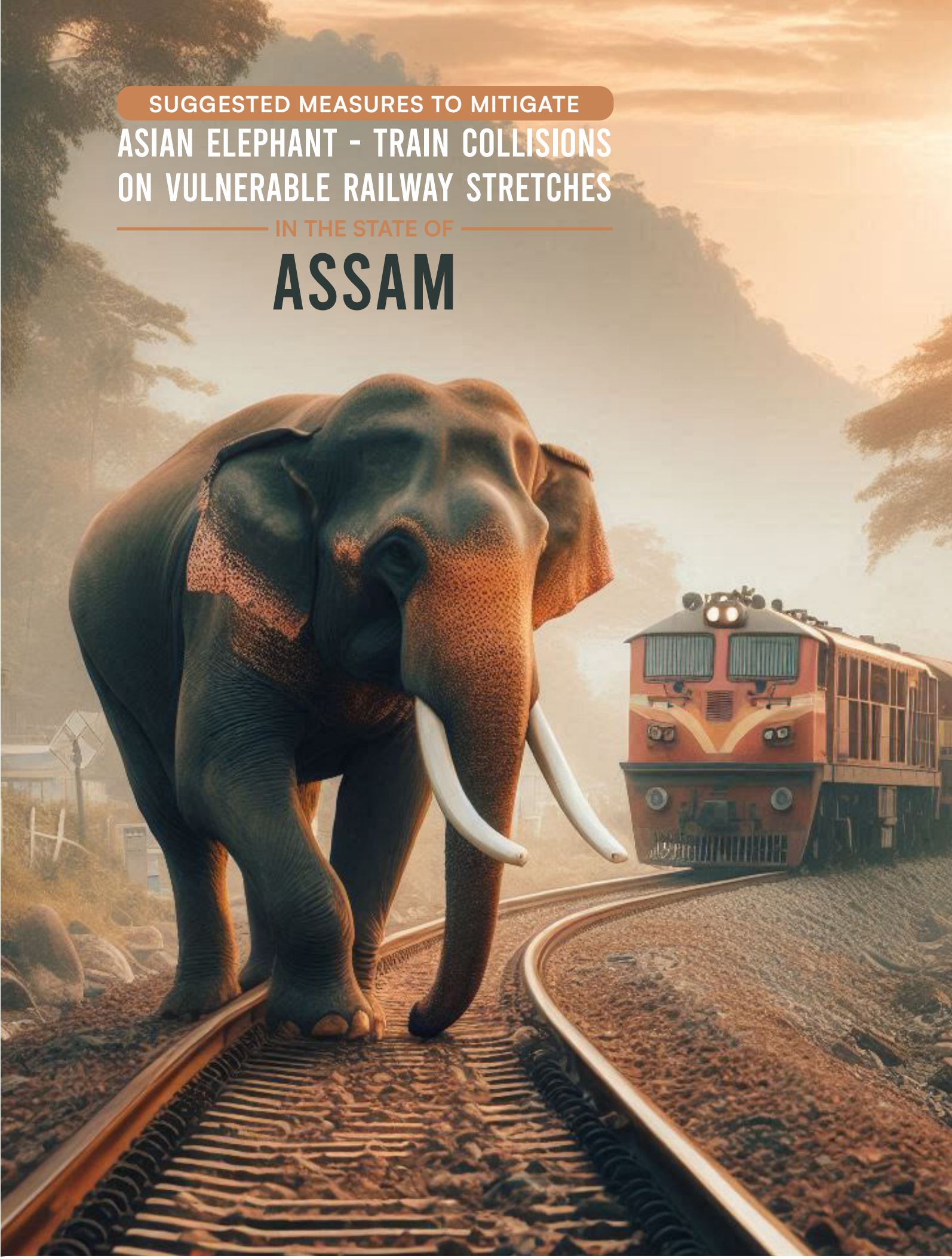
SUGGESTED MEASURES TO MITIGATE

ASIAN ELEPHANT - TRAIN COLLISIONS ON VULNERABLE RAILWAY STRETCHES

IN THE STATE OF

ASSAM



सत्यमेव जयते

भारतीय वन्यजीव संस्थान
Wildlife Institute of India

AUGUST 2024

Project Elephant, Ministry of Environment, Forest and Climate Change, Government of India & Wildlife Institute of India

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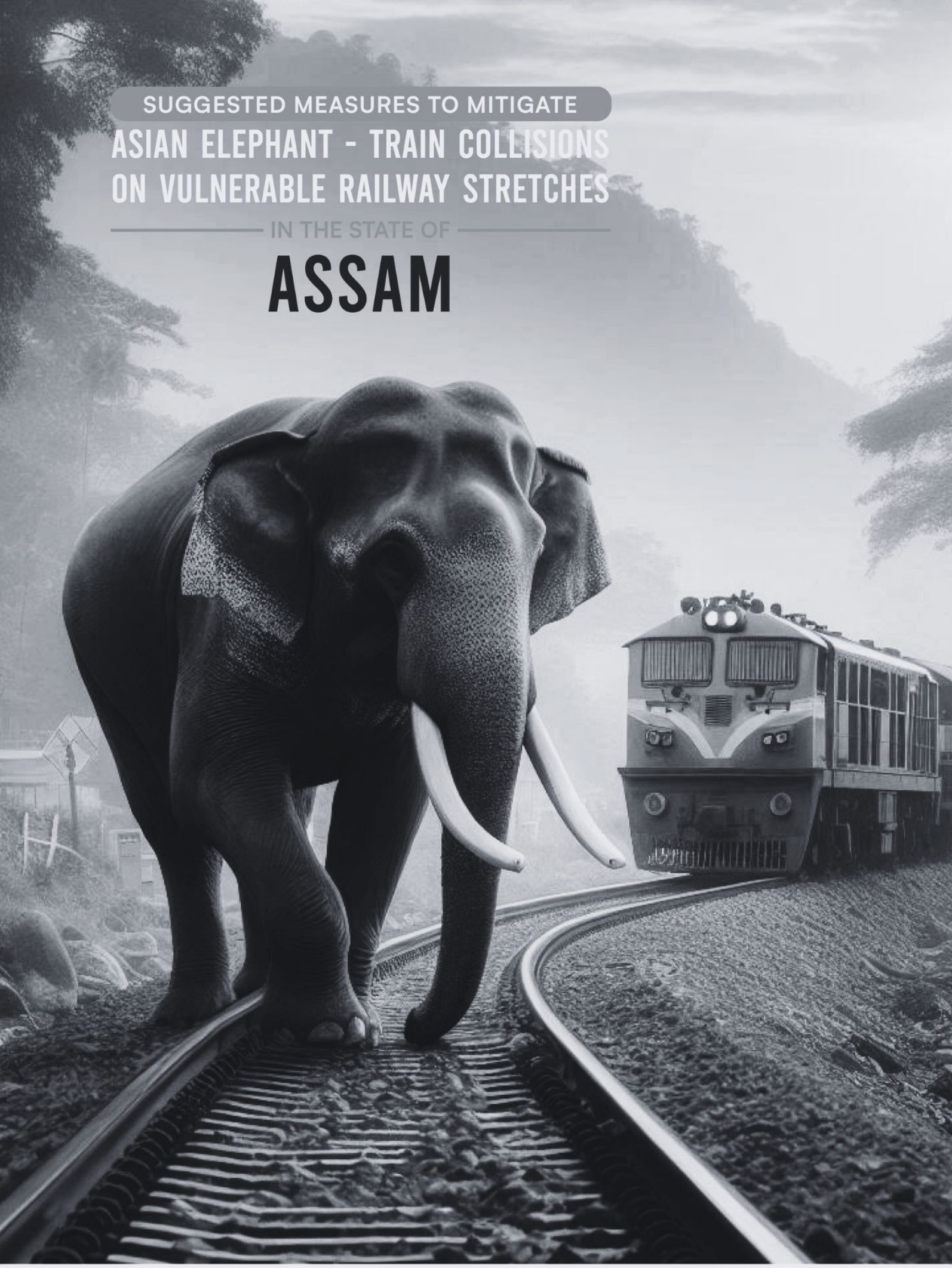

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To minimize the risk of collisions between elephants and trains, the Ministry of Environment, Forest and Climate Change and the Ministry of Railways in India have jointly undertaken several measures. These include the construction of underpasses and 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.

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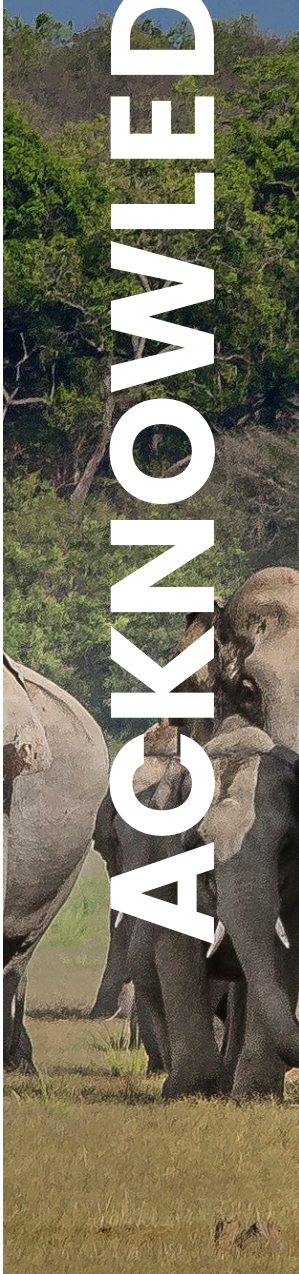

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CONTENTS

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. Despite being the second-largest state by area in the north-eastern region, and the largest in terms of human population, Assam is home to rare and endangered wild animals including the greater one-horned rhinoceros, hoolock gibbon, golden langur, and a wide range of birds and reptiles. Significantly, Assam is home to around 56% of Asian elephants found in north-eastern India[1], and is an important landscape for conservation of wild elephants in the country.

The state is divided into three regions – the Brahmaputra valley, the Barak valley and hills of North Cachar and Karbi Anglong. 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.

Assam has a fast-growing economy, and the potential for further growth. Important urban centres in Assam include Guwahati, Silchar and Dibrugarh, that are densely populated. The state is rich in petroleum and natural gas deposits, and other minerals such as coal and limestone.

[1] *https://moef.gov.in/moef/division/forest-divisions-2/project-elephant-pe/introduction/index.html*

Other major economic activities of the state include tourism, agriculture, and oil and tea production. Assam has the largest railway network in the north-east region, with about 2435 km of railway lines[2] connecting it to the rest of the country, and providing access to other north-eastern states.

Despite being the most connected state in the north-east in terms of the railway network, railway operations in Assam account for the highest impacts on biodiversity in terms of elephant mortality. The vast railway network often intersects wildlife habitats, and movement pathways of wild elephants that occur outside the purview of protected areas. Consequently, train hits account for the second-highest cause of non-natural elephant mortality in the state, with reports indicating deaths of 115 elephants between 1990 and 2018[3] , and at least 33 elephants between January 2017 and March 2023[4] . Further, the Northeast Frontier Railway (NFR) zone accounted for the highest number of elephant deaths in the period 2014-2022 (65 deaths)[5] . Consequently, while all new railway line construction projects passing through habitats and corridors of elephants and other wildlife must take mitigative actions, it is pertinent that measures to retrofit existing railway lines to mitigate the impacts of railway lines on elephants are taken proactively.

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 18 priority railway segments were identified and surveyed in Assam. The stretches were surveyed by joint teams consisting of State Forest Department, Indian Railways and WII representatives.

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.

