JUSTIFICATION FOR LOCATING PROJECT IN FOREST AREA

The Project road starts from km Stone 67 of 310A near just after Mangan town at km 67+000. Mangan is marked km 0+000 at Kilometre stone 67+000. Gangtok is the start of the NH-310A. The road Gangtok to Mangan (Km 0.0 to Km 67.0) is part of the NH 310A. The project road is from Mangan to Chungthung. This section is around 29.40 km in length.

The entire stretch passes through winding hilly terrain of Himalayas and sight distance is restricted due to sharp horizontal curves and vertical cuts slopes. At present the project road is maintained by Border Road Task force of Border Roads Organization (BRO). There have been number of landslides noted along the road which has been cleared by BRO. The road has been made cutting through rocky strata at some locations and the vertical slopes are retained by masonry wall/retaining wall at various locations. The height of these retaining structures varies from 10m to 20m. From Mangan at RL 3940 ft. the present alignment traverses on the right side hill of the alignment up to Tung village. After crossing Teesta river via existing new 2 lane RCC Bridge (RL 4316 ft.), alignment switches to left side of the Teesta river and moves up in hill near Chhateng where 1200 (MWt) Teesta III Hydro Power Project Dam work is in progress. To reach Chungthung alignment again crosses Teesta river on new RCC Bridge (RL 5190 ft.) where two main tributaries of Teesta river i.e. Lachung Chhu merges with Lachen Chhu in to the main stream to form Teesta River. The road network has been shown in Figure 1 as below and detailed features of the existing road have been detailed in TABLE 1.

Table 1.1

Sl. No.	Description of item	Details
1	Road length	Existing – 28.000 km Design – 27.476 km
2	Road Configuration	7.00 m wide carriageway with 1.5 m paved shoulder
3	Terrain	Mountainous and Steep
4	Land use pattern	Mixed land use between forest, built up
5	Existing Surface of carriageway	Flexible pavement with BC for majority of length. Rigid pavement at a few scattered stretches in Slide zones/ Urban

(Vaibhav Srivastava)
Major
Officer Commanding
86 RCC (GREF)

Sl. No.	Description of item	Details
		Areas
6	Shoulder width	Existing – 0.5m to 1.0m Proposed Paved Shoulder – 1.5m Proposed Earthen Shoulder – 1.0m
7	Existing Formation width	8m – 10m
8	Right of Way (RoW)	25.0 m (Proposed) 6.0-11.0m (Existing)
9	Pavement Condition	Good-Fair
10	New Flexible Pavement thickness	BC-40mm; DBM-70mm; WMM-250mm; GSB-200mm
11	Design CBR	10%
12	Junctions	Major-01, Minor-10
13	Traffic	AADT-1814 MSA-20
14	Cross drainage structures (Proposed)	Major bridge -01, Minor bridge – 10, Viaduct-01, Culvert-102
15	Settlement	Mangan, Singhik, Kadyong, Naga-Namgor, Tung, Chungthang
16	General remarks	Slide Zones present at few places along the existing road Carriageway width restricted to 3.5-4.0 m t slide zone areas Wearing Course of the pavement have washed away at various slide zone locations

2. Project Benefits:

2.1. Savings in Distance

There is a significant change or reduction in the length of new corridor of Mangan to Chungthang. The initial length of the corridor is presently 29.0 km and after introduction of the corridor it will be 27.47 km. Another major advantage of this project is savings in road user cost after introduction of the new corridor.

2.2. Vehicle Operating Cost Savings

The model comprehensively predicts the performance and operating costs of motorized vehicles in the selected fleet. Motorized vehicle performance predictions include speeds (free flow and congested conditions) and consumptions. Predictions for vehicle operating costs include fuel, oil, tyre and parts costs, crew and maintenance labour costs, capital depreciation, borrowing costs, and overhead costs. HDM-4 was used to estimate the Vehicle Operating Costs (VOC) for traffic in each vehicle category on each selected road with and without new road. The model estimates VOC in both the with- and without-project situations taking into account the speed and travel time including surface quality and road congestion. The resulting VOC values for each road and section can be found in the HDM results.

The Table 2.1 shows the vehicle operating cost of heavy commercial vehicles before and after up gradation of the project road. The section-wise VOC/km (Rs./km) analysis has been analysed to assert the benefit rigorously.

