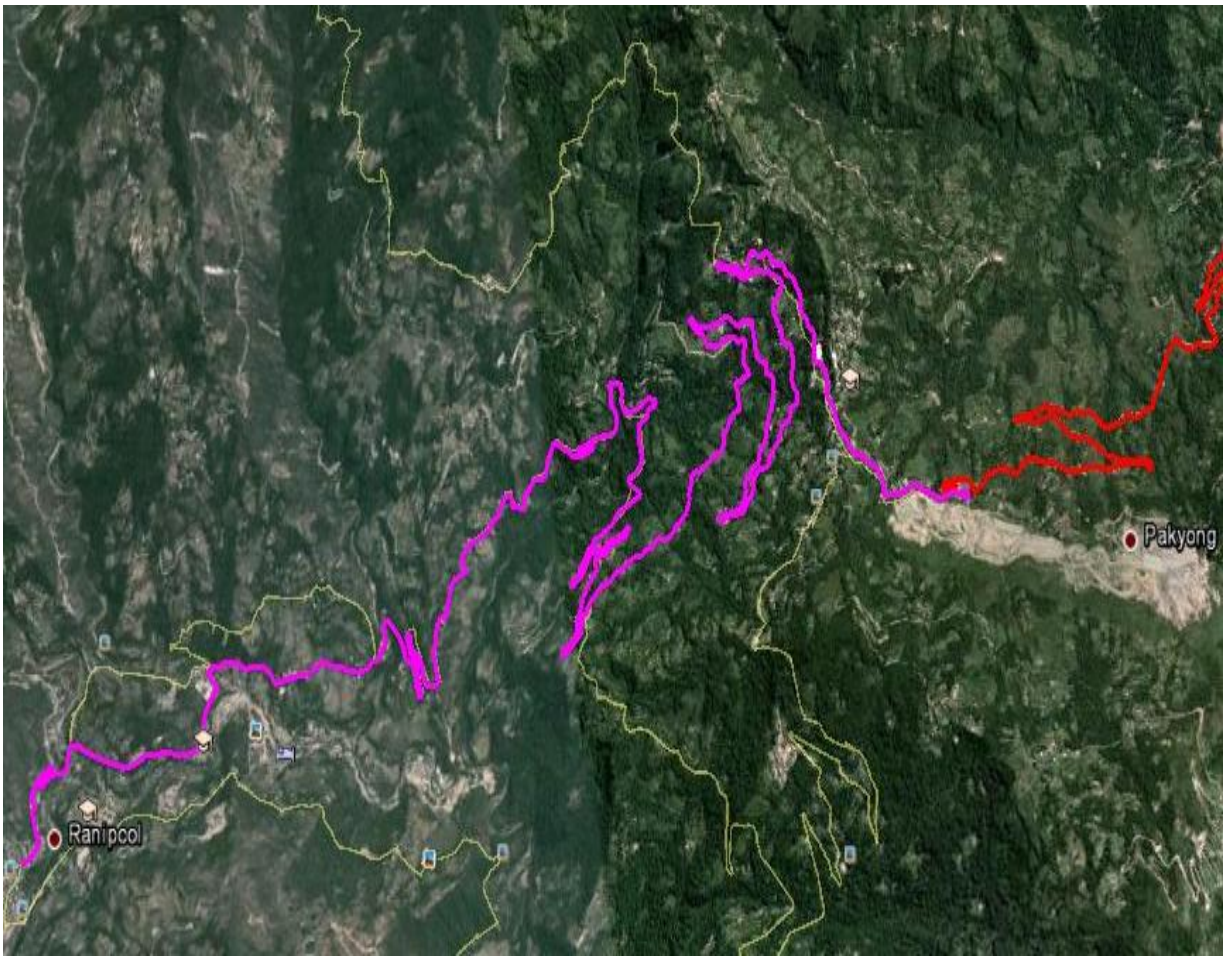
MINISTRY OF ROAD, TRANSPORT & HIGHWAYS
GOVERNMENT OF INDIA

DETAILED PROJECT REPORT FOR CONSTRUCTION OF 2 LANE HIGHWAY NH-717-A (FROM RANIPOOL TO PAKYONG) IN EAST SIKKIM



DETAILED PROJECT REPORT

VOLUME – I: MAIN REPORT
(From Km 0.00 to Km 16.167)
ESTIMATED COST: Rs.240.73 Cr.

