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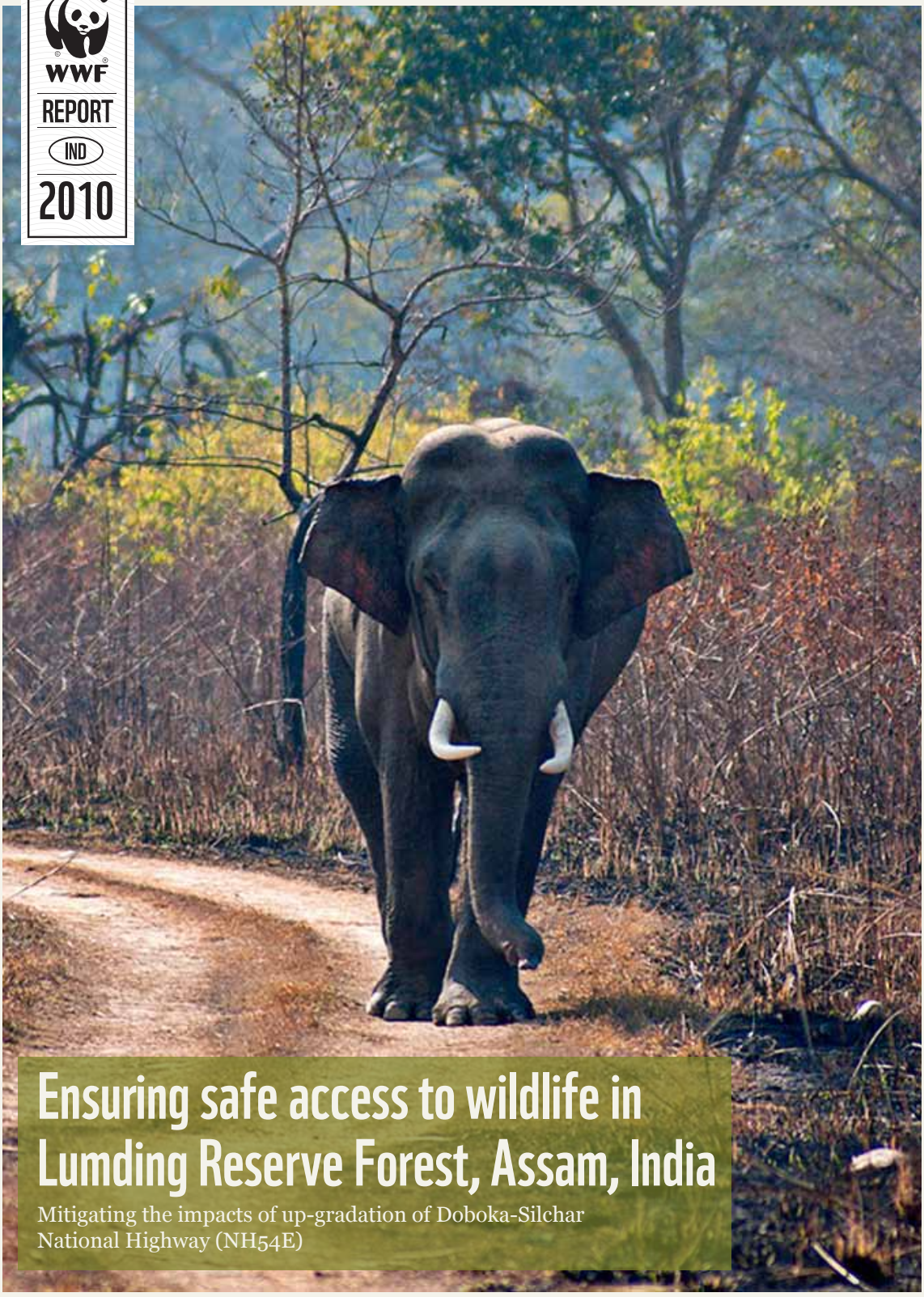

# Ensuring safe access to wildlife in Lumding Reserve Forest, Assam, India

Mitigating the impacts of up-gradation of Doboka-Silchar National Highway (NH54E)

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## Mitigating the impacts of up-gradation of Doboka-Silchar National Highway (NH54E)


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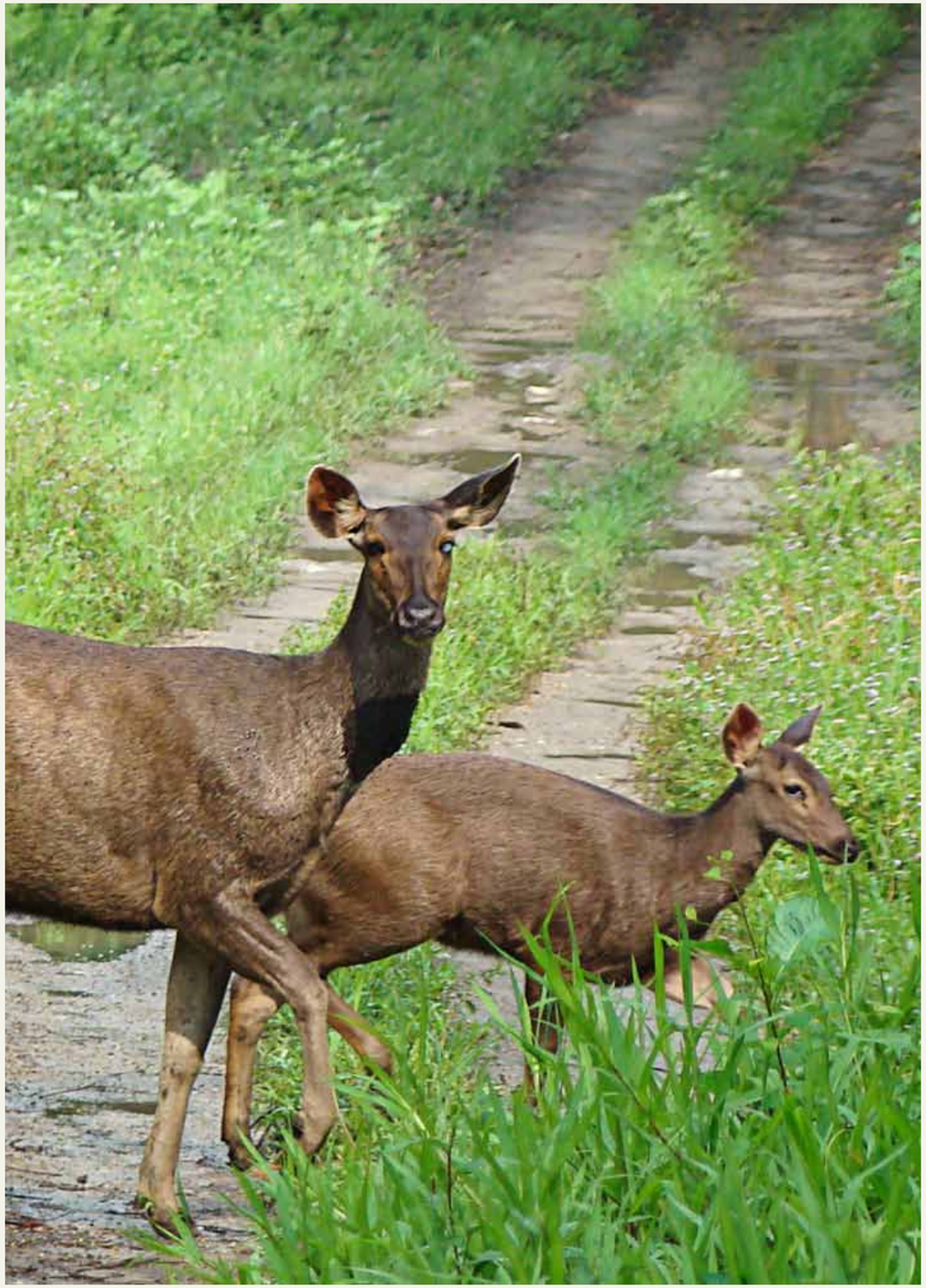