Table 2.1: Vehicle operating cost for 2021-2050

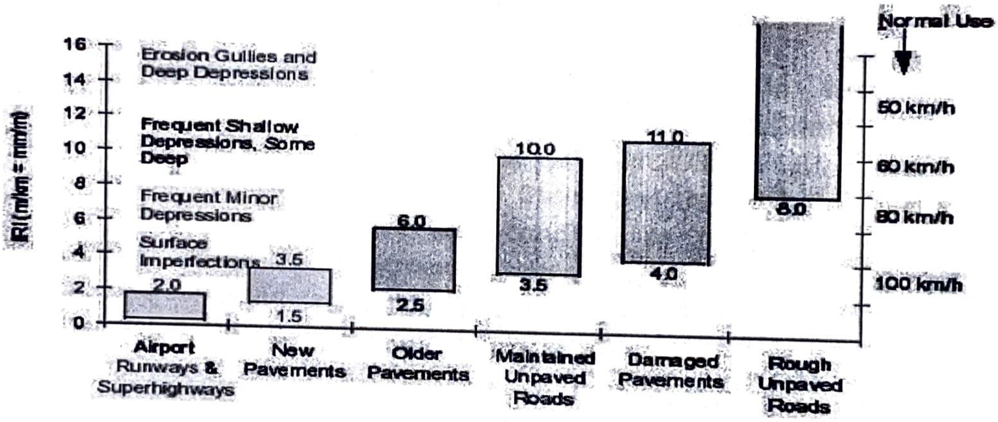
Mangan to Chungthang							
Car		Bus		LCD		2 Axie Truck	
Base Case	Improved Case	Base Case	Improved Case	Base Case	Improved Case	Base Case	Improved Case
16.98	-	37.79	-	13.26	-	45.95	-
17.10	-	38.24	-	13.35	-	46.38	-
17.29	-	38.89	-	13.47	-	46.97	-
17.85	**10.64**	40.98	**22.10**	13.84	**7.76**	48.77	**27.48**
19.01	**10.81**	45.22	**22.68**	14.51	**7.87**	52.52	**28.14**
19.02	**11.01**	45.26	**23.42**	14.52	**8.02**	52.57	**28.97**
19.02	**10.94**	45.32	**23.09**	14.52	**7.99**	52.66	**28.61**
19.04	**10.98**	45.45	**23.29**	14.59	**8.04**	52.84	**28.81**
19.06	**11.32**	45.65	**24.57**	14.65	**8.35**	53.12	**30.33**

2.3. The Residual Value

Considering the remaining life of the construction items the residual value (salvage value) has been assessed at the end of the analysis period. For structures, the life is assumed to be 50 years. Values of the selected construction items such as land acquisition, structures, sub-base, social displacement cost etc. are included in the economic analysis as residual values at the end of the analysis periods. These residual values are considered, as benefits to the project in the analysis. The value has been taken as 10% of capital cost of construction and maintenance.

2.4 Roughness in Existing and Improved Road

Roughness in IRI of the under improved conditions are given below. In case of AC a roughness below 2.0 is difficult to achieve. So in the case of AC it has been considered as 3.0 IRI.



3. Speed Reduction Factor

The speed reduction factor for the existing road has been taken as 1.1. For the new road, vehicles will maintain a mean speed more than design speed so the speed reduction factor has been taken as 1.1.

4. Roadside Friction

Roadside friction is a function of carriageway width, percentage of slow moving vehicles, roadside parking and other activities along the corridor. The friction factor has been taken as 1.0, that is, free from roadside friction.

5. **Travel Time Saving**
The model estimates the Value of Travel Time (VTT) for passengers and goods in transit in both the with- and without-project scenarios taking into account speed and travel time including surface quality, road congestion etc.

6. **Accidental Cost Savings**
There can be some anticipated reduction of accidents due to improved signing and engineering intervention, the benefits deriving from this rehabilitation project are deemed to be moderate and consequently the accident-related benefits have not been discounted in the HDM-4 analysis. As a result the actual economic return in respect of increased of Road Safety would be expected to be somewhat higher than the rates of return presented in this report.

7. **Roads Condition Trends**
The predicted average road condition is measured in terms of roughness (IRI), for the project option. These condition trends represent, on average, the engineering performance of the project options over the entire life cycle. The Base Case Do Minimum option would lead to worsening of the road condition to 16 IRI by the end of the analysis period. The investment options show low rates of pavement deterioration and would require periodic maintenance interventions over the analysis period. When the results of all the sections within the project option is combined, the weighted average road condition trends one option as shown in Figure below. The deterioration trends show that up gradation investment option is technically better than base option since they exhibit following average roughness in 2024, 2030, 2040 & 2050.

