	389+040	LHS, Riverbank	161,750.00	With protection of gabion wall
5	417+880	LHS, Riverbank	1,093,500.00	With protection of gabion wall
6	429+500	LHS, Riverbank	130,729.00	With protection of gabion wall

Source: Field survey, 2023

2.6.5 Human Resources Requirement

The project requires skilled and unskilled worker during construction work. The number of required unskilled and skilled manpower is presented in Table below.

Table 17: Type and number of human resources requirement

Type of Human Resources	Person Days
Skilled	854181
Unskilled	2,631,333

Source: Detail design of PHN road, 2025

2.6.6 Land Requirement

Proposed upgrading works will be done within the RoW, hence there will be no needed additional permanent land beyond RoW (as per detail design). The formation width of road and bridges as designed is a) 50 m at urban area, b) 37.4 m at semi-urban area and c) 24 m at rural and forest area. The RoW of highway is 50 m (25 m on both sides from centre line). RoW of East West Highway has already been gazetted under the jurisdiction of GoN/MoPIT, to be used for the transport development of the nation.

However, for ancillary facilities (Camp, stockpile, batching plant, crusher plant, asphalt plant) approximately 10 ha temporary land belonging to private and/or public owned will be required (Table below) for camp establishment, stockpile of construction material, batching plant, crusher plant, and asphalt plant. During upgrading of the road, approximately 247.85 ha of RoW land use pattern will be changed into asphalt road.

Table 18: Land required for the project.

Project Components	Land Type (ha)								Total Area (ha)
	Forest		Cultivated Land		Built up/ Residential/Road		Barren		
	GoN	CF/LF	GoN	Private	GoN	Private	GoN	Private	
Land Requirement for the Temporary Support Facilities									
Construction Camp/Labour Camp, Equipment yard	-	-	-	3.0	-	-	-	-	3.0
Stockpiling Site		-	0	3.0	-	-	-	-	3.0
Crusher Plant, Asphalt Plant, Batching Plant	-	-		4.0	-	-	-	-	4.0
Total				10.0					10
Total Land Requirement for Temporary Purpose									10

Source: Field survey, 2024

2.6.7 Crusher Plant and Asphalt Plant Sites

Crusher plant and Asphalt plant will be established in proposed locations. There is availability of the land near the existing road and bridges which can be used for the crusher plant and Asphalt plant. Possible locations are given in Table 15 and will be confirmed during construction period.

2.6.8 Project Construction Schedule and Cost

Following the completion of pre-implementation works activities (such as tree cutting, shifting of public utilities etc.) the contractors will be mobilized to commence construction. The project is planned scheduled to start on 2025 end of 2025 with estimated construction duration of 3 years, followed by a 12-month Defects Liability Period (DLP) and a 5-year Performance-Based Maintenance (PBM).

The Cost estimates for the construction of the Road and Bridges are based on an evaluation of the unit rates and quantities obtained derived from the approved designs, drawings and inventories. The cost has been carried out in the format using district rates and in accordance with the Department of Roads (DoR) norms. The total estimated project cost for construction of road and bridges has been estimated NRs. 54,293,647,526.

2.6.9 Construction Approach and Methods

The general construction method of construction will be mechanical labour based considering climate resilient will be adopted where applicable during design and construction of the proposed road project.

Table 19: Project construction schedule of PHN road

TASK DESCRIPTION	PLAN START	PLAN DURATION	ACTUAL START	2026		2027				2028				2029				2030		2035
				3 Qtr	4 Qtr	1 Qtr	2 Qtr	3 Qtr	4 Qtr	1 Qtr	2 Qtr	3 Qtr	4 Qtr	1 Qtr	2 Qtr	3 Qtr	4 Qtr	1 Qtr	2 Qtr	
Construction Phase - Construction Activities																				
Site Clearance	1	2	1																	
Earthwork Excavation	2	4	2																	
Cross Drainage Structures	3	4	3																	
Bridges Construction	4	8	4																	
Retaining Structures	5	4	5																	
Side and Drainage Structures	6	4	6																	
Road Pavement Structures	7	6	7																	
Bio-engineering	9	2	9																	
Environmental Activities	3	10	3																	
Traffic Safety, Painting & Road Furniture	11	2	11																	
DLP	13	4	13																	
PBM (5 Years)	17	36	17																	

3 METHODOLOGY ADOPTED

The EIA study has followed the EPA 2076, basic steps outlined in EPR, 2077 and Scoping Document and ToR for this EIA approved from MoFE on 2081-06-11 BS (27 September 2024) (Annex I-A). Following approach and methodology were adopted during the EIA preparation.

3.1 Desk Study and Literature Review

Prior to the mobilization to the field study, the team reviewed related documents, collected information from the detailed engineering design, inventory report road alignment, feasibility report of the project, maps, topo sheets were reviewed. EPR 2020 of GoN, Forest Regulations 2022, Environment and Social Management Framework (ESMF), 2023 of DoR, ADB's SPS 2009, ADB'S ESF 2024, district profile of project districts, publications of Divisional Forest Office (DFO) Chitwan, Bara and Makawanpur, Chure Development Board, and Parsa and Chitwan National Parks, reports of population data by National Statistics Office, project affected municipalities profiles, ADB TA report on Smart Infrastructure Planning and Design to Protect Natural Habitats and Biodiversity: Ecological Assessment of the NHP Road Upgrading, Biodiversity assessment of East-West Highway and Bridges, Nepal, EIA of Kakarbhitta - Laukahi road and relevant published reports were reviewed. In addition, prevailing policies, acts, rules, guidelines, manual relevant to the project were reviewed. Questionnaires and checklists were prepared to collect information on physical, chemical, biological, socio-economic, and cultural environment of the project.

3.1.1 Study of Project Area Map and Interpretation

Topographical maps, Google maps were analyzed to identify impacts along the proposed road. The major settlements, major river crossings, agriculture area and forest area were delineated during the desk study. Moreover, the KML file of the alignment was loaded in Google earth to familiarize and quick gathering of information and data of the project area. The KML file was loaded in ArcMap (GIS) to overlay the alignment above topographic map as well. The GIS maps of province, district and rural municipality/municipality and ward maps were added over topographic map to learn direct impact area, indirect impact area and zone of influence. The topographic maps of the project area used were scaled 1:25000 and Google earth maps of the project area were taken overlaying highway alignment before leaving for the field.

Table 20: List of maps studied during EIA

Map Type	Map No.	Scale
Topographical Maps, Department of Survey, (Published Date 1997)	097-11, 097-12, 097-16, 098-10, 098-11, 098-12, 098-13, 098-14, 098-15, 099-13, 278204c, 278203a, 278203c, 278203d	1:25,000

Geological Maps of Part of Bara, Makawanpur and Chitwan Districts of 1994		1:50,000
Satellite Imagery, Google Earth Map		

3.1.2 Review of Relevant Government's Policies, Laws, Regulations, and Guidelines

The proposed project attracts various national policies, laws, guidelines, manuals, and standards of GoN. Apart from the GoN policies, laws, guidelines, and standards, the Project will also attract the ADB safeguard policy and international convention treaties to which Nepal is a signatory. The relevant documents were reviewed and summarized in Chapter 4 of this report.

3.2 Preparation of Scoping Document (SD) and Terms of Reference (ToR)

The SD for the EIA was undertaken in accordance with the EPA/EPR-2076/2077 BS (2019/2020) to determine the scope of the EIA, inform stakeholders about the proposed project, receive their concerns and comments on relevant environmental issues, and prioritized issues for environmental assessment. 7 days public notice was published in national daily newspaper during scoping. A formal and informal deliberation with local people, government officials and other concerned stakeholders was conducted.

The issues and possible impacts identified in the Scoping were categorically tabulated as Issues identified and prioritized for EIA study and were incorporated in the ToR. The ToR was prepared by including potential issues, as per the Schedule 3, Rule 3, Road sector E (6). The SD and ToR was approved by MoFE, on dated 2081-06-11 BS (September 27, 2024) and approved ToR is given in Annex I-C. The EIA was focused on the analysis of the environmental issues identified in the approved SD and ToR.

3.3 Preparation of Checklist/Questionnaire

Checklist and Questionnaires were prepared mainly for conducting public consultations, focused group discussions (FGDs), key informant interview (KII) and household survey (for both sample household survey and census household survey). Checklist and Questionnaire used during the study is given in Annex VI-F.

3.4 Project Area Delineation

Right of Way (RoW)

Twenty-five meters both sides from center line of the proposed road have been considered RoW of the proposed road. As per the declaration published in Gazette in 2034 BS (1977), all the land within 50 m (*i.e.* 25 m either side from central line of the road) is considered RoW of the road (Annex X).

The road widening will be done within ROW only; no additional land beyond RoW is required permanently for the project.

Direct Impact Zone (DIZ)

The area within the construction width, 50 m (25m on either side from the center of the road) and ancillary facilities required for the Project including worker camps and stockpiling yards will be included as DIZ. DIZ is considered based on as per constructions activities in the RoW, Expert Judgement and DoR's environmental assessment guidelines.

Indirect Impact Zone (IIZ)

Adjacent areas with RoW were considered as IIZ (within 300 meters physical and socioeconomic environment or 1 km for biological environment) on either side of the road alignment. The construction activities will have an indirect impact on the physical, ecological, socioeconomic, and cultural environments. IIZ is considered based on outside of constructions activities, expert judgement and DoR's environmental assessment guidelines.

Zone of Influence (ZoI)

The ZoI of the project includes all the affected wards: 1, 21 and 22 of Jitpursimara Sub-Metropolitan City, 1, 2, 4, 8, 9, 10, 11, 14, 15 and 19 of Hetauda Sub-Metropolitan City, 6, 7, 8 and 9 of Manahari Rural Municipality, 1, 2, 3, 4, 5, 6, 7, and 8 of Rapti Municipality, 1, 2, 8 and 9 of Khairani Municipality, 1, 2, 3, 4, 9 and 10 of Ratnanagar Municipality and 9 and 12 of Bharatpur Metropolitan City. ZoI will be diversified for biological environment, and will beyond the IIZ, depending on species habitat/characteristics, food habit and mobility pattern of fauna.

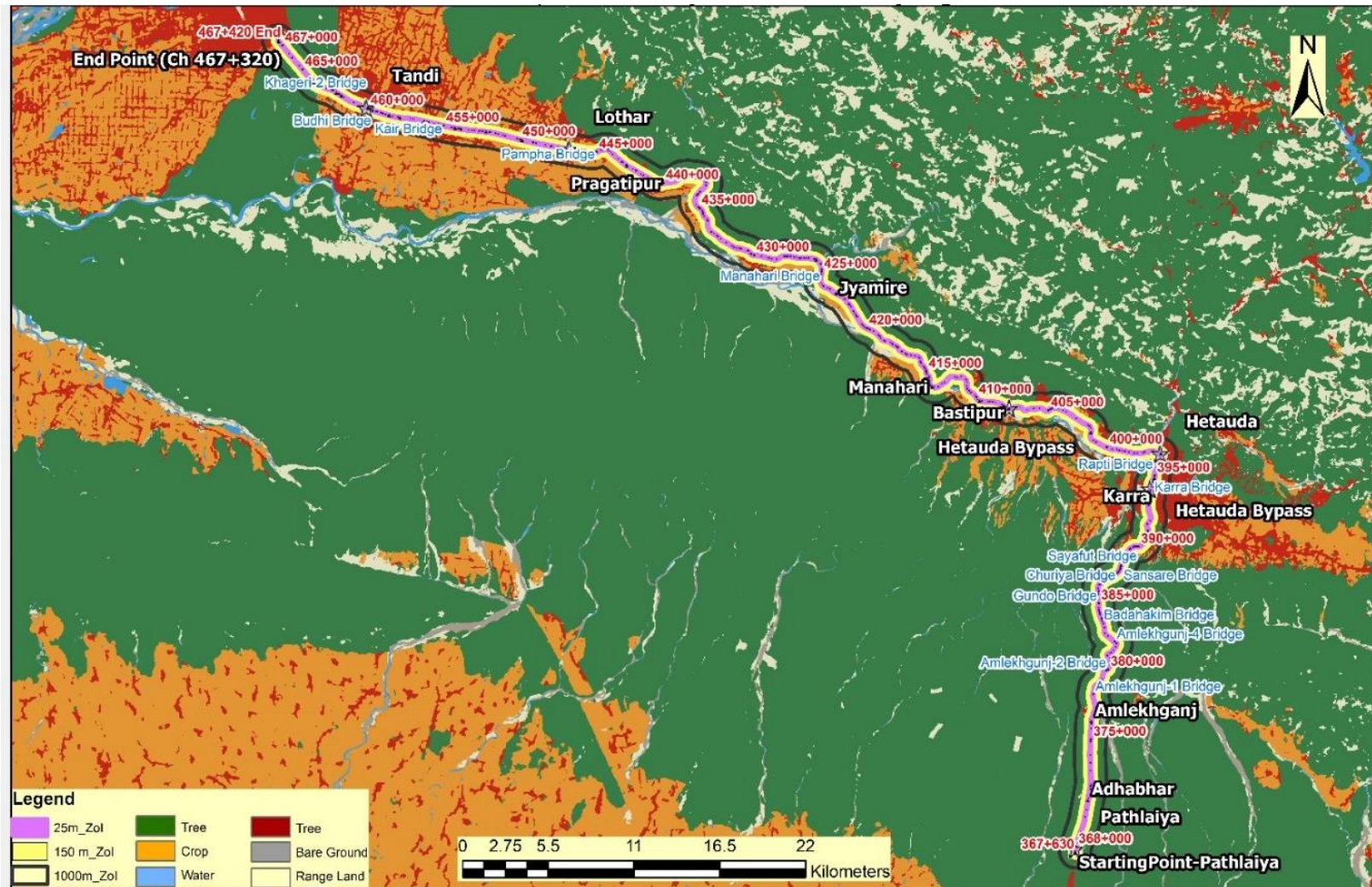


Figure 20: Zone of Influence map showing 50m (25-25m both side), 300m(150m -150m both side) 2km (1km-1km both side) of PHN Road

3.5 Field Study

Walk Through Survey

The EIA team had conducted walk through survey throughout the proposed road alignment and its surrounding for data collection of significant environmental features and make necessary measurements, inspect/observe and discuss with the local stakeholders throughout the study period. The information was collected covering the physical, biological, socio-economic, and cultural aspects of the environment.

Checklists and questionnaire survey forms were used to collect physical, biological, socio-economic, and cultural environment and related information from January to August 2022, March –May 2023, November-December 2024. Related photographs were taken during field work are attached in Annex XX. Further, following methods were adopted during the field data collection on physical, biological, and socio-economic and cultural environment.

3.5.1 Physical Environment

- Physiology and Land Use

Topographical map, Geographic Information System (GIS) tools were used for the analysis of physiological and topographical variables. Topographical map produced by Survey Department was used to produce land use map. Further produced maps were verified and updated by field survey and tallied with Google Earth Images.

- Hydrology

Rivers and rivulets (*Kholas and Kholsies*) crossed by the road alignment was recorded. Further perennial and seasonal rivers were categorized. Catchment of the river area have been delineated by GIS and checked by overlapping them on Google map. Further river hydrological data was collected from detail engineering report. For additional information, local people were enquired about the occurrence of flooding, induration in the project area.

- Climate

Temperature and rainfall data were collected from Department of Hydrology and Meteorology (DHM) record of nearest station (Hetauda Station-311). Temperature data of 10 years were analyzed whereas rainfall data of more than 45 years were analyzed to determine climate condition of the project area. Review Climate Risk Country Profile for Nepal (Ref.10) through Climate Change Knowledge Portal (CCKP), which was published by World Bank Group and Asian Development Bank.

- Geological Characteristics

The geology around the project area was collected from field visit and secondary available information, stereographic projection for slope stability, rock mass analysis tools was used for preparation of geological mapping. The stability of slopes and the presence of landslides, debris/fan deposits and slope failure within the project area were recorded and evaluated by site observations. For additional information, local people were enquired about the occurrence of debris flow, landslides and soil erosion in the project area.

- Air and Noise Quality

The air quality monitoring was carried out in 28 locations (Annex IV-O). The 28 locations were selected in order to represent such as highly crowded areas and sensitive receptors (hospital, school, etc.), settlements, forest areas and rural areas. A set of link receptors were taken at various receptor locations within at 10m, 20m, 50m, both sides from center line of the carriageway to know the dispersion of pollutant from the road. Air pollutants parameters such as Particulate Matter (PM_{2.5} & PM₁₀), Total Suspended Particles (TSP), SO_x, NO_x, CO, Lead and Benzene have been measured. 24-hours average concentration of pollutants was recorded and analyzed using Low-Cost Portable Sampler. SO_x, NO_x were analyzed from diffusive sampling, lead from atomic absorption spectrometry, Benzene from gas chromatographic technique and CO from non-dispersive infra-red spectrophotometer respectively. Further, the data have been analyzed with references of National Ambient Air Quality Standards (NAAQS), 2062 (Annex IV-S) and WHO Air Quality Guidelines, 2005.

Noise level was measured at same 28 locations i.e. where air quality was measured (Annex IV-O). The noise level was measured on daytime and nighttime using noise level meter. The daytime was considered from 7am to 8pm and nighttime was considered from 9pm to 6am. Equivalent noise levels due to traffic at the receivers are estimated using Federal Highway Noise model 2017. Equivalent Sound Level (LAeqT) is Ten times the base-10 logarithm of the square of the ratio of time-average, mean-square, instantaneous A-weighted sound pressure, during a stated time interval, T (where T=t₂-t₁). LAeqT is related to LAE by the following equation:

$$L_{AeqT} = L_{AE} - 10 \cdot \log_{10}(t_2 - t_1) \dots\dots\dots (i)$$

Where, L_{AE} = Sound exposure level in dB

Further, the recorded data were analyzed based on National Ambient Sound Quality Standard, 2012 and WHO Standards, 1999.

- Water Quality

Water samples were collected from 9 rivers (Annex IV-T) to understand the water quality of the water bodies along the road. Similarly, Ground water quality has been collected from 3 locations (Annex IV-V). 24 parameters were analysed for ground water and surface water. The major parameters analysed with testing methods/equipment are given in Table below. Ground water samples were collected covering major market and settlement of project affected area.

Table 21: Parameters measured for water quality assessment

Parameters	Test Methods
pH at 17°C	Electrometric, 4500 - H ⁺ B,; APHA
Electrical Conductivity, (μ S/cm)	Conductivity Meter, 2510 B, APHA
Turbidity, (NTU)	Nephelometric, 2130 B, APHA
Total Hardness as CaCO ₃ , (mg/L)	EDTA Titrimetric, 2340 C, APHA
Total Alkalinity as CaCO ₃ , (mg/L)	Titrimetric, 2320 B, APHA
Chloride, (mg/L)	Argentometric Titration, 4500 - Cl ⁻ B, APHA
Ammonia, (mg/L)	Direct Nesslerization, 4500 - NH ₃ C APHA
Nitrate, (mg/L)	UV Spectrophotometric Screening, 4500 - NO ₃ ⁻ B, APHA
Calcium, (mg/L)	EDTA Titrimetric, 4100 - Ca B & 4100 - Mg B APHA
Magnesium, (mg/L)	
Iron, (mg/L)	Direct Air - Acetylene AAS, 3111 B, APHA
Manganese, (mg/L)	
<i>E. coli</i> Count, (MPN Index /100mL)	Multiple Tube Fermentation, 9221 E, APHA

All the recorded data were further analyzed based on National Drinking Water Quality Standards (NDWQS), 2079 BS and WHO Standards, 2005.

- Source of Construction Materials

The location, type, volume, and sources of construction materials were identified through field investigation in and around the alignment area. The locations also were verified with the local government, proposed locations for construction materials were conducted the environmental study to ensure using during the road construction. The detail location is given in baseline information and Annex IV-G.

- Public Properties/Utilities

During field survey, detail public properties/utilities were recorded chainage wise using format/checklist. Public properties/utilities found during field survey were recorded such as public water tank, water taps, water supply pipe, public toilet, passenger waiting shed, resting place

(Chautara), religious structures, solar street lights, telephone pole, transformers, electric pole (concrete & steel), irrigation canal etc. Detail is given in Annex VI-D.

- Identification of Spoil Disposal Sites, Camp Sites and Material Storage Sites, Crusher plant, Asphalt Plant Sites

The sites were identified for the project activities such as spoil disposal sites, camp sites and materials stockpiling sites, crusher plant and asphalt plant through field-based survey, interaction with project engineers and local stakeholders. The locations were identified based on minimum impact on the environment such as far from dense settlement, school, hospital, wildlife crossing corridor, water course.

3.5.2 Biological Environment

Vegetation, NTFPs, wildlife, aquatic, amphibians and reptiles, etc. were collected on biological environment. According to Forest Regulation (FR) (2022), a tree enumeration was conducted census based. Other than trees, flora and fauna were enumerated using different sampling techniques. The methodology was designed to capture the baseline information on biodiversity and potential impacts imposed by proposed construction. The methodology followed for biological studies is given below.

i. Approaches

Consultation: To obtain the relevant information about the study area, participatory, multi-stakeholder and multi-community consultation/ meetings were conducted. Formal and informal consultation meetings, focus group consultations were held with DFO of Bara, Makawanpur and Chitwan. Meetings were held with the Chief Warden's Office of Parsa National Park and Chitwan National Park. Chairperson of the BZ Community Forest User Groups (BZCFUGs) of the BZ area of PNP and CNP, Community Forest User Groups (CFUGs), Office Head of the Tikauli Wildlife Corridor Forests, NGOs etc. to understand their concerns, apprehensions, and overall opinion.

Direct field observation/assessment: During the field assessment, Tree Census Survey (TCS), Wild Mammals Survey, Avian (bird) survey, Fish Survey and Herpetofauna survey were conducted, and photographs were taken to support the baseline data.

Measurement of independent floral variable (total tree population with its location) like DBH, height and other parameters of trees along with counting of sapling/seedling (through sampling) and notable NTFPs etc were made. Following the procedure prescribed in Annex 9 of Forest Regulation 2022, data was collected for all forest trees along the proposed width of the alignment.

Flora Survey: A "Tree Census Survey" (TCS) was carried to measure all the trees distributed along the RoW of required construction width (35m to 50 m). All necessary characteristics of a tree were identified and collected systematically. During the TCS, parameters of a tree measured were diameter

at breast height (dbh), above the ground level, height and location. Location of all individual tree was measured using a hand-held GPS, coordinates was recorded. The diameter at breast height of 5 inch (12.7cm) and above were categorized as tree and below 12.7 cm upto 4 cm were categorized as sapling and below 4 cm as regeneration. The data (e.g. trees species, number of regeneration) collected were also compared and verified to the lists prepared/published by IUCN Red Data List and List of Protected, Endangered, Rare and Threatened Plant Species prepared by DNPWC of GoN.

For location and size of the pole/tree a hand-held GPS was used to know and record the coordinates of the tree, diameter tape was used to measure dbh (cm). DBH of all pole/trees with 5 inch and above were measured at 1.3 m from the ground level. A clinometer and a 50 m linear tape were used to measure height.

ii. Sampling Design for Other Flora

Forest Regulation (2022) has specified “enumeration of sapling, regeneration, NTFP, etc.”. For the enumeration of sapling population, a systematic sampling technique (SST) was adopted, with randomization to start with, an equal distance was adopted to determine the location of sample plot. In here a “strip method” with “Clustered mosaic quadrants (CMQ)” were laid. These are commonly followed practices in forest inventories (DOF 2004). A CMQ of 5 m X 5 m with built in quadrat of 2 m X 2 m size was laid. Saplings were enumerated in the larger 5 m X 5 m quadrat and Seedlings including NTFP and others in smaller 2 m x 2 m quadrat.

For sapling < 5 inch DBH were measured and seedlings (< 4 cm dbh) were counted. In sub-plot 2 m x 2 m, seedling (below 4 cm), regeneration (<1m), NTFP, grasses are counted.

In the SST, a random no point was identified using a random number table. Two random numbers (of three digits) were generated (adopted as distance from Pathalaiya to west). An equal distance between the CMQs was identified to be 500 m. to lay CMQ in both sides of

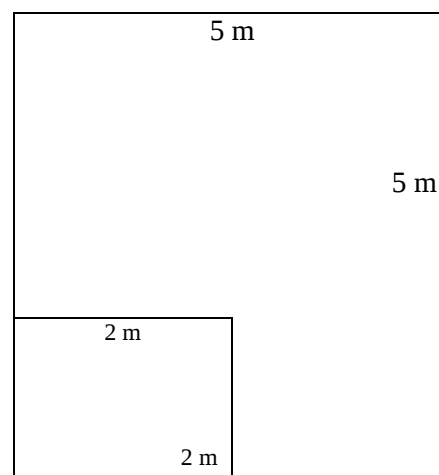


Figure 21: Cluster Mosaic Quadrat

the forests of the alignment. First plot was identified and laid on the LHS of the PHN starting at Pathalaiya. Intensive sampling measures were adopted to describe highly diverse roadside forest vegetation. A total of 1% of the vegetal population was sampled.

Statistical analysis: Statistical tools and principle were applied in enumerating the tree population with their locations. Sampling techniques were selected for analysis of other floral details like saplings,

seedlings, NTFP. Information/data regarding species composition, total tree biomass, and total carbon stock was estimated.

Estimating standing volume, biomass, and carbon of a tree: As per Forest Regulation (2022) Number of Trees is required to be estimated.

i) Calculation of impacted Tree within RoW:

The tree population was distributed on both sides of the highway. The forest and Rural area of the highway will have a carriageway of 24 m. Approximate width of the existing carriageway is 9 m. Trees which within 35 m (including present carriageway) will be removed from RoW, hence were enumerated and listed in Annex V.

ii) Calculation of impacted forest area within RoW:

The Forest and Rural Section of the highway will have a carriageway of 24 m. Present width of the existing carriageway is 9 m and added 15 m of the forests area will permanently change its land use from forest to roads. Added area 11 m of forest will be used for construction. A total of 35 m of forests, including present carriageway, will be cleared for construction. However, a permanent carriage/road way will be 24 m.

$\text{Impacted Area} = (\text{Construction width} - \text{existing carriageway}) * \text{linear distance}$

iii) Estimating total wood volume impacted within RoW:

Estimating above ground wood volume of standing trees:

a. Estimating volume of standing trees:

Volume of standing trees was estimated using formula suggested by Forest Regulation 2022, for stem volume

$\ln(V) = a + b * \ln(d) * \ln(h) \dots\dots\dots (i)$
--

Where

a, b, c are tree-based values

d is dbh,

h is total height of the tree

b. Estimation branch volume of standing tree:

Based on DBH, an R-value was obtained which was used in estimating the branch wood volume. R value can be obtained with the help of table 2 and 3 (Forest Regulation 2022). Species R-value was derived using model - ii

$$R\text{-value} = [(d\text{-lower value}) * b + (\text{upper value} - d) * m]/30 \dots\dots\dots (ii)$$

Where,

d = dbh of a tree

b = species parameter from table 2

m = species value from table 3

$$\text{Branch Volume} = \text{Branch R-value} * \text{stem volume} \dots\dots\dots (iii)$$

Total above ground wood volume of a tree is summation of Stem and Branch wood volume.

iv) Estimating above ground wood Biomass of a standing tree:

Above ground Biomass and Carbon Estimation:

Biomasses of trees or shrubs were estimated using standard biomass equation, and biomass tables for tree species. As enough data was not available, Sharma and Pukkala (1990) and Jackson (1994) methods were followed. Sharma and Pukkala (1990) advised use of Chaturvedi and Khanna (1982) for species with data deficiency.

After calculating volume of the tree, it was multiplied by species wood density (Chaturvedi and Khanna, 1982, Jackson 1994) to derive above ground biomass.

The biomass value of branches and leaves were estimated as 45% and 11% of the stem biomass respectively, in general (Sharma, 2003). However, studied value for sal species, the branch and leave biomass is at a ratio of 30% and 6.2% respectively for stem DBH of 28 cm or less; 34.1% and 6.7% for those with DBH between 28 cm to 53 cm; and 35.7% and 6.7% for sal trees with DBH greater than 53 cm.

$$\text{Above Ground Biomass (AGB)} = \text{SB} + \text{BB} + \text{LB} \dots\dots\dots (iv)$$

Where,

SB: is Stem Biomass,

BB: is Branch Biomass and

LB: is Leaves Biomass.

In case of below ground biomass, root biomass (RB) was calculated. RB for broadleaved vegetation was considered 30% of AGB (FAO, 2000). Total carbon was taken to be 43% of the total biomass (Negi et al., 2003).

iii. Faunal Diversity

Both fields based direct observation methods, consultation and collected data from secondary information were applied for wildlife-biodiversity study. Conducted consultation with key person interviews with the CNP and CNP Wardens, and PNP and CNP BZMC chairman, wildlife experts from WWF Nepal Office and from Department of National Parks and Wildlife Conservation (DNPWC) etc. Review the report of ADB, January 2022, Smart Infrastructure Planning and Design to Protect Natural Habitats and Biodiversity: Ecological Assessment of the NHP Road Upgrading (Draft Final Report).

For wildlife biodiversity study, methods applied for Mammals, Avifauna, Herpetofauna and Fish biodiversity will follow different methods/techniques and will be explained separately below. Subject matter experts were deployed for studying the occurrences and potential impacts on the wildlife diversity.

iv. Wild Animal

The approach of surveying mammal species presence and impact in the project zone of influence was carried applying i) direct observation using animal tracks along the roadside, direct impact zone. Considering the 2-kilometer distance (1 km either side) of the road as the Ecologically Appropriate Area of Analysis (EAAA) with higher possibilities of wildlife movement to and from the highway, the study was carried along the grid. A grid size of 2 Km x 2 Km range was created through the application of Geographic Information System (QGIS v. 3.10.9) (Figure 21). A Direct Impact Area (DIA) of 300 m (150 m X 150 m) was considered as critical habitat screening.

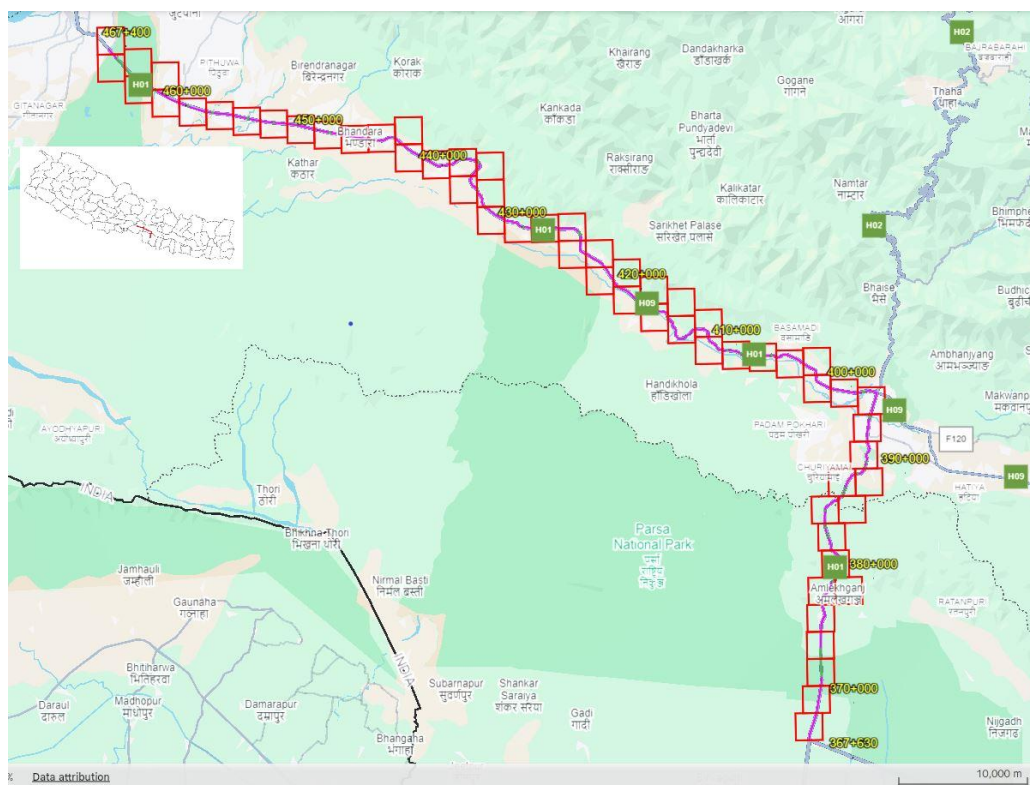


Figure 22: Mammal Survey Grids (2 Km x 2 Km)

During the mammalian survey, signs survey was carried to identify mammals through its pugmark/footprint/hoof mark, scats/pellets/dung, carcasses, scales, scratch on the tree trunks were thoroughly conducted in designated DIA. Signs would help indicate the species presence and the crossing points in the project area. Calls were also recorded/heard. Wildlife Crossing points of a mammal, including other indicators such as nests, dens, burrows and hence were studied to identify species habitat, a resting place. These simple pieces of information/data are important aspects of road ecological study.

Underpasses survey/observation of culverts, pipe culverts, bridges were made. Under and by the side of these are potential crossings or den used by wildlife, hence help understand species occurrence and potential migratory route. Sequency, review of “Roadkill” data for three years was evidence on presence of wildlife near the road and effective crossing point (Chitwan district). Review of “*Smart Infrastructure Planning and Design to Protect Natural Habitats and Biodiversity: Ecological Assessment of the NHP Road, 2022*” was also made.

Another tool of use was consultation and key informant survey. Addition to the field study consultation and key person interviews were carried with the CNP and PNP Wardens and their staff members; Forest Officials and other staff (Division and Sub-division Forest Office), Local Forest Management Groups (Community Forest User Group, Collaborative Forest Management Groups, Government forest management group); PNP and CNP BZMC chairman and other members, Wildlife

experts from WWF Nepal Office, Department of National Parks and Wildlife Conservation (DNPWC), National Trust for Nature Conservation (NTNC) and other stakeholders were consulted.

The participants were consulted/discussed to share information and their knowledge and understanding of presence of wildlife, their habitat and their movement. Some of the points discussed were a) presence of wildlife species in the forests (mammal, avian, herpetofauna, fish); b) Human-Wildlife Conflict; c) Wildlife movement/corridor, den and borrow area in the forests; d) Initiatives for wildlife conservation, habitat restoration, and way forth di) Planting herbivore preferred species, dii) Controlling illicit hunting and poaching, diii) Constructing water hole/ pond in the forests and e) Any other activities related to wildlife biodiversity.

v. Avifauna diversity

The bird survey for the project was conducted in the month of January 2025 by employing the point count method. It was ensured that diverse habitats, varying elevations was represented. Bird survey was done with allocation of points done on the basis of strategic location representing various habitats and birding sites to ensure a comprehensive assessment of bird diversity.

The survey was carried in 13 designated points chosen, detail location is given in table below (Annex-V-F). Of these there are 5 extended points studied (5, 6, 9, 12, 13). The survey was carried with a walking speed not exceeding 1 km an hour. Bird observations were conducted between 7:00 am to 6:30 pm in the evening with some breaks in the afternoon. It is the dawn and dusk when the bird activity was at its high. All the bird species sighted or heard were recorded. Any bird species, roosting sites, or nests near the proposed alignment, within or outside the project area, were documented. Besides the field data were also assembled through a literatures review.

Table 22: Sample points for Avifauna

Sample point	Location of sample points with coordinates	Coordinate
1.	Around Parsa National Park Gate	27.230292° N, 84.98756° E
2.	Bridge no. 1 to Pathalaiya	27.291367° N, 84.99066° E 27.199609° N, 84.980926° E
3.	Bridge no. 3 to Bridge no. 1	27.291367° N, 84.990663° E 27.318937° N, 85.00465° E
4.	Karra River to Bridge no. 3	27.414172° N, 85.026179° E 27.318937° N, 85.00465° E
5.	Machhapalan – extended 2.5 km east from 396+470	27.416771° N, 85.04994° E
6.	Rapti River to Samari River – extended point 3.54 km north of EWH	27.432088° N, 85.02496° E 27.455649° N, 85.04249° E
7.	Hetauda Forestry Campus	27.419826° N, 85.022322° E
8.	Hetauda dumping site	27.424313° N, 85.020911° E
9.	Rapti Bridge to Jaishing Bridge– extended point	27.432088° N, 85.02496° E 27.4872° N, 84.869416° E

Sample point	Location of sample points with coordinates	Coordinate
10.	Manahari to Simapani Farmland	27.540465 ⁰ N, 84.744073 ⁰ E
		27.523607 ⁰ N, 84.814024 ⁰ E
11.	Manahari to Tadi	27.540465 ⁰ N, 84.744073 ⁰ E
		27.621615 ⁰ N, 84.516049 ⁰ E
12.	Bishazari Taal to Barandabar, Kumal Taal	27.617285 ⁰ N, 84.438811 ⁰ E
13.	Rhino lake, Barandabar to 2km North Forest/small lakes	27.666471 ⁰ N, 84.472395 ⁰ E

Equipment used during the survey was Opti corn Binoculars of 10 x 42 for observation and identification of a bird and a camera Canon 90D with 55-250 mm lens was used to photograph birds. For identification, “Birds of Nepal” a book by Grimmett et al, 2016 was used. Further for migratory pattern and conservation status of birds, each species was noted following the IUCN Red list (IUCN, 2021) and for national status was followed National Red list of Birds (Inskipp et al, 2017) and CITES list category were used based on CITES official Website.

Limitation: The study was carried out only once during the month of December 2024.

vi. Aquatic and Herpetofauna Diversity

Herpetofauna: The visual encounter survey (VES) method was employed to systematically document the diversity and abundance of herpetofauna within the project area. This technique involved actively searching for amphibians and reptiles along the road while recording all individuals encountered. Surveys were conducted across various habitats, including forests, wetlands, grasslands, and agricultural landscapes, ensuring comprehensive coverage of microhabitats such as leaf litter, under logs, rocks, tree bark, and water bodies. All culverts and under bridge area were studied, as well. The survey effort was standardized by maintaining consistent search durations (day and night) and team compositions across all sampling sites.

Field surveys were conducted both during the day and night to account for diurnal and nocturnal species activity patterns. Diurnal surveys focused on basking lizards, active snakes, and frogs in open areas, while nocturnal surveys targeted amphibians and nocturnal reptiles using torchlights and flashlights. Each survey sessions were conducted using a slow and systematic search method with more than an hour in each sampling sites, to maximize detection probability.

Upon encountering herpetofauna, species identification was carried out using “Herpetofauna of Nepal: A Conservation Companion” (Shah & Tiwari, 2004), a standard field guide and taxonomic keys. For Turtles followed “Turtles of Nepal: A Field Guide for Species Accounts and Distribution” (Aryal, P.C. *et al.*, 2010). Additionally, photographs were taken and GPS coordinates for further verification. To minimize disturbance, handling of species was kept to a minimum, and all individuals were released.

Fish: To assess fish diversity, field surveys were conducted across various rivers and wetlands. A combination of direct sampling and local knowledge was used to ensure comprehensive data collection. Capture and Release method applied for sample collection, local anglers were engaged to assist in fish data collection using traditional fishing method such as hand catching and using hand fishing nets (trapping and angling). The captured specimens were carefully examined, photographed, and identified using standard field guide and taxonomic key “Ichthyology of Nepal: A study of Fishes of the Himalayan Waters” (Shrestha, 2008) and “Fish, Fisheries and Farmers in Nepal”. After taking photographs, fishes were released to its natural habitat.

To supplement the field survey, informal interviews were conducted with local fisherman to gather information on the fish species present in the rivers, wetlands, their seasonal occurrence, and habitat preferences. This participatory approach helped in identifying species that were not captured during direct sampling and provided insights into local fishing practices and ecological trends.

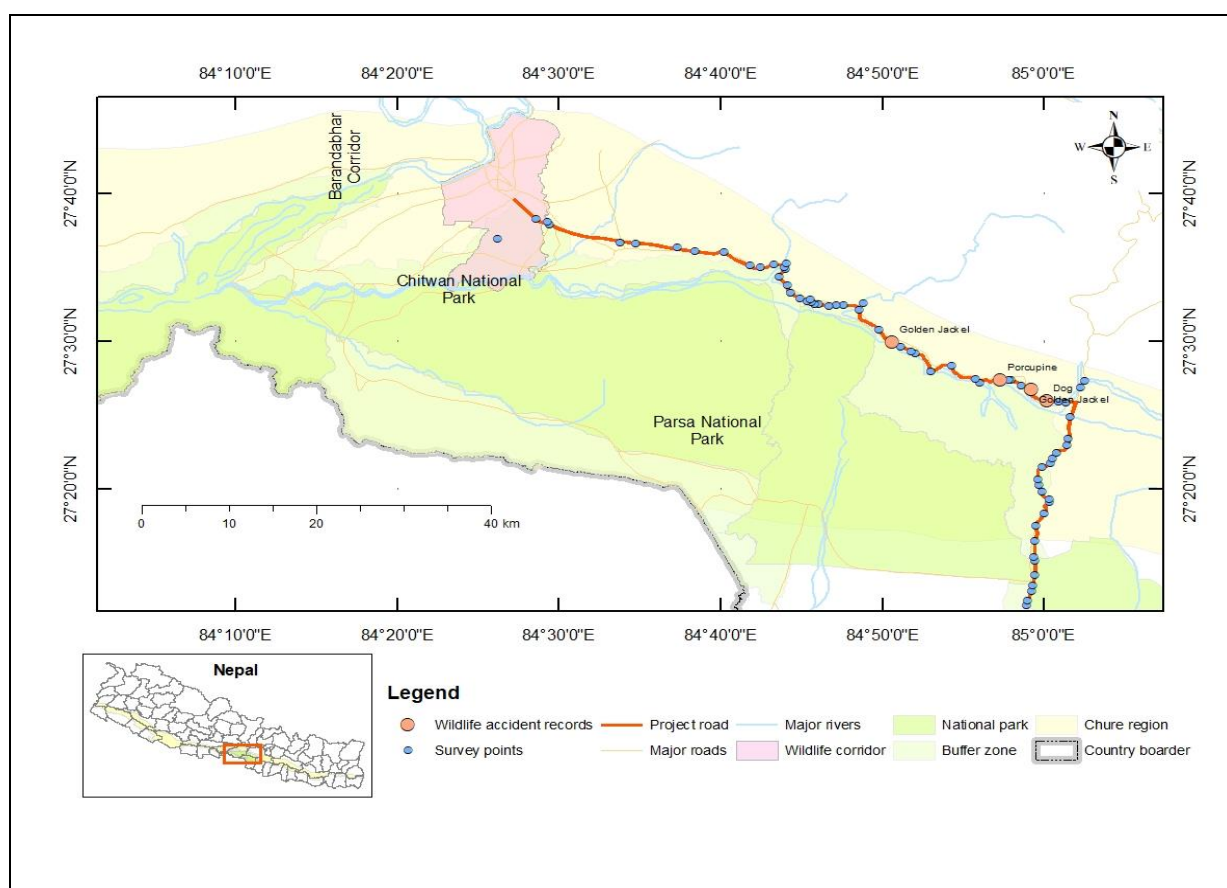


Figure 23: Mapping sample points for fish and herpetofauna study

Cost estimation of replacement plantation: According to Forest Regulation 2022, Rule 102 (3) and (4), Rule 93 (4), Rule 94 and as Guided by Forest Act 2019 Section 42 (6) cost for replacement plantation @ 1:10 i.e plantation of 10 plants for felling of each single tree will be addressed. Total cost of replacement plantation will be deposited in Forest Development Fund (FDF) established by Section 45 of Forest Act.

Ethnobotanical survey has been carried out to study the socially useful and commercial importance of the species of NTFPs and Medicinal plants in the forests of the project area. For this purpose, plant species of the area were listed during vegetation survey and information on their use were recorded by interviewing the relevant local informants.

Conservation status of the trees: Conservation status of trees was reviewed. Through the research/study published by IUCN (Nepal) and Department of Plant Resources (DPR) or MOFE, medicinal and aromatic values of species found in the project area was studied and recorded. Botanical Gardens and Floral study groups and institutions, in and around the project area was documented in consultation during the study. The conservation status was verified to the lists published by IUCN Red Data List, CITES and List of Endangered, Rare and Threatened Plant Species published by the Department of National Parks and Wildlife Conservation.

3.5.3 Socio-economic and cultural Environment

The study comprised of both qualitative and quantitative data from primary and secondary sources. The primary data were collected from sample household survey in the project road section and the secondary data were obtained from the published materials, CBS publications, Municipality profiles, ADB recommendations and related reports to the project. The household survey questionnaire was prepared in Nepali. Field works for the Pathalaiya-Hetauda-Narayanghat road section were carried out during 2022- 2024. Census survey was conducted to the project's affected households (378HHs) on August, 2022- 2024. In order to obtain detail socioeconomic information, altogether 1867 households were interviewed (20% of the total households from the project influence region was selected using a systematic random sampling method). Besides, Key Informant Interviews, Group Interviews, Focus Group Discussions with different community, Public Consultations, Municipality level consultation were conducted. Demography affected private and community property, resources, utilities, health and sanitation, historical and cultural sites within the impact area etc. were collected on socio-economic and cultural environment.

The socioeconomic survey team compiled a list of all the losses that have occurred as a result of the road widening. In addition, all affected dwellings, and structures, as well as potentially affected fruit trees and public properties, were validated during the socioeconomic survey. The social team used a methodology that included a number of actions such as pre-questionnaire testing, household interviews, group discussions, data gathering, data input, and data processing in the course of putting up this study. The majority of the information was gathered through primary sources such as a household (HH) survey questionnaire, a public meeting, and a focus group discussion.

The project's affected households (378HHs) were conducted census survey in the month of August 2022 in order to obtain socioeconomic information about them. Detail information of HH level questionnaire covering information about HH profile population, health status, family revenue and

expenditure motif, institutions, sanitation, educational institutions, major market places, major residential areas, educational institutions, agricultural productions and major farming practices, type of land, productivity of land and the land price and other relevant factors is used in the census surveys of APs. The census survey was carried out in accordance with the precise plan and drawings that had been developed by the technical team.

The household survey questionnaire was written in Nepali, the lingua franca among Nepali people. The questionnaire investigated the following main parameters:

- Household Profile
- Socio-economic and demographic information
- Health, Well - being and Education Status
- Family Revenue and Expenditure
- Human Trafficking
- Need Assessment
- Gender Equality and Inclusion etc.

3.6 Data Analysis

The data collected through various tools and sources were analyzed using both descriptive and statistical methods. Qualitative data of physical, biological and socio-economic and cultural environment were analyzed using software like MS Excel, GIS etc. The analyzed data were then interpreted and discussed in appropriate sections of EIA. Necessary tables, figures and charts have been presented in the related sections.

3.6.1 Impact Identification, Evaluation and Prediction

A logical, simple, and systematic approach has been adopted for impact identification, evaluation, and prediction. The impact has been identified for physical, biological, socio-economic, and cultural environment of the project area. Field inventories before project implementation provide baseline condition of resources. The assessment of impacts is based on the baseline environment conditions of the affected area with the project activities in relation to spatial and temporal aspects in terms of magnitude, extent and duration using various environmental prediction methods. The impacts have been predicting over a specified period and within defined area. Consequences of environmental impacts were interpreted in terms of local, regional, and national contexts. The significant positive and adverse environmental impacts associated with the project components have been identified considering the impact zone. The magnitude, extend and duration of the impacts which were categorized is given below:

i. Magnitude of Impacts

Low Impact (Lo): If the value of the resources could be used with no or minimum inconvenience to the public.

Medium/Moderate Impact (M): If the value of the resources could be used with inconvenience to the public.

High Impact (H): If the value of the resources reduced far below publicly acceptable level.

ii. Extent of Impacts

Site Specific (SS): If the impact is limited to the project area, then it is a site specific one.

Local (L): If the impact of the work extends to the watershed, then it is termed as local.

Regional (R): If the impact of the work extends beyond the watershed, then it is termed as regional.

iii. Duration of Impacts

Short Term (ST): If the impacts less than 4 years after project initiation it is classified as short term. The construction phase impacts are mostly categorized under this category.

Medium Term (MT): An impact that continues for more than 4 years but less than 20 years is considered as medium-term. The construction phase impacts which carry over 1-2 years of operation phase falls under this category.

Long Term (LT): An impact that lasts beyond 20 years is considered to be long term. The operation phase impacts are mostly categorized under this category.

Table 23: Characterization of magnitude, extend and duration.

Impact	Category	Score
Magnitude	High (H)	60
	Medium (M)	20
	Low (L)	10
Extend	Regional (R)	60
	Local (L)	20
	Site Specific (SS)	10
Duration	Long Term (LT)	20
	Mid Term (MT)	10
	Short Term (ST)	5

Source: EPR, 2020

3.6.2 Significance of Impacts

Significant: If the impact is considerable and changes the baseline condition it is considered significant impact.

Insignificant: If the change is minor that baseline condition is not affected considerably it is called insignificant.

On the basis of expert judgment following scoring method will be used for the identification and prediction of significance of impact.

Table 24: Categorization of significance of impacts

Category	Score
High Significant (HS)	Greater than 75
Moderate /Medium Significant (MS)	45 to 75
Insignificant (I)	Less than 45

Source: GESU Template for IEE of Road and Bridge Project, 2077

3.7 Preparation of Draft EIA Report

EIA was prepared incorporating with Environment management plan and monitoring plan. Impact mitigation measures were identified from the analysis of the negative environmental impacts, issues raised by local stakeholders and included in the environmental study report as per Schedule-12 of EPR, 2077.

3.8 Public Consultation, Meeting, Interaction and Public Hearing

Consultations were carried out with various key institutional and community stakeholders, including municipal authorities, Forest Authorities, and Forest User Groups, and local peoples. Informal meetings/ focus group discussion were carried out at different municipalities, local people, beneficiary, district forest office, community forest groups, Department of National Parks and Wildlife Conservation (DNPWC), Divisional Forest Offices (DFOs), Parsa National Park (PNP), Chitwan National Park (CNP) and NGOs.

Consultation Meetings

55 consultation meetings with the different stakeholders of the project area were conducted to obtain their opinions and suggestions. Consultations were carried out with various key institutional and community stakeholders, including municipal authorities, Forest Authorities, and Forest User Groups, and local peoples. Informal meetings/ focus group discussion was carried out at different municipalities, local people, beneficiary, district forest office, community forest groups. Through consultations, project concepts and objectives were disclosed and noted their ideas, suggestions, and concerns to inform the project design. Minutes of consultation meetings are given in (Summary of Issues Concerns Raised During Public Hearing and Summary of consultations is given in Table below) and Annex VII.

Table 25: Summary of Consultations held with Relevant Stakeholders

SN	Name of Stake Holder	Name	Position	Municipality and Ward	Date
1	Jeetpursimara Sub-Metropolitan	Rajan Poudel	Mayor	Jeetpursimara _7	9/9/2081

SN	Name of Stake Holder	Name	Position	Municipality and Ward	Date
2	Ward Office	Hira Bahadur Gurung	Ward Chairperson	Jeetpursimara _1	9/11/2081
3	Ward Office	Subash Shrestha	Ward Chairperson	Jeetpursimara _21	9/11/2081
4	Ward Office	Shekhar Kaji Rumba	Ward Chairperson	Jeetpursimara _22	9/11/2081
5	Hetauda Sub-Metropolitan	Meena Kumari Lama	Mayor	Hetauda _2	9/15/2081
6	Manahari Rural Municipality	Ranjan Kalakheti	Mayor	Manahari _8	9/13/2081
7	Rapti Municipality	Shamsher Lama	Mayor	Rapti _5	10/6/2081
8	Khairahani Municipality	Shashi kumar Khaniya	Mayor	Khairahani _6	9/14/2081
9	Ratnanagar Municipality	Pralhad Sapkota	Mayor	Ratananagar _1	9/14/2081
10	Bharatpur Metropolitan City	Renu Dahal	Mayor	Bharatpur _10	10/6/2081
11	Drinking Water & Sanitation Users' Committee	Suresh Kumar Lama	Committee Chief	Jeetpursimara _1	10/20/2081
12	Amlekhgung Karmakumari Drinking Water & Sanitation Users' Committee	Narayan Lamichhane Magar	Committee Chief	Jeetpursimara _21	9/9/2081
13	Sodhar Drinking Water & Sanitation Users' Committee	Bhagwati Thakuri	Committee Chief	Jeetpursimara _22	9/10/2081
14	Duibasti Drinking Water Management Committee	Dev Kumar Shrestha	Committee Chief	Hetauda _11	10/20/2081
15	Drinking Water & Sanitation Users' Committee, Newarpani	Bishnu Lal Sanwa	Committee Chief	Hetauda _19	10/20/2081
16	Shree Kedareshwor Drinking Water & Sanitation Users' Committee	Ambika Ghimire	Committee Chief	Manahari Rural Municipality _9	10/21/2081
17	Simpani Drinking Water & Sanitation Users' Committee	Laxman Karki	Committee Chief	Manahari Rural Municipality _8	9/16/2081
18	Manahari Drinking Water & Sanitation Users' Committee	Bhuvan Kumar Joshi	Committee Chief	Manahari Rural Municipality _7	10/21/2081
19	Bijauna Drinking Water & Sanitation Users' Committee	Janak Lal Baniya	Committee Chief	Manahari Rural Municipality _7	10/9/2081
20	Piple Drinking Water & Sanitation Users' Committee	Udhav Prasad Silwal	Committee Chief	Rapti _2	10/8/2081
21	Bhandara Second Drinking Water & Sanitation Project Users' Organization	Chandra Bahadur Lama	Organization Chief	Rapti _4	10/9/2081

SN	Name of Stake Holder	Name	Position	Municipality and Ward	Date
22	Bhandara Shikharbasti Drinking Water & Sanitation Users' Organization	Ekraj Kharel	Organization Chief	Rapti _5	9/15/2081
23	Birendranagar Small Urban Drinking Water & Sanitation Users' Committee	Chuda Prasad Silwal	Committee Chief	Rapti _8	10/8/2081
24	Parsa Small Urban Drinking Water & Sanitation Users' Committee	Ganesh Prasad Bataula	Committee Chief	Khairahani _8	10/8/2081
25	Ratnanagar Drinking Water & Sanitation Users' Organization	Madhav Prasad Aryal	Organization Chief	Ratananagar _2	9/15/2081
26	Manahari Users Committee/Jyamire Buffer Zone	Sitaram Aryal/Ram Puri	Chairperson	Manahari Rural Municipality_9	10/21/2081
27	Janahit Users Committee Under Parsa National Buffer Zone	Amrit Lal Shrestha	Committee Chief	Jeetpursimara _2	10/19/2081
28	Gadhimai Collaborative Forest Management User Group	Ram Ekwil Prasad Teli	Committee Chief	Jeetpursimara _1	9/10/2081
29	Shree Amleshwor User Committee, & Shree Churiyamai Zone Community Forest User Group	Raj Kumar Manandhar	Committee Chief	Jeetpursimara _21	10/5/2081
30	Shree Ranakumari Community Forest User Group	Jit Bahadur Tamang	Committee Chief	Jeetpursimara _22	9/11/2081
31	Shree Ban Devi Community Forest User Group	Mamita Blon	Committee Chief	Jeetpursimara _22	9/11/2081
32	Shree Mahila Milan Community Forest User Group	Navraj Lama	Committee Chief	Jeetpursimara _22	9/11/2081
33	Hariyali Buffer Zone Community Forest Users Group	Ram Kumar Pulami	Committee Chief	Hetauda _14	10/19/2081
34	Shree Churiyamai Bandevi Community Forest User Group	Harka Man Pakhrin	Committee Chief	Hetauda _15	10/5/2081
35	Ratomate Community Forest User Group	Ishwor Pakhrin	Committee Chief	Hetauda _15	10/6/2081
36	Mahila Shreejana Community Forest User Group	Laxmi Shrestha	Committee Chief	Hetauda _8	10/5/2081
37	Betkholi Community Forest User Group	Basudev Pyakhurel	Committee Chief	Hetauda _9	10/20/2081

SN	Name of Stake Holder	Name	Position	Municipality and Ward	Date
38	Dangdunge Community Forest User Group	Shalik Ram Pudasaini	Committee Chief	Hetauda _11	10/5/2081
39	Shree Lewat Community Forest User Group	Sher Bahadur Syangtang	Committee Chief	Hetauda _3	10/6/2081
40	Chanauta Community Forest User Group	Harisharan Paudel	Committee Chief	Hetauda _19	10/5/2081
41	Shree Kalika Hariyali Community Forest User Group	Gamdhi Dhalan	Committee Chief	Hetauda _19	10/5/2081
42	Shree Hariyali Forest User Group	Iman Singh Thing	Committee Chief	Manahari Rural Municipality_9	10/9/2081
43	Jyamire Kalika Community Forest User Group	Sadhuram Adhikari	Committee Chief	Manahari Rural Municipality_9	9/16/2081
44	Simpani Devkot Community Forest User Group	Govinda Prasad Dakal	Committee Chief	Manahari Rural Municipality_8	9/16/2081
45	Shree Manakamana Community Forest User Group	Suresh Kumar Muktang	Committee Chief	Manahari Rural Municipality _7	10/5/2081
46	Shree Pashupati Community Forest User Group	Radhunath Lama	Committee Chief	Manahari Rural Municipality _7	10/9/2081
47	Dipad Community Forest User Group	Dambar Bahadur Muktang	Committee Chief	Manahari Rural Municipality _6	10/6/2081
48	Shree Sunachuri Community Forest User Group	Parwati Tamang Moktang	Committee Chief	Manahari Rural Municipality _6	10/6/2081
49	Shree Surdevi Community Forest User Group	Ram Hari Dallakoti	Committee Chief	Rapti _1	10/7/2081
50	Shree Parewashwari Community Forest User Group	Singa Bahadur Tamang	Committee Chief	Rapti _1	10/7/2081
51	Shree Panchakanya Community Forest User Group	Krishna Prasad Bagale	Committee Chief	Ratanagar _11	10/7/2081
52	Rambel Community Forest User Group	Madhav Prasad Dhital	Committee Chief	Bharatpur _12	10/7/2081
53	Barandabhar Forest Conservation Area Council	Dipak Thapa Magar	Committee Chief	Bharatpur _11	10/8/2081
54	Chitwan National Park Buffer Zone Management Committee	Prakash Dhungana	Committee Chief	Bharatpur _9	10/21/2081
55	Shree Churemai Temple & Tunnel Conservation & Management Committee	Prem Bahadur Bhomjan	Committee Chief	Jeetpursimara _22 /Hetauda _15	9/13/2081

Focus group discussion: The consultation included inviting people to the discussion at project site, where a member of the project consultant's team explained the road project and the likely impacts and solicited community inputs on the proposed road upgrading, their expectations and concerns on construction as well as operation of the road. Feedback was sought on community involvement and sustainable environmental management. Further consultations were held with persons related with local people, community forest group, government agencies and NGOs.

3.8.1 Public Hearing

For public hearing, public notice was published in the National Daily Newspaper and local daily newspaper on 10 and 14 April 2025 (2081-12-28 BS and 2082-1-1BS) in Nepali language (Annex VIII-A). Other means of information dissemination like radio, FM (such as Radio Samaya, Hamro Rapti, Radio Makawanpur) also used. The announcement contained information on road upgrading, type of road, new bridge construction, project affected municipalities and wards of 7 Municipalities/Rural Municipalities of Bara, Makawanpur and Chitwan Districts under Madhesh and Bagmati Provinces. The announcement also sought feedback and suggestions from relevant stakeholders on the project's physical, biological socio economic and cultural environmental impacts. A copy of public notice together with the project information sheet was provided and pasted to the affected agencies, ward, and public places to ensure the affected stakeholders receive the information, notice, and provide comments. Consultation meetings were carried out all 7 municipalities/RM of 3 project affected districts. Total 285 peoples have participated in the public hearing. Out of 285, 236 were male and 49 were female. Summary of the public hearing meetings is given in Table below. Minutes of public hearing is given in Annex VIII-C.

Table 26: Summary of public hearing

S.No	Location	Date	Male	Female	Total
1	Ratnanagar Municipality	2082/01/06	44	14	58
2	Jitpursimara Sub-metropolitan City	2082/01/07	35	4	39
3	Bharatpur Metropolitan City	2082/01/08	25	4	29
4	Rapti Municipality	2082/01/09	26	9	35
5	Khairahi Municipality	2082/01/09	37	6	43
6	Manohari Rural Municipality	2082/01/10	51	4	55
7	Hetauda Sub-metropolitan city	2082/01/10	18	8	26
Total			236	49	285

3.9 7 Days Public Notice and Recommendation Letter

According to Rule 7(2) of EPR, 2077, notice requesting for written suggestions were affixed in notice board of affected municipalities, ward offices, schools, health post and other public places of project affected wards. The deeds of notice affix were collected (Annex VIII-D). After notice affix, 7 days

public notice was published in Kantipur, a national daily newspaper on 2082-1-29 as per the rule 7(2) of EPR, 2077. The 7 days public notice is attached in AnnexVIII-E. Recommendation letters were collected from affected municipalities, Divisional Forest offices and other concern stakeholders along with feedback and suggestions. The recommendation letters are included in Annex VIII-F.

The relevant issues raised during public hearing and consultation were address in the EIA and the project design. The Summary of issue, concern raised during public hearing and consultation is given in Table below.

