SUGGESTED MEASURES TO MITIGATE

ASIAN ELEPHANT - TRAIN COLLISIONS ON VULNERABLE RAILWAY STRETCHES

IN THE STATE OF

NAGALAND

भारतीय वन्यजीव संस्थान
Wildlife Institute of India

AUGUST 2024

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Kashish Sherdia

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To minimize the risk of collisions between elephants and trains, the Ministry of Environment, Forest and Climate Change and the Ministry of Railways in India have jointly undertaken several measures.These include the construction of underpasses and overpasses for safe elephant passage, setting up of signage boards to warn locomotive drivers, and speed regulations in elephant corridors. Further, efforts have also been made to sensitize train drivers and railway staff about elephant movements and using technology to track and predict elephant movements near railway tracks .These collaborative efforts aims to safeguard elephant populations while ensuring the smooth operation of railway services, and are part of a comprehensive strategy to reduce train-elephant collisions.

By implementing early warning systems like DAS, underpasses, overpasses, level crossings and installing barriers at vulnerable points along railway tracks, the Ministry of Environment, Forest and Climate Change and the Ministry of Railways aim to create a safer environment for elephants while maintaining efficient rail operations.

The collaboration between the Ministry of Environment, Forest and Climate Change and the Ministry of Railways underscores the importance of inter-departmental cooperation in wildlife conservation. By aligning their efforts, these ministries are working towards a sustainable solution to mitigate the risk of elephant-train collisions.

A combination of technological innovations, such as the use of thermal imaging cameras and automated alert systems, & traditional methods, like patrolling and community involvement, are being employed by the Ministry of Environment, Forest and Climate Change and the Ministry of Railways to protect elephants from train accidents.

ACKNOWLEDGEMENT

Shri Bhupender Yadav
Hon'ble Minister, Environment, Forest and Climate Change, Govt. of India

Shri Kirtivardhan Singh
Hon'ble Minister of State, Environment, Forest and Climate Change, Govt. of India

Ministry of Environment, Forest and Climate Change, Govt. of India

Ms. Leena Nandan
Secretary, MoEF&CC

Shri Jitendra Kumar
Director General of Forest & Special Secretary, MoEF&CC

Sh. C. P. Goyal
Former Director General of Forest & Special Secretary, MoEF&CC

Dr. S. P. Yadav
Former ADG, (PT & E), MoEF&CC

Dr. G. S. Bharadwaj
ADG, (PT & E), MoEF&CC

Principal Chief Conservators of Forests (Wildlife) of Elephant Range States

Ministry of Railways, Govt. of India

Shri Ashwini Vaishnaw
Hon'ble Minister, Environment, Forest and Climate Change, Govt. of India

Shri V. Somana
Hon'ble Minister of State, Environment, Forest and Climate Change, Govt. of India

Shri Ranveet Singh
Hon'ble Minister of State, Environment, Forest and Climate Change, Govt. of India

Ms. Jaya Varma Sinha
Chairman & Chief Executive Officer, Railway Board

Shri. Anil Kumar Lahoti
Former, Chairman & Chief Executive Officer, Railway Board

Shri. Vinay Kumar Tripathi
Former, Chairman & Chief Executive Officer, Railway Board

Shri Anil Kumar Khandelwal
Member Infrastructure

Shri N. C. Karmali
ED (Coord.)/Gati Shakti

Shri. Kamlesh Gosai
ED/Gati Shakti (Traffic)

Shri Dhananjaya Singh
ED/GS(Civil)-II

General Managers and Divisional Railway Managers of Various Railway Zones

Wildlife Institute of India

Dr. Ruchi Badola
Dean, FWS, WII

Dr. S. Sathyakumar
Scientist G/Registrar, WII

Dr. Bivash Pandav
Scientist G/Research Coordinator

Ministry of Environment, Forest and Climate Change, Govt. of India

Shri Ramesh K. Pandey
IG, (PT & E), MoEFCC

Dr. Dheeraj Mittal
AIGF, (PT & E), MoEF&CC

Dr. Dharmendra Gupta
Director (S), (PT & E), MoEF&CC

Dr. K. Muthamizh Selvan
Addl. Director (S), (PT & E), MoEF&CC

Dr. Rajendra Kumar
Scientist D, (PT & E), MoEF&CC

Ministry of Railways, Govt. of India

Shri Anil Kumar Khandelwal
Member Infrastructure

Shri. Kamlesh Gosai
ED/Gati Shakti (Traffic)

Shri Dhananjaya Singh
ED/GS(Civil)-II

Wildlife Institute of India

Sh. Virendra R. Tiwari
Director

Dr. Parag Nigam
Scientist G & NO Elephant Cell

Dr. Bilal Habib
Scientist F & ANO Elephant Cell

Dr. Lakshminarayanan
Project Scientist

Sh. Udhayaraj A. D.
GIS Expert

Core Coordination Team

Dr. Bilal Habib
Scientist F & ANO Elephant Cell, WII

Dr. Akanksha Saxena
Project Scientist, WII

Shri Aditya Bisht
Project Consultant- B

SURVEY TEAM: WII & PE, MoEFCC

Dr. Akanksha Saxena
Project Scientist-I

CONTENTS

01. Introduction

The Asian elephant (*Elephas maximus*) distribution in the north-eastern states of India is spread over the states of Assam, Nagaland, Arunachal Pradesh, Tripura, Mizoram and Meghalaya. However, most of this population is concentrated in Assam, with continuous distribution in Arunachal Pradesh and Nagaland. The following description relates to elephant distribution in this semi-contiguous population spread across the states of Assam, Arunachal Pradesh and Nagaland, as it pertains to the purpose of this survey.