JAN- 2018

CM ENGINEERING & SOLUTION
House No. –1473A, Maruti Vihar, Gurgaon, Haryana – 122002, Tel – 0124 –4255138
Mobile No – 09811406386/09911052266, Email- cmesconsultancy@gmail.com

NHIDCL SIKKIM

GOVERNMENT OF SIKKIM
PUBLIC WORKS DEPARTMENT

- - oo - -

DETAILED PROJECT REPORT FOR CONSTRUCTION OF 2 LANE HIGHWAY NH-717-A (FROM RANIPOOL TO PAKYONG) IN EAST SIKKIM

Name of Road :NH-717 within Sikkim (KM 00+00 TO KM- 16+167)

Length of road : 16.167 Km

VOLUME - I

MAIN REPORT

TABLE OF CONTENT

EXECUTIVE SUMMARY

1. INTRODUCTION

Recognizing the current inadequate transportation infrastructure facility of the country and the vital role transportation sector plays in the accelerated economic growth of the country, the Government of India has placed a high priority in this sector's development to meet the current and future highway transportation needs.

The Roads & Bridges Department, Govt. of Sikkim on behalf of the Ministry of Roads Transport and Highway, Govt. of India has prioritized to take up for up gradation and improvement of NH 717-A from Km 0/00 to Km 19/100 to 2-lane NH Standard in Sikkim. The existing road has steep gradient and sharp curves/zigs at various stretches. It is of single lane road with formation width of 6.00 m to 6.50 m without conforming any standard / specification. As a result, the heavily loaded trucks and large sized vehicles find it difficult to pass through these stretches safely.

The existing NH-717 (A) takes off at Km 80.500 on existing NH 10 at Ranipool in East Sikkim and runs towards North to South direction passing through a number of towns/villages like Ranipool - Aho – Yangtam – Panchwati – Pakyong within East District.

Pakyong is connected with State capital and other places by road. Due to the upcoming Green Field Airport road need to be upgraded from exiting Single Lane Road to Double lane road and to keep the road to and fro Pakyong in good trafficable condition is there in the overall interest and benefit of the State in general and for Socio-economic development of the people in Particular. Pakyong, one of the Sub-Division Head Quarters of the East District has been gaining its importance due to upcoming Green Field Airport. It is situated at a distance of 30Km from the Gangtok where all round development is taking place. There is several Educational Institutions like Public School, Senior Secondary School, Government Hospital and other Industrial centers. The State Government has proposed many schemes to attract tourist, the Nathula Trade in between two Giants of Asia has also some influence hence it is fast developing into a tourism centre and becoming an important business centre too. Previously Ranipool -Pakyong Road was under the custody of BRO and now it has been handed over to State PWD (Roads & Bridges).

It is imperative to upgrade the road by widening, improving curves and Bends for proper sight distance so that it can be brought into good condition to provide smooth and good riding quality, to save the time as well as to avert incident of accident during unpleasant weather. There are some vulnerable zones susceptible to landslide which required stabilizing by properly engineered retaining structure. It is equally important to upgrade and replace the old exiting steel bridge near Ranipool Crematorium and 2(two) nos. of RCC Bridges at Andhery and near Aho School.

This is an important NH and life line for the people of the East District of Sikkim & Darjeeling District in West Bangal and a number of villages which are located in the area

adjoining to this road are also heavily dependent on this road for their social and economic development. Thus, the importance of this road and hence the role it plays for the upliftment of the region needs no more emphasis. It is very essential for improvement & up-gradation of existing NH-717-A conforming to National Highway Standards.

2. PROJECT BACKGROUND

The initial stretch of existing / present NH-717 A passes through heavily built-up areas which shall involve costly Land Acquisition and serious resettlement problems for improvement. Due to these reasons, it was felt absolutely necessary to re-align the existing initial stretch of the NH 717 A between km 0/00 – 2/45 by shifting the existing take-off point at km 80/60 to a proposed new take-off point at km 78/100 (i.e. located at out skirt of Ranipool town toward Singtam) on Sevok - Gangtok section of NH-10. The proposed alignment is realigned from the existing road from Km 7/250 to Km 12/520 to bypass the Sinking & Sliding Portion. The proposed realignment take off points are very near due to which, it will not affect and deprive the connectivity with villages and hence, the villagers would be the beneficiaries with the proposed alignment. The proposed re-alignment does not pass through heavily built-up area and would involve much less L.A cost as well as resettlement problem as compared to the existing alignment. The re-alignment also passes through an area with a much better topographical as well as soil conditions. The re-alignment also passes through an area with a much better topographical as well as soil conditions. Hence, apart from the reduction in distance between Pakyong Airport and Capital City Gangtok by Km 2.5, which would greatly benefit for the public in terms of vehicle operating cost and travel time, the proposed re-alignment is technically far better and financially cost effective in the long run.

The existing NH717 (A) was constructed during the reign of Chogyal, the then King of Sikkim and has a total length of 19.10 Kms .The road alignment passes through frequently cultivated land, Forest plantation & habitation etc. The road was constructed to provide connectivity to East Districts of Sikkim. **The road was upgraded to the status of National Highway in the year 2016.** No substantial improvement of the road other than routine normal repairing works have been carried out since the road was declared a National Highway. The pavement work and the permanent works of retaining wall and cross drainage structures were done at the time of construction as per ODR standards and the width of the cross drainage structures are also only 6.0 m. Most of the retaining wall /wing wall had been collapsed and the road formation width also breaches at many stretches.