Table 27: Summary of Issues Concerns Raised During Public Hearing and Consultations

Major Issues/Concerns/Demands	Response/Action
Land and properties acquisition and compensation issues	Compensation will be provided all affected private structures. Project's construction works will begin after the completion of compensation process. Separate RAP is prepared (Chapter 5.3.11 and Table 73- Socio-economic and Cultural Environment -Private structure Acquisition)
Possibility of displacement of persons and resettlement of the displaced persons	Compensation will be provided all affected private structures. Project's construction works will begin after the completion of compensation process. Separate RAP is prepared (Chapter 5.3.11 and Table73- Socio-economic and Cultural Environment -Private structure Acquisition)
Relocation of Public structures (Electrical Pole, Telecommunication system and Pole, Water supply system, Fencing)	RAP is prepared, Chapter 5.3.14 and Table 75- Socio-economic and Cultural Environment - Disruption of Community Structure and Public Utilities
Provision of overhead bridges and underpasses as required in the road design to reduce road accidents and for easy access of pedestrians	Address on Chapter 2.5.1, 2.5.2 cross drainages and side drain
Proper management of drainage/sewage in market and market areas along the roadside	Address on Chapter 2.5.8 Pedestrian crossing
Planting of evergreen plants and elegant flowers in green belt	16,666 different type of plants will be planted in median
Proper measures to minimize air and noise pollution during road construction, No work in nighttime,	Address under chapter 8.2 , Table 86: Impact Prediction and Mitigation Measures of Adverse Impacts
Construction of new bridge in place of outworn bridge	41 new bridges are proposed, Chapter 2.5.1
Provision of necessary measures regarding road safety in road design and during construction.	Address on Chapter 2.5.7and 2.5.9 Road safety measures, Junction improvement
Implementation of proper measures for affected public utilities, undergrounding the electricity cables and telephone wires, irrigation canal, water supply pipe, etc.	RAP is prepared, Chapter 5.3.14 Chapter 5.3.14 and Table 74- Socio-economic and Cultural Environment - Disruption of Community Structure and Public Utilities
Provision of footpath, parking and bicycle lane in road design	Address on Chapter 2.5.7
Employment to local people in project related job by providing necessary training	Table 17: Type and number of human resources requirement

Major Issues/Concerns/Demands	Response/Action
Construction of animal pass at key road section for safer movement of wildlife	Details are presented in Chapter 2.5.5, wildlife crossing
Coordination with local bodies / organization / user's committee during construction of the project.	The project will consider during construction
Provision of Resting Place, Toilet and Drinking Water	The project will consider during construction
Provision of street light, traffic light in junction	The project will consider during construction
Provision of 6 lane	6 lane is proposed in bazaar section
Provision of necessary measures for wildlife during construction	Chapter 2.5.5, wildlife crossing, and Table 86- Impacts on wildlife/Fauna. A working norm will be made "What to do and not do in the forests during construction".
Provision of training regarding road safety, forest conservation, sanitary and health, project information and construction methodology	Included in mitigation cost
Construction work should be in small packages	The project will consider during construction
Issue on disable friendly as well as children friendly road	The project will consider during construction
Provision of access for petrol pump, fire brigade, ambulance, public concern office.	The project will consider during construction
Provision of safer railing, footpath at Viaduct.	Chapter 2.5.5, wildlife crossing, and Table 86- Impacts on wildlife/Fauna
Issue of fell tree claim and plantation of compensatory tree.	Followed as per Forest Act and Forest Regulation 2022
Provision of protection measures for land slide and erosion	Physical Environment Slope failure, riverbank Erosion
Project support for maintenance of structures, Rhino lake, forest conservation, conservation for endangered wildlife	Chapter 2.5.5, wildlife crossing, and Table 86- Biological Environment- Impacts on wildlife/Fauna
Study regarding climate change in design	During design of bridge, cross drainage and asphalt work is consider for climate change affect
Project time should be within schedule	Chapter 2.6.8

4 POLICIES, ACTS, RULES, MANUALS & GUIDELINES, INTERNATIONAL CONVENTIONS

The proposed PHN Road Project attracts the following policies, acts, rules, guidelines, manuals and standards of Government of Nepal (GoN) and international convention treaties.

Table 28: Review of relevant policies, acts, rules, guidelines, and standards

Constitution of Nepal	Article 30 (1) of the constitution has granted ‘every person will have the right to live in a clean and healthy environment’ as a fundamental right for the people. The victim will have the right to obtain compensation, in accordance with the law, for any injury caused by environmental pollution or degradation. Article 51 of the constitution mentions pursuing policies to develop balanced, environment friendly, quality and sustainable physical infrastructures, while according to priority to the regions lagging behind from development perspective. The article also mentions about sustainable development. In Article 25: Rights relating to Property mentions that the State shall not, except for public interest, requisition, acquire, or otherwise create any encumbrance on, property of a person.
Policies and Plans	
Sixteenth Plan (2024/25 to 2028/29)	It has provided guidelines for the economic, social, and environmental aspects of development of the nation. It has taken transformative strategy to develop a sustainable and faster transport system by interconnecting road networks, strengthening road and transport infrastructure sector by expansion of national highways and strategic roads through amendment and integration of relevant laws related to infrastructure development and make this sector sustainable and productive. It has also prioritized those factors that directly link to the production process, paying attention to capacity development, and resource mobilization. To make roads safe and accessible, it has recommended for review of national road safety master plan and enforces it. To link infrastructure development with economic benefits in an objective manner, it has planned to initiate policy, legal and structural reforms to reduce cost, time and distance in road construction. Create competitive environment to reduce transportation Development of Quality Infrastructure and Intensive Inter-connectivity cost by developing inter-agency and inter-level collaboration and forward and backward linkages.
Occupational Health and Safety Policy for Road Infrastructure Development and Management, 2080 BS" (Departmental Policy	The Occupational Health and Safety Policy for Road Infrastructure Development and Management, 2080 BS, issued by Nepal's Department of Roads, establishes a comprehensive framework to ensure the safety and well-being of workers involved in road construction and maintenance. The policy emphasizes the implementation of safety measures such as the provision of personal protective equipment (PPE), establishment of first aid facilities, and appointment of safety officers at

	construction sites. It also addresses environmental concerns by advocating for dust and noise control measures, proper waste management, and the preservation of natural habitats. Furthermore, the policy mandates regular training and awareness programs to promote a culture of safety among workers and stakeholders. By integrating these provisions, the policy aims to minimize occupational hazards, protect the environment, and ensure sustainable development in Nepal's road infrastructure sector.
National Environment Policy, 2076 BS (2019 AD)	The GoN endorsed policy to control pollution, manage waste and promote greenery to ensure citizens' right to live in a fair and healthy environment. The policy is framed to guide implementation of environment-related laws and other thematic laws, realize international commitment, and enable collaboration between all concerned government agencies and non-government organizations on environmental management actions. Similarly, the policy has objectives of mainstreaming the environmental concerns in development activities. It has emphasized to promote reuse and recycle of the waste. To prevent, control and minimize the pollution has proposed following 5 policies and strategies; a) to manage efficiently and sustainably natural and physical resources; b) to balance development efforts and environmental conservation for sustainable fulfilment of the basic needs of the people; c) to safeguard natural heritage; d) to mitigate adverse environmental impacts of development projects and human actions; and e) to integrate environment and development through appropriate institutions, adequate legislation and economic incentives, and sufficient public resources.
National Climate Change Policy, 2076 BS (2019)	The National Climate Change Policy in Nepal aims to create a climate-resilient society that contributes to socio-economic prosperity. The policy focuses on several key objectives that includes (i) promoting a green economy by adopting low carbon emission development and integrating climate change considerations into all government policies, strategies, plans, and programs including projects carried out by DoR; (ii) Climate-resilient economic development through development of reliable, sustainable, and low-carbon in transportation systems. It aims to identify and address main sources of emissions in transport sectors; (iii) Energy efficiency by encouraging use of energy-efficient technologies in transport, and physical infrastructure. It also promotes selection of environmentally friendly sites and use of climate-friendly technologies during development of transport infrastructure; (iv) Disaster risk reduction by aiming to reduce loss and damage caused by climate-induced disasters, including threats to lives, property, health, livelihoods, physical infrastructure, and cultural and environmental resources. It calls for the development of disaster risk reduction and management systems at the federal, provincial, and local levels; and (v) Preparedness and response measures: by emphasizing development of effective monitoring, forecasting, and early warning

	systems for climate-induced disasters such as floods, landslides, droughts, windstorms, heat waves, cold waves, wildfires, fires, and epidemics. It also focuses on ensuring that comprehensive and systematic information on climate-induced disasters is collected and made accessible to all groups, levels, and areas. Additionally, the policy identifies eight thematic areas and four cross-cutting areas that will be particularly impacted by climate change.
National Forest Policy, 2075 BS (2018)	The policy emphasizes conservation of forests, species and soil and their sustainable use, natural resources, and biodiversity. It calls upon enhancing people's participation in the development and management of forests and promotes including the communities in decision-making process. Besides promoting benefit sharing, which is accrued from natural resources management, particularly forests, the policy instruments oblige the project proponent to avoid or limit damage and/or affect environmental resources while implementing a project and/or program. It has long term vision of contributing to local and national prosperity through sustainable management of forest, biodiversity and watershed. However, the forest policy re-emphasizes to avoid forest destruction or tree cutting while constructing infrastructures during implementation of project other than forest sector. The policy has ensured watershed conservation, conservation of endangered species, emphasized on community and private forestry development programs, national parks and conservation areas management programs, soil and watershed conservation program, management and development of medicinal plants, and conservation of biological diversity. The alignment of PHN road traverse significant portion of the forest including core area of National Park and Buffer Zones.
Land Acquisition, Resettlement and Rehabilitation Policy, 2015 AD	The policy emphasizes scientific standards for land valuation and extension of compensation equivalent to the minimum market value of land. A provision in the policy allows the government to take action against those who try to disrupt land acquisition process or create hurdles for the project of greater national and public benefit. In this regard, the policy has stressed the need to first assess the socio-economic impacts of a project. All expenses related to land acquisition, compensation and implementation of resettlement and rehabilitation plans should be considered as a project cost. It has four approaches for land acquisition: voluntary donation; direct negotiation; land development program; and expropriation. The main goal of this policy is to improve social and economic status of project affected families by providing fair and adequate compensation, appropriate resettlement, and rehabilitation assistances. Its main objective is to create conducive environment for timely completion of the project by simplifying land acquisition, valuation, compensation, and resettlement and rehabilitation process. This policy asks to carry out meaningful consultation with affected persons and vulnerable

	groups and provide compensation on time based on current market value. The project do not require permanent acquisition of land since the work will be undertaken within RoW i.e., 50m however in an exceptional situation of road alignment changes or taking over of the alternative routes and for temporary purpose the land acquisition will be inevitable. The project requires private 403 Nos. of structures belonging to 378 HHs that will be wholly or partially removed for maintaining Right of Way (RoW)
ADB Safeguard Policy Statement, 2009 AD	The Asian Development Bank has defined its environmental safeguard requirements under its "Safeguard Policy Statement, 2009" (SPS 2009). The SPS 2009 key requirements include screening for significant impacts and categorization, consultation, and disclosure. Proposed projects are screened according to type, location, scale, and sensitivity and the magnitude of their potential environmental impacts, including direct, indirect, induced, and cumulative impacts. Here, Projects are classified into four categories in terms of significance of impact to the environment.
National Wetland Policy, 2059 BS (2003 AD)	The policy includes the need for carrying out an Environmental Impact Assessment following provision of existing laws for development projects and actions, which are planned for implementation in nearby wetlands
National Transport Policy, 2058 BS (2002 AD)	The policy emphasizes construction and improvement of road/s that provide beneficial environmental impacts. This policy states, among others, that the entire process of land acquisition and transferring of land ownership to the project shall be established before the commencement of road project implementation. Equally, a basis for livelihood shall be established for the fully displaced families by way of rehabilitation or by any other means. The policy also focuses on arranging to dispose of batteries, waste oil, grease, and other oily substances at designated places
President Chure-Tarai Madhesh Conservation Development Master Plan, 2017	The plan has suggested following actions and implementing strategies to be adopted by the concerned authority for development of environment-friendly structures in the Chure region: Follow the existing laws and sector-wise policies, manuals, and standards for making development and operation of physical infrastructures environment-friendly. For this, case-studies will be carried out on the condition of existing acts, rules, manuals, abeyance of standards, impacts (both positive and negative) on environment and so on. In order to make a similar opinion regarding results of case studies and activities (that can be done or cannot be done) to be carried out, the public will be notified through media, and will be even uploaded on the website. Field observations of sites with both environment-friendly and non-environment friendly physical structures will be organized for policy-level personnel (political and administrative) so as to make them aware of the development and operation of environment-friendly physical structures. In case of political personnel, the target

	will be towards the honorable members of the Environment Committee under Legislature Parliament. Field observation of sites with both environment-friendly and non-environment-friendly physical structures for honorable members of the Environment Committee under Legislature Parliament.
Acts	
Statistics Act, 2079 BS (2022 AD)	This act aims to generation, processing, storage, publication, distribution in a reliable and timely manner for the policy formulation, implementation, resources management and effective service delivery in federal, provincial, and local level.
Federation, Province, and Local Level (Coordination and Inter-relation) Act, 2077 BS (2020 AD)	This Act aims to manage the inter-relations between the Federation, Province and Local level that exercise the state powers under the Constitution of Nepal on the basis of cooperation, co-existence, coordination and mutual cooperation. Chapter 5 of this act explains the resolution of disputes, if arises among federation, province, and local level.
Land Use Act, 2076 BS (2019 AD)	In order to achieve maximum and sustainable benefits through land classification, proper use, and effective management, there is a legal provision to update the landowner list and evidence part according to Section 7 brought by the Land Use Act. According to section 8 (1), the lands classified as per section 4 cannot be used for other purposes, but according to sub-section 8 (71) of the same section, the land use shall be changed for projects of national pride or priority, industrial areas and special economic zones.
Environment Protection Act, 2076 BS (2019 AD)	The Environment Protection Act (EPA), 2019 recognizes the interdependence between development activities and the environment; and emphasizes the proper use and management of natural resources. This Act provides the legal basis for environmental study and implementation and stresses the minimization of adverse impacts on the physical, biological, and socio-economic environments. Sections 3 require that the project proponent conduct an IEE or EIA of the proposed Project and obtain approval from the concerned ministry (MoFE) for project implementation. It empowers the government to declare specific areas as environmentally protected areas. This project has traversed Parsa National Park and Barandabhar Forest Corridor. The EPA, 2019 clearly mentioned about the mandatory for environmental studies of any development project. Section 4 entails about detail analysis of alternative to the project. Section 5 is related to the preparation of SD and ToR documents and section 6 stresses on maintaining standard and quality of environment assessment work while section 7 talks about approval of study report. Section 8 prohibits implementation of projects without approval of EA report. Section 10 highlights on Environmental Management Plan, section 11 on conducting supplementary EIA, section 12 on

	Environmental Audit within 6 months following operation of project for 2 years. Similarly, section 15 talks about prevention of pollution. Section 34 through 23 has provision of matter related to climate change. Clause (24) entails to prepare and implement an adaptation plan to avoid adverse impacts and risks of climate change. The act has also stipulated provisions for the protection of natural heritage and Environmental Protection Area; compensation provisions arising from the discharge of waste and pollution; punishment for actions against the Act and rules, guidelines and standards formulated under the rights to appeal to the concerned Appellate court against the decision of concerned authority.
Forest Act, 2076 BS (2019 AD)	The Act aims to control the encroachment into forests and forest areas, illegal cutting, falling, hunting, and trading of flora, fauna and forest products. It aims to attain social and economic development and to promote a healthy environment and to ensure the development and conservation of forest and the proper utilization of forest products and extend co-operation in the conservation and development of private forest by managing the national forest in the form of government managed forest, protected forest, community forest, leasehold forest, and religious forest. In Section 42 (1), the government will give approval to use forest land if there exist no alternative other than using forest land to any national priority projects, projects given to be developed by the Investment Board, and projects of national pride and if it is found from the environmental study that there will be no significant adverse impact on the environment. Sub-section 8 through 2 provisioned on the compensatory measures for use of forest land by mentioned projects. Provincial and local governments have to request the Government of Nepal if they use forest area when constructing projects including roads. Section 45 mention about the provision of Forest Development Fund (FDF) for addressing objective of the act and conserving and promoting forest.
Child Related Act, 2075 BS (2018 AD)	As mentioned in chapter 2 of this act, Children below fourteen years of age shall not be deployed in any risky work or used as a house-servant or housemaid and the Government of Nepal, Provincial Government and Local Level may follow the necessary measures and make and implement the standards for the protection of the children.
Disaster Risks Reduction and Management Act, 2074 BS (2017 AD)	The Act aims to protect human lives and properties of the public, private and individual, to preserve natural and cultural heritage, and to keep physical infrastructures safe from natural and non-natural disasters by effectively coordinating and managing all activities on reduction of disaster risk and management. Section 3 of the Act mentions the establishment of a National Council for Disaster Risk Reduction and Management, headed by the Prime Minister, to operate disaster related functions effectively. Further the Act also envisages the

	establishment of a National Disaster Risk Reduction and Management Authority under the Ministry of Home Affairs to effectively carryout and manages disaster management activities (Section 10).
Performance Based Social-Security Act 2074	It ensures the social security rights of workers based on their contribution. It requires that the listed employer should deposit funds regularly as per their contract or deposit additional amount to the workers' contributable income as mentioned in Article 7. According to sub-section 1, the amount should be deposited from the day the worker is listed to the last day of his/her employment. If a situation arises where the labor does not receive remuneration and cannot deposit the amount to be deposited by him/her then the listed employer should deposit the funds for a maximum of 3 months. The listed employer can deposit the amount by deducting from the laborer's remuneration, allowance or other facility as prescribed. If the employer does not deposit the fund within the cited period, then s/he will have to pay an interest of 10% of con
National Civil Code and Criminal Code (<i>Muluki Debani Samhita</i>), 2074 BS (2017 AD)	Section 112 of the Act states regarding prohibition Against Environmental Pollution: No person shall engage in the production, processing, transmission, storage, emission, transportation, or disposal of hazardous waste in a manner that causes significant adverse impact on the environment. No person shall cause pollution or engage in the production, processing, transmission, storage, emission, transportation, or disposal of hazardous waste through any mechanical means that produces sound, heat, radioactive radiation, or any hazardous substances, in a way that endangers public health or poses a threat to life, without prior approval from the authorized authority as per the prevailing laws. A person who commits or causes to be committed an offense under sub-section (1) shall be liable to imprisonment for up to one year or a fine of up to ten thousand rupees, or both. A person who commits or causes to be committed an offense under sub-section (2) shall be liable to imprisonment for up to five years or a fine of up to fifty thousand rupees, or both.
Local Government Operation Act, 2074 BS (2017 AD)	This act has been promulgated according to the right conferred by Article 296 of Constitution of Nepal to provide accessible and quality services by ensuring public participation, accountability and transparency while promoting cooperation, co-existence, and coordination between the Federal, Provinces and local levels in order to regulate rights of the local level. Section 11 mention about the right of local government where its sub-section 11(2)(g) stipulates on local level development projects and programs which entails about formulation, implementation, monitoring and evaluation of needful social, economic, cultural, environmental, technological and infrastructure development projects and programs. Sub-section (2) (g) (3) mention about study, research, and

	impact assessment of the project. sub-section 2 (j) mention about local market management, environmental protection and biodiversity where it outlines local policy, laws and standard formulation of plans and its implementation, monitoring and evaluation, mitigation of environmental risk at local level, environmental pollution and control of hazardous material, solid waste management, environmentally friendly and low carbon development initiative, management and delimitation of environmental protection area. Section 11 (4) mention about details rights and duties of local government that cover subjects related to environment and biodiversity in elaborated form. Section 24 (2) (1) while forming fiscal, periodic, medium- and long-term plans interrelated and cross cutting matters like environment, good governance, child friendliness, climate change adaptation, disaster management, gender and social inclusion should be given due consideration. Section 44 stipulates about application and following of National and Provincial Road standards. According to section 45(1)(2), the local municipality can determine RoW of local roads within its area and can create and apply standards of RoW of national and province level roads. Section 45(5) states that if any structure, land has to be removed or acquired as a part of change in road RoW compensation has to be paid for such acquisition or removal of property of owner. Section 62 a mention about right of local government to sell soil, stones and aggregates in prescribed quantity following environmental assessment of such undertaking.
Labor Act, 2074 BS (2017 AD)	Classification of employment, provision of appointment letters, and prohibition of child labor are the main provisions of this act. Section 5 of the act prohibits use of child labor, section 6 prohibits discrimination in workplace, and section 7 mandates equal pay for the same job, section 8 right to formation of trade unions, section 9 provision of legal treatment for unfair acts. Chapter 3 of the act has provision for employment, chapter 4 regarding the training and on the job training, chapter 5 has provision on part time labor, chapter 6 deals with the provision of obtaining the license, chapter 7 has provision of time of work, chapter 8 has provision about the wages and chapter 9 about the holidays. Additionally, chapter 10 has provision on employee fund, insurance and social security, chapter 11 about hiring abroad workers, chapter 12 about the provision of occupational health and safety, chapter 13 has provision about the special industry or service and the chapter 15 has provision regarding the monitoring.
Control of International Trade of Endangered Wild Fauna and Flora	The act includes legal provisions for conservation of various species of the endangered fauna and flora in order to implement the Convention on International Trade in Endangered Species of Wild Fauna and Flora, 1973 to which Nepal is a

Act (CITES), 2017	party and for regulation and control of international trade content provisions concerning Trade of Endangered wild fauna or flora or specimen thereof contains the endangered flora and fauna and Chapter 3 covers provisions concerning Registration of the Endangered wild fauna or flora or specimen thereof. Chapter 5 contains the provision of offences and punishment. Offences deemed to be committed: In case anyone commits any of the following acts, shall be deemed to have committed an offence under this Act:- a) Purchasing, selling, possessing, using, rearing, planting, upbringing, captive breeding, transporting, importing or exporting a threatened or vulnerable wild fauna or flora or a sample thereof or cause to do so in contravention of Section 3; b) Purchasing, selling, possessing, using, rearing, planting, upbringing, captive breeding, transporting, importing or exporting a protected wild fauna or flora or a specimen thereof or cause to do so in contravention of Section 8; c) Failing to register an endangered species of a wild fauna or flora or a specimen thereof pursuant to Section 13 or 14; d) Transferring title or changing ownership of an endangered species of a wild fauna or flora or a specimen thereof pursuant to Section 15; e) Committing any act in contravention of this Act or Rules framed thereunder, other than those referred to in clauses (a), (b), (c) and (d).
Solid Waste Management Act, 2068 BS (2011 AD)	This law has been amended and consolidated to maintain a clean and healthy environment by minimizing, reusing, processing or disposing of waste at source, for systematic and effective management of waste, and to reduce adverse impacts of waste on public health and the environment. In accordance with Section 3 (1), the local level shall be responsible for construction and assembly of infrastructure and structures necessary for waste collection, final disposal and processing, including transfer center, landfill site, processing plant, compost, biogas plant, etc. According to section 4(2), whatever is written in sub-section (1), the responsibility of processing and managing water harmful waste, health institution waste, chemical waste or industrial waste shall be the responsibility of the person or entity producing such waste subject to the prescribed standards. According to Section 6(1), the local level should at least divide the waste into various types, including organic and inorganic, and segregate it at the source.
Plant Protection Act, 2064 BS (2007 AD)	This act aims to prevent or control harmful epidemic insect or disease spread in plant or plant products while importing or exporting. By notification in the Nepal Gazetted the GoN may impose restrictions or conditions for the import of plant or plant products.
Child Labor (Prohibition and Regularization) Act, 2056 BS (2000 AD)	Child related Act, 2048 (1993) and Child Labor (abolition and regulation) Act, 2056 (2001) are the major acts related to child labor in Nepal. The Child Labor (Abolition and Regulation) Act, 2056 (2001), Article 3, Clause 1 prohibited for labor employment any child below the age of 14 years. Clause 2 prohibit child

	below 16 years to work in risk-prone sectors such as public transportation and construction related works.
Motor Vehicles and Transport Management Act, 2049 BS (1993 AD)	The Act defines and prescribes necessary standards for vehicles emission and mechanical condition for vehicle registration by the Transport Management Office (TMO) and the TMO can deny a permit based on environmental factor. Standards are set for petrol and diesel engine under the Nepal Vehicle Mass Emission Standard 1999.
Mines and Minerals Act, 2042 BS (1985 AD)	This act provides for the development of mines and mineral deposits existing in the country. The act classifies minerals based on their nature and importance as specified in section 3A. The Government of Nepal shall have the exclusive power to carry out mining operations. The act further provides for: restrictions on the export of minerals; royalties; inspection and investigations; establishment of a minerals development center to launch a minerals promotion programme.
Soil and Watershed Conservation Act, 2039 BS (1982 AD)	Soil and Watershed Conservation Act makes provision to control floods landslides (Watershed Conservation Rules, 1985). The Watershed Conservation Office is the authority and District Watershed Conservation Committee must implement watershed conservation practices and promote public participation for soil and land protection. This act also attracts as and when slide or erosion within road is surfaced up significantly.
Public Road Act, 2031 BS (1974 AD)	According to section 3 a, it may be prohibited to construct buildings etc. within the prescribed area (jurisdiction). Section 3b states that the Government of Nepal shall publish a notice in the Nepal Gazette and classify public roads as national public roads, provincial public roads, local roads, rural roads, urban roads, agricultural roads and other roads as specified and specify the road border not exceeding 31 meters on both right- and left-hand sides from the central line of such roads. The road limit will be set without increasing it, but even for the entire length of the same road, due to the geographical situation and population, such a road limit can be reduced, or four farts can be opened to protect the embankment of the river around the bridge. According to section 4, land can be acquired for public roads and road boundaries according to prevailing laws. In accordance with Section 14, the provision that other land can be acquired during road construction, expansion, or improvement. Compensation and determination of land to be acquired in accordance with section 15 According to Section 16, provision for planting and maintaining trees on the right and left sides of the road According to section 17, the right to remove goods obstructing movement of public roads According to the provision in section 19, the work should be carried out in the road

	area with the permission of the road department; According to section 29, road department should be notified to do the work. The Department of Roads may temporarily acquire the land and other property adopting compensatory measures during the construction, rehabilitation and maintenance of the public roads may operate quarries, borrow pits and other facilities during the road construction.
National Park and Wildlife Conservation Act, 2029 BS (1973 AD) and amendment 2049 BS (1992 AD)	This Act includes provisions to restrict damage to forest products and to block or divert any river or stream flowing through a national park or reserve or any other source of water. It also states that, without permission, no one shall cut, fell, remove, or overshadow any tree, plant, or any forest produce or do anything by which the forest produce may die, burn, or get damaged. Section 10 of the Act has a list of protected wildlife that is banned for hunting. The Act has provisions for fine and punishment for illegal killing, wounding, sale, and purchase of protected wildlife.
Aquatic Animal Protection Act, 2017 BS (1960 AD)	The Aquatic Animal Protection Act, 1960 provides the legislative protection of aquatic habitats. The section three (3) of the Act renders punishment to any party introducing poisonous, noxious or explosive materials into the water source or destroying any dam, bridge or water system with the intent of catching or killing aquatic life. The section four (4) empowers the government to prohibit catching, killing, and harming certain kinds of aquatic animals through notification in the Nepal Gazette.
Land Acquisition Act, 2034 BS	Article 3 grants power to the Government to acquire any land anywhere for public purposes, subject to compensation under the Act; Rule 4 empowers Government to acquire land upon request by institutions subject to the payment of compensation and all other expenses under the Act; Rules 5, 6, 7 and 8 stipulate provisions and procedures for initiating initial land acquisition process and estimating compensation rates; Rules 8 and 9 stipulate procedures and provisions for notification of land acquisition; Rule 11 provides for the right to file complaints by those affected by public notice with regard to the land rights; Rules 13, 14, 15 stipulate procedures and provisions of setting compensation; Rules 16 and 17 stipulate criteria for setting compensation; Rule 19 stipulates disclosure of compensation entitlement through public notification; Rule 25 includes provision of complaints against the compensation rates to the Ministry of Home affairs. The decision of the Ministry of Home affairs on the complaint is final.
Rules and Regulations	
Forest Rules, 2079 BS (2022 AD)	It has provided more detailed legal measures for protection of forests and wildlife. The main provisions of this regulation are as follows – Chapter 2- Determination of land use and boundaries of national forests Rule 3 – No change in land use of National Forest Rule 4 – The entity entitled to use forest area for development of construction

	projects should deposit the amount estimated by DoFSC that includes the cost of tree planting and conservation for five years and deposit to FDF. Rule 36 mention about the management of Risky trees Rule 85 mention on removing trees from public land Rule 87- While designing a development project, it should be done in such a way that the national forest area is not affected as much as possible. Forest area should be used only when no other option is possible for a development project. Rule 88- National forest area can be used for development projects only if it is found necessary to use the national forest area for development projects and if it is found from the environmental study that there will be no significant adverse impact on the environment. Rule 89 talks about keeping records of trees having circumference greater than 5 inch that are to be removed while constructing project Rule 90- Regarding use of any part of the national forest area, DoFSC shall study the details received from the DFO and, if necessary, conduct on-site monitoring and send it to the MoFE with its opinion. After studying the details and documents received, if deemed appropriate, the Ministry shall determine conditions to be followed by the development project, including commitment of the project to comply with the national forest area, number of trees to be removed and, if found, land ownership of such forest area, including conditions to be followed by the development project. It will be submitted to the Government of Nepal for approval. Rule 93 mention about the compensation cost and deposit on FDF Rule 94: only following deposit of cost to FDF can the forest department undergo agreement with project proponent. Rule 102 has provision of removing trees for approved projects or those projects which hold own RoW including highway from GoN before activation of Forest Act 1992. The compensation cost for removed trees must be deposited into the FDF.
Environment Protection Rules, 2077 BS (2020 AD)	Rules 3 to 13 have detailed step-by-step procedures to be followed when conducting a brief environmental study or preliminary environmental test or EIA, process to be followed during the preparation and approval of ToR for BES, IEE and Scoping and ToR for EIA, and the preparation of BES, IEE or EIA reports for proposed project. zoning documents, agenda, public consultation and hearing, and environmental monitoring. The environmental law empowers relevant ministries to monitor environmental activities and adopt mitigation measures, while empowering the MoFE to conduct environmental audits. The environmental impact of proposals mentioned in schedule-3 of this rule should be evaluated. MoFE has been authorized to approve the final EIA report for this project. This regulation lists various types of development activities that require a preliminary EA or environmental impact assessment study. Along with these rules, it also provides a draft outline for work schedule, preliminary EIA and EIA report.

	It also includes provisions for prevention and control of pollution; description of the functions, duties, and powers of Environmental Inspectors; conservation of national endowments; establishment of environmental laboratories; mechanisms for operating the environmental conservation fund; rights to environmental compensation; and other related matters
Plant Protection Regulation, 2080 (2023)	The Plant Protection Regulation, 2080 (2023) of Nepal incorporates several environmental provisions aimed at safeguarding plant health and biodiversity. Key measures include conducting pest risk analyses to identify regulated pests (Section 17), allowing the declaration of quarantine pest-affected areas (Section 19), and implementing control measures such as treatment, destruction of infested materials, and movement restrictions within these areas (Section 20). The regulation also mandates regular monitoring of quarantine pest-affected areas, with provisions to cancel such declarations once pests are controlled (Section 21). These provisions collectively aim to prevent the introduction and spread of harmful pests, thereby protecting Nepal's agricultural resources and natural ecosystems.
Conservation Area Management Regulations, 2053	The concerned conservation officer shall constitute a conservation area management committee within the Conservation Area for the effective implementation of the construction works related to the community development activities in the Conservation Area, protection of the natural environment of that area and management program related to the balanced utilization of natural heritage.
Vehicle and Transportation Management Regulation, 1998	The Vehicle Transport Management Rules, 1998 include several important provisions aimed at ensuring vehicle standards and safety. These regulations specify the standard dimensions for public vehicles, along with detailed requirements regarding the number of seats, vehicle height and width, and the inclusion of folding seat mechanisms. To enhance passenger safety, the rules mandate the installation of fire extinguishers and emergency exit doors in public transport vehicles. Additionally, vehicles must be insured and equipped with first aid kits. The rules also require that all door and window locks be in proper working condition and that shock absorbers be well-maintained. Speed limits and axle load limits are strictly enforced to promote road safety and prevent vehicle overloading. Furthermore, for long-distance routes, there must be provisions for driver changes and adequate rest or refreshment opportunities to reduce fatigue and ensure safe driving practices.
Labor Rules, 2075 BS (2018 AD)	According to Rule 16 (1) of Labor Rules, 2075, employers shall determine working time in the establishment based on the nature of the work of establishment and inform all workers about it. In accordance with rule 34 (1) of this regulation, except as written elsewhere in this regulation, when the employer makes a policy related to safety and health of workers and other persons working at the workplace, safety precautions to be adopted at the workplace according to nature of work of

	establishment, health of workers, possible accidents that may occur at the workplace, machinery and equipment at the workplace.
Solid Waste Management Rules, 2070 BS (2013 AD)	Rules 3, 5 and 7 have made provisions related to waste separation and management, harmful or chemical waste disposal and management, and waste transportation. According to rule 3 (1) of this regulation, the local body shall, at least in accordance with Section 6 of the Act, specify that organic and inorganic waste that should be separated at the source, and harmful or chemical waste should be separated and managed separately. If it is specified in this way, the person, organization, or agency that produces waste should separate it accordingly. Rule 4 talks about discharge of solid waste and as per rule 5 (1) of this regulation, harmful, chemical, biological or inorganic waste should not be mixed with other waste.
Buffer Zone Management Regulation, 2052 BS (1996 AD)	This Regulation prohibits the following activities without permission from the Warden: (i) squatting, (ii) cutting of trees, clear forest or cultivate forestland, (iii) any activity that could damage forest resources like setting fire, (iv) excavating stone, earth, sand, (v) use of harmful poison or explosive substances into the river, stream or source of water flowing in the buffer zone, and (vi) hunting or any activity damaging to wildlife.
Child Labor (Prohibition and Regulation) Rules, 2062 BS (2006 AD)	This Rule was framed in exercise of powers conferred by section 27 of the Child Labor (Prohibition and Regulation) Act, 2056. Before, employing a child as a Labor an application will be filed in the Labor office to examine his /her health in relation to his/her ability and inability to do the work, mentioning about the nature of the work and the age of the child. A child working in an Enterprise will get the monthly remuneration and allowance not less than prescribed by the Government of Nepal by publishing a notice in Nepal Gazette from time to time. A child working in an Enterprise will get at least Thirteen days public holiday with full salary each year. A child who goes to school will get Ten days educational leave during the annual examination in a year.
National Park and wildlife Conservation Regulation, 2030 BS (1974 AD)	According to Rule 3, maintenance work can be carried out without changing the basic structure of the religious, historical, cultural or archaeological sites within the National Park, Wildlife Reserve, Conservation Area or Buffer Zone area and various arrangements have been made for this. Similarly, according to Rule 4, entry into regulated nature reserves is prohibited without obtaining written permission. Rule 5 provides that females (animal) with pregnant or young children should not be hunted during hunting hours and at night. Rule 22 stipulates that permission should be obtained for catching or hunting any wild animals or birds for scientific research or for harvesting any insect, insect, fish or any natural product.
Chitwan National Park Rules, 2030 BS (1974 AD)	Rule 6: states about the prohibited activities within the CNP; Rule 9: states about the Prohibition of hunting and moving or destroying the nest of bird; Rule 11: states about the Prior Approval of the Government of Nepal to be obtained; Rule 14: states about the Prohibition on throwing waste; Rule 18: states about the Prohibition

	of Traffic (Travel). Except in the hotel, lodge or prescribed place for the camp, no person shall be allowed to enter or walk within the park, since the sunset (evening) to the sunrise (dawn) without the written permission of the warden.
Soil and Watershed Protection Rules, 1982	For purposes of works mentioned in Section 4 of the Act for land and watershed protection in the protected watershed area in accordance with Rule 4(1) using the authority given by Section 25 of the Act, the watershed protection officer shall clearly classify the land within the protected watershed area including boundaries, area and activities to be done on such land. Rule 12 (1) mentions that the Officer may prohibit any work that may cause soil erosion or soil erosion on the land where any work is carried out under Section 4 of the Act and on the land surrounding such land.
Guidelines and Manuals	
Procedure for availing land for Construction of Physical Structures in Conserved area - 2080	Land for construction within the protected/conservation or buffer zone area will be availed to projects approved by the concerned ministries and those of National Priority. Effort should be made, if at all possible, to avoid aligning the project through such conservation areas. In case if there are no other alternatives, effort should be made to ensure use of possibly minimal land. Concerned Conservation area should be informed and coordinated to be involved in the study, project activities and for which a prior permission should be acquired from the concerned ministry/department. If the requested area, is specified (by the conservation area office) to be highly sensitive wildlife habitat of Endangered floral or faunal species (that means a Prime wildlife habitat of Endangered/protected species, a Ramsar site, a Religious/cultural site, scientifically important area or others), the Department may request for a re-study (Feasibility study, Environmental study or alignment survey or all of them) of the project area. Request for conservation area for construction and operation of physical structures can be made with a request letter (concerned ministry) together with a DPR report, Approved Environment Impact report and others. A detailed map of its location, Area, GPS coordinate of four corners of the area specified, number of trees (greater than 5 inches circumferences at breast height), consent letter from the concerned local management council/office, details of impacts on natural resources, and a letter of removal of trees from concerned GON office. The GON will sign an agreement (renewable periodic agreement) with the project, regarding the use details of the land and obligations of both the parties. Other than the National Priority Project, the project will have to pay for the land being used. After the agreement, the conservation office will provide a detailed information on trees with Tancha/tagged and detailed enumeration to the Department for approval so that the conservation office can provide a cutting permit. The project will harvest, assemble and haul all the marked trees to a specified log yard, under the

	supervision of the official specified, and handover the harvested tree/forest product to the conservation office. The forest product from the conservation area will be oxen as per available regulation. Regarding the trees from the buffer zone forests, the trees will be handed over to the local forest management group free of cost. A compensatory plantation, at a ratio of 1:10 will be carried by the project in the location specified by the conservation officer. The plantation will be reared for 5 years before being handed over to the local forest management entity /group. In case if the project is unable to raise the plantation, the project will pay the GON, an estimated amount as per the Government Standard Norms. A five-member committee will be formed to monitor the progress of the project, to evaluate the comments received, to evaluate following of legal contract by both the parties, to evaluate activities carried to minimize the impacts on biodiversity, environment, etc., once in two years and reported to the department.
Directive for Wildlife Friendly Infrastructure Development, 2078 BS (2022 AD)	The minimum size of the underpass for different types of wildlife will be as prescribed in Directives for Wildlife Friendly Infrastructure Development, 2078. This Directive classified the underpass size as per classification of very large, large, medium, and small Wildlife. The size of underpass structure is given as per road width.
Guideline on Hydrologic and Hydraulic Analysis and River Training Works for Bridge Design, 2022 AD	This guideline is based on the latest IRC codes with added methodologies and explanations wherever necessary. It aims to address the hydrological dilemmas in the bridge design with proper explanations and calculations. This guideline has covered the topics of determination of design discharge, high flood level, scour estimation and river training works. This guideline describes the design discharge shall be increased by 10% in case the river reach is subject to enormous quantity of sediment transport. Most of the climate change models project increase in rainfall during monsoon in Nepal. The design discharge shall be increased by 10% to consider the impact of climate change in flood.
MoPIT's GESI: Gender Equality and Social Inclusion Guideline, 2074 BS (2017 AD)	An institutional arrangement has been established for GESI implementation from Ministry Level to Regional, Division/Sub-divisional offices. At the departmental level, Geo-environment and social unit (GESU) has been responsible for the implementation and overseeing of GESI-related activities. This unit has comprised a sociologist designated as the GESI focal point with GESI responsibilities.
ADB Environmental Assessment Guidelines, 2003 AD	These Guidelines describe how to fulfil the requirements outlined in ADB's Environment Policy and the Operations Manual on Environmental considerations in ADB' project operations. Information on ADB's policies and procedures for conducting and reporting on the environmental assessment is also provided for all types of Projects. Strategic tools such as country environmental analysis and strategic environmental assessment are also included.
Environmental	This guideline assists to integrate environmental consideration in each phase of the

Management Guidelines, (Road), 2056 BS (1999 AD)	project cycle. The guideline consists of environmental mitigation measures to be incorporated into Road projects, procedures for public participation, and socio-economic consideration.
Working policy on construction and operation of physical infrastructure inside protected area, 2065 BS (2008 AD)	The working policy mentions that the land of protected area and its buffer zone shall be provided exclusively for the projects with national priority. Government of Nepal, (Ministerial Council) shall decide whether the project is National Priority Project or not. The policy states that the tax for the forest products like soil, sand, gravel, boulders etc. need to be paid to the respective Protect Area office as per the rate declared by Forest Regulation. The policy requires monitoring from the representative from the respective protected area office to conduct any Construction related works.
Forest Products Collection, Sale and Distribution Guidelines 2073 BS	The guidelines specify various procedure and formats for getting approval for vegetation clearance, delineation of lands for vegetation clearance, evaluation of wood volume, etc.
Environmental and Social Management Framework (ESMF), 2023	The Environmental and Social Management Framework (ESMF), 2023 developed by Nepal's Department of Roads (DoR) provides a comprehensive strategy to integrate environmental and social considerations into all phases of road infrastructure projects. It outlines a systematic approach encompassing project screening, impact assessment, mitigation planning, implementation, and monitoring. The ESMF mandates the identification of potential environmental and social impacts, including those related to land acquisition, biodiversity loss, and community displacement, and prescribes measures to mitigate these effects. It emphasizes stakeholder engagement, particularly involving vulnerable groups, to ensure inclusive decision-making. The framework aligns with national legislation and international best practices, aiming to promote sustainable and socially responsible road development across Nepal.
Roadside bio-engineering handbook 2002	This reference manual on bio-engineering works along roads, gives comprehensive information on the use of vegetation in engineering. In addition to covering the principles underlying techniques of slope stabilization, the manual also outlines those aspects of the ecology, geology, geography and law of Nepal that would be of relevance. The manual provides standard specifications for bio-engineering works, profiles of the main bio-engineering species and rate analysis norms of bioengineering approved by the Government. The manual provides the information needed to design, plan, implement and maintain roadside bio-engineering works and is intended for use in the site.
National EIA guidelines 1993	It is mandatory to follow the National EIA Guidelines, 2050 (1993) during the EIA. Following the guidelines, the environmental impact prediction and evaluation of the proposed project has been done on physical, biological and socio-economic and cultural environment of the project area. The guideline is used for analysis of

	significant issues. The schedules attached to the Guidelines include: Schedule 1 : Projects requiring IEE Report Schedule 2 : Projects requiring EIA Schedule 3 : EIA based on project sites Schedule 4 : Format for Terms of Reference Schedule 5 : EIA Report Format Schedule 6 : Format of EIA Report Annexes
Community Forest Guidelines, 2058 BS	Through this guideline, persons involved in the development and management of community forest like facilitators, user groups, forester and managers etc. will get help to understand about the process and stages of development of community forest. Forest Users Group, forest officials, NGOs and INGOs are getting benefit by this guideline.
Occupational Health and Safety Guideline for Road Infrastructure Development and management, 2023 (Departmental Guideline)	In order to facilitate implementation of occupational health and safety policy for road infrastructure development and management, 2080, DoR has produced directives encompassing hazard identification, risk assessment and management, emergency procedures, welfare amenities, and occupational health oversight across a spectrum of infrastructure endeavors. Strict compliance with these directives is paramount to guaranteeing robust occupational health and safety protocols within DoR undertakings
Environmental Standards	
Standard on Extraction, Sale and Management of Stone, Gravel and Sand from Chure Area, 2077 BS (2020 AD)	The standard aims to determine practical procedures to be adopted by rural municipalities and municipalities in exercising the power to sell stones, pebbles, sand and soil. As per the standard, local levels shall extract and collect river and mine-based products from the areas as specified in the approved environmental study report. The standard stipulates a provision for designating certain areas to operate mine and crusher industries. "A local unit shall prepare an environmental study report and get it approved by the concerned village or municipal executive body for extraction, collection and sale of river and mine based products. They may award a contract to registered companies or organizations to carry out these tasks at the rate approved by the executive body. The standard prohibits extraction and collection of river and mine-based products in an area two kilometers from dense settlement and forest. No local level shall carry out such work in river areas within areas 500metres from the highway and one kilometer from motorable bridge and suspension bridge. The standard prohibits extraction and collection of stones, pebbles and sand from the Chure region. However, stones, pebbles and sand deposited within the Chure region due to flood may be collected as per the decision of the concerned district disaster management committee.
Nepal Road Standard, 2070 BS (2014 AD)	Nepal Road Standards-2014, applies to all Strategic Roads in rural areas being constructed within Nepal. Based on this standard, standard designs for roads and bridges including typical drawings were prepared.
National Ambient Air Quality Standard, 2069 BS (2012 AD)	The new National Ambient Air Quality Standard (NAAQS) 2012 that came into effect requires effective monitoring and collection of eight-hour and 24-hour samples of air pollutants like Total Suspended Particulates (TSP), Particulate

	Matter (PM ₁₀ and PM _{2.5}), carbon monoxide, lead and ozone levels for at least 347 days out of a 365-day year. The NAAQS further states that no particular place should fail to monitor air samples for two consecutive days. TSP consists of solid and liquid particles in the air that are harmful to health while PM ₁₀ is an air particle with a volume less than 10 micron that can easily enter into the end of the respiratory tract and cause serious health impacts. Both TSP and PM ₁₀ are considered major air pollutants.
National Standard about Noise Level, 2013 (2069 BS)	The National Noise Standard 2012 that came into effect as per the rule 15 of Nepal Government Environmental Protection Regulation that requires effective monitoring and collection of Daytime and Night-time noise level permitted limits.
Nepal Vehicle Mass Emission Standard, 2069 BS (2012 AD)	As per the EPR 2054 Rule 15, Government of Nepal has prescribed different National standards for emissions from vehicles. There are limit values for emission of harmful gases from vehicles as mentioned in the standards.
Nepal Bridge Standard, 2067 BS (2011 AD)	Department of Roads (DoR) has formulated these standards with a view to establish a common procedure for design and construction of road bridges in Nepal. All permanent bridges will be designed for a design life of a minimum of 50 years. Traffic projections will be made for a period of 30 years and designed for a design discharge of 100 years return period.
National Drinking Water Quality Standards, 2022	Major tasks during monitoring to be performed by water supplier are cited as follows: Controlling regularly the quality to ascertain that the water supplied complies with the NDWQS; Periodic monitoring of all the components of the water supply system from the perspective of sanitation and risk to health; Proper supervision, inspection and maintenance as part of operation of the water supply systems; Development of necessary infrastructure like water quality testing laboratory and quality control. Following factors to be considered while monitoring: Type and quality of water sources i.e. surface water, springs, dug-wells, shallow wells, deep wells; Type and size of the water supply system (pipe system, treatment facilities); Local environmental settings (physical infrastructure, geography, etc.); Sanitation and hygienic condition surrounding the water supply system; Socio-economic environment at the local level; Site specific conditions for complying with the standards; User's opinion and suggestions regarding water quality; Health and Hygiene Information (information on water related diseases) and quality of water sources i.e. surface water, springs, dug-wells, willow wells, deep wells; Type and size of the water supply system (pipe system, treatment facilities); Local environmental settings (physical infrastructure, geography, etc.); Sanitation and hygienic condition surrounding the water supply system; Socio-economic environment at the local level; Site specific conditions for complying with the standards; User's opinion and suggestions regarding water quality; Health and

	Hygiene Information (information on water related diseases).
Procedures and Criteria to be followed for Development Works in Chure Conservation Area 2077 BS	The document outlines the procedures and standards to be followed during development and construction activities in the Chure Conservation Area. It emphasizes minimizing environmental degradation, especially to fragile ecosystems, through proper planning, land use regulation, and adherence to environmental impact assessment procedures. The procedures emphasize conservation-friendly construction methods, risk on sensitive development planning, and to be coordinated among various stakeholders including government bodies, local communities, and technical experts. Special focus is given to preventing deforestation, soil erosion, landslides, and the disruption of natural water systems to maintain ecological balance and sustainable development in the region.
International Conventions and Treaties	
Convention on International Trade in Endangered Species of Wild Fauna and Flora, 1973 AD	Nepal became party to CITES in 1975. CITES has facilitated international co-operation to regulate international trade in endangered wild flora and fauna with the aim of reducing or eliminating trade in species whose numbers or conditions suggest that further removal from their natural habitat would lead to their extinction. The National Parks and Wildlife Conservation (NPWC) Act, 1973 regulates the trade of species listed in CITES appendices. The Government has designated the Natural History Museum (Tribhuvan University) and the Department of Plant Resources as the scientific authorities for wild fauna and wild flora respectively. Similarly, the Government has designated the Department of National Parks and Wildlife Conservation and the Department of Forest and Soil Conservation as the management authorities for wild fauna and flora. The convention urges parties not to allow trade in specimens of species included in the CITES Appendices I, II and III except in accordance with the provisions of the convention.
ILO Convention on Indigenous and Tribal Peoples, 1989	ILO Convention No.169 highlights the need to recognize indigenous and tribal people's specific knowledge, skills, and technologies as the basis for their traditional economies and self-determined development process. Article-1 of the convention provides definition of the tribal and indigenous people. In Article 15, the rights of the peoples concerned to the natural resources pertaining to their lands will be specifically safeguarded. The uses of the term lands include the concept of territories, which covers the total environments of the areas that the peoples concerned occupy or otherwise use. The people concerned will wherever possible participate in the benefits of such activities and will receive fair compensation for any damages which they may sustain because of such activities. Article 16 (2) clearly mention that where the relocation of these peoples is considered necessary as an exceptional measure such relocation will take place only with their free and

	informed consent.
United Nations Framework Convention on Climate Change 1992	As per the convention the reduction/limitation requirements of Green House Gases (GHG) apply only to developed countries. The only reporting obligation for developing countries relates to the construction of a GHG inventory (GHG sources and sinks, potential vulnerability to climate change, adaptation measures and other steps being taken to address climate change). Nepal ratified the protocol on September 16, 2005 and became the signatory of the protocol on 14 December, 2005. Nepal is categorized as non-annex countries. Hence the country is not obliged to set a reduction target like the Annex I countries and it can only participate in the Clean Development Mechanism (CDM) of the protocol. However, Nepal can raise its voice to receive resources for adaptation and mitigation through the Conference of Parties, as individual country or via group of countries.
Kyoto Protocol, 1997	The Kyoto Protocol operationalizes the United Nations Framework Convention on Climate Change by committing industrialized countries and economies in transition to limit and reduce greenhouse gases (GHG) emissions in accordance with agreed individual targets. The Convention itself only asks those countries to adopt policies and measures on mitigation and to report periodically.
Ramsar Convention on Wetlands, 1971	The Convention on Wetlands, signed in Ramsar, Iran, in 1971, is an inter-governmental treaty, which provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources. The convention entered into force in Nepal on 17 April 1988. Nepal currently has 10 sites designated as Wetlands of International Importance (Ramsar Sites). Out of 10 designated wetlands of International Importance in Nepal, none of them is located in project influence area.
Convention on Biological Diversity, 2049	Nepal signed the convention on Biological Diversity on June 12, 1992 in Rio de Janeiro. The convention provides a broader framework on the need for carrying out EIA to minimize adverse impacts of the projects and programs on biodiversity. The Article 14 of the convention provides for the impact assessment and minimizes the adverse impact. In broader sense, it calls upon the Parties to introduce appropriate procedures for EIA and ensure public participation, exchange information and consult on adverse effects on biodiversity of other states, notify immediately to other states in case of danger or damages to the biodiversity and initiate action to prevent or minimize such damages.

5 EXISTING ENVIRONMENTAL CONDITION

5.1 Physical Environment

5.1.1 Topography

The road passes through Bara, Makawanpur and Chitwan district of Madhesh and Bagmati Province of Nepal. The alignment starts at Pathalaiya intersection and ends at Gondrang (Bharatpur). The elevation of alignment ranges from 178 m amsl (Pathalaiya) to 688 m amsl (Churiyamai) and elevation of end point (Gondrang) is 204.793m amsl. 19.5 km of road section lies in Bara district, 50.12 km lies in Makawanpur district and 30.02 km lies in Chitwan district. The road alignment passes through Terai, Siwalik and Dun valley. There is found slope instability in Siwalik area and bank cutting along the Amlekhgunj, Churiya mai area, Karra river, Rapti river, Manahari river, Lothar river. Topographic Map of the project area is attached in Annex III.

Pathlaiya to Hetauda: This section lies in Terai Plains to Siwalik: characterized by flat and fertile plains, from Amlekhgunj gently rise toward the Siwalik hill. This section crosses significant geological structures, including the Himalayan Front Thrust and Central Churia Thrust, indicating complex tectonic activity. The alignment passes through areas with varying slope stability, with approximately 60-75% of the road length considered stable, 20-30% fair, 5-15% weak, and 2-5% critical.

Hetauda to Narayanghat: Traversing an Inner Terai in southern Nepal, the alignment crosses the East Rapti River near Hetauda, continuing toward west along the Dun valley, characterized by flat to gently sloping terrain. Elevation is 200–300 meters above sea level.

5.1.2 Land Use Pattern

Land use pattern within 50 m Right of Way (RoW) of the road alignment and adjacent of RoW was studied through cadastral, topographic maps and walkthrough survey and analyzed. The major land use of the project area included settlements, agricultural land, forest areas and water bodies/river. There is no required additional forest land, agricultural land or private land beyond RoW. The ownership of RoW's land has already been transferred to GoN/MoPIT (Annex X) with exception at Hetauda Bazaar. Proposed design of formation width of road is 50 m at urban area, 37.4 m at semi-urban area and 24 m at rural and forest area. Figure 23 illustrates the land use patter of the PHN road section.

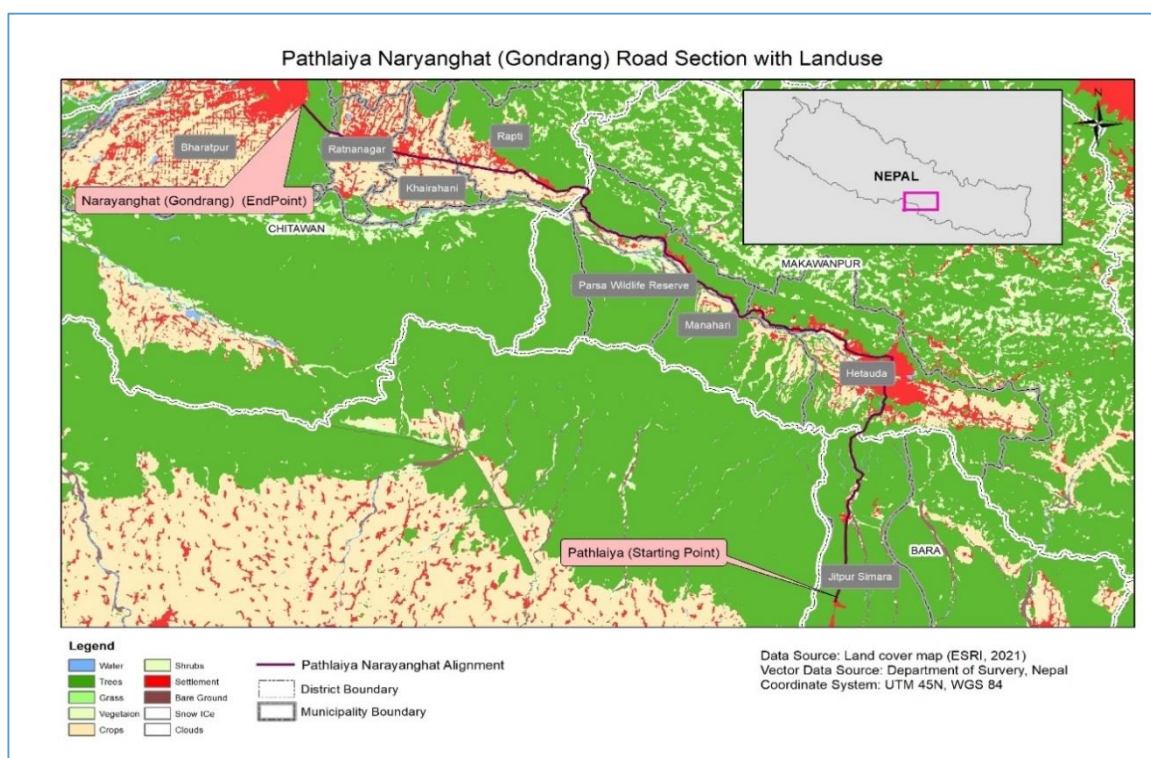


Figure 24: Land use pattern of project area

During upgrading of this road, RoW land approximately 245.64 ha land use pattern will be changed into asphalt road. Agriculture and settlement is the predominant landuse 187.56 ha (76.3%) of the Project alignment followed by 54.35 ha (22.1%) ha forests and barren land, and Rivers and others 3.73 ha (1.6%) ha (Total 245.64 ha). The summary of land use pattern of the road section is illustrated in table below. The detail chainage wise land use pattern of the land adjacent to the RoW of road section is given in Annex IV-H.

Table 29: Land Use Pattern of RoW of PHN Road

Description of RoW Land	Area covered by Existing Road Width, Ha	Area Covered by 50m ROW excluding existing road width, Ha	Area required as per Design width, Ha	%
Cover by Forest and Barren Land	30.74	142.89	54.35	22.12
Cover by Agriculture Land and Settlement	64.43	254.28	187.56	76.36
Others (Rivers etc)	1.31	5.97	3.73	1.52
Total	96.47	403.13	245.64	100.00

Source: Field Survey, 2024, and Design Report of PHN 2025

5.1.3 5.1.3 Geology and Soil

PHN road lies in Upper Terai, Siwalik and Hetauda-Chitwan Dun valley. Approximately 37 % of the road segments lying in the Upper Terai plain are comprised of dominantly coarse-grained sediments. These sediments represent the proximal alluvial fan of south flowing rivers from the hinterland area, which are characterized by well graded boulders, cobbles, and pebbles with sands, silts and clay.

More than 40% of PHN road section lies in Siwalik (Table below). Conglomerates, sandstones, siltstones, and mudstones are found in the Siwalik (Chure) mountains. Normally the rock in the Siwalik group is divided according to sediment sizes and their proportion in to lower, middle and upper Siwalik. The lower Siwalik is predominantly consisting of very fine to medium grain sized rocks i.e. fine to medium grained sandstones, siltstones and mudstones, while the middle Siwalik is rather consisting of coarser grained rocks. From Hetauda bazaar to the west, the road passes through the lower Siwalik. Dun Valley is filled by river transported sediments consisting of sub-rounded to rounded boulder to pebble size clasts with sands and silt. These sediments are found unconsolidated to semi-consolidated.

Table 30: Geomorphological Sub-division of the Project Area

Name of road section	Geomorphological sub-division	Chainage	
		From	To
Pathalaiya – Hetauda-Narayanghat	Upper Terai	367+800.000	376+800.000
		440+100.000	467+400.000
	Lower Siwalik	376+800.000	378+100.000
		397+500.000	440+100.000
	Middle Siwalik	378+100.000	383+100.000
	Upper Siwalik	383+100.000	392+300.000
	Dun Valley	392+300.000	397+500.000

Source: Field Survey, 2022

There are two major thrust faults passes through the road namely Himalayan Frontal Thrust (HFT) and Central Churia Thrust/Main Dun Thrust. The Himalayan Frontal Thrust is mapped at the junction between the Terai plain and the Siwalik hills at Amlekhgunj area. Central Churia Thrust/Main Dun Thrust is developed by thrusting of lower Siwalik rocks over the upper Siwalik rocks at around Ch 391+200 at Ratmate area. It is an active thrust fault; therefore, need to pay attention while widening the road and construction of major structure.

5.1.4 Regional Geology

Geologically, the road alignment passes through Upper Terai plain, Lower, Middle and Siwalik and Dun Valley. Brief regional geology of the studied road segments is described below:

In the regional geological scale of the surveyed area, particularly around the mountainous part i.e., Chure range is composed of coarse- to fine-grained sandstones, siltstones and mudstones, while the Terai plain consists of river sediments comprising of gravels, sands, silts and muds. The road alignment lies in the Terai plain, Siwalik range and Dun valley that are composed of river deposits (Figure 24).