[2]*https://industries.assam.gov.in/portlet-sub-innerpage/transportation*
[3]*https://www.deccanherald.com/india/assam-third-elephant-injured-in-train-hit-dies-1153132.html*
[4]*https://theprint.in/ground-reports/in-assam-trains-prey-on-elephants-but-hathi-mitras-ai-have-been-defeating-them-for-4-yrs/1656636/*
[5]*https://www.news18.com/news/india/more-than-130-elephants-killed-on-railway-tracks-since-2014-most-in-northeast-frontier-zone-7095799.html*

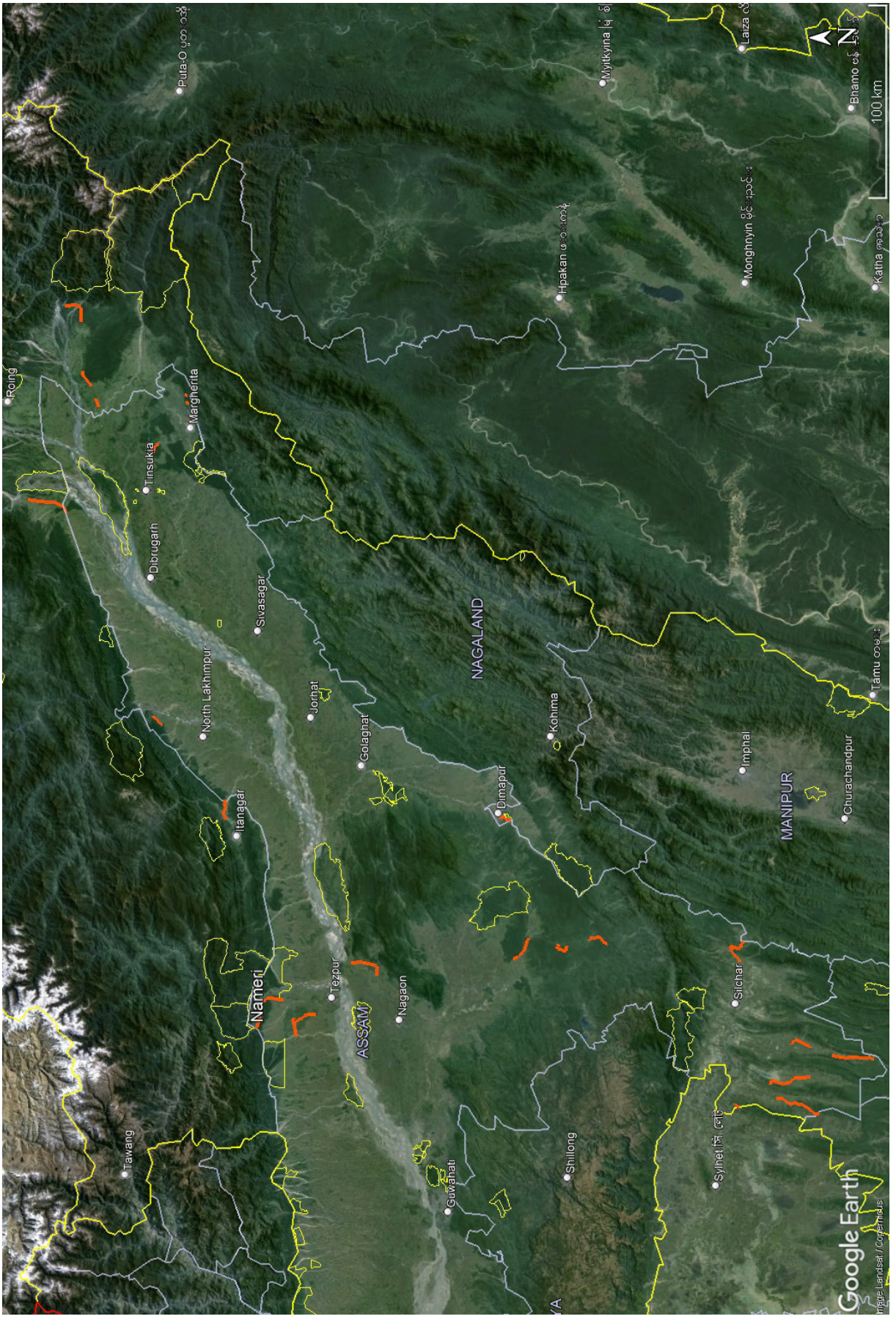


Figure 1: Identified priority railway line stretches (orange lines) for field survey in the states of Assam, and bordering Nagaland and Arunachal Pradesh, with respect to the protected areas (yellow polygons).

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 site specific mitigation details are provided in the following sections.

Table 1: Details of railway line stretches vulnerable to elephant-train collisions in the state of Assam surveyed during 19th – 27th March 2024.

S.No.	Railway lines surveyed	Length
1.	Tingrai-Bogapani-Digboi-Golai Gaon railway line passing through the Bogapani corridor, Digboi Forest Division, Assam	6.7
2.	Railway line passing though the Dulung Forest Reserve, Lakhimpur Forest Division, Assam	7.0
3.	Harmuti-Gumto-Naharlagun railway line passing through the Durpong-Doimukh at Khundakuwa elephant corridor	10.9
4.	Chariduar-Bhalukpong railway line passing through Balipara Reserve Forest (buffer of Nameri Tiger Reserve) and surrounding forests in Sonitpur Forest Division, Assam	25.0
5.	Railway lines near Rangapara (Rangapara to Misamari, and Rangapara to Bindukuri) in Sonitpur Forest Division, Assam	9.6, 14.4
6.	Silghat Town – Puranigudam railway stretch near Kaziranga National Park, Nagaon Forest Division, Assam	4.6, 2.11, 10.2, 5.3
7.	Lumding – Habaipur railway line passing near the Lumding Reserve Forest (part of Dhansiri-Lungding Elephant Reserve), Nagaon South Forest Division	14.2

* 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.

03. Site-Specific Findings & Mitigation Measures

3.1. Tingrai-Bogapani-Digboi-Golai Gaon Railway line passing through the Bogapani Corridor, Digboi Forest Division

Survey date: 20th March 2024

The railway line, coming from Tinsukia, passes through Tingrai, Bogapani and Digboi railway stations. As per forest officials, the railway line passes through two important elephant movement corridors adjacent to the Dihing Patkai National Park (Fig. 2). The Bogapani corridor, connecting the Upper Dihing East and Upper Dihing West Blocks, is regularly used by elephants to cross the railway track. Nine elephants died on the railway track between 2001 and 2015.

The Golai corridor is heavily degraded, and elephant movement has been blocked owing to multiple human infrastructure in the area, including IOCL infrastructure. This corridor is heavily degraded as per field observations and information from the Forest Department, and requires urgent restoration measures.

The Tingrai-Bogapani-Digboi-Golai Gaon railway line intersects the Bogapani corridor connecting the Lakhipather and Digboi ranges between the Upper Dihing East and Upper Dihing West Forest Blocks respectively. The National Highway 315 (previously 38) also runs parallel to the railway line along the corridor (Fig. 3).

Observations:

- The land use types immediately adjacent to the highway and railway line are forests, agriculture and tea gardens.
- According to information provided by the Forest Department, the Bogapani Forest Village also falls within the corridor, making it vulnerable to human-elephant conflict.
- Movement of elephant herds (size 5 – 100 elephants per herd) across these corridors through the railway line and highway have been reported to be of seasonal nature, particularly between the months of October and February, that coincides with the paddy-harvesting season. Occasional use by lone elephants has also been reported in the corridor.
- Though development of human infrastructure along the road and railway line, and the traffic on the road and railway line, have led to a decrease in the intensity of use of the corridor by elephants, the animals still use the corridor to move between the two important habitat patches.
- Owing to the co-occurrence of forest villages along elephant movement corridors, conflict incidences such as house damage and human casualties have occurred in the area.

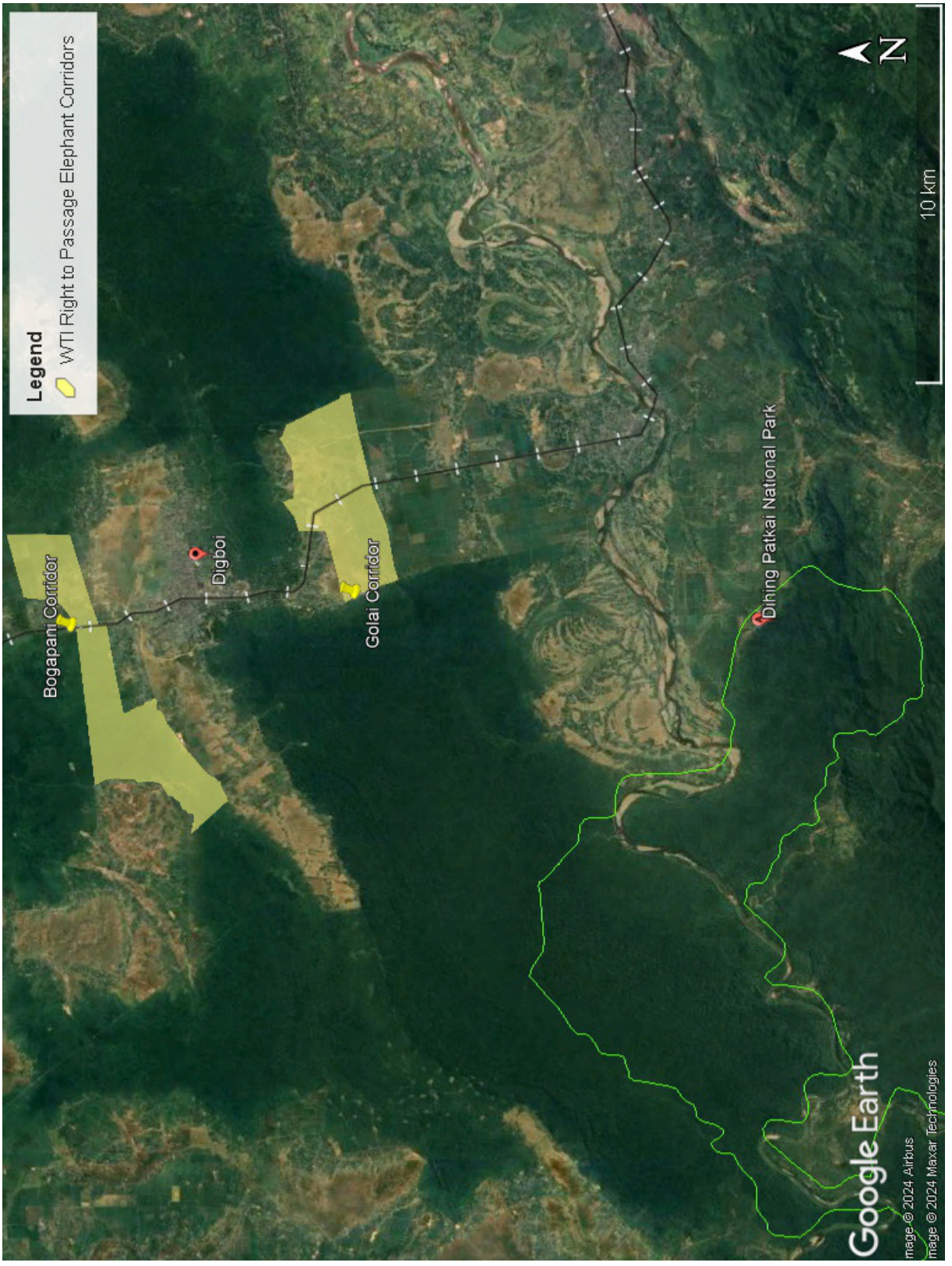


Figure 2: Location of the Bogapani and Golai corridors (Project Elephant, 2023) intersected by the railway line and National Highway 315 near Dihing Patkai National Park, Digboi, Assam.

Figure 3: The National Highway 315 (right) runs parallel to the Tingrai-Bogapani-Digboi-Golai Gaon railway line (left) that passes through the Bogapani corridor near Dihing Patkai National Park, Digboi Forest Division, Assam.

Recommendations:

- Four frequently used trails intersecting the railway line by elephants were observed on field. A series of ramps and level crossings are suggested for the railway line at these points in the corridor, considering the flat terrain of the track bed. The width of the ramps should be at least 30 m, and that of level crossing should be at least 50 m (details in Table 2).

- Upgradation of NH 315 that runs parallel to the railway line had been proposed, for which the Forest Department had submitted a proposal to incorporate animal underpasses (flyover for vehicular traffic). However, the highway upgradation did not materialise. It is, thereby, recommended that in the event of upgradation of NH 315, a flyover or animal underpass measuring 500 m in length and 6 m in height is to be made to ease animal movement across the highway. The span of the flyover would cover the three elephant trails (Bogapani 1, 2, & 3), and funnel elephant movement on Bogapani 4 towards the opening. The construction of this flyover in the event of upgradation of the highway is vital to maintain connectivity of the Bogapani corridor. Start and end point GPS locations of the highway underpass are given below:

  Start: 27° 25.484'N, 95° 36.587'E;
  End: 27° 25.214'N, 95° 36.613'E

- Encroachment between the highway and the railway line should be removed on priority.

Table 2: Mid-point GPS locations for construction of ramps on frequently used trails across the railway line.

S.No.	Crossing points	Mid-point GPS
1.	Bogapani 1	27° 25.436'N 95° 36.564'E
2.	Bogapani 2	27° 25.380'N 95° 36.572'E
3.	Bogapani 3	27° 25.291'N 95° 36.583'E
4.	Bogapani 4	27° 25.208'N 95° 36.591'N

3.2. Railway line passing though the Dulung Forest Reserve, Lakhimpur Forest Division, Assam

Survey date: 21st March 2024

The Dulung Forest Reserve is an important habitat for elephants in Northern Assam, and provides connectivity with several adjacent habitats in the region, particularly with elephant habitat in the Himalaya to the north. It is rich in both flora and fauna, and is known for being home to the endemic *Mesua assamica* or Sia nahor tree. The RF is part of the important Dulung-Subansiri elephant corridor that facilitates east-west movement of elephants across the Subansiri river.

A ~7 km stretch of railway line passes along the south-eastern boundary, and through the Forest Reserve (Fig. 4). Regular elephant mortality has been observed on the railway track. More recently, a female elephant was killed in an accident on the track in early March this year.

Observations:

- A 6.7 km (approx.) stretch of railway track passes through the forest reserve (Fig. 5).
- Use of the railway track by elephants was reported and observed to be uniform across the entire stretch of the track passing through the forest. The primary reason for elephant movement across the track is possibly daily access to resources on either side, since no corridor exists beyond the forest reserve to the south-east.
- Further, many accident sites and sites of probable crossing or use were found near bridges built on drainages, with elephant signs found under the bridges as well.
- A 1.4 km (approx.) stretch of the railway track runs parallel to the National Highway 15. Considerable number of human settlements exist on either side of the railway track in this stretch, and between the railway track and the highway. Elephant movement across the track in this segment can potentially lead to incidents of conflict.