The wilderness of the north-east consisting of several states supports a wide variety of biodiversity and is home to several important protected areas, including the Kaziranga and Manas National Parks, both being UNESCO World Natural Heritage Sites.

The elephant distribution in and around Assam is spread out over four distinct populations (Project Elephant, 2023), and is contiguous with some neighbouring states as well. Apart from the four major populations, few isolated habitats also exist that support some elephants.

- The population on the north bank of the Brahmaputra extends from northern West Bengal through the Himalayan foothills and Duars covering southern Bhutan, northern Assam and Arunachal Pradesh along the Brahmaputra River, and part of the flood plains of the Brahmaputra and Lohit River in eastern Assam.

Three populations exist on the southern bank of the Brahmaputra – the eastern, central and western areas.

- The eastern population is spread over lower Dibang Valley and Lohit, Changlang and Tirap districts in Arunachal Pradesh, Tinsukia, Dibrugarh, Sibsagar, Charaideo, Jorhat and Golaghat districts in Assam; and Mon, Tuensang, Mokokchung and Wokha districts in Nagaland.
- The central range extends from Kaziranga National Park across the Karbi plateau, parts of the central Brahmaputra plains, and the basin of the Diyung Rivers to the foot of the Meghalaya plateau in Assam and Meghalaya.
- The western range extends from near Guwahati through the foothills of the Meghalaya plateau including Kamrup, Goalpara districts in Assam, and Rhi-Bhoi, West Khasi Hills, East Garo Hills, West Garo Hills, Southwest Garo Hills and South Garo Hills in Meghalaya.

The corridors connecting the north-eastern elephant populations spread across these states are also coming under threat from the operational railway tracks in the region. Consequently, these railway lines are a threat to the connectivity amongst these elephant range states that are already under pressure from other anthropogenic activities.

Based on a meeting on 17th August 2022, the Hon'ble Minister of Railways, Government of India, instructed the Ministry of Environment, Forest and Climate Change (MoEF&CC) to provide at least 100 locations of existing railway segments across sensitive elephant and tiger landscapes in the country for construction of permanent mitigation measures in view of wildlife-train collisions (Proceedings under Ministry of Railways letter No. 2022/CE-IV/ Elephant Pass dated 30th September 2022). Consequently, details of sensitive stretches for constructing permanent and temporary mitigation measures were provided by the MoEF&CC (vide OM F.No. 12-1/2019-PE (Part-I), dated 30th August 2022).

A total of 24 priority railway segments were identified in the region, including one in Nagaland. The railway lines in Nagaland and Arunachal Pradesh states lay on the border with Assam.

02. Field Survey

A representative of the Wildlife Institute of India, local representatives of the Forest Department and Indian Railways (NFR) conducted a joint field survey of the identified priority railway stretches in the states of Assam, Arunachal Pradesh and Nagaland (Fig. 1) during 19th – 27th March 2024. During the survey, the survey team inspected the railway track, particularly sites vulnerable to elephant mortality and areas where frequent elephant crossings were observed, based on information from the Forest Department. We relied on information such as previous incidences of elephant/wild animal mortality, elephant movement trails intersecting railway tracks, GPS coordinates and chainages (km) of these sites from concerned officials. We then suggested mitigation measures based on multiple factors including width of crossing zone, track height of the railway line, presence of drainage structure and human infrastructure (and consequent potential for conflict) in that segment.

On consultation with field forest and railway officials, it was observed that some railway lines had not been constructed yet, were not operational, or did not lie in elephant areas. These were not inspected. Further, we inspected additional railway stretches that were highlighted by forest officials as vulnerable to elephant-mortality or as a barrier to their movement in the area.

* The objective of the field survey was to minimise elephant-train collisions either by constructing underpasses and overpasses wherever possible, by reducing the time taken by elephants to cross the railway tracks by easing movement across the track through construction of ramps and level crossings, and by implementation of technology for early detection and warning systems.