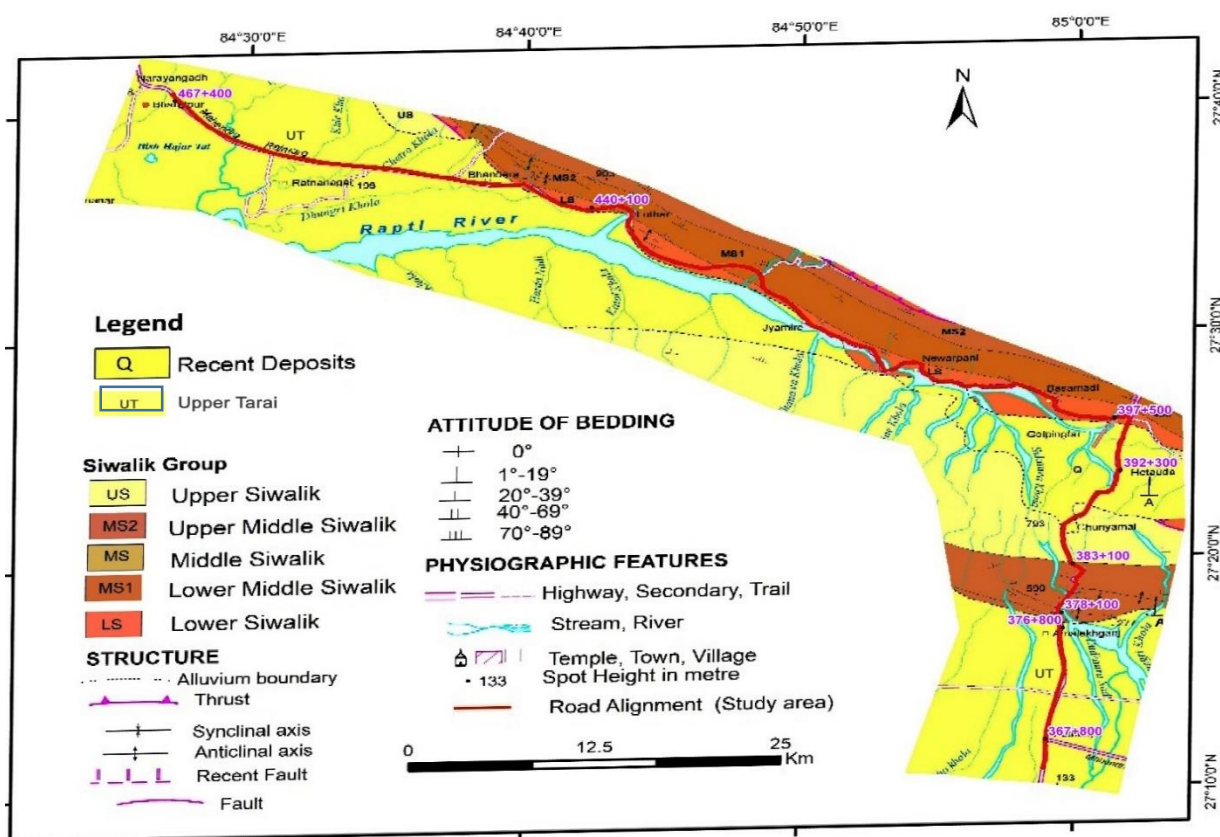


Figure 25: Regional Geological Map of the Project Area (modified after DMG)

Sediments of Terai plain: The northern plain area of the Terai situated at a distance of about 10-15 km from the mountain front to south is comprised by dominantly coarser sediments. The road segments lying in the Upper Terai plain is comprised by dominantly coarse-grained sediments like gravels and coarse sands. These sediments represent the proximal alluvial fan of south flowing rivers debouched from the hinterland area, which are characterized by well graded boulders, cobbles, pebbles and minor number of sands and muds (silts and clay).

Towards southern part from the Upper Terai, sediments are composed dominantly of rather finer grained like sands, silt and clay with small gravel size rock fragments. Gravels are sub-rounded to well-rounded and size decreases as the distance from the mountain front increases to the southern plain area. To the upper part of the deposit, soil horizons are developed due to pedogenesis that produced several horizon consisting of organic matter, fine silty sands, and clays and partially altered recent sediments. These sediments constitute the area of Middle Terai (Figure 25).

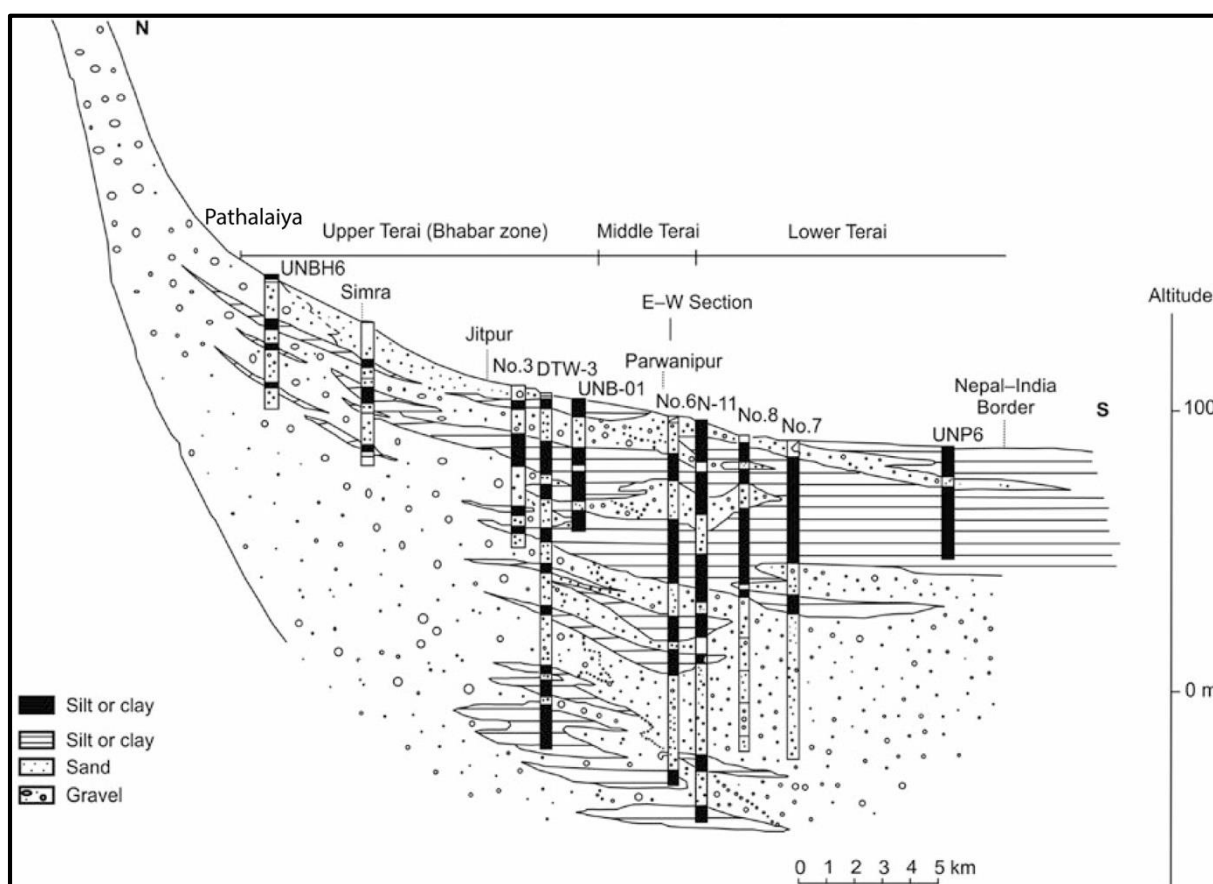


Figure 26: Typical Geological cross-section of Terai plain showing Upper Terai, Middle Terai and Lower Terai with a large vertical exaggeration of scale (modified from Dhital, 2015)

Siwalik Group: The road section partly lies in Siwalik range (Siwalik Group). Terai plain and Siwalik Group are separated by Himalayan Frontal Thrust (HFT). It is an active thrust fault located at the front of the mountain range. To the northern part of Amlekhganj bazaar the HFT runs in east-west direction and has transported Siwalik rocks over the Upper Terai sediments. It has developed a nick point on the Highway section (Figure 25). Rocks in the Chure (Siwalik) mountains are comprised by conglomerates, sandstones, siltstones, and mudstones. Conglomerates are comprised by pebble to boulder size rock clasts. These are matrix supported (predominant fines) to clast supported (predominant coarse grained) and most of the clasts are sub-rounded to well-rounded. Normally the rock unit in the Siwalik Group is divided according to sediment sizes and their proportion in to lower, middle and upper Siwalik. The lower Siwalik is predominantly consisting of very fine to medium

grain sized rocks i.e. fine to medium grained sandstones, siltstones and mudstones, while the middle Siwalik is rather consisting of coarser grained rocks. From Hetauda Bazar to the west, the Highway passes through the lower Siwalik.

Middle Siwalik is further sub-divided into lower middle Siwalik (Ms1), and upper middle Siwalik (Ms2). Ms1 is composed of fine to coarse-grained sandstones alternating with thick layer of mudstones. Because of cementation by calcium carbonate in sandstone, these are compact and very hard, while the mudstones are poorly cemented and fragile than sandstones. Ms2 are consisting pebbly conglomerates, coarse to very coarse-grained sandstones and mudstones. Pebbly conglomeratic layers are lying at the base of very coarse-grained sandstones. Small coal lenses are also sometimes encountered within the sandstone beds. The road sector to the north of Amlekhganj Bazaar passes through the rocks of Ms2, however, river terrace deposits mostly have covered the rocks of Siwalik in the area. The upper Siwalik is consisting of pebble to boulder size conglomerate, coarse to very coarse-grained sandstones with mudstones. Mudstones are less consolidated than that observed in middle and lower Siwalik. The segment of East-West Highway is lying within the upper Siwalik zone in Churia Mai area. Lower Siwalik rocks are tectonically transported over the upper Siwalik rocks by Central Churia Thrust (CCT)/Main Dun Thrust (MDT). The Highway passes through the thrusting zone in Ratmate area (Figure 27).

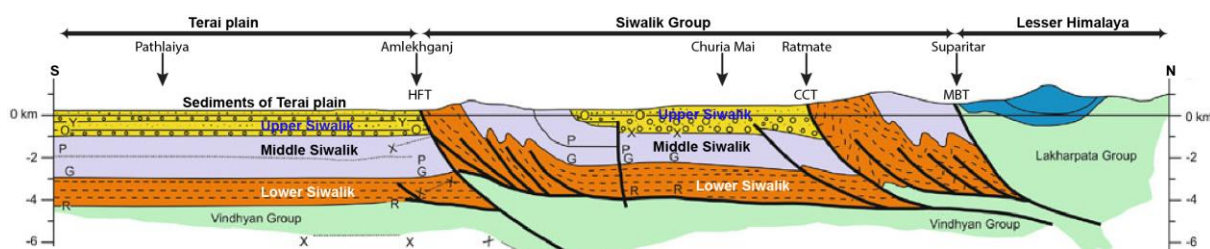


Figure 27: Geological cross-section across Siwalik Group showing major geological structures Himalayan Frontal Thrust (HFT), Central Churia Thrust (CCT) and Main Boundary Thrust (MBT) with names of major bazar (modified from Dhital, 2015)

Dun Valley: Hetauda-Chitwan Dun valley is filled by river transported sediments consisting of sub-rounded to rounded boulder to pebble size clasts with sands and silt. These sediments are unconsolidated to semi-consolidated. Western part of the Dun valley along the Highway strip is composed of dominantly fine-grained sediments, while in the eastern part sediments are rather coarser like boulders to pebble size rock clasts, coarse sands and silt.

Lesser Himalaya: The Lesser Himalayan rocks are composed of sedimentary to metamorphosed rocks which are transported in the Highway area by Midland rivers. These rocks are not exposed along the East-West Highway.

Major Geological Structures: Tectonic structures are important to delineate for the East-West Highway widening project in order to understand its role on the slope instability along the alignment.

There are two major thrust faults namely Himalayan Frontal Thrust (HFT) and Central Churia Thrust/Main Dun Thrust. The Himalayan Frontal Thrust is mapped at the junction between the Terai plain and the Siwalik hills in Amlekhganj area. The rocks of the Siwalik group are overridden to the modern alluvial fan sediments deposited by the south flowing Dudhaura Khola that debouched from the Siwalik Mountain to the Terai plain area. The Himalayan Frontal Thrust is a very active thrust in the Himalaya. Therefore, attention has to be given for the structures passing across the thrust around the Ch 376+800. Central Churia Thrust/Main Dun Thrust is developed by thrusting of lower Siwalik rocks over the upper Siwalik rocks at around Ch 391+200 in Ratmate areas.

5.1.5 Bridge Site Geology

There are small and major bridges along the road. The geology of the bridge sites is described in Table below.

Table 31: Geological characteristics along the bridge sites from PHN

Chainage (Ch)	Bridge Name	Geological and geomorphological characteristics
378+024	Amlekhgunj - 1	Depth to bed rock at foundation and abutment: sediment cover – bedrock exposed. rock at depth- Sandstone and siltstone river flow direction- from North west to Southeast -Nature of bed rock suitable for taking static bridge load and dynamic load during traffic: Sandstone and siltstone Structural disposition: attitude of foliation/- dip dir./amount- 191/70
379+882	Amlekhgunj - 2	Depth to bed rock at foundation and abutment: sediment cover – bedrock exposed. rock at depth- Sandstone and siltstone river flow direction- from North west to Southeast -Nature of bed rock suitable for taking static bridge load and dynamic load during traffic: Sandstone and siltstone Structural disposition: attitude of foliation/- dip dir./amount- 135/11
381+807	Amlekhgunj - 3	Depth to bed rock at foundation and abutment: sediment cover – bedrock exposed. rock at depth- Sandstone river flow direction- from east to Southwest -Nature of bed rock suitable for taking static bridge load and dynamic load during traffic: Sandstone and siltstone -Structural disposition: attitude of foliation/- dip dir./amount- 322/17

Chainage (Ch)	Bridge Name	Geological and geomorphological characteristics
382+184	Amlekhgunj - 4	Depth to bed rock at foundation and abutment: sediment cover – BMS rock at depth- river flow direction- from North east to South west
383+999	Badahakim	Depth to Soil/bed rock at foundation and abutment: sediment cover – Boulder mixed soil (Sand and Gravel) rock at depth – No river flow direction- north to south Fluvial deposits
384+982	Gundo	Depth to Soil/bed rock at foundation and abutment: sediment cover – Boulder mixed soil (Sand and Gravel) rock at depth – No river flow direction- east to west flow Fluvial Sediments
387+653	Churiya	Depth to Soil/bed rock at foundation and abutment: sediment cover – 1-3 m BMS rock at depth – Conglomerate and semi-consolidated sandstone and mudstone river flow direction- North to South flow Straight river near the bridge site area Fluvial sediments at channel
387+943	Pakkipul	Depth to Soil/bed rock at foundation and abutment: sediment cover – Boulder mixed soil (Sand and gravel) rock at depth – No Small Gully
388+144	Sansare	Depth to Soil/bed rock at foundation and abutment: sediment cover – Boulder mixed soil (Sand and gravel) rock at depth – No Small Gully
388+325	Sayafut	Depth to Soil/bed rock at foundation and abutment: sediment cover – Boulder mixed soil (Sand and gravel) rock at depth – sandstone and mudstone Small Gully
394+572	Karra	Depth to Soil/bed rock at foundation and abutment: sediment cover – BMS (Sand) rock at depth- No river flow (Small Gully) direction- flow from North to south
397+510	Rapti	Depth to Soil/bed rock at foundation and abutment:

Chainage (Ch)	Bridge Name	Geological and geomorphological characteristics
		sediment cover –BMS (Sand and Gravel) at left bank and sandstone and siltstone at right bank rock at depth- river flow direction- flow from northeast to southwest
425+497	Manahari	Depth to Soil/bed rock at foundation and abutment: Sediment cover –BMS (Sand, gravel and small boulder) rock at depth- No river flow from Northwest to South Sediment Aggradation
437+230	Lothar	Sediment cover –BMS (Sand, gravel and small boulder) rock at depth- No river flow from North to South Sediment Aggradation
438+525	Lothar Branch	Depth to Soil/bed rock at foundation and abutment: sediment cover – Boulder mixed soil (Sand and Gravel) rock at depth – Sandstone and mudstone small gully Fluvial Sediments
444+270	Martal	Depth to Soil/bed rock at foundation and abutment: sediment cover – Boulder mixed soil (Sand and Gravel) rock at depth – No river flow direction- North to South flow Straight river near the bridge site area Fluvial sediments
449+164	Pampha	Depth to Soil/bed rock at foundation and abutment: sediment cover – BMS (Sand and gravel) rock at depth- No river flow (Small Gully) direction- flow from North to south
455+349	Budhi Rapti	Depth to Soil/bed rock at foundation and abutment: Sediment cover –BMS (Sand and Gravel) rock at depth- No river flow from North to South Meandering River
457+996	Kair	Depth to Soil/bed rock at foundation and abutment: Sediment cover –BMS (Sand and Gravel) rock at depth- No river flow from North to South Meandering River

Chainage (Ch)	Bridge Name	Geological and geomorphological characteristics
459+885	Budhi Khola	Depth to Soil/bed rock at foundation and abutment: sediment cover – Sand and mud
462+521	Khageri – 2	Depth to Soil/bed rock at foundation and abutment: Sediment cover –BMS (Sand and Gravel) rock at depth- No river flow from North to South
462+634	Khageri – I	Depth to Soil/bed rock at foundation and abutment: Sediment cover – Sand and mud

Source: Field Survey, 202; Project Geological Report of 2021

The soil is in general alluvial and fine to medium textured in the project area which is suitable for agriculture. The baseline soil quality was monitored at five locations along the project area. The soil of project area is acidic in nature and suitable for agriculture purpose. Soils are mostly stable, but riverbank erosion is noticed. Riverbank protection is required during construction of bridges.

5.1.6 Natural Hazard Assessment

As the area lies in the Terai plain, Siwalik and Dun valley, which is characterized by warmer climatic weather as well as having low relief along the road section, snow drifts and rock avalanching activities cannot be expected.

There are two major thrust faults passes through the road namely HFT and Central Churia Thrust/Main Dun Thrust. The HFT is mapped at the junction between the Terai plain and the Siwalik hills at Amlekhganj area (around the Ch 376+800). Central Churia Thrust/Main Dun Thrust is developed by thrusting of lower Siwalik rocks over the upper Siwalik rocks at around Ch 391+200 at Ratmate area. It is an active thrust fault and need to pay attention while widening the road and construction of major structure.

HFT is passes near Suparitar and oriented in an east-west direction and lies at the contact between the Churia Group and the Lesser Himalayan sequence.

The project area is prone to riverbank erosion, flooding during monsoon. Mining activities of construction materials from the active channel area triggered channel morphological degradation of Rapti river, Lothar river and Manahari river.

a. Seismic Hazard

Based on the building code and supporting literature, the seismic coefficient for the project area is estimated to range between 0.095g and 0.115g, which should be used for seismic risk assessments. The probability of strong ground motion is particularly high near active fault zones. One such fault runs across the road near the northern boundary of Amlekhganj Bazar, making this area especially

vulnerable. Therefore, special attention must be given to the design and construction of bridges and other critical infrastructure in this vicinity to ensure seismic resilience.

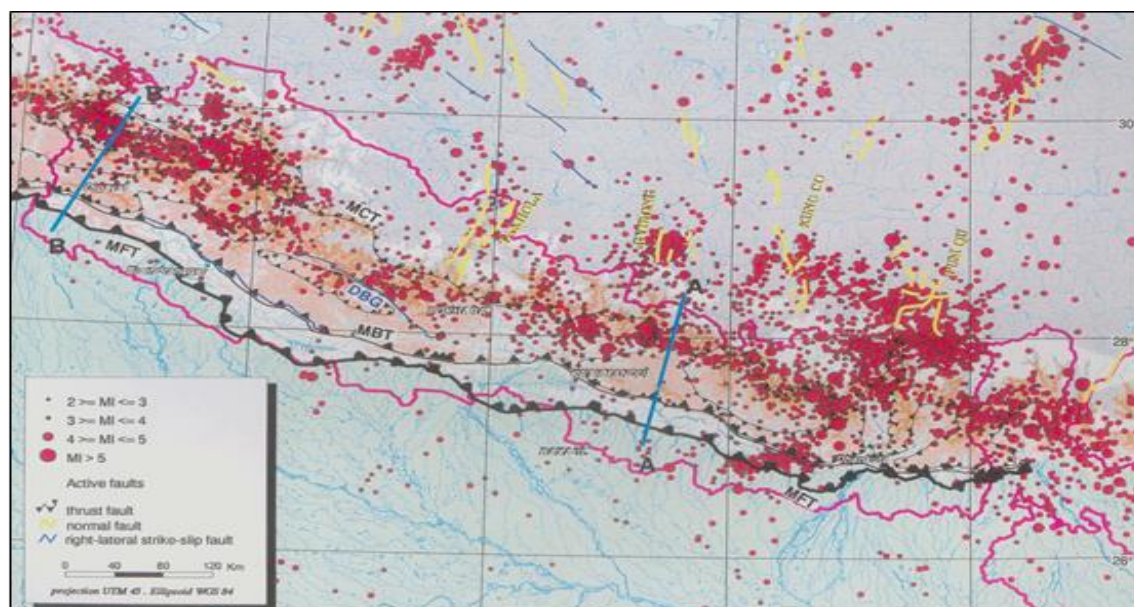


Figure 28: Epicentral distribution map of Nepal showing light to major earthquakes measured by the seismological center of the Department of Mines and Geology, (DMG, 2006)

According to Bajracharya (1994), the Nepal Himalaya has been subdivided into five seismic zones (Zone 1, Zone 2, Zone 3, Zone 4, Zone 5) with relation to the seismic hazard (Low, Moderate and High). The project area falls in the moderate to high (3 to 5) seismic hazard zone. The Peak Gravitational Acceleration (PGA) value in the project area ranges from 0.095g to 0.115g (Figure 28).

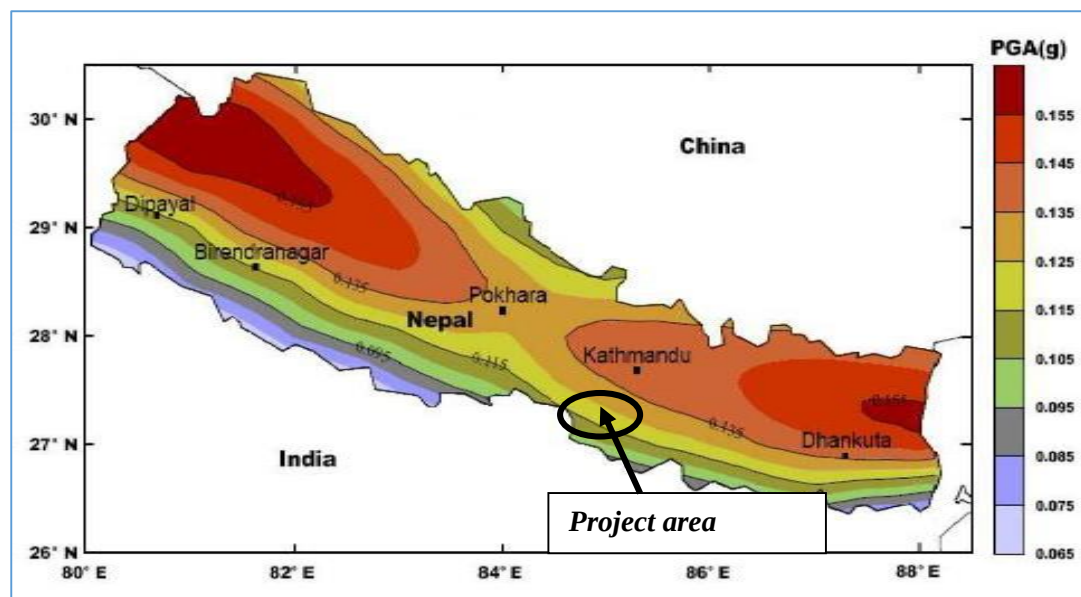


Figure 29: Peak ground acceleration map of Nepal

During bridge design has been considered the seismic risk with active thrust faults.

b. Flood

The area is low risk on flood and inundation. Due to further minimize any potential risk, the size and numbers of cross-drainage structures have been increased. For instance, all pipe culverts have been replaced by box culverts. Bridges are increased from 22 nos to 41 numbers. The flood estimation for drainage structures have considered different parameters. Since bridges have been designed taking 100 years return period, DoR (2017) estimated the design flood discharge passing through the existing bridges using rational formula and were compared with flood discharge estimated using several empirical methods. The highest value has been taken for design (Table below). Cross drainage structures (culverts) have been designed for 50 years return period flood (DoR, 2017). Using rational formula for discharge estimation of cross drains, this study pointed out the necessity of new crossing structures along with replacing existing culverts that are inadequate to pass design discharge. The side drains have been designed for 25 years return period flood.

Table 32: Estimation of floods by different methods for box bridges and adopted in design (Sample)

Chainage	River/Khola	A, km ²	100 Year Design Flood (Q100), m ³ /s					Add 10% for CC	Adopted Method	Remarks
			RFF 2006	DHM 2004	MHSP 1997	PCJ 1996	Adopt			
384+220	Box Bridge	0.0912		3.7	3.8	3.9	3.9	4.3	PCJ	Box
384+719	Box Bridge	0.1605		5.5	5.7	6.3	6.3	6.9	PCJ	Box
385+981	Box Bridge	0.0726		3.1	3.2	3.3	3.3	3.6	PCJ	Box
389+897	Box Bridge	0.5405		13.3	13.7	17.2	17.2	18.9	PCJ	Box
390+749	Box Bridge	1.1052		22.2	23.1	26.2	26.2	28.8	PCJ	Box
391+096	Box Bridge	0.9585		20.1	20.9	23.4	23.4	25.7	PCJ	Box
404+357	Box Bridge	5.869		74.0	78.1	96.2	96.2	105.8	PCJ	Box
405+622	Box Bridge	2.395		38.8	40.6	51.1	51.1	56.2	PCJ	Box
408+081	Box Bridge	5.362		69.4	73.1	90.4	90.4	99.4	PCJ	Box
409+100	Box Bridge	1.976		33.8	35.3	43.7	43.7	48.1	PCJ	Box
427+217	Box Bridge	2.865		44.2	46.3	58.5	58.5	64.4	PCJ	Box
427+982	Box Bridge	1.459		27.2	28.3	33.6	33.6	37.0	PCJ	Box
429+939	Box Bridge	2.645		41.7	43.7	55.1	55.1	60.6	PCJ	Box
431+284	Box Bridge	3.951		55.7	58.5	73.3	73.3	80.6	PCJ	Box
433+167	Box Bridge	2.889		44.4	46.6	58.9	58.9	64.8	PCJ	Box
438+525	Lothar	1.0		20.7	21.5	23.9	23.9	26.3	PCJ	Box
453+377	Box Bridge	19.124		173.3	184.5	218.2	218.2	240.0	PCJ	Box

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The high seismic risk area, faults and thrusts, water hazards (including flash floods), and Chure's fragile geology have all been carefully taken into account while designing of pavement, cross drainages, and other road infrastructure.

5.1.7 Hydrology and Drainage

The drainage network in the project area is represented by rivers and streams. Other water bodies are wetlands, canals, and artificial ponds. 22 rivers and streams (*Kholas and Kholsies*) crossed by the road alignment is presented in the Table below. Rivers are originated from Mahabharat and Siwalik hills. Karra, Rapti, Manahari, Lothar are major river in the project area and these are perennial rivers. However, some rivers have low flows during the dry season. Some small rivers and streams originated from Siwalik hill are prone to flash floods during the monsoon but have no flow rest of the time.

Table 33: River/Stream Crossing of PHN Road Section

SN	Name Of River/Stream	From	To	Length (m) across road crossing	Remarks
1	Amlekhgunj-1	377+991	378+056	65.14	
2	Amlekhgunj-2	379+838	379+925	86.44	
3	Amlekhgunj-3	381+773	381+840	66.44	
4	Amlekhgunj-4	382+147	382+220	72.44	
5	Badahakim	383+983	384+014	31.20	
6	Gundo	384+945	385+018	72.44	
7	Churiya	387+621	387+684	62.44	
8	Pakkipul	387+933	387+952	19.70	
9	Sansare	388+136	388+151	15.70	
10	Sayafut	388+312	388+337	25.70	
11	Karra	394+516	394+627	111.68	
12	Rapti	397+395	397+624	228.90	
13	Manahari	425+376	425+617	240.51	
14	Lothar	437+154	437+305	150.30	
15	Lothar Branch	438+521	438+529	8.00	
16	Martal	444+246	444+293	46.85	
17	Pampha	449+141	449+186	45.42	
18	Laderi	455+314	455+383	68.14	
19	Kair	457+961	458+030	68.14	
20	Budhi Khola	459+876	459+893	16.50	
21	Khageri- 2	462+486	462+555	68.42	
22	Khageri- 1	462+613	462+654	41.20	

Source: Field Survey, 2024

River bank cutting and scouring are common in most rivers due to their meandering character. Additionally, the flat landscape and high ground water table cause floods during the monsoon. The project area's catchments have been defined by GIS and verified by superimposing them on a Google Earth image (Figure below).

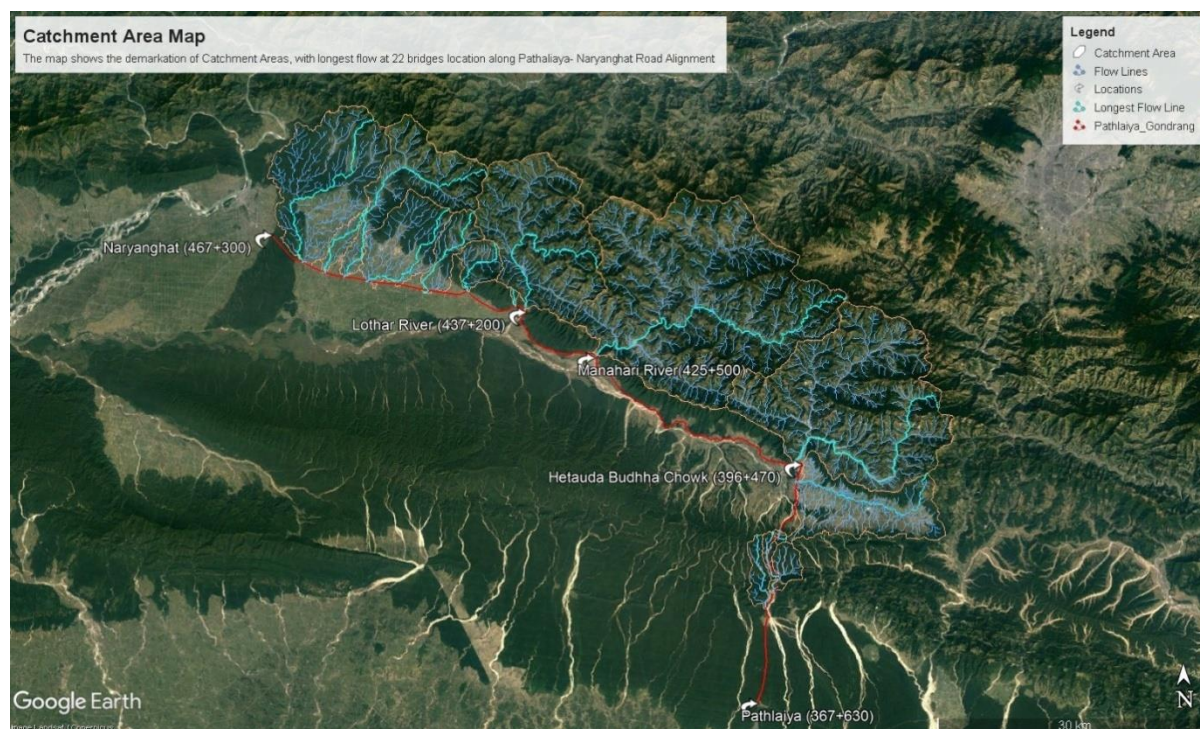


Figure 30: Catchment Map of PHN road

Wetland is another source of water. Rhino lake at Chainage Ch 466+500(1600m far from the road RHS), Kalimati Lake (1800m far from the road LHS), Chepang Lake (200m far from the road LHS) and Bishajari Lake (about 4 km far from the road) are situated in the Barandabar Corridor Forest. Small private pond for cultivation of fishery is found at many locations along the road. At many locations, irrigation canals cross and pass along the road. Detail list is given in table below.

Table 34: Irrigation canal along the road

S.N.	Chainage (Ch)	Remarks
1	409+100	Irrigation canal crossing
2	425+497	2 Irrigation canal both side of Manohari river
3	429+100	Irrigation canal Valley side
4	430+600	Irrigation canal Valley side more than 1Km long
5	437+230	Irrigation canal at Lothar river

Source: Inventory survey 2024

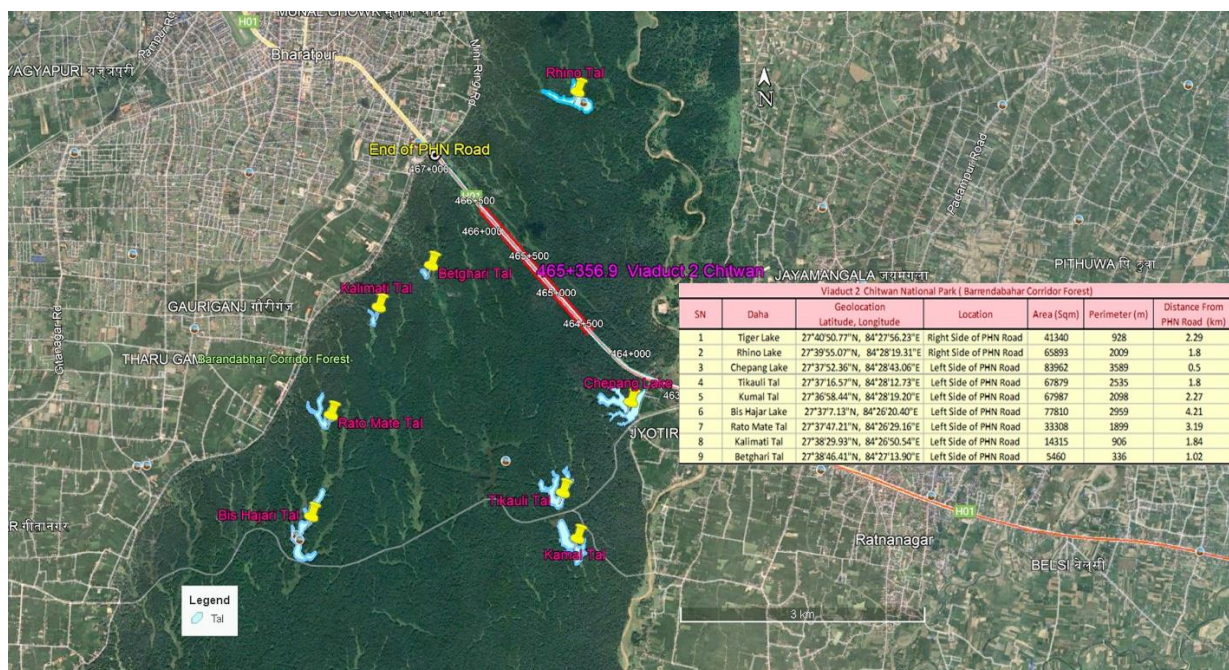


Figure 31: Wetland around the BCF

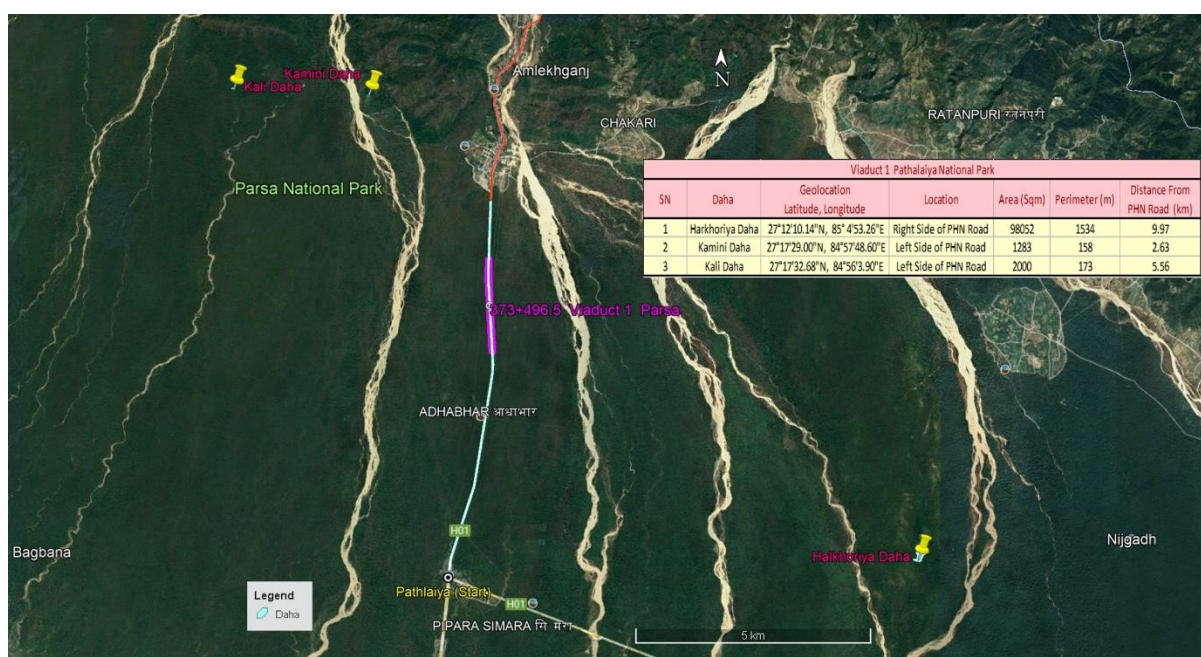


Figure 32: Wetland near PHN of PNP

5.1.8 Climate

The project lies in the tropical and sub-tropical climate. The summer (May to September) is quite hot while the winter is comparatively cold. The average low temperature is between 9.4 °C and 24.6 °C, while the average maximum temperature is between 20.8 °C and 32.6 °C. The average annual rainfall is approximately 2,407 mm. About 80% of the yearly precipitation occurs during the monsoon season and remaining 20% occurs during the dry season. The highest relative humidity is 87 % in July. The lowest relative humidity is 53 % in April. Average monthly temperature and monthly rainfall is illustrated in Figure below. Monthly temperature (Maximum, minimum and average), monthly rainfall and humidity of the year 2024 is provided in Annex IV-N.

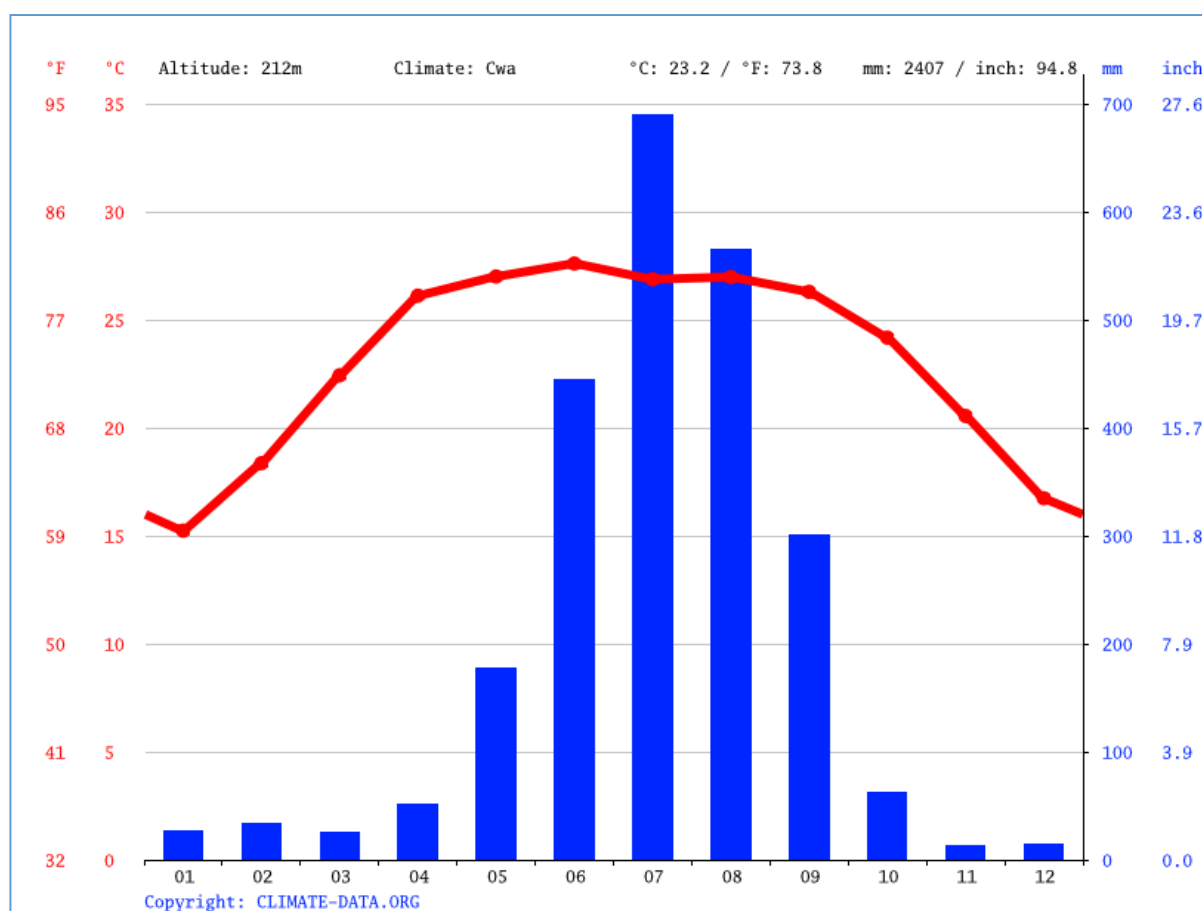


Figure 33: Average temperature and monthly rainfall of project area

Source: DHM (2024)

5.1.9 Slope Instability

Landslides, gully erosions and old scars have been found at Ch 382+180, Ch 405+940 – Ch 406+250, Ch 406+700, Ch 409+900 – Ch 410+300, Ch 412+250, Ch 414+000, Ch 414+150, Ch 415+000 – Ch 415+400, Ch 418+100 – Ch 418+500. Gully formation: Ch 385+370, Ch 385+300, Ch 386+423, Ch 386+000. During widening of the road, there will be possibility of new slope failures at Ch 388+140,

Ch 388+200, Ch 405+900-406+200, Ch 406+700, Ch 409+900-410+300, Ch 412+250, Ch 413+200-414+400, Ch 418+700, Ch 419+000 due to colluvial deposits.

At Chure Mai area 1 km stretch of the road (Ch 386+850 - Ch 387+700) is vulnerable during widening of the road because of the frazile consolidated conglomerate and mudstone.

Embankment erosion was observed at bridge sites at Ch 401+300 to Ch 401+600, at Karra bridge, at Bothside of Mardar bridge Ch 444+271, at Khageri bridge Ch 462+500, and Ch 462+800.

Due to widening of the road, landslide, and erosion will be occurred at many locations and slope protection measures will be required.

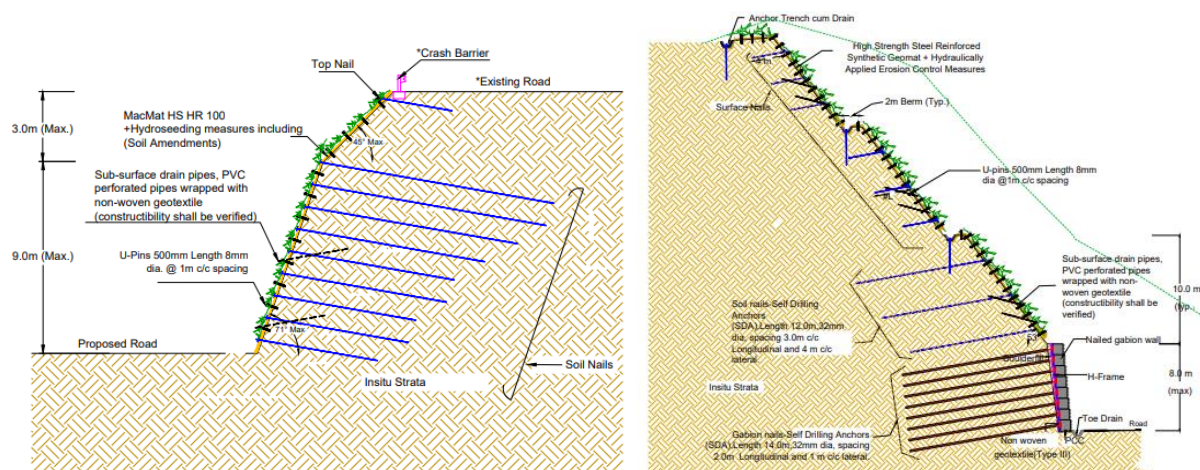


Figure 34: Proposed slope protection measures at Chure Area

5.1.10 Riverbank Erosion and Sedimentation

River channel and bank erosions are noticed on the left bank, upstream of Amlekhgunj Bridge No. 2, which has impacted the existing road alignment. At around 550 m to 800 m downstream from Amlekhgunj Bridge No.3 had caused subsidence problems in the existing road section. The probability of riverbank erosion is higher during intensive rainfall, particularly in the monsoon season. The left bank upstream of Amlekhgunj bridge No. 4 is also vulnerable to river bank erosion. The possibility of riverbank erosion will on the left bank up to 3.5 kilometers downstream of the Churia Mai temple. From Ch 413+500- Ch 413 +800 (Manahari Rural Municipality office) and Ch 414+800 - 415+700 stretch are vulnerable to riverbank erosion that could affect the road alignment. There is also observed riverbank cutting at Ch 383+700, Ch 384+500, Ch 387+700 - Ch 389+500, Ch 388+900, Ch 411+500, Ch 416+450 - Ch 416+550, Ch 462+500 - Ch 462+700.

Bridge site locations along the Manahari river and Lothar river are vulnerable to river channel sedimentation due to the high rate of suspended load sediment transportation along these rivers during the monsoon season, which reduces the height between the bridge deck and the river surface and may impact the bridge deck during floods.

5.1.11 Air Quality

Particulate Matter

The main sources of air pollution in the project area include vehicular emission and dust pollution due to vehicular movement on the road and unpaved shoulders, industries, agricultural farming activities, and fuelwood of cooking. The baseline information of the air quality and noise level status along the road has been measured once at 28 locations during December 2023 to May 2024 using low-cost sensor (Temptop, M2000) to characterize the current air quality within the study area. The monitoring stations along the alignment were selected in order to represent the sensitive receptors (Hospital, School), forest areas and residential areas. This section describes the current baseline condition of ambient air quality in the area where project activities are proposed. Measurements taken during the observation period revealed significant variations of PM_{2.5}, PM₁₀ and TSP concentrations across different locations along the road alignment.

Concentration of PM_{2.5} levels ranged from 35.61 µg/m³ (at Bridge No.3) to 91.46 µg/m³ (at Manahari Bridge). Concentrations of PM₁₀ ranged from 49.82 µg/m³ (at Gadyauli) to 163.86 µg/m³ (at Rajaiya). These levels are primarily influenced by site specific activities, vehicular emissions, and proximity to industrial areas and other local activities. The observed disparities highlight the importance of implementing targeted mitigation measures to reduce exposure to harmful particulate matter particularly in densely populated areas and locations with high traffic or industrial activity.

Table 35: Daily average concentration of particulate matter pollutants

S.N	Location	Particulate Matter (PM)			Duration
		PM 2.5 (µg/m ³)	PM10 (µg/m ³)	TSP (µg/m ³)	
1	Pathlaya Bazar	86.64	125.56	188.34	24 Hour
2	Amlekhgunj (School & Temple)	51.51	75.13	112.69	24 Hour
3	Bridge No.3	35.61	51.03	76.545	12 Hour
4	Churia Mai Temple	40.2	57.93	86.89	12 Hour
5	Hetauda Bazar (Seema Chowk)	62.26	90.77	136.15	24 Hour
6	Hetauda Bazar (Hetauda Hospital)	55.42	80.96	121.44	24 Hour
7	Hetauda Bazar (Hetauda Industrial Zone)	78.89	115.95	173.92	24 Hour
8	Ratomate (School)	53.23	77.43	116.14	24 Hour
9	Thanabharyang (Hospital)	66.51	97.9	146.85	24 Hour
10	Rapti Bridge	84.00	122.69	184.03	24 Hour
11	Nawalpur (School)	42.82	61.75	92.62	24 Hour
12	Basamodhi, (School)	56.8	81.91	122.86	24 Hour
13	Lewat (School)	66.3	97.31	145.96	24 Hour

S.N	Location	Particulate Matter (PM)			Duration
		PM 2.5 ($\mu\text{g}/\text{m}^3$)	PM10 ($\mu\text{g}/\text{m}^3$)	TSP ($\mu\text{g}/\text{m}^3$)	
14	Forest Area (Manahari Rural Municipality -07)	64.69	93.53	140.29	12 Hour
15	Nirmal Secondary School	79.69	142.76	214.14	24 Hour
16	Rajaiya (School)	84.96	163.86	245.79	24 Hour
17	Manahari Bridge	91.46	163.36	245.04	24 Hour
18	Bijauna, Ramantar	50.64	81.15	121.72	24 Hour
19	Sunachuri (School)	74.18	157.53	236.29	24 Hour
20	Lothar Bridge	46.03	57.31	85.96	24 Hour
21	Piple	44.36	54.35	81.52	24 Hour
22	Gadyauli	40.98	49.82	74.73	24 Hour
23	Bhandara Bazar	49.37	64.38	96.57	24 Hour
24	Birendranagar	44.12	53.42	80.13	24 Hour
25	Parsa Bazar	49.71	63.31	94.96	24 Hour
26	Tarkari Chowk	59.50	79.86	119.79	24 Hour
27	Tandi Bazar	55.59	73.31	109.96	24 Hour
28	Khageri Bridge	47.04	59.36	89.04	12 Hour
NAAQS, 2012		40	120	23	24 Hour
WHO 2021		15	45	-	24 Hour

Source: Field Survey 2023-2024

Trace Gas

Vehicular emissions contribute a significant number of pollutants in roads and urban areas, leading to major health and well-being concerns. Moreover, vehicular emissions are one of the major sources of gaseous pollutants (Wang et. al.). Trucks, Container Freight have grown exponentially in this road. The monitoring data indicates that some locations have higher concentrations of pollutants than the recommended standards. For instance, Pathalaiya Bazar and Hetauda Bazar (Hetauda Industrial Zone) have raised levels of NO_x, which exceed WHO guidelines.

During monitoring, some stations have found significantly higher concentrations as compared with NAAQS (2012) and WHO (2021). The detailed study result is shown in the Table below.

Table 36: Average concentration of air pollutants (Nitrogen Oxides (NO_x), Sulfur dioxide (SO₂), Lead (Pb), Benzene & Carbon Monoxide (CO))

S.N.	Location	Average 24-h Concentration (µg/m ³)				Average 8-h Concentration (µg/m ³)
		NO _x	SO ₂	Pb	Benzene	CO
1	Pathlaya Bazar	45.34	18.91	6.64	5.99	1368.32
2	Amlekhgunj (School & Temple)	32.2	18.44	5.03	3.82	1299.55
3	Bridge No.3	40.77	15.94	7.23	2.93	1123.86
4	Churia Mai Temple	5.24	16.6	7.76	3.51	1060.47
5	Hetauda Bazar (Seema Chowk)	38.76	18.94	7.31	4.66	1718.87
6	Hetauda Bazar (Hetauda Hospital)	25.35	12.3	5.15	4.69	1477.76
7	Hetauda Bazar (Hetauda Industrial Zone)	53.81	14.66	9.96	4.96	2009.45
8	Ratomate (School)	24.74	17.28	4.3	2.85	1820.53
9	Thanabharyang (Hospital)	29.99	12.82	4.51	2.72	1321.23
10	Rapti Bridge	32.1	12.99	7.47	3.68	1325.38
11	Nawalpur (School)	32.26	13.01	5.19	2.78	1208.34
12	Basamodhi, (School)	41.32	14.36	4.5	2.77	1279.99
13	Lewat (School)	36.03	15.21	8.03	2.83	1255.16
14	Forest Area (Manahari Rural Municipality -07)	30.49	14	5.87	3.19	1287.51
15	Nirmal Secondary School	24.77	13.47	6.27	3.02	1255.74
16	Rajaiya (School)	28.01	14.34	6.26	2.32	1313.71
17	Manahari Bridge	29.42	13.68	5.98	2.06	1161.78
18	Bijauna, Ramantar	30.82	13.79	5.84	2.11	1169.85
19	Sunachuri (School)	27.13	14.15	5.92	3.24	1146.63
20	Lothar Bridge	28.82	13.5	5.77	3	1137.18
21	Piple	40.83	14.08	5.89	4.22	1124.97
22	Gadyauli	36.37	15.64	6.24	5.81	1016.5
23	Bhandara Bazar	38.78	14.43	5.94	3.35	1104.77
24	Birendranagar	39.42	13.82	5.78	2.12	1049.55
25	Parsa Bazar	36.89	13.17	5.61	2.87	1090.42
26	Tarkari Chowk (Between industry and Navodaya School, Khairahani Municipality-01)	35.45	12.8	5.52	2.73	1057.79
27	Tandi Bazar	34.3	12.49	5.44	3.61	1130.65
28	Khageri Bridge	33.2	12.22	5.37	2.5	1109.6
NAAQS, 2012		80	70	-	-	10000
WHO, 2021		25	40	-	-	-

Source: Field Survey 2023-2024

5.1.12 Noise Quality

The main sources of noise pollution in the project area are traffic and other commercial activities in the road alignment. The Sound Pressure Level (SPL) measurements were taken continuously for 24 hours at 28 locations (Annex IV-S). The data was recorded by using a Digital sound level meter. At all these locations, daytime noise level were considered for the period 6 am to 10 pm and night time from the period 10 pm to 6 am. The readings were calculated, and frequency distribution was prepared in a table categorizing minimum, average, and maximum sound levels.

The noise level measurements show variations in noise levels across the 28 different locations during the daytime and nighttime. During the day, minimum noise levels ranged from 34 dB(A) to 58 dB(A), with average levels between 55 dB(A) and 73 dB(A). The maximum daily noise levels varied from 89 dB(A) to 107 dB(A). At night, the minimum noise levels ranged from 30 dB(A) to 42 dB(A), while the average levels ranged from 50 dB(A) to 63 dB(A). The maximum nighttime noise level was recorded ranged from 77 dB(A) to 99 dB(A).

These findings indicate that noise level along PHN Road is primarily caused by densely populated, high vehicular traffic and commercial activities. Additionally, the proximity of the road to residential areas, cities, and noise-sensitive locations such as hospitals and schools underscores the urgency of addressing noise pollution in the area. Detail of noise level is provided in Table below.

Table 37: The Noise level measurement result of the PHN Road Section

S.N.	Location	Noise Level dB(A) (24 hours)					
		Day Time			Night Time		
		Minimum	Average	Maximum	Minimum	Average	Maximum
1	Pathalaiya Bazar	45.7	57.3	91.9	42.6	56.84	91.1
2	Amlekhgunj (School & Temple)	43	64.56	104.2	35.9	56.01	78.4
3	Bridge No.3	36.1	55.65	81.7	-	-	-
4	Churia Mai Temple	45.9	69.22	101.9	-	-	-
5	Hetauda Bazar (Seema Chowk)	57.7	73.43	105.3	34.9	60.4	88.4
6	Hetauda Bazar (Hetauda Hospital)	53.9	68.21	94.2	44.6	60.78	91.1
7	Hetauda Bazar (Hetauda Industrial Zone)	42.9	69.82	107.4	38.2	57.57	94.6
8	Ratomate (School)	35.9	58.64	87.2	34.5	54.71	77.8
9	Thanabhanyang (Hospital)	47.9	66.44	95.9	34.8	58.66	90.2
10	Rapti Bridge	48.7	61.91	87.7	40.1	54.91	79.7
11	Nawalpur (School)	40	64.85	98.2	30.8	52.98	84.1
12	Basamodhi, (School)	40.1	60.24	92.1	30.6	50.04	84.6
13	Lewat (School)	36.3	59.1	89.6	31.1	51.99	84.3
14	Forest Area	35.9	58.15	98.3	-	-	-
15	Nirmal Secondary School	48.3	65.04	98.1	32.3	55.21	85.2

S.N.	Location	Noise Level dB(A) (24 hours)					
		Day Time			Night Time		
		Minimum	Average	Maximum	Minimum	Average	Maximum
16	Rajaiya (School)	39.7	59.85	93.4	39.2	55.79	83.5
17	Manahari Bridge	52.5	67.61	101.9	38.3	62.51	93.7
18	Bijauna, Ramantar	34.6	57.15	87.5	34.7	53.51	80.9
19	Sunachuri (School)	34.9	59.42	96.4	32.8	55.4	80.6
20	Lothar Bridge	43.9	63.99	96.8	36.9	59.89	97.6
21	Piple	44.9	63.19	94.1	35.8	56.15	87.1
22	Gadyauli	44.1	66.08	105.7	36.8	56.27	87.6
23	Bhandara Bazar	51.9	67.13	108.3	35.2	60.87	97
24	Birendranagar	44.1	64.09	95.8	40.6	58.44	85.5
25	Parsa Bazar	51.7	67.44	102.4	42.3	62.34	94
26	Tarkari Chowk	45.3	66.25	103.4	34.8	57.28	84.1
27	Tandi Bazar	58.2	71.05	103.4	40.1	63.94	99.6
28	Khageri Bridge	35.6	56.05	89.2	-	-	-

Source: Field Survey 2023-2024

The following sources of noise were identified in the project area:

- **Traffic:** Traffic was a significant contributor to noise levels, particularly at sampling locations near sealed roads (e.g., N4 and N5). Vehicles were frequently observed traveling at relatively high speeds (up to 50 km/h) on narrow roads adjacent to these locations, often accelerating and decelerating rapidly. Noise levels were notably higher during the day due to increased traffic volume compared to nighttime conditions.
- **Natural sources:** The primary natural source of ambient noise was the numerous streams that traverse the mountainous terrain. Additional natural contributors included rainfall and wind. At night, the drop in temperature increases air density and pressure, which may enhance the transmission of sound from these natural sources: Nearly every household along the project alignment owned at least one dog. During nighttime hours, dogs were observed to bark in response to passing vehicles, often continuing even after the vehicle had moved away. This behavior contributed to elevated noise levels.

5.1.13 Water Quality

Water quality samples were collected from rivers, streams, and community springs to establish baseline conditions of both surface and groundwater.

The project area is experiencing growing urbanization and industrial development, which are potential source of water pollution. Additionally, riverbed mining activities contribute to degradation of river water quality. The project alignment located in region rich in water resources, which is utilized for both drinking and irrigation purposes. Located in Terai region the project area benefits from abundant

groundwater reserve and potable water needs. The seasonal depth to water table in the Terai varies between 1 to 10 meters below ground surface.

Surface water samples were collected and analyzed from nine different rivers to establish baseline water quality conditions. The result is summarized in Table below. The surface water quality analysis of rivers and streams along the Pathalaiya- Hetauda-Narayanghat Road reveals that most parameters comply with the Generic Effluent Standards for Inland Surface Water (GoN, 2001). pH values across all the samples fall within the safe range of 5.5–9.0, supporting aquatic life. Electrical Conductivity (EC) and turbidity values are generally low, indicating good water clarity and moderate ionic content. The highest EC was recorded in Kair Khola at 485 $\mu\text{S}/\text{cm}$. Total dissolved solids (TDS) and total suspended solids (TSS) are within acceptable limits, except for Martal Khola, which showed minimal TSS (<1 mg/L). Nutrient concentrations, including nitrates and sulphates, vary across locations however remain within safe limits. The highest nitrate level was observed in in Khageri Khola-1 (12.84 mg/L) and the highest sulphate concentration in the Lothar River (28.64 mg/L). Microbial contamination is generally low; however, *E. coli* exceeds 200 CFU/100mL in Lothar River, indicating localized pollution. Chemical oxygen demand (COD) and biochemical oxygen demand (BOD) values are low, suggesting minimal organic pollution. Heavy metals such as iron, manganese, lead, cadmium, copper, and arsenic, were within safe thresholds or below the detection limit.

Overall, the surface water quality in the project area is satisfactory, however targeted interventions are required to address microbial contamination particularly Lothar River. Results of surface water quality is provided in the Table below.

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Table 38: Test Result of Surface Water (River/Stream) of PHN Road

S. N.	Parameters	Observed Values									Generic Effluent Standards Discharged into Inland Surface Water, GoN 2001
		Karra Khola	Rapti River	Manahari River	Lothar River	Martal Khola	Ladari Khola	Kair Khola	Khageri Khola – 2	Khageri Khola – 1	
1	pH at 21°C	6.6	8	8.3	8	8.2	7.2	7.6	7.5	6.9	5.5 - 9.0
2	Electrical Conductivity, ($\mu\text{S}/\text{cm}$)	161	271	260	405	255	275	485	423	360	-
3	Turbidity, (NTU)	7	10	3	3	2	9	3	9	3	-
4	*Total Dissolved Solids, (mg/L)	87	127	122	174	120	127	200	180	158	-
5	Total Suspended Solids, (mg/L)	10	24	4	10	<1	24	8	16	6	30 - 200
6	Total Hardness as CaCO_3 , (mg/L)	56	124	120	200	116	124	226	210	164	-
7	Calcium, (mg/L)	15.23	34.47	29.66	44.89	31.26	24.05	45.69	38.48	31.26	-
8	Magnesium, (mg/L)	4.37	9.24	11.18	21.39	9.24	15.56	27.22	27.71	20.90	-
9	Total Alkalinity as CaCO_3 , (mg/L)	53	121	107	160	121	107	194	189	131	-
10	Nitrate, (mg/L)	12.25	1.99	0.74	0.89	0.30	6.94	8.86	9	12.84	-
11	Sulphate, (mg/L)	6.59	11.52	12.35	28.64	9.06	5.76	26.34	4.12	1	-
12	Chloride, (mg/L)	13.23	1.47	0.50	1.47	1.47	7.35	5.39	5.39	11.27	-
13	Dissolved Oxygen, (mg/L)	9.0	8.6	9.0	8.4	-	-	-	-	-	-
14	Biochemical Oxygen Demand, (mg/L)	<1	<1	0.82	<1	<1	2	<1	<1	<1	30 - 100
15	Chemical Oxygen Demand, (mg/L)	4	1	6	5	1	6	3	6	4	250
16	Total Phosphorous as $\text{PO}_4\text{-P}$, (mg/L)	0.05	0.04	0.05	0.04	0.05	0.03	0.01	0.04	0.04	-
17	Iron, (mg/L)	0.95	0.80	0.25	0.13	0.05	0.42	0.19	0.45	0.18	-
18	Manganese, (mg/L)	0.08	0.02	<0.02	<0.02	<0.02	0.07	<0.02	0.04	<0.02	-

S. N.	Parameters	Observed Values									Generic Effluent Standards Discharged into Inland Surface Water, GoN 2001
		Karra Khola	Rapti River	Manahari River	Lothar River	Martal Khola	Ladari Khola	Kair Khola	Khageri Khola – 2	Khageri Khola – 1	
19	Lead, (mg/L)	N. D. (<0.01)	N. D. (<0.01)	N. D. (<0.01)	N. D. (<0.01)	N. D. (<0.01)	<0.01	N. D. (<0.01)	<0.01	N. D. (<0.01)	0.1
20	Cadmium, (mg/L)	N. D. (<0.003)	N. D. (<0.003)	N. D. (<0.003)	N. D. (<0.003)	N. D. (<0.003)	N. D. (<0.003)	N. D. (<0.003)	N. D. (<0.003)	N. D. (<0.003)	2
21	Copper, (mg/L)	N. D. (<0.01)	N. D. (<0.01)	N. D. (<0.01)	N. D. (<0.01)	<0.01	N. D. (<0.01)	N. D. (<0.01)	<0.01	<0.01	3
22	Zinc, (mg/L)	0.08	0.03	0.04	0.04	0.03	0.04	0.03	0.04	0.04	5
23	Arsenic, (mg/L)	N. D. (<0.01)	N. D. (<0.01)	N. D. (<0.01)	N. D. (<0.01)	N. D. (<0.01)	N. D. (<0.01)	N. D. (<0.01)	N. D. (<0.01)	N. D. (<0.01)	0.2
24	<i>E. coli</i> Count, (CFU/100mL)	10	25	20	>200	20	10	Nil	12	50	-

Source: Lab result of surface water quality, 2024

Drinking water samples were collected from three locations—Basmadi, Manahari, and Hardi—and analyzed for 14 key parameters and indicate that all measured values fall within the permissible limits set by the Nepal Drinking Water Quality Standards (NDWQS). The results is summarized in Table below.