Recommendations:

- All major bridges on the railway track within the forest are to be expanded to facilitate elephant and wildlife movement underneath (with the exception of bridges number 670 and 671). The expansion in width may be done by constructing additional spans on either side of the existing bridges. Further the bridges should be made suitable for movement by discouraging any human disturbance underneath. Details of the bridges to be modified are given in Table 3.
- Ramps with level crossings for easy movement of elephants across the track should be built every 1 km, as per WII's guidelines (General Guidelines for Suggesting Mitigation Measures on Existing Railway Tracks through Elephant Habitat in India), except for the 950 m stretch as shown in Fig. 6.
- Similarly, escape ramps (same design as level crossings and ramps) on either side of all railway bridges along the entire stretch are to be provided.
- The railway line segment running parallel to NH 15 (approximately between 327/3-4 to 325/9) is to be fenced off from the forest reserve side (Fig. 6), to discourage elephant movement towards human habitation.

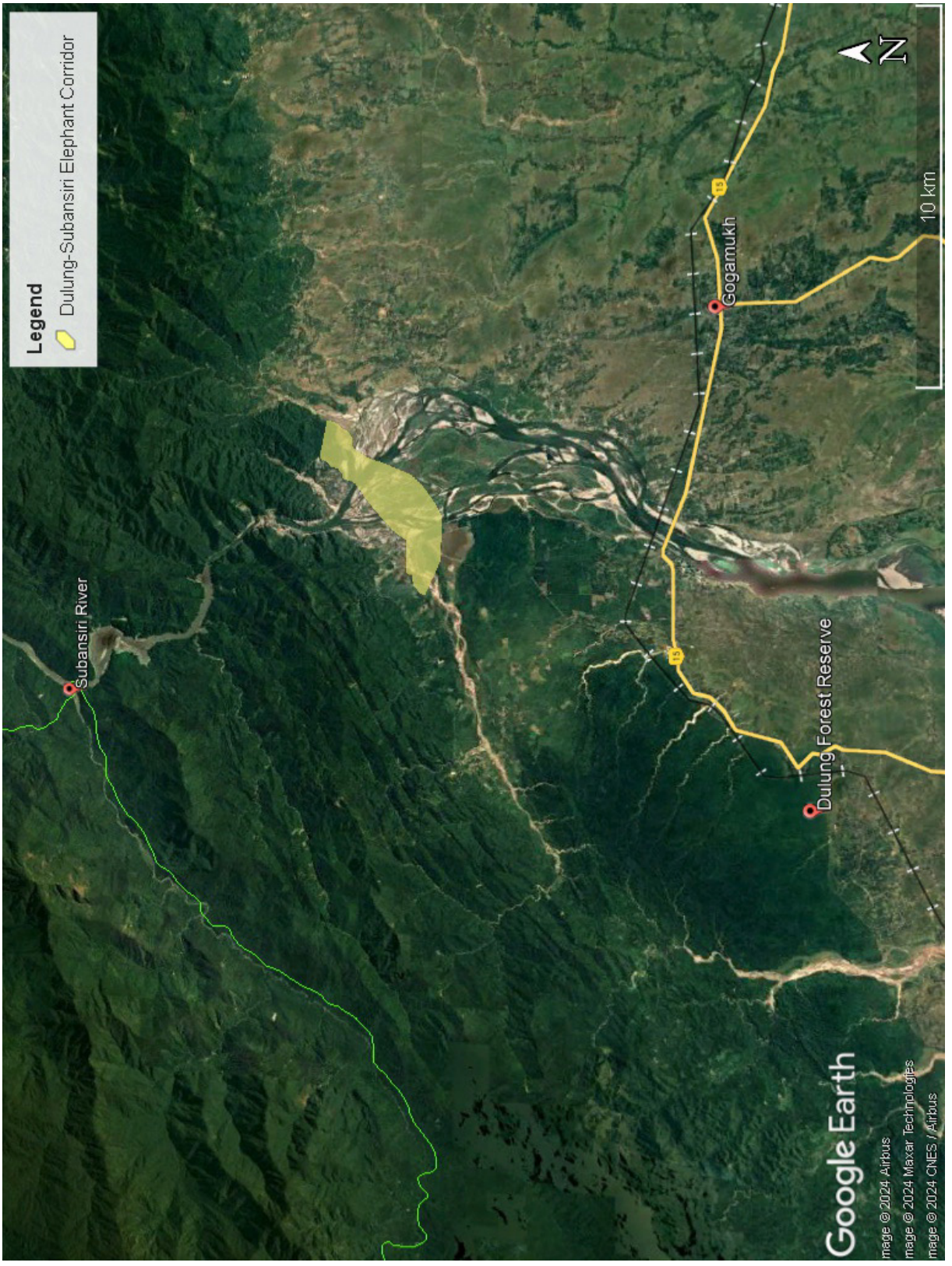


Figure 4: Location of the Dulung Forest Reserve, Assam, and railway line with respect to elephant corridors in the area (Project Elephant, 2023).

Figure 5: The railway track passing through the Dulung Forest Reserve, Assam.

Table 3: Details of existing railway bridges to be expanded to facilitate elephant and movement in the Dulung Forest Reserve, Assam.

S.No.	Bridge No.	Present dimensions (m)	Total length (m)	Recommended dimensions
1.	664	5 x 6.10	36.55	6 x 6.10
2.	665	2 x 3.05 + 3 x 6.10	29.03	4 x 6.10
3.	666	2 x 3.05 + 4 x 6.10	36.34	6 x 6.10
4.	667	2 x 3.05 + 3 x 6.10	29.03	4 x 6.10
5.	669	5 x 6.10	169.41	No increase required
6.	672	3 x 6.10	21.93	4 x 6.10
7.	673	3 x 6.10	21.93	4 x 6.10
8.	674	6 x 12.20	72.06	No increase required

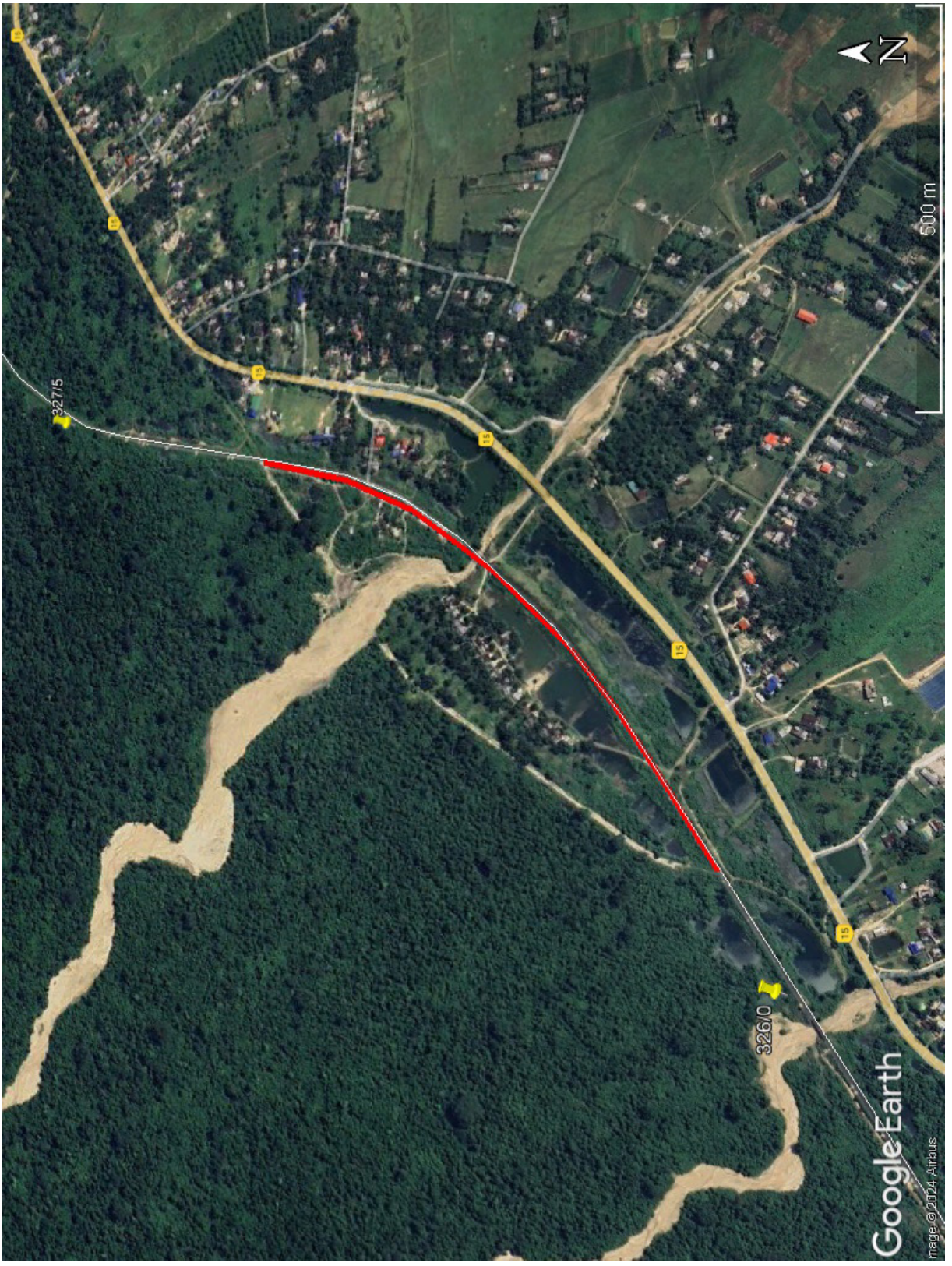


Figure 6: Approximately 950 m of the railway track (in red) where construction of ramps is not required, and where fencing is to be done to discourage elephant movement into human settlement south-east of Dulung Forest Reserve.

3.3. Harmuti-Gumto-Naharlagun railway line passing through the Durpong-Doimukh at Khundakuwa elephant corridor

Survey date: 21st March 2024

The Durpong-Doimukh at Khundakuwa corridor connects the Durpong Reserve Forest to the south-west with the Doimukh Reserve Forest to the north-east. The corridor is intersected by the National Highway 415 connecting Banderdawa to Itanagar, the Doimukh-Harmuti road, the Harmuti-Gumto-Naharlagun railway line and multiple human settlements and agricultural fields (Fig. 7).

Observations:

- The corridor connecting the two reserve forests is intersected by multiple roads, a railway line, stone crusher sites, human settlements and agricultural land. Some of the human settlements were reported to be encroachments, such as those on the nalas used by elephants for movement. Walls and human activities such as burning of fire in these areas to repel elephant movement have been reported.

- The railway line was established in 2014, and the train traffic is currently low (4 trains daily). No elephant accidents have been reported on the stretch yet.

- Reduced use of the corridor was reported in 2017. According to forest officials, movement has been infrequent in recent years too, except for paddy-harvesting season. However, it is improbable that elephants have been able to cross the corridor completely.

Recommendations:

- The railway line is soon to be electrified. All electrical infrastructure should be proofed so as to avoid incidences of wildlife electrocution.

- Drainage structures on the railway line are to be kept free of human encroachments.

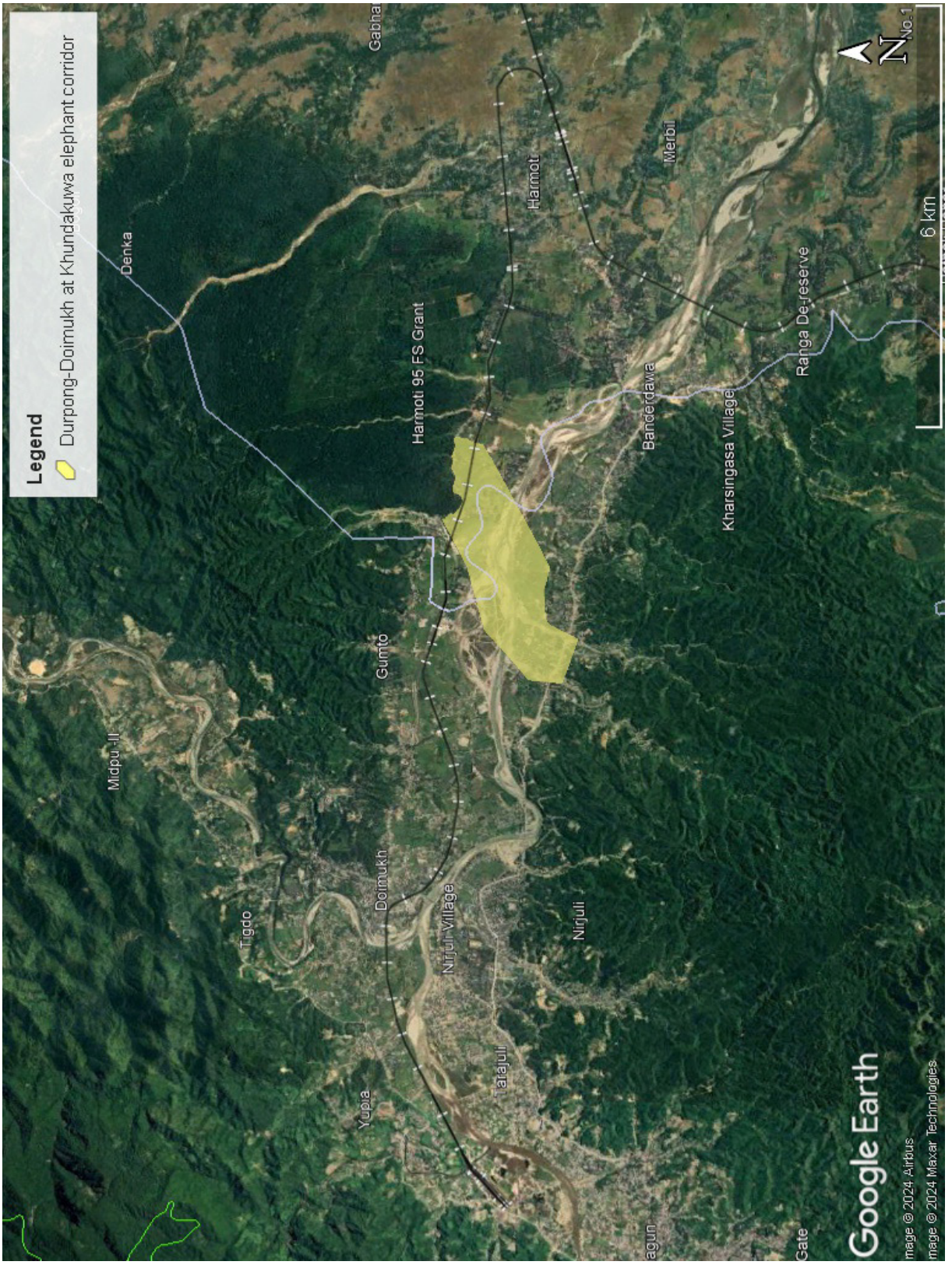


Figure 7: Location of the Harmuti-Gumto-Naharlagun railway line, and other anthropogenic infrastructure and land uses, intersecting the Durpong-Doimukh elephant corridor (Project Elephant, 2023).