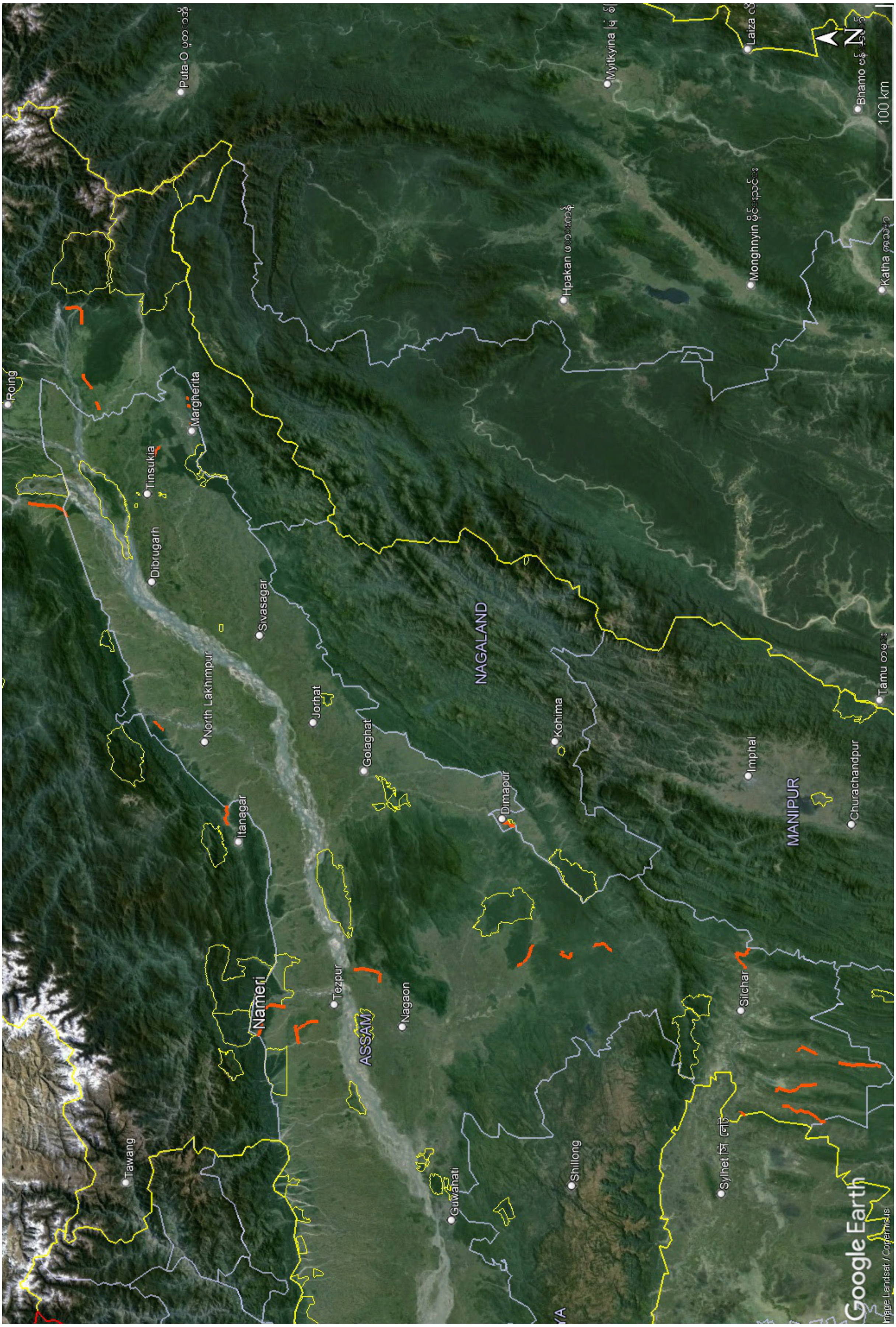


Figure 1: Identified priority railway line stretches (orange lines) for field survey in the states of Assam, and bordering Nagaland and Arunachal Pradesh, with respect to the protected areas (yellow polygons).

03. Site-Specific Findings & Mitigation Measures

1. Railway line near Rangapahar and Dimapur, Nagaland

Survey date: 24th March 2024
Infrequent elephant movement has been reported near this stretch. It constitutes the southern Brahmaputra elephant population moving between Dhansiri-Intanki region, covering parts of Karbi Anglong in Assam and Peren districts in Nagaland.

Observations:

- According to forest department personnel, movement of a herd of 20-30 elephants has been occasionally (once/twice a year) reported in the area from Dhansiri forest range (territorial).
- No elephant-train accidents have been reported from the railway stretch yet.
- The main crossing point is near where the Dhansiri river flows near the railway line (Fig. 2) (approximate chainage 251/0-241/2).

Figure 2: Location where occasional elephant crossing is reported to occur.