The pH values of the water from Basmadi (6.5), Manahari (7.5), and Hardi (7.1) are within the acceptable range of 6.5–8.5. Also, Electrical conductivity, a measure of ionic concentration, is observed to be highest in Hardi (640 $\mu\text{S}/\text{cm}$), yet significantly below the standard limit of 1500 $\mu\text{S}/\text{cm}$. The turbidity levels across all locations are consistent at 1 NTU, indicating excellent water clarity and below the 5 NTU limit. Total hardness ranges from 50 mg/L in Basmadi to 304 mg/L in Hardi, which is within the safe limit of 500 mg/L. Similarly, Chloride concentrations are, ranging from 2.45 mg/L in Manahari to 15.19 mg/L in Basmadi, far below the maximum allowable limit of 250 mg/L.

Parameters, including nitrate and nitrite, remain within safe limits of concentrations. Nitrate levels are highest in Basmadi (26.57 mg/L) but remain well below the permissible limit of 50 mg/L, while nitrite concentrations are negligible (<0.02 mg/L). Other chemical parameters like ammonia, calcium, magnesium, iron, manganese and arsenic are either minimal or undetectable adhering to the standards. The drinking water quality in all three locations meets the NDWQS criteria, indicating that the water is safe for human consumption and poses no significant health risks.

Table 39: Lab Test Result of Drinking Water of Settlements of PHN Road

S. N.	Parameters	Observed Values			NDWQS, Nepal
		Basmadi, Hetauda Sub-metropolitan City, Ward No. 03	Manahari Rural Municipality, Ward No. 03	Hardi, Rapti Municipality, Ward No. 6	
1	pH at 23°C	6.5	7.5	7.1	6.5 - 8.5
2	Electrical Conductivity, ($\mu\text{S}/\text{cm}$)	159	509	640	1500
3	Turbidity, (NTU)	1	1	1	5
4	Total Hardness as CaCO_3 , (mg/L)	50	258	304	500
5	Total Alkalinity as CaCO_3 , (mg/L)	44	252	276	-
6	Chloride, (mg/L)	15.19	2.45	9.31	250

S. N.	Parameters	Observed Values			NDWQS, Nepal
		Basmadi, Hetauda Sub-metropolitan City, Ward No. 03	Manahari Rural Municipality, Ward No. 03	Hardi, Rapti Municipality, Ward No. 6	
7	Ammonia, (mg/L)	<0.05	N. D. (<0.05)	<0.05	1.5
8	Nitrate, (mg/L)	26.57	0.66	3.25	50
9	Nitrite, (mg/L)	<0.02	<0.02	<0.02	3
10	Calcium, (mg/L)	11.22	62.52	72.94	200
11	Magnesium, (mg/L)	5.35	24.79	29.65	-
12	Iron, (mg/L)	0.06	<0.05	0.10	0.3
13	Manganese, (mg/L)	<0.02	<0.02	<0.02	0.2
14	Arsenic, (mg/L)	Nil	Nil	Nil	Nil

Source: Lab result of surface water quality, 2024

5.1.14 Soil Quality

Soil samples were also collected from three locations—Basmadi, Manahari, and Hardi—and analyzed. The pH levels in all tested locations (Basmadi: 7.1, Manahari: 7.9, and Hardi: 7.6) indicate neutral to slightly alkaline soil conditions, which are favorable for plant growth. Organic matter content is significantly high across all locations, with values of 8.69% in Basmadi, 11.45% in Manahari, and 19.64% in Hardi. These levels, (exceeding 5%) as per NARC (2004), suggest excellent soil fertility. Whereas, Total Nitrogen content is uniform across all locations at 0.07%, reflecting adequate nitrogen availability. Available phosphorus levels vary, with Hardi showing the highest value (10.91 µg/g) and Manahari the lowest (4.00 µg/g). Similarly, available potassium is highest in Basmadi (10.67 µg/g) and slightly lower in Manahari (6.67 µg/g) and Hardi (6.27 µg/g). These variations indicate differences in nutrient availability.

In terms of texture, the soil in Basmadi is classified as loam (L), while in Manahari and Hardi; it is sandy loam (SL). This is further supported by the particle composition, where sand content is highest in Hardi (58%) and lowest in Basmadi (48%), while silt and clay percentages decrease accordingly. The soil along the surveyed settlements exhibits high fertility and neutral pH, suitable for agricultural use.

Table 40: Lab Test Result of Soil Quality of Settlements of Pathlaiya-Hetauda-Narayanghat Road (SASEC)

S. N.	Parameters	Observed Values		
		Basmadi, Hetauda Sub-metropolitan City, Ward No. 03	Manahari Rural Municipality, Ward No. 0	Hardi, Rapti Municipality, Ward No. 6
1.	pH at 22°C, (1:1)	7.1	7.9	7.6
2.	Organic Matter, (%)	8.69	11.45	19.64
3.	Total Nitrogen, (%)	0.07	0.07	0.07
4.	Available Phosphorous, (µg/g)	7.88	4.00	10.91
5.	Available Potassium, (µg/g)	10.67	6.67	6.27
6.	Texture	L	SL	SL
a.	Clay, (%)	13.50	11.50	11.50
b.	Silt, (%)	38.50	32.50	30.50
c.	Sand, (%)	48.00	56.00	58.00
	Remarks	The observed value for organic matter in tested sample was at high rating level (>5%, NARC, 2004).		

5.1.15 Traffic Volume and Composition

Baseline traffic survey was conducted at five stations. The daily traffic volume of different stations varies from 12,000 ~ 25,000 vehicle/day (Annex IV-Y). The urbanized Narayanghat, Hetauda area shows more traffic than other sections. The road widening activities will affect the normal traffic on the highway and could lead to traffic congestion. The traffic included a range of vehicles including multi-axle trucks, heavy trucks, light trucks, buses, mini buses, cars, taxis, vans, four-wheel drive, farm tractors, utility vehicles, motor cycles, power tillers and rickshaws. Among the total volume of traffic, 30-56% is occupied by 2~3wheel vehicles followed by cars (13%), buses (8%) and trucks (15%). It is expected that the volume of traffic will be increased, after the road is upgraded. In this section, the proportion of truck traffic is high (13%~22%) due to cargo transportation from Birgunj dry port. Summary of traffic count survey is presented in Table below.

Table 41: Summary of Traffic Count Survey

Sta. No.	Station Name	Survey Date From	Survey Date To	Seasonal Factor	ADT	ADT exc. MC and Rickshaw	AADT	AADT exc. MC and Rickshaws	AADT in PCU	AADT in PCU exc. MC and Rickshaws
1	Pathalaiya North	17-Sep-21	19-Sep-21	0.90	8746	5963	7871	5367	13384	12132
2	Amlekhgunj North	17-Sep-21	19-Sep-21	0.90	7901	5522	7111	4970	12579	11508

Sta. No.	Station Name	Survey Date From	Survey Date To	Seasonal Factor	ADT	ADT exc. MC and Rickshaw	AADT	AADT exc. MC and Rickshaws	AADT in PCU	AADT in PCU exc. MC and Rickshaws
3	Hetauda West	17-Sep-21	19-Sep-21	0.90	26622	13755	23960	12380	25851	20061
4	Tikauli East	17-Sep-21	19-Sep-21	0.90	20616	9885	18554	8897	22140	17312
5	Bypass North	17-Sep-21	19-Sep-21	0.90	23262	11086	20935	9777	22191	16688

Source: Detail Design Report of PHN, 2025

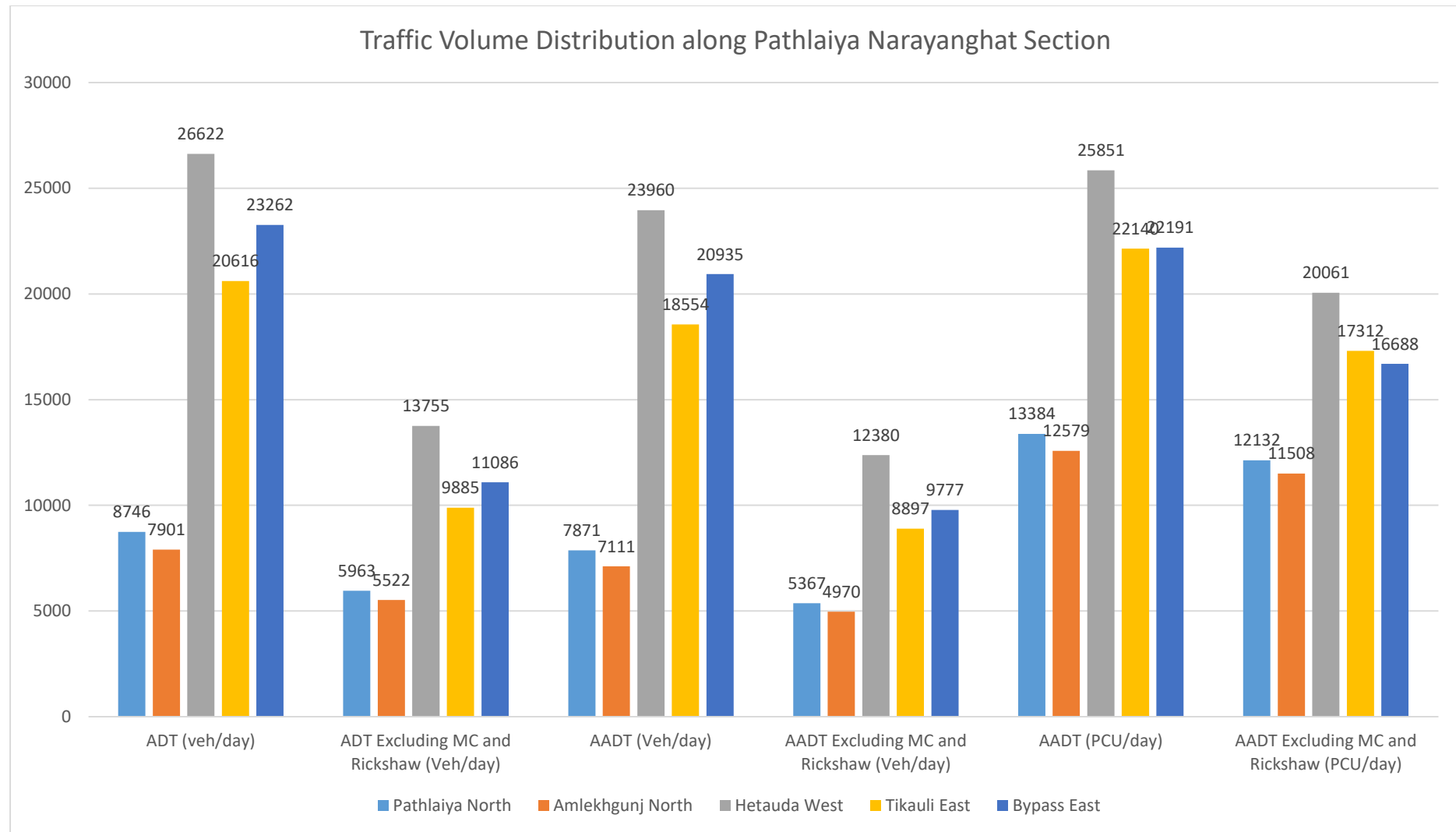


Figure 35: Traffic Volume Distribution in Veh/day

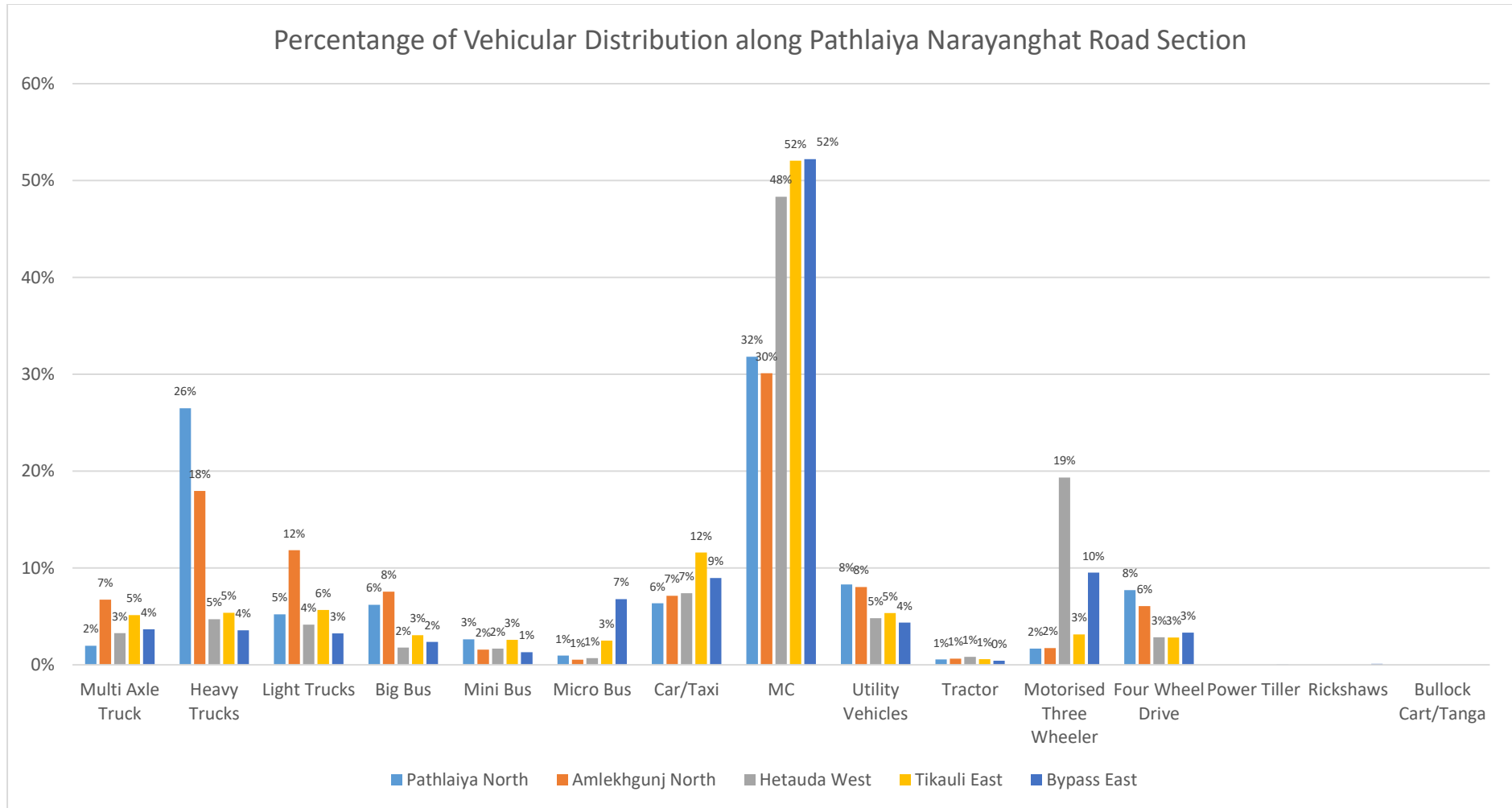


Figure 36: Percentage of Vehicular Distribution

Traffic hourly variation

Looking at the traffic volume fluctuations by the time, the morning's peak is about 7.8% at 9 o'clock, 6.3% at 12 o'clock during the daytime, and 7.2% at 18:00 during the afternoon peak. The traffic volume fluctuation shows a pattern like that of general traffic volume fluctuation. It is analyzed that the traffic volume survey point is a point adjacent to the urbanized area, thus showing the general urban area traffic pattern.

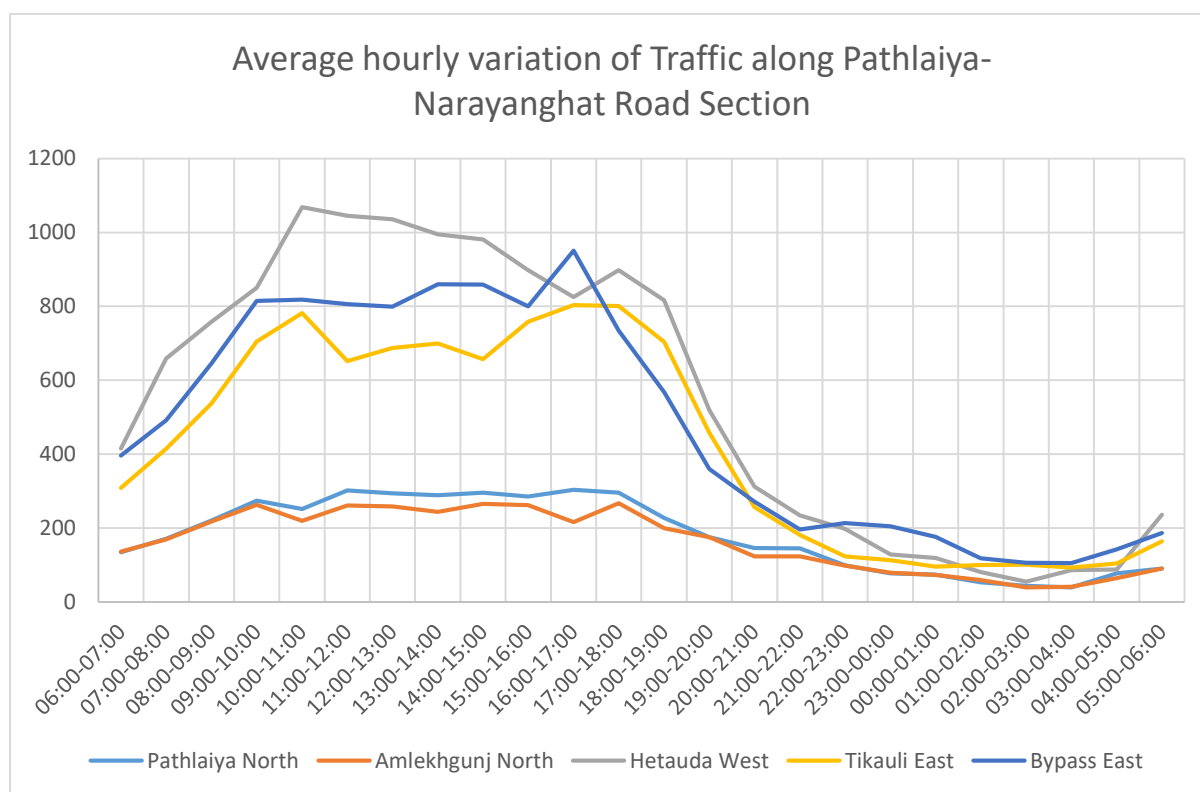


Figure 37: Average Hourly Variation of Traffic

Existing traffic growth trend

Reviewing the overall past increased rate of proposed road, it has been found that passenger cars has increased by 14.4%, buses by 9.6%, and 2-3 wheelers by 13% whereas truck has increased by 3.7%. The table shows that there are decreases of car and trucks in some sections of the proposed road. However, there is significant increase of all type of traffic including trucks and cars while analyzing increase rate from the operation phase (2028) to 2047(twenty years period).

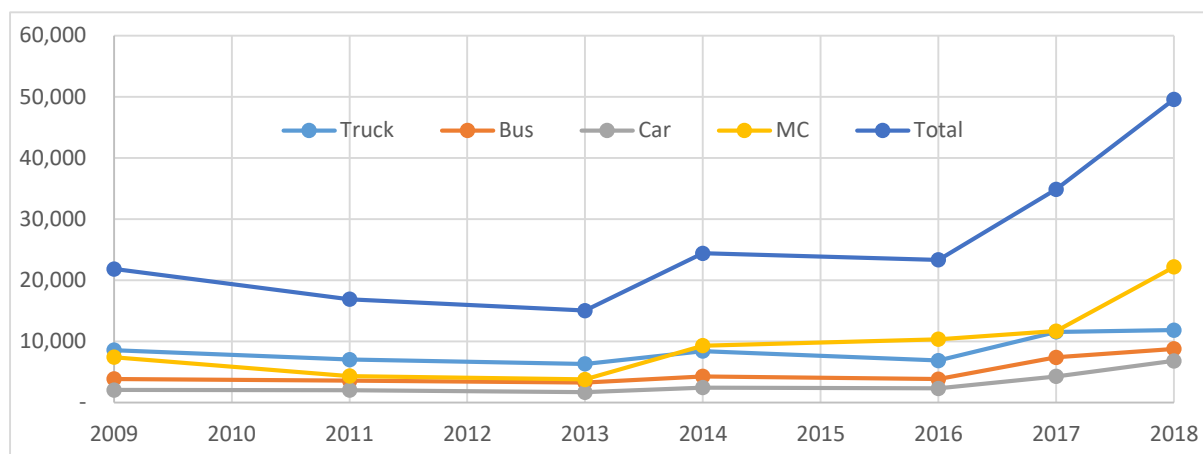


Figure 38: Traffic growth trend

Result for the number of lanes

Number of lanes in carriageway for both urban and rural area have been calculated based on the traffic demand excluding 2~3 wheeled vehicles. The calculation reveals that four lanes are required for all sections of the proposed road to cater future demand of traffic in projected year i.e., 2046. It was analyzed that the carriageway in the urban areas of PHN road would have two-way four lanes, the service road had two-way two lanes, and the rural areas had two-way four lanes. The details are given in Table below.

Table 42: The number of Lanes based on 20 years Traffic Demand

Link		H0129	H0130	H0131	H0132	H0133	H0134	H0135
		Pathalaiya-Chure	Chure-Ratmate	Ratmate-Hetauda	Hetauda-Sarashwati Khola	Sarashwati Khola-Lothar	Lothar-Tikauli	Tikauli-Hakimchok
Urban area	Carriageway	4	4	4	4	4	4	4
	Service road	2	2	2	2	2	2	2
Rural area		4	4	4	4	4	4	4

Source: Detail Design Report, 2025

a. Road Accident

The road widening activities will affect the normal traffic on the highway and local traffic and could lead to traffic congestion. The construction activities can potentially impact the residents of settlements along project Road, particularly the movement and safety of school children and elders. Due to increased use of trucks and other vehicles on the narrow roads in the project area, pedestrians, particularly elderly people and children will be more exposed to dangerous situations, which may lead to traffic accidents. There was a total of 737 road accidents in five years (2016-2020), which killed 93

people, 230 are serious injured. Road accident data of Bara, Makawanpur and Chitwan district of last five years is given in Table below.

Table 43: Road Accident Data of Bara, Makawanpur and Chitwan Districts (2016-2020)

S.No.	District	No. of years considered (Data available 2016-2020)	Total no. of crashes	Crash type		
				Fatal	Serious	Minor
1	Bara	4.75	373	45	87	241
2	Chitwan	0.75	164	28	61	75
3	Makawanpur	0.75	200	20	82	98
		Total	737	93	230	414

Source: Institutional strengthening and capacity building for road safety and gender equality (ADB TA- 9604), 2020

Note: 4.75 years means, in five years period only 4.75 year's data is available, Similarly 0.75 years means in five years period only 0.75 year's data is available in Makawanpur and Chitwan districts.

Road accident data of East West Highway is not available, and it is assumed that 60% was happened in the East West Highway. Assuming 60% of total accident, 56 fatal accident, 138 serious accident and 248 minor accidents was found along the PHN road section from 2016 to 2020. During construction the accident may increase if not given necessary measures.

5.1.16 Construction Material

Various type of construction materials requires for road and bridge construction. The naturally available materials nearby the project site play a vital role in the project cost. Naturally available materials like stones, sands, boulders, and base/subbase will be needed in one or other form. Approximately 372,550 cum sand, 1,025,891 cum aggregate, 243,730 cum stone, 1,133,764 cum subbase, 868,147 cum base materials is required for the project. During the field survey, potential sources of materials were identified in and around the alignment. Construction material likes stones, sands and boulders are sufficiently available nearby the project sites. The potential 16 sources and locations of construction materials (stone, coarse aggregates, sand, sub base, base course, and asphalt concrete chips) and alternatives sources from rivers of buffer zone are also analysis and given in Annex IV-G. The final locations of quarries and borrow areas will be determined at the implementation stage from identified sources. The Project will not implement any exploration activities from illegal sources. During extraction of construction materials, the contractor will coordinate with local bodies, if necessary, shall be taken approval from concern municipalities or approved locations of municipalities will be used for extraction of construction materials. Before extraction permissible bench mark will be fixed.

Possible alternatives: for the reduction of aggradation can be used suitable locations of the river even fall in Chure area or BZ, forest area (Alternative possible locations are also given in Annex-IV-G-a). In the bridge area (within 500m), the deposition of materials above the score depth level will be used

A satellite map from Google Earth showing the proposed road route from Eskişehir to Bursa. The route is highlighted in red, passing through various towns and regions. Key locations marked include Eskişehir, Kütahya, Afyonkarahisar, Karaman, Konya, Antalya, and Bursa. The map also shows major roads, rivers, and geographical features like the Taurus mountains.

Figure 39: Location of Potential Sources of Construction Material

Table 44: Potential sources of construction materials

Sn	Name of Source	Location	Available Materials	Estimated Quantities (m3)	Coordinates	Extraction Method	River Bed Level of Proposed Bridge Axis	Scour Level of Pier according to Hydrology	IEE/BES study prepared or not	Remarks
1	Bakaiya Khola	22 Km away from Chainage 367+630 Start Point (Pathalaiya) on Right Hand Side of the road alignment	Boulders, Cobbles, Gravels and Sand	6,00,000	From 45R	Labour, Shovel, pick, excavator, loder and truck/tractor for transportation	NA	NA	IEE – 2081/2082	19 km black topped road and 3 km gravel road
					319103mE 3006109mN					
					to					
					320654mE 3003981mN					
					From 45R					
					320881mE 3003725mN					
					to					
					321865mE 3002727mN					
					From 45R					
2	Pasaha Khola	12 Km away from Chainage 367+630 Start Point (Pathalaiya) on Right Hand Side of the road alignment	Cobbles, Pebbles, Gravels and Sand	3,00,000	321676mE 3002510mN	Labour, Shovel, pick, excavator, loder and truck/tractor for transportation	NA	NA	IEE – 2081/2082	About 7 km black topped road and 5 km gravel road
					to					
					321993mE 3001034mN					
					From 45R					
					308794mE 3005620mN					
					to					
					308703mE 3004072mN					
					From 45R					
					308703mE 3004072mN					
3	Dudhaure Khola	5 Km away from Chainage	Boulders, Cobbles, Gravels and	1,12,500	to	Labour, Shovel, pick, excavator,	NA	NA	IEE – 2081/2082	About 3 km black topped road
					308745mE 3002392mN					
					From 45R					
					308752mE 3002300mN					
					to					
					309112mE 3001010mN					

Sn	Name of Source	Location	Available Materials	Estimated Quantities (m3)	Coordinates		Extraction Method	River Bed Level of Proposed Bridge Axis	Scour Level of Pier according to Hydrology	IEE/BES study prepared or not	Remarks
		367+630 Start Point (Pathalaiya) on Right Hand Side of the road alignment	Sand		302795mE	3007541mN	loder and truck/tractor for transportation				and 2 km gravel road
					From 45R						
					302411mE	3006063mN					
					to						
					302047mE	3005557mN					
					From 45R						
					300889mE	3003765mN					
					to						
					299930mE	3002803mN					
4	Samri Khola	7 Km away from chainage 396+600 (Hetauda Bazaar) on Right Hand Side of the road alignment	Boulders, Cobbles, Gravels and Sand	3,00,000	307343mE	3038325mN	Labour, Shovel, pick, excavator, loder and truck/tractor for transportation	NA	NA	NA	About 5 km black topped road and 2 km gravel road in right hand side of the road alignment
5	Khisedi Khola	8 Km away from chainage 396+600 (Hetauda Bazaar) on Right Hand Side of the road alignment	Boulders, Cobbles, Gravels and Sand	2,04,000	309109mE	3037989mN	Labour, Shovel, pick, excavator, loder and truck/tractor for transportation	NA	NA	NA	About 6 km black topped road and 2 km earthen road in right hand side of the road alignment

Sn	Name of Source	Location	Available Materials	Estimated Quantities (m3)	Coordinates		Extraction Method	River Bed Level of Proposed Bridge Axis	Scour Level of Pier according to Hydrology	IEE/BES study prepared or not	Remarks
6	East Rapti River	11 Km away from chainage 396+600 (Hetauda Bazaar) on Right Hand Side of the road alignment	Boulders, Cobbles, Gravels and Sand	1,12,500	307077mE	3042411mN	Labour, Shovel, pick, excavator, loder and truck/tractor for transportation	NA	NA	NA	About 9 km black topped road and 2 km gravel road in right hand side of the road alignment
7	Rapti River	At chainage 405+000 on LHS and 3 km away from the road alignment	Boulders, Cobbles, Gravels and Sand	4,05,000	297799mE	3037989mN	Labour, Shovel, pick, excavator, loder and truck/tractor for transportation	NA	NA	NA	About 3 Km away in Left hand side of road alignment with 8 km earthen road
8	Manohari Khola	At chainage 425+700 on RHS and 8 km away from the road alignment	Boulders, Cobbles, Gravels and Sand	6,00,000	285788mE	3048789mN	Labour, Shovel, pick, excavator, loder and truck/tractor for transportation	290.210	281.060	IEE – 2081/2082 (Undoing)	About 8 km earthen road on Right hand side
					287050mE	3048625mN					
9	Lothar Khola	At chainage 436+000 on LHS and 3 km away from the road alignment	Cobbles, Gravels and Sand	2,25,000	275481mE	3052371mN	Labour, Shovel, pick, excavator, loder and truck/tractor for transportation	263.520	253.060	NA	About 5 km earthen road on Left hand side

Sn	Name of Source	Location	Available Materials	Estimated Quantities (m3)	Coordinates		Extraction Method	River Bed Level of Proposed Bridge Axis	Scour Level of Pier according to Hydrology	IEE/BES study prepared or not	Remarks
10	Ladari Khola	8 Km away from chainage 454+000 on Right Hand Side of the road alignment	Cobbles, Gravels and Sand	50,000	261433mE	3058866mN	Labour, Shovel, pick, excavator, loder and truck/tractor for transportation	191.620	183.780	NA	About 6 km black topped road and 2 km earthen road in right hand side
11	Kair Khola	4 Km away from Kair River (457+980) of East West Highway on upstream of Kair River. Khairahani Municipality	Cobbles, Gravels and Sand	42,875	From 45R		Labour, Shovel, pick, excavator, loder and truck/tractor for transportation	189.040	174.390	IEE – 2081	
					258780mE	3060445mN					
					to						
					258691mE	3060278mN					
					From 45R						
					258674mE	3060207mN					
					to						
					258738mE	3059267mN					
					From 45R						
					258730mE	3059667mN					
					to						
					258557mE	3059267mN					
					From 45R						
					258565mE	3059270mN					
					to						
					258461mE	3059139mN					
					From 45R						
258441mE	3059124mN										
to											
258127mE	3059127mN										

Sn	Name of Source	Location	Available Materials	Estimated Quantities (m3)	Coordinates		Extraction Method	River Bed Level of Proposed Bridge Axis	Scour Level of Pier according to Hydrology	IEE/BES study prepared or not	Remarks
12	Khageri River	9 Km away from Chainage 467+550 End Point (Gondrang) on Right Hand Side of the road alignment	Gravel and Sand	75,000	251425mE	3065623mN	Labour, Shovel, pick, excavator, loder and truck/tractor for transportation	185.940	177.800	NA	About 7 km black topped road and 2 km earthen road in right hand side of the road alignment
13	Narayani River	14 Km away from Chainage 467+550 End Point (Gondrang) on Left Hand Side of the road alignment	Cobbles, Gravels and Sand	1,50,000	250324mE	3073845mN	Labour, Shovel, pick, excavator, loder and truck/tractor for transportation	NA	NA	NA	About 11 km black topped road and 3 km gravelled road in left hand side of the road alignment
14	Trishuli River	17 Km away from Chainage 467+550 End Point (Gondrang) on Right Hand Side of	Cobbles, Gravels and Sand	1,60,000	248424mE	3075190mN	Labour, Shovel, pick, excavator, loder and truck/tractor for transportation	NA	NA	NA	About 16 km black topped road and 1 km gravelled road in right hand side of the road

Sn	Name of Source	Location	Available Materials	Estimated Quantities (m3)	Coordinates		Extraction Method	River Bed Level of Proposed Bridge Axis	Scour Level of Pier according to Hydrology	IEE/BES study prepared or not	Remarks
		the road alignment									alignment
15	Jharahi Khola	23 Km away from Chainage 467+320 End Point (Gondrang) on Left Hand Side of the road alignment	Boulders, Cobbles, Gravels and Sand	75,000	224007mE	3063889mN	Labour, Shovel, pick, excavator, loder and truck/tractor for transportation	NA	NA	NA	About 20 km black topped road and 3 km graveled road in left hand side of
16	Pampha Khola	3 Km away from chainage 449+180 on Right Hand Side of the road alignment	Cobbles, Gravels and Sand	25,000	265236mE	3056100mN	Labour, Shovel, pick, excavator, loder and truck/tractor for transportation		NA	NA	About 2 km black topped road and 1 km earthen road in right hand side

Source: Field survey and Detail Design Report of PHN Road, 2024

5.1.17 Waste Management

Roadside markets, small shops, grocery, hotels, restaurants, and teashops are the major source of waste generation, which are seen along the roadside. The major percentage of waste generated from the roadside market and hotels are organic wastes such as waste food materials, fruits and vegetables, wood pieces, etc. whereas remaining percentage of waste are plastics, pet bottles, beer/whisky glass bottles, tin cans, broken pieces of glasses, rubber, iron pieces etc. Current practice of waste management observed in the project area is the degradable wastes are managed by local technology, i.e. they make compost manure. Non- biodegradable wastes are collected by municipality and disposed in dedicated locations, there is also seen direct thrown along the roadside, highway or directly disposed into river. All municipalities and rural municipalities allocate budget for collection and the management of solid waste. However, the management of waste exists along the existing highway as well. Bharatpur Metropolitan City and Hetauda Sub-Metropolitan City has landfill site.

Solid waste will be generated from the construction camps and offices, which include food waste, paper and plastic, and garbage. About 600 workers will live in the construction camp and the average solid waste generation per worker will be 0.17 kg per capita/day. Approximately 102 kg waste will be generated from the camps per day.

Further excess materials will generate from construction sites (concrete, discarded material, etc.) workshop, material yards including other debris. In addition, small quantities of hazardous waste will also be generated mainly from the vehicle maintenance activities (liquid fuels; lubricants, hydraulic oils; chemicals, machine/engine filter cartridges; oily rags, spent filters, etc.). Spillage of liquid waste will contaminate with soil and water. Generation of major type of waste during construction is given in the following table.

Table 45: Generation of Non-Hazardous, Hazardous and Liquid Waste during Construction

Aspects	Type of Construction Waste
Non-Hazardous	Vegetations, woods
	Concrete and gravel
	Scrap metal
	Soil, stone
	Scarified/Dismantled Bituminous materials
	Organic Waste from Kitchen/Workers Mess
	Steel reinforcement
	Pipes
	Formwork (timber)
	Paper, cardboard
Hazardous and Liquid Waste	Bitumen
	Scarified Blacktop

Aspects	Type of Construction Waste
	Paint
	Used tires
	Oil filters of construction equipment, vehicles and other machinery
	Out-dated and damaged accumulators
	Waste fuel, lubricants
	Welding electrodes
	Batteries
	Bottles
	Plastics

5.1.18 Climate Change Adaptation Measures

Impact of climate change mainly takes the form of concentrated high rainfall resulting in the accelerated surface run-off from slopes and increased flows in gullies, drainage channels, streams, and rivers, possibility of flash floods, debris flows in rivers/streams, and increase sedimentation. The proposed cross drainage structures are designed based on the historical hydrological data and adding the factor of climate change predictions. The proposed bridges are designed for 100-year return flows, culverts are designed for 50-year return flows, and side drains are returned for 25-year return flows.

For the design of drainage structures, the design floods have been estimated in safe side considering 16% increase in extreme rainfall in future.

Following Climate Change consideration was taken:

World Bank Group and Asian Development Bank have published Climate Risk Country Profile (CRCP) for Nepal through Climate Change Knowledge Portal (CCKP) and concluded following effects of climate change on temperature and precipitation:

- Warming in Nepal is projected to be higher than the global average. By the 2080s, Nepal is projected to warm by 1.2°C–4.2°C, under the highest emission scenario, CRCP8.5, as compared to the baseline period 1986–2005. The range in possible temperature rises highlights the significantly lower rates of warming expected on lower 21st century emissions pathways.
- Rises in maximum and minimum temperatures are expected to be stronger than the rise in average temperature, likely amplifying the pressure on human health, livelihoods, and ecosystems. Temperature increase is expected to be strongest during the winter months.
- Climate change is already having significant impacts on the environment in Nepal, species' ranges are shifting to higher altitudes, glaciers are melting, and the frequency of precipitation extremes is increasing.

- Modelling has suggested that the number of people annually affected by river flooding could more than double by 2030 as a result of climate change. At the same time the economic impact of river flooding could triple.

Following table gives the future rainfall increase in monsoon of Nepal which considered for flood estimation of drainage structures.

Table 46: Comparison of historical rainfall and CCKP output for Nepal

Month	Historical rainfall in mm (1980-2015)	Predicted Rainfall in mm (2020-2099)	Increment
July	326	342	4.9 %
August	279	325	16.5 %
September	202	205	1.5 %

Source: CCKP Portal, 2024

Guidelines for Hydrology and Hydraulic Analysis and River Training Works for Bridge Design, Department of Roads, Government of Nepal, 2020 (Ref. 12 Consideration of Climate Change 1.1.5) has mentioned that the design discharge shall be increased by 10% to consider the impact of climate change. Considering increase in monsoon rainfall in future due to climate change, the average predicted rainfalls have been increased by 16% and all drainage structures are designed considering 16% increase in extreme rainfall in future.

5.2 Biological Environment

The project area lies in Terai, Siwalik, and Dun valley. PHN road traverses through protected areas such as Parsa National Park and its BZ, BZ of Chitwan National Park and Barandabhar Corridor Forest. The project area is located in the landscape of the Terai Arc Landscape (TAL).

5.2.1 Flora

The project area lies in the tropical and sub-tropical forests dominated by Sal and its associated species. The road intersects core area of Parsa National Park from Ch 370+550 to Ch 374+000 and Buffer zone of Parsa National Park from Ch 367+630 to Ch 370+550, Ch 374+000 to Ch 387+200, Ch 387+200 to Ch 391+700 LHS, and Ch 419+250 to Ch 432+200.

PHN road traverse through the Sal Forest Type (SFT) starting 367+300, changing to Subtropical Deciduous Forest Type (SDFT) at 374+000. Crossing Amlekhgunj bridge 1, Riverine Forest Type (RFT) found at 378+040, at 387+680, Ratmate (392+400). Further a small patch of forest was found in 398+800 to 399+600, in Golpingtar. Other various blocks of SFT were found at 405+100 to 406+400 (Bastipur), 409+900 to 410+800 (Sannani Tar), 412+700 to 415+700 (Newarpani), 416+800 to 420+700 (Jyamire) and 426+750 to 439+900 (Manahari, Sunachauri and Mahadevtar) and Barandabhar Corridor Forest.

5.2.1.1 Forest Type by Vegetation

Tropical Evergreen Forest, Tropical Deciduous Riverain forest, and Riverine Khair-Sissoo (Senegali catachu-Dalbergia sisoo) forest are found along the road area.

a. Chir Pine Forest

The chir pine (*Pinus roxburghii*) forest corresponds to sub-tropical pine forest (Champion and Seth, 1968) and *Pinus roxburghii* forest (Stainton, 1972). Naturally, the forest type is found extending from west to central Nepal, at altitude between 1000-2000 m, mostly on south-facing slopes in central and eastern Nepal. Chir pine forests normally do not have a second storey of small trees. It is mixed with sal (*Shorea robusta*) trees in the project area, Churiya hills. This forest is frequently fired and hence does not have climbers and epiphytes, and the ground vegetation is also poor. There was a species elimination trial of eotic pines where the chir acted as control species and was reported the winner species (Ch 391+160 to Ch 391+400).

b. Sal Forest

Sal (*Shorea robusta*) forest at its climax will not have many associated species, and sal tends to dominate other terrestrial vegetation. Sal is capable of colonising new areas with heavy growth of seedlings. However, it prefers the Bhabar region and the alluvium of Tarai where water logging does not occur. Its dominance is thus often broken along streams, rivers, waterbodies and waterlogged patches in the forests.

Sal forest is dominated by sal species and some of the associated species are Bhalayo (*Semecarpus anacardium*), Barro (*Terminalia bellirica*), Asana (*Terminalia tomentosa*). Some of the associated species found are Harro (*Terminalia chebula*), Satisal (*Dalbergia latifolia*), Botdhayero (*Lagerstroemia parviflora*), Banjhi (*Anogeissus latifolia*), Panchphal (*Dillenia indica*), Amala (*Phyllanthus emblica*) and Dabdabe (*Garuga pinnata*). Near riverine association are Khair (*Senegalia catechu*), Sissoo (*Dalbergia sissoo*), Simal (*Bombax ceiba*), Bhellar (*Trewia nudiflora*), etc. Khote salla (*Pinus roxburghii*) is found associated with sal, mostly along the southern faces of the Churia Hills. Some shrubs species associations are Gwello (*Callicarpa macrophylla*), Bhant/Bhanti (*Clerodendrum viscosum*) and others.

Angeri (*Melastoma melabathricum*), Ank (*Calotropis gigantea*), Asuro (*Justicia adhatoda*), Ban kapas (*Thespesia lampas*), Barhamase ank (*Calotropis procera*), Barkula (*Casearia graveolens*), Bayar (*Zizyphus mauritiana*), Beli phul (*Jasminum multiflorum*), Bhant (*Clerodendrum viscosum*), Bhende kuro (*Barleria cristata*), Bhuin amala (*Phyllanthus virgatus*), Bhujetro (*Butea minor*), Bihin (*Solanum anguivi*), etc. A large number of other trees, shrubs, creepers, ferns, flowers and grasses grown in the forest are yet to be identified. More detailed study of the species composition found distributed within the DIZ area will be censused during the EIA study.

c. Tropical Evergreen Forest

Narrow strips along water courses and wet gullies allow for the occurrence of tropical evergreen forests. The true tropical evergreen forest does not occur in Nepal because of the reduced amount of rainfall compared to the regions. Palms, bamboos, screw pines, tree ferns, cycads, canes and rattans may be commonly found among large trees such as *Michelia champaca*, *Eugenia jambolana* and some deciduous species such as *Albizia* sp., *Cedra la toona*, *Acrocarpus fraxinifolius* and so on. Geographical coverage of this forest type is limited and small but the number of species occurring is large; over 45 species of trees and 30 species of shrubs and woody climbers are listed so far (TISC 2002).

d. Tropical Deciduous Riverain forest

The forest type is dominated by *Sal malabaricum*, *Holoptelea integrifolia*, *Schleichera trijuga*, *Ehretia laevis*, *Trewia nudiflora* and *Garuga pinnata*. Sal trees are found in areas away from the riverain habitat. In the riverain area, where annual flooding occurs, the habitat is found occupied by *Senegalia catechu* and *Dalbergia sissoo*.

e. Khair-Sissoo Forest (KSF)

Riverain Khair-Sissoo Forest occurs in the lower tropical area. It occurs along water courses in the Tarai and Dun valleys, within the range of 70 m to 500 m. The forest type occurs near the river side, where annual flooding could occur. Being a pioneer vegetation, the forest appears in new land formed, such as flood plains, small gravel islands, and near flat sand beds formed along water courses. The Khair Sissoo Forests are normally found with uniform canopy / even-aged forests.

Natural sissoo forest never have sissoo regeneration, except some root suckers, but not enough to retain the forest with a pure Khair Sissoo species. The process thus completely displaces the pioneer species. The khair-sissoo forest is often succeeded by *Sal malabaricum*, Dogari (*Eugenia jambolana*), Gutel (*Trewia nudiflora*) and Sindure (*Mallotus philippinensis*) forming tropical deciduous riverain forest or second succession of Khair Sissoo Forest type.

Degraded KSF, due to grazing pressure in the riparian habitat, natural indication of unpalatable, alkaloid-bearing, and thorny species such as *Zizyphus jujuba*, *Acacia caesia*, *Acacia concinna*, *Calotropis gigantea*, *Adhatoda vasica*, *Cassia tora*, *Clerodendrum infortunatum*, *Colebrookea oppositifolia*, etc. take over the vegetation. Common tree species of riverine forest are Simal (*Bombax ceiba*), Sissoo (*Dalbergia sissoo*), and Bhellar (*Trewia nudiflora*) and in the lower canopy / shrub Bhand (*Clerodendrum viscosum*), Bayar (*Zizyphus jujuba*) etc.

The alluvial flood plains support a luxuriant growth of tall and short grasses between the patches of riverine forest. These tall and dense stands of grasses are popularly called 'elephant grass'. Tall

grassland is dominated by kans (*Saccharum spontaneum*), and found along the Rapti and Budhi Rapti riverside. Short grassland, which is mainly dominated by Siru (*Imperata* sp.). It is the most important grass for roof thatching. The KSF have very valuable Khair and Sissoo as both have significant economic value in Nepal.

5.2.1.2 Tree Species Diversity

The tree species in the project area were counted on 2022 and 2025. PHN road is traversing through the Terai and crossing f the Churiya. Lower Tropical Sal and Mixed Broadleaved Forest type is found in the project area. During study 103 species of tree are listed, (> 5 inch dbh has been entered into the tree category). Species found during the tree census survey is given in the table below.

Table 47: Tree species found in the PHN project area

SN	Name of the tree Species			Conservation status		
	Local Name	Botanical Name	Family name	IUCN	National	CITES
1.	Amala	<i>Phyllanthus emblica</i>	Euphorbiaceae			
2.	Amba	<i>Psidium guajava</i>	Myrtaceae			
3.	Ashare	<i>Lagerstroemia indica</i>	Lythraceae			
4.	Ashoka	<i>Phyllanthus indica</i>	Fabaceae			
5.	Asna	<i>Terminalia alata</i>	Combretaceae			
6.	Asor	<i>Justicia adhatoda</i>	Acanthaceae			
7.	Ateri, Tichode	<i>Bauhinia purpurea</i>	Fabaceae			
8.	Aule	<i>Croton roxburghii</i>	Euphorbiaceae			
9.	Badahar	<i>Artocarpus lakoocha</i>	Moraceae			
10.	Badkaula	<i>Casearia graveolens</i>	Flacourtiaceae			
11.	Bakaino	<i>Melia azedarach</i>	Meliaceae			
12.	Banjhi	<i>Anogeissus latifolius</i>	Combretaceae			
13.	Bar	<i>Ficus benghalensis</i>	Moraceae			
14.	Barro/Barau	<i>Terminalia bellirica</i>	Combretaceae			
15.	Bayar	<i>Zizyphus jujuba</i>	Rhamnaceae			
16.	Bel	<i>Aegle marmelos</i>	Rutaceae			
17.	Bhalayo/Dudge	<i>Rhus javanica</i>	Anacardiaceae			
18.	Bharuwa	<i>Flemingia macrophylla</i>	Fabaceae			
19.	Bhatte khirro	<i>Holarrhena pubescens</i>	Apocynaceae			
20.	Bhelauri	<i>Semecarpus anacardium</i>	Anacardiaceae			
21.	Bhogate	<i>Citrus grandis</i>	Rutaceae			
22.	Bhurkot	<i>Hymenodictyon excelsum</i>	Rubiaceae			

SN	Name of the tree Species			Conservation status		
	Local Name	Botanical Name	Family name	IUCN	National	CITES
23.	Bhusune, Bhusure	<i>Leucosceptrum canum</i>	Labiatae			
24.	Birendra phool	<i>Jacaranda mimosifolia</i>	Bignoniaceae			
25.	Botdhairo	<i>Lagerstroemia parviflora</i>	Lythraceae			
26.	Casemia/Kasemia	<i>Madhuca longifolia</i>	Sapotaceae			
27.	Champ	<i>Magnolia champaca</i>	Magnoliaceae	EN	TE P	
28.	Chhatiwan	<i>Alstonia scholaris</i>	Apocynaceae	LC		
29.	Chilaune	<i>Schima wallichii</i>	Theaceae			
30.	Chiuri	<i>Diploknema butyracea</i>	Sapotaceae			
31.	Coconut	<i>Cocos nucifera</i>	Arecaceae			
32.	Dabdabe	<i>Garuga pinnata</i>	Bursaraceae			
33.	Datringo	<i>Ehretia laevis</i>	Cordiaceae			
34.	Deri/dar	<i>Boehmeria rugilosa</i>	Urticaceae			
35.	Dhursul	<i>Colebrookea oppositifolia</i>	Labiatae			
36.	Dudhilo	<i>Ficus neriifolia</i>	Moraceae			
37.	Dumari	<i>Ficus racemosa</i>	Moraceae			
38.	Gulmohar	<i>Delonix Regia</i>	Fabaceae			
39.	Hade	<i>Aporosa octandra</i>	Euphorbiaceae			
40.	Halude	<i>Lannea coromandelica</i>	Anacardiaceae		P	
41.	Harro	<i>Terminalia chebula</i>	Combretaceae			
42.	Ipil ipil	<i>Leucaena leucocephala</i>	Fabaceae	LC		
43.	Jamun	<i>Syzygium cumini</i>	Myrtaceae			
44.	Jinger	<i>Zingiber officinale</i>	Fabaceae			
45.	Kadam	<i>Anthocephalus chinensis</i>	Rubiaceae			
46.	Kalikath	<i>Myrsine semiserrata</i>	Myrsinaceae			
47.	Kalki phool	<i>Callisteomon citrinus</i>	Myrtaceae			
48.	Kalo siris	<i>Albizia chinensis</i>	Fabaceae			
49.	Kapur	<i>Cinnamomum camphora</i>	Lauraceae			
50.	Karma	<i>Adina cordifolia</i>	Rubiaceae			
51.	Karvo	<i>Ficus lacor</i>	Moraceae			
52.	Katahar	<i>Artocarpus heterophyllus</i>	Moraceae			
53.	Keshari phool	<i>Mealaleuca citrina</i>	Myrtaceae			
54.	Khair	<i>Senegalia catechu</i>	Leguminosae	TH		
55.	Khalung, Khallu	<i>Diospyros malabarica</i>	Ebenaceae			

SN	Name of the tree Species			Conservation status		
	Local Name	Botanical Name	Family name	IUCN	National	CITES
56.	Khanyau	<i>Ficus semicordata</i>	Moraceae			
57.	Khasre, Tuut	<i>Ficus hispida</i>	Moraceae			
58.	Khirro	<i>Hollarhena antidysentrica</i>	Apocynaceae			
59.	Kimbu	<i>Morus alba</i>	Moraceae			
60.	Kumbhi	<i>Morus australis</i>	Moraceae			
61.	Kusum	<i>Schleichera oleosa</i>	Compositae			
62.	Kutmero	<i>Litsea monopectala</i>	Lauraceae			
63.	Kyamuna	<i>Hedychium ellipticum</i>	Zingiberaceae			
64.	Lampatey	<i>Duabanga grandiflora</i>	Sonneratiaceae			
65.	Lasune	<i>Dysoxylum gobara</i>	Meliaceae			
66.	Lichi	<i>Litchi chinensis</i>	Sapindaceae			
67.	Maidal	<i>Acrocarpus fraxinifolius</i>	Fabaceae			
68.	Mango	<i>Mangifera indica</i>	Anacardiaceae	LC		
69.	Mashala	<i>Eucalyptus camaldulensis</i>	Myrtaceae	NT		
70.	Maule/Malu	<i>Phanera vahlii</i>	Fabaceae			
71.	Naspati	<i>Pyrus communis</i>	Rosaceae			
72.	Neem/Nimkath	<i>Azadirachta indica</i>	Meliaceae	LC		
73.	Nimaro	<i>Ficus auriculata</i>	Moraceae			
74.	Odal	<i>Sterculia villosa</i>	Sterculiaceae			
75.	Padke siris	<i>Albizia gamblei</i>	Fabaceae			
76.	Parijat	<i>Nyctanthes arbor-tristis</i>	Oleaceae			
77.	Patmero	<i>Cryptocarya amygdalina</i>	Lauraceae			
78.	Peepal	<i>Ficus religiosa</i>	Moraceae			
79.	Pithari/padari	<i>Stereospermum chelonoides</i>	Bignoniaceae			
80.	Pyari	<i>Buchanania latifolia</i>	Anacardiaceae			
81.	Rajbrikshya	<i>Cassia fistula</i>	Fabaceae			
82.	Raniful/Chameli	<i>Jasminum officinale</i>	Oleaceae			
83.	Ratari/Ratripuspa	<i>Cestrum nocturnum</i>	Solanaceae			
84.	Ritta	<i>Sapindus mukorossi</i>	Sapindaceae			
85.	Rohini/Sindure	<i>Mallotus philippensis</i>	Euphorbiaceae			
86.	Ruber	<i>Ficus recuta</i>	Meraceae			
87.	Sadan	<i>Desmodium oojenense</i>	Fabaceae			
88.	Sajiwan	<i>Jatropha curcas</i>	Euphorbiaceae			

SN	Name of the tree Species			Conservation status		
	Local Name	Botanical Name	Family name	IUCN	National	CITES
89.	Sal	<i>Shorea robusta</i>	Dipterocarpaceae		P	
90.	Salifa	<i>Annona squamata</i>	Annonaceae	TH	P	
91.	Salla	<i>Pinus roxburghii</i>	Pinaceae			
92.	Satisal	<i>Dalbergia latifolia</i>	Fabaceae	VU	VU, P	
93.	SetiKath	<i>Hymenodictyon excelsum</i>	Rubiaceae	VU		
94.	Seto siris/Siris	<i>Albizia lebbeck</i>	Fabaceae	CR		
95.	Simal	<i>Bombax cibeia</i>	Bombacaceae			
96.	Sissoo	<i>Dalbergia sissoo</i>	Fabaceae	LC		
97.	Swami	<i>Ficus benjamina</i>	Moraceae			
98.	Tatari/Tata	<i>Dillenia pentagyna</i>	Dilleniaceae			
99.	Tatelo	<i>Oroxylum indicum</i>	Bignoniaceae	VU		
100.	Teak	<i>Tectona grandis</i>	Verbenaceae			
101.	Tejpatta	<i>Cinnamomum tamala</i>	Lauraceae			
102.	Tikuli	<i>Mitragyna parviflora</i>	Rubiaceae			
103.	Vilor/Gutel	<i>Trewia nudiflora</i>	Euphorbiaceae			

Source: Forest Tree Census Survey 2022/2024

(P=National list of timber trees banned for felling, transportation or export, TE=Medicinal plants threatened through over-collection for the export trade (see conservation). Globally state of conservation and action needed - VU = Vulnerable; LC = Least Concerned; CR = Critical; TH = Threatened; NT = Near Threatened; and EN = Endangered

5.2.1.3 Agricultural Biodiversity - Agro-forestry practices and Trees in the settlement area:

PHN road has a rich Agriculture and Biodiversity, as the proposed alignment runs through large block of agriculture, whose biodiversity is enriched by the forest biodiversity interlinked. Tree species from the settlements/agroforestry farms were recorded from the proposed project area. Among the trees mango tree found several. 61 tree species were found intercropped in the project farm area and the details of the species are listed in Table 48.

Table 48: Common agroforestry plants found in the project area.

Nepali Name	Scientific Name	Family	Remarks
Bel	<i>Aegle marmellos</i>	Rutaceae	Fruit
Siris	<i>Albizia lebbeck</i>	Fabaceae	
Bhuikatahar	<i>Ananus comosus</i>	Bromeliaceae	
Sarifa/Sitafal	<i>Annona squamosa</i>	Annonaceae	Fruit
Rukh Katahar	<i>Atrocarpus heterophyllus</i>	Moraceae	Fruit
Bans	<i>Bambusa spp</i>	Graminaceae	
Tanki	<i>Bauhinia purpurea</i>	Fabaceae	

Nepali Name	Scientific Name	Family	Remarks
Shimal	<i>Bombax cibe</i>	Bombaceae	
Coffee	<i>Caffia arabica</i>	Rubiaceae	
Bottle Brush	<i>Callistemon lanceolatus</i>	Myrtaceae	
Chiya	<i>Camelia chinensis</i>	Rubiceae	
Bhang or Gaaja	<i>Cannabis sativa</i>	Cannabaceae	
Mewa/Papita	<i>Carica papaya</i>	Caricaceae	
Lapsi	<i>Choerospondias axillaris</i>	Anacardiaceae	
Kapur	<i>Cinnamomum camphora</i>	Lauraceae	
Tej Patta	<i>Cinnamomum tamala</i>	Lauraceae	
Bhogate	<i>Citrus grandis</i>	Rutaceae	
Kagati	<i>Citrus aurantifolia</i>	Rutaceae	Fruit
Nimbuwa/Chuk	<i>Citrus limon</i>	Rutaceae	
Suntala	<i>Citrus reticulata</i>	Rutaceae	
Junar/ Mousam	<i>Citrus sinensis</i>	Rutaceae	
Nariwal	<i>Cocun nucifera</i>	Arecaceae	
Rudrakshya	<i>Elaeocarpus ganitnus</i>	Tiliaceae	
Amala	<i>Emblica officinalis</i>	Euphorbiceae	Fruit
Faledo	<i>Erythrina indica</i>	Fabaceae	
Shami	<i>Ficus benjamina</i>	Moraceae	
Khanayo	<i>Ficus camia</i>	Moraceae	
Pakhauri	<i>Ficus glaberrima</i>	Moraceae	
Thotne/Khashreto	<i>Ficus hipsida</i>	Moraceae	
Rubber	<i>Ficus recuta</i>	Meraceae	
Peepal	<i>Ficus religiosa</i>	Moraceae	
Nevaro	<i>Ficus rosenbergii</i>	Nevaro/Nimaro	
Dabdabe	<i>Garuga piñata</i>		
Kaiyo Plant	<i>Gravellia robusta</i>	Proteaceae	
Gayo /Gai Tihare	<i>Innula cappa</i>	Asteraceae	
Okhad/Okhar	<i>Juglanus regia</i>	Juglanadaceae	
Thulo Ashare	<i>Largerstromia regime</i>	Lythraceae	
Epil	<i>Leucena leucocephala</i>	Leguminoseae	
Litchi	<i>Litchi chinensis</i>	Sapindaceae	Fruit
Aanp	<i>Magnifera indica</i>	Anacardiaceae	Fruit
Syaau	<i>Malus pumilia/ domestiica</i>	Rosaceae	
Chanp	<i>Michelia champaca</i>	Magnoliaceae	
Kimbu/ Kimi	<i>Morus alba/Nigeria</i>	Moraceae	
Buldhangro	<i>Mucuna macrocarpa</i>	Fabaceae	Flower/Fruit
Kamini	<i>Murra paniculata</i>	Rutaceae	

Nepali Name	Scientific Name	Family	Remarks
Kera/ Kela/ Kola	<i>Musa paradisica</i>	Musaceae	Fruit
Tarkari Kera	<i>Musa sapientinum</i>	Musaceae	
Parijat	<i>Nyctanthus arbutristis</i>	Oleaceae	
Ghyufal	<i>Persia americana</i>	Luraceae	
Chokada/ Chora	<i>Phoenix dactylifera</i>	Arecaceae	
Khurpani	<i>Prunus americana</i>	Rosaceae	
Naspati	<i>Prunus communis</i>	Rosaceae	
Aarubakhada	<i>Prunus domestica</i>	Rosaceae	
Aaru	<i>Prunus persica</i>	Rosaceae	
Aamba	<i>Psidium guajava</i>	Myrtaceae	
Anaar	<i>Punica granatum</i>	Lythraceae	
Putranjiva	<i>Putranjiva roxburghii</i>	Putranjivaceae	
Imili	<i>Tamarindus indica</i>	Euphorbiceae	
Mendula	<i>Tephrosia candida</i>		
Angur	<i>Vitis vinifera</i>	Vitaceae	
Bayer	<i>Zizyphus retundifera</i>	Ramnaceae	Fruit

Source: Forest Tree Census Survey 2024

5.2.1.4 Floral Species with Medicinal Values:

The major species reported during field study were Jamun (*Syzygium cumuni*), Barro (*Terminalia bellirica*), Harro (*Terminalia chebula*), Tatar (Dillenia pantagyna), Wild Guava (*Psidium guajava*), Chiure (*Aesandra butyraceae*), Amala (*Phyllanthus emblica*), etc

Others species found in these forests of the project area, with varying medicinal values are Khair (*Senegali catechu*), Karma/Haldu (*Adina cordifolia*), Bael/Bel (*Aegle marmelos*), Hattibar (*Agave americana*), Chhatiwan (*Alstonia scholaris*), Asarey (Currey tree) (*Murraya koenigii*), Casia Semia, Indrajau (*Holarrhena antidysenterica*), Kharane (*Symplocos paniculata*), Lalikath/Latikath (*Cornus ablonga*) Mahauwa/Mahuwa (*Madhuca longifolia*), Parijat (*Nycatanthes arbotristics*), Pipla (*Piper longum*). Medicinal herbal and NTFPs species found during study are presented with their use values in the Table below.