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**Sambar** in the Kaziranga Karbi Anglong Landscape

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# SUMMARY

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The Doboka-Silchar National Highway (NH-54E) in the northeastern Indian state of Assam is proposed to be upgraded into a four-lane highway. This highway bisects the Lumding Reserve Forest. The course of proposed expanded highway is planned almost in the same alignment of the existing road with smoother and flatter horizontal and vertical curves. Though the existing road currently does not affect the crossing of elephants and other mammals, an upgraded four-lane highway with increased traffic and speeding vehicles is bound to be unsafe for wild animals as well as people travelling in the vehicles. Therefore, construction of safe passages for wild animals like elephant and gaur is mandatory. Given this need a team supported by WWF-India surveyed the area and came up with suggestions for mitigation measures.

This report details the mitigation measures proposed to facilitate wildlife movement. These include appropriate underpasses for wildlife at identified areas, culverts and provision of artificial lianas for arboreal mammals.

# A. INTRODUCTION

In the northeastern Indian state of Assam the existing one-lane Doboka-Silchar National Highway (NH-54E) is proposed to be upgraded into four-lane highway. This highway currently bisects the Lumding Reserve Forest (RF) between chainage km32.787 to km57.40. The proposed expanded highway is planned almost in the same alignment of the existing road with smoother and flatter horizontal and vertical curves. Lumding RF with an area of 22,403 hectare is an important wildlife habitat in Assam's Nagaon district. It stretches through Lanka and Lumding ranges of Nagaon South Forest Division and was notified as part of Dhansiri-Lumding Elephant Reserve in 2003. The Lumding RF is also connected to the Marat-Longri Wildlife Sanctuary (WLS) in Karbi Anglong district in the east and to Langting Mupa RF in the west in the North Cachar Hills district of Assam (Figure 1).

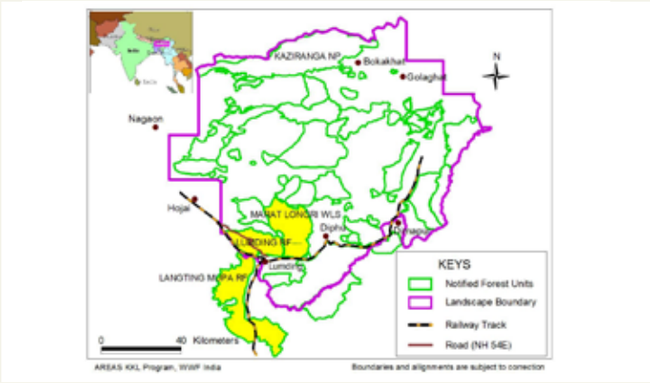



**Figure 1:** Map of Kaziranga Karbi Anglong Landscape showing the study area

This continuous stretch of forest acts as a migration route to many wildlife especially Asian elephants (*Elephas maximus*). Elephant herds of the central and southern part of Karbi Anglong move west towards the forests of North Cachar Hills, Nagaon and western part of Karbi Anglong and in the reverse direction through this forest. Field biologists of WWF-India have recorded 37 species of mammals in Lumding RF which include the Bengal tiger (*Panthera tigris)*, Asian elephant, clouded leopard (*Neofelis nebulosa*), and western hoolock gibbon (*Hylobates hoolock*).

Currently, the bisection of the entire reach of the Lumding RF – an important elephant habitat, by the present road has not severely affected the migration/ movement of elephants. The elephants can, and in fact are, crossing the existing road at many locations along the entire stretch of 24.6km without any noticable problems. Currently the road traffic is almost nil during night hours and very low during the day time with hours restrictions due to security issues. Therefore, no significant obstruction to elephants' movement is occuring in the present scenario. However, once the road is upgraded and traffic intensity and speed increases the access to elephants across the highway is bound to become difficult and unsafe. There are chances of elephants getting hit by speeding vehicles, and resulting injury or death to elephants as well as the people travelling in those vehicles. Hence establishment of appropriate safe passages are required for the elephants to cross the proposed expanded highway successfully.

Apart from elephants, other wild animals that cross this road from time to time are gaur (*Bos gaurus*), barking deer (*Muntiacus muntjak*) and sambar (*Rusa unicolor*). This is possible only due the low intensity of the vehicular traffic on the road as described above. These animals also require appropriate safe passages to cross the proposed expanded highway.

The topography of the terrain within the Lumding RF is semi-hilly and densely vegetated. The road passes along the ridge and partly on the flat hill slopes. At all crossings of the natural streams, cross drainage structures like pipe culverts, slab culverts, box culverts and pier & abutment type bridges are proposed as part of the road expansion.