Recommendation:

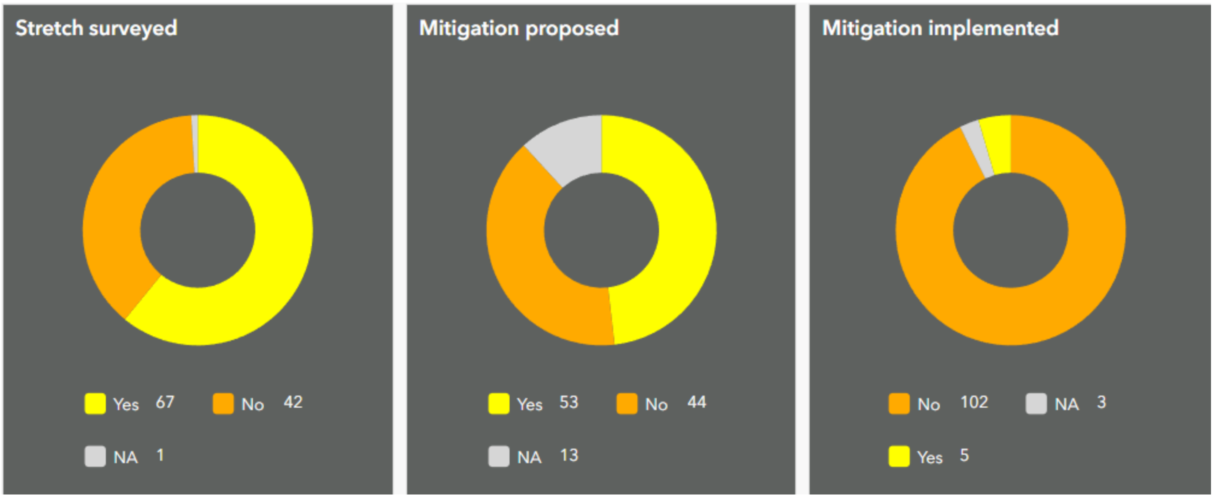
- An elephant crossing structure measuring 30 m wide with maximum possible height is to be constructed at the crossing site (25° 50.773'N, 93° 41.186'E).

04. General recommendations for all sites

The following blanket recommendations are to be implemented across all sites:

1. Distributed Acoustic Sensing (DAS) – based Intrusion Detection Systems (IDS) are to be implemented on all sensitive stretches on priority. Further all level crossings and ramps should incorporate the DAS IDS system as well.
2. Sign boards on the sensitive stretches should be erected to alert loco pilots, along with indications of specific wildlife-crossing zones.
3. Goods trains should be scheduled for the daytime as much as possible or during the time period when the activity of the wildlife species especially elephants is at its minimum.
4. For construction of structural mitigation measures (underpasses, overpasses, level crossings and ramps), the WII report on specifications of mitigation measures should be referred.
5. Regular clearing of vegetation till at least 30 m on either side of the railway tracks is to be done to increase visibility for both loco pilots and elephants. The frequency and responsibility of carrying out pruning may be decided mutually by both parties.
6. Strict restriction and fines on disposal of garbage, especially food items, from operating trains on railway tracks in sensitive stretches and railway stations near them should be imposed.
7. Joint teams of railways and forest department personnel should be formed for all critical stretches. The team would be responsible for joint patrolling on the track of elephant presence, coordination and information sharing, and regular cleaning of railway tracks. This can be achieved by creating WhatsApp groups for each region comprising of senior officials and frontline staff of the railways and forest department.
8. There should be regular cooperation and exchange of information between forest department and railways staff. Regular sensitization workshops for railway staff, especially loco pilots and ground staff should be conducted.
9. Most railway tracks in the surveyed areas are in the process of getting electrified. Adequate measures (insulation and proofing of all electric infrastructure) should be taken to avoid incidents of electrocution of wildlife because of the railway electric infrastructure.
10. To discourage use of wildlife-friendly ramps and level crossings by people and vehicles, concrete barrier poles and/or other barriers should be built that are high enough to block passage of 2 and 4-wheelers, but low enough to allow elephants to pass.
11. Incidences of elephant and wildlife injury and mortality should be documented by both parties, with complete details on GPS location, chainage, date and time of day.
12. In the future, all metre-gauge to broad-gauge conversion projects in elephant landscapes should include comprehensive elephant mitigation plans.
13. In the future, railway stretches posing collision and barrier risks to wildlife should be identified that exist beyond elephant reserves and protected areas, such as corridors.

05. Dashboard for monitoring implementation of mitigation measures



Crossing zone details

Serial No	Name of area	State	Crossing zone width (m)	Stretch surveyed	Mitigation proposed	Mitigation implemented	Remarks	ReportLink
1	Elephant reserve	Uttarakhand	8.60	Yes	Yes	No		https://drive.google.com/file/d/1PZ2YCcHrQKnVcRywn7iyoOgDLiYQQkpe/view?usp=drive_link
2	Elephant reserve	Uttarakhand	14.30	Yes	Yes	No		-
3	Elephant reserve	Uttarakhand	28.90	Yes	Yes	Yes	This stretch has been surveyed under Harrawala Project & seperately discussed with MoR	-
4	Elephant reserve	Uttarakhand	4.50	Yes	Yes	Yes	This stretch has been surveyed under Harrawala Project & seperately discussed with MoR	-
5	Elephant reserve	Uttarakhand	21.30	Yes	Yes	Yes	This stretch has been surveyed under Harrawala Project & seperately discussed with MoR	-
6	Elephant distribution	Uttarakhand	5.90	Yes	No	No	Stretch falls within Kathgodam city limits	-
7	Elephant distribution	Uttarakhand	4.40	Yes	Yes	No	Surveyed by Forest Deparment	https://drive.google.com/file/d/1tFFaY4n5kYA9OhcBqeO5egHMzq9TjWlt/view?usp=sharing
8	Elephant distribution	Uttarakhand	39.80	Yes	Yes	Yes	This stretch has been surveyed under Harrawala Project & seperately discussed with MoR	-
9	Elephant distribution	Uttarakhand	30.70	Yes	Yes	Yes	This stretch has been surveyed under Harrawala Project & seperately discussed with MoR	-
10	Elephant reserve	Uttar Pradesh	7.60	No	No	No		
11	Elephant distribution	Uttar Pradesh	7.60	No	No	No		
12	Elephant distribution	Uttar Pradesh	3.30	No	No	No		
13	Elephant distribution	Uttar Pradesh	10.30	No	No	No		
14	Elephant distribution	Uttar Pradesh	49.80	No	No	No		
15	Elephant distribution	Uttar Pradesh	19.00	No	No	No		