Table 49: Medicinal plants and their uses

Local Name	Scientific Name	Uses
Jamun	<i>Syzygium cumuni</i>	Treat sore throat, bronchitis, asthma, thirst, biliousness, dysentery and ulcers. It is also a good blood purifier
Barro	<i>Terminalia bellirica</i>	Protect liver and treat respiratory conditions, including respiratory tract infections, cough, and sore throat.
Harro	<i>Terminalia chebula</i>	Treat dementia, constipation, and diabetes and dysentery
Saj	<i>Terminalia Alata</i>	To cure respiratory illnesses such respiratory tract infections, coughs, and sore throats as well as to safeguard

Local Name	Scientific Name	Uses
		the liver.
Tatari	<i>Dillenia pentagyna</i>	Source of fruit, traditional medicine, timber and charcoal.
Wild Guava	<i>Cereya arborea</i>	Treat ulcer, cough, eruptions in the skin, wound and promotes digestion.
Khair	<i>Senegali catechu</i>	stomach problems such as diarrhea, swelling of the colon (colitis), and indigestion.
Babul	<i>Acacia nilotica</i>	Treat human immunodeficiency virus, hepatitis C virus and cancer.
Haldu	<i>Adina cordifolia</i>	Chronic cough, jaundice, stomachache, fodder and swelling in stomach, The Roots are astringent and constipating, and are useful in diarrhea and dysentery.
Bel	<i>Aegle marmelos</i>	Cure inflammation, leaf juice with honey used for fever.
Hattibar	<i>Agave spp</i>	Feed ruminants in arid areas where drought episodes are prevalent.
Chhativan	<i>Alstonia scholaris</i>	Malaria, jaundice, gastrointestinal troubles, cancer and ailments.
Amala	<i>Phyllanthus emblica</i>	In Ayurveda, used as potent rasayana and traditional medicine for the treatment of diarrhea, jaundice, and inflammation.
Asarey	<i>Currey tree</i>	Weight loss, used in dysentery, constipation and diarrhea, Relieves morning sickness and nausea.
Indrajau	<i>Holarrhena antidysenterica</i>	traditional medical system for constipation, colic, and diarrhea.
Kharane	<i>Symplocos paniculata</i>	menorrhagia, bowel complaints, eye diseases and ulcers
Latikath	<i>Cornus ablonga</i>	contains essential oils and tannins – used in folk remedies to treat arthritis and injuries
Mahuwa	<i>Madhuca Longifolia</i>	external application in treating skin diseases, rheumatism, headache, chronic constipation, piles, hemorrhoids and an emetic and galactagogue
Parijat	<i>Nycatanthes arbotristics</i>	anti-helminthic and anti-pyretic; a laxative, in rheumatism, skin ailments
Pipla	<i>Piper longum</i>	chronic bronchitis, asthma, constipation, gonorrhea, paralysis of the tongue, diarrhea, cholera, chronic malaria, viral hepatitis, respiratory infections, stomachache, bronchitis, diseases of the spleen, cough, and tumors.
Black Plum	<i>Eugenia jambolana</i>	
Red date	<i>Ziziphus jujubae</i>	

Source: Forest Survey 2023

5.2.1.5 Conservation status of trees species:

Government of Nepal has identified Sal (*Shorea robusta*) and Satal (*Dalbergia latifolia*) as protected species which are banned from felling, transportation, and export. Globally Sal is least concern, Satal vulnerable and Bijayasal Least concerned.

The data (trees species) collected were also compared and verified to the lists prepared/published by IUCN Red Data List, CITIES and List of Protected, Endangered, Rare and Threatened Plant Species prepared by DNPWC of GON.

5.2.1.6 Forest Management Practice in the Project area

The proposed highway passes through various forests under different management regimes. The details of the management regime found in the project area are as listed in the table below (Table 53). There are Community Forest Management Practice, Collaborative Forest Management Practice, and Private Forest Management Practice (Settlement forests/trees), being practiced in the project area which are adjacent to the RoW. Within the community forests management there are two approaches observed, one with conservation focus and other with production promotion. The conservation focused community forests were largely in the BZ area of a protected or conservation area. Details of these forest management regimes are listed in Table below.

Table 50: Forest Management regimes found in adjacent to the RoW in the project area

Project District	Forests aligned adjacent to the ROW along the road		Management Regime
	Left of Road	Right of Road	
Bara		Parsa BZ -PNP	Community
Bara		Gadimai - PNP	Collaborative
Bara	Settlement (S 376+096)	Settlement Amlekhgunj	Private/Govt
Bara	Ranakumari	Rana Kumari	Community
Bara	Bandevi	Bandevi	Community
Bara		Arakshyand Area	Community
Bara	Mahila Milan	Mahila Milan	Community
Bara	National Forests	National Forest (385+012- 386+757)	Government
Makawanpur	BZ PNP		Community
Makawanpur	Bedkholi		Community
Makawanpur		Churemai	Community
Makawanpur		Ratemate	Community
Makawanpur	Settlement (S-392+146)	Settlement (S-391+108)	Private/Govt
Makawanpur		Mahila Shrijhana	Community
Makawanpur		Settlement (S-392+098)	Private/Govt
Makawanpur		Dandunge	Community
Makawanpur	Parsa BZ (S 397+800)		Community
Makawanpur		Settlement (S-399+755)	Private/Govt
Makawanpur		Lebat	Community
Makawanpur	Settlement (S 407+200)	Settlement (S-406+309)	Private/Govt
Makawanpur		Chanauta	Community
Makawanpur		Settlement (S-410+859)	Private/Govt

Project District	Forests aligned adjacent to the ROW along the road		Management Regime
	Left of Road	Right of Road	
Makawanpur	Aadmara S 414+800		BZCF
Makawanpur		Kalika Hariyali	Community
Makawanpur		Hariyali	Community
Makawanpur		Jyamire Kalika	Community
Makawanpur	Settlement (S 415+700)	Settlement (S-415+773)	Private/Govt
Makawanpur	Aadmara -S 416+400		BZCF
Makawanpur		Jyamire Kalika	Community
Makawanpur	Settlement (S 421+050)	Settlement (S-420+875)	Private/Govt
Makawanpur		Simpani Devkot	Community
Makawanpur		Manakamana	Community
Makawanpur		Pashupati	Community
Makawanpur		Dipad	Community
Makawanpur		Sunachari	Community
Makawanpur	Parsa BZ (S 429+250)		Government
Makawanpur		Lothar	Community
Chitwan		Parewasuri	Community
Chitwan		Surdevi	Community
Chitwan	Parsa BZ (S- 435+190)		Government
Chitwan	Settlement (S- 435+900)	Settlement (S-439+925)	Private/Govt
Chitwan	Tikauli BZCF-S463+400	Panchakanya	Community
Chitwan	Barandabar BZ CF	Ram Beli	Community

Source: Biodiversity Survey (2021)

Note: S = Starting point; Private/Govt = Private and Government owned

5.2.1.7 Important Plant Species from Ethno-botanical Perspective

Some of the species with Ethno-botanical value are tabulated below (Table 51) and more will be studied in the EIA.

Table 51: Ethno-botanical plant species found along the project area

SN	Local Name	Scientific name	Plant parts used
1	Khayar	<i>Senegalia catechu</i>	Edible, polish
2	Bojho	<i>Acorus calamus</i>	Medicinal
3	Ghiu kumari	<i>Aloe vera</i>	Medicinal
4	Chhatiwan	<i>Alstonia scholaris</i>	
5	Tite pati	<i>Artemisia indica</i>	
6	Neem	<i>Azadirachta indica</i>	Medicinal

SN	Local Name	Scientific name	Plant parts used
7	Kuvindo	<i>Benincasa hispida</i>	Edible/fruit
8	Chutro	<i>Berberis aristata</i>	Edible/fruit
9	Pakhan Ved	<i>Bergenia ciliate</i>	Medicinal
10	Palans	<i>Butea monosperma</i>	Medicinal
11	Ganja	<i>Cannabis sativa</i>	Medicinal
12	Rajbrikcha	<i>Cassia fistula</i>	Medicinal
13	Musure katush	<i>Castanopsis tribuloides</i>	Edible/fruit
14	Ghodtapre	<i>Centella asiatica</i>	Medicinal
15	Bethe	<i>Chenopodium album</i>	
16	Lapsi	<i>Choerospondias axillaris</i>	Edible/fruit
17	Tejpat	<i>Cinnamomum tamala</i>	Spices
18	Kyamuno	<i>Cleistocalyx operculatus</i>	Edible/fruit
19	Besar	<i>Curcuma domestica</i>	Spices
20	Kalo Dhaturu	<i>Datura metel</i>	Medicinal
21	Tulasi	<i>Ocimum sanctum</i>	Medicinal
22	Dabdabe	<i>Garuga pinnata</i>	Edible
23	Phaledo	<i>Erythrina arborescens</i>	Edible
24	Mewa	<i>Carica papaya</i>	Edible/fruit
25	Avijalo	<i>Drymaria cordata</i>	
26	Swami	<i>Ficus benjamina</i>	Medicinal

Source: Field Survey, 2022.

5.2.1.8 Aquatic vegetation

In the wetland, rivers and other water bodies of the project area, different type of aquatic vegetation were observed during the survey. The species observed are tabulated below.

Table 52: Name of aquatic plants found in the project area

SN	Local name	Scientific name	Remarks
1	Jalkumbhi	<i>Eichhornia crassipes</i>	
2	Karaute jhar	<i>Leersia hexandra</i>	
3	Mauth jhar	<i>Cyperus sp</i>	
4	Singada	<i>Trapa quadrispinosa</i>	
5	Bandaa jhar	<i>Azolla imbricate</i>	
6	Gande	<i>Argeratum conyzoides</i>	

Source: Field Survey, 2024

5.2.1.9 RoW Tree Loss

Tree Census Survey (TCS) was conducted in 2022, followed by a re-verification in 2025. According to the tree census survey 23,326 nos trees (DBH greater than 5 inch) were recorded to be felled. Following the re-verification, most of the previously recorded saplings had grown into trees. As a result, the estimated number of trees requiring felling has increased to 23,326 due to natural growth over time. Forest Act and Regulation specified a tree to have a DBH of 5 inch and above, all poles and trees are considered trees and below 5 inch which are seedlings and saplings. According to DFRS (2009) and Tamrakar (1993, 1992), Sal and other forests in the Terai and inner Dun valley, during the earlier stage of succession stage (when at sapling stage, dbh between 5 cm to 20 cm, the forest attains its fastest growth. Growth of associated species is faster than Sal species. DFRS (2009) shows that in 4 year's time, even those saplings with 6 cm dbh will increase more than 5 inch. Due to the growth rate it could be assumed that during implementation time there will be many new saplings grown and old sapling attain a tree. The detail list is given in Annex V-A.

Table 53: Understory growth rate of Sal and other tropical forests

		Early selection CWS 25%		Late Selection CWS 25%		Remarks
SN	Crop age (Years)	Species DBH (cm) growth rate				
		Sal	Others	Sal	Others	
1	4	5.14	5.46	-	-	
2	5	6.43	6.39	-	-	
3	6	7.72	7.31	-	-	
4	7	8.73	8.24	6.36	5.49	
5	8	9.98	10.60	7.77	7.38	
6	9	11.23	12.96	9.18	9.28	
7	10	12.17	15.32	10.59	11.17	
8	11	13.39	17.09	12.64	14.18	
	12	-	-	14.69	17.19	

Adopted from DFRS (2009)

5.2.2 Fauna

Mammals

The PHN Road passes through core areas of PNP (Ch 370+550 to Ch 374+000) and BCF (Ch 463+600 - Ch 467+320). The road alignment also travels through the BZ areas of both PNP and CNP, where the movement of mammal is relatively high as compared to other forest area i.e., community forest and collaborative forest. This corridor is constantly hit by anthropogenic development activities, encroachment, roadkill, poaching has made wildlife for the wildlife very difficult. PHN traverses on to the next block starting at Ch 378+040, a large block crossing the whole of Siwalik into the Inner Dun Valley of Hetauda, the forest ends at Ratmate (Ch 392+400). In between there is a tiger bottleneck at the Badahakim bridge. At Golpintar PHN will cross a small patch of forest (Ch 398+800

to Ch 399+600). Following on other blocks are at Bastipur (Ch 405+100 to Ch 406+400), Sannani Tar (Ch 409+900 to Ch 410+800), Newarpani (Ch 412+700 to Ch 415+700), Jyamire (Ch 416+800 to Ch 420+700) and a large chunk at Manahari, Sunachauri and Mahadevtar (Ch 426+750 to Ch 439+900). There is another tiger bottleneck connecting the Middle hills and BZ of CNP. The wildlife is said to be crossing the Rapti river just after Manahari. Finally, the PHN hits a Valued Environmental Component (VEC), Barandabhar Corridor Forest and wetland, almost 4 km of vibrant wildlife movement corridor will be bisected. This is a connector between protected area and the Middle hills for the wide-ranging species.

Chitwan National Park is home for the many mammals like One-Horned rhinoceros, Gaur, Royal Bengal tiger, Rhesus monkey, Terai Gray langur, Indian porcupine, Wild boar, Sambar deer, spotted deer, Hog deer, Barking deer, Wild Dog, Indian mongoose, Five-striped Palm squirrel, Short-nosed Fruit bat etc. Parsa national park is also home to many mammals, some of them are Wild Asian elephant, Royal Bengal tiger, Sloth bear, Common leopard, Sambar deer, Indian Spotted deer and Hog deer among others are found in the park area.

To keep the safety of human and wildlife, it is very important that wildlife in the project area with its passage, movement behavior and location is identified, as essential measures and/or connectivity can be placed to control the accident due to their appearance in the road. In case its visit nearby farm; a situation of direct confrontation arises. A study carried in CNP revealed that Tiger-human coexistence was likely enhanced by abundant tiger prey and low levels of tiger poaching.



Figure 40: Distribution of forests explaining wildlife movement within and linking Terai-Churiya-Hill forests

Wildlife movement is influenced by both green channel (forests) and blue channels (water course/rivers). Human interferences in the wildlife habitat, i.e. forests have a direct consequence in wildlife movement. Community forests in the BZ forest area and around it could play a vital role. When the herbivore preferred species are not found in the forests, they have no other alternative other than to visit the farms nearby. Such movement will attract and force carnivorous species as well to visit the farm. Wildlife drinking water as well needs to be sustained. Water sources at large have guided the wildlife movement. Khageri river flowing through the Barandabar Corridor Forest is impacted by Padampur expansion and human settlement is extending further north. Similarly, the Halkhoriya Lake, is a popular destination of wild animal, as there is no source of water in the PNP core area.

Proposed road passes through, intact large and small block of forests of Terai, Bhabar Tract, Churiya, riverside and Inner Terai forests. The alignment also traversed through rural, semi-urban and urban settlements. The nature of human habitation and farms play important role in wildlife movement and habitat, especially Avian population. PNP is an IBA (Important Bird Area) as well as CNP.

Somehow, distribution patterns of forests together with the management practices followed determines the movement of wild animals. Most of the forests are large block. The forests of Terai, Bhabar tract and Churiya range is distributed in a single block of forest, between Pathalaiya and Hetauda. This allows wildlife a better place to move freely within the forests (Figure 41 and Figure 42).

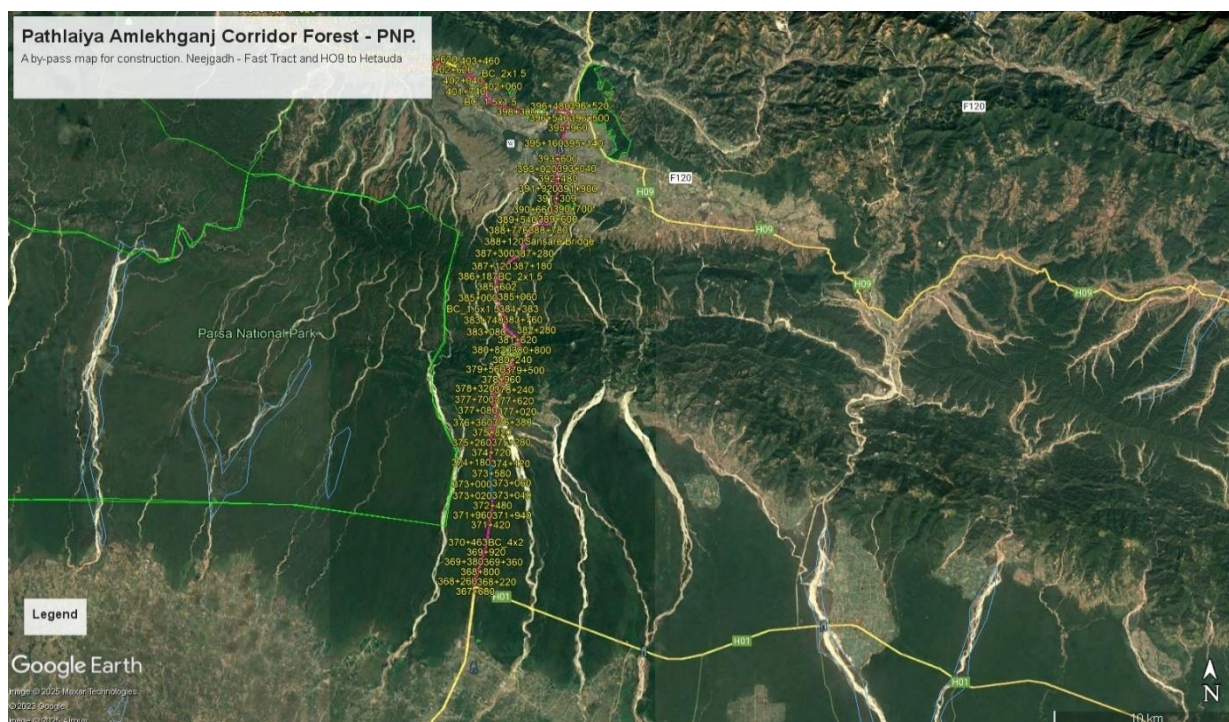


Figure 41: Pathalaiya Hetauda Section: Detouring during construction, so that other roads are not made in the forests

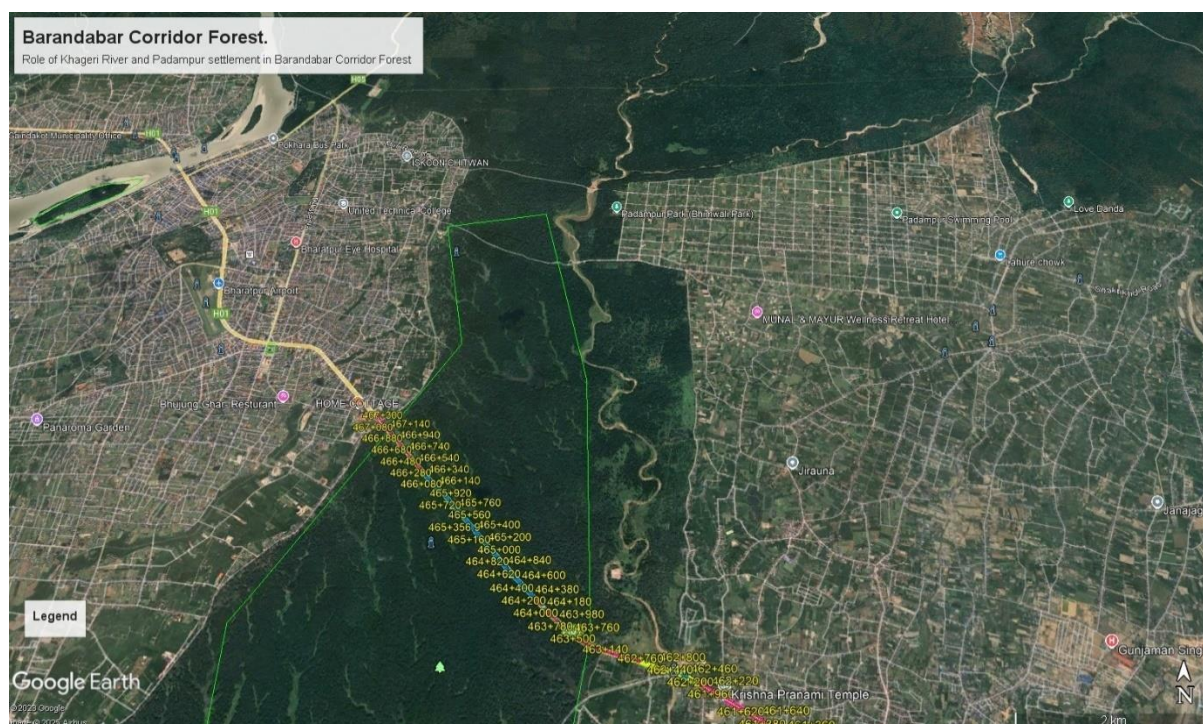


Figure 42: Barandabar Corridor Forest: Detouring from PADAMPUR road during construction

Valued Environmental Components (VECs) Biodiversity

The road intersects core area of PNP from Ch 370+550 to Ch 374+000 and Buffer zone (BZ) of PNP from Ch 367+630 to Ch 370+550, Ch 374+000 to Ch 387+200, Ch 387+200 to Ch 391+700 LHS, and Ch 419+250 to Ch 432+200. The project area lies in the tropical and sub-tropical forests dominated

by Sal and its associated species. The project area is in the landscape unit of the Terai Arc Landscape (TAL) and Chitwan Annapurna Landscape (CHAL).

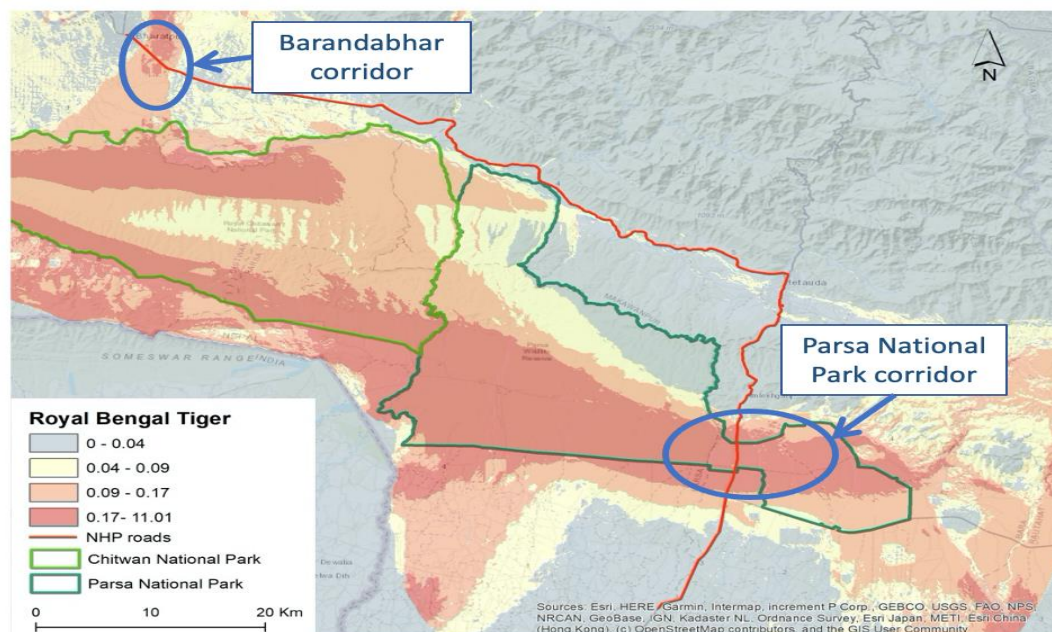
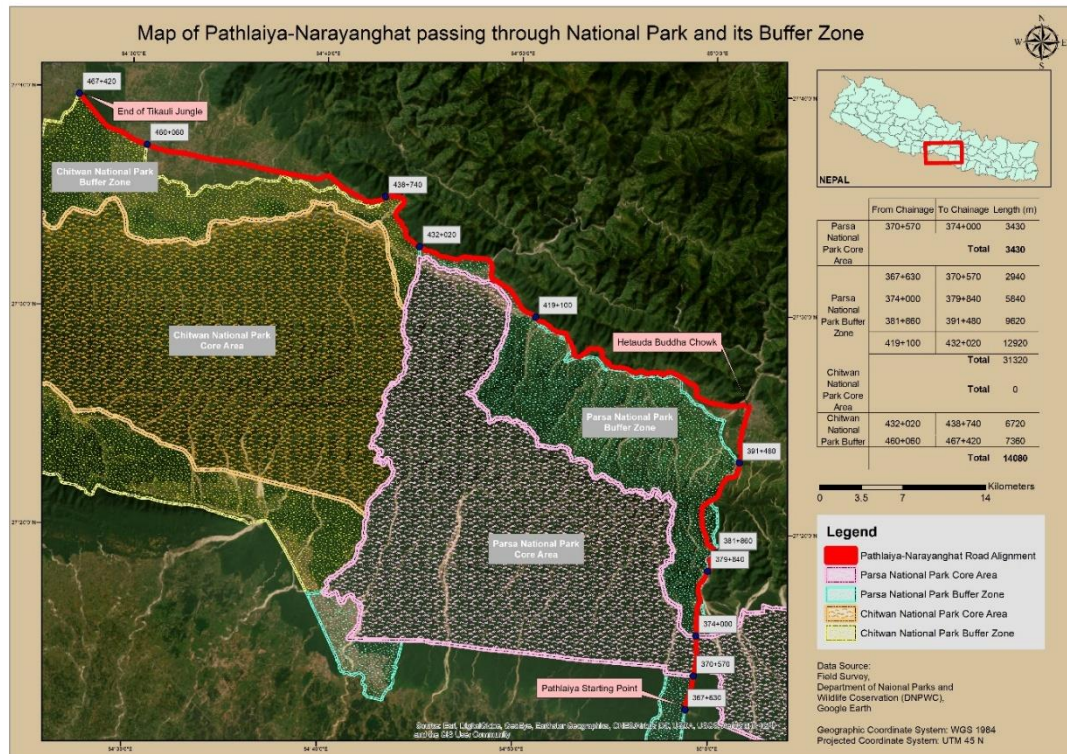
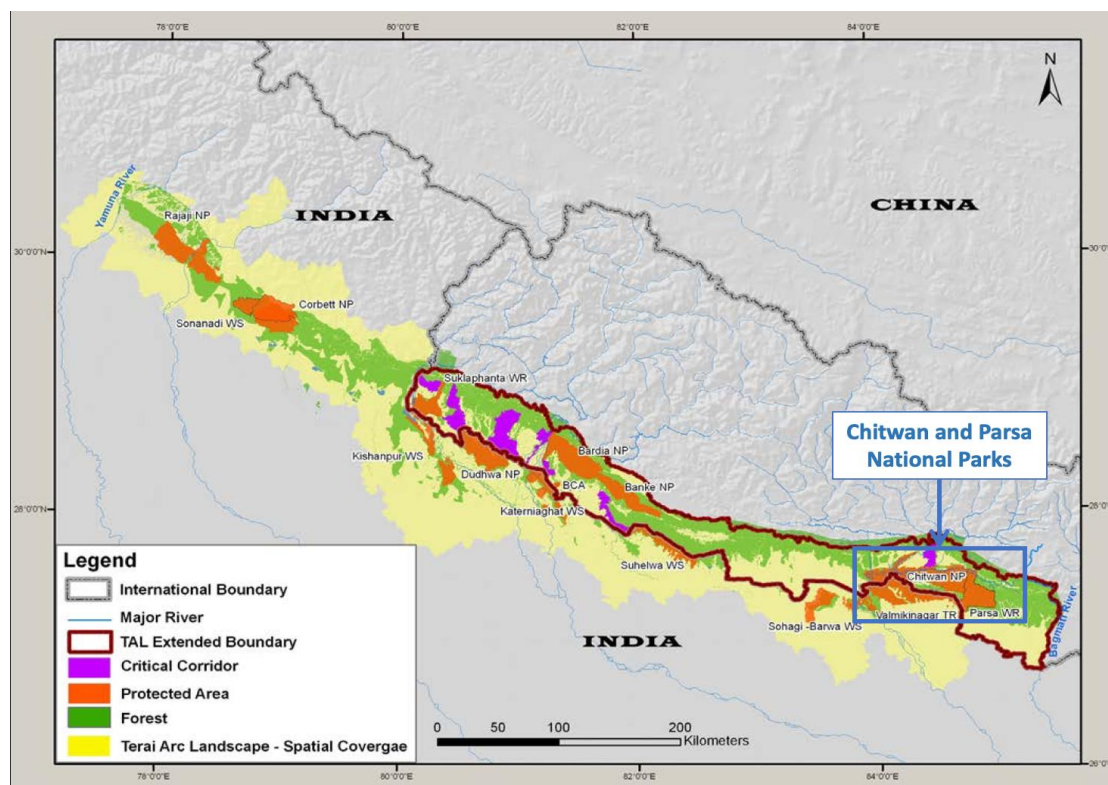


Figure 43: Location of PHN road relative to Chitwan and Parsa National Parks



(Source: Adapted from Ministry of Forest and Soils 2015)

Figure 44: Location of Chitwan and Parsa National Parks within the TAL region

The CHAL is a rich biodiversity landscape, drained by eight major rivers (Kali Gandaki, Seti, Madi, Marsyangdi, Daraundi, Budi Gandaki, Trishuli, Rapti) and their tributaries. CHAL embraces all or part of 19 districts and six protected areas. The Siwalik has unique grasslands and riverine forests, high density of ungulates, high numbers of carnivore species, and a growing population of tiger and rhino (CHAL 2013), that could probably be impacted by PHN highway expansion.

Chitwan National Park (CNP) and Barandabhar Corridor Forest and Wetland (BCFW) are recognized as Important Bird Areas of the country. The Bishazari Lake is also a Ramsar site and Halkhorja is another very important wetland for Avian and Wild animals prevailing within PHN Zone of Influence.

a. Parsa National Park (PNP)

PNP was gazetted as Parsa Wildlife Reserve (PWR) in 1984 and as Parsa National Park in 2017 with an area totalling to 627.39 km². Aim of forming PWR was to preserve Wild Asian Elephant (*Elephas maximus*) and their habitat. PNP has diverse flora and fauna distributed in the tropical and sub-tropical forests of Churia (Siwalik) and Bhabar physiographic regions.

PNP covers a small Terai-Bhawal area with 90% Sal Forest and 10% other mixed hardwood and riverine Khair Sissoo forests with small area of grasslands. It is connected with CNP in the west, Valmiki Tiger Reserve (VTR) of India in the south-west and National forests in the east and north.

The Park also provides extended habitat for migratory wildlife species as well as dispersal site for spill over population of many Largefauna species mainly from CNP.

PNP holds about 530 hectares of grassland. There are 336 species of plants, 37 species of mammals, 490 species of avian fauna and 13 species of reptiles, 3 species of amphibians and 8 species of pisces are reported here. Despite limited wetlands, mainly due to porous soil of bhavar tract, it is an important IBA.

PNP provide shelter to many wildlife species like Wild Asian elephant (*Elephas maximus*), Gaur (*Bos gaurus*), Royal Bengal tiger (*Panthera tigris*), Striped hyena (*Hyaena hyaena*), Asian One-Horned rhinoceros (*Rhinoceros unicornis*), Python (*Python molurus*), Giant hornbill (*Buceros bicornis*), Lesser adjutant (*Leptotilos javanicus*), and Sarus crane (*Grus antigone*) are some of the protected species found in PNP. Among the floral species, Satisal (*Dalbergia latifolia*) and Sal (*Shorea robusta*) found in this region are listed in the category of protected species of GoN.

b. Chitwan National Park (CNP)

CNP and its BZ has a unique landscape which is the amalgamation of floodplain grasslands, Churia hills, riverine forests, tropical Sal forests and unique aquatic systems of Narayani, Rapti and Reu rivers along with many tributaries and various wetlands within, like Bishazari Lake. CPN landscape is connected with PNP in the east, Valmiki Tiger Reserve of India in the south, Barandabhar Corridor Forest and Wetland (BCFW) and Daunne forest in the north. Barandabhar and Daunne forests connect the park to the Churia and Mahabharat ranges.

Chitwan National Park and its BZ is a large, protected area in the Terai and Siwalik. The Park along with surrounding landscape is supposed to be ecologically inclusive. Though, CNP represents all types of habitats of the region, but the aquatic habitat is not adequately included to ensure movement and long-term survival of Gharial, Gangetic Dolphin and other aquatic fauna. About 2/3rd of the park forests spread over the Inner Terai and is Sal Forest. Remaining vegetation is grassland and riverine forests in various stages of succession. The forests are continuously impacted by flood, fire and riverine erosion.

The centre of the park, Kasara, has the purest stands of Sal. Sal is available elsewhere as well in pure and mixed with Chir Pine (*Pinus roxburghii*), mostly along the southern face of the Churia Hills. Some of the associated species found are Harro (*Terminalia chebula*), Satisal (*Dalbergia latifolia*), Botdhayero (*Lagerstroemia parviflora*), Banjhi (*Anogeissus latifolia*), Panchphal (*Dillenia indica*), Amala (*Phyllanthus emblica*) and Dabdabe (*Garuga pinnata*). Near riverine association are Khair (*Senegalia catechu*), Sissoo (*Dalbergia sissoo*), Simal (*Bombax ceiba*), Bhellar (*Trewia nudiflora*), and shrubs species association are Gwello (*Callicarpa macrophylla*), Bhand/Bhanti (*Clerodendrum viscosum*), and others.

c. Barandabhar Corridor Forest and Wetland (BCFW)

The Barandabhar forest intersects the PHN road from Ch 463+600 to Ch 467+320. The forest is dominated mainly by sal forest and partly by riverine and tall and short grassland. 22 species of mammals including Tiger (*Panthera tigris*), Rhinoceros (*Rhinoceros unicornis*), Wild Asian elephant (*Elephas maximus*), Sloth bear (*Melursus ursinus*), Wild boar (*Sus scrofa*), Sambar deer (*Rusa unicolor*), Indian Spotted deer (*Cervus axis*), Hog deer (*Axis porcinus*), Barking deer (*Muntiacus muntjak*) and 280 species of birds including Giant hornbill (*Buceros bicornis*), Hill myna (*Gracula religiosa*), and Storks, waterfowls and wintering birds. It has been listed also as IBA.

Barandabhar forest between Chitwan National Park and Mahabharat Mountain range remained the only forest strip connecting two different ecological systems. It serves to function as a wildlife corridor for some animals and alternative or seasonal/and temporal habitat for others. This forest has been frequently utilized as a corridor by Large-Herbivores like Rhinoceros, carnivores like Tigers and Leopards (*Panthera pardus*) and reptiles like mugger crocodiles (*Crocodylus palustris*).

BCF is a wildlife movement corridor and play a critical role in maintaining connectivity outside of the protected areas ensuring the long-term population persistence and metapopulation integrity of wildlife species. It is a habitat for species like Royal Bengal tigers (*Panthera tigris*), Greater One-Horned rhinoceros (*Rhinoceros unicornis*), and Wild Asian elephants (*Elephas maximus*) among others.

Table 54: Fringe area conservation in Barandabhar Corridor Forest and Wetland

S.N.	Community Forest	Area	Location
1	Indreni	207.7	Va Pu Maha NP
2	Udayapur	199.19	Kalika NP
3	Tin Kanya	198.29	Ichya Kamana
4	Chandisthan	198.55	Ichya Kamana
5	Kali Khola Deurali	197.53	Ichya Kamana
6	Rani Khola	199.61	Ichya Kamana
7	Kalika Pipaltar	200.28	Ichya Kamana
8	Somari	152.84	Ichya Kamana
9	Chaturmukhi	197.65	Kalika NP
10	Thangkhola	199.85	Kalika NP
11	Vimwali	199.53	Kalika NP
12	Padampur	199.40	Kalika NP
13	Panchyakanya	198.73	Ratnanagar NP
14	Rambel	197.11	Va Pu Maha NP
15	Satanchuli	198.1	Va Pu Maha NP

S.N.	Community Forest	Area	Location
16	Jaldevi	197.87	Va Pu Maha NP
17	Nawajagriti	315.76	Va Pu Maha NP
	Total area (ha)	3457.99	

Source: Field Survey, 2022

d. Chure Conservation Area

Chure is also habitat of many mammals, herpetofauna (amphibians and reptiles), and butterflies. Most of the species found in the region are also listed in the CITES Appendices and IUCN Red data book, e.g., Tiger, Elephant, and Rhinoceros. Largefauna like Tiger, Elephant, Rhinoceros, Wild Buffalo, Bison, and many others are flagship species to the Chure and lowland ecosystems. As the landscape is rich in biodiversity, Government of Nepal has established networks of protected areas in Terai-Chure to conserve mostly the major faunal species. Of these protected areas, Chitwan National Park, Parsa National Park, Beeshhajari and Associated Lakes are in Chure-Terai and project area. Young and fragile deposits in Chure provide important nesting sites for birds.

5.2.2.1 Mammals found in the Project area.

The project area is home to different species of mammals (Survey 2023/4). Of this population Chinese Pangolin was the only species found to be critically endangered. Government of Nepal have protected the species. Among others there are 6 (10%) endangered, 4 (6%) near threatened and 9 (15%) vulnerable. Very large species like Asian elephant and Royal Bengal tiger are endangered and Great one horned rhinoceros is vulnerable.

The status is even worst when it comes to national state. Here 15, out of total population is endangered. Chinse pangolin, Asian elephant, Bengal tiger, Honey badger, One Horned rhinoceros is in this category. Government of Nepal has categorized Chinse pangolin and Asian elephant, Bengal tiger, Honey badger, One Horned rhinoceros in the protected category.

Terai Gray Langur a species categorized as endangered in the global category is safe in Nepal. National conservation status of Bengal tiger is yet Endangered (EN), however population growth of the species has reached beyond the carrying capacity of Nepalese forests. A tiger died when it met an accident in the BZ of Parsa National Parks . On the other hand, endangered Asian Elephant is cruelly being killed by encroachers in the East and met an accident/killed by a National Park in an established settlement (Sauraha) of Chitwan National Parks (CNP). Nine species in the list are in vulnerable and under the category species like Common leopard, Sambar deer, Bengal fox, Southern Red Muntjac, etc. are in the category.

Table 55: Mammals found in and around the PHN

S.N.	Name of the mammals			Conservation status				Habitat
	Common	Scientific	Family	NPWC Act	IUCN	National	CITES	
1	Hog Deer	<i>Axis porcinus porcinus</i>	Cervidae		EN	EN	III	Forest
2	Gaur	<i>Bos gaurus</i>		P	EN	VU	I	Forest
3	Hispid Hare	<i>Caprolagus hispidus</i>	Leporidae	P	EN	EN	I	
4	Asiatic Elephant	<i>Elephas maximus</i>	Elephantidae	P	EN	EN	I	Forest, grassland
5	Striped Hyaena	<i>Hyaena hyaena</i>	Hyaenidae	P	EN	NT	III	
6	Smooth-coated Otter	<i>Lutrogale perspicillata</i>	Mustelidae		EN	VU	II	
7	Indian Pangolin	<i>Manis crassicaudata</i>	Manidae	P	EN	EN	I	
8	Chinese Pangolin	<i>Manis pentadactyla</i>	Manidae	P	EN	CR	I	Farmland and edge of forests
9	Honey badger	<i>Mellivora capensis</i>			EN	LC	III	
10	Sloth bear	<i>Melursus ursinus</i>	Ursidae		EN	VU	I	Forest
11	Royal Bengal Tiger	<i>Panthera tigris tigris</i>	Felidae	P	EN	EN	I	Forest
12	Fishing cat	<i>Prionailurus viverrinus</i>	Felidae		EN	VU	II	
13	Greater One-horned Rhinoceros	<i>Rhinoceros unicornis</i>	Rhinocerotidae	P	EN	VU	I	Forest
14	Barasingha	<i>Rucervus duvaucelii</i>	Cervidae	P	EN	VU	I	
15	Four-horned Antelope	<i>Tetracerus quadricornis</i>		P	EN	VU	III	Forest
16	Large Indian Civet	<i>Viverra zibetha</i>	Viverridae		NT	LC	III	Forest
17	Rhesus monkey	<i>Macaca mulatta</i>	Cercopithecidae		SU	LC	II	Forest
18	Black buck	<i>Antilope cervicapra</i>	Bovidae	P	VU	LC	III	
19	Nilgai, Blue bull	<i>Boselaphus tragocamelus</i>	Bovidae		VU	LC	III	Forest
20	Dhole, Asiatic Wild dog	<i>Cuon alpinus</i>			VU	EN	II	Forest
21	Crab-eating Mongoose	<i>Herpestes urva</i>	Herpestidae		VU	LC	III	River beds
22	Southern Red Muntjac, Barking Deer	<i>Muntiacus muntjak</i>	Cervidae		VU	LC		Forest
23	Leopard	<i>Panthera pardus</i>	Felidae		VU	VU	I	Forest
24	Leopard Cat	<i>Prionailurus bengalensis</i>	Felidae	P	VU	LC	II	Forest
25	Sambar Deer	<i>Rusa unicolor</i>	Cervidae		VU	VU		Forest
26	Bengal Fox	<i>Vulpes bengalensis</i>	Canidae		VU	LC	III	Forest

S.N.	Name of the mammals			Conservation status				Habitat
	Common	Scientific	Family	NPWC Act	IUCN	National	CITES	
27	Terai Gray Langur	<i>Semnopithecus hector</i>	Cercopithecidae		NT		I	Forest

5.2.2.2 Roadkill study

Biodiversity baseline assessment report and data were review from TA report of Smart Infrastructure Planning and Design to Protect Natural Habitats and Biodiversity: Ecological Assessment of the NHP Road, 2022 which are summarized below:

“Roadkill and live species surveys started in January 2020 for 5 days/week along the NHP corridor. Data were collected on occurrence of wildlife along the NHP road as roadkill (dead) and live observations of wildlife road-crossings and adjacent to the road. In total, 52 wildlife-vehicle collisions were detected, with jungle cat (*Felis chaus*) and common palm civet (*Paradoxurus hermaphroditus*) being the species with most records. Dhole (*Cuon alpinus*), sloth bear (*Melursus ursinus*) and leopard (*Panthera pardus*) were also recorded as roadkill at the Barandabhar corridor. During the time of the survey, it was also reported that a female tiger was killed by car collision south of Parsa National Park.

Camera trapping was conducted at 82 locations along the NHP road during both wet (June-October) and dry (January-May) seasons. A total of 559 species were detected from the 3909 photos captured by the cameras. The species most detected as Rhesus monkey (*Macaca mulatta* n=64 locations), followed by Southern Red Muntjac (*Muntiacus muntjak* n=56 locations), and wild boar (*Sus scrofa* n=51 locations). Royal Bengal tiger was detected in 20 different locations being the majority in the Barandabhar and Parsa corridors; this pattern of spatial distribution of camera observations is shared for most of the detected species.

Besides camera trapping, a transect method was used to conduct sign surveys when visiting camera traps during set up and removal. Point count bird surveys were conducted at a sub-sample of the camera sites, representing of wide diversity of birds' habitats and terrain in the study area. Field data on the occurrence of arboreal/canopy-dwelling species, in addition to other wildlife such as small- and medium-sized terrestrial vertebrates, were collected as part of the camera/sign surveys. Additionally, 13 underpasses (ranging in size from 0.8 to 28 m) were monitored twice per week from February 2020 to June 2020.

Connectivity modeling: Connectivity models are useful for identifying important habitat linkages and areas for highway mitigation. We used a landscape resistance model (i.e., Circuitscape) based on habitat suitability maps to predict connectivity and identify habitat linkages and movement corridors across the NHP road.

To model connectivity, we selected 17 species (based on the results of species occurrence and roadkill surveys) representative of four groups: large mammals of conservation concern, ungulates, primate of conservation concern (Tarai Grey Langur - *Semnopithecus hector*) and small/medium size mammals. We generated maps of habitat suitability for each of the 17 species combining data on these species' occurrence from NTNC camera trapping (2019) with environmental variables (e.g., altitude, land use, soil type, and human disturbance such as distance to roads, human population density, density of buildings and cattle abundance).

The combined connectivity models for large mammals and small mammals highlighted the importance of Barandabhar and Parsa as key corridors of movement of these species. We also observed that large mammal prey like Chital, Southern Red Muntjac, Sambar and wild boar may likely use these two corridors. For the Tarai Grey Langur, spots of moderate connectivity were found south of Hetauda and in the region of Parsa National Park; mainly along the riverine forests, at Amlekhgunj and Pathlaiya forest blocks. These results are in line with camera trapping detections.

13 road crossing points were detected. Rhesus monkey as the species most detected crossing the roads. 66 observations in the road vicinity, Rhesus monkey and Chital were the species most frequently observed close to the roads with 416 and 156 individuals detected, respectively. Two rhinoceros were observed in the proximity of the road. Most of these sightings concentrated on the road segment between Pathlaiya and Hetauda.

TA report "In total detected 52 wildlife-vehicle collisions. One roadkill of a Royal Bengal tiger was recorded at south of Parsa National Park, though the kill was noted beyond the systematic roadkill survey. Dhole, sloth bear and leopard were also recorded during survey as roadkill at the Barandabhar corridor. Jungle cat was the species with the highest roadkill record followed by common palm civet"¹

Data of DFO Chitwan (2024): In total appearance and kill of Python was highest in Chitwan district, followed by Spotted Deer being killed. There were 68 cases/incidents of wildlife-vehicle collisions in Chitwan district. Mammal species like Tiger, Leopard, Spotted Deer, Sambhar, barking deers and others were recorded (Table below).

Table 56: Species movement and killed and rescued in Chitwan district

Name of the species	Species name in Nepali	%	Ranking
Python	अजाँगर	44.7	1
King Cobra	किङ्ग कोब्रा	0.8	
Dhaman Snake	धामन सर्प	1.2	

¹ Smart Infrastructure Planning and Design to Protect Natural Habitats and Biodiversity: Ecological Assessment of the NHP Road Upgrading Draft Final Report January 2022 TA-9461 (Table 2), Prepared for the Asian Development Bank.

Name of the species	Species name in Nepali	%	Ranking
Tortoise	कछुवा	2.0	
Black Monitor Lizard	कालो गोहो	0.8	
Golden Monitor Lizard	सुनगोहोरो	0.8	
Crocodile	घडियाल गोही	0.8	
Crocodile	मगर गोही	3.3	
Tiger	भाले पाटेबाघ	0.4	
Leopard	चितुवा	0.8	
Spotted deer	चित्तल	23.0	2
Barking deer	रतुवा मृग	8.6	3
Sambhar deer	जरायो	3.7	4
Ghoral	घोरलको वच्चा	0.4	
Porcupine	दुम्सी	0.8	
Fox	फ्याउरो	0.4	
Wild boar	बनेल	1.2	
Monkey	बाँदर	1.6	
Mangos	मलसप्रा	0.8	
Jungle cat	वन विरालो	1.2	
Jackal	स्याल	0.4	
Peacock	मयुर	0.8	
eagle owl	हु-चिल	1.2	
Total		244	

Source: DFO, Chitwan (2024)

Enhancement of wildlife corridors that exists in the PHN area is of highly significance which can be categorized at a regional level. Should be one of the most vibrant area in this region connecting the Terai, Churiya Region (including Dun valley and inner terai) and Mahabharat hill forests. The drinking facilities in the inner terai and Dun valley is ample hence the wild animals from the dry Bhabar Churiya Range travel to these areas and a seasonal visit to the Mahabharat Range for refreshing the health periodically by these mammals.

The PHN section of the EWH should be the only stretch constructed where a very vibrant movement of wild animals are on move, between the flat Terai forests and between the forests of Terai Range, Bhavar/Churiya Range, Dun and Inner Terai Forest area and the forests of Mahabharat Range.

The vibrant nature of the wildlife movement is fascinating, as in this very short period of study a recommendable information on the movement corridor was identified and the study indicates strong

needs for further in depth studies, to foster and specify detailed needs of wildlife in the project area. During study found 4 (four) very prominent wildlife movement corridors were found and they are:

- Adhabar Corridor Forests - Terai <> Terai <> Bhabar Tract
- Barandhabhar Corridor Forests - Terai<>Inner Terai<>Mahabharat Range
- Rajiya Connectivity Forests Complex (including Rapti River) - the Churiya Range/Dun Valley <> Rapti River <> Mahabharat Range and
- Rapti Connectivity Forests - Terai <> Bhabar Tract <> Churiya Range <> Dun valley (Hetauda forests) <> Rapti River/forest <> Mahabharat Mid Hill Forests

For the natural flow of wild animal movement, there will be wildlife crossing structures constructed in the Adhabar Corridor Forests, Bhabar Tract Churiya Hill Forests, Rajiya Connectivity Complex and Barandhabhar Corridor Forests. The details of the structures are discussed in the mitigation chapter.

5.2.3 Avian fauna

The project area is very vibrant from the Avifauna perspective. The Pathalaiya Hetauda Narayanghat (PHN) road is aligned across many large forest blocks, Farms, Rivers, wetland, and other waterbodies.

Wetlands are taken as the transition zone between aquatic and terrestrial habitats and are essential natural territory for numerous faunae, especially for waterbirds. The abundance of waterbirds was found higher during Winter compared to Summer (Basaula, etal 2021). Distance to forest from the wetland determined the Avian species richness. Nearer the forest greater the species population and higher diversity. The habitats for waterbirds in the Bishazari lake complex are degrading due to various anthropogenic pressures and excessively spreading of invasive weeds.

The bird survey was conducted in the month of December 2024 -January 2025 by the point count method. It was ensured that diverse habitats, varying elevations was represented.

5.2.3.1 Birds in the project area

Among all the bird areas spread near and within the project area, Bishhazari and associate lakes (A RAMSAR site), Barandabhar Forests and Wetland, Chitwan National Parks, Parsa National Parks are important ones.

The other is Parsa National Park. Over 250 species have been reported from Parsa National Parks (Todd 2001, Baral and Pradhan 1992). More than 500 species of resident and migratory bird species hover around the park. Some of these birds include White-breasted kingfisher, Paradise flycatcher, large racquet-tailed drongo, Golden-backed woodpecker, etc. The giant hornbill, one of the endangered birds is also seen at times. However, the reserve is very under-recorded, and many more species are likely to be found. There are 245 species of birds living all year round in the forests of the park (<https://ebird.org/region/NP-2-PAR/bird-list> - 2025). Four globally threatened and one near-

threatened bird species occur here. There are large areas of dry tropical forest that are likely to support significant populations of characteristic species of the Indo-Malayan Tropical Dry Zone biome.

The Manahari Buffer zone area of Parsa National Park, embraces similar importance for the birds. With Rapti River in the vicinity, Manahari (425+497) is an important site for the birds, During study 31 bird species was found.

Table 57: Birds found in PHN area.

S.N.	Common Name	Scientific name	NPWC Act	IUCN	National	CITES
1.	Black Kite	<i>Milvus migrans</i>				II
2.	White-rumped Vulture	<i>Gyps bengalensis</i>		CR	CR	II
3.	Blue Whistling-Thrush	<i>Myophonus caeruleus</i>		EN	VU	II
4.	Steppe Eagle	<i>Aquila nipalensis</i>		EN	VU	II
5.	Asian Barred Owlet	<i>Glaucidium cuculoides</i>		LC		II
6.	Asian Openbill	<i>Anastomus oscitans</i>		LC	VU	
7.	Black Stork	<i>Ciconia nigra</i>		LC	VU	II
8.	Black-faced Bunting	<i>Emberiza spodocephala</i>		LC	VU	
9.	Black-winged Kite	<i>Elanus caeruleus</i>		LC		II
10.	Booted Eagle	<i>Hieraaetus pennatus</i>		LC		II
11.	Changeable hawk Eagle	<i>Nisaetus cirrhatus</i>		LC		II
12.	Common hawk-cuckoo	<i>Hierococcyx varius</i>		LC	VU	
13.	Cotton Pygmy-Goose	<i>Nettapus coromandelianus</i>		LC	VU	
14.	Crested Serpent-Eagle	<i>Spilornis cheela</i>		LC		II
15.	Himalayan Buzzard	<i>Buteo refectus</i>		LC		II
16.	Indian Peafowl	<i>Pavo cristatus</i>		LC		III
17.	Jungle Owlet	<i>Glaucidium radiatum</i>		LC		II
18.	Kalij Pheasant	<i>Lophura leucomelano</i>		LC		III
19.	Osprey	<i>Pandion haliaetus</i>		LC		II
20.	Peregrine Falcon	<i>Falco peregrinus</i>		LC		I
21.	Plum-headed Parakeet	<i>Psittacula cyanocephala</i>		LC		II
22.	Scaly-breasted Munia	<i>Lonchura punctulata</i>		LC		III
23.	Alexandrine Parakeet	<i>Psittacula eupatria</i>		NT		II
24.	Asian Woolly-necked Stork	<i>Ciconia episcopus</i>		NT		
25.	Grey Headed fish Eagle	<i>Ichthyophaga ichthyaetus</i>		NT		
26.	Grey-headed Fish Eagle	<i>Ichthyophaga ichthyaetus</i>		NT	CR	II
27.	Himalayan Griffon	<i>Gyps himalayensis</i>		NT	VU	II
28.	Lesser Adjutant	<i>Leptoptilos javanicus</i>		NT	VU	
29.	Oriental Darter	<i>Anhinga melanogaster</i>		NT		
30.	River Lapwing	<i>Vanellus duvaucelii</i>		NT		

S.N.	Common Name	Scientific name	NPWC Act	IUCN	National	CITES
31.	Rock Pigeon	<i>Columba livia</i>		NT		

Source: Field Survey 2024

Note: NT: Nearly Threaten; LC: Least concern; CR: Critically Endangered.

5.2.4 Herpetofauna

Parsa National Park and BZs: The forest along the Pathalaiya to Hetauda road, traverses Adhabar forests of Parsa National Park. Adhabhar forest is crucial habitat for various herpetofauna species, including endangered Golden Monitor Lizards, Bengal Monitor Lizard, Numerous Snakes (such as Indian Rock Python, King Cobra, Nepalese Sand Boa), Frogs, Skinks, and Geckos. The mixed Sal Forest provides abundant shelter, foraging opportunities, and microhabitats like leaf litter, tree trunks, and rock crevices. such as Indian Rock Python, King Cobra, Nepalese Sand Boa.

Chitwan National Park and BZs: Chitwan National Park and its BZs, known for its diverse ecosystem, provide a wealth of habitats for herpetofauna, including wetlands, grasslands, and riverine forests. The park is home to various species such as crocodiles, snakes, amphibians, utilizing its protected areas for breeding and feeding.

Community forest: The community forests between Hetauda and Bhandara also harbor several herpetofauna, where disturbed habitats and natural forests offer resources like fallen logs, leaves, and moist environments suitable for amphibians and reptiles.

Barandabar Corridor Forest and Wetland: This corridor forest, which directly crossed by the road, is an important microhabitat for herpetofauna. The forested areas, wetlands, and diverse vegetation along the corridor provide vital breeding and feeding grounds for various species, especially amphibians and reptiles. Bishazari and Rhino lakes in the corridor forest provide an important habitat for Mugger crocodile and many other species.

Wetland and rivers: The East Rapti river, along with its tributaries, is a key aquatic habitat for numerous herpetofauna species, including the Mugger Crocodile. It's slow-moving waters, banks and surrounding wetland areas provide ideal conditions for reptiles and amphibians, including Snakes, Turtles, and Frogs. The East-West highway crosses the tributaries of East Rapti river such as Manahari river, Lothar river, Budhi Rapti River, Pampha river, Karra River, along with many small rivers and rivulets. These ideal habitats of herpetofauna is directly impacted by the road.

Culverts and Irrigation Canals: These man-made structures create small, localized microhabitats that support a variety of reptiles and amphibians. Moist conditions, water sources, and vegetation near these areas make them important for species like snakes, frogs, and lizards.

Irrigation canal along with the road supports many amphibian species such as *Euphlyctis cyanophlyctis*.

Agricultural Lands: Agricultural lands near these forests and wetlands provide additional microhabitats, especially in the form of irrigation canals, drainage ditches, and disturbed vegetation. These areas are vital for species like skinks, geckos, and snakes, which adapt to the modified landscape.

5.2.5 Fish

Wetlands and Rivers: The East Rapti river, being the crucial habitat for numerous freshwater fish species, including the endangered Sahar Machha (*Tor spp.*), a migratory fish species, and other fishes. The river's varied flow patterns, pools, and rocky substrata supported a diverse fish community. Tributaries like the Manahari, Lothar, Budhi Rapti, Pampha, and Karra rivers further create additional aquatic microhabitats with their own distinctive water flow and seasonal changes. Bilauri river, a torrential stream, has its own characteristics providing habitats for small fishes, and refuge site for large fish species during rainy season.

Bish Hazari Lake: This lake is an important microhabitat for fish, particularly those that thrive in still or slow-moving waters. It supports diverse species and serves as an important spawning ground for various fish species.

Table 58: Herpetofauna Species of the project area

SN	Common Name	Scientific name	Conservation Status	CITES	Remarks
1	Indian Rock Python	<i>Python molurus</i>	NT		
2	Nepalese Sand Boa	<i>Eryx conicus</i>	NT		
3	Golden Monitor Lizards	<i>Varanus flavescens</i>	EN		
4	Bengal Monitor Lizard	<i>Varanus bengalensis</i>	NT		
5	Mugger Crocodiles	<i>Crocodylus palustris</i>	VU		
6	Three-Striped roofed Turtle	<i>Batagur dhongoka</i>	CR	II	
7	Common Krait	<i>Bungarus caeruleus</i>	LC		
8	Banded Krait	<i>Bungarus fasciatus</i>	LC		
9	Oriental Garden Lizard	<i>Calotes versicolor</i>	LC		
10	Marsh Crocodile	<i>Crocodylus palustris</i>	VU	I	
11	Asian Common Toad	<i>Duttaphrynus melanostictus</i>	LC		
12	Skittering Frog	<i>Euphlyctis cyanophlyctis</i>	LC		
13	Gharial	<i>Gavialis gangeticus</i>	CR	I	
14	Spotted House Gecko	<i>Hemidactylus brookii</i>	LC		
15	Indo-Pacific Gecko	<i>Hemidactylus garnotii</i>	LC		

SN	Common Name	Scientific name	Conservation Status	CITES	Remarks
16	Masket Water Snake	<i>Homalopsis buccata</i>	LC		
17	Indian Bull Frog	<i>Hoplobatrachus tigerinus</i>	LC	II	
18	Elongated Tortoise	<i>Indotestudo elongata</i>	CR	II	
19	Spectacled Cobra	<i>Naja naja</i>	LC	II	
20	King Cobra	<i>Ophiophagus hannah</i>	VU	II	
21	Chunam Tree Frog	<i>Polypedates maculatus</i>	LC		
22	Indian Rat Snake	<i>Ptyas mucosa</i>	LC	II	
23	Burmese Python	<i>Python bivittatus</i>	VU		

Source: Field Survey, 2024; Rai et al (2022)

Note: VU = Vulnerable, EN = Endangered, R = Rare, CR = Critically Endangered and LC = Least Concerned

J. Shrestha. 1999. Cold water fisheries of Nepal. FAO Technical Paper No. 385;

J. Shrestha and D.B. Swar. 1998. EIA of Tamor Hydropower Project. NEA.;

J Shrestha. 1998. Aquatic habitat and natural water fish and fisheries inn Nepal. Kathmandu

Fish species found in the project area: The survey was conducted in the month of January. Major rivers in the section are Rapti, Lother and Manohari. Major fish species found in these rivers during the field visit are in Table 59. Local anglers were used to collect fish data from above three rivers.

Table 59: Major fish species found in project area

S.N	English Name	Scientific Name	IUCN	References
1	Indian Mottled Eel	<i>Anguilla bengalensis</i>	NT	Khatri K., et al (2020)
2	Catla	<i>Gibelion catla</i>	LC	Observed
3	Indian trout	<i>Raiamas bola</i>	LC	Observed
4	Tor Mahseer	<i>Tor tor</i>	EN	Chaudhaey, 1994; Shrestha 1994,
5	Rohu	<i>Labeo rohita</i>	NT	Khatri K., et al (2020)
6	River minnow	<i>Raiamas bola</i>	LC	https://en.wikipedia.org/wiki/Trout_barb
7	Copper Masheer	<i>Neolissochilus hexagonolepis</i>	NT	Khatri K., et al (2020)
8	Spotfin Swamp Barb	<i>Puntius sophore</i>	LC	https://en.wikipedia.org/wiki/Pool_barb
9	Faketa	<i>Barilius</i> spp.		Observed
10	Hile	<i>Channa punctatus</i>		Observed
11	Sahar fish	<i>Tor putitora</i>	EN	Observed
12	Chhuche Bam	<i>Macrognathus aral</i>		Observed
13	Goira fish	<i>Acanthocobitis botia</i>		Observed
14	Budhuna	<i>Garra annandalei</i>		Observed
15	Shidhera	<i>Puntius</i> spp.		Observed

Source: Field Survey, 2022

VU = Vulnerable, EN = Endangered, R = Rare, CR = Critically Endangered and LC = Least Concerned

Limitation: Short-term monitoring: The study involved short term monitoring focusing on immediate effects, while long-term population declines, genetic isolation, and habitat fragmentation is not studied.