3.4. Chariduar-Bhalukpong railway line passing through Balipara Reserve Forest (buffer of Nameri Tiger Reserve) and surrounding forests in Sonitpur Forest Division

Survey date: 22nd March 2024

Nameri Tiger Reserve is an important large protected area in the region, bordering Arunachal to the north and contiguous with the Pakke Tiger Reserve in Arunachal Pradesh. Both tiger reserves form one of the largest blocks of semi-evergreen and evergreen forests in Northeast India. The Nameri National Park, Sonai-Rupai Wildlife Sanctuary, and Naduar and Balipara Reserve Forests together make up the Nameri Tiger Reserve. The tiger reserve is home to a wide variety of charismatic fauna, including tiger, elephant, goral, marbled cat, Asiatic wild dog, and leopard.

The Sonitpur Forest Division, once known to be one of the greenest districts of Assam, has faced intense forest conversion in the past 20 years, including the Balipara Reserve Forest. Extensive loss of natural vegetation has been indicated to be the cause of rampant human-elephant conflict in the region (Kushwaha & Hazarika, 2004; Mahato *et al.*, 2021). Further, the 25 km (approx.) railway line from Charduar to Bhalukpong stations intersects the connectivity between the Nameri Tiger Reserve and the Balipara Reserve Forest which is part of the Nameri- Sonai Rupai Arimora (NSA) elephant corridor (Fig. 8), at different points.

Observations:

- The railway track passes through a mix of agricultural fields, human habitation and narrow forested sections at different segments (Fig. 9). Non-forested tracts are regularly used by elephants for movement.
- According to railway personnel, the railway line currently has low traffic, with 2 trains plying on the track daily, in addition to few goods trains. No elephant mortality has been recorded on the tracks till date.
- Eight main crossing points were highlighted by the Forest Department personnel on field (Table 4, Fig. 10).
- The track height is low as compared to adjacent terrain, with an average height of 1.5 – 2 m.
- In many places, ROBs and level crossings for villages are being used by elephants to cross over (Fig. 11), often from the reserve forests towards villages on towards Balipara Reserve Forest, that could potentially lead to conflict.
- The railway stretches going through the narrow and forested corridors near Kalabil (Ch. 15/2 – 15/6), and near Gamani Ban Gaon (Ch. 22/0 – 22/4) (corridors 7 and 8 in Fig. 10) have walls on both sides for at least 400 m each (Fig. 12). Multiple elephant signs were recorded in both stretches. Railway personnel have also reported seeing deer in the Kalabil stretch. This could potentially lead to elephants and other animals getting trapped in the event of a train passing through the stretch, without an escape route present.

Figure 8: The Chariduar-Bhalukpong railway line intersecting the corridor between Nameri Tiger Reserve and Balipara Reserve Forest, Sonitpur Forest Division, Assam.

Figure 9: The Chariduar-Bhalukpong railway line near the Nameri Tiger Reserve and Balipara Reserve Forest, Assam, passes through a mix of land uses, including agricultural fields and human habitations, also used by elephants for movement.

Table 4: Characteristics of major elephant crossing corridors visited on the Chariduar-Bhalukpong railway line between the Nameri Tiger Reserve and Balipara Reserve Forest, Assam.

S.no.	Crossing points	Characteristics
1.	1, 2, 3, 4, 5, & 8	Forest on one side and human habitation on the other.
2.	3 & 4	Elephant crossing across level crossing meant for vehicles and humans.
3.	6	Elephant crossing across the non-functional Gamani railway station.
4.	7 & 8	Railway track is cut into slightly elevated terrain, thus has walls on both sides of the tracks.
5.	6 & 7	Forests on either side of the track.

Figure 10: Locations of the eight major elephant crossing corridors visited on the Chariduar-Bhalukpong railway line between the Nameri Tiger Reserve and Balipara Reserve Forest, Assam.

Recommendations:

Almost the entire stretch of the railway line seems to be regularly used by elephants. Specific measures are recommended for stretches highlighted as major corridors by forest department personnel.

- Escape ramps and level crossings are to be provided every 1 km in consultation with the forest department along the entire stretch.
- Railway stretches where low-voltage live wires have been put up by villagers for repelling elephants from agricultural fields (Fig. 13) should not overlap with those delineated for construction of ramps.
- Considering the possibility of the railway line to get electrified in the future, all electrical infrastructure should be properly insulated and proofed so as to avoid incidences of wildlife electrocution. Adequate measures to ensure this should be taken.
- For the two railway segments near Kalabil (Ch. 15/2 – 15/6), and that near Gamani Ban Gaon (Ch. 22/0 – 22/4), smooth ramps/exits for elephants are to be provided at every 100 m by breaking the walls in the two highlighted stretches (corridors 7 and 8 in Fig. 10). The design of the exit ramp can be similar to those constructed on canals in Odisha (Fig. 14).
- Specific actions to be taken at select points have been detailed in Table 5 below.

Figure 11: Level crossing BB/7 (Ch. 10/2) is used by elephants to cross over towards villages.

Figure 12: Concrete walls along two sections of the railway line Kalabil (Ch. 15/2 – 15/6), and that near Gamani Ban Gaon (Ch. 22/0 – 22/4) could cause elephants and other wild animals from getting stuck in the rail corridor. Multiple animal signs were found here.

Figure 13: Low-voltage live-wire fencing used by villagers against crop-depradation by elephants along the Charduar-Bhalukpong railway line.

Table 5: Specific mitigation measures to be taken on select points of the Chariduar – Bhalukpong railway line, between Nameri Tiger Reserve and Balipara Reserve Forest, Assam.

S.No.	Chainage	GPS location	Remarks	Measures recommended
I.	9/5	26° 53.294'N 92° 47.910'E	Crossing BB/6 is used by elephants for crossing.	Four level crossings and ramps, two beside each of the level crossings are to be made. Barriers to dissuade elephants from using the existing level crossings are to be constructed.
II.	10/2	26° 53.672'N 92° 47.983'E	Crossing BB/7 is used by elephants for crossing into village.	
III.	14/6 - 14/7	26° 56.013'N 92° 48.415'E	Elephant signs and trails seen on both sides of the bridge.	Present slab bridge of 2 x 20 m dimension may be expanded to include two dry spans of 5 m on either side for elephant movement.

Figure 14: Ramps/exits similar to these built on canals, to facilitate escape of wild animals in the event of approaching trains in the walled sections Kalabil (Ch. 15/2 – 15/6), and that near Gamani Ban Gaon (Ch. 22/0 – 22/4) should be provided [Picture courtesy: Jagyandatt Pati]

3.5. Railway lines near Rangapara (Rangapara to Misamari, and Rangapara to Bindukuri) in Sonitpur Forest Division, Assam

Survey date: 22nd March 2024

The area surveyed in the Sonitpur forest division and district lies between the Nameri National Park and Sonai-Rupai Reserve Forest and Wildlife Sanctuary. These PAs and adjacent forest patches provide refuges for wild elephants. The land use in the district is mostly tea plantations (18.8%), with few human settlements and forest patches (3%), with tea gardens also being used as refugia by elephants (Wilson *et al.*, 2015; Fig. 15). The intervening forest patches are reportedly small (<0.5 km^2), but also serve as refuge areas (Wilson *et al.*, 2015).

The forests of the Sonitpur Forest Division have, in the past few decades, witnessed extensive loss of vegetation cover (Mahato *et al.,* 2021) owing to multiple reasons. The district also has amongst the highest rates of human-elephant conflict in the state. The conflict is mostly seasonal in nature, commonly crop damage and property damage (Wilson *et al.*, 2015). This is also the season when most elephant-train collisions occur.

We surveyed the two major railway lines cutting through the region - Rangapara North Junction to Misamari (East-West), and Rangapara North Junction to Bindukuri station (North-South). Even with low elephant density and train traffic (10-20 average daily trains) on these tracks, the area accounts for high collision rates (Ahmed & Saikia, 2022) because of gregarious and seasonal movement of elephants in the region. A herd of 5 elephants was

killed in December 2017 near a level crossing[6], pointing to the need for retro-fitting railway infrastructure in this region to facilitate elephant movement. During the survey, additional sites of concern as flagged by the local forest department staff were also inspected (Fig. 16).

Figure 15: Tea plantations along the railway lines in Chariduar Forest Range are regularly used by elephants for movement.

Observations:

- The railway tracks surveyed were almost at ground level (<1 m) for most of the length.
- There is regular movement of elephant herds between railway gates number 66 to number 69.
- Rail gates or level crossings, especially those near tea plantations and agricultural areas, are regularly used by elephants for crossing the railway tracks. These are also points where elephant mortality has occurred in the past, as elephants would get trapped in the barriers along the rail line on both sides of the level crossings (Fig. 17).
- Most of the elephant movement in large herds occurs during the winter months of November – March. This movement has a direct bearing on the probability of elephant-train collisions as well as human-elephant conflict.

Recommendations:

- Level crossings are to be provided every 1 km all along the vulnerable segments of the two railway stretches (Fig. 18) to facilitate quick movement of elephants across the tracks, as indicated in Table 6. More level crossings may be constructed if needed.
- Level crossings for vehicles, such as those where elephant mortality has occurred in the past, are to be manned and monitored vigilantly. Early warning elephant detection systems are vital for this landscape, and the Railways should implement the DAS system here on priority basis.

[6] *https://scroll.in/latest/861004/assam-speeding-train-kills-five-elephants-crossing-tracks-to-find-food*

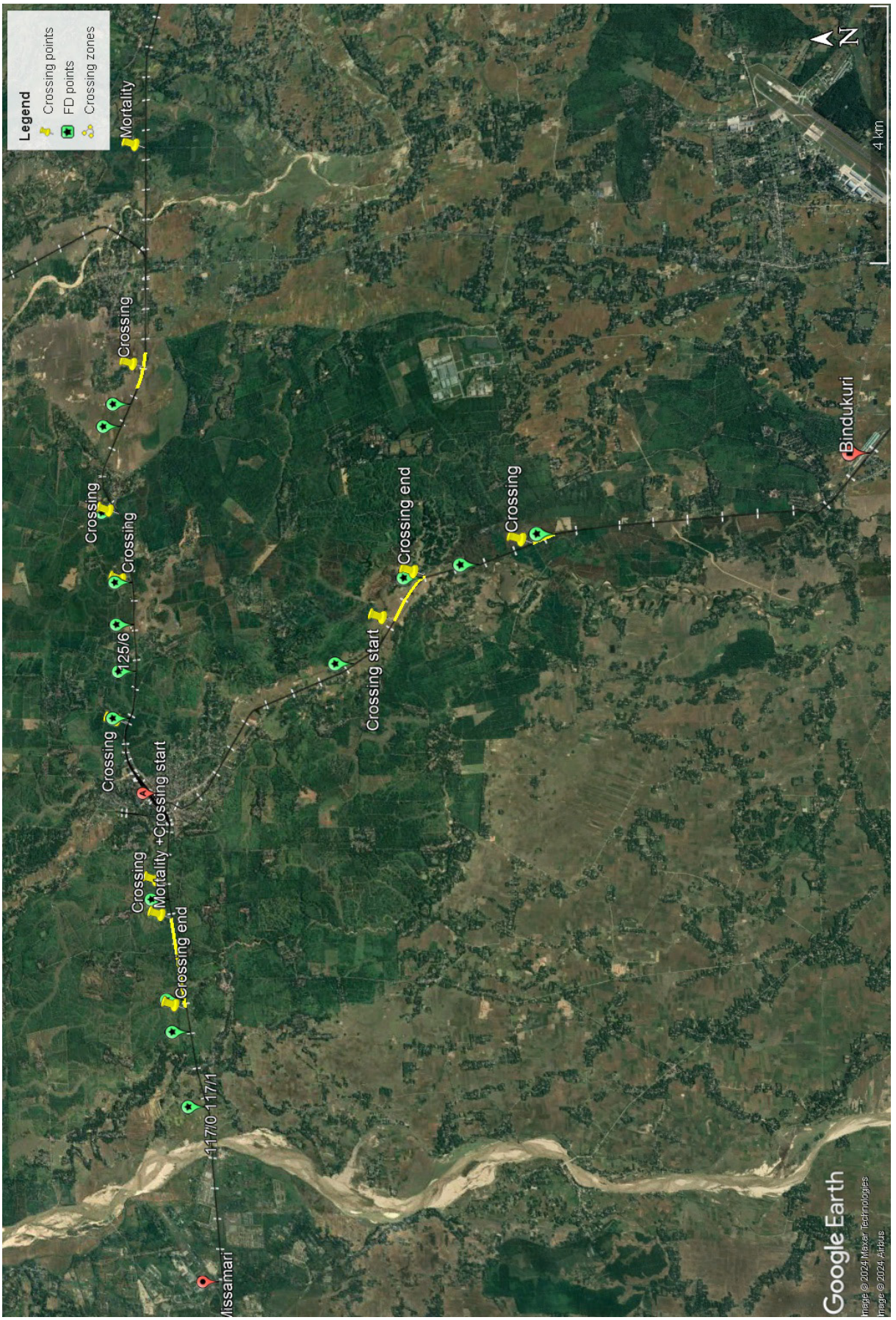


Figure 16: Extent of the two railway lines (Rangapara Jn. – Misamari (East-West) and Rangapara Jn. – Bindukuri (North-South)) surveyed in Chariduar Range, Sonitpur Forest Division. Yellow pins/lines denote crossing points/ zones noted on field as reported by Forest Department staff, green pins denote additional points of concern flagged by the Forest Department.