India is a megadiverse country, with only 2.4% of the world's land area, but accounts for 7-8% of all recorded species of the world, including about 91,000 species of animals and 45,500 species of plants. India is also the second-most populous country in the world with a population of over 1.3 billion people! To transport and cater to the needs of such a large population, the Indian Railway is the main artery of inland transportation in India. In 2020, it carried a total of 808.6 crore passengers! Indian Railways is also the single largest employer in India and the eighth largest in the world, employing approximately 13 Lakh people. It is the country's lifeline for large-scale traffic movement – freight and passengers. Railways are at the core of India's economic development and make it possible to conduct many activities like business, sightseeing, and pilgrimage along with the transportation of goods over longer distances. In fact, the Indian Railways is among the world's largest rail networks and runs thousands of trains daily. To cater to India's fast-growing economy, the railway sector has envisaged Vision 2024 to achieve targets of 2024 MT freight loading by 2024. The railway also aims to electrify the entire network.

Recognized as economic, energy-efficient, and environment-friendly relative to other means of transport such as roads and air, the expansion and upgrading of railways is seen as an important measure in supporting development through large-scale movement of people and goods. However, railway construction and operation has its ecological effects, and a range of impacts on wildlife and habitats have also been documented. Several of India's passenger

and freight trains crisscross through some of the country's most sensitive wildlife habitats, particularly protected areas and corridors that are home to critically endangered tigers and elephants, amongst other animals. The extensive network of our Railways cuts through several of these forested landscapes, compromising the connectivity of the landscape and resulting in a barrier effect.

To reduce the impact of railways on our wildlife, it is important to come together and develop measures that can protect India's rich biodiversity and also help to develop a system that is more sustainable and effective in minimizing mortalities and reducing barrier effects across the railways tracks passing through sensitive habitats in India

Project Elephant Division of MoEF&CC in coordination with Ministry of Railways and Wildlife Institute of India has identified sensitive stretches which need prioritization for mitigation planning. The portal is developed to monitor the progress of implementation of mitigation measures from the beginning. The process involves joint surveys of the identified stretches by officials of the Forest Department, Railways and Wildlife Institute of India, recommendation of mitigation measures and implementation of the mitigation measures. The mitigation proposed on the stretches surveyed by various team has been upload on the dashboard. The dashboard can be accessed at Railway Crossing Zones Dashboard (arcgis.com)

The purpose of the dashboard is to monitor the implementation of the mitigation measures on the surveyed stretches. The officers are requested to update the information on the dashboard developed for the purpose. In case of any issues please reach us at projectelephant.moef@gmail.com or elephantcell@wii.gov.in

06. List of State Forest Department and Indian Railways officials consulted during the survey

S.No.	Name and Designation	Contact details
State Forest Departments		
1.	Sri Thokaho *Dimapur, Nagaland Forest Department*	87318 21345
2.	Sri T. Setsali *Forest Guard, Dimapur*	87876 16699
3.	Sri Pongli *Forest Guard, Dimapur*	
Indian Railways (NFR)		
4.	Sri A. K. Kushwaha *Northeast Frontier Railway*	90020 52204
5.	Sri Vivek Bajaj *DEN 1, Tinsukia Division*	99575 55202
6.	Sri Lakshman Singh *DEN 1, Lumding Division*	99575 53201
7.	DEN 3, Lumding Division	99575 53206
8.	Sri Arvind Kumar *DEN 3, Rangia Division*	99757 54203
9.	Sri Abhishek Choudhary *XEN, Pasighat*	99575 56458
10.	Sri Vishnu Kumar *ADEN Dimapur*	99575 53219
11.	Sri Dibyajyoti Dutta *ADEN 3, Lumding Division*	99575 53213
12.	Sri Gautam Saikia *SSE/P.Way/I.C/MRG*	99575 55217
13.	Sri Biman Doley *SSE, Works, Pasighat SPTR*	99575 56459
14.	Sri Deep Das *SSE/P.WAY/NLP/east*	99575 54284
15.	Sri Ratan Majumder *SSE/P.Way/H/LMG (Sc)*	99575 51036
16.	Sri Jayanta Rajbongshi *SSE/PWay/INE/BBU-BJL*	
17.	Sri Dizen Medhi *SSE/PWay/RPAN*	96137 17029
18.	Sri Lima Sungba *AO, SSE/P.Way/DMV*	84718 03593
19.	Sri Dharvesh Pal Singh *Jr. Engr./PWay, Naharlagun*	78958 55801
20.	Sri Himanshu Bisht *JE/P.Way/JRBM*	89389 67260
21.	Sri Mintu Choudhury *Trolley Man, Balipara-Bhalukpong*	88768 14722
22.	Sri Bijay Boro *TRM1/BBU*	91014 12871