	
Hile (<i>Channa punctatus</i>) fish in stream	Chuche Bam (<i>Macrogynathus aral</i>) fish in stream
 Group of Shidhera (<i>Puntius</i> spp.) fish in irrigation canal near the road.	

	
Sahar fish (<i>Tor</i> spp.)	Chhuche Bam (<i>Macrognathus aral</i>)
	
Goira fish (<i>Acanthocobitis botia</i>)	Budhuna (<i>Garra annandalei</i>)
	
Faketa (<i>Barilius</i> spp.)	Hile (<i>Channa punctatus</i>)

5.3 Socio-Economic and Cultural Environment

5.3.1 Demography of Project Affected Municipalities

PHN road section lies in Bara, Makawanpur and Chitwan districts. It covers one metropolitan city, 2 Sub-metropolitan cities, 3 municipalities and one rural municipality. Major settlements along the project alignment includes Pathalaiya (Ch 367+630), Amlekhgunj (Ch 371+080), Churiya Mai (Ch 386+050), Ratmate Bazaar (Ch 391+200), Hetauda (Ch 396+460), Newarpani (Ch 411+700), Manahari (Ch 425+700), Lothar (Ch 436+960), Mahadevtar (Ch 439+200), Bhandara (Ch 446+760), Parsa (Ch 454+300), Tandhi (Ch 459+680), Bharatpur Gondrang (Ch 467+320). Total population of the project municipalities have 957,699. The male population has 470,348 (49%) and female population has 487,351 (51%).

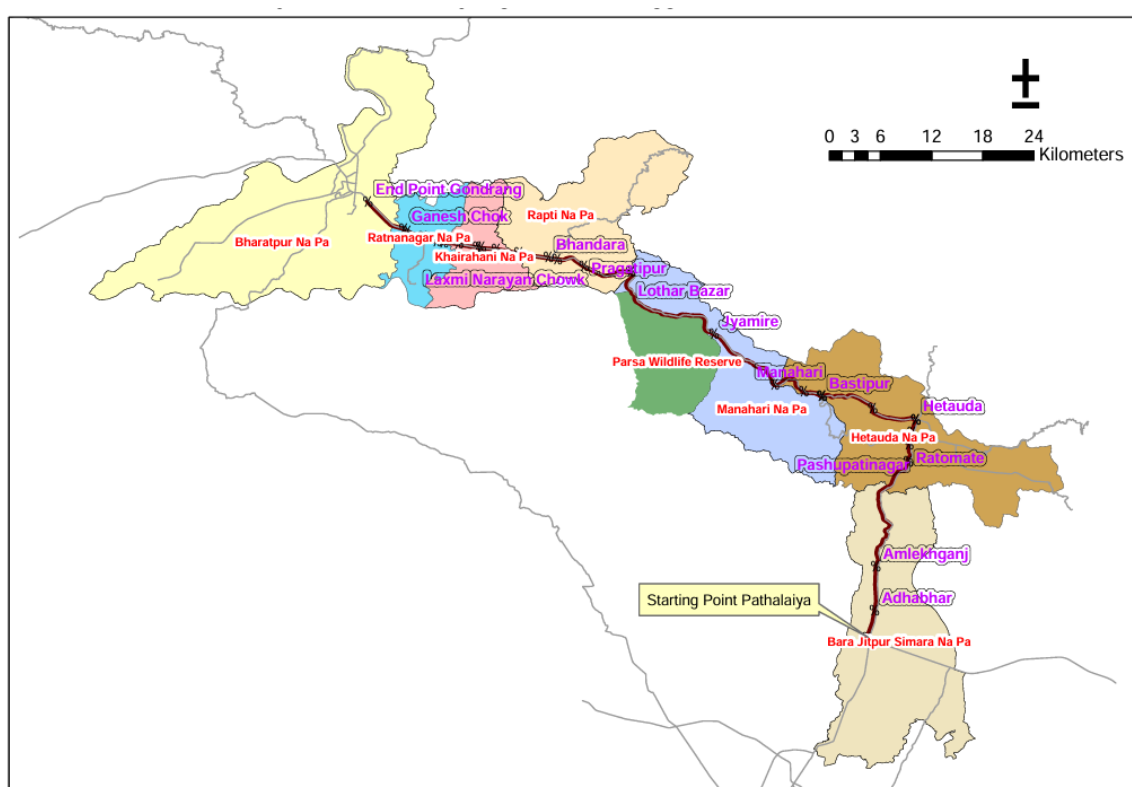


Figure 45: Major settlements along the road

Table 60: Population composition of project municipalities

SN	Municipality	District	Male	Female	Total
1	Jitpur Simara Sub-Metropolitan City	Bara	60,461	58,687	119,148
2	Hetauda Sub-Metropolitan City	Makawanpur	97,324	98,627	195,951
3	Manahari Rural Municipality	Makawanpur	22,986	24,158	47,144

SN	Municipality	District	Male	Female	Total
4	Rapti Municipality	Chitwan	32,609	33,817	66,426
5	Khairani Municipality	Chitwan	33,104	35,571	68,675
6	Ratnagar Municipality	Chitwan	44,120	46,858	90,978
7	Bharatpur Metropolitan City	Chitwan	179,744	189,633	369,377
	Total		470,348	487,351	957,699

Source: Municipality Profile 2018

5.3.2 Population Composition of the affected wards under Municipality

Total HHs of the affected wards under Sub-metropolitan city/Municipalities/Rural Municipalities is 68,370 and Total population under affected wards is 313,438. The detail is presented in Table below.

Table 61: Population composition of the affected wards under municipality

Municipality	Total Ward Affected	Total HHs	Male	Female	Total Population	Remarks
Jeetpur Simara Sub-Metropolitan City	1,21,22	2851	6867	6579	13446	District profile, Bara 2074
Hetauda Sub-Metropolitan City	1,3,4,8,9,10,11,14,15,19	18937	41887	42763	84650	District Profile; 2074
Manahari Rural Municipality	6,7,8,9	4603	10338	10573	20911	RM Profile 2075
Rapti Municipality	1,2,3,4,5,6,7,8	9367	24477	22697	47174	RM Profile 2075
Khairani Municipality	1,2,8,9	12340	26748	30177	56925	RM Profile 2074
Ratnagar Municipality	1,2,3,4,9,10	16090	33579	36647	70226	RM Profile 2074
Bharatpur Metropolitan City	9, 12	4182	9735	10371	20106	Metropolitan city profile 2076
Total	37	68,370	153,631	159,807	313,438	

Source: Municipality Profile 2018

Further 20% of the total households from the project influence region were selected using a systematic random sampling method. The household survey questionnaire was developed in Nepali, the lingua franca among Nepali people. The household survey was carried out July-August, 2022. During the baseline survey, altogether 1867 households were interviewed. HHs survey was conducted

to assess the socio-economic conditions, community perceptions towards the project, to identify poor and vulnerable groups, poverty levels, gender status, social risks, and community involvement in project implementation. Total population of 1867 HHs are 10,050 comprising 5,246 males (52.2%) and 4,804 females (47.8%). the average household size is 5.4, which is higher than the district average of 4.8.

The project area is predominantly inhabited by Brahmin/Chhetri accounting for 895 HHs (47.94%), this is followed by Indigenous People (IP) with 748 HHs (40.06%), Madhesi with 76 HHs (4.07%), Dalit with 129 HHs (6.91%) and Muslims with 19 HHs (1.02%) (*Source: PSA Report 2024*). Among the Indigenous Peoples, the major ethnic groups include Tamang, Magar, Chaudhary, Newar, and Gurung, with Tamang being the predominant group.

Population by Age Group of the Sampled Households: Based on the socio-economic survey conducted in the project area, the population distribution across age groups is as follows, 16-25 years is 19.30% whereas population in the range of 26-60 years is 50.74%. Population aged 61 and above is 10.56%. Table below shows the total population with different age groups.

Table 62: Population by Age Group of the Sampled Households

Age Group	Sex			Percentage (%)
	Male	Female	Total	
0-5	330	302	632	6.29
6-15	737	581	1318	13.11
16-25	1008	932	1940	19.30
26-60	2614	2485	5099	50.74
61-75	424	386	810	8.06
>75	133	118	251	2.50
Total	5246	4804	10050	100

Source: PSA Report 2025

5.3.3 Literacy Level

Out of the total surveyed population of 9,691 individuals, 89.3% are literate, while 10.7% are illiterate. The literacy rate among males is significantly higher at 93.6%, compared to 84.6% among females. Conversely, 6.59% of males and 15.38% of females are illiterate, highlighting a gender gap in educational attainment.

Table 63: Literacy Status of Surveyed Populations

Education Status	Male		Female		Total	
	No	Percentage (%)	No	Percentage (%)	No	Percentage (%)
Literate	4723	93.6	3922	84.62	8645	89.3
Illiterate	333	6.59	713	15.38	1046	10.7
Total	5056		4635		9691	

Source: PSA Report, 2025

5.3.4 Caste and Ethnic Group

The project area, which includes several Rural Municipalities and Municipalities, is predominantly inhabited by Indigenous Peoples, including Tamang, Magar, Chaudhary (Mahato/Tharu), Newar, and Gurung communities. Indigenous Peoples represent 40.06% of households, Brahmin/Chhetri account for 47.94%, Dalits make up 6.91%, Madhesis comprise 4.07% and Muslims represent 1.02%. Most Janajati groups—including Tamang, Magar, Chaudhary (Mahato/Tharu), Newar, and Gurung—as well as Madhesi communities, speak their native languages. However, Nepali serves as the national language and the common lingua franca, facilitating communication across diverse ethnic groups. The ethnic composition of the project area is shown in the table below.

Table 64: Ethnic Composition

S.N.	Ethnicity	HHs	Percentage (%)
1	Indigenous (Janjati)	748	40.06
2	Dalit	129	6.91
3	Muslim	19	1.02
4	Madhesis	76	4.07
5	Brahmin/Chhetri	895	47.94
	Total	1867	100

Source: PSA Report 2025

5.3.5 Occupation

The project area exhibits a diverse range of occupations among its economically active population. Nearly 7.36% are engaged in foreign employment. 10.13% are involved in agriculture is. 12.41% engaged in business (i.e., Hotels and Lodge, Grocery, Food Grain vegetable and fruit shop, Tea shop, Cloth shop, electronics, and mobile maintenance, stationary, garage and vehicle maintenance, and Hardware, beauty parlors, tailoring etc.) contributing the family income by these businesses. A notable 15.71% of the population are homemaker.

The survey highlights the multi-source income structure of households and the growing importance of foreign employment in improving socio-economic condition. Details are presented in the table below.

Table 65: Main Occupations of the Households

Occupation	Sex	No. of People	Percentage (%)
Agriculture	Male	551	5.48
	Female	467	4.65
Agricultural Labor Work	Male	491	4.89
	Female	123	1.22
Service	Male	626	6.23
	Female	274	2.73

Business	Male	792	7.88
	Female	455	4.53
Foreign Employment	Male	523	5.20
	Female	217	2.16
Students	Male	1590	15.82
	Female	1331	13.24
Jobless	Male	261	2.60
	Female	188	1.87
Home Maker	Male	0	0.00
	Female	1579	15.71
Others	Male	412	4.10
	Female	170	1.69
Total		10050	100

Source: PSA Report 2025

5.3.6 Health, Sanitation Condition and Drinking Water Facilities

The socio-economic survey revealed that tap water is the primary source of drinking water across the project area, particularly for households located near the highway. In contrast, households situated in the outskirts rely more on tube wells and boring water systems. This variation reflects differences in infrastructure accessibility and water supply coverage across different zones of the project area. Details are presented in the table below.

Table 66: Sources of drinking water

S.N.	Sources	Number of HHs	Percentage (%)
1	Tap	1252	67.06
2	Well	102	5.46
3	Tube well	330	17.68
4	Boring	104	5.57
5	Hand pump	11	0.59
6	Public tap Water	56	3.00
7	Others	12	0.64
	Total	1867	100

Source: PSA Report 2025

Access to sanitation is a key indicator of public health. In the project area, the majority of households use septic tank toilets, accounting for 87.31% of the population. 8.94% of HHs use flush toilet whereas 3.75% rely on pit toilet. The types of toilets being in use along the project area are listed in the table below.

Table 67: Type of toilets available

S.N.	Types of Toilet	Number of HHs	Percentage (%)
1	Flush Toilet	167	8.94
2	Septic Tank Toilet	1630	87.31
3	Pit Latrine	70	3.75
	Total	1867	100

Source: PSA Report 2025

The project area is served by several health posts, hospital along the project alignment. Major health issues reported by the local residents include gastric problem, water borne diseases, Gynecological conditions, respiratory illnesses, skin infections, malnutrition, typhoid, parasitic infections (e.g. Worms). Encouragingly, sanitation awareness is increasing among the local population, and a growing number of households now have access to toilet facilities, contributing to improved public health outcomes.

5.3.7 Economic and Poverty Situation

The socio-economic survey of households along the project road revealed a diverse income profile, Majority of the sampled households earns above 400,000 annually contributing to 69.44% and 14.24% people earn between 301,000-400,000. 10.82% earns between 201,000-300,000. 5.50% earns in the range of 100,000-200,000 per year. Table below shows the income range of sampled households.

Table 68: Households having different income level.

Income Range	No. of HHs	Percentage (%)
100000-200000	103	5.50
201000-300000	202	10.82
301000-400000	266	14.24
Above 400000	1296	69.44
Total	1867	100

Source: PSA Report 2025

5.3.8 Food Sufficiency

The primary sources of household income in the project area includes business, foreign employment, agriculture, governmental/non-governmental services. As part of the socio-economic survey, the food sufficiency level at survey household were assessed. Out of the total 1867 households, 17.62%, or 329 households, have sufficient food throughout the year, 1.77% have food sufficiency for 10 to 12 months, 3.11% have food sufficiency for 7 to 9 months, 7.28% have food sufficiency for 4 to 6 months. 8.78% have food sufficiency for less than three months and 61.44% HHs have depend upon other source of food like small business (tea & snacks/restaurant etc.).

Table 69: Food sufficiency status

S.N.	Food Sufficiency Months	No. of HHs	Percentage (%)
1	0-3 months	164	8.78
2	4-6 months	136	7.28
3	7-9 months	58	3.11
4	10-12 months	33	1.77
5	12 months	329	17.62
6	Others	1147	61.44
	Total	1867	100

Source: PSA Report 2025

5.3.9 Types of House/Buildings

According to the socio-economic survey, 54.58% of the sampled households in the settlements have modern houses (RCC with pillar), 17.35 percent have RCC (without pillar), 4.61 percent have wood and block houses. 2.25 percent have soil and rocks houses, and 21.21 percent have other types of houses.

Table 70: Types of houses in sampled households

S.N.	Type of House	No. of HHs	Percentage (%)
1	R.C.C (with pillar)	1019	54.58
2	R.C.C (without pillar)	324	17.35
3	Wood	86	4.61
4	Soil and Rocks	42	2.25
5	Others	396	21.21
	Total	1867	100

Source: PSA Report 2025

5.3.10 Access to Basic Facilities and Services

The main market centres provide access to fundamental services such as schools, health/sub-health posts, primary health centres, local markets, main markets, district headquarters. According to the socio-economic survey, hospitals are located within 40 minutes' walking distance from the most settlements and medical facility are accessible within 20 minutes. Primary, Lower Secondary and Secondary Schools are typically located walking distance of 11-20 minutes. Primary health care, health posts and sub health posts services are easily accessible within 15 minutes. Table below shows the access to basic facilities and services.

Table 71: Access to basic facilities and services

S.N.	Services	Mode of Transportation Travel Time
1	School	11 minutes
2	College	20 minutes
3	Medicinal Facility	20 minutes
4	Ayurvedic Centre	25 minutes
5	Health Centre	11 minutes
6	Health Post	11 minutes
7	Hospital	40 minutes
8	Veterinary	25 minutes
9	Agricultural Service Centre	25 minutes
10	Bazar	11 minutes
11	Local Body Office	11 minutes

Source: PSA Report 2025

5.3.11 Market

Several major market centers are located along the project road alignment, serving as key hubs for daily commodities and essential services for local residents and nearby settlements. These includes Amlekhganj (Ch 371+080), Hetauda (Ch 396+460), Manahari (Ch 425+700), Lothar (Ch 436+960), Bhandara (Ch 446+760), Parsa (Ch 454+300), Tandi (Ch 459+680) and Bharatpur (Ch 467+3500).. n addition to these established centers, small local markets are emerging at various points along the highway, contributing to increased access to goods and services. These market centers play a vital role in supporting the economic activities and livelihoods of the local population. Furthermore, settlements along the highway are gradually expanding, driven by improved connectivity and access to infrastructure, indicating a trend of urbanization and regional development.

5.3.12 Agriculture

The major crops grown in the project area includes paddy, maize, wheat, mustard oil, oilseed, potato, sugarcane, etc. In addition to staple crops, the region is known for its fruit and vegetable production, with banana, mango, and papaya being the most prominent fruits grown. A variety of vegetables are also cultivated to support local consumption and market demand. The cropping pattern varies across locations depending on land fertility and availability of irrigation. Fertile lands with year-round irrigation are typically cultivated three times a year, while other areas are cultivated twice annually. The project district's cash crop portfolio includes sugarcane, banana, maize, potato, mango, papaya, and a wide range of vegetables, contributing significantly to the local economy and food security.

5.3.13 Sources of Energy

Electricity is the main source of lighting energy, used by more than 80 percent households in project affected municipalities. For cooking, however, majority of the households rely on LPG, firewood and biogas. Use of electricity for cooking purpose is comparatively low in project area. This energy usage pattern reflects both the availability of infrastructure and the economic preferences of households in the region.

5.3.14 Community Structures

A total of 180 community structures are present within the Project corridor of impact, these includes 5 resting places, 23 temples (small size), 28 public tube wells, 19 police/traffic beats, 4 public toilets, 15 walls & gates and 6 government structures. The temples and the resting places are built by brick-cement mortar and will require to be rebuilt in consultation with the community. Table below presents the details of community structures to be affected during widening of the road. Detailed list of affected public structures are provided in Annex VI-D.

Table 72: Summary of Affected Community Structures

S.N.	Structure Types	No.
1	Resting Place (Pratikshalaya)/Bus Stop	85
2	Temple Small (Like Deities' Place)	23
3	Wall & Gate	15
4	Public Tube Well/Tap	28
5	Public Toilet	4
6	Government Utility Aanterick Karalaya, School Canteen, Valve Chamber, Container, Water Tank, Structure of Pond etc)	6
7	Police Beat/Traffic Post	19
	Total	180

Source: RAP of PHN Road 2025

5.3.15 Affected Private Structures

Beside the Hetauda Bazar section (Ch.394+320-397+620), A total of 403 private structures will be affected by the project along the alignment. These includes residential, resident cum commercial, commercial, sheds and others as well as 2 institutional buildings.

Out of the 403 private affected structures, 46 are residential structures, 116 are residences cum commercial structures, 129 are commercial structures and 112 are others. Among the total affected households, 30 residential households comprising 165 individuals and 28 commercial structures comprising 154 individuals will be fully impacted and require relocation. The affected commercial structures are used exclusively for business purpose. Therefore, only the 30 residential households and

28 residential-cum-commercial households will be physically displaced due to the project. Additionally, 60 movable kiosks (Ghumti) located within the 50-meter Right of Way (RoW) will need to be relocated as part of the project intervention. Further details are provided in the Resettlement Action Plan (RAP).

Table 73: Detail of affected private structures

Affected Assets	Partially Affected	Fully Affected	Total	Percentage (%)	HHs	Affected Persons
Residential Structures	16	30	46	11.41	46	253
Residential cum Business Structure	88	28	116	28.78	113	622
Commercial Structures (temporary shed)	16	113	129	27.06	123	677
Other Structure (Cattle shed, wall, gate etc)	11	101	112	32.75	96	528
Total	131	272	403	100	378	2079

Source: RAP of PHN Road, 2025

5.3.16 Historical and Cultural Sites

Although the project area itself does not contain any officially recognized cultural heritage sites, the project districts are home to numerous religious and culturally significant locations. The population in the area is diverse, with varying cultural values across different ethnic groups. Prominent religious sites in the vicinity includes Gorakheshwor temple at Hetauda, Laxmi Narayan temple, Mukundeswor temple, Churiya Mai are famous in the project area. The Churiya Mai Temple holds special cultural significance. It is widely believed to protect pilgrims from accidents and misfortunes, making it a vital spiritual landmark for local communities.

Adjacent to the Churiya Mai Temple lies Nepal's first tunnel, designed in 1917 by Brigadier General Dillijung Thapa, Nepal's first civil engineer. Although the tunnel has been unused since the construction of the Pathalaiya–Hetauda road, it remains a historical structure. Due to decades of disuse and lack of maintenance, the tunnel is currently non-functional. However, Hetauda Sub-Metropolitan City, in collaboration with the Churiya Mai Temple and Tunnel Conservation Committee, is actively working on its conservation.

Several religious sites fall within the Right of Way (RoW) and may be impacted by road and bridge widening activities. These includes Bhimsen temple Ch 368+050 (out of RoW), Churiya Mai (Ch 386+050), Churiya mai Tunnel at Ch 387+160, Compound wall of Nava Durga Temple within CoI (Ch 394+360), Gorachheswor Temple at Ch 397+280, footsteps, Om Kareshwor Mahadev area at Ch 398+100, Krishmna Temple small Ch 411+800, Shiva Parbati temple at Ch 420+970, Jaleshwor Shiwalaya at Ch 421+320, Shiva temple at Ch 424+180, Babadham at Ch 424+740. A detail religious site (Temples) along the road alignment is presented in the table below.

Table 74: Cultural Resources along the Road

Chainage	Name of Structure	Municipality	Distance	Side
368+040	Bhimsen Temple	Jitpur Simara	Out of RoW	LHS
367+320	Shiva Trishul	Jitpur Simara	COI	LHS
376+620	Pipal tree	Jitpur Simara	ROW	RHS
376+620	Durga Temple	Jitpur Simara	CoI	RHS
378+150	Small Temple	Jitpur Simara	ROW	LHS
386+760	Churiya Mai		ROW	RHS
387+160	Chure Tunnel		ROW	RHS
389+700	Kirat Temple		Out of RoW	
391+000	Sarswati Temple		ROW	RHS
391+240	Ganesh Temple		ROW/COI	RHS
392+600	Shiva Temple		Out of ROW	RHS
393+500	Ganesh Temple		COI	RHS
394+360	Nabadurga Temple		Gate+ Compound wall	LHS
397+280	Gorakheshwor Temple		ROW Foot steps	LHS
398+100	Om Kareshwor Temple		ROW, Compound wall	RHS
399+020	Ganesh Temple		COI	RHS
399+580	Bageshowari Temple		COI	LHS
400+320	Small temple		ROW	LHS
400+780	Small temple private		COI	LHS
402+600	Dhaneshowar Mahadev		COI	RHS
403+180	Laxmi Narayan Temple		COI	LHS
403+820	Small private Churiyamai		COI	RHS
404+960	Small Santaneshwor		ROW	RHS

Chainage	Name of Structure	Municipality	Distance	Side
	Mahadev			
408+480	Monument		ROW	RHS
409+540	Riksheshwori Temple		Shed affected	LHS
410+840	Nandeshwori Devalaya, Small		COI	RHS
411+560	Krishna Temple		COI	LHS
411+800	Krishna Temple		COI	RHS
413+900	Small Temple		COI	LHS
414+740	Gupteshwor temple		Out of ROW	RHS
415+680	Shree Jalpa Devi		ROW	LHS
419+940	Shree Jangaleshwor Mahadev		Out of ROW	LHS
420+970	Shiva Parbati		COI	LHS
421+320	Jaleshwor Shivalaya		COI	LHS
421+700	Church		Out of ROW	RHS
421+940	Ganesh Temple		ROW	LHS
422+400	Jaleshwor Mahadev		COI	RHS
424+180	Shiva Temple, private		COI	RHS
424+740	Babadham		COI	LHS
426+060	Shree Bajrangabali		Out of ROW	LHS
434+040	Religious tree		COI	RHS
445+520	Laxmi Narayan, Private		ROW	RHS
444+250	Mukundeshwor Sivalaya		Out of ROW	RHS
446+740	Small Temple		COI	RHS
447+948	Ganesh Temple		ROW	LHS
457+320	Ganesh Temple		COI	LHS
457+997	Mukteshwor		ROW	LHS
459+300	Small temple		ROW	RHS
462+120	Krishna Temple		Out of ROW	RHS

Source: PSA report ,2025/Field Survey, 2024

5.3.17 Festivals and Other Rituals

The project area is home to followers of Hinduism, Buddhism, Islam and Christianity. each contributing to the region's rich cultural and religious diversity. Numerous temples and places of worship, along with distinct traditions and practices, reflect the spiritual significance of these communities. Dashain, Tihar, Chath Parba, Loshar Maghe skranti, Shrawan Purnima, Eid, Christmas,

etc are major Hindu festivals in the project area. Buddha Purnima is the big day for the Buddhist communities. Similarly, Eid-ul-Fitr and Eid-ul-Azha are celebrated by Muslim communities. Christmas is the most widely celebrated festival for Christian followers followed by Easter.

5.3.18 Affected Roadside Public Utilities

During the road widening, several public utilities will be affected along the project alignment which includes Electric Pole, Access Road, Low tension (LT) Line, Optical Fibre Cable, Gate, Fencing, Overhead Bridge, Tap, Telephone Pole, Water Tank, Water supply pipe, Irrigation canal etc. will be affected. A detailed summary of the affected utilities is presented in the table below and detail is given in Annex VI-D.

Table 75: Roadside public utilities

Description	Quantity
Electrical Pole – Concrete	2256
Electrical Pole – Steel	875
Electrical Pole – Wooden	90
Gate	14
LT Line Steel	27
LT Line Concrete	17
LT Line Concrete	45
LT Line Steel	46
Optical Fiber cable	22
Overhead Bridge	3
Solar Street Light	28
Tap	25
Telephone Pole steel	403
Transformer	105
Water Tank	2

Source: Detail Design report of PHN, 2025

6 ALTERNATIVE ANALYSIS

As part of the detailed design stage for the proposed upgrading of the Pathalaiya–Hetauda–Narayanghat (PHN) Road section of the East-West Highway, various design alternatives were explored. This section summarizes the assessment of the various alternatives studied.

A. No Action Alternative

The “No Action” alternative assumes that no improvements will be made to the existing road infrastructure. Under this scenario the road would remain in its current condition, which includes the several deficiencies:

- Hazardous road geometry including “S” curves with poor visibility;
- Localized flooding and overtopping due to narrow cross-sections with inadequate drainage; Water logging, inundation of the carriageway due to lack of and shallow side drains;
- Absence of crash barriers particularly along embankment in built-up areas;
- No provision for wildlife crossing, increase the risk of collision with vehicles;
- Inadequate road signage to alert motorists of impending hazards; and
- Lack of community safety, pedestrian crossings in the settlements;

The impacts of these defects against the backdrop of increase in traffic in the future are: i) increased risk of injuries and mortalities from road crashes due to inadequate road safety measures; ii) accelerated deterioration of the road condition due to inadequate drainage works, will increase road maintenance cost; iii) increase in road congestion due to lack of road capacity will lead to increase in operating cost, and travel time resulting to economic loss; iv) congestion and accelerated deterioration of road will increase fuel consumption leading to emissions, deterioration of air quality, and increase impacts on human health. Increased traffic particularly at night will increase the risk of vehicle-wildlife crashes endangering the population of wildlife.

However, one positive note of not improving the road is the preservation of trees along the road right-of-way and avoid further disturbance to wildlife habitat in the project area. Without the project all impacts related to construction like camp site management, operation of crusher plant, asphalt plant, batching plant, occupational and community health and safety, shifting of utilities, and dust, noise, vibration, and water pollution from construction activities will not be occurred.

B. Upgrading Options Considered under the Detail Design

The “Upgrading of the Road Section Alternative” assumes that the road will be improved as 4 lanes. The upgrading of the road will rectify the geometric defects and comply with the Asian Highway standard, improving riding quality, increasing road capacity, and enhancing road and community safety.

During the detail design stage, 2 design options were investigated to determine the most feasible options needed on upgrading for each of the land used by the road to service projected traffic. Design parameters like at grade vs. elevated intersections, pavement materials, lane width and numbers, shoulder materials, maintenance or improvement of drainage and bridges type were assessed and combinations thereof were formulated to come up with the project design that meets the financial, economic, and technical requirements. These parameters are presented in the Table below. Of the 2 options studied, Option- I was selected for the project mainly due to environment, social, technical and financial reasons.

Table 76: Design Options Assessed in the Details Design

Design Alternative	Description
Option-I	This option comprised of • Intersections improvement, in existing major Bazaar Areas crossings with adequate traffic safety signage • Service lane, Cycle Lane, Footpath i.e. in urban area, • Road width 24 m in forest area/rural area, 37.4m in semi urban and 50m in urban area • AC pavement in all length • Paved Shoulder in jungle section, • 4 Lane • Two lane additional new concrete bridges • Replacement of pipe culvert and construction of 246 box culvert • Service lane and drain • Pedestrian crossing of foot over bridge, underpass • VIADUCT and under pass for Wildlife crossing • Installation of traffic safety and community safety measures
Option-II	This option comprised of • Intersections improvement, Underpass for major intersection and remaining, • Service lane i.e. existing major Bazaar Areas, • 50 m road width in all section • Asphalt/Concrete pavement in all length • Paved Shoulder in Jungle Section, • All additional Steel bridges • Pipe culvert • Service lane and drain, • Utility crossing HPC on Bazaar • Foot over bridge • VIADUCT and under pass for Wildlife crossing • Installation of traffic safety and community safety measures

Source: Detail Design Report, 2025

A number of site-specific options have been studied to upgrade PHN road from 2 lane to 4 lane with the objective of reducing further environmental and social risks, cost and impacts of this chosen option.

Since the project involves an existing road and not a Greenfield Road, the environmental implications for the various options were more or less similar. All the design options will have a range of environmental impacts that will require concomitant mitigation measures to ensure residual impacts are not significant. Typical road construction-related impacts will be land use pattern change, loss of vegetation, deterioration of water and air qualities, disturbance in wildlife movement and occupation and community health and safety are expected from all the design options. Minimizing road width from 50 m to 24m in forest area and rural area and 37.4m semi urban area will reduce the change in land use pattern of forest land by 40% and agriculture land by 20%.

C. Less Forest Option

In the forest area widening the existing 2 lanes into 4 lanes in the existing RoW is better option than opening of new road in either the northern or in the southern side of the existing road which will affect significance loss of natural forest and habitat fragmentation than existing RoW. Existing forest of ROW has more than 9m width in all sections and degraded compared to other option. The most moderate significant adverse impacts of the widening the existing 2 lanes to 4 lanes at forest area pertain to loss of vegetation and risk of further destruction of wildlife crossing. Widening to 4 lanes will increase the linear barrier for wildlife to cross the road and design speed of traffic will significance increase the wildlife-vehicular collision, unless mitigation measures are implemented. At forest area road pavement is proposed only 24m width, which significantly reduce adverse impacts on vegetation, wildlife habitat.

The existing road alignment is the better option rather than others. This is site specific best alternative option in forest area. Widening of the existing 2 lanes to 4 lanes, all impacts will be mitigated/reduce by following measures.

- Clearing of vegetation/trees in forest area road width will be confined 24m. The proposed road widening require clearing of about 24 m additional width in forest area and felling of 23,326 forest trees (which is more than 5 inch DBH). If road will be constructed in entire width of ROW, forest will loss more than 34,000 (approximately) trees, reducing the width has significantly decrease the tree losses.
- The project will carryout in median and roadside plantation. About 16,666 plants will be planted all along the roadside and median (distance between 3-6 m). The plantation will be carried out by the contractor and will be later maintained by DOR.
- Impact on wildlife movement corridors may be reduced through establishment of improved crossing structures, VIADUCT at ACF and BCF will enhance free crossing by wild animals'. Additional wildlife crossing facilities such as under pass structures, canopy bridges has been

designed at identified locations. The recommended wildlife crossing structures and locations are incorporated into the detailed road design.

- Warning sign, speed limit, display board of wildlife will be erected in the forest areas.

Awareness on wildlife co-existence and regulation of Illegal wildlife hunting to the community residing in the area is recommended which would help lessen poaching triggered wildlife movement in the periphery of highway.

D. VIADUCT at PNP and BCF

Viaduct is proposed at PNP and BCF section of the road project to protect wildlife corridors involves evaluating the environmental, technical, and economic aspects of different design options, with a focus on minimizing ecological impact.

Parsa National Park and Barandabar Corridor Forest is a critical conservation area in Nepal that hosts diverse flora and fauna, including endangered species such as the Bengal tiger, Asian elephant, Terai Gray Lounger and sloth bear. The planned road infrastructure traverses a designated wildlife corridor essential for seasonal and daily animal movement between Parsa National Park and Chitwan National Park, forming part of the Terai Arc Landscape.

The proposed project aims to develop transport infrastructure while minimizing ecological disruption and ensuring the safe passage of wildlife, thereby reducing roadkill incidents and habitat fragmentation. This alternative analysis compares different engineering solutions — at-grade road, (tunnel is not feasible due to plain area), and viaduct — with a focus on environmental, technical, and economic viability and develop evaluation matrix (Optional). Create a table ranking each alternative across criteria with brief assessment of reviewing supporting studies:

Table 77: Analysis of Alternative of VIADUCT

Criteria	At-Grade Road	Viaduct
Wildlife Mortality	High (roadkills)	Very Low
Habitat Fragmentation	High	Minimal
Vegetation Loss	Extensive	Low
Surface Water Disruption	Moderate–High	Minimal
Barrier to Animal Movement	Major	None
Wildlife Protection	Low	High
Cost	Low	Moderate-High
Technical Feasible	High	Moderate
Environmental Impact	High	Low
Long-Term effect on Roadkills (ecological and economic)	High	Low

Technical Feasibility

- At-Grade: Technically simple, standard design, fast implementation.
- Viaduct: Requires technical analysis for foundations, seismic-resilient design (relevant in Nepal), but moderate complexity.

Supporting Studies and References:

Viaduct option has been recommended by Asian Development Bank, (TA-9461, 2022), Smart Infrastructure Planning and Design to Protect Natural Habitats and Biodiversity: Ecological Assessment of the NHP Road Upgrading Draft Final Report strongly suggested to construct VIADUCT at PNP and BCF sections.

Viaduct option has been recommended by Ministry of Forests and Environment, Department of National Parks and Wildlife Conservation and PNP and CNP office has recommended VIADUCT at PNP and BCF, and government bodies at Secretarial level have shown strong preference for alternatives that reduce wildlife conflict and support sustainable infrastructure. According to the minute of meeting (*dated Magh 02, 2080 B.S.*) at MOFE, between the Secretaries of MOFE and Ministry of Physical Infrastructure and Transport decided to build a 4002 meters flyover/VIADUCT at BCF 2001m and at PNP 2001m with funneling fences (refer the decision of MoFE and MoPIT below).

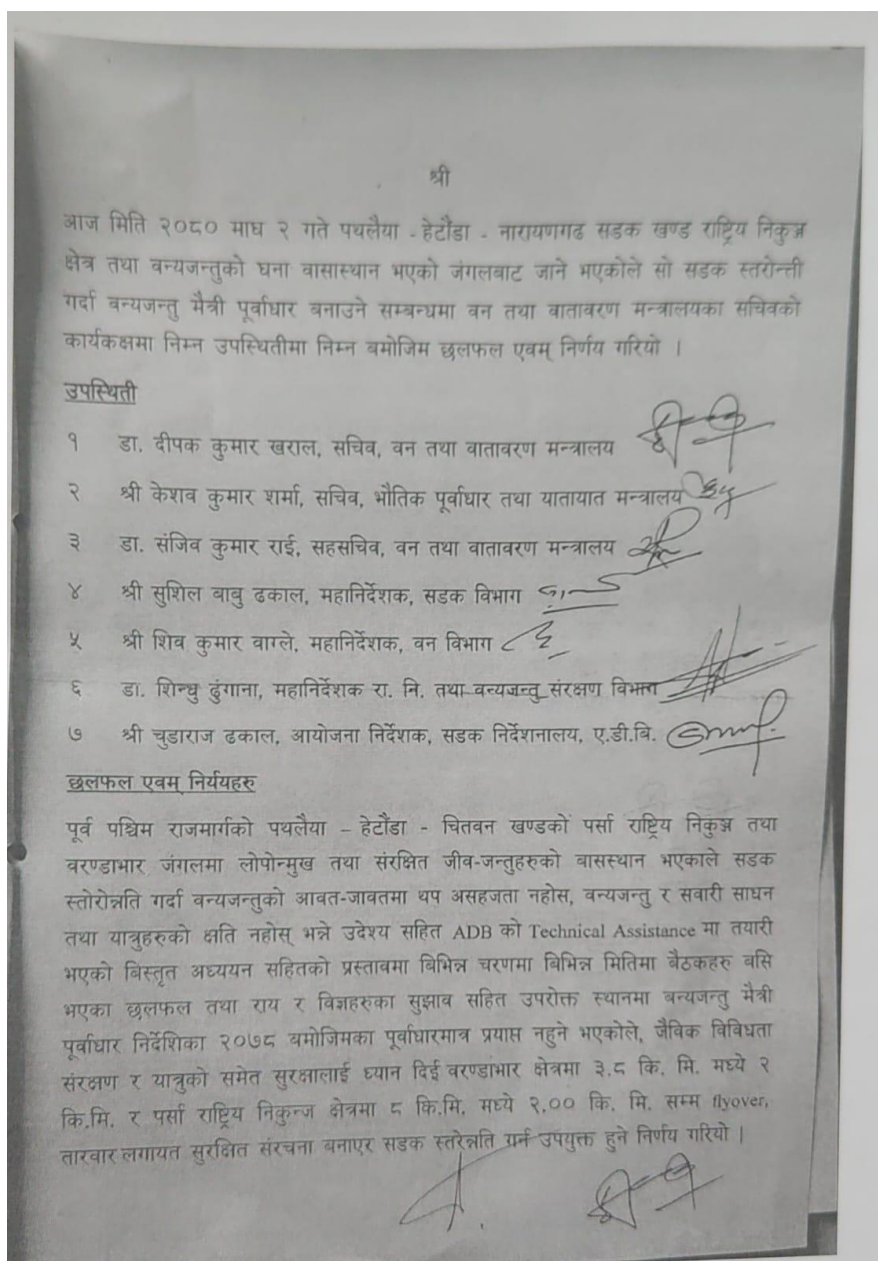


Figure 46: Decision of MoFE and MoPIT for VIODUCT construction at PNP and BCF

Conclusion: The viaduct provides the highest level of ecological integrity, allowing free wildlife movement while minimizing habitat alteration. Based on the environmental sensitivity of Parsa National Park and BCF the critical role of the wildlife corridor, the viaduct alternative is strongly recommended. It balances infrastructure development needs with ecological stewardship, aligning with both national policy and global conservation frameworks.

E. Alternative of Hetauda Bazar

Here's a context-specific alternative analysis with a focus on the Hetauda Bazaar section. The analysis compares three road alignment/design options: bypass, road widening with demolition, and retaining

existing available width — emphasizing the goal of avoiding demolition of private houses, minimizing social disruption, and maintaining urban functionality.

The Pathlaiya–Hetauda–Narayanghat road is a critical component of Nepal's East-West Highway network and the Asian Highway Route AH-2. The road section passing through Hetauda Bazaar presents unique challenges due to dense urban development, narrow existing right-of-way (ROW), and the presence of private houses and commercial structures adjacent to the road.

This alternative analysis compares three strategies to upgrade or manage the road and the goal is to support transportation efficiency while minimizing environmental impact, displacement, preserving social infrastructure, and supporting economic activity in Hetauda Bazaar.

Alternative Options

Alternative 1: Bypass Route

- Construct a new alignment around the urban core (east bypass).
- Divert through-traffic, especially heavy trucks, outside city center.
- Protects existing infrastructure and communities.
- Affect Agriculture land, BZ of PNP, habitat loss.

Alternative 2: Road Widening with Demolition

- Expand to 4 lanes by acquiring private land and demolishing buildings within the ROW.
- Improves traffic flow but causes displacement and social unrest.

Alternative 3: Retain Existing Available Width (with Urban Traffic Management)

- Maintain existing available width.
- Optimum design- introduces traffic management measures.
- Enhance walkability and local access.

A table ranking each alternative and criteria with brief assessment is given below.

Table 78: Analysis of Alternative of Hetauda Bazaar

Impact Category	Bypass	Widening with 50 m, Demolition	Retain Existing Available Width
Displacement of Houses	None	High	None

Impact Category	Bypass	Widening with 50 m, Demolition	Retain Existing Available Width
Loss of Livelihood	Low	High (due to demolitions)	None
Impact on Cultural Sites	None	None	None
Land Acquisition	High	Moderate	None
Urban Livability	Improved (indirectly)	Degraded	Preserved / Improved
Traffic Congestion	Reduced (for through-traffic)	Reduced locally	Moderate (if unmanaged)
Ecological Impact (Loss of vegetation, wildlife impact, habitat loss)	High	Low	Low

Conclusion: An existing available width offers the best outcome in terms of preserving private properties and livelihoods, minimizing ecological impacts rather than other options. It is a practical low-cost option with urban management strategies.

7 IDENTIFICATION OF ENVIRONMENTAL IMPACTS

Potential impacts on physical, biological, and socio-economic, and cultural environment are identified and predicted based on the existing baseline condition with respect to the proposed project. Road and bridge improvement projects are likely to bring several changes in the local environment both beneficial and adverse. The project will follow the prevention measures, corrective measures, and compensatory measures to minimize the adverse impacts.

This chapter highlights significant impacts of the project on physical, biological, and socio-economic environment during different phases of the project.

EPR 2077 BS and National EIA Guidelines (1993) have been taken as reference to analyze the impact (with numerical value) of the proposed project. Abbreviation's use is as: *Nature: Direct (D)/Indirect (I); Magnitude: M (High-60, Moderate-20, Low-10); Extent: E (Regional-60, Local-20, Site Specific 10) Duration: D (Long term-20, Mid-term-10, Short term-05), Significance: High Significant (HS), Medium Significant (MS) and Insignificant/Low Significant (IS/LS). The combine score below 45 shall be termed as insignificant impact (IS); scores ranging between 45 to 75 shall be termed as medium significant impact (MS), scores ranging more than 75 shall be termed as high significant impact (HS). The numerical scale is presented in tables below. Further Environmental Management Plan (EMP) has been prepared as per EPR 2077 BS (Schedule 12) is given in Annex IX.

7.1 Beneficial Impacts

7.1.1 Construction Stage

The beneficial impacts of the project during the construction stage are summarized below.

7.1.1.1 Employment Opportunities

One of the key benefit for the local population during the construction phase is the generation of employment opportunity. Based on the estimate, the project is expected to create approximately 854,181 person-days of skilled labor and 2,631,333 person-days of unskilled labor. On average, around 1,000 workers will be required daily to support construction activities. It is estimated that 20% to 30% of these jobs will be filled by residents, providing a significant boost to the local economy. According to the socio-economic survey, 2.6% of males (approximately 261 individuals) and 1.87% of females (approximately 188 individuals) in the area are currently unemployed. This project will help address local unemployment by offering unskilled and semi-skilled job opportunities, thereby enabling residents to earn a stable income and improve their livelihoods. *The impact is direct, high significance, local, short term in nature.*

7.1.1.2 Development of Enterprise and Commercialization

The construction activities will not only increase the income sources of the local people but will open opportunities for additional businesses such as the establishment of additional food and tea shops, groceries for serving large numbers of people. The demand for local products such as pulses, vegetables, fruits, etc. will increase during the construction period which may add motivation for local production and marketing. Further supply of the construction materials such as cement, steel, paints for construction activities and other goods for daily uses at camp also help to increase local business. This will contribute to increase in the local people's economy. *This impact will be direct, of moderate significance, local and short term in nature.*

7.1.1.3 Skills Enhancement

Project will provide priority for use of local people for construction activities, which will facilitate the transfer of skills and technical knowledge in construction and related technical sectors. A considerable number of workers expected to upgrade their skills and transition into skilled labour roles in area such as masonry, gabion works, bar binding for bridge, and slope stabilization work such as bioengineering works etc. This initiative will not only support immediate employment but also contribute to the long-term development of a skilled local workforce, enhancing future livelihood opportunities in the region. *This impact will be direct, moderate in significance, local and long-term in nature.*

7.1.1.4 Landscape and Soil Stabilization

Through measures such as erosion control and vegetation planting, road construction can contribute to soil stabilization, especially when accompanied by reforestation or greening initiatives. Biodiversity Offsets: When road projects impact sensitive ecological areas, developers may compensate by creating or restoring habitats elsewhere. This approach can potentially enhance biodiversity in nearby regions. *This impact will be direct, moderate in significance, local and long-term in nature.*

7.1.2 Operation Stage

The beneficial impacts of the project during the operation stage will be high, long term and local, regional, and trans-boundary level which are summarized below.

7.1.2.1 Improvement of Trade

The upgraded road will enhance connectivity along the East-West Highway and facilitate the trade with the neighboring countries via Birgunj Dry Port. Improved access will reduce the time taken of goods to reach their destination there by supporting regional economic integration. The road provides faster access to the urban centres, and essential services such educational, recreational, medical, and other emergency facilities. *This impact will be high, regional/transboundary, and long term and high significant.*

1. Reduce Travel Time, Travel Cost

The road will be upgraded from 2 lanes to 4 lanes including bridges, cross drainages, side drain, pedestrian walks, bus stops, traffic signs, streetlight, pedestrian crossing, overpass, crash barrier, median fencing, footpath railing, junction improvement, VIADUCT, wildlife crossing etc. An efficient and safe road transport system will reduce travel times, road accidents, vehicle operating and maintenance costs and transportation cost of goods. 45 to 60 minutes travel time will be reduced from Pathlaya to Narayanghat after road improvement. The improved road will also enhance connectivity with neighboring countries—India, Bangladesh, and Bhutan—via Birgunj and the dry port, facilitating cheaper, faster, and more efficient cross-border trade. *The impact will be direct in nature, high in magnitude, regional in extent, long-term in duration and significant.*

2. Reduce Traffic Congestion and Road Accident

The daily traffic volume across different stations along the project alignment ranges from 12,000 to 25,000 vehicles per day. The urbanized areas of Narayanghat and Hetauda experience higher traffic density compared to other sections. A significant portion of this traffic—13% to 22%—consists of trucks, primarily transporting cargo from the Birgunj dry port to various parts of the country. The road will upgrade to four lanes and increases the road's capacity, reduce congestion, and improve better traffic flow and safety. To ensure road safety, various measures have been proposed, which includes Overhead bridge (5nos) and under pass for pedestrian crossings (12 nos) are proposed in high pedestrian movement areas such as schools/ colleges, hospitals. Zebra crossings are proposed at 76 locations for pedestrian and schools children safety. Different types of intersections are designed and proposed for the free flow of high-speed vehicle. There is also provision of VIADUCT and wildlife crossing at sensitive areas to reduce the vehicle and wildlife collisions. All new bridges have been designed with provision of footpath for the pedestrian. *This impact will be direct, high significance, and long term in duration.*

3. Women Empowerment

Improved transportation will strengthen women while providing better access to schools, health centers, and markets. The project will create employment opportunities for women in roles such as laborers, technical and ensuring that women have equal access to employment and training opportunities. Training will be conducted focusing on women empowerment (such as GBV, skills enhancement etc provision in RAP). The project will support to increase women's skills, awareness and confidence level. *The impacts will be indirect, low significance, local and long-term in nature.*

4. Improved Road Infrastructure Reduce Green House Gas Emission

During operation, 4 lanes asphalt concrete road will provide easy, comfortable, safe and quick access, eliminating existing traffic congestion and reduce road accidents. The improved road surface will reduce the wearing and tearing of vehicles parts and reducing the general costs for spare parts; increase the fuel efficiency and reduce vehicular emissions. Because of good riding condition,

vehicles will use less gasoline as a result will reduce CO₂ emissions and fuel consumption. The proposed median plantation will also support to consumption of CO₂ in the surrounding atmosphere. *This will be direct, medium magnitude, local to regional and long-term in nature.*

5. New Income Generation (Tourism, Trade/Industry)

The road connects with importance tourist destination places such as Parsa and Chitwan National Park, Sauraha, Churia Mai temple and Churia Mai Tunnel, etc. VIADUCT will be constructed for minimization on wildlife impact at BFC and PNP section. It is new concept in the country and will support to increase domestic and international tourist flow in this area. Better road and increase tourist will create opportunities for local people to establish and run guesthouses, restaurants, shops, and other businesses.

More economic activities such as industries, shops, and hotels will be increased along the road at Pathalaiya, Amlekhgunj, Hetauda, Ratmate, Tandi, Bharatpur. *This impact will be direct, moderate significance, local and long-term in nature.*

6. Enhancement of Social Services

Upgraded roads will enhance the overall quality of life nearby residents by providing better transportation facilities and reducing travel-related stress. Rural populations can easily travel to get government/public facilities (such as Ambulances, clinics and hospitals for regular checkups and treatments). Remote communities will easily connect to urban centers; local product can sell in nearby markets, which will support for local community livelihoods and well-being. *This will have indirect, moderate significance, local and long-term in nature.*

7. Enhancement to Wildlife Corridors

21 underpass crossing points including approximately 4002 m long of 2 VIADUCT (2001 m at BCF and 2001 m at ACF of PNP) and other enhancement measures has been designed for wildlife crossings at different locations. These wildlife crossing structures will significantly reduce the number of collisions, increased habitat connectivity. Adabhar forests of Parsa National Park is a critical conservation area in Nepal that hosts diverse flora and fauna, including endangered species such as the Royal Bengal tiger, Asian elephant, Terai Gray langur, One horn rhinoceros, Sloth bear etc. The proposed road traverses through the wildlife corridor, which is essential for seasonal and daily animal movement between Adabhar forests of Parsa National Park and Chitwan National Park, forming part of the Terai Arc Landscape.

The proposed project aims to upgrade the road while minimizing ecological disruption and ensuring the safe passage of wildlife, thereby reducing roadkill incidents and habitat fragmentation.

Road upgrading with wildlife crossings help to reconnect fragmented habitats. By allowing animals to move freely between habitats, these measures promote genetic exchange, increase access to resources,

and support to increase the population of fauna including endangered species. *This impact will be direct, high significance, regional to trans-boundary and long-term in nature.*

7.1.3 Pre-Construction Stage

1. Vegetation Clearance

In the forest area road width was design 24 m to minimize the tree loss. Approximately 54 ha forest area will be loss during widening the road. Prior to construction, vegetation from RoW needs to be cleared. The proposed road and bridge widening requires clearing of more than 26m additional width and felling of 23,326 trees (which is more than 5 inch dbh) from RoW (Annex V-A). Vegetation/tree will be cleared prior to construction work to facilitate the civil works for the contractor. *The anticipated impacts will be direct, significance, local and long-term in nature.*

2. Temporary Land Acquisition

PHN road and bridge improvement will not require permanent private land acquisition beyond the RoW. Only temporary land will be required during road construction for contractor's campsites, labor force camps, crusher plant, asphalt plant, batching plant and stockpiling yard etc. Approximately 10 ha of the land will be used temporarily. Private lands are proposed as possible locations of labor force camps, crusher plant, asphalt plant, batching plant and stockpiling yard, public land, and open spaces also will be used as much as possible for these purposes. The likely impact in temporary use of private land will have adverse impact on loss of crops, HHs requiring rent/compensation of the land and the crops. *The impacts will be direct, low significance, short-term and local in nature.*

3. Private Structures Acquisition

PHN road and bridge improvement will not require any private land beyond the RoW but 403 private structures will be affected during widening of the road. Out of the 403 private affected structures, there are 46 residential structures, 116 residences cum commercial structures, 129 commercial structures and 112 others. The detail is given in RAP of PHN road. *These impacts will be direct, local, high significance and long term in nature.*

Table 79: Detail of affected private structures

Affected Assets	Partially Affected	Fully Affected	Total	Percentage (%)	HHs	Affected Persons
Residential Structures	16	30	46	11.41	46	253
Residential cum Business Structure	88	28	116	28.78	113	22
Commercial Structures	16	113	129	27.06	123	677

(temporary shed)						
Other Structure (Cattle shed, wall, gate etc)	11	101	112	32.75	96	528
Total	131	272	403	100	378	2079

Source: RAP of PHN road, 2025

4. Impact on Community Structure

The improvement of road and new bridges will affect 180 numbers of public structures during the construction. Community structures are resting places/Bus shelters, temples, tube well, police check point, statue, public toilets, school compound wall, governments, and some semi government structures. The detail is given in RAP of PHN road².. Summary of affected community structures area listed in table below, details are provided in Annex VI-B. The impacts will be direct, medium significance, short-term to long term and local in nature.

Table 80: Summary of Affected Community Structures

S.N.	Structure Types	No.
1	Resting Place (Pratikshalaya)/Bus Stop	85
2	Temple Small (Like Deities' Place)	23
3	Wall & Gate	15
4	Public Tube Well/Tap	28
5	Public Toilet	4
6	Government Utility Aanterick Karalaya, School Canteen, Valve Chamber, Container, Water Tank, Structure of Pond etc)	6
7	Police Beat/Traffic Post	19
	Total	180

Source: RAP of PHN road, 2025

7.2 Adverse Impact

7.2.1 Construction Phase

7.2.1.1 Physical Environment

1. Change in Land Use Pattern of RoW

The average existing width of the road has in semi urban and rural/forest area 9m to 12m and in urban area more than 15m. The design of road width in rural area/forest area is 24m, semi urban area is 37.4m and urban area is 50m. The road upgrading will convert approximately 245.64 ha of RoW land into asphalt road. The design is optimized for reducing the RoW land use change which is presented

² Resettlement Action Plan of PHN road 2025.

in Figure below. The road upgrading will only change the RoW land use patterns. *The impact will be direct, medium magnitude, site specific and long-term in nature.*

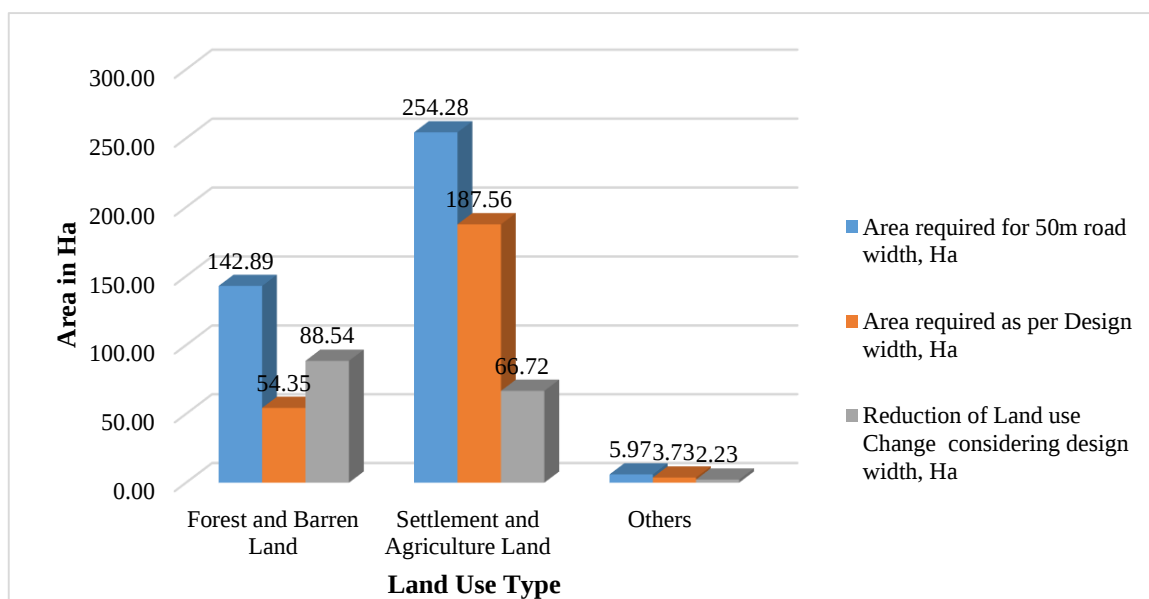


Figure 47: Reduction of land use change as per design consideration of PHN Road

The land of the RoW (50m, 25m on both sides from centre line) of the road has been already transferred to GoN/MoPIT.

2. Impacts on Air, Noise Pollution and Vibration

Air Quality: Potential sources of air pollution during the construction stage include Fugitive dust emissions from excavation work, digging, stacking of soils, filling, handling of construction material, transportation of material, emission due to movements of tyres, plying of heavy construction machinery, operation of crushers plant and batching plant. Vehicular emissions due to traffic movement at the site and on the connecting road. • and Gaseous emissions from operation of hot mix plant, diesel generators for power requirement during construction. During the construction of road, petrol, diesel, kerosene will be used. The estimated quantities and corresponding carbon emissions (in tons) are provided in the table below. Construction activities are expected to generate temporary air emissions, which may cause nuisance to residents living along the road corridor. Additionally, airborne dust from excavation, material handling, and vehicle movement will pose risks to: Construction workers; Public health, Agricultural crops and Local wildlife. *The anticipated impacts on air will be direct, moderate significance, local and short-term in nature.*

Table 81: Energy required and expected carbon emission

S. N	Types of Fuels	Quantity (Litre)	CO ₂ Emission per Liter	Expected Carbon Emission (Ton)	Remarks
1	Diesel	8,147,137	2.39kg Co ₂ /ltr	19,471 tons	Reference: Energy Consumption and Co ₂ emissions baseline Clean Energy for EU Islands, 2020 by Wannes Vanheusden
2	Kerosene	3,194,262	0.259kg Co ₂ /ltr	827 tons	
			Total	20298	

Source: Detail Design of PHN Road, 2025

Noise Pollution: Noise generated from construction, vehicles machineries, equipment's and quarrying operations can cause nuisance to residents and workers. Sensitive locations such as schools, hospitals, forest, and wildlife are particularly vulnerable to nuisance from noise. As per the baseline noise monitoring undertaken along the project alignment, the noise level was observed to be within the day and nighttime noise limits of WHO as well national standard. During the construction phase, ambient noises are expected to increase intermittently and temporarily especially in areas close to active construction zones. However, the impact on sensitive receptors (e.g., schools and hospitals) is expected to be minor, as most settlements are located at a safe distance from the road alignment.

The anticipated impacts of noise will be direct, moderate significance, local and short-term in nature.

The major construction equipment to be used during construction and noise generation is given in following Table below.

Table 82: List of Major Construction Equipment and Noise Generation

S. N	Major Construction Machinery	Generation of Noise (dBA)
1	Concrete Mixture	80
3	Excavator	81
4	Asphalt plant	85
5	Dozar	82
6	Tractor	84
7	Grader	85
8	Roller	85
9	Loader	80
10	Tripper	74
11	Concrete cutter	90
12	Road marker	NA
13	Concrete Batch Plant	83
14	Crane	85
15	Pavers	85
16	Compressor	80

S. N	Major Construction Machinery	Generation of Noise (dBA)
17	Pavement Scarifier	90

Source: www.fhwa.dot.gov/Environment/noise/construction_noise/handbook

Vibration Impact: Construction equipment may generate vibrations that affect properties located immediately adjacent to the road alignment. These vibrations may cause temporary nuisance to residents and workers but are expected to be localized and short-term in nature. Importantly, the vibration levels are unlikely to cause structural damage to buildings or boundary walls of nearby private properties. In the event that any damage does occur as a result of construction activities, it will be repaired, or the affected property owners will be compensated. *The anticipated impacts of vibration will be direct, low significance, local and short-term in nature.*

3. Deterioration on Water Quality

22 rivers and rivulets cross the road (Chapter 5.1.7). During the construction of road and bridges oil and lubricants will be used. There will be possibility of spillage of oil and construction materials and possibility of contamination with water. During the bridge construction, natural water flow will disturb and water pollution will be increase, which will impair the water quality of the river. Increase in turbidity of the river waters during construction of bridge and cross drainage structures. Uncontrolled wastewater (e.g. sewage, grey water and wash water) discharges from the camp will be the likely to contaminate with soil and water. Bridge and cross drainage work at river/streams to be consider fish breeding time (May/June to August/September), not to be disturbed in river during this time. The significance of the impacts depends on the scale and duration of the release, adequacy of sewage facilities. *The anticipated impacts on water quality will be indirect/direct, medium significance, local and short-term.*

4. Loss of Topsoil

Construction activities such as excavation, site clearances will generate approximately 101,340 (12*56.3KM*0.15) cum topsoil. *The predicted impact is direct, medium in magnitude, site-specific and long-term in duration.*

5. Slope Failure, Riverbank Erosion

The road upgrading involves widening of the road from two lane to four-lane, as the terrain passes through Siwalik area and high possibility to increase slope instability, cause landslide, soil erosion and siltation during monsoon and will affect road blockage, siltation, clogging drains and cross-drainage. Immediately upstream of the Amlekhganj Bridge No. 1, there is a high probability of erosion/landslide occurrence that can trigger river channel. Excavation for the foundation of the bridge will cause landscape disturbance land instability, disturbance in natural water flow, erosion, riverbank cutting may occur. Existing and possibility of landslides, gully erosions and old scars have been found at Ch 382+180, Ch 405+940 – Ch 406+250, Ch 406+700, Ch 409+900 – Ch 410+300, Ch 412+250, Ch 414+000, Ch 414+150, Ch 415+000 – Ch 415+400, Ch 418+100 – Ch 418+500 . Gully

formation: Ch 385+370, Ch 385+300, Ch 386+423, Ch 386+000. Possible new slope failures are at Ch 388+140, Ch 388+200, Ch 405+900-406+200, Ch 406+700, Ch 409+900-410+300, Ch 412+250, Ch 413+200-414+400, Ch 418+700, Ch 419+000.