Table 7.1: Average IRI over the Project Period

Year	Base Case	Up gradation
2024	10	3
2030	16	4
2040	16	4
2050	16	4

(Vaibhav Srivastava)
Major
Officer Commanding
86 RCC (GREF)

HDM-4 **Average Roughness by Section (Graph)**

HIGHWAY DEVELOPMENT & MANAGEMENT

Study Name: Sikkim
Run Date: 30-03-2020

Section: Mangan to Chungthang
Sensitivity: No Sensitivity Analysis Conducted

ID: S-1
Rise + Fall: 29.00m/km

Road Class: Primary or trunk
Width: 4.00m

Length: 29.00km
Curvature: 85.00deg/km

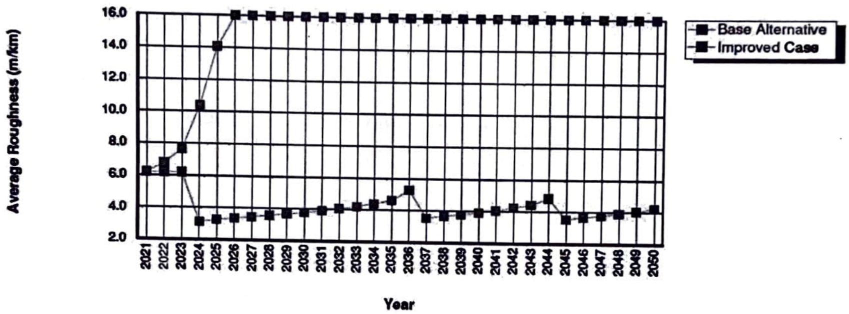


Figure 7: Roughness of Mangan to Chungthang (2024-2050)

8. Economic Viability

The Economic Internal Rate of Return (EIRR) is calculated by the model applying a project discount rate of 12% to the annual undiscounted net differences of the economic elements considered in the analysis. The sum of these discounted values gives the economic Net Present Value (NPV) of the project which is generated and presented, together with the associated EIRR in the HDM-4 output sheets for sectional and project basis attached in last, respectively.

The results of the HDM-4 analysis are summarized below in **TABLE 8.1** for original model generated sheets.

(Vaibhav Srivastava)
Major
Officer Commanding
86 RCC (GREF)

Table 8.1: Results of the Economic Analysis

Road	Road	EIRR (%)	NPV at 12%
NH-310A	New road from Mangan to Chungthang	30.8	4254.79

Source: HDM-4 Output sheets

8.1. Sensitivity Analysis

A sensitivity analysis has been performed under the following scenarios and found that the project is economically viable in all scenarios of sensitivities. The sensitivity analysis is presented in **TABLE 8.2.**

Table 8.2: Sensitivity Analysis of EIRR (%)

Scenario	EIRR (%)	NPV (Rupees Million)
Base case	**30.8**	**4254.79**
1. 15% increase in capital cost	27.8	3986.64
2. 15% decrease in MT volume	29.7	3775.41
3. 15% decrease in MT VOC	29.3	3839.80
4. 15% decrease in MT time	29.0	3768.00
5. All scenarios together	23.7	2677.02

Source: HDM-4 Output sheets

Conclusion

The study was based on an appropriate methodology that made use of field data and design options provided by the design consultant and then economic analysis using the Highway Development and Management (HDM-4) tool. HDM-4 simulates the interaction between pavement construction standards, maintenance standards and the effects of the environment and traffic loading in order to predict the annual trend in road condition. This, together with the geometric standards of the road, has a direct effect on vehicle speeds and on the costs of vehicle operation and accident rates on the road. The interacting sets of costs, related to those incurred by the road authority and those incurred by the road users, are added together over time in discounted present values. Economic benefits are then determined by comparing the total cost streams for various maintenance and construction alternative with a base case or "without investment" scenario. For this study, economic benefits were calculated as the difference between the "without investment" option and the up gradation investment option. The HDM-4 model was used to simulate future changes to the road sections from current conditions. Estimates of benefits included dis-benefits during the construction period and the direct impact on all users of the proposed facility.