A team made up of WWF-India staff along with officials from the Forest Department, Government of Assam and officials of NHAI made a joint visit to the above mentioned stretch of this highway to assess the situation and come up with recommendations.

# B. COMMENTS ON THE PROPOSED MIGRATION ACROSS THE PROPOSED HIGHWAY

**(1) There is no dedicated passage** proposed for the elephants across the proposed expanded highway in the entire stretch between km32.787 to km57.46 within the Lumding RF. At two locations viz. at km44.975 and km51.645, the head-room below the slab and the span of the openings of the bridges on rivers is proposed to be increased so that the elephants can cross below the road bridge. The details of the proposed bridges are as follows:

**a)Bridge at km44.975**

In this bridge six spans, with end spans of 30m each and four middle spans of 40m each (30+4x40+30) are proposed with a head-room of 13m. The terrain along the river course and in the sides of the river near the bridge is also very good from the elephants' movement point of view. The cross drainage structure, 220m long with six 40mX13m openings should be appropriate for an elephants' herd to cross through it. It should however be ensured that the proposed height of the bridge remains available in at least 80% width of the passage.

**b)Bridge at km51.645**

In this bridge four spans, end spans of 30m each and two middle spans of 40m each (30+2x40+30) are proposed with a head-room of 10m. Here also the terrain along the river course and in the sides of the river near the road bridge is also very good from the elephants' movement point of view. This cross drainage structure, 140m long, with four 40mX10m openings shall be appropriate for the elephants' herd to cross through it. Again it should be ensured that the proposed height of the bridge remains available in at least 80% width of the passage.

**(2) At other locations of the highway,** openings ranging from 6m to 25m are proposed in different cross drainage structures. These bridges can be modified to be used as elephant passage, to create a more connected habitat, which is already on the verge of fragmentation due to the proposed four lane highway. Table 1 shows the spacing of the proposed structures and their opening size vis-a-vis proposed modifications with reference to elephant passage -

**Table-1:** Details of the passages for the elephants

| Sr. No. | AS PER N.H.A.I. | | | | Proposed minimum size of Passage (Nos X Width X Height) | Ideal size of the passage (Nos X Width X Height | Remark |
|---|---|---|---|---|---|---|---|
| | Location of the cross drainage structure (Km) | Spacing between the passage (Km ) | Height (m) | Opening Size (m) | | | |
| 1 | 32.787 | NA | NA | NA | NA | NA | Start of the RF |
| 2 | 35.800 | 3.013 (first passage) | 4.5 | 2x6 | 1x25X6 | 2x25X6 | Two openings side by side will have more visibility of other side of forest which is likely to facilitate wildlife movement . |
| 3 | 40.4 | 4.6 | A new passage in the form of an overpass for the elephants in the natural existing ground should be provided by encasing the road as a cut and cover section (Tunnel ) in a reach of 300 m. Please refer Sketch No-1 | | | | Evidences of elephant crossing on the road between km 35.8 to 44.379.So one passage is suggested at this location |
| 4 | 44.379 | 3.979 | Not Known | 1x6 | 1x25x6 | 2x25X6 | Two openings side by side will have more visibility of other side of forest |
| 5 | 44.975 | 0.596 | 13.0 | 30+4x40+30= 220 m | Already provided passage size is O.K. | Already provided passage size is O.K. | NA |
| 6 | 49.600 | 4.624 | 6.0 | 1x25 | 1x25X6 | 2x25X6 | Two openings side by side will have more visibility of other side of forest |
| 7 | 50.900 | 1.30 | 6.0 | 1x25 | 1x25X6 | 2x25X6 | --do-- |
| 8 | 51.645 | 0.745 | 10.0 | 30+2x40+30 =140 m | Already provided passage size is O.K. | Already provided passage size is O.K. | NA |
| 9 | 53.725 | 2.08 | 6.0 | 1x25 | 1x25X6 | 2x25X6 | Two Nos opening side by side will have more visibility of other side of forest |
| 10 | 55.125 | 1.40 | 6.0 | 1x25 | 1x25X6 | 2x25X6 | --do-- |
| 11 | 57.400 | 2.275 (End to last passage) | NA | NA | NA | NA | End of RF |
| | | 24.613 | | | | | |

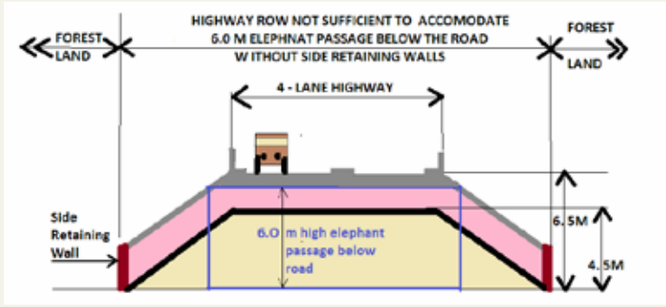
**(3) Provision of only two passages in a stretch of 24.613km of elephant habitat is not at all sufficient,** as presently elephants cross through almost the entire stretch of this road. More elephant passages at suitable locations are required. At km49.6, 50.9, 53.725, and 55.125, bridges with single barrels of 25m width x 6m height and at km35.8, bridge with twin barrels of 6m width x 4.5m height are proposed at cross drainage locations which are likely to facilitate wildlife movement. At km44.379, in spite of clear evidences of the elephants crossing the road near existing torrent, NHAI has proposed a narrow culvert of only 6m width. It is advised to have an appropriate elephant passage at this location too.

**(4) The main features for the acceptability of the passage beneath the road (underpass) by the elephants is the openness of the structure.** The main repelling factors for the passage are – (a) the barrier effect due to the road, (b) tunnel syndrome due to the underpass and (c) the disturbance level by the vision and the sound of frequenting traffic.

The openness of the passage and the vision of the other side play an important role in making the structure acceptable to the elephants. The depth of the structure (road width) is around 22m at the bridge location. Two barrels of 25m width and minimum 6m height are proposed at all the locations which would be of ideal size for safe passage of elephant herds. Two 25m wide, 22m long and 6m high passages shall provide sufficient opening for elephants' movement. In a recent judgment in IA No 2147-2148 in WP(C) no 202/ 1995 on the issue of wild elephants' migration along Chilla-Motichur corridor across the proposed four-lane highway (National Highway-54 connecting Delhi to Dehradun) within the Rajaji National Park in the state of Uttrakhand, the Hon'ble Supreme Court has directed that the height of the passage be kept at least 6m.