Figure 17: Barriers along the railway level crossing that led to the trapping of a herd of elephants leading to the mortality of 5 after colliding with a train near Bamgaon tea estate.

Table 6: Details of railway stretches in Chariduar Range, Sonitpur Forest Division, where construction of ramps for easing elephant movement has been suggested.

Stretch ID	Start GPS	End GPS	Length (m)	Number of elephant level crossings (minimum)
Bamgaon – Rangapara Jn. – Misamari				
1	26° 49.066'N 92° 48.396'E	26° 49.105'N 92° 47.367'E	1700	2
2	26° 49.167'N 92° 46.005'E	26° 49.661'N 92° 44.689'E	2400	3
3	26° 49.580'N 92° 44.184'E	26° 49.472'N 92° 43.999'E	375	1
4	26° 49.427'N 92° 43.568'E	26° 49.561'N 92° 41.547'E	3400	4
5	26° 49.124'N 92° 40.472'E	26° 48.789'N 92° 37.237'E	5400	6
Rangapara Jn. – Bindukuri				
6	26° 47.199'N 92° 42.270'E	26° 44.397'N 92° 43.584'E	6000	7

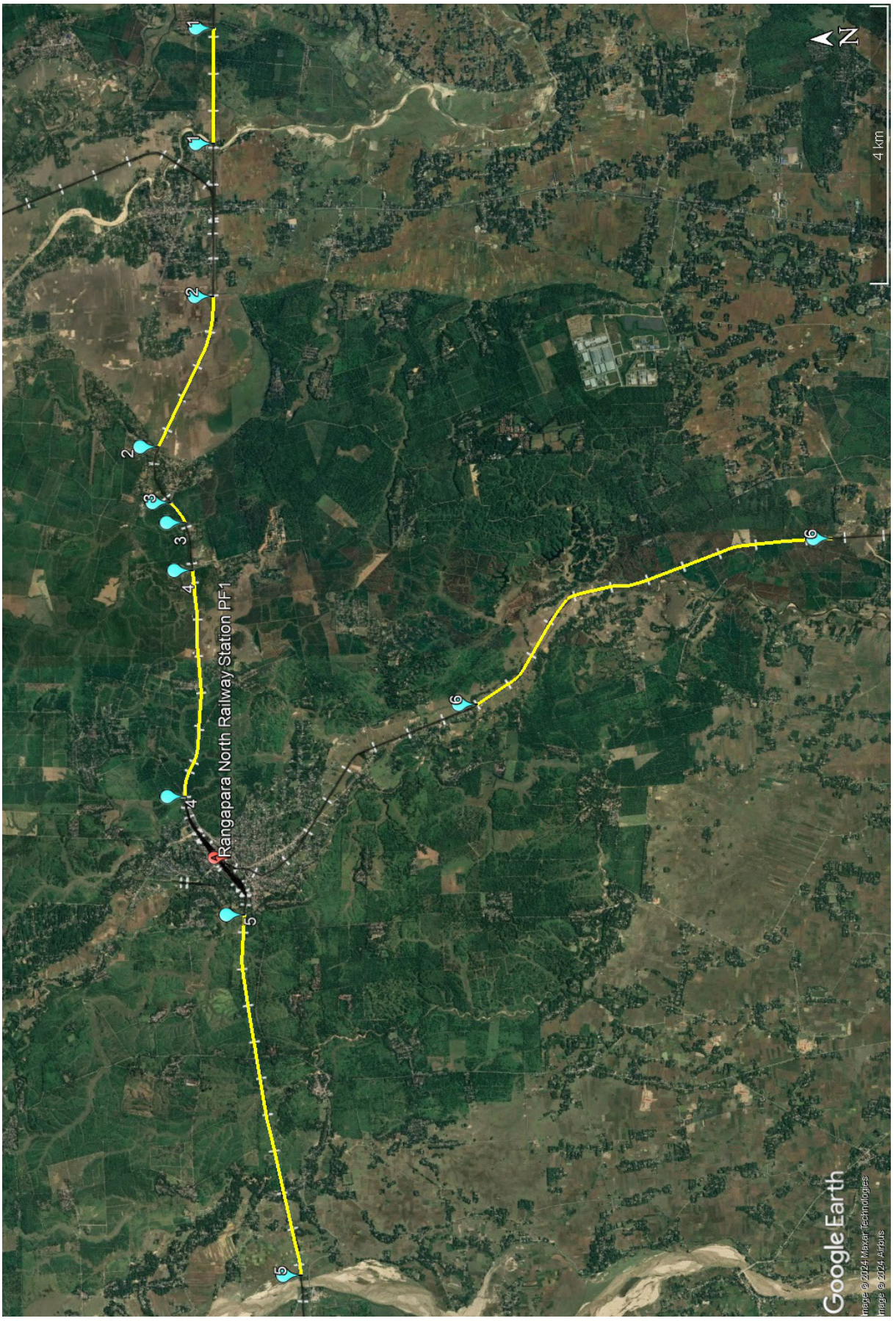


Figure 18: Representation of the stretches susceptible to elephant-train collisions (in yellow) on the railway stretches in Chariduar Range, Sonitpur Forest Division, where construction of ramps has been recommended to ease elephant movement.

3.6. Silghat Town – Puranigudam railway stretch near Kaziranga National Park, Nagaon Forest Division, Assam

Survey date: 23rd March 2024

The railway line between the Silghat town, that lies in the southern bank of the Brahmaputra River, until the Puranigudam railway station near Nagaon city passes mostly through agricultural fields, tea plantations and some forest patches, specifically on the stretch near Kaziranga NP (Bagser Reserve Forest). Elephant herds traveling between adjacent habitat and resource patches such as the Brahmaputra bank, Kamakhya Reserve Forest, Bagser Reserve Forest, Kaziranga NP, Karbi Anglong hills, North Diju Reserve Forest, Salona Forest Range, and intervening refuges often come across the railway track. Few incidences of elephant mortality have been recorded on the railway tracks in the region, potentially inhibiting west-east elephant movement.

As indicated by the Forest Department, there are four vulnerable stretches of the railway line totalling 24.5 km (Fig. 19). These four stretches were surveyed during the visit

Observations:

i. Silghat (59/9) to Jakhalabanda station

- Elephant herds traveling between Brahmaputra and Kamakhya Reserve Forest cross this track, moving through tea plantations.
- The land use on either side of the track on this stretch is tea plantations to the north and agricultural lands to the south, with intermittent human settlements and vegetation (Figs. 20 and 21).
- The track is not high as compared to the adjacent terrain (~1 m).
- A case of elephant mortality involving a tusker occurred on this stretch.

ii. Jakhalabanda (50/1) to Salona (48/0):

- Elephant herds moving between the Bagser Reserve Forest to the east towards the west (and vice versa) come across this railway stretch (Fig. 22).
- A tusker was hit by a train on this stretch in 2021, moving between tea plantation on one side and agricultural fields on the other.

iii. Ch. 45/0 to Amoni (34/8):

- This railway stretch intersects the elephant movement pathway between the Karbi Anglong hills, Reka Pahar, North Diju Reserve Forest, Salona range, and adjacent tea plantations and agricultural fields (Figs. 23 and 24).
- The track is relatively flat as compared to adjacent terrain.
- Regular movement of deer species, wild pig, tiger and leopard was reported to occur across the railway track inside the North Diju Reserve Forest.

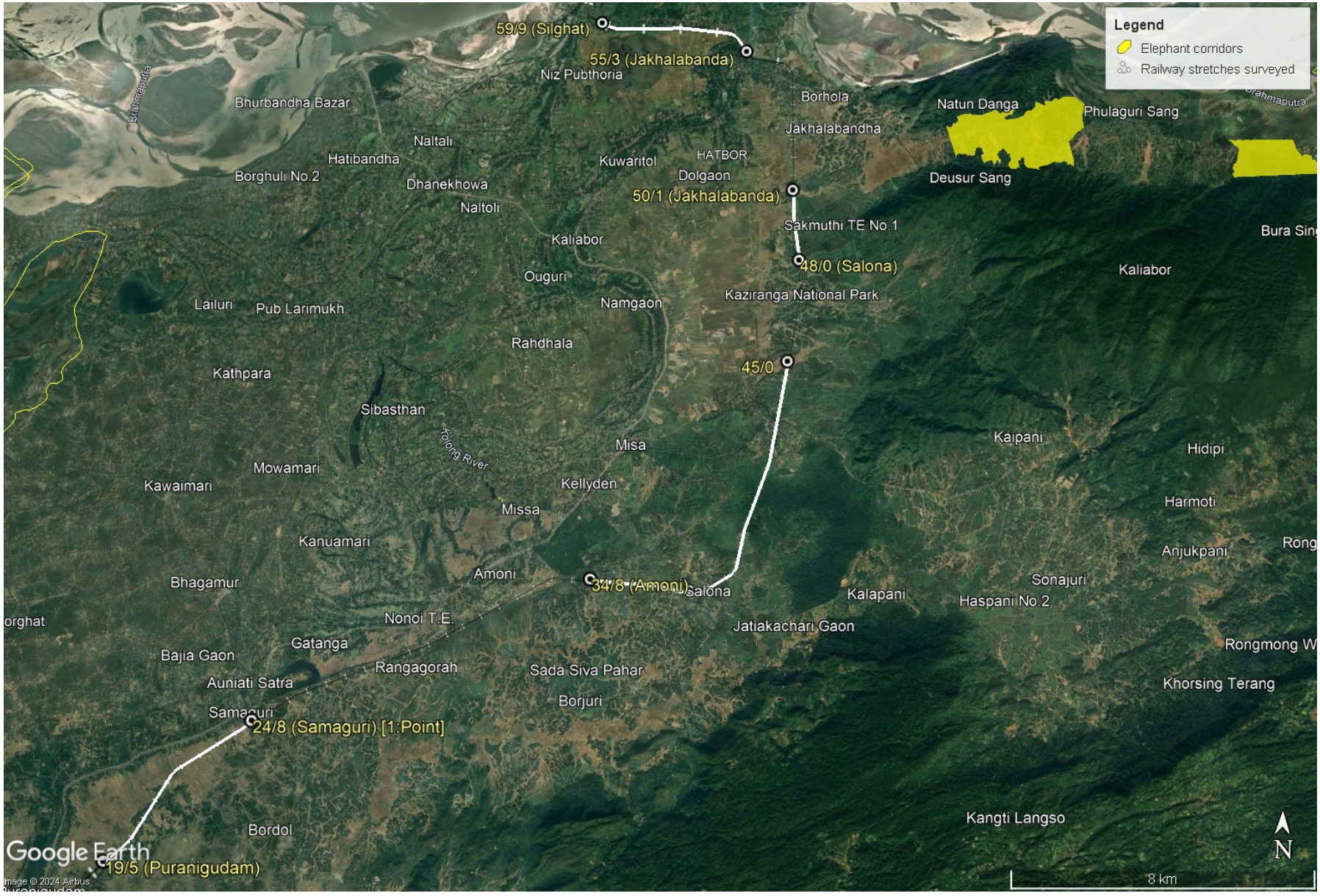


Figure 19: Four priority vulnerable railway stretches (white lines) next to Kaziranga National Park in the Nagaon Forest Division,Assam, visited during the survey.

Figure 20: Elephant crossing zones delineated based on past reports of crossing/mortality and signs observed during the survey along the Silghat (59/9) to Jakhalabanda station section.

Figure 21: Tea plantations adjacent to the Silghat (59/9) to Jakhalabanda station railway segment where elephant movement was reported to occur.

iv. Samaguri (24/8) to Puranigudam (19/5):

- The land use adjacent to the track along this segment is mostly agricultural fields interspersed with human settlements and few small private forest patches (Fig. 25).
- It was reported that a herd of 6-7 elephants are resident in this area.
- It was also reported that elephant movement across the railway track in the region is regular and uniform, with no fixed spatial movement pattern or specific crossing zones (Fig. 26).
- The track height is about 1 m throughout the stretch.