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Project Elephant, MoEF&CC, Government of India (2023), Elephant Corridors of India 2023 (Edition – I/2023).

WII, (2024). General Guidelines for Suggesting Mitigation Measures on Existing Railway Tracks Through Elephant Habitats in India.

APPENDIX 1

भारतीय वन्यजीव संस्थान
Wildlife Institute of India

GENERAL GUIDELINES

FOR SUGGESTING MITIGATION MEASURES ON EXISTING RAILWAY TRACKS THROUGH ELEPHANT HABITATS IN INDIA

MAY 2023

General Guidelines for Suggesting Mitigation Mesaurs on Railways Tracks through Elephant Habitats in India

Railway lines passing through elephant habitats can alter movement patterns and cause collisions of elephants with trains. Considering the threats to both elephant and human life, WII in consultation with Project Elephant Division of MoEFCC and State Forest Departments has identified 105 stretches of railway lines cutting through elephant reserves and elephant distribution beyond elephant reserves. Subsequently, the Ministry of Environment, Forests and Climate Change (MoEF&CC) and the Ministry of Railways (MoR) in a joint meeting directed that surveys by the railway officials, respective state forest department officers, and WII should be conducted within these stretches. The objectives of the joint field surveys would be to identify specific elephant crossing zones on these stretches and to suggest site-specific mitigation measures based on the location and the extent of these crossing zones.

In the case of existing railway lines, designing and locating structural mitigation measures for wildlife are confounded by several factors. Most critical among these is the limitation of the track height i.e., the height of the railway track with respect to surrounding terrain, making it difficult to allocate the minimum underpass height of 6 m required for animal underpasses in elephant landscapes. Additionally, excavating the ground under the track to achieve the prescribed height makes structures vulnerable to damage by rainwater, and also renders the structures unusable by wildlife. Thus, the choice of mitigation measures on existing railway lines has to be based on multiple factors that include wildlife, landscape as well as railway track design considerations. However, in the case of new railway lines, allocating adequate height to the railway tracks to incorporate wildlife mitigation measures along the line should be ensured.

In light of these factors, the following general pointers are prescribed to guide the Railway and Forest Officials in designing and choosing between different structural mitigation measures in the identified critical elephant zones intersected by railway lines. The choice of mitigation measures can be based on landscape, topography, railway track height, and other logistics.

1. Level crossings

The coarse ballast used on railway tracks is unsuitable for movement by wildlife, particularly elephants. For this reason, level crossings for elephants built using suitable material (soil, cement) and with smooth gradient can help ease movement across the railway track at grade. Level crossings are ideally located where the surrounding land is at level (flat) with the railway track and coincides with a known/identified elephant crossing area. Rubberized level crossings[1] (Fig. 1) may also be used in place of cement and soil.

[1] Functional Specification for Rubberised Surface at Level Crossings. 2019. Ministry of Railways, Govt of India. https://rdso.indianrailways.gov.in/

Figure 1. A level crossing with a rubberised surface that can be replicated on level crossings for wildlife.

2. Ramps

At most elephant crossing locations intersected by railway lines, the elevation in track height and the additional layer of ballast makes it difficult for a large-bodied hoofed animal like an elephant to make quick decisions and move away from a railway track in the event of an approaching train, leading to elephant-train collisions. At such locations, ramps using suitable material (soil, cement) may be constructed that flattens towards the top of the track, and allow for smooth and quick movement by elephants. It is important to include a level crossing instead of ballast at the top of the ramp (near the railway track) to ensure smooth movement by elephants. The sites for construction should be based on identified animal crossing zones and suitable terrain. Ramps should be levelled with the surrounding terrain by smoothening out the slope (Fig. 2). Additionally, in areas with human presence, the ramps may be fenced to funnel elephant movement across the railway track.

The orientation of the ramps with respect to the railway track may be oblique or perpendicular, depending on the land available for flattening the ramp to a navigable slope. The width of ramps and level crossings for elephants should be at least 50 m wide. Early warning systems or wildlife sensors may be provided at these places as additional measures to detect elephant movement and to avoid collision with trains.

Figure 2. An example of a ramp built for aiding elephant movement across a railway line near Coimbatore, Tamil Nadu, India (Top) and an elephant group using a ramp constructed for ease of movement in Deepor Bheel Assam, India (Bottom).