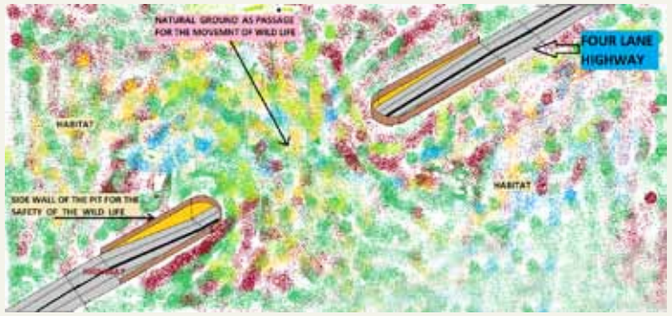
**(5)It was informed by the National Highways Authority of India (NHAI) officers that the land width at km35.8 is not sufficient** to raise the height of passage from 4.5m to 6m, as the side slopes of the embankment will encroach upon the forest land. It is advised that this location should be retained at its present state for the safe passage of elephants, as the surrounding landscape strongly advocates for elephants' passage at this location. Presently they are crossing through the road. To overcome the land constraint, a retaining wall of suitable height can be constructed at the land boundary to allow raising of the adjoining embankment for 6m high passage (Figure 2).

**Figure 2:** Schematic diagram showing arrangement to accomodate 6m high elephant passage in areas with limited land availability




**(6)In a 24.613km long stretch of forest,** passages with less than 5km spacing are desirable for maintaining the connectivity of the habitat. Therefore, one more suitable passage is required between km35.8 to km44.379 (8.579km) which is likely to help maintain better connectivity. The best passage for animal movement, particularly the elephants, is the natural terrain. In this section the road near km40.4 can be accommodated in a tunnel section (cut and cover) in suitable length, leaving the elephants' movement unaffected through the adjoining natural ground. The location of the passage is selected in such a way that the water collected in the underground portion of the passage is drained to lower areas through pipes laid laterally, as the terrain is hilly. The details are shown in Figure 3 .

**Figure 3:** Isometric view of the natural passage over the underground road in the forest



It is suggested that some additions be made to accommodate ecological features in the proposed passages for the elephants such as:

**(a)Side Railings of the road bridge**
In the road bridge over the elephants' passage, a 2.5m high opaque sidewall railing shall be provided at the side-edges of the bridge and along the approaches, with an objective of not disturbing aesthetically, the crossing elephants in the daytime and restricting the glare of highway traffic's headlights during the night. This opaque barrier with some sound dampening devices will also restrict the noise generated by the passing vehicles.

**(b)Landscaping**
Landscaping of the area will help reduce the impact of the new structure in the habitat. In the state of Colorado in USA a road bridge is constructed over a torrent. The landscaping below the bridge is done in such a way that it does not have any negative impact for the inhabiting wildlife in their natural movement. The image of the bridge is shown in Figure 4.

**Figure 4:** View of an eco-friendly passage below a road bridge in Colorado, USA

**(c) Construction period of the structure**
The construction period of the passage in the area should be so selected that the elephants are away on seasonal migration. This will reduce any disturbance to elephants due to construction activities, and also reduce chances of resulting human-elephant conflict with the construction workers.

**(d) Construction Techniques**
Precast construction techniques will reduce the construction time of the structures drastically hence will not compel the elephants to leave the area due to construction activities related disturbance. With precast construction techniques, the proposed bridges can be constructed within six months.

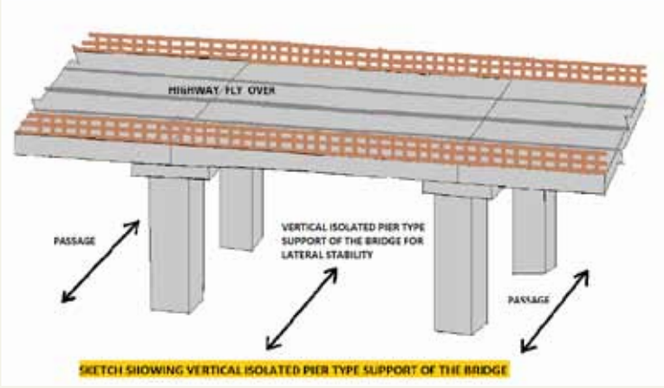
**(e)Attractions for the elephants**
To attract the elephants towards the structure for them to start using it, some sort of attractions can be provided like -

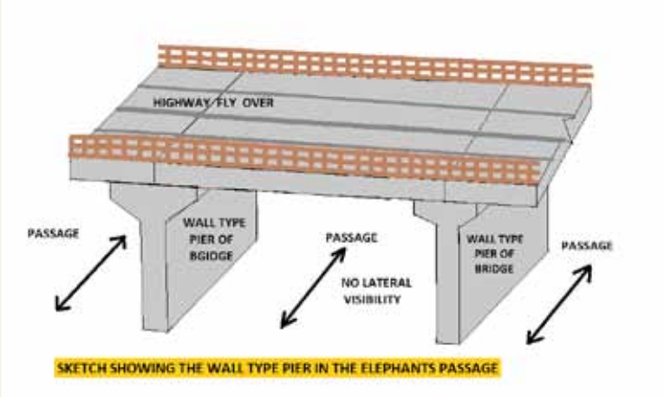
(i) Creating some water ponds near the passage
(ii) Planting some favourable fodder trees on the approach of the passage
(iii) Periodically allowing domestic or Kunki elephants' movement along the passage. Their fresh dung piles and urine will attract the wild elephants to come around the passage because the presence of fresh dung piles and urine is likely to create a familiar feeling among the wild elephants.

**(f)Lateral visibility under the passage**

It is indicated by the NHAI officials that the underpass bridges will be supported on the RCC wall type piers. The wall type piers will create problem of lateral visibility of the crossing elephant herd. It is suggested that isolated end piers with cross beam at the top should be provided instead of wall type piers (Figure 5). This will provide better lateral visibility and movement to the crossing herd below the bridge. It is also informed by the NHAI officials that in place of the median between the left and right halves of the deck slab, about 1m wide opening shall be provided along the full length of the bridge. This should be avoided to minimize the noise disturbance level for the elephants using the passage, as the opening will give way to disturbing sound propagation.