At Chure Mai 1 km stretch of the road (Ch 386+850 - Ch 387+700) area is vulnerable during widening of the road because of the weak geology with consolidated conglomerate and mudstone. Embankment erosion may occur at bridge sites due to high embankment. High embankment has been found at Ch 401+300 - Ch 401+600, Karra bridge, Both side of Mardar bridge Ch 444+271, Khageri bridge Ch 462+500, Ch 462+800.

Excavation for bridge foundation is expected to cause landscape disturbance, land instability, disruption of natural water flow, water pollution, soil erosion along the river banks and approach road. Given that the project area is located in the Terai region, excavation activities may further compromise slope stability. Land disturbance and bank instability are anticipated at all proposed new bridge sites along the existing road.

The impact will be direct, medium magnitude, site specific and short-term to long term and reversible in nature.

6. Disruption of Natural Flow of Water due to Construction of Bridges, Cross Drainage Structures

The project involves the construction of 41 bridges and 246 Box culverts (Annex IV-A&B). These activities will require the diversion of water channels during the construction of cross drainage structures. Which may lead to disruption in natural water flow potentially altering the surface runoff patterns and concentrating flow at specific points, increased flow velocity, which may cause erosion and downstream sedimentation. Inevitable modification of natural drainage patterns, especially during bridge and culvert construction.

Piling works, River diversion:

During piling works of the bridges will disturb natural river profile, piling and excavation release suspended solids, reduce water quality, affects aquatic life, particularly fish spawning. Possibility of cement, lubricants, fuels, or other chemicals spill into the water. Noise and vibration from piling operations can disturb aquatic life/fish. Labors may go for fishing during free time leading to loss of fishes. *The anticipated impacts will be direct, medium significance, local and short-term.*

7. Generation of Spoil Materials

Road widening will generate 2,499,538 cum of spoil material. The construction materials if not properly stored or stockpiled will lead to dust pollution, siltation and pollution of surface water. When excess soil is left unmanaged, it can easily erode, especially during heavy rain. This runoff can carry sediments into nearby water bodies, affecting water quality, disrupting aquatic habitats, and leading to sedimentation in rivers and streams. Most of the cut material (soil and rock) will be used as fill

material for embankment construction backfilling of retaining structures and as the base or subbase. Disposal of spoils is not anticipated due to potential use of all cut material. Disposal of spoils is anticipated minimal due to reuse of all cut material. Number of asphalts materials also generated during scarifying the existing asphalt. Spoil materials disposal is not allowed into water channel of river/streams. If spoil disposal is needed, will be managed at designated location (such as Ch 380+900/320, Ch 385+700/340, Ch 388+600, Ch 389+040, Ch 417+880, Ch 429+500). Further, spoil materials will be used for the restoration of the borrow sites. *The anticipated impacts will be direct, low significance, local and short-term.*

8. Generation of Solid Waste, Hazardous, Non-Hazardous and Liquid Waste

The construction activities will generate significant volumes of wastes, which includes concrete, discarded material, and domestic wastes from workers camps and construction yards. In addition, small quantities of hazardous waste and liquid waste also be generated from vehicle, equipment, and machineries maintenance activities such as batteries, lubricants, hydraulic oils; machine/engine filter cartridges; oily rags, spent filters, and other chemical residues. Improper handling and disposal of these wastes may lead to soil and water contamination, posing risks to human health and the environments. Approximately 1000 workers will be employed for the road upgradation works. About 600 workers will be live in the construction camps and the average solid waste generation per worker will be 0.250 kg per day (including at camp & construction site). Approximately 125 kg solid waste will be generated from these 500 workers. The average solid waste generation on construction site per worker will be 0.150 kg per day. Approximately 400 local workers which will not be living in labour camps will generate about 60 kg solid waste per day on construction site only. Hence, in construction phase, total 185 kg solid waste will be generated per day by workers. Improper dumping and management of these wastes can result in unpleasant odors, deterioration of water quality in the river water and groundwater, visual impacts that can cause health related hazards to the local inhabitants and the workers. In addition, small quantities of hazardous waste and liquid waste will also generate from the camp, asphalt plant, batching plant, vehicle maintenance activities such as batteries, glass, bottle, lubricants, hydraulic oils; machine/engine filter cartridges; oily rags, spent filters, etc.), such waste to be managed in designated area to avoid adverse environmental and human health impacts.

Large quantity of scarified asphalt materials will be generated during upgrading of the road. If suitable it can be reuse for subgrade and back filling. Remaining will be managed in designated locations/proposed spoil disposal locations.

Inert construction wastes to be used to reclaim borrow pits *the anticipated impacts will be direct, moderate significance, local and short-term.*

Table 83: Types Major Non-Hazardous, Hazardous and Liquid Wastes Generated during Construction

Aspects	Type of Construction Waste
Non-Hazardous	Vegetations, woods
	Concrete and gravel
	Scrap metal
	Soil, stone
	Scarified/Dismantled Bituminous materials
	Organic Waste from Kitchen/Workers Mess
	Steel reinforcement
	Pipes
	Formwork (timber)
	Paper, cardboard
Hazardous and Liquid Waste	Bitumen
	Paint
	Used tires
	Oil filters of construction equipment, vehicles and other machinery
	Out-dated and damaged accumulators
	Waste fuel, lubricants
	Welding electrodes
	Batteries
	Bottles
	Plastics

9. Operation of Quarries and Borrow Pits

The construction of the proposed road works particularly embankment fill, sub- base, base, asphalt concrete, drainage, cross-drainage, and other structures will require extraction substantial quantities of construction materials, including 1,023,795 cum of aggregates 347,226 cum sand, and 3,699,070 cum of fill (borrow) material 1,176,366 cum subbase, 896,450 cum base materials. Material will be sourced from 16 identified locations primarily from approved river quarry sites alternative sources are also identified, which is given in Annex IV-G. The final locations of quarries and borrow areas will be determined at the implementation stage. For the reduction of aggradation can be used suitable locations of the river even fall in Chure area or BZ, forest area. The extraction of materials will be done using equipment and labour (such as pick, shovel, excavator, loader, truck, labours etc.). All construction materials will be brought from the approved river quarry sites. Improper extraction of construction materials will have significant impacts on the physical and biological environment of the area. However, Improper sitting and extraction of these construction materials can lead to significant environmental impacts at quarry and borrow areas, including. disruption of natural water course and land contours, alternation of natural drainage patterns, increased siltation and water pollution, air pollution from fugitive dust emission.

The anticipated impacts will be direct and indirect, moderate significance, local and short-term.

10. Operation of Crusher Plant, Asphalt mixing plant and Batching Plant

The establishment of Crushing Plant/Hot mix Plant/Batching Plant during the construction phased is expected to generate significant quantities of dust particles and gaseous pollutants wastewater potentially leading to air, water and land pollution. These activities may adversely affect public health, local communities, and the construction workforce through increased exposure to air and noise pollution. The operation of Crushing Plant, Asphalt mixing Plant, Batching Plant will create enormous quantity of dust particles and gaseous pollutants into the atmosphere and ground. Runoff from the site can carry silt, oil, or chemicals into water bodies. Due to operation of Asphalt mixing plant, emissions of volatile organic compounds (VOCs), sulfur dioxide (SO₂), nitrogen oxides (NO_x), carbon monoxide (CO), and particulate matter. Noise generated at crushing plant location. This plant will impact on air and soil and water, public health and well-being emits air, water and soil pollution. Concrete wash water from batching plant is highly alkaline and can pollute nearby water bodies. There is risk of burns and fire due to hot materials and flammable substances, respiratory issues for workers and nearby residence. *The anticipated impacts will be direct, moderate significance, local and short-term.*

11. Waste Water Discharge from Construction Sites

The potential sources of wastewater generation from the construction sites included batching plant, crusher plant, asphalt plant, construction yards worker's camps, vehicle and machinery washing facilities. If discharged untreated into rivers and streams, these effluents can lead to: soil and surface water pollution, egradation of aquatic ecosystems, health risks to nearby communities. . *The anticipated impacts will be direct, low significance, local and short-term.*

7.2.1.2 Chemical Environment

1. Hazardous Waste

During construction, different types of hazardous materials like epoxy, additives, admixtures, cements, bitumen, paints, anti-stripping agents, etc. will be used. Waste containing such chemicals can be hazardous and needs special attention for storage and disposal. Further, hazardous waste would also arise from the maintenance of equipment which may include used engine oils, hydraulic fluids, waste fuel, scrap batteries or spent acid/alkali, spent solvents etc. Leakage or spillage of oils, fuels, and chemicals can contaminate soil, affecting fertility. Runoff carrying hazardous waste (e.g., oils, concrete wash water) can pollute surface and groundwater. High pH from concrete waste is toxic to aquatic life. *The impact will be direct in nature, moderate significant, site specific in extent, short-term in duration.*

2. Potential Hazards Caused by Bitumen and other Toxic Chemicals

The proposed project involves the use of asphalt concrete pavement which will require the safe handling and storage of approximately 33,522 Mt. bitumen. If not managed properly, it can contaminate, surface water, groundwater and soil in the Project alignment and the surrounding area. *The anticipated impacts will be direct, moderate significance, site specific and short-term.*

7.2.1.3 Biological Environment

1. Loss of Vegetation/Trees

The proposed road widening requires clearing of about 16m to 26m additional width of RoW. Tree Census Survey documented 23,326 trees being felled from RoW. The tree population have considered all those which are 5 inch or more diameter at breast height (DBH) (FA 2022).

There are 9,646 trees from Bara district, 10,278 trees from Makawanpur district and remaining 3,402 trees from the Chitwan district being felled for the road widening. Detail list of trees to be felled down are given in Annex VA 1.

The anticipated impacts will be direct, high significance, local and long-term.

2. Loss of Volume, Biomass and Carbon

During road widening, corresponding to the total number of trees of 23,326, the Wood volume was estimated to be 6049 cu. m. Biomass and Carbon contain of the trees was estimated to be 6,299 ton and 2,960 tons. The volume, biomass and carbon contained of the lower section of the saplings (Lathra) and others below 5-inch dbh has not been counted. Detail is given in table below.

Table 84: District wise loss of tree volume, biomass and carbon

Project Districts	Number of trees	Total tree Volume (Cu. m.)	Biomass (M. tonnes)	Carbon (M. tonnes)
Bara	9646	1458.45	1484.01	697.49
Makawanpur	10278	2604.60	2673.97	1256.77
Chitwan	3402	1986.16	2141.61	1006.56
Total	23,326	6049.21	6299.59	2960.82

The project will apply the mitigation hierarchy to avoid, minimize, mitigate and compensate for cleared trees. *Thus, the anticipated impacts will be direct, high significance, local and long-term in nature.*

3. Setting Camps near forests and Use of Forest Products (NTFPs) by Construction Workers

During construction, large number of labor force is assembled from different places by the contractor. Conflicts/competition for use of resources such as food, water, forest products, and other natural resources in the vicinity of camps is inevitable.

Fuel for cooking is still firewood yet in many communities. There is possibility of increase in illicit timber logging and trading of non-timber forest products from the forest will not only degrade the forests. Construction workers may get involved in unauthorized collection of NTFPs from adjoining forest area during their leisure time. NTFPs have been important for the income generation and improving local economics. The harvesting and collection of NTFPs leads to conflict with local community. However, the workers will be forced to follow the code of conduct during construction activities at forest section. *The impact will be direct, site specific, short term in nature and of low in magnitude.*

4. Loss of Protected Species of Flora

Satsal (*Dalbergia latifolia*) tree is under vulnerable category of IUCN. Similarly, Sal (*Shorea robusta*); Satsal; Simal (*Bombax ceiba*); Sisoo (*Dalbergia sissoo*) and Khair (*Senegalia catechu*) trees are banned by Government of Nepal for commercial felling, transport, or export of timber of these trees. *The impact will be local, direct, long term and medium in magnitude.*

5. Impacts on movement of Wildlife/Fauna

The PHN Road intersects core areas of Adabhar, Parsa National Park (Ch 370+550 to Ch 374+000) and Barandabhar Corridor Forests (Ch 463+600 - Ch 467+320) and the BZ of Parsa National Park and Chitwan National Park, several forest blocks starting at Ch 378+040, a large block crossing the Siwalik and Inner Dun Valley, the forest ends at Ratmate (Ch 392+400). There are a number of locations as a connector between protected areas and the Chure, Middle hills for the wide-ranging species.

Linkage 1 - Adhabhar Corridor Forest (ACF) (Ch 370+550 to Ch 374+000): Parsa National Parks (PNP) is home to 37 species of mammals. The national park is also resided by a population of 60-65 Asian elephants (PNP 2018). The wild animals including the herd of elephants were reported crossing PHN highway (373+513 – fire line) frequently to visit Halkhoria Lake (about 10 km from the PHN crossing) for food and water. The species reported crossing was Asian elephant, Bengal tiger, Rhinoceros, and others.

After the monsoon, when the availability of food and water is scarce, Asian elephant has mostly been reported leaving the parks to visit the farms, about 8-10 km South of PHN. Manier times elephant was found indulged in confrontation with the farmers. Large wild animals also crossed the highway and

traveled east for Nunthar (salt leak), which is located in the bank of Bagmati River, about 50 km air distance from PHN.

In Adhabhar, (Ch 373+513) fire line crossing is a critical crossing point, which is in the middle of forest (Pathalaiya Amlekhgaunj Section) and has been reported to be used by herd of Asian elephants including other large and medium sized wildlife. Other wildlives reported using the fire line were Royal Bengal tiger, One horned rhino, Jungle cat, Sloth bear, Dhole, Sloth bear, and many others. When wildlife (especially Asian elephant) was moving in pairs or lonely, other than herd, the very large/large wildlives used the crossing points at Ch 372+380 and Ch 374+580.

Linkage 2 - Barandabar Corridor Forests (BCF. Ch 443+410 to Ch 467+320):

Movement of Asian elephants, Rhinoceros and other large animals was reported in Barandabar Corridor Forest. 6 to 8 numbers of Asian elephants were found crossing the PHN (Ch 465+373) in herd. A similar animal behaviour as Adhabhar Corridor Forest (PNP) crossing was found. The lonely or paired ones crossed PHN and used crossing points, Ch 464+220 area. Other large wildlife crossing the highway was Royal Bengal tiger and Rhinoceros. Small and medium wild animals (Common leopard, Sloth bear, Indian spotted deer, Common palm civet, Dhole, Sloth bear and others) were also reported crossing the middle part of the corridor forest.

Barandabar Corridor Forests is managed under protection forest management scheme. BZ Community Forest (BZCF) also practice an “protection/conservation approach”, like community forestry (CF), forests are handed over to CFUGs. There will be high possibility of road kill, as Barandabar is recorded as wildlife movement corridor.

The Rajiya Connectivity Network (RCN) (Ch 404+800 to Ch 439+200) and Rapti connectivity (Ch 397+510)

There are two points which links the Mahabharat range, linkage 1 - is the Rapti bridge connectivity; and other is linkage 2 - wider Rajaiya connectivity sector covering Rajaiya - Manahari - Lothar River. These bridges are attached to the settlements and need to be segregated for a normal flow of wild animals.

Linkage 3 - Rapti connectivity Forests (RCF) - The Rapti wild animal movement, starting at PNP/PNPBZ <> Churiya forests <> Ratomate <> Kukhureni Khola <> Karra River <> IOF Forest <> Mahabharat forests via under the Rapti bridge. Till now, the corridor is undisrupted and except some occasional movement/roaming out of the corridor, the corridor is fully functional providing the ecological services.

Linkage 4 - Rajiya Connectivity Network Forests (RCN) - The wild animals visit Rapti river, adjacent to Rajaiya settlement, for a drink, and they just follow the prevailing forest corridor to Mahabharat Hill Forests, using any one among the network of culverts (table 13) to travel to Mahabharat Forests.

So far there have not been any major accidents in this stretch of connectivity, as the network of culverts is ample and functional. This is an example of proper use of existing underpasses by wild animals.

During construction, movement of these mammals might have been hindered due to heavy traffic and human Human-wildlife conflict disturbances along the PHN road. *The anticipated impacts will be indirect, high significance, local-trans boundary and short-term in nature.*

6. Disturbance on Wildlife Movement/ Wildlife Vehicle Collision

Due to the increasingly close proximity of people and wildlife and with increasing habitat degradation and declining prey numbers, conflict often occurs as a result of crop raiding, predation on livestock and damage to property. With reference to TA report and Divisional Forest office, National Park report, the PHN road has many vehicles and wildlife collision. The anticipated impacts will be indirect, high significance, local and long-term in nature.

In total appearance and kill of Python was highest in Chitwan district, followed by Spotted Deer being killed. There were 68 cases/incidents of wildlife-vehicle collisions in Chitwan district. Mammal species like Tiger, Leopard, Spotted, Sambhar, barking deers and others were recorded (Table below, Annex V for greater details). Adhabhar Forest of Parsa National Parks experienced a road-kill of a Royal Bengal Tiger.

Table 85: Species movement and killed and rescued in Chitwan district

Name of the species	Species name in Nepali	%	Ranking
Python	अजाँगर	44.7	1
King Cobra	किङ्ग कोब्रा	0.8	
Dhaman Snake	धामन सर्प	1.2	
Tortoise	कछुवा	2.0	
Black Monitor Lizard	कालो गोहो	0.8	
Golden Monitor Lizard	सुनगोहोरो	0.8	
Crocodile	घडियाल गोही	0.8	
Crocodile	मगर गोही	3.3	
Tiger	भाले पाटेबाघ	0.4	
Leopard	चितुवा	0.8	
Spotted deer	चित्तल	23.0	2
Barking deer	रतुवा मृग	8.6	3
Sambhar deer	जरायो	3.7	4
Ghoral	घोरलको वच्चा	0.4	

Name of the species	Species name in Nepali	%	Ranking
Porcupine	दुम्सी	0.8	
Fox	फ्याउरो	0.4	
Wild boar	बनेल	1.2	
Monkey	बाँदर	1.6	
Mangos	मलसाप्रा	0.8	
Jungle cat	वन विरालो	1.2	
Jackal	स्याल	0.4	
Peacock	मयुर	0.8	
eagle owl	हु-चिल	1.2	
	Total	244	

Source: DFO, Chitwan (2024)

Movement of these mammals might have been hindered due to heavy traffic and human disturbances along the PHN road. Major threats to the mammals in the project area include roadkills, poaching/illegal hunting, human interferences, etc.



Figure 48: Roadkill of a Royal Bengal Tiger in Adhabhar Section of PHN

Construction activities in the forest area: A chance remains for a confrontation with wildlife while working in the forests, mainly during the Dawn & Dusk while wildlife is out for food, game or mating. Such movement timing be shared and working hours differed.

TA report³ mentioned total detected 52 wildlife-vehicle collisions. One road-kill of a Royal Bengal tiger was recorded southern Parsa National Park, although not as part of our systematic roadkill survey. Dhole, sloth bear and leopard were also recorded during survey as roadkill at the Barandabhar corridor. Jungle cat was the species with the highest roadkill record followed by common palm civet". *The anticipated impacts will be indirect, high significance, local and short-term in nature.*

7. Impact on Avifauna

Construction phase will have certain impacts on the avifauna. Cutting down of trees at the road side will reduce bird habitat, foraging and roosting trees. Increased people mobility and noise during construction might disturb the bird habitat and affect their behaviors. Trapping and killing of ground dwelling avifauna (e.g. Indian Peafowl). However, it is assumed to have insignificant impact on birds as there are few trees in the road side supporting food and nests. Deterioration, fragmentation, and loss of forest are threats to forest birds, which have led to loss of biodiversity.

Wetland related issues: Bishazari and associated lakes, a Ramsar sites, is highly threatened and need protection. Rhino lake, adjoining the EWH in Barandabhar Forest is a part of the Ramsar. Low flying birds will be affected, including other birds impacted, due to human influence, immensely during the construction phase. *The anticipated impacts will be direct, low significance, local and short-term in nature.*

8. Impact on Herpetofauna and Aquatic Species

There will be impact for free movement of aquatic species due to bridge construction and extraction of sand and gravel from river. Spoil disposal, accidental spill of materials, chemicals, and oils will deteriorate quality of streams/river water which may affect the aquatic species.

Potential impacts of road widening and bridge construction on herpetofauna: Some of the potential impacts during the construction phase of the project on herpetofauna are:

- Habitat destruction and fragmentation: Clearing of forests, and grasslands results in habitat loss for amphibians and reptiles, reducing breeding and foraging areas.
- Pollution and contamination (Noise, Air, Water, and Waste): Noise and vibration from heavy machinery can disturb sensitive species like frogs and burrowing reptiles, especially during breeding season. Dust, oil spills, and debris can contaminate nearby wetlands. Artificial lighting can disrupt nocturnal species behavior.
- Direct mortality (labor poaching): Increased conflict or poaching by labor during construction may cause loss of amphibians and reptiles, including threatened species.

³ "Smart Infrastructure Planning and Design to Protect Natural Habitats and Biodiversity: Ecological Assessment of the NHP Road Upgrading, January 2022"

Amphibians and reptiles often take refuge under rocks, in burrows, or near water bodies, making them vulnerable to machinery, excavation, and land clearing.

Potential impacts of road and bridge construction on fishes

During the construction phase, some of the potential impacts are as follows:

- Habitat destruction, degradation, and fragmentation: Destruction of riverbanks and river channel which serve as breeding and spawning grounds for many fishes. Alterations in flow while constructing bridges, culverts
- Pollution and contamination: Excavation during construction leads to increase sedimentation in rivers and streams. The high turbidity can clog fish gills, reduce oxygen availability, and limit visibility affecting feeding behavior. Noise and vibration from heavy machinery can disturb sensitive fish species, especially during breeding season.
- Increased fishing activity: Labors may go for fishing during free time leading to loss of fishes, including threatened species. *The anticipated impacts will be direct, medium significance, local and short-term in nature.*

7.2.1.4 Socio-Economic and Cultural Environment

1. Private Structure Acquisition

The project affects 403 private structures (beside Hetauda bazar) belonging to 378 HHs. Out of the 403 private affected structures, 272 are fully affected and 131 are partially affected. Among the fully affected houses, 30 are residential and 113 are commercial houses. The affected private structures are without Hetauda bazaar area. Details of affected private structure are provided in Annex VI-C. *The impacts will be direct, local, high significance and long term in nature.*

2. Disruption of Community Structure and Utilities

During the road widening 180 community structures (85 resting places, 23 temples, 28 tube well, 19 police beat, 1 statue, 4 public toilets and 6 governments and semi government structures) will be affected (Annex VI-D). Additional public utilities such electric pole (5349 nos.), telephone pole (533 nos.), transformer (203 nos), irrigation canal water supply pipe etc will be affected during widening of the road. These will require reinstate/relocate depending upon their requirements. 54 Schools (primary to Higher Secondary) lies in the direct and indirect impact area but these schools does not requires for relocation only during the construction and operation phase need to consider on safety. *The anticipated impacts will be direct, high significance, local and short-to long term in nature.*

3. Stress on Public Utilities and Facilities

Influx of large numbers of construction crews will exert pressure on existing public utilities and service facilities such as water supply, solid waste management, health and medicine and transportation. As the project area located at well-developed area, where adequate social and public services are adequate available, pressure on existing services will be minimal. *The anticipated impacts will be indirect, low significance, local and short-term in nature.*

4. Impact from Labor Influx

For the proposed project activities, the labor requirement per day will be approximately 1,000. Unskilled workers will be hired locally; however, the skilled workers will be brought by the contractor from other parts of Nepal or abroad. It is estimated that about 600 migrant workers will work in the project. Labor influx may lead to negative impacts on the host community. Presence of workers living on the area can lead to increased risk of social conflict, illicit behaviors and have negative impacts on community dynamics. The potential risks associated with labor influx will social tension arise between the local community and the construction workers, increase the rate of crimes and/or a perception of insecurity by the local community and influx of people may bring communicable diseases to the project area, increase spread STDs such as HIV/AIDS from workers, increase risk of GBV and sexual exploitation and abuse, harassment etc. *The anticipated impacts will be indirect, moderate significance, local and short-term in nature.*

5. Occupational Health and Safety

Occupational Health and Safety risks which are likely to arise during the construction works which include: exposure to physical hazards from use of heavy equipment; working at height, working in water during bridge construction, trip and fall hazards; exposure to dust, noise, and vibrations; exposure to hazardous materials; and exposure to electrical hazards from the use of tools and machinery. Potential health issues of workers are due to poor accommodation, sanitation facilities, disease, sleeping space, quality of food, personal safety and security, and recreation facilities. *The anticipated impacts will be direct, high significance, local and short-term in nature.*

6. Community Health and Safety

Safety Hazards due to construction vehicles: The daily traffic exits vary from 15,600- 33,600 vehicle/day. The construction activities will be required number of construction vehicles such as trucks, tractor, excavators, loader, etc. Physical works on the roads will disrupt the flow of traffic and create congestion to the pedestrians and public vehicles as well as safety risks. Additionally, offloading and delivering construction materials, construction activities will affect the normal traffic on the highway and increase the traffic congestion, and increase risk of accidents during construction

work. Road users particularly pedestrians, elderly people and children will be more exposed to dangerous situations, which may lead to traffic accidents. *The anticipated impacts will be direct, medium significance, local and short-term in nature.*

Community Exposure to Work Hazards: Communities will be exposed to construction-related hazards due to excavation of road, bridge foundation, and heavy equipment movements. These types of risks will be high at the construction works located close to the settlement. Roadwork such as excavation of slope, scarring the asphalt pavement, subbase and base preparation will generate large amounts of dust. Fugitive dust can deteriorate local air quality, causing respiratory problem, especially for cardiovascular problems, among children, the elderly, and people with pre-existing conditions. During the construction phase, there will be increased the risk of traffic accidents, due to poorly managed detours, or lack of proper demarcation of construction sites, barricade and signages. *The anticipated impacts will be medium significance, local and short-term in nature.*

7. Risk of Gender Based Violence

Due to influx of labor, as well as local workers (male workers), female workers may face Sexual Exploitation and Abuse (SEA) and Sexual Harassment (SH), or discrimination on-site with limited options for redress or reporting. Increase the cases of girls and women trafficking. *The impact will be direct, low in magnitude, local and short term in nature.*

8. Impacts on Religious Sites

During widening of the road, 23 temples fall within construction width of the proposed road and will be affected during the construction phase. Churiya Mai temple (Ch 386+050) and Churiya mai tunnel at Ch 387+160 are near the RoW. Compound wall of Nava Durga temple within CoI (Ch 394+360), Gorachheswor temple at Ch 397+280, Om Kareshwor Mahadev and footsteps at Ch 398+100, Krishmna temple at Ch 411+800, Shiva Parbati temple at Ch 420+970, Jaleswor Shiwalaya at Ch 421+320, Shiva temple at Ch 424+180, Babadham at Ch 424+740 etc. lies in the RoW. During the construction or excavation, if any physical cultural resources found at sites, the Contractor to be followed a Chance Find Protocol. *The impact is considered as direct, medium in magnitude, local and short term to long term in nature.*

7.2.2 Operation Stage

7.2.2.1 Physical Environment

1. Air and Noise Pollution

The improvement of the highway is expected to lead to increased traffic volume and commercial activities, which may result an elevated levels of air and noise pollution, while the upgraded asphalt surface will reduce dust. *The anticipated impacts will be direct, low significance, local and long-term in nature.*

2. Water Pollution

The road crosses many rivers and water sources. During operation, there will be increase workshop, settlements, hotels and lodges and other business activities in the project area and which also increase the volume of waste material and wash center. There is possibility to runoff carrying oil, grease, heavy metals, and debris from roads into nearby rivers or groundwater. *The impact will be direct, low in magnitude, site specific and short term in nature.*

3. Increase traffic and Increase Road Accident

Review of traffic growth rate indicates that, passenger cars has increased by 14.4%, buses by 9.6%, and 2-3 wheelers by 13% whereas trucks decreased by 3.7%. With the improved road infrastructure, travel speeds are expected to increase by approximately 30%. However, this improvement may also lead to a higher risk of road accidents, particularly due to Increased vehicle speeds, inadequate enforcement of traffic regulations. *The anticipated impacts will be direct, medium significance, site specific and long-term in nature.*

4. Slope Instability and Blockage of Cross Drainage

During the operational phase of the project, there is potential slope failure particularly Chure range (Ch 386+850 - Ch 387+700), high embankment slope (Ch 401+300 - Ch 401+600) during monsoon season is anticipated. Inadequate regular maintenance of cross drainage system, may lead to the debris accumulation and resulting in blockage of water flow and damage to culverts and drainage structures and disruption of natural drainage patterns. These issues may further contribute to erosion, sediment deposition, and landslides, particularly in the Chure region. *The anticipated impacts will be direct, medium significance, local and short-term in nature.*

5. Climate Change

The frequency and intensity of rainfall are increasing, as a result rainfall causing a rise in flash floods and debris flows in the monsoon season. The change in temperature and precipitation deteriorate the

pavement surface earlier than expected. *The impact will be indirect in nature, medium significant, local, long term in duration.*

7.2.2.2 Biological Environment

1. Impact on Flora and Fauna

The compensatory plantations and tree plantation along the median and roadside need to be maintained with pruning and thinning, without routine maintenance will not grow healthy and will dead. The improved vehicle speeds due to improved road conditions may increase road kills, if wildlife do not use the wildlife crossing structures. The fences established in the forest areas and proposed structures for wildlife, reptile movement to be maintained regularly to ensure their use. *The anticipated impacts will be indirect, moderate significance, local and long-term in nature.*

2. Disturbance to Wildlife Movement

Fast vehicular movement (especially during night), excessive use of horn in forest area will disturb wildlife. The lighting of vehicles during nighttime restricts the movement of wildlife and also possibility of collision with vehicles. However, after construction of all mitigation measures the impact will be expected minimal.

Other potential impacts during the operation phase of the project on herpetofauna are as listed under.

- a) Roadkill (Vehicle collisions): Higher vehicle speed and traffic will result in increased mortality for slow moving reptiles and amphibians while crossing road, especially near wetlands and forested areas.
- b) Increase human colonization: Newly expanded road allows human settlements, agriculture, and other development leading to further habitat loss, pollution, and human-wildlife conflict.
- c) Barrier effect and genetic isolation: The expanded road may isolate herpetofauna populations, preventing genetic exchange and leading to inbreeding and local extinction of some herpetofauna.
- d) During the operation phase, probable impact on the fish species is: Increase human colonization: Newly expanded road allows human settlements which increases increased fishing activities.

The impact is indirect in nature, low in magnitude, local in extend and long term in duration.

7.2.2.3 Socio-Economic and Cultural Environment

1. Road Safety

Improved road increases the traffic and may induce speeding behavior amongst the road users. The proposed road passes through dense settlements, school areas and forest areas. In areas where there is

significant movement of people will increase the risk of frequent road accidents. *The anticipated impact will be direct, medium in magnitude, local and long term in nature.*

2. Community Health and Safety

Although the project includes provisions for various road safety features traffic signs, pedestrian crossings, under passes, crash barrier, median fencing, footpath, footpath railing, junction improvement etc. there remain potential risks to community safety during the operational phase. These risks include, pedestrians and bicyclists are at risk of serious injury from collisions with moving vehicles. Children are generally the most vulnerable due to lack of experience and knowledge of traffic related hazards. Collisions and accidents can involve a single or multiple vehicles, pedestrians or bicyclists, and animals. Multiple factors contributing to which includes driver behavior, vehicle conditions, road design and construction quality and in adequate maintenance. *The anticipated impacts will be direct, moderate significance, local and long-term in nature.*

3. Encroachment of RoW

There will chance of encroachment of RoW by local people for different purposes such as vegetables and fruit sales stalls etc. The encroachers will construct permanent or temporary structures within the RoW. Encroachment of RoW will increase of accidents, undesired landscape aesthetics and reduces overall road capacity. *The impact will be direct, low in magnitude, local and long-term in nature.*

4. Workers Health and Safety

The workers' health and safety risks associated with the O&M stage mainly result from the routine maintenance works and they include (i) exposure to higher levels traffic because of working in proximity to live traffic, and (ii) exposure to high noise levels from the traffic. *The anticipated impacts will be direct, low significance, local and short-term in nature*

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8 ENVIRONMENTAL ENHANCEMENT AND MITIGATION MEASURES

Environmental study of the proposed project has addressed enhancement measures for beneficial impacts and the mitigation measures for the adverse impacts.

8.1 Beneficial Impacts Augmentation Measures

The Augmentation measures for beneficial impacts are given in Table below.

Table 86: Augmentation Measures for Beneficial Impacts

Environmental Impacts	Nature	Magnitude	Extent	Duration	Total	Significance	Augmentation Measures
Beneficial Impacts							
Construction Stage							
Employment Opportunities	D	H (60)	L (20)	ST (5)	85	High significance	The construction works create employment during the construction stage. The construction works required about 854,181 person-days of skilled 2,631,333 person-days of unskilled labor. It is assumed that approximately 20% to 30% local people will get employment opportunities during construction. Everyday approximately 1000 labours will be required. During bridges and VIADUCT construction will get approximately 15%-20% employment opportunities. This project will support local people to generate incomes from unskilled and skilled jobs.
Development of Enterprise and Commercialization	D	M (20)	L (20)	ST (5)	45	Medium significance	Due to influx of construction workers, demand of local products such as pulses, vegetables, fruits, etc. will increase, which will motivate for local production and marketing. This will contribute to increase in the local people's economy.
Skills Enhancement	D	M (20)	L (20)	LT (20)	60	Medium significance	Local work forces will convert themselves into skilled laborers in works such as masonry, gabion works, bar binding for bridge, and slope stabilization work such as bio-engineering works etc. Livelihood enhancement training also to be provided to the affected people.
Operation Stage							

Environmental Impacts	Nature	Magnitude	Extent	Duration	Total	Significance	Augmentation Measures
Improvement of Trade	ID	H (60)	R (60)	LT (20)	140	High significance	This road link to the neighboring countries via Birgunj. Better access facility will reduce the time taken of goods to reach their destination from neighboring countries which will support in regional economic activities. The road provides quick access to the other cities of the country.
Reduce Travel Time, Travel Cost	D	H (60)	L (20)	LT (20)	100	High significance	The road will be improved from 2 lanes to 4 lanes. An efficient and safe road transport system will reduce travel times, road accidents, fuel, vehicle operating and maintenance costs and transportation cost of goods. 45 to 60 minutes time will be reduced after road improvement. This will lead to overall cost savings in the transportation of goods.
Reduce Traffic Congestion and Road Accident	D	H (60)	L (20)	LT (20)	100	High significance	The road will be upgraded to four lanes and increase the road's capacity which contribute reducing traffic congestion and allowing better traffic safety. Road safety measures are adequately provisioned (Section 2.5.8). Overhead bridge (5nos) and under pass for pedestrian crossings (12 nos), vehicle underpass (6 nos) are proposed in high pedestrian movement areas such as schools/ colleges, hospitals (Table 9 & 11). Zebra crossing for pedestrian safety is identified and proposed in 76 locations (Table 10). Different types of intersections are designed and proposed for the free flow of high-speed vehicle. There is provision of VIADUCT and wildlife crossing at sensitive areas which will reduce the vehicle and wildlife collisions (Section 2.5.5).
Women Empowerment	ID	M (20)	L (20)	LT (20)	60	Medium significance	The project will create employment opportunities for women in roles such as laborers, technical and ensuring that women have equal access to employment and training opportunities. Training will be conducted focusing on women empowerment (such as GBV, skills enhancement etc.). The project will support to increase women's skills, awareness and confidence level.
Improved road infrastructure Reduce Green House Gas Emission	D	M (20)	L (20)	LT (20)	60	Medium significance	The improved road surface will reduce the wearing and tearing of vehicles parts and reducing the general costs for spare parts; increase the fuel efficiency and reduce vehicular emissions. Because of good riding condition, vehicles will use less gasoline as a result will reduce CO ₂ emissions and fuel consumption. The proposed plantation of road side avenue trees will also support to consumption of CO ₂ in the surrounding atmosphere.

Environmental Impacts	Nature	Magnitude	Extent	Duration	Total	Significance	Augmentation Measures
New Income Generation	D	M (20)	L(20)	LT (20)	60	Medium significance	The road connects with importance tourist destination places such as Parsa and Chitwan National Park, Sauraha, Churia Mai temple and Churia Mai Tunnel, etc. VIADUCT will be constructed for minimization on wildlife impact at BFC and PNP section. It is new concept in the country and will support to increase domestic and international tourist flow in this area. Shops, hotels will be increased along the road at Pathlaiya, Amlekhgunj, Hetauda, Ratmate, Tandi, Bbharatpur.
Enhancement of Social Services	D	M (20)	L (20)	LT (20)	60	Medium significance	Upgraded roads will enhance the overall quality of life for residents in the region by providing better transportation facilities and reducing travel-related stress such as faster and more reliable transport facilities will be increase for daily life and ambulances and emergency medical services (EMS) to reach patients.
Enhancement to wildlife corridors	I	H (60)	R (60)	LT (20)	140 0	High significance	Reduce Wildlife-Vehicle Collisions: 21 underpass crossings including 4002m VIADUCT (2001m at BFC and 2001m at PNP) has been proposed in the PHN road (refer section 2.5.6). This will significantly reduce the chances of collisions, increase the faunal habitat connectivity. Monitoring will be done through camera trapping the use of crossingstructures by different wildlife. Increase Habitat Connectivity: Road upgrading with wildlife crossings help reconnect fragmented habitats. By allowing animals to move between habitats, these measures promote genetic exchange, increase access to resources.
Improve esthetic view	D	M (20)	L (20)	LT (20)	60	Medium significance	In operation, improve road, slope stabilization, vehicular underpasses, road underpasses, junction improvement, median plantation, VIADUCT, road furnitures etc. will enhance the esthetic view of the road.

8.2 Adverse Impact Mitigation Measures

Mitigation measures are proposed for all identified adverse impacts during construction and operation stage of the project. The mitigation measures are proposed based on the following:

- i. Compensatory measures: It includes measures to compensate for adverse effects that could not be reduced or eliminated.
- ii. Corrective measures: It includes remedial measures which could reduce adverse impacts to acceptable levels.
- iii. Preventive measures: It includes measures that mitigate before serious impacts occur.

The details mitigation measures on physical, chemical, biological, and socio-economic and cultural environment are given in Table below.

Table 87: Impact Prediction and Mitigation Measures of Adverse Impacts

Environmental Impacts	Nature	Magnitude	Extent	Duration	Total Sum	Significance	Mitigation measures
Pre-Construction Stage							
Vegetation Clearance	D	M (20)	SS (10)	LT (20)	50	Medium significance	The proposed road and bridge widening requires clearing of about 16m to 20m additional width and felling of 23,326 trees (which is more than 5-inch dbh) from RoW. According to GoN rules the cost will be deposited to the forest development fund under MoFE as compensation. NRs. 220,266,768 is estimated as a compensatory plantation cost.
Temporary Land Acquisition	D	M (20)	SS (10)	ST (5)	35	Insignificance	Temporary land will be required during road construction for contractor's campsites, labor force camps, crusher plant, asphalt plant, batching plant and stockpiling yard etc. Approximately 10 ha of the land will be used. All temporary land will be done agreement with private land owners and compensation (lease) will be provided as per agreement.
Private Structures Acquisition	D	H (60)	SS (10)	LT (20)	35	High significance	The improvement of road and bridge will affect 403 private structures. A Resettlement Action Plan (RAP) has been prepared to address and compensation on the affected households. Details of affected households are given in Annex VI-C. The affected households will not only receive cash compensation of structures, also additional assistance will be given for relocation and livelihood restoration.
Community Structure	D	H (60)	SS (10)	ST (5)	35	High significance	The improvement of road and new bridges will affect 180 numbers of public structures during the construction. The project will take necessary process for clearance, transfer of funds etc. to the respective utility service provider so as not cause any delays to the road construction schedule. Prior inform to public before shifting of the public structures, utilities.
Physical Environment							

Environmental Impacts	Nature	Magnitude	Extent	Duration	Total Sum	Significance	Mitigation measures
Construction Stage							
Change in Land Use Pattern of RoW	D	M (20)	SS (10)	LT (20)	50	Medium significance	The road upgrading will change RoW land use patterns. The road upgrading will convert approximately 245.64 ha of RoW land into asphalt road. The ownership of RoW's land is already transferred to the MoPIT/GoN. The design of road is 50m in urban area, in forest area and rural area, 24 m and semi urban area 37.4m. The optimum road design has reduced RoW land use change.
Loss of Top Soil	D	M(20)	SS(10)	LT(20)	50	Medium significance	Topsoil approximately 101,340 cum will be stockpiled in designated location and reused for plantation in medians, and during site restoration (camps, quarry and borrow pit).
Air Pollution	D	M (20)	L (20)	ST (5)	45	Medium significance	For the control of fugitive dust, water sprinkling would be carried out throughout the construction period three times a day, cover the materials during transportation of soil and sand particularly during windy conditions, Personal protective equipment (PPEs) shall be provided to the construction workers. Construction of road will be done in section wise, existing pavement will be scarified after completion of necessary structures in both sides of road, and this will support to reduce dust pollution during vehicle plying on the road. Reducing the time between the earthwork and covering the road surface can significantly control dust pollution. Periodic air quality monitoring will be carried out (Construction camp, asphalt plant, hot mix plant, crusher plant, settlements, School, Hospital, Forest area) to ensure compliance with national ambient air quality Standards and WHO Air Quality Guidelines (Annex IV-S). Possible locations are identified for crusher plants, asphalt and hot-mix plants (Ch 405+780, 428+800, 437+400) which are at least 500 m away from the nearest sensitive receptor (e.g. school, hospital and wildlife habitat

Environmental Impacts	Nature	Magnitude	Extent	Duration	Total Sum	Significance	Mitigation measures
							(PNP/BFC) and at least 50m from a water body. All approval from concerned agencies shall be obtained prior to the construction. Construction equipment and vehicles will be well maintained so that emissions will be minimal and comply with emission standards of Nepal Vehicle Emission Standards 2012 (Annex IV-W). Open burning of solid wastes (plastic, paper, organic matters) shall be prohibited. With coordination and getting approval from Hetauda Sub-Metropolitan City, Bharatpur Metropolitan City's landfill sites could be used for the disposal of waste. Plantation will be done in the median and roadside in the sensitive area (about 16,666 nos plantation will be done in median).
Noise Pollution	D	M (20)	L (20)	ST (5)	45	Medium significance	Temporary construction facilities such as labour camps, vehicle maintenance workshop, crusher plant will be located away from settlements and sensitive receptors as far as possible. Noise sources such as stone crushers, asphalt plant shall shield with appropriate materials. Equipment and machinery with lower sound power levels shall be used for construction. Protection devices such as ear plugs/ or ear muffs shall be provided to the workers during operation of high noise generating equipment. Construction activities shall be carried out only day time to avoid disturbance to nearby communities and wildlife (BCF,PNP) at night. Noise barriers such as wall of wood/ metal shall be used, especially in the sensitive receptors (schools Ch 376+840, 379+180, 381+970, 400+810, 402+780, 414+400, 420+320, 426+260, 428+030, 434+850, 439+280, 441+740, 442+840, 444+400, 444+820, 462+680 and hospitals). Vegetative plantation will be done in the median and roadside. However, zebra crossing will be installed in 54 locations focusing for schools in the direct impact zone and indirect impact zone.

Environmental Impacts	Nature	Magnitude	Extent	Duration	Total Sum	Significance	Mitigation measures
							Periodic noise quality monitoring will be carried out in the project area to ensure compliance with national noise level (Annex IV-W).
Generation of Vibration	D	Lo(10)	L (20)	ST (5)	35	Insignificance	During construction period before start the work old houses which will be risk due to vibration will be documented. Old houses that pose a danger of vibration during the construction phase will be noted before work begins. Contractor shall aware the operator for careful handling of machines and equipment. The workers will be provided with Personal Protective Equipment (PPE) such as anti-vibration gloves, avoid continuous exposure by taking rest periods.
Deterioration on Water Quality	D	M(20)	L (20)	ST(10)	50	Medium significance	Prohibited to dispose excavated spoils and wastes into river/streams water. Spoil will be managed at designated locations. All chemicals and oil shall be stored away from water and shall be stored in drum, concrete platform with catchments pits will be constructed at maintenance yard for spills collection. The Contractor shall arrange awareness programmed to all equipment operators, drivers, on immediate response for spill contamination and eventual clean-up. Silt collection pond (two/three settling system) shall be constructed at batching plant, crusher plant, asphalt plant for collecting sediments before letting them into the water body. All wastes arising from the construction sites shall be collected and disposed in a designated location. The wastes shall be collected, stored and transported at approved disposal sites. No vehicles or equipment shall be washed in the streams water to avoid contamination of streams water from fuel and lubricants. No untreated sanitary wastewater from camps shall be discharged into the streams water. Bridge and cross drainage work at river/streams to be consider fish breeding time (May/June to August/September), not to be disturbed in river

Environmental Impacts	Nature	Magnitude	Extent	Duration	Total Sum	Significance	Mitigation measures
							during this time. Surface and ground water quality monitoring shall be conducted.
Slope failure, river Bank Erosion	D	H(60)	L (20)	ST (5)	85	High significance	Soil erosion shall be stabilized by applying engineering as well as bioengineering techniques. During road improvement, only required vegetation shall be cleared and all high embankment, eroded bare slopes shall be re-vegetated. At Siwalik area special slope protection measures are proposed. 1,540,010 sqm hill slope and embankment, bridge embankment and river side slope protection will be done by applying bio-engineering technique (Grass plantation, Brush layering, and Tree/Shrub plantation) with combination of civil structures. Reinforced concrete wall and geogrid reinforced retaining wall, 4,526 cum gabion wall, 54,072 sqm reinforced earth wall will be constructed for hill slope and river bank protection. Excess spoil will be managed at designated locations to control erosion; river water flow will not be disturbed during construction.
Generation of spoils	D	L(10)	L(10)	ST(5)	25	Insignificance	Most of the cut material will be used as fill material for embankment construction, backfilling for retaining structures and road material will be used as the base or subbase. Disposal of spoils is not anticipated due to reuse of all cut material. Prohibited to dispose excavated spoils and wastes into river/streams water. If spoil disposal is needed, will be managed at designated location (such as 380+900/320, Ch 385+700/340, Ch 388+600, Ch 389+040, Ch 417+880, Ch 429+500), further the borrow sites developed for the project will be used as spoil disposal sites. Additional locations if required, will identify during implementation. The spoils will be used for the restoration of the borrow sites. The contractor shall prepare spoil disposal plan before commencement of the activities.
Disruption of Natural Flow of	D	M(20)	L (20)	ST (5)	45	Medium significance	Existing natural drainage system will not be disturbed by providing temporary measures (such as hump pipe), and construction near/inside

Environmental Impacts	Nature	Magnitude	Extent	Duration	Total Sum	Significance	Mitigation measures
Water due to Construction of Bridges, Cross Drainage Structures							rivers, streams will be limited during the rainy season. The excess spoil will be stockpile in designated location. The size of the drainage structures shall be designed to accommodate increasing volumes of water. During upgrading of road, 41 new major/minor bridges, 246 box culverts and additional 174,612 m side drain will be constructed to minimize flooding, inundation, and maintain natural flow. Construction will be limited during monsoon and fish spawning seasons in the perennial river like Lohari, Manahari, Rapti, Karra etc. and will be used silt curtains, sediment traps, fuel chemicals will be stored in bunded area or in sealed drums. All affected locations will be reinstated immediately after the necessary activity in the rivers. River diversion, water flow will be maintained providing hump pipes during bridge construction. All chemicals, bitumen, oil and fuel will be stored in drums on impervious floor so that no leakage or spillage will reach water bodies. Prohibit fishing by the construction workers. Bridge and cross drainage work at river/streams to be consider fish breeding time (May/June to August/September), not to be disturbed in river during this time. Construction activities will be limited/to be considered during this period. Construction sites will be barricaded, warning sign/information board will be installed to aware local community as well as workers for safety. Regular water quality monitoring will be conducted.
Generation of waste (Hazardous, non-hazardous and	D	M (20)	L (20)	ST (5)	45	Medium significance	Prior to start of construction activities, the contractor shall be required to prepare and submit a Waste Management Plan for review and approval, the plan shall include procedures for handling hazardous materials, including their use, storage, transport, and

Environmental Impacts	Nature	Magnitude	Extent	Duration	Total Sum	Significance	Mitigation measures
liquid waste)							disposal (Refer Annex XVII - Guidelines for Hazardous and Non-Hazardous Waste Management Plan) Designated area to be allocated for temporary storage of hazardous waste in containers and no mixing of hazardous waste with any other waste shall be allowed. Various types of wastes such as non-hazardous, hazardous and liquid from the worksites, and transport these wastes regularly to a centralized facility. For Hazardous and Liquid Waste Management: The contractor will return batteries, bottle, and the empty containers to the suppliers as far as possible. Oil, battery, tyre will be collected separately at each workshop location. Further, the oil is collected the in the drums. Similarly, the batteries/ tyres those are un-usable are stored at safe place. Those wastes when collected in sufficient volumes are generally sold in the market for re-use. Hazard to the surrounding due to such waste will be prevented. The proper record of such waste will be maintained at site. Impervious concrete base floor will be constructed at all the fuel, waste oil and bitumen, emission and chemical storage yards. All petroleum products and chemicals for construction shall be stored in accordance with guidelines provided in Materials Safety Data Sheet (MSDS). The waste shall be removed every month. Any accidental leakages of oil/fuel will be immediately rectify onsite. Personal protection equipment such as footwear, masks, protective clothing and goggles inappropriate areas, emergency eyewash and shower stations, ventilation systems, and sanitary facilities will be provided to the workers. For Non-Hazardous Waste Management: Segregation will be done all solid waste of kitchen waste (organics), paper

Environmental Impacts	Nature	Magnitude	Extent	Duration	Total Sum	Significance	Mitigation measures
							and plastic (recyclable) and garbage (non-recyclable). Three kinds of waste bins (with different colors) with adequate numbers and capacities will be placed at the campsite (kitchen, offices, and rooms) for the segregation of the waste at source. Organic waste will be treated through onsite composting. Recyclable waste will be compressed through bailers to minimize the volume of waste to be stored and transported. Procure the services of waste management contractors for the collection and management of recyclable waste. Many non-hazardous waste such as debris, gravel, soil will be reuse. Metal, paper, cardboard and plastics will be supply to the collectors for recycle. The disposal of any biodegradable waste shall be collect in pits covered with a layer of earth within the camp site. Discarded plastic bags, paper and paper products, bottles, packaging material, gunny bags, hessian, metal containers, strips and scraps of metal, PVC pipe drums and other such materials shall be either reused or sold /given out for recycling. Large quantity of scarified asphalt materials will be generated during upgrading of the road. If suitable it can be reused for subgrade and back filling. Remaining will be managed in designated locations/proposed spoil disposal locations. Scarify material to be stored at site and preserved. These materials may be mixed in required percentage with WMM (Wet Mix Macadam) material to achieve the desired gradation. The material is carted by tippers to the stockyard and preserved for reuse. Dismantled Concrete/Bricks Waste is generally stacked at or near the site and later is disposed in approved locations. Staff to be trained for waste management practice. With coordination and getting approval from Hetauda Sub-Metropolitan City, Bharatpur Metropolitan City and local municipal landfill sites could

Environmental Impacts	Nature	Magnitude	Extent	Duration	Total Sum	Significance	Mitigation measures
							be used for the disposal of waste. No disposal sites will be established by the contractor.
Operation of Quarries and Burrow Pits	D	M(20)	L (20)	ST (5)	45	Medium significance	The contractor shall use the government-approved quarry sites, or to be obtained approval from concern authorities'/ local government, National Park. During the operation of quarry and borrow pit, coordination will be done with local government, National Park, DFO. 16 possible quarry/borrow pits locations are identified during study by design team and EIA team. Contractor shall prepare borrow pits and quarry sites operation and restoration plan and submit for approval from Engineer prior to commencing extraction activities. Mining activities will not be done at forest area, protected area or near sensitive areas. However, for the reduction of aggradation can be used suitable locations of the river even fall in Chure area or BZ area. The extraction of materials will be done using equipment and labour (such as excavator, loader, truck, labours). 16 possible quarry/borrow pits locations are identified during study which are given in Annex IV-G. The final locations of quarries and borrow areas will be determined at the implementation stage. Does not disturb river water course during the operation of quarry, maintain a BZ of 5 to 10m between the low flow channel and the mining operations to minimize the downstream impacts and limit the excavation activities to the low flow season (non-monsoon). Material will be covered with tarpaulin during transportation to prevent dust emission. The contractor will be responsible for maintenance of haul roads if damage. Reuse of excavated material from the construction sites to the extent

Environmental Impacts	Nature	Magnitude	Extent	Duration	Total Sum	Significance	Mitigation measures
							feasible. Restore the site as per restoration plan maintaining natural contours and revegetation after use.
Establishment and Operation of Crusher Plant, Hot mix plant and Batching Plant	D	M (20)	L (20)	ST (5)	45	Medium significance	The contractor shall propose appropriate locations for stone crushing plant, cement batching plant, asphalt plant and before establishment of stone crushing plant, cement batching plant, asphalt plant the contractor shall obtain permit from local stakeholder/Municipality. Possible locations are identified during the study also. Stone crushing equipment / cement batching plant, asphalt plant shall be fitted with dust control devices and operated as per Manufacturer's Specification. Locate plant site away from sensitive receptors (500m), settlement, drinking water sources, cultivated lands and water bodies. For the control of fugitive dust, water sprinkle to be done at crusher plant during operation of crusher running materials to minimize dust; The contractor to be constructed a siltation pond (two/three settling system) to regulate wastewater prior to its discharge into the drainage system. The plant shall be operated during day time only. Restore the site after use.
Stockpiling of Construction Materials	D	M(20)	L (20)	ST (5)	45	Medium significance	Stockpile shall not be located on water courses; shall not be within 50m of schools, hospitals or public standpipes; Obtain written permission from landowners and local bodies for stockpiling on their land. Sockpiles materials which generate dust will be covered with tarpaulins if located near the settlement. For large stockpiles, it will be enclosed with side barriers and also covered when not in use; Hard surface will be prepared for chemical hazard materials store to prevent the contamination/leakage in the soil. Locate, peg and seek approval from the supervising consultant for the use of stockpile sites. 8

Environmental Impacts	Nature	Magnitude	Extent	Duration	Total Sum	Significance	Mitigation measures
							possible locations are identified for stockpiling of construction materials (Table 15). <i>Additional if required will be identified during implementation.</i>
Waste water discharge from construction sites	D	Lo (10)	L (20)	ST (5)	35	Low significance	Sedimentation ponds of adequate size and capacity will be built for the treatment of discharges from the batching plants, asphalt plant and the crushing plants to allow the sediments to settle. Final discharge from the sedimentation ponds shall comply with the National standards for wastewater standards. The settled sediments will be periodically removed and will be disposed of at the designated spoil disposal sites. At camp will be constructed wastewater treatment facilities (e.g., septic tank and soak pit and site drainage). The contractor will take measures to avoid any spillage and pollution of the water. Periodically monitoring of wastewater quality will be conducted to ensure compliance with the standards.
Operation Stage							
Air and Noise Pollution	D	Lo (10)	L (20)	LT (20)	50	Medium significance	Regular maintenance of the road, maintenance of plants (approximately 16,666 plants will be planted and maintain at urban and semi urban area which act as air and noise absorbers). If require, additional information board will be installed, enforce for No Blowing of Horn Zones particularly in settlement areas, sensitive areas. Enforce Nepal vehicle mass emission standard. Air and noise monitoring shall be conducted during operation.
Water Pollution	D	Lo (10)	SS (10)	ST (5)	25	Insignificance	Do not dispose directly soil, sludge, and other wastes in water bodies which generate from maintenance of road, drain and cross drainage, use designated spoil disposal locations; Prohibition of washings activities near water bodies.
Increase Traffic and Increase	D	M (20)	SS (10)	LT (20)	50	Medium significance	Road safety features will be maintained properly so that they remain functional at all times.

Environmental Impacts	Nature	Magnitude	Extent	Duration	Total Sum	Significance	Mitigation measures
Road Accident							Enforcement of traffic rules, conduct on-site pilot safety campaigns with coordination local traffic police for drivers to prevent accidents (such as follow rules for keeping left, rules for overtaking, rules for motorists passing cyclists, rules for changing lanes, rules for merging, rules for making U-turns, rules for using overhead control signs, rules for making right turns left turns on multi-lane roads, follow rules for overtaking at the approaches to zebra pedestrian crossings, rules for keeping intersections clear off stop lines, rules on priority at zebra crossings etc).
Slope Instability and Blockage of Cross Drainage	D	M (20)	L (20)	ST (5)	45	Medium significance	Slope/soil conservation activities through plantation will be promoted in hill slopes and embankment slopes. Routine and recurrent maintenance of roads like cleaning of cross drainage, drains and additional embankment protection structures will be carried out along with road maintenance to minimize blockage problem, flooding, inundation, and maintain natural flow. Deposition of sediment will be regularly removed and river channelization will be maintained in the heavy sedimentation locations.
Climate Change Increased flow in rivers, Pavement cracking and bitumen bleeding	I	M (20)	L(20)	LT (20)	60	Medium Significance	All the drainage and cross drainage structures have been designed considering increased precipitation due to climate change. The design floods have been estimated in safe side considering 16% increase in extreme rainfall in future. Further, during design sustainable pavement design (Bitumen VG 30, which helps reduce deterioration in extreme weather condition has been adopted); Encouraged to maintain the road side greenery.
Chemical Environment							
Potential Hazards Caused by Bitumen and other Toxic Chemicals	D	M (20)	SS (10)	ST (5)	35	Insignificance	Automated asphalt plants (Batching plant) will be used. Bitumen drums will be stored in a secure place within the construction and camp site and at least 500m from any water bodies. Bitumen mixing plant shall have in-built mechanisms for the absorption of gases. All fuel, lubricants and chemicals will be stored in an enclosed and

Environmental Impacts	Nature	Magnitude	Extent	Duration	Total Sum	Significance	Mitigation measures
							designated area within the camp site. The area will be concrete floor facilities with provision to capture any spilled fuel or chemicals. Regular monitoring will be conducted and record data sheets will be maintained.
Hazardous Waste	D	M (20)	SS (10)	ST (5)	35	Insignificance	Construction workers will be oriented on safety rules for proper handling, storage and disposal of hazardous substances like fuel and bitumen; Hazardous or toxic substances will be stored in leak- proof containers labelled; Chemicals (paints) and oil will be stored in a well-ventilated room away from water bodies; Fire extinguisher will be installed in such chemical storage area and training will be provided to related staff for proper handling.
Biological Environment							
Construction Stage							
Loss of Vegetation/trees (23,326 trees to be cleared from RoW)	D	H(60)	L (20)	LT (20)	100	High significance	In forest area, road width has been minimized to 24m, which reduce significant number of tree clearance from RoW. Compensation of tree loss: According to Forest Rules 2022, the proponent will deposit funds in the "Forest Development Fund's Account" under MoFE . A budget of NRs. 220,266,768 has been estimated for the compensatory plantation. Re-vegetating RoW: To enhance bird habitat, saplings will be planted in the RoW after the road is built. The saplings will be fast-growing nature, so that the establishment period will be shorter. Restoration of degraded habitat and corridor forests: Restoration of wildlife habitat and migratory corridors will carry out at PNP and Barandabhar Corridor Forests to minimize keeping the animals away from the highway, species which are preferred by herbivores. Area

Environmental Impacts	Nature	Magnitude	Extent	Duration	Total Sum	Significance	Mitigation measures
							and selection of species for plantation to be consulted during the implementation with DNPWC, PNP, CNP, DFOs.
Loss of Protected Species of Flora	D	M(20)	L(20)	LT (20)	60	Medium Significance	Significant number of Sal species will be lost during construction. Compensatory plantation will be given priority as per conservation status (Such as Sal, Satal and other indigenous species).
Setting Camps near forests, Use of Forest Products (NTFPs) by Construction Workers	D	L(10)	SS(5)	ST (5)	20	Insignificance	Construction workers will follow the code of conduct during works in forest area. Worker's camps and construction facilities will not be constructed in the forest/protected area. Construction workers will be strictly prohibited for use of Forest products or Non-Timber Forest Products (NTFPs) for personal or commercial purpose during construction works in the forest.
Impacts on wildlife/Fauna	I	H(60)	L(20)	LT(20)	100	High significance	Reduction in loss of forest area: Road width in forest/rural area has been reduced to 24m to reduce impact on forest and wildlife habitat. No clearance of forests or reduce clearing of forest will help naturalize wildlife habitat to the maximum. Appropriate Structures made for Natural flow of Wildlife: Through wildlife survey (camera trapping, roadkill survey, interactive wildlife survey etc.) wildlife crossing points were identified to facilitate the movement. Hence to retain wildlife habitat and connectivity and to reduce/control roadkill (Wildlife Vehicle Collision) following measures are proposed. Structures for Wildlife Crossing Points: The wildlife survey, supplemented by cammera trapping study, road kills (Clevenger etal 2022) identified 21 critical points dedicated to construct specific wild animals' friendly structure (GON 2022). Structures for Wildlife Crossing Points: The wildlife survey, supplemented

Environmental Impacts	Nature	Magnitude	Extent	Duration	Total Sum	Significance	Mitigation measures
							by camera trapping study, road kill survey (Clevenger et al 2022) identified 21 critical points dedicated to construct specific wild animals' friendly structure (GON 2022). When most of the crossings detected were under-passes, over ground. Over-ground wildlife crossing was very vibrant in Adhabhar Corridor Forests (ACF)/PNP and Barandabar Corridor Forests (BCF). Endangered species like Asian elephant and Bengal tiger were most common, compared to other forests of PHN and Asian elephant was found migrating in herds of 70 and above, in addition to distractive loaners indulging in smashing structures and even human. This size of elephant population is reported growing. VIADUCT at PNP and BCF has been proposed for a natural flow of these vulnerable species. VIADUCT is designed for all the mammals travelling across the Adhabhar (East <> West) and Barandabar (North <> South), overground. 2001 m long VIADUCTs are proposed at Adhabhar (373+496) and 2001m long at Barandabar (Ch 465+356). Similarly, 3 very large animal crossing structure (VLACS) are proposed at Ch 382+897, Ch 391+096 and Ch 420+178. Large animal crossing structure (LACS) will be built at Ch 413+160, Ch 418+550, Ch 419+539, Ch 419+733 and Ch 429+939. Of the 10 crossings proposed for Medium Sized Mammals (Ch 382+752, Ch 383+636, 405+622, Ch 409+100, Ch 418+168, Ch 419+026, Ch 429+350, Ch 429+717, Ch 432+968 and Ch 435+520). The small animal crossing is as well upgraded at Ch 415+190. The underpass structures will be successful in keeping the animals away from the road. The structure has also been approved by the "Council of Ministers" as recommended by TA report⁴.