3. *Wildlife underpasses*

The term wildlife underpass can be used to describe different types of structures built below the railway track to facilitate wildlife movement. These can be box culverts, viaducts, or bridges with natural drainage of different heights and widths, depending on the target wild species or community. In elephant landscapes, the minimum height of an underpass should be 6 m, with adequate width (minimum 30 m) to allow for the movement of large elephant herds (Fig. 3). However, the actual size would depend on the width of the crossing zone and feasibility of construction of underpass considering track height and curvature. Nonetheless, all efforts should be made to maintain a minimum width of 30 m. At locations where the track height is suitable, the topography of the adjacent land should be such to avoid flooding of the underpass by rainwater. Additionally, light and sound barriers should be installed above the railway track to reduce the disturbance due to train traffic on animals using underpasses.

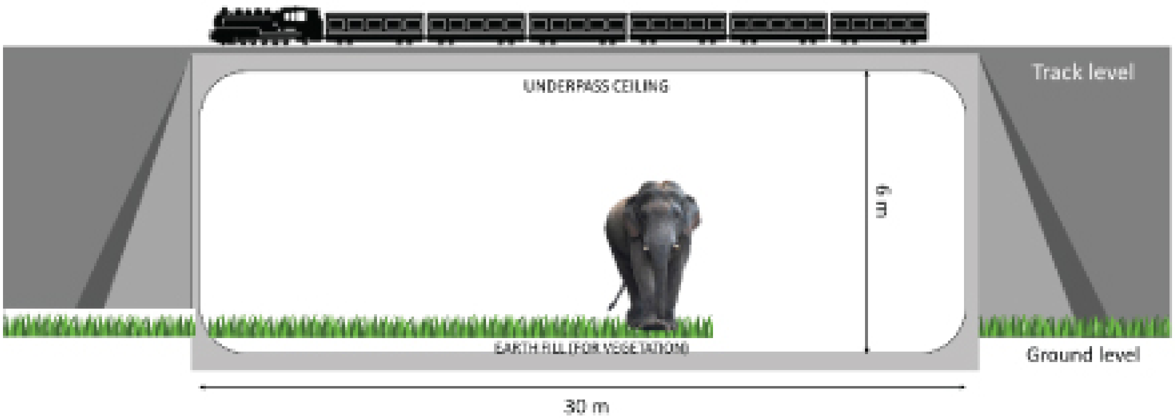

Figure 3. Graphic representation of an underpass for elephants below a railway track.

4. *Wildlife overpasses*

Wildlife overpasses are bridge-like structures built at a height across linear infrastructure (roads and railway lines) to allow wildlife to move across the gap in the habitat. Such structures are usually enhanced with natural habitat features such as native vegetation, rocks and logs. Wildlife overpasses are less confining, quieter and have ambient natural conditions of light and weather as compared to wildlife underpasses. Since wildlife overpasses are built at a height, construction of overpasses requires adequate height on either side of the road/railway line. Thus, overpasses should be built at locations with suitable height (> 7m) and topography on either side. A wildlife overpass should not be less than 30 m wide, and may be wider in case of double or triple parallel railway lines.

Overpasses should ideally be built using pre-fabricated material and installed on-site. The overburden from the construction site or excavated from other sites may be used for filling. Further a suitably thick layer of soil should be laid on top of the pre-fabricated material. Revegetation should then be carried out using native grasses and shrubs on the substrate to provide a natural movement path. Either side of the top of the overpasses should be fenced with light and sound barriers (Fig. 4). The slope/approach of the overpass should be not more than 30 degrees at any point. If the overpass is to be constructed across two or more railway tracks, a supporting pillar/post may be provided for structural support (Fig. 5).