**Figure 5** – Diagram of isolated and wall type piers in underpass




An elephant underpass has been constructed across the highway adjoining the Manas National Park in Assam, a photo of which is shown in Figure 6. The central pier in this underpass can be modified as depicted in Figure 7 to facilitate lateral visibility for the benefit of passing elephant herds.

**Figure 6** – Elephant underpass with solid wall type pier

**Figure 7** – Elephant underpass in which portal type piers replace wall type thereby providing lateral visibility

**(g)Speed limit**
The restriction of the speed of vehicles using the highway above the underpass should be limited to maximum 40km/ hour so that the sound effect is minimum.

**(h)Low beam movement of vehicles in the night**
As the highway is divided into two lanes, the vehicles using the highway above the underpass should be forced to move with low beam during the night, which will reduce the glare effect of the vehicles headlight on the crossing elephants.

**(i)Ban on blowing of horns**
A complete ban on blowing of vehicles' horns along the highway above the underpass should be enforced.

**(j)Ban on the movement of humans in the passage**
There should be a complete ban on human presence in the path of the elephants. It has been observed that human disturbance in or along the passage discourages wild animals to use the passage during day time. It is advised that this action be imposed through appropriate legislation.

**(k)Road signage near the passage**
There should be sufficient road signage written in Assamese, Hindi and English on both directions of the road with reference to the presence of the elephants nearby. These signages should contain clearly marked wordings like "You are approaching the elephant passage" and "No horns, elephants are crossing".

**(l) Opening between the deck slabs of the bridge**
It is also informed by the NHAI officials that in place of the median between the left and right halves of the deck slab, about 1.0m wide sky light opening shall be provided along the full length of the bridge. This should be avoided to minimize the noise disturbance level for the elephants using the passage, as this opening will give way to disturbing sound propagation.

**(m) Camouflaging the walls of the structures with wall creepers**
The faces of the walls and the slabs of the structure can be suitably camouflaged by wall creepers. These creepers climb on the wall surface and give an appearance similar to the surrounding forest.

Animal kills due to vehicle hits

As the rainfall in the area is high, these creepers can survive on their own.

On the power canal of the *Chilla*-Hydro Electric Project in the *Rajaji* National Park in the state of Uttrakhand, several structures like small bridges, barrels below the canal and super passages are made over the canal. The herds preferred using the narrow road bridge (Figure 8) over long barrels of *Duggada* drainage crossing (Figure 9).


**Figure 8** – Elephant herd crossing the *Chilla* Hydro power canal in *Rajaji* National Park, Uttrakhand, through a road bridge near the *Soni Sot* torrent


**Figure 9** – Barrels of *Duggada* drainage crossing on the *Chilla* Hydro Power Canal in *Rajaji* National Park, Uttarakhand

# ENSURING SAFE ACCESS

Elephant herds are using almost the entire stretch of the road as a part of their habitat. Currently, the road traffic is very low therefore, there is no significant obstruction to elephants' movement. However, once the road is upgraded and traffic intensity and speed increases, the access to elephants across the highway is bound to become difficult and unsafe. Hence establishment of appropriate safe passages are mandatory for the elephants and other wildlife to cross the proposed expanded highway successfully.

# C. COMMENTS ON THE PROPOSED PASSAGES FOR WILD ANIMALS OTHER THAN ELEPHANTS

**(1)Apart from elephants there are other wild animals using Lumding RF.** Currently they are crossing the existing road at random locations, between the gaps in the moving traffic on the road. The underpass below the road is the only alternative for the wildlife to cross the proposed expanded highway. The passages of 2.5m width and 2m height are large enough for other wild animals of the area. Generally, prey species do not use such passages as they apprehend getting trapped whereas wild predators use such passages more confidently.

**(2)In the entire patch of the forest the NHAI has provided pipe culverts, box culverts, slab culverts and big bridges on the natural drainages across the highway.** They have provided different sized openings in the structures. The proposed small slab/ box culverts with minimum opening size of 2.5m width and 2m height can well be used as the crossing passages by wild animals other than elephants (Figure 10). In the passage where there is continuous running of water, some side space should be made for the reptiles and amphibians (Figure 11).

**Figure 10 -** Isometric view of the proposed underpass below the highway

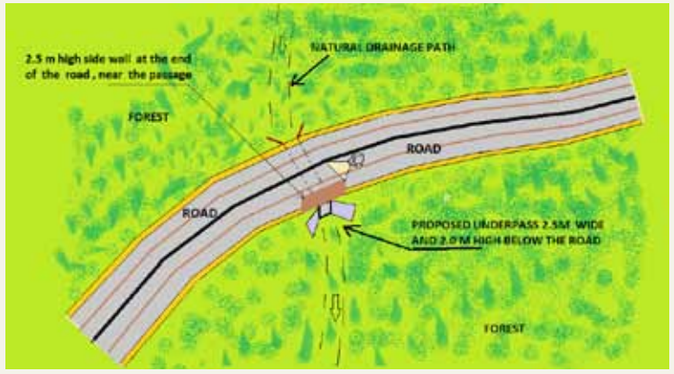



**Figure 11 -** View of the underpass with side space from a different location

**(3)The spacing of the proposed culverts by NHAI** ranges from 200m to 800m. The minimum spacing for the passage should be around 500m. With this, the crossing animals will sense and remember the location and within short time they will start using them regularly.

**(4) For this a detailed** analysis has been shown in the following chart so that the passages of size 2.5m x 2m are made available to small animals within a range of 500m for crossing the highway.

**(5) In a reach of 24.6km**, 51 cross drainage structures are being provided by the NHAI for meeting the drainage requirements. For maintaining proper connectivity of the habitat by providing 2.5m wide and 2m deep underground passage at approximately every 500m across the highway, 36 proposed cross drainage structures should be modified to the required dimensions. In addition seven new structures are being suggested.