Recommendations:

- The points/structures listed in Table 7 below may be converted to a crossing structure of 30 m width and maximum possible height.

Table 7: Chainage and GPS locations of sites/existing drainage structures that should be converted to crossing structures for elephants considering height of the track and high probability of elephant movement.

S.no.	Chainage	GPS location	Stretch	Existing structure	Proposed structure
1.	49/3	26° 32.741'N 92° 59.481'E	Jakhalabanda (50/1) to Salona (48/0)	Pipe culvert	Underpass of 30 m width
2.	44/1 - 44/2	26° 29.981'N 92° 59.325'E	Ch. 45/0 to Amoni (34/8):	Nil	Underpass of 30 m width

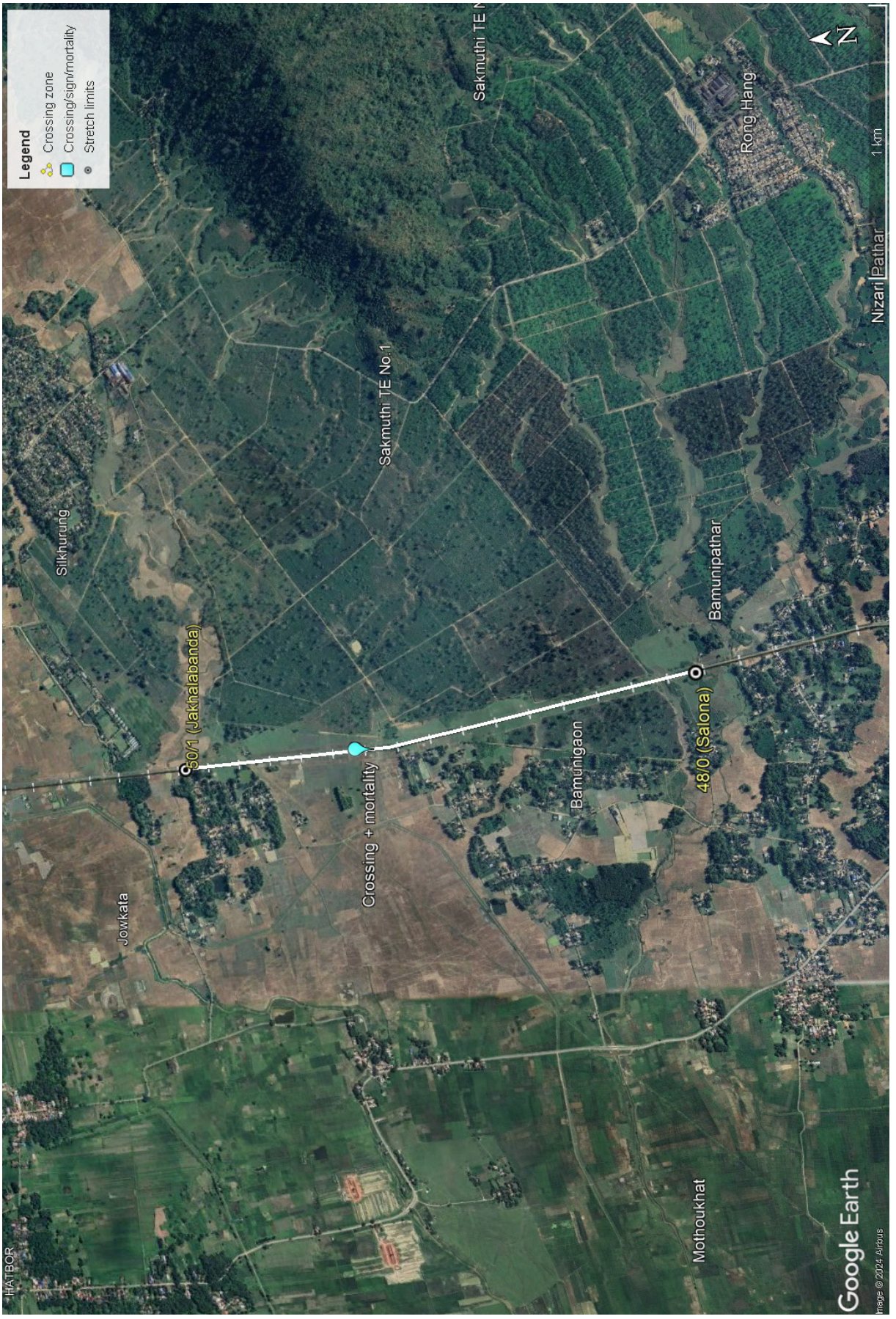


Figure 22: Elephant crossing zones delineated based on past reports of crossing/mortality and signs observed during the survey along the Jakhalabanda (50/1) to Salona (48/0) section.

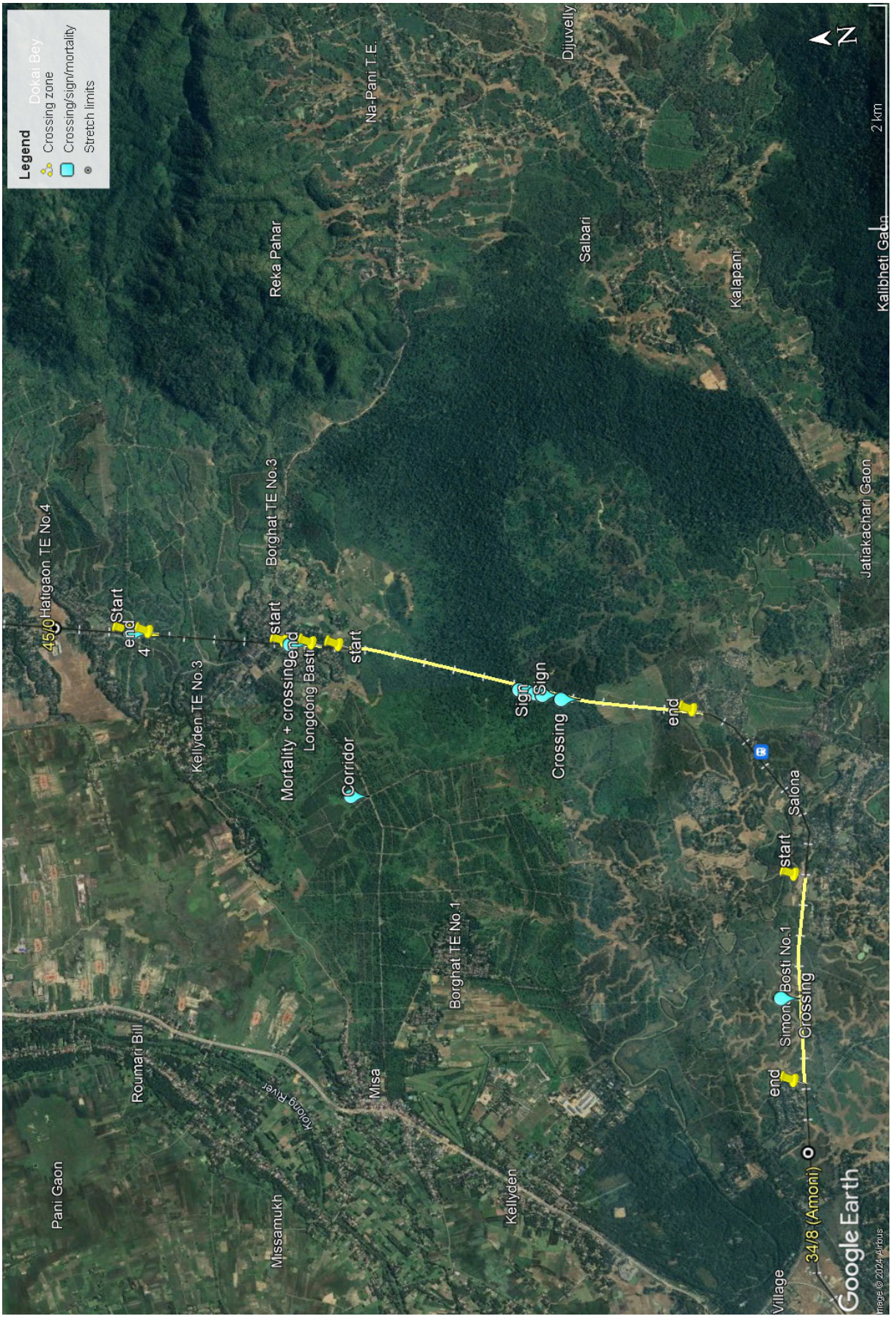


Figure 23: Elephant crossing zones delineated based on past reports of crossing/mortality and signs observed during the survey along the Ch. 45/0 to Amoni (34/8) section.

Figure 24: Tea plantations along the Ch. 45/0 to Amoni (34/8) railway section where elephant movement was reported to occur.

Figure 26: Agricultural fields adjacent to the Samaguri (24/8) to Puranigudam (19/5) railway section where regular elephant movement was reported to occur. Elephant hoof marks can be seen in the fields next to the railway line.

- Ramps with level crossings for ease of elephant movement across the railway track are to be constructed at every 1 km for the following vulnerable stretches (Table 8). The exact location of the ramps may be decided in coordination with the local Forest Department.

- The entire length of stretches Jakhalabanda to Salona (50/1 to 48/0) and Samaguri to Puranigudam (24/8 to 19/5) have been marked as sensitive.

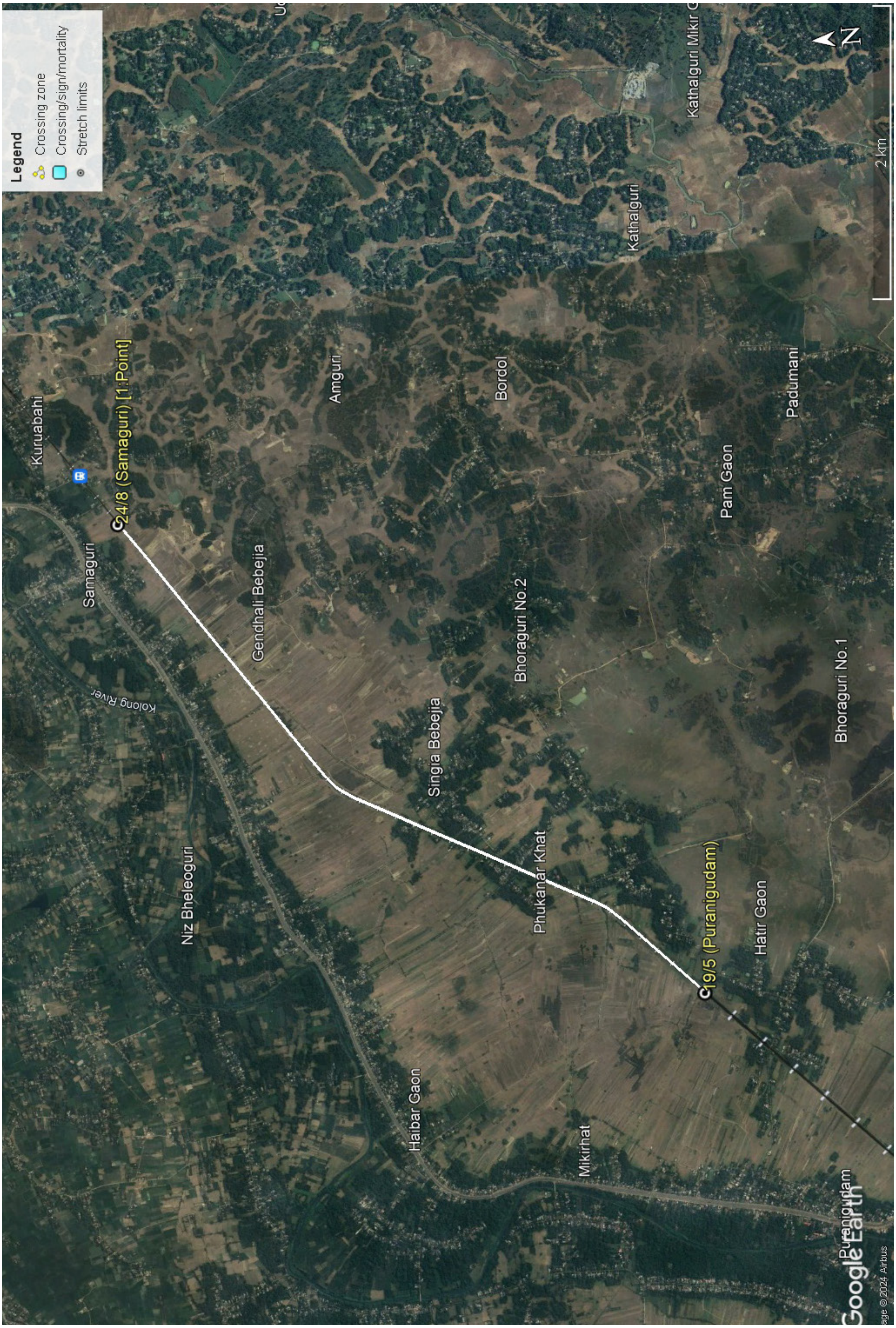


Figure 25: Elephant crossing zones delineated based on past reports of crossing/mortality and signs observed during the survey along the Samaguri (24/8) to Puranigudam (19/5) section.

Table 8: Railway stretches with high probabilities of elephant movement where level crossings and ramps for elephants are recommended.