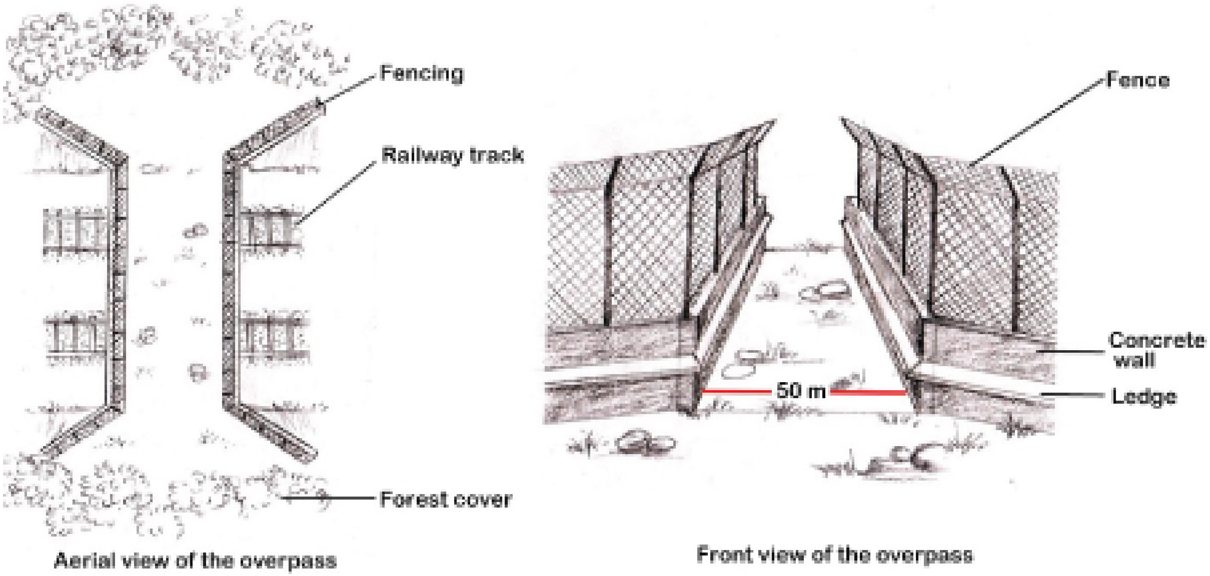

Figure 4. Aerial and front view of overpasses on railway tracks, with fencing/noise and sound barrier details.

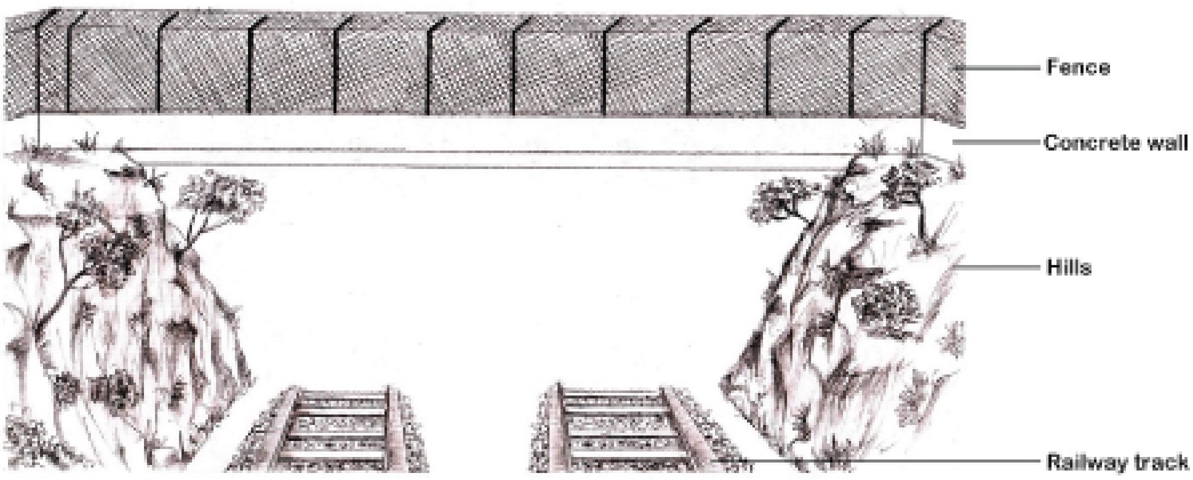

Figure 5. Lateral view of a wildlife overpass on a double-track railway line.

5. Installation of Distributed Acoustic Sensing (DAS) System

Irrespective of the type of mitigation measures to be employed across the sensitive railway stretches, all the sensitive stretches have to be installed with DAS. The system developed by railways to detect the presence and movement of the elephants along the railway tracks is basically an intrusion-based detection system based on Distributed Acoustic Sensing (DAS). A DAS monitoring interrogator converts a standard communications single-mode fiber into thousands of extremely sensitive acoustic and vibration sensors. The Distributed Acoustic Sensor connected to one end of the fiber uses a laser to send thousands of short pulses of light along the fiber every second. A small portion of the light traveling in fiber is reflected by the process known as Rayleigh Backscatter. The concept of securing a network from malicious entities by capturing and monitoring data packets was first employed by James Anderson in 1980. Since then, researchers have developed various approaches to enhance the performance and accuracy of intrusion detection.

Vibrations from the surrounding environment will disturb the light in the fiber and will therefore be observed by the DAS interrogator. The events that are of concern are reported to the alarm server. As the data is processed in real-time, advanced algorithms can recognize the unique signatures of each type of event.

The system can show the precise location of the event, and information about what event has taken place, which means the laser pulse frequency, pulse width, and many other parameters. These parameters can be controlled, enabling the system to be tuned to the desired requirement. Integrated with machine learning and artificial intelligence, the system can differentiate even between minor variations in the scatter. The optic fiber cable running along infrastructure and other important assets can give uninterrupted and real-time feedback on activities occurring along and around them.

The recommendations of the MoEFCC committee constituted vide office order No. WL-8/28/2022-WL on 3rd January 2023 needs to be considered for the implementation of the DAS.

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Project Elephant Division
Ministry of Environment, Forest & Climate Change
6th Floor, Jal Block,
Indira Paryavaran Bhawan,
Jor Bagh Road,
New Delhi 110003.
E-mail: projectelephant.moef@gmail.com

भारतीय वन्यजीव संस्थान
Wildlife Institute of India