**Table-2**, Details of the passages for the small wild life of the area

| Sr. No. | Details of the structure as proposed by N.H.A.I. | | | | Spacing | Proposed chainage of the passage @ approx 0.5 Km c/c | Modified spacing of the passage | Ideal Size of the passage for small wild life (Width X Height) | Remark |
|---|---|---|---|---|---|---|---|---|---|
| | Location of the cross drainage structure (Km) | Type of Structure | Opening Size (m) | Height (m) | | | | | |
| 1 | 32.787 | NA | NA | NA | NA | 32.787 | NA | NA | Start of the RF |
| 2 | New Location | NA | NA | NA | NA | 33.48 | 0.693 | 2.5x2 | New passage for small animals |
| 3 | 34.185 | Not Known | 1x1.8 | 2.0 | 1.398 | 34.185 | 0.705 | 2.5x2 | Modified new passages for small animals |
| 4 | 34.485 | N.K | 1x1.5 | 2.0 | 0.3 | NA | NA | NA | NA |
| 5 | 34.985 | N.K | 1x1.5 | 2.0 | 0.5 | 34.985 | 0.800 | 2.5x2 | Modified new passages for small animals |
| 6 | 35.238 | N.K | 1x1.5 | 2.0 | 0.253 | NA | NA | NA | NA |
| 7 | 35.530 | N.K | 1x1.5 | 1.5 | 0.292 | 35.53 | 0.545 | 2.5x2 | Modified new passages for small animals |
| 8 | 35.546 | N.K | 1x1.5 | 2.0 | 0.016 | NA | NA | NA | NA |
| 9 | 35.800 | N.K | 2x6 | 4.5 | 0.254 | 35.8 | 0.27 | 25x6 | Modified new passage for elephant |
| 10 | 36.045 | N.K | 1x1.8 | 2.0 | 0.245 | NA | NA | NA | NA |
| 11 | New Location | NA | NA | NA | NA | 36.45 | 0.65 | 2.5x2 | New passage for small animals |
| 12 | 37.116 | N.K | 1x1.8 | 2..0 | 1.071 | 37.116 | 0.666 | 2.5x2 | Modified new passages for small animals |
| 13 | 37.61 | N.K | 1x1.5 | 2.0 | 0.494 | 37.61 | 0.494 | 2.5x2 | --do-- |
| 14 | 38.35 | N.K | 1x1.6 | 2.0 | 0.74 | 38.35 | 0.74 | 2.5x2 | --do-- |
| 15 | 38.85 | N.K | 1x1.8 | 3.0 | 0.5 | 38.85 | 0.50 | 2.5x2 | --do-- |
| 16 | 39.08 | N.K | 1x1.5 | 2.5 | 0.23 | NA | NA | NA | NA |
| 17 | 39.050 | N.K. | 1x1.5 | 2.0 | 0.03 | NA | NA | NA | NA |
| 18 | New Location | NA | NA | NA | NA | 39.475 | 0.625 | 2.5x2 | New passage for small animals |
| 19 | 40.100 | Slab Culvert | 1x2 | N.K | 1.05 | 40.1 | 0.625 | 2.5x2 | Modified new passages for small animals |
| 20 | 40.400 | A new passage as overpass for the elephants in the natural existing ground be provided by encasing the road as a cut and cover section( Tunnel ) in a reach of 300 m. Please refer Sketch No---. | | | | 40.4 | 0.300 | Cut and cover section | Proposed new passage for elephants |

| Sr. No. | Details of the structure as proposed by N.H.A.I. | | | | Spacing | Proposed chainage of the passage @ approx 0.5 Km c/c | Modified spacing of the passage | Ideal Size of the passage for small wild life (Width X Height) | Remark |
|---|---|---|---|---|---|---|---|---|---|
| | Location of the cross drainage structure (Km) | Type of Structure | Opening Size (m) | Height (m) | | | | | |
| 21 | 40.831 | Slab Culvert | 1x5 | N.K | 0.731 | 40.831 | 0.431 | 2.5x2 | Modified new passages for small animals |
| 22 | 41.705 | Slab Culvert | 1x2 | N.K | 0.874 | 41.705 | 0.874 | 2.5x2 | --do-- |
| 23 | New Location | NA | NA | NA | NA | 42.26 | 0.555 | 2.5x2 | New passage for small animals |
| 24 | 42.828 | Pipe Culvert | 1x1.2 | N.K | 1.123 | 42.828 | 0.568 | 2.5x2 | Modified new passages for small animals |
| 25 | New Location | NA | NA | NA | NA | 43.293 | 0.463 | 2.5x2 | New passage for small animals |
| 26 | 43.758 | Slab Culvert | 1x2 | N.K | 0.93 | 43.758 | 0.463 | 2.5x2 | Modified new passages for small animals |
| 27 | 44.082 | Slab Culvert | 1x6 | N.K | 0.324 | NA | NA | NA | NA |
| 28 | 44.379 | Slab Culvert | 1x6 | N.K. | 0.297 | 44.379 | 0.621 | 25x6 | Modified new passage for elephants |
| 29 | 44.975 | Bridge | 3030+ 4x40+30 | 13.0 | 0.596 | 44.975 | 0.596 | 220X13 | Proposed Elephant Passage |
| 30 | 45.261 | Slab Culvert | 1x2 | N.K | 0.286 | NA | NA | NA | NA |
| 31 | New Location | NA | NA | NA | NA | 45.475 | 0.5 | 2.5x2 | New passage for small animals |
| 32 | 45.984 | Slab Culvert | 1x3 | N.K | 0.723 | 45.984 | 0.509 | 2.5x2 | Modified new passages for small animals |
| 33 | 46.650 | Slab Culvert | 1x5 | N.K | 0.666 | 46.650 | 0.666 | 2.5x2 | --do-- |
| 34 | New Location | NA | NA | NA | NA | 47.129 | 0.479 | 2x2.5 | New passage for small animals |
| 35 | 47.609 | Slab Culvert | 1x3 | N.K | 0.959 | 47.609 | 0.48 | 2.5x2 | Modified new passages for small animals |
| 36 | 47.937 | Pipe Culvert | 1x1.2 | N.K | 0.328 | NA | NA | NA | NA |
| 37 | 48.200 | Slab Culvert | 1x5 | N.K | 0.263 | 48.2 | 0.591 | 2.5x2 | Modified new passages for small animals |
| 38 | 48.500 | Slab Culvert | 1x5 | N.K | 0.300 | 48.5 | 0.3 | 2.5x2 | --do-- |