S.no.	Start GPS	End GPS	Length (m)	Number of elephant level crossings (minimum)
		Silghat (59/9) to Jakhalabanda station		
1.	26° 35.858'N 92° 56.379'E	26° 35.835'N 92° 58.130'E	2900	3
2.	26° 35.586'N 92° 58.550'E	26° 35.452'N 92° 58.656'E	300	1
		Jakhalabanda (50/1) to Salona (48/0)		
3.	26° 33.190'N 92° 59.470'E	26° 32.053'N 92° 59.592'E	2100	3
		Ch. 45/0 to Amoni (34/8)		
4.	26° 30.038'N 92° 59.336'E	26° 29.932'N 92° 59.316'E	200	1
5.	26° 29.276'N 92° 59.189'E	26° 29.143'N 92° 59.165'E	250	1
6.	26° 29.014'N 92° 59.141'E	26° 27.344'N 92° 58.602'E	3200	7
7.	26° 26.938'N 92° 57.670'E	26° 27.038'N 92° 56.568'E	1845	2
		Samaguri (24/8) to Puranigudam (19/5)		
8.	26° 24.872'N 92° 50.808'E	26° 22.855'N 92° 48.637'E	5300	6

3.7. Lumding – Habaipur railway line passing near the Lumding Reserve Forest (part of Dhansiri-Lungding Elephant Reserve), Nagaon South Forest Division

Survey date: 24th March 2024

The Lumding Elephant Reserve is one of the five elephant reserves of Assam, and is a connecting link between the Marat-Longri Wildlife Sanctuary to the east and the Langting Mupa Reserve Forest in the west. Elephant movement between central and southern Karbi Anglong, forests of North Cachar Hills, Nagaon and west Karbi Anglong occurs through Lumding ER (Singh *et al.*, 2010). The forest is also home to other important fauna such as tiger, clouded leopard, western hoolock gibbon, gaur, barking deer and sambar. The 14.2 km Lumding-Habaipur railway line circumvents the south-western boundary of the ER (Fig. 27), and has been an elephant mortality hotspot in the past (Ahmed & Saikia, 2022).

Observations:

- The DAS-based (Distributed Acoustic Sensing) Intrusion Detection System (IDS) is currently operational along the Habaipur-Lumsakhan-Patharkhola-Lumding section, and is being actively monitored.
- Caution orders (speed reduction measures) for day and night time are implemented at identified sensitive stretches.
- According to railway personnel, no recent incidents of elephant-train collision have occurred on the segment, except for the mortality of a female elephant and calf in 2021.

Figure 27: The Lumding-Habaipur railway line passing near the Lumding Reserve Forest (part of the Dhansiri-Lungding Elephant Reserve, Nagaon South Forest Division, Assam.

- The forest department, railways and local people jointly patrol the sensitive stretches, and alert the station masters and train loco pilot.

- The railway track has forests on both sides for about 5.3 km (from Lumding to Pagla Nadi railway bridge), and the rest of the track has forest on one side and human settlement and agricultural fields on the other (Pagla Nadi railway bridge to Habaipur).

- Elephant herds crossing over to villages from the forest often become involved in conflict with humans and crop-raiding incidences.

- According to field observations and information from forest department personnel, the use of the railway track by elephants is more or less uniform across the stretch (Fig. 28). Well-defined trails indicate regular crossing zones of elephants (Fig. 29).

Recommendations:

- The railway track height is for most part not higher than 4 m. The railway line is triple-tracked till Patharkhola railway station, beyond which it is double-tracked.

- The DAS-based IDS set-up should be continued, and monitoring and effectiveness evaluation done regularly.

- The structure at ch. 184/2 (6 x 5.5 m) should be expanded by openings of 10 m on either side. Use of the crossing by humans should be discouraged. (GPS location: 25° 46.257', 93° 06.868').

- Ramps and level crossings are to be constructed at the identified crossing locations/zones, and locations of past collisions in the forested section (Table 9 below). Additional ramps may be constructed where necessary, in consultation with the forest department.

- In the non-forested section (Pagla Nadi railway bridge to Habaipur), ramps and level crossings are to be constructed in identified locations of elephant crossings (Table 10 below). Additional ramps and level crossings may be constructed, keeping in mind the potential for conflict with adjacent villages.

- To discourage the use of the ramps and level crossings for elephants by humans, especially in the railway stretches next to villages, barriers that cannot be navigated by two- and four-wheelers, but can be crossed by elephants, must be installed.

- Level crossings are to be constructed over the space between the tracks (Fig. 30).

- Smoothening, slope stabilisation and revegetation (with grassy/herbaceous vegetation) of the slopes on either side of the railway track (Fig. 31) in most segments (e.g., between ch. 174/4 – 174/1) should be done.

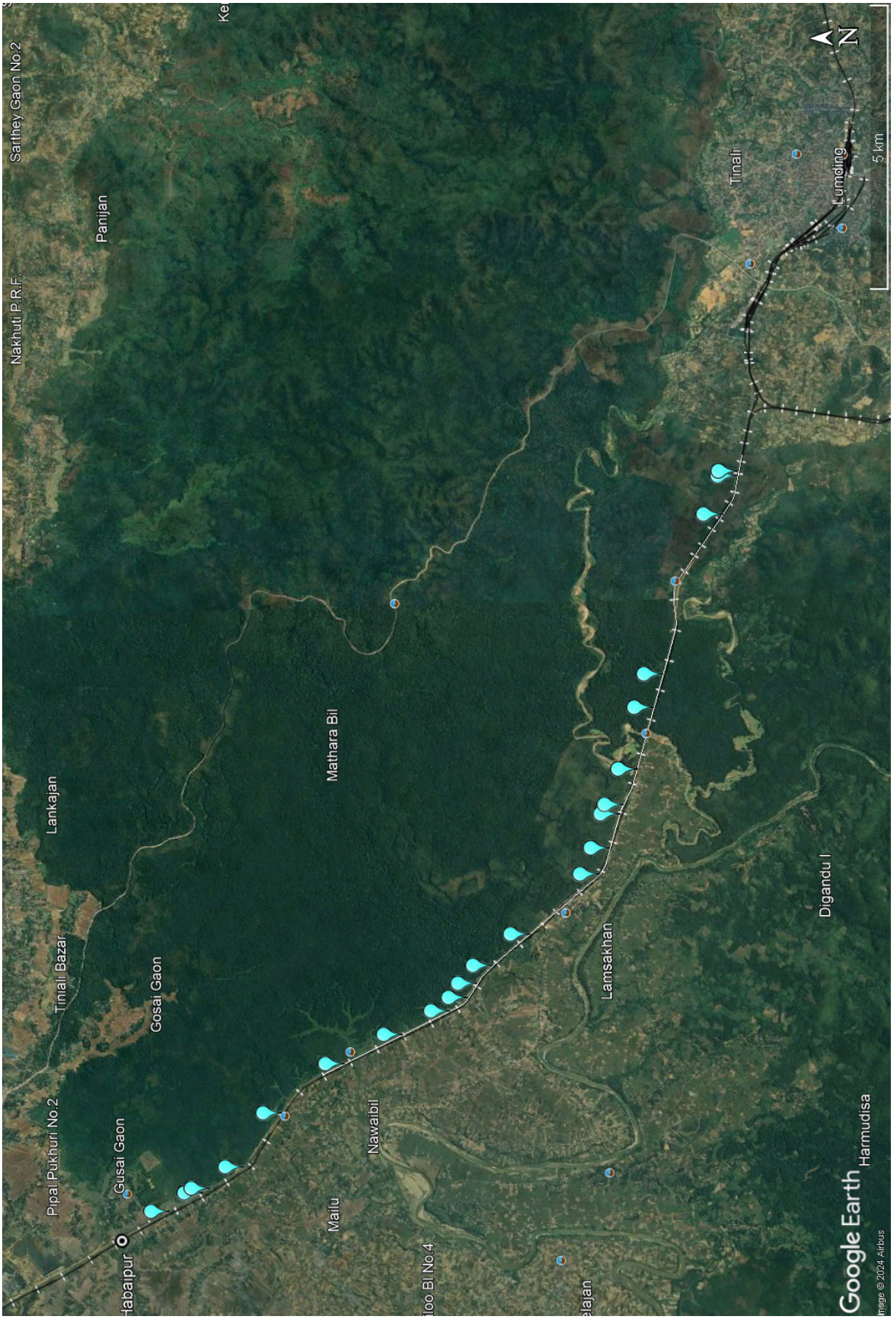


Figure 28: Elephant crossing points, crossing zones, past mortality locations, and locations of elephant signs observed during the survey along the Lumding-Habaipur railway line near Lumding Reserve Forest, Assam.

Table 9: GPS locations and chainage of crossing locations/zones and past elephant train collisions on the forested stretch (Lumding to Pagla Nadi railway bridge) of the Lumding-Habaipur railway line.

S.no.	GPS location	Approximate chainage
1.	25° 46.105'N 93° 7.319'E	185/0
2.	25° 46.114'N 93° 07.268'E	
3.	25° 46.859'N 93° 05.194'E	Between 181/0 - 181/1
4.	25° 46.959'N 93° 04.842'E	Between 180/4 - 180/5

Figure 29: A well-defined elephant trail across a crossing zone on the Lumding-Habaipur railway line.

Table 10: GPS locations and chainage of crossing locations/zones and past elephant train collisions on the non-forested stretch (Pagla Nadi railway bridge to Habaipur) of the Lumding-Habaipur railway line.

S.no.	GPS location	Approximate chainage
1.	25° 47.127'N 93° 04.189'E	Between 179/3 - 179/4
2.	25° 47.408'N 93° 03.354'E	-
3.	25° 47.517'N 93° 03.077'E	177/3
4.	25° 48.199'N 93° 02.441'E	175/7
5.	25° 48.570'N 93° 02.108'E	174/8
6.	25° 48.990'N 93° 01.620'E	173/7
7.	25° 50.672'N 93° 00.510'E	170/0
8.	25° 51.064'N 92° 59.917'E	168/8
9.	25° 51.176'N 92° 59.827'E	168/5
10.	25° 51.412'N 92° 59.679'E	168/0
11.	25° 51.484'N 92° 59.627'E	-
12.	25° 51.825'N 92° 59.420'E	167/1
One ramp at a suitable place within crossing zones		
13.	Between 25° 47.266'N, 93° 03.814'E and 25° 47.306'N, 93° 03.715'E	Between 178/5 - 178/7
14.	Between 25° 48.720'N, 93° 01.916'E and 25° 48.815'N, 93° 01.763'E	Between 174/4 - 174/1
15.	Between 25° 49.458'N, 93° 01.365'E and 25° 50.040'N, 93° 01.048'E	Between 172/8 - 171/5

Figure 30: The space between parallel tracks should also be covered with the level crossing material recommended at elephant crossing sites.

Figure 31: Slope stabilisation of embankments and slopes should be done through revegetation using herbaceous (grassy) vegetation.

NOTE:

A. The following railway stretches were surveyed, but it was reported by forest and railway representatives that no elephant movement or mortality has occurred in these stretches in the past.

- Hatikali to Dibolong (Surveyed on 25th March 2024)
- Langting to Dihaku (Surveyed on 25th March 2024)
- Jiribam to Sribar stations (Surveyed on 26th March 2024)

B. The following railway tracks were not surveyed since prior communication with the Forest Department officials revealed no requirement of a survey or mitigation measures.

- Near Ledo (Tinsukia) and Bargolai stations
- From Lekhapani towards Nagaland border
- Lalpahar Gaon to Tipong Colliery
- Assam-Mizoram border (Bairabi) to Alaicherra
- Rongpur to Chandrapur
- Dullabcherra to Duhalia
- Maishasan to Karimganj

C. Survey of the Kathaltali to Patharkandi stations (near Logai forest, Karimganj Forest Division) could not be conducted, and may be taken up at a later date, since forest department officials informed us of recent elephant movement in the nearby forests.

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.

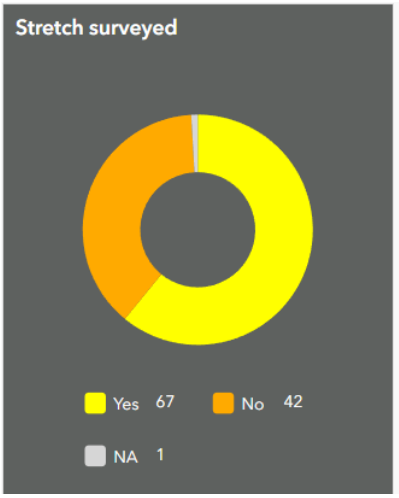
10. To discourage use of wildlife-friendly ramps and level crossings by people and vehicles, concrete barrier poles and/or other barriers should be built that are high enough to block passage of 2 and 4-wheelers, but low enough to allow elephants to pass.

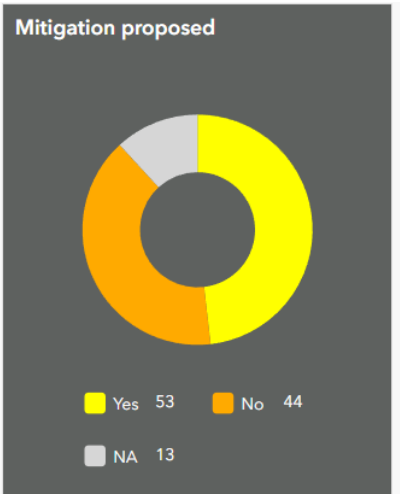
11. Incidences of elephant and wildlife injury and mortality should be documented by both parties, with complete details on GPS location, chainage, date and time of day.