(Vaibhav Srivastava)
Major
Officer Commanding
86 RCC (GREF)

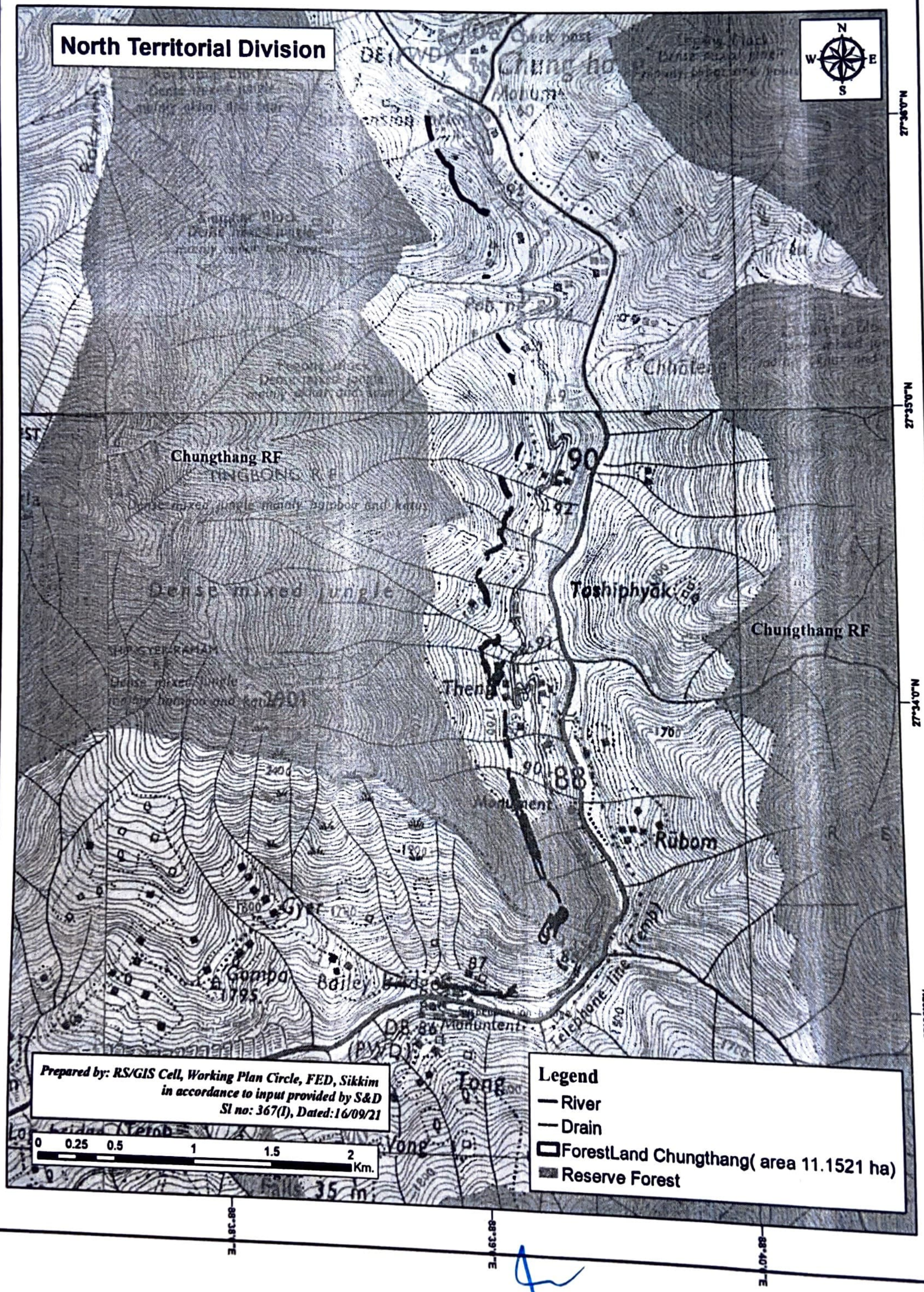
In terms of HDM-4 modelling, the predicted pavement deterioration trends over the pavement design life have been illustrated graphically for the project options. Up - gradation indicates very good engineering performance through lower rate of pavement deterioration. The up gradation is strongly recommended for implementation, since, the project is found economically viable, having EIRR well above 12%, under all possible scenarios including the worst one.

The project is a widening project of existing road and therefore the required forest land for diversion for implementation of the project is bare minimum including minimum felling of trees considering the other optional alignments where there is no existing road under consideration and requirement of forest land diversion is more.

(Vaibhav Srivastava)
Major
Officer Commanding
86 RCC (GREF)

MAP SHOWING THE LOCATION OF PROPOSED DIVERSION OF FOREST LAND 11.1521 HA FOREST LAND FOR WIDENING OF ROAD FROM TOONG BRIDGE TO CHUNTHANG UNDER BHARAT MALA PROJECT CHUNTHANG(T) RANGE

REF: RO(T) MANGAN REF NO. 497/CTR/NTD



(Vaibhav Srivastava)
Major
Officer Commanding
86 RCC (GREF)