| Sr. No. | Details of the structure as proposed by N.H.A.I. | | | | Spacing | Proposed chainage of the passage @ approx 0.5 Km c/c | Modified spacing of the passage | Ideal Size of the passage for small wild life (Width X Height) | Remark |
|---|---|---|---|---|---|---|---|---|---|
| | Location of the cross drainage structure (Km) | Type of Structure | Opening Size (m) | Height (m) | | | | | |
| 39 | 49.125 | Pipe Culvert | 1x5 | N.K. | 0.625 | 49.125 | 0.625 | 2.5x2 | --do-- |
| 40 | 49.600 | Bridge | 1x25 | 6.5 | 0.475 | 49.600 | 0.475 | 25x6 | Modified New passage for elephants |
| 41 | 50.068 | Slab Culvert | 1x2 | N.K | 0.468 | 50.068 | 0.468 | 2.5x2 | Modified new passages for small animals |
| 42 | 50.365 | Slab Culvert | 1x2 | N.K | 0.297 | NA | NA | NA | NA |
| 43 | 50.611 | Slab Culvert | 1x2 | N.K | 0.246 | 50.611 | 0.543 | 2.5x2 | Modified new passages for small animals |
| 44 | 50.900 | Bridge | 1x25 | 6.0 | 0.289 | 50.900 | 0.289 | 25x6 | Modified new passage for elephants |
| 45 | 51.075 | Slab Culvert | 1x1.5 | N.K | 0.175 | 51.075 | 0.464 | 2.5x2 | Modified new passages for small animals |
| 46 | 51.350 | Slab Culvert | 1x1.5 | N.K. | 0.275 | NA | NA | NA | NA |
| 47 | 51.645 | Bridge | 30+2x4 +30 | 10.0 | 0.295 | 51.645 | 0.57 | 140x10 | Proposed Elephant passage |
| 48 | 52.346 | Slab Culvert | 1x2 | N.K | 0.701 | 52.346 | 0.701 | 2.5x2 | Modified new passages for small animals |
| 49 | 52.787 | Slab Culvert | 1x6 | N.K | 0.441 | 52.787 | 0.441 | 2.5x2 | --do-- |
| 50 | 53.262 | Slab Culvert | 1x6 | N.K | 0.475 | 53.262 | 0.475 | 2.5x2 | --do-- |
| 51 | 53.725 | Bridge | 1x25 | 6.0 | 0.463 | 53.725 | 0.463 | 25x6 | Modified new passage for elephants |
| 52 | 54.243 | Slab Culvert | 1x2 | N.K. | 0.518 | 54.243 | 0.518 | 2.5x2 | Modified new passages for small animals |
| 53 | 54.722 | Pipe Culvert | 1x1.2 | N.K. | 0.479 | 54.722 | 0.479 | 2.5x2 | --do-- |
| 54 | 55.125 | Bridge | 1x25 | 6.0 | 0.403 | 55.125 | 0.403 | 25x6 | Modified new passage for elephants |
| 55 | 55.325 | Slab Culvert | 1x2 | N.K | 0.2 | 55.762 | NA | NA | NA |
| 56 | 55.762 | Slab Culvert | 1x3 | N.K | 0.437 | 55.762 | 0.637 | 2x2.5 | Modified new passages for small animals |
| 57 | 56.083 | Box Culvert | 2x2 | N.K | 0.321 | NA | NA | NA | NA |
| 58 | 56.362 | Slab Culvert | 1x5 | N.K | 0.279 | 56.362 | 0.6 | 2x2.5 | Modified new passages for small animals |
| 59 | 56.650 | Slab Culvert | 1x2 | N.K | 0.288 | 56.650 | 0.288 | 2x2.5 | Modified new passages for small animals |
| 60 | 57.375 | Slab Culvert | 1x5 | N.K | 0.725 | 57.375 | 0.725 | 2x2.5 | --do-- |
| 61 | 57.400 | Bridge | 30+2x 40+30 | N.K. | 0.025 | NA | 0.025 | NA | End of RF |
| | | | | | 24.613 | | 24.61 | | |

**Abbreviations:**
**N.K.** : Not Known, **NA** : Not Applicable

# D. COMMENTS ON PROPOSED MITIGATION MEASURE FOR ARBOREAL MAMMALS

## Hoolock gibbon, Capped langur, Stump-tailed macaque and Pig-tailed macaque

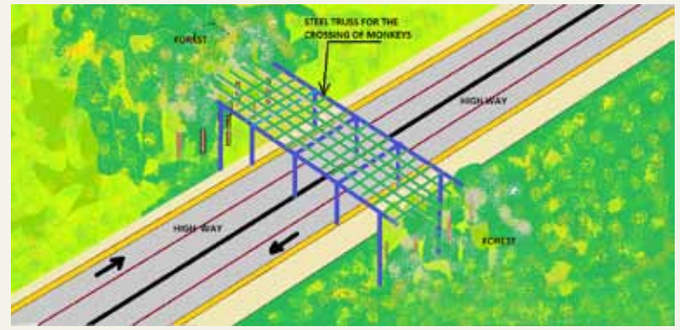
In November 2009, a WWF field team recorded canopy continuity over the road within the stretch from Lankajan to Lumding at 119 places indicating that hoolock gibbons and other arboreal mammals at that time could cross over at many places over the road without the fear of being run over by speeding vehicles. Hoolock gibbons are territorial and exclusively arboreal. Any widening would immediately remove the existing 119 sites where canopy continuity was recorded during November 2009. Even if we were to make canopy bridges, it is doubtful that hoolock gibbons will use them while heavy traffic is moving underneath. If the canopy bridges are not spread all along (in fact, at each of those 119 sites), hoolock gibbons and many other arboreal mammals, being territorial, will not be able to use canopy bridges that are not inside their own territory. Thus the young dispersing animals from their natal home ranges would have nowhere to go. Therefore we propose two types of mitigation measures as follows –

**(1)A canopy type steel structure with sufficient** head-room (5.5m approximately) for the road traffic may be provided for the connectivity for arboreal mammals in the habitat across the road. The canopy type steel structure will have to be connected to the trees of both sides. It is most likely that the arboreal mammals will use the canopy. The arrangement is shown in Figure 13. These canopy type steel structures should be covered with natural vegetation.