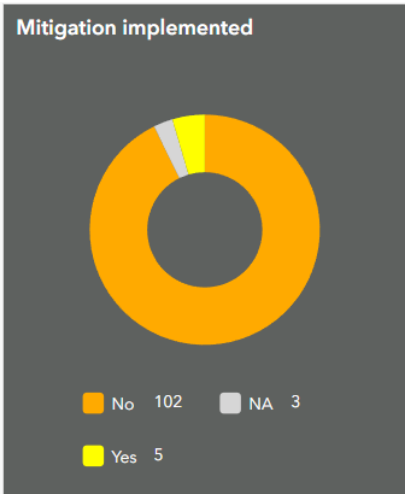
12. In the future, all metre-gauge to broad-gauge conversion projects in elephant landscapes should include comprehensive elephant mitigation plans.

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/1tFYaY4n5kYA9OhcBqeO5eqHMzqTTJWlt/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 & Indian Railways officials consulted during the survey

S.No.	Name and Designation	Contact details
State Forest Departments		
1.	Sri Sandeep Kumar *Principal Chief Conservator of Forests, Wildlife & Chief Wildlife Warden, Assam*	97175 09600
2.	Smt. Jayashree Naiding *Divisional Forest Officer, Guwahati (Wildlife)*	79830 70574
3.	Sri T.C. Ranjith Ram, *IFS Divisional Forest Officer, Digboi Division*	91010 93019
4.	Sri Ashok Chaudhury *DFO Lakhimpur Forest Division, Assam*	94351 03061
5.	Sri Piraisoodan *DFO, Western Assam (Wildlife)*	99940 12534
6.	Sri Suhas Kadam *DFO, Nagaon (Territorial)*	69001 34855
7.	Sri Vijay Palve *DFO, Cachar Forest Division*	80970 22065
8.	Sri Champak Deka *ACF, Hojai/DFO (IC) Nagaon South Division*	86382 72749
9.	Sri Mazumdar *RFO, Jakhalabanda*	70020 31470
10.	Sri Gobin Gogoi *RFO, Lekhapani Range, Digboi*	81358 89211
11.	Sri Raju Saikia *RFO, Amaribari Range*	60039 14315
12.	Sri Mukut Rabha *RFO, Jonai Range, Assam*	97070 26027
13.	Sri A Motin *RFO, Dulung Forest Reserve*	99548 05806
14.	Sri Burgohain *RFO, Lumding*	70020 44516
15.	Sri Depolala Langthasa *RFO, Hathikali Range*	87539 33177
16.	Range Officer, Lanka Range, Lumding	96780 04115
17.	Sri Hirai Kamneume *Deputy Ranger, Hatikhali*	99573 08284
18.	Sri Biraj Barman *RO, Chariduar*	98647 00307
19.	Sri Rowel Rongphar *RO, Lakhipur, Cachar*	70867 45496
20.	Sri. Prasanto Boruah *Junior Assistant, Digboi DFO Office*	70020 83303
21.	Sri Kulendra Bhuyan *Beat Officer, Jakhalabanda*	91016 40616
22.	Sri Md. Nurul Ishlam *CL, Jakhalabanda*	
23.	Sri Naba Samua *Forest Guard, Jakhalabanda*	
24.	Sri Manmohan Das *Forest Guard, Pathalipam Beat Dulung Forest Reserve, Assam*	
25.	Sri Prasant Baruah *Forest staff Dulung Forest Reserve Assam*	
26.	Sri Deejyoti Baishya *Forester I, Jirighat Range*	91017 55603
27.	Sri Zia Ur Rahman *Forest Guard, Chariduar Range*	70130 26125
28.	Sri Dibakar Basumatary *Forest Staff, Amaribari Range*	88222 35664
29.	Sri Biren Rabha *Forest Guard, Amaribari Range*	98644 61821
30.	Smt Rita Das *Forest Guard, Amaribari Range*	70994 60166
31.	Sri Jagdish Sarania *Forest Guard, Lumding*	93657 31202
32.	Sri Bipin Saikia *Forest Guard, Lanka Range*	

S.No.	Name and Designation	Contact details
Indian Railways (NFR)		
33.	Sri A. K. Kushwaha *Northeast Frontier Railway*	90020 52204
34.	Sri Vivek Bajaj *DEN 1, Tinsukia Division*	99575 55202
35.	Sri Lakshman Singh *DEN 1, Lumding Division*	99575 53201
36.	DEN 3, Lumding Division	99575 53206
37.	Sri Arvind Kumar *DEN 3, Rangia Division*	99757 54203
38.	Sri Abhishek Choudhary *XEN, Pasighat*	99575 56458
39.	Sri Dibyajyoti Dutta *ADEN 3, Lumding Division*	99575 53213
40.	Sri Gautam Saikia *SSE/P.Way/I.C/MRG*	99575 55217
41.	Sri Biman Doley *SSE, Works, Pasighat SPTR*	99575 56459
42.	Sri Deep Das *SSE/P.WAY/NLP/east*	99575 54284
43.	Sri Ratan Majumder *SSE/P.Way/H/LMG (Sc)*	99575 51036
44.	Sri Jayanta Rajbongshi *SSE/PWay/INE/BBU-BJL*	
45.	Sri Dizen Medhi *SSE/PWay/RPAN*	96137 17029
46.	Sri Lima Sungba *AO, SSE/P.Way/DMV*	84718 03593
47.	Sri Dharvesh Pal Singh *Jr. Engr./PWay Naharlagun*	78958 55801
48.	Sri Himanshu Bisht *JE/P.Way/JRBM*	89389 67260
49.	Sri Mintu Choudhury *Trolley Man Balipara-Bhalukpong*	88768 14722
50.	Sri Bijay Boro *TRM I/BBU*	91014 12871
WWF-India		
51.	Ms. Tejaswini Nagesh *(Previously with WWF, India)*	tejnagesh@gmail.com

07. References

Ahmed, R., & Saikia, A. (2022). Pandora's Box: A spatiotemporal assessment of elephant-train casualties in Assam, India. PLoS ONE, 17(7), e0271416. https://doi.org/10.1371/journal.pone.0271416

Kushwaha, S. P. S., & Hazarika, R. (2004). Assessment of habitat loss in Kameng and Sonitpur Elephant Reserves. Current Science, 87(10), 1447–1453.

Mahato, R., Nimasow, G., Nimasow, O. D., & Bushi, D. (2021). Assessing the tropical forest cover change in northern parts of Sonitpur and Udalguri District of Assam, India. Scientific Reports, 11(1), 11170. https://doi.org/10.1038/s41598-021-90595-8

Project Elephant, MoEF&CC, Government of India (2023), Elephant Corridors of India 2023 (Edition – 1/2023).

Singh, A. P., Singh, A. K., Mishra, D. K., Bora, D. P. J., & Sharma, A. (2010). Ensuring safe access to wildlife in Lumding Reserve Forest, India, Mitigating the impacts of up-gradation of Doboka-Silchar National Highway (NH54E). WWF-India.

Wilson, S., Davies, T. E., Hazarika, N., & Zimmermann, A. (2015). Understanding spatial and temporal patterns of human–elephant conflict in Assam, India. Oryx, 49(1), 140–149. https://doi.org/10.1017/S0030605313000513

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.

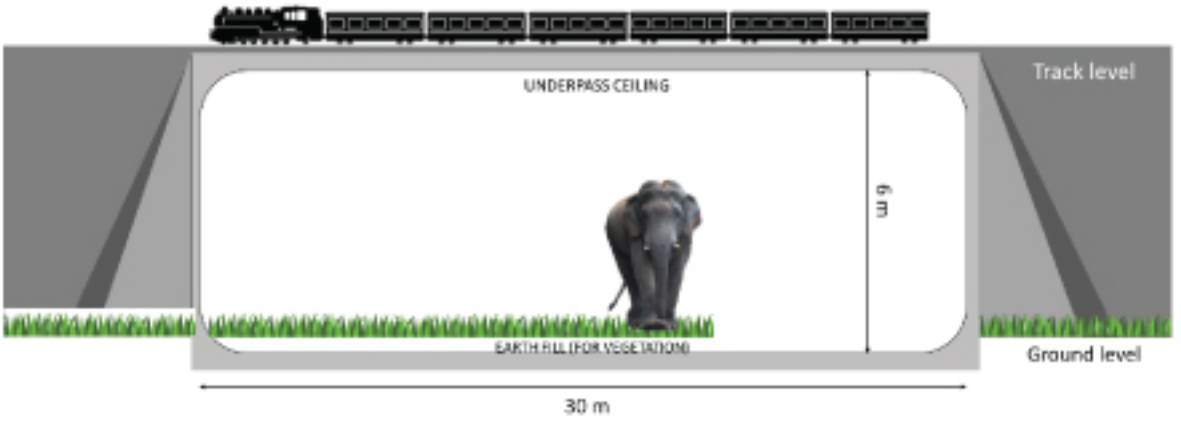


Figure 3. Graphic representation of an underpass for elephants below a railway track.

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).

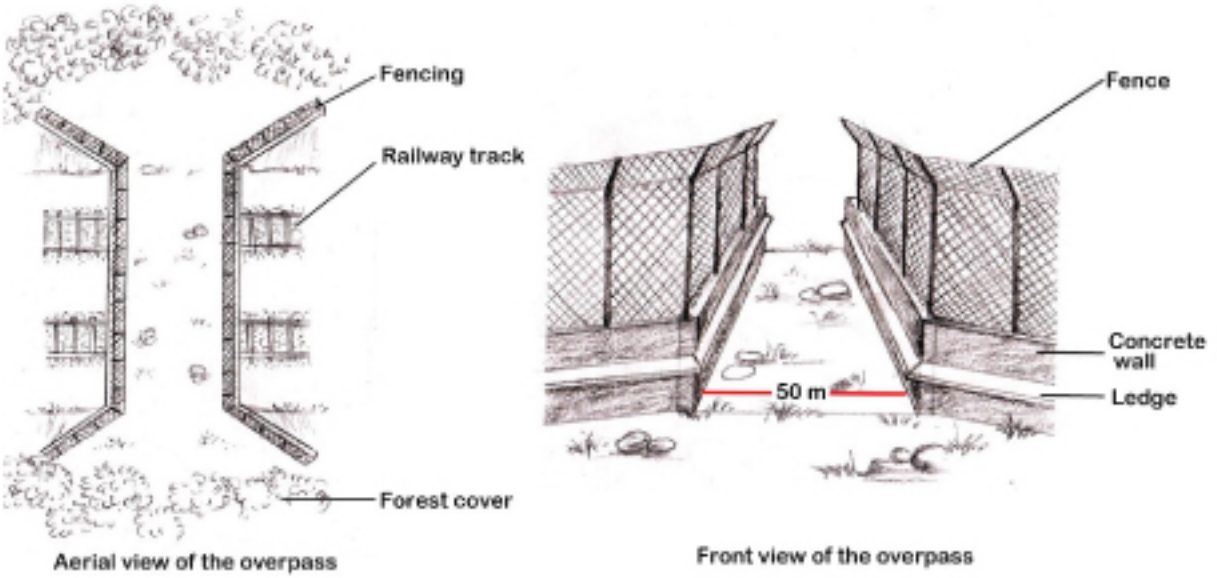


Figure 4. Aerial and front view of overpasses on railway tracks, with fencing/noise and sound barrier details.

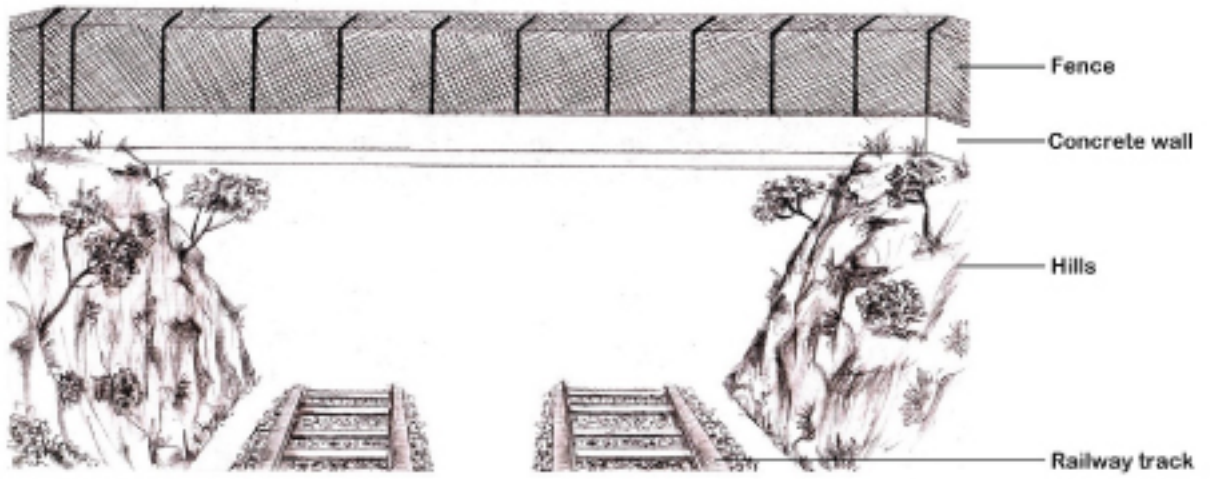


Figure 5. Lateral view of a wildlife overpass on a double-track railway line.

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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