⁴ "Smart Infrastructure Planning and Design to Protect Natural Habitats and Biodiversity: Ecological Assessment of the NHP Road Upgrading, January 2022"

Environmental Impacts	Nature	Magnitude	Extent	Duration	Total Sum	Significance	Mitigation measures										
							VIADUCT: 2001m long VIADUCT at Parsa National Park and 2001m long at Barandabar Corridor Forest has been proposed. Light index: The one way VIADUCT/Bridges will stand at least 8 m apart. The height of the VIADUCT will be not less than 7 m. Funnelling fencing: Solar or electrified funnelling fencing (EFF) are proposed to guide and use the structure efficiently. <u>About 14,000 m of EFF is proposed in PNP and about 4000 m in BCF.</u> Waterholes and salt lick: Two waterholes are constructed, on either side of VIADUCT and source and supply of water has been identified. Rhino Lake in the Barandabar and Kamini/Bridge no 1 source will be maintained. One salt lick each will be constructed in the ACF and BCF. Increase Light Index: Further to enhance the light index, after increasing Box 1: Dedicated Wildlife friendly structures Government of Nepal (GON) has categorized wild animals as small, medium, large and very large wildlife. As per these categories, underground structures have been specified for <table><tr><td></td><td>Turtoise, Snakes, Crocodile, Gohar, Frog species, Lizard spp, etc</td></tr><tr><td>Small</td><td>Rabbit, Percupine, Civet, Monkey Pangoline, Habre, Chari-bagh, Lingsang, etc</td></tr><tr><td>Medium</td><td>Jungle cat, Neer biralo, Dhole, Jackle, Fox, Lings, small deer species, Krishnasar, Chauka, Hundar, Chituwa, Dolphin, Bandeel, etc</td></tr><tr><td>Large</td><td>Gainda, Bagh, Bhalu, Thulo mriga, Jharal, Ghoral, Neel gai, Gauri gai, Arna, etc</td></tr><tr><td>Very large</td><td>Hati</td></tr></table> The underpass structure size allocated for these categories are 15 m x 6.5 m, 15 m x 4.5 m, 8 m x 3 m and 3 m x 2.5 m for small, medium, large		Turtoise, Snakes, Crocodile, Gohar, Frog species, Lizard spp, etc	Small	Rabbit, Percupine, Civet, Monkey Pangoline, Habre, Chari-bagh, Lingsang, etc	Medium	Jungle cat, Neer biralo, Dhole, Jackle, Fox, Lings, small deer species, Krishnasar, Chauka, Hundar, Chituwa, Dolphin, Bandeel, etc	Large	Gainda, Bagh, Bhalu, Thulo mriga, Jharal, Ghoral, Neel gai, Gauri gai, Arna, etc	Very large	Hati
	Turtoise, Snakes, Crocodile, Gohar, Frog species, Lizard spp, etc																
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Environmental Impacts	Nature	Magnitude	Extent	Duration	Total Sum	Significance	Mitigation measures
							the size of box culverts, in design an opening/hole be made in the middle of the structure (in the median – opening size of 3 m x 3 m) . Soundproof barriers: The soundproof barriers will be constructed to keep sound away/down and block light during the night time, to maximize natural flow and use of structure by wildlife in both the VIADUCTS. Culverts and Bridge improvement: Use of culverts were found natural and the wildlife were found using the culverts for underground movement and a very dynamic overground movements in Adhabhar and Barandabar Corridor forests area (Clavenger, et.al. 2022 – (5.3.2)). All pipe culvert will be replace by Box Culverts (BC). This will enhance the mobility as the BC ground mobility will be increased with one and two wildlife walking lanes in BCs greater than 1.5 m x 1.5 m size. Two Wildlife Walking Lanes (WWL) are proposed under the Very Large Wildlife Crossing Structure (VLWC) and Large Wildlife Crossing Structure (LWC) structures. The wildlife crossing structures will have animal trail and waterway designed. All the culverts will have an opening of 3 m X 3 m is placed in the median of the highway to improve the light index and increased use of the culvert by the wildlife. Size of the box culvert for large wildlife will be increased considering the standard openness index advised by the Guidelines for wildlife friendly structures of the Government of Nepal (GON 2022), The Under Bridge Surfaces: Under bridge surface of bridge no 1, bridge no 2, bridge no 3, bridge no 4, Gundo bridge, Churiya bridge, Pakkipul bridge, Sansare bridge, Sayafut bridge, Badahakim bridge, Rapti bridge, Manohari bridge and Lothar Bridges are improvised for animals walking tracts to cross the highway. Most large bridge will have RCC base (upto 3 m) and later naturalize as wildlife tract. Dual function of Box Culverts and bridges: The upgraded box culverts will

Environmental Impacts	Nature	Magnitude	Extent	Duration	Total Sum	Significance	Mitigation measures
							have its base designed as underpass in addition to the waterway functions. Depending upon the size, there are one or two wildlife tracks. Large bridge floors will have riverside of under-bridge of Bridge no 1, 2, 3, 4, Badahakim, Rapti, Manohari and Lothar as well for the Very large wildlife, large wildlife and others to walk through Canopy bridge: 24 canopy bridges will be built for these arboreal species to cross PHN road. There are wildlife using air/canopy to move around in the forests.. Awareness increasing: warning sign, speed limit, display board of wildlife will be erected in the crossing areas. To minimize noise and disturbance to wildlife honking will be restricted at sensitive wildlife crossing locations. Awareness on wildlife co-existence and regulation of illegal wildlife hunting to the community residing will be conducted in the periphery of highway. Camera trapping: Cameras will be installed at different locations for effectiveness monitoring. Existing Forest Fence: Existing fencing will be reinstated. Detouring the Vehicles during construction - traffic management: Adhabhar Road Construction: During the construction, there should be provision to use some other alternative roads for vehicles coming from the eastern and western Nepal and from Bringaunj. Neejghad/Fast Track Road is the safest road to arrive H09 and follow on to Hetauda. By doing so the construction activities can be carried much quickly.

Environmental Impacts	Nature	Magnitude	Extent	Duration	Total Sum	Significance	Mitigation measures
							Barandabar Corridor Forest: Bypass for the construction period of Barandabar area shall be Padampur Road. The Padampur Road starts at Ch 460+460, after about 6.5 km of drive on Padampur road, one will arrive Kamal chowk. From where it is 8 km to arrive Bharatpur city.
Disturbance on Wildlife Movement/ Wildlife Vehicle Collision	D	H (60)	L (20)	LT (20)	100	High significance	After Construction of Viaduct, under pass structures, canopy bridges, fencing has been proposed to reduce wildlife vehicle collision. There is provision of 21 wildlife crossing structures including VIADUCT at PHN and BCF along the forest area. To minimize the disturbances several over and under passing structures are designed. In major wildlife moving corridor forests PNP and BCF two VIADUCTs has been designed. Besides these, in Chure hill forests, Dun and Inner Terai Forests the improved box culverts will function as under pass structures. Canopy bridges and fencing prevent wild animals approach the highway, thus reduce wildlife vehicle collision. Speed reduction zones: Warning sign, speed limit, display board of wildlife will be erected in the crossing areas. Informatory signboards on the presence of wildlife and importance will be installed along the forest sections that have wildlife movement. Waterholes: Waterholes will be constructed as appropriate locations. Waterholes are proposed in PNP/Adhabhar (4), at Ratmate forests (4), Rapti forests (2), Rajiya forest (3), and Manohra/Lothar Forests. Existing RhinoLake in the Barandhabhar forests will be maintained.

Environmental Impacts	Nature	Magnitude	Extent	Duration	Total Sum	Significance	Mitigation measures
							The lake will be managed as water source for the animals. The water holes/ditches will be fed from the water sprouting from the lake. Camera trapping: Cameras will be installed at different locations for effectiveness monitoring of animal appearing abruptly causing confrontation in the road leading to an accident. 21 wildlife crossing structures (including VIADUCT at PNP and BCF along the other forest), canopy bridges, fencing has been proposed to reduce wildlife vehicle collision. Speed reduction: Warning sign, speed limit, display board of wildlife will be erected in the crossing areas. Informatory signboards on the presence of wildlife and importance will be installed along the forest sections that have wildlife movement. Camera trapping: Cameras will be installed at different locations for effectiveness monitoring. Fencing will prevent wild animals approach the highway, thus reduce wildlife vehicle collision.
A chance meeting with wildlife working on the road passing through the national parks (PNP), BCF, BZ Workers and Wildlife Safety							A chance meeting with wildlife while working at passing through the national parks, BCF, Buffer zone. Dawn & Dusk and wildlife movement timing will be avoided to avoid a chance meeting with wildlife especially working in the National Parks (Work 8AM to 6 PM in Summer and 9AM to 5 PM in Winter). Inform Park management of construction schedules, coordination with concern Office. Camp will not establish in the sensitive area (PNP,BCF, BZ). Workers will be in groups while working. Safety awareness will be provided to the workers for self-protection in case of wildlife encounter before start the work. One person to be deployed as watchman. Emergency response plan to be prepared. There will not be any ditches left uncovered or unfilled after the work is

Environmental Impacts	Nature	Magnitude	Extent	Duration	Total Sum	Significance	Mitigation measures
							halted for the day. This will be a standard practice conducted for the safety of wild animals and construction team members and others. Worker's camps and construction facilities will not be constructed in the forest area.
Impact on Avifauna	D	Lo (10)	L(20)	ST (5)	35	Insignificance	In forest area, The design of road width has been minimized to 24 m, which will reduce impact on forest clearance and bird habitat. No construction materials will be disposed in critical forests and wetland area. If vegetation clearance takes place within the bird (including vulture) breeding season (October –April), trees will be checked for nests of raptors or other large birds prior to felling. If active nests are identified, an exclusion zone will be established around the nest to avoid disturbance until the young have fledged. Unnecessary sounds produced equipment during the construction work shall be regulated through regular awareness and traffic no-horn zones. The project will also conduct sensitization and awareness to workers.
Impact on Herpetofauna and Aquatic Life	D	M (20)	L (20)	ST (5)	45	Medium significance	Rivers will be canalized without disturbing river regime as far as possible. Excavation of sand and gravel will not be done unless is approved by concerned authority and excavated only in specified locations without affecting the river regime and hence the aquatic life. All affected locations/sites, after excavation will be immediately reinstated once the job is done in the rivers. Flow of water will be maintained providing hume pipes during the construction in the rivers. All chemicals, bitumen, oil and fuel will be stored in drums on impervious floor so that no leakage or spillage will reach water bodies. Fishing by construction workers in these rivers will be strictly prohibited. Bridge and cross drainage work at river/streams to be considered during fish breeding time (May/June to August/September) and not to be disturbed

Environmental Impacts	Nature	Magnitude	Extent	Duration	Total Sum	Significance	Mitigation measures
							the river during this time. Prohibit fishing by the construction workers.
Operation Stage							
Impact on Flora and Fauna, Monitoring and Biodiversity impact/study mitigation efforts	ID	M (20)	L (20)	LT (20)	60	Medium significance	Regular maintenance of VIADUCT/ Underpass of wildlife crossing, regular cleaning, clearing and maintenance of all culverts to reduce the chances of blocking. Camera trapping: Cameras will be installed at different locations for effectiveness monitoring. Install cameras to regularly monitor wildlife crossing. Roadkill study: Conduct monitoring by installing devices to monitor wildlife movement, use of structures by wildlife. Together with respective DFOs, maintain recording of road kill.
Disturbance to Wildlife Movement/ Wildlife Vehicle collision	ID	Lo (10)	L (20)	LT (20)	50	Medium significance	Regular cleaning and maintenance of all wildlife crossing structures to reduce the chances of blocking and facilitate animal movement; Installation of additional measures to reduce collisions between animals and vehicles (e.g. use of signs to alert drivers where animals frequently cross; installation of fencing along the roadway to direct animals toward crossing structures; and use of reflectors along the roadside to deter animal crossings at night when vehicles are approaching) The Government or community forests, which have existing fence, these fencing will be rebuilt once the construction will be completed. The fence will be the vital in reducing or keeping the wildlife vehicle collision at its lowest.
Awareness increasing activities	ID	Lo (10)	L (20)	LT (20)	50	Medium significance	Warning sign, speed limit, display board of wildlife will be erected in the crossing areas. To minimize noise and disturbance to wildlife honking will be restricted at sensitive wildlife crossing locations. Awareness on wildlife co-existence and regulation of illegal wildlife hunting to the community

Environmental Impacts	Nature	Magnitude	Extent	Duration	Total Sum	Significance	Mitigation measures
							residing will be conducted in the periphery of highway. Wildlife information: Informative signboards on wildlife, their presence and their importance to be installed along the forest area where wildlife movement. Workshops for locals for awareness-raising on forest fire/management/coordination, wildlife protection, wildlife and their relation with waste dumping (from vehicles), Speed limit, and Potential collision/Roadkill.
Maintenance of crossing structures and others	ID	Lo (10)	L (20)	LT (20)	50	Medium significance	Regular maintenance of VIADUCT/ Underpass of wildlife crossing, regular cleaning, clearing and maintenance of all culverts to reduce the chances of blocking/cluging and facilitate wildlife movement. Conduct monitoring by installing devices for the wildlife movement and use of wildlife crossing facilities for wildlife. Together with respective PNP, CNP, DFOs, maintain recording of road kill. Regular inspection and maintenance of water sources/pond, fencing installed in the forest areas. Maintenance/management of plantation area. <u>The Biodiversity Expert to be prepared the maintenance plan (Annually/seasonally, appropriately all crossing structures VIADUCT, under pass structures of all the crossings and supporting structures).</u>
Socio-economic and Cultural Environment							
Construction stage							
Private structure Acquisition (The project will affect 403 private structures (beside Hetauda	D	H (60)	L (20)	LT (20)	100	High significance	403 private structures of 378 HHs will be affected. A Resettlement Action Plan (RAP) has been prepared to address and compensation on the affected households. Details of affected households are given in Annex VI-C. The affected households will not only receive cash compensation of structures, but also additional assistance will also be given for relocation and livelihood restoration.

Environmental Impacts	Nature	Magnitude	Extent	Duration	Total Sum	Significance	Mitigation measures
bazar)							Compensation of livelihood impacts on the affected businesses will be paid to the affected households for lost income from businesses in accordance with RAP. Additional cash compensation will be paid to vulnerable households. Livelihood restoration measures will also be implemented in accordance with the RAP. <i>(The RAP provides detailed information on compensation rate and relevant livelihood restoration activities. The objective of the plan is to improve or at least restore the income and livelihood conditions of the people to at least the pre-project level. The affected households will not only receive cash compensation for assets at prevailing rates for full replacement cost, but also additional assistance will be given for relocation and livelihood restoration. Overall, the RAP presents (a) socio-economic profile of the affected households; (b) type and extent of loss of assets; including land, structures, (c) principles and legal framework applicable for mitigation of these losses; (d) the entitlement matrix; (e) income and livelihood restoration program; (f) relocation and resettlement budget; (g) institutional framework for the implementation of the plan, including monitoring and evaluation).</i>
Disruption of Community Structure and Public Utilities	D	H(60)	L(20)	LT(20)	100	High significance	Prior inform to public before shifting of the public structures, utility. The project will take necessary process for clearance, transfer of funds etc. to the respective utility service provider so as not cause any delays to the road construction schedule. Plan shifting activities. - Community structures- Rebuilt with consultation of the local community, local authorities, the cost is allocated in project cost - Irrigation canal and water supply lines – contractor will relocate the irrigation canal, water pipelines – provision in the engineering costs - Electric poles and power lines – coordination with Nepal Electricity Authority for relocation

Environmental Impacts	Nature	Magnitude	Extent	Duration	Total Sum	Significance	Mitigation measures
							• Telephone lines – Communication Department • Public toilet– Coordination with local government • Access roads – Realign the roads before demolition of the existing roads. • Tube wells -new tube well before demolishing the existing on
Stress on public utilities and Facilities	ID	L(20)	L(20)	ST(5)	45	Insignificance	The contractor will ensure to source of water for construction and construction camps in a manner not to burden the existing local water supply system, new sources such as new bore wells for use in construction camps and river water when rivers exist near the construction site. Primary health facilities will be arranged in camp. Waste management facilities at the camp sites such as dust bins, compost pits and linkage with relevant municipal waste collection system shall be arranged at all camp sites by the contractor.
Impacts from Labour Influx	ID	M (20)	SS (10)	ST (5)	35	Insignificance	The Contractors will be aware of the possibility and risks of miscommunications between local residents and workers, to reduce conflicts; this will be prevented by raising awareness and implementing a Code of Conduct for the workers. The Contractor shall develop a Worker Code of Conduct to govern the behavior of workers on-site, in camps, and in local communities. Awareness campaign will be conducted to construction workforce on spreading of sexually transmitted diseases such as HIV/AIDS, GBV. Construction camps will be built in the designated areas, located away from the settlements.
Occupational Health and Safety	D	H (60)	SS (10)	ST (5)	75	Moderate significance	The contractor will be required to prepare, obtain approval and implement an occupational health and safety (OHS) plan for all identified hazards under each work activities, and site-specific OHS hazard and risks during construction, and control and preventive measures. The Plan shall be reviewed and updated if there any changes in the construction

Environmental Impacts	Nature	Magnitude	Extent	Duration	Total Sum	Significance	Mitigation measures
							methodologies. OHS Plan shall contain general guidance for all identified hazards under each work activities and they should be presented in three discrete headings, (a) Contractor's standards on the identified hazard management, (b) Expected site-specific OHS hazard and risks during construction, and (c) Control and preventive measures proposed by the Contractor. Conduct a 'job hazard analysis at the new construction site to identify potential hazards that may arise from the proposed works or working conditions to the project workers and implement necessary control measures. Conduct regular training program for workers on occupational health safety (daily/weekly toolbox talks). Provide personal protective equipment (PPE) for workers (such as safety boots, helmets, masks, gloves, body harness, protective clothing, goggles, fully face eye shields and ear protection). Facilities of firefighting, ambulance, medical and rescue shall be provided at the site for implementation of an emergency response. The construction camp will be built with all adequate facilities (safe drinking water and sanitation, kitchen, rest areas, etc.) including entertainment facilities so that there will be minimal interaction between them and local communities. Awareness-raising material will be used including posters, signage, booklets, and others at the worksites. Ensure equal wages for women and men for same works. First aid facilities will be made available at the worksites and in the camps. The contractors will engage qualified first aider(s). Separate toilet facilities will be provided to men and women workers. The Contractor shall establish a mechanism (maintaining grievance

Environmental Impacts	Nature	Magnitude	Extent	Duration	Total Sum	Significance	Mitigation measures
							register) to collect the complaints from the workers and address those complaints.
Community Health and Safety	D	M (20)	L (20)	ST (5)	45	Medium significance	Safety Hazards due to construction vehicles: The contractor will develop and implement comprehensive traffic management plan with adequate measures such as proposing traffic diversion measures, alternate routes for local traffic, avoiding school hours, following speed limits, etc. The plan will be implemented with the aim of preventing unsafe situations, especially near schools, settlement, market areas, construction areas • The road shall not be stopped for existing traffic. Road signage will be installed at construction sites to reduce safety hazards associated with project-related vehicular traffic. • Liaison with traffic police. • Project drivers will be trained regular. • Ensure that all construction vehicles observe speed limits on the construction sites and on public roads. • Training for risk mitigation (e.g. on HIV AIDS, trafficking, child labour) • Provide adequate signage, barriers, and flag persons for traffic control. Community Exposure to Work Hazards: Barricade the work areas with fencing to prevent the entry of community in the construction areas. • Placing of adequate information, install signboards and flagmen to divert the community away from the construction works. • Community awareness programs will be conducted on construction-related hazards and risks to the nearby people. There will be adequate mechanisms in place to protect the local vulnerable population, especially women and minors from risks associated with the

Environmental Impacts	Nature	Magnitude	Extent	Duration	Total Sum	Significance	Mitigation measures
							influx of workers (harassment). This mechanism will ensure the sensitization and enforcement of code-of-conduct by the Contractor employees and workers and all other parties that are involved in the project implementation. Zebra crossing will be installed in 54 locations focusing for schools in the direct impact zone and indirect impact zone (The detail locations are given in Annex IV-G).
Risk of Gender-Based Violence	D	Lo (10)	L (20)	ST (5)	35	Insignificance	Ensure the sensitization and enforcement of code-of-conduct by the Contractor employees and workers and all other parties that are involved in the project implementation. Conduct awareness training of supervision consultant, contractor, sub-contractor and service providers staff to sensitize them about SEA, and SH. Make aware about code of conduct to all workers in Nepali language.
Impacts on Religious Sites	D	M (20)	L (20)	LT (20)	60	Medium significance	Prior inform to public before shifting of the affected structures. Community temple will be rebuilt with consultation of the local community, local authorities, the cost is allocated in project cost. Churiya Mai (Ch 386+780), Churiya mai tunnel at Ch 387+160, Compound wall of Nava Durga Temple within CoI (Ch 394+360), Gorachheswor Temple at Ch 397+280, footsteps, Om Kareshwor Mahadev area at Ch 398+100, Krishmna Temple small Ch 411+800, Shiva Parbati temple at Ch 420+970, Jaleshwar Shivalaya at Ch 421+320, Shiva temple at Ch 424+180, Babadham at Ch 424+740 etc. lies in the RoW. Chance Finding: During the construction encountering any finding of physical cultural resources at sites, the Contractor will follow a Chance Find Protocol as follows: Stop the construction activities in the area of the chance find;

Environmental Impacts	Nature	Magnitude	Extent	Duration	Total Sum	Significance	Mitigation measures
							Delineate the discovered site or area; Notify the supervisory Engineer and relevant Department of Archaeology immediately. Construction work could resume only after permission is given from the local authorities and relevant Department of Archaeology concerning the safeguard of the cultural sites.
Operation Stage							
Road Safety	D	M (20)	L (20)	LT (20)	60	Medium significance	Maintenance of safety furniture's, pedestrian crossing (preferably over or under, zebra crossing the roadway); Crossing locations should take into account community preferences, including those related to convenience or personal safety. Additional installation signs, signals, markings, and other devices used to regulate traffic, specifically those related to pedestrian facilities; Speed control and regulations (especially in market, settlement areas, schools and other public places). Establishment of traffic signals, CC cameras for monitoring in the highway. Road safety awareness trainings will be conducted with coordination of local traffic police to drivers and locals.
Community Health and Safety	D	M (20)	L (20)	LT (20)	60	Medium significance	- Provision of safe corridors along the road alignment and safe crossings (preferably over or under the roadway) for pedestrians during maintenance. - Additional installation and maintenance of all signs, signals, markings, and other devices used to regulate traffic, specifically those related to pedestrian facilities. - Road crossing infrastructures incorporating principal of universal

Environmental Impacts	Nature	Magnitude	Extent	Duration	Total Sum	Significance	Mitigation measures
							access. - Establishment of traffic signals, CC cameras for speed control for public buses plying the highway. - Manage temporary bypass while maintenance the road. - Road safety awareness trainings to drivers and locals.
Encroachment of RoW	D	Lo (10)	L (20)	LT (20)	50	Medium significance	Project/DoR will conduct awareness to local about RoW encroachment. With coordination of local government, enforcement of law. Conduct coordination for combined efforts of various governmental agencies and awareness activities.
Workers Health and Safety	D	Lo (10)	L (20)	ST (5)	35	Insignificance	Establishment of work zones safety to separate workers from traffic, Closure of lanes and divert the traffic to the remaining lanes if the road is wide enough (e.g.re-routing of all traffic to one side of a multi-lane highway). Where worker exposure to traffic use of protective barriers to shield worker from traffic vehicles, or installation of channeling devices (e.g. traffic cones and barrels) to delineate the work zone, regulate traffic flow by warning lights, flaggers.

8.3 Environmental Management Plan

The Environmental Management Plan (EMP) encompasses a set of measures on physical, biological and socio-economic and cultural environment to be taken in different construction stages to eliminate, offset or reduce adverse environmental impacts to acceptable levels. EMP presents the mitigation and management measures to be taken its location, timeframe, cost for implementation and institutional responsibility to ensure that no significant adverse impacts will be occurred from the project intervention. A detail EMP matrix for road and bridge has been prepared and presented in Annex IX.

8.4 Environmental Budget

Cost estimation for the proposed mitigation measures and enhancement measures on physical, biological, and socio-economic and cultural environment of PHN roads is given in the Table below.

Table 88: Environmental Mitigation and Enhancement Cost of PHN Road

Sn	Items	Quantity	Unit	Amount	Remarks
A	Capacity building				
1	Workshop/Public hearing for information dissemination	21.00	No	1,050,000.00	
2	Environment Awareness Campion (7 Municipality + 2 NP)	9.00	No	1,800,000.00	
	Sub-total			2,850,000.00	
B	Physical Envoinment				
1	Traffic management provisions for construction sites				Responsibility of the Contractor
2	Excess spoil materials (safe disposal) management				Reuse of excavated materials Scrifying/dismantalin g and disposal
3	Slope protection work (Bio-engineering works)			297,528,086.96	Embankment Slope protection and other Bio-engineering works
4	Air and Noise Quality monitoring Air and Noise quality monitoring 28locations @6months*3 years + 1baseline+1 post construction) (28*8*30000)	224.00	No	6,720,000.00	Provisioned in provisional sum
5	Water quality monitoring Water quality monitoring (12*25000* 8) locations@6months*3 years + 1baseline+1 post construction)	96.00	No	2,400,000.00	Provisioned in provisional sum
6	Water Sprinkling to reduce dust			18,335,000.00	Provisioned in day works
7	Drainage management work				Included in project cost
8	Installation of Road Safety signs				Included in project cost

Sn	Items	Quantity	Unit	Amount	Remarks
9	Flood protection. River training			289,268,119.00	Included in project cost
11	Pedestrian crossings/overhead bridges	6.00	No	101,000,000.00	Included in project cost
12	Reinstate of Quarry borrow pit, Batching plants, camp etc.			6,000,000.00	Contractor responsibility
13	Camp establishment			-	Responsibility of the Contractor
14	Supply of Protective gears (PPEs), First aid facilities	36.00	Month	3,600,000.00	Provisioned in provisional sum
15	Construction of Small Animal Crossing (3 x 2.5) m	1.00	Nos	5,763,761.00	Included in project cost
16	Construction of Medium Animal Crossing (MAC)	10.00	Nos	157,648,770.00	Included in project cost
17	Construction of Large Animal Crossing (LAC)	3.00	No	154,292,859.00	Included in project cost
18	Construction of Very Large Animal Crossing (VLAC)	5.00	No	439,192,863.33	Included in project cost
19	Construction of Viaduct	2.00	No	10,504,410,355.00	Included in project cost
	Sub-total			11,986,159,814.29	
C	Biological Environment				
1	Felling trees including cutting of trunks, branches, root, stacking and transportation			42,802,952.48	Included in project cost
2	Compensatory tree plantation			220,266,768.00	Provisioned in provisional sum
3	Wildlife crossing, wildlife compatible fencing in the forest blocks, warning sign, speed limit, display board of wildlife			24,086,696.00	Included in project cost
4	Installation of Canopy bridges	24.00		4,800,000.00	Provisioned in provisional sum
5	Physical and Biological enhancement (Roadside plantation, avenue plantation, roadside water sources/wetland maintenance at forest section), awareness on wildlife, monitoring of wildlife movement			20,000,000.00	Provisioned in provisional sum
6	Development of grassland, construction of waterhole, development of pond			23,000,000.00	Provisioned in provisional sum
7	Provision of barbed wire fencing and Electrical fencing (Parsa-1 Km, Amlekhgunj - 1.5 Km, Tikauli-1 Km, Gondrang - 1 Km and Existing area of community forest)			22,455,828.00	Provisioned in provisional sum
8	Sound Barrier			3,010,000.00	Provisioned in provisional sum
	Sub-total			360,422,244.48	

Sn	Items	Quantity	Unit	Amount	Remarks
D	Socio-economic and Cultural Environment				
1	Relocation of public utilities (Drinking water supply lines, electric poles, irrigation canal etc.)			2,25,253,170.00	Provisioned in provisional sum
2	Restoration of damaged community infrastructures/ Private infrastructure all complete except Hetauda Bazaar.			104,247,522.48	Provisioned in provisional sum
3	Livelihood & Income Restoration Training for Project APs			5,250,000.00	Provisioned in RAP
4	Community sensitization and orientation on GBV/HIV AIDS			1,000,000.00	Provisioned in RAP
5	Awareness to Labours on communicable diseases (including HIV/AIDs), SEA, SH etc			1,000,000.00	Provisioned in RAP
6	Awareness/ capacity building to workers, local communities and traffic police on road safety			1,000,000.00	Provisioned in RAP
	Sub-total			112,497,522.48	
	Total			12,461,929,581.25	

9 ENVIRONMENTAL MONITORING OF THE IMPACTS

Environmental Monitoring is an integral part of the environmental mitigation measures. As per EPR, 2077, the project proponent is responsible for monitoring of the impacts. The Environmental Monitoring Plan (EMoP) has defined all environmental components to be monitored at different project stage with parameters, methods, locations, frequency, cost, institutional responsibility for implementation. Detail is given in Table 89 and cost for environmental monitoring is given in Table 90.

Table 89: Environmental Monitoring Plan

.	Indicators	Methods	Monitoring Time	Location	Monitoring Agency	Monitoring Cost
A. Baseline Monitoring						
Air quality	PM _{2.5} , PM ₁₀ , NO _x , SO _x , CO _x , Lead, Benzene	Ambient air quality sampling and analysis at selected sites/sensitive spots using through High Volume Sampler 24-hour	Before construction	28 locations (Annex IV)	Contractor, SC/PIU/DoR	NRs 840,000 (28*30,000)
Noise level	1 hr Leq dB(A))	Points source measurements in dB(A) at settlement sites/sensitive spots for noise level at 2.5 and 15 m from roads	Before construction	28 locations (Annex IV)	Contractor, SC/PIU/DoR	
Water quality	pH, Electric conductivity, Turbidity, Total Hardness, Total Alkalinity, Chloride, Ammonia, Nitrate, Calcium, Magnesium, Iron and <i>E Coli</i> etc.	Collect and analyze sample from source	Before construction	12 locations (Annex IV)	Contractor, SC/PIU/DoR	NRs 300,000 (12*25000)
Proposed Borrow Areas, Quarry Sites, Crusher Plant/Hot mix Plant/Batching plants, Camp sites	Land use, drainage condition, surface water pollution, erosion, Get approval/permit from concern	Site observation, discussion with local people	Before construction	Proposed sites	Contractor, SC/PIU/DoR	Contractor's responsibility

.	Indicators	Methods	Monitoring Time	Location	Monitoring Agency	Monitoring Cost
	authorities					
Slope failure	Erosion, Land slide	Observation	Before construction	Along the road	Contractor, SC/PIU/DoR	Contractor's responsibility
Wildlife movement	Road kills/collision	Monitoring record, Site observation and consultation with DFO, local people	Before construction	PNP, BZ, Forest area, BFC	SC/PIU/DoR	Included in Project cost
Community structures, public utilities	Existing condition/ disrupted/damage	Direct observation and consultation with local authorities, local people	Before construction	Within RoW locations	SC/PIU/DoR	
Private structures	Removal compensation	Direct observation and consultation with local authorities, local people	Before construction	Within RoW locations	SC/PIU/DoR	Included in RAP
B. Compliance monitoring						
Contractor's commitment in Environment and Social Safeguarding Before construction	Revised and Prepared Plans by Contractor (e.g. CESMP, Quarry and Borrow Pit Management Plan, Camp Management Plan, Traffic Management Plan, OHS Plan, Site Restoration Plan, BMP etc.	Review of Document Site visit	Within 1 month of awarding contract	Along the road	Contractor, SC/PIU/DoR	Contractor's responsibility
Employment opportunity to local people	Number of laborers from road affected municipality	Employment records, Consultation with Local	Periodically during construction phase	Construction sites	Contractor	No extra cost required

.	Indicators	Methods	Monitoring Time	Location	Monitoring Agency	Monitoring Cost
	employed as skilled/ unskilled Labour in the road construction,	Government/Local people				
Removal of tree from RoW	Get approval from DoF/DFO	Felling of tree from RoW before construction work start	Before construction	Along the road	SC/PIU/DoR/DFO	Included in Project cost
Resettlement, assistance and compensation for private structures	Allowances and support provided to affected HHs Price fixation for loss structure by CDC/ Compensation amount/ acquired properties	Records of CDC and FGD with families which have lost properties, photos	Before construction	Along the road	SC/PIU/DoR/ CDC/Municipality	Included in RAP
Relocation of Public structures/utilities	Timely relocation of community/ pubic structures	Observation, consultation with affected communities	Before construction	Along the road	SC/PIU/DoR/ Concern stakeholders	Included in project cost, NRs. 2,25,253,170.00
Establishment of camp, stockpile, Crusher Plant/Hot mix Plant/Batching plants	Get approval from Engineer, Local authorities'	Contractor's arrangements regarding labor camps materials storage and construction activities	Before construction	Proposed sites	SC/PIU/DoR/ Concern stakeholders	Contractor's responsibility
Physical Environment						
Slope protection	Civil structures with Bioengineering methods used at recommended sites	Observation, Walk through survey	During construction before monsoon, after monsoon	Hill embankment and locations	SC/PIU/DoR	Included in Project cost

.	Indicators	Methods	Monitoring Time	Location	Monitoring Agency	Monitoring Cost
Extraction of material from recommended quarry sites and borrow pits	No cases of material extraction reported from unauthorized sites	Walk through survey, interaction with local peoples	During construction phase	Quarry and borrow locations	SC/PIU/DoR	Contractor's responsibility
Control of dust emission	Dust level at construction site, water sprinkling practice observed, road maintenance	Observation, Use of sprinkler tank, interview local about dust problem	During construction phase Regular	Along the road,	SC/PIU/DoR	NRs. 18,335,000
Air quality	PM _{2.5} , PM ₁₀ , NO _x , SO _x , CO _x , Lead, Benzene	Ambient air quality sampling and analysis at selected sites/sensitive spots using through High Volume Sampler 24-hour	During construction 6 monthly	28 locations (Annex IV-)	Contractor, SC/PIU/DoR	NRs 6,720,000 (28*yearly@2*3years*30,000)
Noise level	1 hr Leq dB(A))	Points source measurements in dB(A) at settlement sites/sensitive spots for noise level at 2.5 and 15 m from roads	During construction, 6 monthly	28 locations (Annex IV)	Contractor, SC/PIU/DoR	
Spoil disposal in safe tipping sites	Erosion protection measures used (grassing), bunds constructed, adequate drainage provided	Interaction with project manager, and local people, Walkthrough survey along road alignment	During construction phase	Proposed soil disposal locations	SC/PIU/DoR	Included in Project cost
Use of garbage bins	Waste bin at camp sites	Observation	During construction phase	All camp sites, equipment yard,	SC/PIU/DoR	Contractor's responsibility

.	Indicators	Methods	Monitoring Time	Location	Monitoring Agency	Monitoring Cost
				plants,		
Waste disposal	Proposed Designated locations	Observation	During construction phase	Proposed waste disposal locations	SC/PIU/DoR	Contractor's responsibility
Monitoring of vulnerable houses to vibration	Damage the house/Record of Vibration effects if any	Observation, record	During construction phase	Roadside houses	SC/PIU/DoR	The project will allocated the budger if affects the houses
Trapping of silt, sediments, oils etc. from the construction sites into the waterbodies	Construction of sediment trap	Observation, record	During construction phase	Camp sites, Asphalt plant, Batching plant, Crusher plant	SC/PIU/DoR	Contractor's responsibility
Diversion and traffic management	Appropriate Construction of diversion	Observation, record	During construction phase	Along the road and bridges	SC/PIU/DoR	Contractor's responsibility
Dust control	Dust level at work sites, major settlements and sensitive spots like health centers and schools	Regular water sprinkle, Air quality testing, Observation	Once in a 3 month during construction	Along the road	SC/PIU/DoR	Included in Project cost
Water quality	pH, Electric conductivity, Turbidity, Total Hardness, Total Alkalinity, Chloride, Ammonia, Nitrate, Calcium, Magnesium, Iron and <i>E Coli</i> etc.	Observation, Collect and analyze sample from source	Once in a 6 month during construction	9 Rivers + 3 ground water	SC/PIU/DoR	NRs 1,800,000 (12*2*3*25,000)

.	Indicators	Methods	Monitoring Time	Location	Monitoring Agency	Monitoring Cost
Road Accidents	Record of accident in the road	Record keeping/ Observation, interview local	During construction and operation phase	Along the road	SC/PIU/DoR	NA
Biological Environment						
Spoil disposal in forest and water bodies	Spoil dumped in forest, and sensitive areas	Observation	During construction period	Forest Section	SC/PIU/DoR	Haulage cost is included in Project cost
Compensatory plantation	Number of trees planted	Visit to plantation area	Before issuing of construction completion certificate	Proposed Compensatory plantation locations	SC/PIU/DoR	NRs 220,266,768.00 Included in Project cost
Use of firewood	Use of firewood by labor, and bitumen heating	Inspection, interaction with local, community forestry and labors	During construction phase	Camp sites, Bitumen plant sites	SC/PIU/DoR	Contractor's responsibility
Disturbing, illegal hunting, poaching of wildlife	Cases of disturbances, illegal hunting and poaching	Interaction with PNP, BFC, CFUG, locals, inspection of labor camp area	During construction phase	Camp sites, Forest area	SC/PIU/DOR	Included in Project cost
Human Wildlife conflict/ Collision	Road kills, Damage Agriculture production	Record, observation Interview with concern stakeholders	During construction phase	Forest area, PNP, BCF,BZ	SC/PIU/DOR	Contractor's responsibility
Wildlife friendly construction approaches	Number of wildlife crossing, VIADUCT	Observation	During construction phase	Forest area, PNP, BCF,BZ	SC/PIU/DOR	Contractor's responsibility
Disturbance to Aquatic Life	Habitat loss/ change the migratory route To be consider fish breeding time (May/June to August/September),	Record, Interview with concern stakeholders	During construction phase	Bridge construction at all Perennial River	SC/PIU/DOR	Contractor's responsibility

.	Indicators	Methods	Monitoring Time	Location	Monitoring Agency	Monitoring Cost
	not to be disturbed in river					
Socio-economic and cultural Environment						
Involvement of local labors in construction activities	Number of local labors employed in project	Inspection at construction site, interaction with labour, local people	Periodically during construction phase	Road and Bridge Construction sites	SC/PIU/DOR	Contractor's responsibility
Worker's sanitation, Occupational health and safety	Incidence of communicable/non-communicable diseases in labor camp, safety gears usage by labor, medical checkup camps, shelter, drinking water and toilet facility	Site inspection, interaction with labors	Periodically during construction phase	Construction sites, camp sites	SC/PIU/DOR	Included in Project cost
Social Conflict	Number of days lost due to conflict, bandhs at project level etc.	Interview with contractor, locals	Periodically during construction phase	Along the road	SC/PIU/DOR	NA
Employment to Project affected people	Number of project affected people employed	Interaction with project affected people, recording	Periodically during construction phase	Along the road	SC/PIU/DOR	Included in RAP
Restoration, rehabilitation of infrastructures damaged by the project activities	Continued services by the facilities and functional public life	Site observation; records; Public Consultation Meetings; Photos	Once in a month during construction phase	Along the road	SC/PIU/DOR	Included in Project cost
Compensation of Private structures	Compensation cost provided to APs	Site observation; records; Public	During construction phase	Along the road	SC/PIU/DOR	Included in RAP

.	Indicators	Methods	Monitoring Time	Location	Monitoring Agency	Monitoring Cost
		Consultation Meetings; Photos				
Community Health and safety	Provision of safety measures,	Site observation; records; Public Consultation Meetings; Photos	During construction phase	Along the road	SC/PIU/DOR	Included in Project cost
Religious Sites	Number of affected religious sites, temple	Site observation; records; Public Consultation Meetings; Photos	During construction phase	Along the road	SC/PIU/DOR	Included in Project cost
C. Impact Monitoring						
Slope protection	Success/failure of bio-engineering solutions, drainage management	Site observation, photos, discussion with people and technicians	During construction and Operation phase	Slope protection/embank slope,	PIU/SC/GESU/MoPIT	Included in Project cost/PBM cost
Air quality	Dust level at construction site, water sprinkling practice observed , PM _{2.5} , PM ₁₀ , NO _x , Sox, Cox, Lead, Benzene	Ambient air quality sampling and analysis at selected sites/sensitive spots using through High Volume Sampler 24-hour	During construction phase	Sensitive receptor's locations	PIU/SC/GESU/MoPIT	NRs 840,000
Noise level	1 hr Leq dB(A))	Points source measurements in dB(A) at settlement sites/sensitive spots for noise level at 2.5 and 15 m from roads	During construction phase	Sensitive receptors locations	PIU/SC/GESU/MoPIT	
Water quality	pH, Electric conductivity, Turbidity, Total	Collect and analyze sample from source	During construction	At water bodies	PIU/SC/GESU/MoPIT	NRs 300,000

.	Indicators	Methods	Monitoring Time	Location	Monitoring Agency	Monitoring Cost
	Hardness, Total Alkalinity, Chloride, Ammonia, Nitrate, Calcium, Magnesium, Iron and <i>E Coli</i> etc.					
Disruption of Drainage System	Status of rehabilitation Service status of irrigation channels and water supply system	Observation and interviews, photos, fisheries data, wildlife records	During construction and Operation phase	Bridge, culvert, irrigation canal	PIU/SC/GESU/MoPIT	Included in Project cost/PBM cost
Forest and Vegetation	Numbers of trees, presence of ground vegetation, signs of illicit logging and extraction of NTFPs	Observations, DFO records, photos, stake- holder interviews	During construction and operation	Forest area	PIU/SC/GESU/MoPIT	Included in Project
Worker's health and safety, GBV	Types of diseases in the labor camp	Discussion with labors, health workers,	Monthly during construction phase	Project Area	PIU/SC/GESU/MoPIT	Included in Project
Occupational Health and Safety	Type and number of accidents occurred during upgrading, Adequacy of occupational safety measured provided Compensation provided in case of fatal accidents or invalidity	Observations, photos, spot checks, Contractors' and health centre records interview with labourer	During construction and operation	Project Area	PIU/SC/GESU/MoPIT	Included in Project
Drainage blockage	Water overflow the	Observation	During operation	Project area	PIU/SC/GESU/	Included in Project

.	Indicators	Methods	Monitoring Time	Location	Monitoring Agency	Monitoring Cost
	road, damage to the drainage structure				MoPIT	
Tree Plantation	Maintenance of planted saplings during construction, survival rate of trees, growth and development of saplings	Direct Observation and Discussion with local people	During construction and operation	Compensatory plantation locations	PIU/SC/GESU/MoPIT	Included in Project
Wildlife movement	Road kills/collision	Monitoring record, Site observation and consultation with DFO, local people	During construction and operation	Forest area	PIU/SC/GESU/MoPIT	Included in Project
Human Wildlife conflict	Road kills, Damage Agriculture production	Record, observation Interview with concern stakeholders	During construction and operation	Forest area,	PIU/SC/GESU/MoPIT	Included in Project cost
Religious sites	Number of affected religious sites, temple	Site observation; records; Public Consultation Meetings; Photos	During construction and operation	Along the road	PIU/SC/GESU/MoPIT	Included in Project cost
Reinstate of public structures (footrail, Access road, Irrigation Canal, Water supply pipes etc.)	Number of affected sites	Site observation; records; Public Consultation Meetings; Photos	During construction and operation	Along the road	PIU/SC/GESU/MoPIT	Included in Project cost
Road Accident/road safety/Community safety	Record of accident in the road, Dust level and noise level at work sites, major settlements	Record keeping/ Observation, Air and Noise testing, Observation of good upgrading practices	During construction and operation	Along the road	PIU/SC/GESU/MoPIT	Included in Project cost

.	Indicators	Methods	Monitoring Time	Location	Monitoring Agency	Monitoring Cost
	and sensitive spots like health centers and schools	and discussion with residents and workers				
Relocation of public utilities	Continued services by the facilities and functional public life	Site observation; records; Public Consultation Meetings; Photos	During construction and operation	Along the road	PIU/SC/GESU/MoPIT	Included in Project cost
Reinstate of Quarry borrow sites	Verification of Restoration plan followed, used quarry and borrow sites are level, revegetation	Observation, record	During operation	Proposed Quarry borrow sites	PIU/SC/GESU/MoPIT	Included in Project cost
Reinstate of Asphalt plant, Batching plant, Crusher plants	Verification of Restoration plan followed; no material left in the sites	Observation, record	During operation	Proposed Asphalt plant, Batching plant, Crusher plants sites	PIU/SC/GESU/MoPIT	Included in Project cost
Reinstate of Camp, Stockpile	Verification of Restoration plan followed; no material left in the sites	Observation, record	During operation	Proposed Camp, Stockpile sites	PIU/SC/GESU/MoPIT	Included in Project cost

Table 90: Environmental monitoring cost

Description	Quantity	Rate (per month) NRs	Amount (NRs)
Environmental Specialist	36	200,000	To be included in Supervision consultant cost
Biodiversity Expert	36	200,000	To be included in Supervision consultant cost
Sociologist	36	200,000	To be included in Supervision consultant cost
OHS/Safety Inspector	36	100,000	To be included in Supervision consultant cost
Field Sampling and Lab Tests			
Air and Noise quality monitoring 28locations @6months*3 years + 1baseline+1 post construction) (28*8*30000)	170	30,000	6,720,000
Water quality monitoring (12*25000* 8) locations@6months*3 years + 1baseline+1 post construction)	96	25,000	2,400,000
Wildlife movement monitoring with installation of CC camera at sensitive locations)	LS		2,000,000
Sub-Total Costs for Environmental Monitoring Works			11,120,000
Monitoring Cost			
Geo-Environment and Social Unit, DoR/MoPIT	LS		1,000,000
MoFE/ Third party	LS		1,250,000
Sub-Total Costs for Monitoring Agencies			2,250,000
Total Monitoring Cost			13,370,000

9.1 Organization for Monitoring

A. Ministry of Physical Infrastructure and Transport (MoPIT)

MoPIT is responsible for approval of BES, IEE of the projects under MoPIT (EPA 2076). MPIT is also responsible for review and endorse EIA report for approval of the MoFE. This function is handled by the Environment and Social section under the Planning, Monitoring and Evaluation Division of MoPIT. MoPIT is responsible for implementation and supervision of the project and will conduct the monitoring periodically.

B. Department of Roads

DoR is directly responsible for managing the Environmental and Social risks of individual projects during implementation. DoR has five (5) branches that develop and implement the projects.

- (1) the Planning and Design Branch, which develops and implements all GoN-funded roads;
- (2) the Bridges Branch, which is in charge of the development of bridges;
- (3) the Maintenance Branch, which is in charge of the repair and rehabilitation of roads and bridges;
- (4) the Development Cooperation Implementation Division (DCID), which handles donor-funded projects; and,
- (5) the ADB Directorate, which handles all roads and bridges projects funded by ADB.

This project is ADB funded project, a Project Implementation Unit (PIU) under ADB Directorate will be created to implement this project.

C. ADB Project Directorate/Project Implementation Unit (PIU)

ADB-Project Directorate is Implementing Agency (IA) of the project. ADB Project Directorate prepares and implements the BES/IEE/EIA (Approved by the ADB and GoN) of the projects. DoR-ADB Project Directorate is directly responsible for managing the environmental issues of the projects. Ensure EMP is integrated in the bidding documents and civil work contracts, establish and maintain procedures to monitor implementation progress, established Grievance and Redress Mechanism, verify compliance as stated in monitoring report. ADB Project Directorate has dedicated Environmental Expert and Social Expert, GESI Expert and supporting consultants.

D. Geo-Environment and Social Unit (GESU)

The focal point for the Environmental and Social risk management of DoR is GESU. GESU also undertakes compliance monitoring of projects, and as result also interacts with Project Implementation Unit (PIU). The role of the GESU is very important not only in environmental and social compliance. GESU has responsibility to conduct BES, IEE, EIA study of the DoR projects. GESU has dedicated Environmental Inspector and Social Officer and supporting consultants.

E. Supervision Consultant (SC)

Supervision Consultant will be responsible for supervision of environmental and social mitigation measures as stated in the EMP and compliance monitoring of the construction contractor's activities and prepare periodic monitoring reports for submission to DOR/ADB Directorate/PIU and ADB. Prepared monthly monitoring report, identify needed corrective actions and follow-up actions, conduct regular site inspection to validate monitoring reports and identify unanticipated environmental impacts, compel contractors to take corrective actions within specified timeframe to

address non-compliances, organize stakeholder consultations workshops. The SC's team includes one Environmental Safeguard Expert and one Social Safeguards Expert and one Occupational health and Safety Officer, Wildlife Expert who will directly assist the PIU with its duties.

F. Contractor

The Contractor will be primarily responsible for the implementation and internal monitoring of all environmental and social management measures associated with Project construction, develop a Contractor's Environmental and Social Management Plan (CESMP) based on EMP of the project, and will revise it as needed in order to obtain approval from SC/PIU. The Contractor will have the sole responsibility for all activities on sites under its control for the duration of construction. This includes the activities of all subcontractors, whether employed or contracted directly or indirectly by the Contractor. Get all permit and approval, and any other statutory requirements. The contractor shall employ qualified Environmental Officer, Social Officer and OHS Officer to oversee the Project's EMP performance. Submit monthly report to SC/PIU on the status of EMP implementation, and implementation of corrective actions as instructed by SC/PIU.

10 ENVIRONMENTAL AUDITING

The main objective of the environment audit is to assess the status of the project in terms of implementation of environmental mitigation measures and review the performance of the project. According to sub-rule 1 of rule 13 of the Environmental Protection Regulation, 2077, Environmental Auditing will be undertaken after two years from the project completion. Audit will be carried out by MoFE together with proponent team.

10.1 Auditing Parameters, Methods, and Indicators

The Ministry of Forests and Environment (MoFE) will audit the environmental protection measures and monitoring parameters as the basis of EIA/EMP. MoFE, as a responsible agency for audit, could hire a team of experts to conduct the audit. The audit plan includes parameters, methods, and indicators.

Table 91: Environmental auditing parameters, methods and indicators

S.N.	Parameters	Location	Methods	Indicators
A. Physical Aspect				
1	Land use	ROW of entire project area	Observation,	Change in land use and land use pattern
2	Management of construction spoils	Designated sites for spoil disposal	Observation, Photographs	Status of disposal sites, affected aesthetic value, forest, and agricultural land
3	Unstable slopes, Embankment erosion	Hill slopes, embankment slope river banks	Observation	Slope failures, embankment erosion, river bank cutting areas along the alignment
4	Natural flow of existing drainage	Drainage crossings at the entire project area, along the alignment and surrounding of road RoW	Observation, Interview with local, photographs	Obstruction in natural flow of drainages
5	Air quality	Sites as per EIA and monitoring during construction	Measurement through portable air monitoring device or high-volume air sampler, observation, consultation with local people	Different air quality parameters as studied in EIA and monitoring during construction
6	Noise level	Sites as per EIA and monitoring during construction	Measurement through portable Noise Level Meter, observation, consultation with local people	Leq (Day and Night)
7	Water quality	Sites as per EIA and monitoring during construction	Sampling and lab analysis, observation, consultation with local people	Different water quality parameters as studied in EIA and monitoring during construction
8	Relocation and	Along the highway	Interview, observation,	Existing status of relocated

S.N.	Parameters	Location	Methods	Indicators
	rehabilitation of affected public infrastructures/ utilities	alignment and its adjoining areas	and photographs	infrastructures such as electric poles, irrigation canals, water taps, water collection tanks and pipelines; its use by local.
9	Road safety /Traffic safety status - accidents. Traffic rules implementation status	Along the highway	Interview with concern stakeholders' observation, and photographs	Traffic safety sign installed along the road, road accident data, record of road safety awareness program conducted.
10	Reinstate/ rehabilitation of camp/ stockpile sites	All camps and stock pile sites	Interview, observation, and photographs	Verification of sites, do not left unwanted materials at site, all sites are reinstated, leveled, revegetation as per plan
11	Reinstate of Quarry and Borrow sites, Crusher plant, Asphalt plant	Quarry and Borrow sites, Crusher plant, Asphalt plant sites	Interview, observation, and photographs	Verification of sites, do not left unwanted materials at sites, all sites are reinstated, leveled, revegetation as per plan
12	Solid waste / Status of solid waste disposal sites	Proposed waste disposal sites	Interview, observation, and photographs	Verification of sites as per plan
B. Biological Aspect				
1	Status of forest adjacent to alignment	At entire project alignment where forest existed	Observation, Survey, Interaction with DFO, CFUG, PNP, CNP	Forest encroachment, degradation
2	Number of trees felled, and compensatory plantation and Avenue plantation	At entire project alignment, Compensatory plantation area , Avenue plantation	Observation and interview with DFO, CFUG, PHN, CNP	Record, sales record, Compensatory plants, status of plants survival in the plantation area
3	Wildlife habitat/ Use of underpass for wildlife crossing,	Forest area and proposed wildlife crossing locations	Camera trapped evidences, interview, observation, photographs, DFO, CFUG, PHN, CNP	Record, Maintenance of wildlife crossing
4	Human Wildlife conflict	Forest area	Interview, observation, photographs, DFO, PNP and CNP records	Record of road kills/collision, damage agriculture product
C. Socio-Economic and Cultural Aspect				
1	Compensation paid to Private structures	Entire project area	Observation and interview with affected people	Living standard of affected households, educational status and availability of service facility with each family
2	Highway safety and accident	At entire project alignment	Observation, official records and interview	Number and type of accident
3	Relocation of affected infrastructures, utilities	At entire project alignment	Observation and interview	Existing status of relocated infrastructures such as temples, wells, public toilets, water supply pipelines, electric poles etc.

S.N.	Parameters	Location	Methods	Indicators
4	Relocation of affected cultural and religious sites	Affected sites as mentioned in EIA report	Observation and interview	Status and use of relocated such sites
5	Livelihood and income generation of local people	At entire project alignment	Observation and interview	Economic activity of the local people and opportunities available to local people
7	Local people movement through underpass/overpass and its affect	At underpass/overpass passing zones; settlements situated close proximity to alignment	Observation and interview	Frequency of use of passing zones by locals and its existing condition
8	Increase trade and commerce industry	Along the project area, interchange area, service area,	Observation, Interview and Photographs	Number of shops, industries, rental houses, involvement of locals in business and commerce, number of freight transportation ply per day, the price of commodity transported through this highway from India and other part of Nepal
9	Reduce Travel Time, Travel Cost and Road Accident	Along the project area	Record of travel time, Interview, Accident record	Maintain the road quality, road safety features, accidents record
10	Tourism Development	Touristic places within the project vicinity	Observation and consultation	Number of people (national as well as international) visiting touristic places within the project vicinity

10.2 Format for Environmental Audit Report

As given in EPR 2077, the structure of the environmental audit report of the proposed project will be as follow.

Table 92: Format for environmental audit

Chapter	Description
Chapter 1	In this chapter, the executive summary of the report should be written including the main points of the environmental audit report.
Chapter 2	In this chapter, details of test administration and test work, interviews conducted at the venue, testing parties and test areas and methods should be included. Also, the facts and details related to environmental monitoring and testing should also be included.
Chapter 3	This chapter should contain complete details of the test
Chapter 4	In this chapter should be included suggestions and corrective actions to be followed in relation to the project.
Annexes	Facts and details should be included in the Annexes.

Human Resources to be included.	Environment Expert, Highway Engineer, Socio-economic and Cultural Expert, Ecologist, and other experts depending upon the nature and severity of the project should be included.
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10.3 Estimated Environmental Auditing Cost

The breakdown of the estimated cost for Environmental Auditing is summarized in the Table below.

Table 93: Cost for environmental auditing

Description	Unit/Month	Unit Cost (NRs.)	Amount (NRs.)	Remark
Environmental Expert	2	200,000.00	400,000.00	
Biologist/Ecologist	1	200,000.00	200,000.00	
Sociologist	1	200,000.00	200,000.00	
Reporting, Logistics, etc.	1	100,000.00	100,000.00	
Transport	1	100,000.00	100,000.00	
Field Sampling and Lab Tests	LS	250,000.00	250,000.00	
Total Estimate			1,250,000.00	

11 CONCLUSION AND COMMITMENTS

The proposed Pathalaiya- Hetauda-Narayanghat road is an existing 2 lanes and will improve 4 lanes road including all bridges. The Right-of-Way (RoW) of the road is 50 m from the road's center line. This road will support capacity, quality, and safety improvements of the road, which is the main domestic and international trade corridor of Nepal.

Implementation of the Project will have significant beneficial impacts on human life, income generation from employment, skill enhancement during the construction stage and increased income generation. The upgraded road will provide smooth, easy and quick access, eliminating existing traffic congestion and reduce accidents. The upgrading of the road will reduce travel time and cost, vehicle running costs such as fuel economy, reduction in wear and tear of vehicle parts, reduce greenhouse gas emission due to better riding quality. At present, travel time from start (Pathalaiya) to end (Narayanghat) of the road section takes around 2.5 hrs and after completion of the project, the travel time will be only 1.5 hrs. The upgraded highway will be Asian Highway (AH2) standard and will get benefit from transportation of goods from neighboring country via Birgunj dry port.

Few impacts have been identified significance to the proposed project, all of which are localized and temporary in nature. Land use pattern (agriculture land and forest land) of RoW will be changed to asphalt road. Hot mix plant, batching plant, crusher plant and construction activities will increase air, noise and water pollution significantly during construction. New Slope failures, embankment erosion will be occurred due to widening of road and bridges at Siwalik area. Construction of bridges and culverts will disturb the river water way. Regular air, noise and water quality monitoring test will be conducted to validate with baseline conditions.

Major impacts in wildlife movement (such as Elephants, Tigers, Rhinoceros, Terai Gray Langour) is noticed for which special provisions like VIADUCT, dedicated under passes, noise reduction measures, guiding fences, canopy bridges etc. have been proposed to address wildlife movement and reduce wildlife-vehicle collision. 4002 m VIADUCT (2001m at BFC and 2001m at PNP) and 19 underpass crossings structures, canopy bridges, fencing have been proposed in the PHN road. After construction of 21 wildlife crossing structures, it is anticipated to reduce significantly Wildlife-Vehicle Collisions; increased habitat connectivity and promote genetic exchange, increase access to resources, and support larger and more resilient populations. Widening of the road, approximately 23,326 nos. of trees will be needed the removal. Compensatory plantation as well as avenue plantation and maintaining greenery in median section of the road has been proposed for minimizing impacts due to felling of trees and land use pattern change. For biodiversity management all suggested mitigation measures of ADB TA report and DNPWC has been incorporated to avoid, minimize and compensate the impacts on biological environment.

The significant impacts on social and cultural environment during construction stage are 403 private structures and 180 number community structures will be affected by the project. Temporary disruption of public utilities and existing services as public tubewell (22), electric pole (5,349 nos.), telephone pole (533 nos.) and transformer (203 nos), irrigation canal water supply pipe etc. will be affected due to the implementation of the proposed project. Other impacts include air quality deterioration due to increase in fugitive dust emissions from construction. Nuisance to nearby residents due to increase in noise from heavy equipment operation, hindrance in accessibility to common property resources and increase in traffic on road sections will cause where construction is on-going. Surface water quality of the rivers and rivulets will be deteriorated, and result in siltation of waterways from silt-laden surface runoff coming from the construction sites. Labours and local people will be prone to adverse health effects and accidents will arise due to construction activities.

The Project will also consider Occupational Health and Safety issues and Community Health issues during construction phase. So as to reduce and mitigate pollution from labour camps, construction camps and construction sites, due consideration for preventing air, water, soil and noise pollution has been done.

During the operation stage, soil erosion and scouring of embankment slopes due to monsoon rain, blockage of cross drainage structures will lead to drainage problems, water logging, and erosion. Community Health and safety risk will be increase due to increase in traffic during operation.

Most of the identified impacts during construction and operation stage are short duration, low to moderate significance and most are local and reversible in nature and minimal residual impacts. The project has proposed mitigation measures to ameliorate all adverse impacts. The detail mitigation measures will be fully complied as mentioned in the EMP and EMoP. NRs. 12,461,929,581 is proposed for environmental mitigation and enhancement cost. The contractor will mobilize resources and prepare different site-specific management plan (as listed in EMP) before commencing the construction works. The EIA of the project ascertains that the project is unlikely to cause any significant environmental impacts. The proponent has allocated budget for environmental mitigation, monitoring, and auditing activities.

Commitments

The proponent is committed to implement the proposed mitigations measures mentioned in the EIA and monitored as proposed by this study, monitoring team will be employed and regular monitoring will be conducted for effective monitoring; Environmental management plan and monitoring plan will be strictly followed during implementation of the project.

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