**Figure 12 –** Liana at the Singapore zoo

**(2) Singapore zoo has invented** an inexpensive way of making artificial lianas (Figure 12) those can be connected at regular intervals of 1-2km across the road from tall trees. These lianas can be made locally and last for many years and almost all arboreal mammals have been seen to use them.

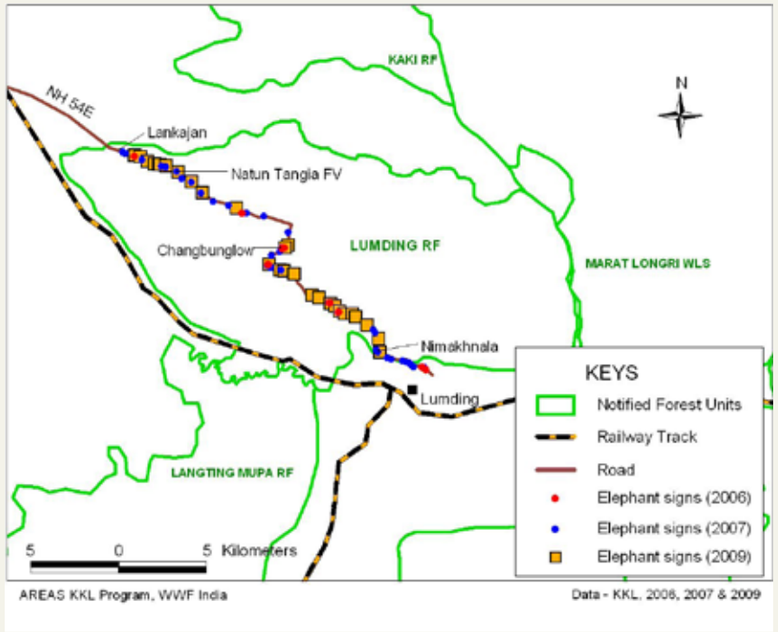
**Figure 13 -** Isometric view of the monkey passage over the proposed highway

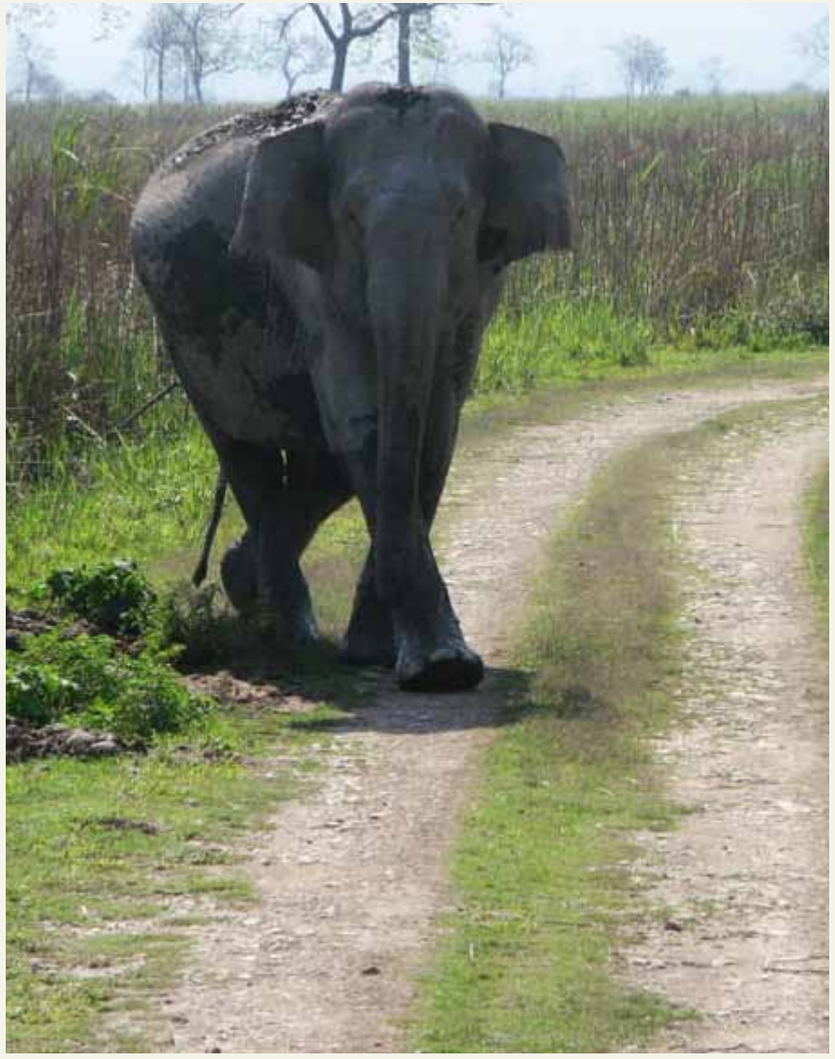



# E. CONCLUSION

Economic growth is important for a developing nation like India which needs to lift millions of people out of poverty. Ensuring that this growth is ecologically sustainable and does not jeopardise the well-being of future generations is a challenge that needs to be addressed now. Balancing the need for rapid infrastructure development like the NH-54E in Lumding RF with the need to keep our wilderness areas from being fragmented beyond recovery is a typical example of the type of situation where it is important to find a solution which will set a future precedent. Towards this end, WWF India has worked with various stakeholders to come up with a win-win formula. This report outlines the mitigation measures that need to be implemented to ensure that wildlife in the Kaziranga-Karbi Anglong Landscape (which includes Lumding RF) is not too drastically affected by the development of NH-54E. We understand that this is not the best solution for the wildlife concerned. However, given that the alternative, i.e. keeping this route at its existing width is probably not pragmatic, we feel the mitigation measures suggested here are the best solution. This report is the result of many hours of discussions, field visits and expert consultations and we now call upon NHAI, MoEF and Assam FD to ensure that the mitigation measures outlined in this report are implemented without major changes. We believe this is a test that must be passed by NHAI to prevent future legal challenges on other such linear developmental projects in critical wildlife habitats. We hope that this spirit of dialogue between a conservation organisation such as ours and a developmental agency such as NHAI is seen as a model for other such developmental projects to protect India's beleaguered wilderness areas.

## Elephant use zone along the study area in Lumding Reserve Forest, Kaziranga Karbi Anglong Landscape, Assam , India



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