3. PROJECT ROAD

The stretches of the road under this report is between 00/00 Km to 19/10 Km of NH 717-A as per existing chainage required for up gradation & improvement to standard 2 lane. In this portion of proposed highway, about 88.80 % length of road passes through heavily built-up areas & private land which involve costly Land Acquisition and serious resettlement problems in the existing road. The existing alignment also passes through

steep terrains which are unstable and landslide prone area at many locations which could also posed serious problems in future.

Land use

As per Right of Way of proposed 2 lane standard alignment 26.80 Ha land is required out of which 14.30 Ha existing ROW is already available and 3.24 Ha of forest land at Andheri Khasmal. About 88.80% length of the road passes through land owned/developed by individual land holders under periodic patta and LSC pass, 11.20 % length of the road passes through Reserved Forest & Khasmal Forest. This land will not be available free of cost and also compensation for plantations, crops etc. within the required corridor is to be paid to each individuals.

OBJECTIVE OF THE PROJECT AND SCOPE

a) Objective of the project :

The stretches of the road under this report is between 00/00 Km to 19/100 Km of NH 717(A) as per existing chainage required for up gradation & improvement to 2 lane standard

In order to improve 19.10 Km stretch of existing road to standard 2-lanes, some stretches of the road will have to be re-aligned whereas some existing stretches can be improved to conform to National Highway Specification in respect of its gradient, curves, super elevations etc. Since the proposed Widening to 2-lane with geometric improvement and re-alignment of NH-717 (A) is passing through steep terrain, gorges, nallah etc. Many number of Retaining wall, Breast Walls, Culverts etc have to be constructed.

b) The Scope of the Project

The scope of work includes:-

I. Up-gradation of the existing road, having formation width of about 6.00m to a formation width of 12.0m.
II. Geometric improvement of existing road by short relocation
III. Realignment at the existing road from Km 0+00 to Km 2+45 at Ranipool Town.
IV. Realignment at the existing road from Km 7+250 to Km 12+520.
V. New construction, re-construction of cross-drainage works, protection works, Bridges and side drains along the whole stretch.
VI. New Construction of pavement on full stretch as flexible pavement (GSB+WMM+DBM+BC).
VII. Construction of Bridges at Km 1.20, Km 2.48 & Km 6.11.
VIII. Road signs, stones, safety measures, etc along the whole stretch.

c) Detailed project report consisting of the following:

- Conduct surveys of the existing alignment and collect inventory data.
- Conduct detailed reconnaissance survey and collect relevant data as well as the remote sensing data.
- Conduct detailed topographical, geotechnical / geological, hydrological and environmental surveys on selected alignment.
- Carry out detailed survey for construction materials

- Preparation of detail alignment drawings and geometric designs and prepare cost estimates
- Analyse the traffic census collected by the Department and conduct economic evaluation of various alternatives
- Analyse various alternatives and recommend the most appropriate for detailed design.
- Prepare Detailed Project Reports covering the following :
  - Main Report
  - Design Report & Survey Investigation report
  - Cost Estimate
  - DPR Drawing
  - Land Acquisition & Utility Shifting Details.

4. ENGINEERING SURVEYS AND INVESTIGATIONS

Detailed engineering surveys and investigation have been carried out along the selected alignment of the project road and major findings are as given below:

a) Terrain:

The alignment of the project road passes through mountainous and steep terrain exceeding 30 % ground slope across the alignment.

b) Rainfall:

The proposed road is in heavy rainfall area. Monsoon period is between May and September when construction work is practically impossible.

c) Topographical Survey:

The topographical survey was conducted with Total Station and Auto Level Bench Marks were established at every kilometer and cross-section levels were recorded at 20m intervals in straight portions in general and at closer intervals at curves and where required. The topo-survey information was then translated into digitized topographical map using suitable mapping software.

d) Alignment & Road Design:

The general alignment of the road under this project is as:

NH 717 (A) Highway from Km 0 /000 to 16/167		Km as per design Chainage
Existing alignment	:	10.867 Km
Re-alignment	:	5.300 Km
Total length of proposed road	:	16.167 Km
Total Length of project road	:	

Road is designed for 2-Lane (12.00 m roadway with 7.00 m carriageway).

Gradient, being the most important parameter, has been the guiding factor. Ruling gradient less than 6.0% has been achieved in most point of the road and the maximum gradient being 6.5 % from Km 15+ 017 to Km 15+232 (215.0 m) due built-up stretch.

e) Realignment of existing road:

For improvement of existing road at some stretches relocation and re-grading are proposed due to which traffic movement on existing road would be disturbed. Permanent diversion will be included in the design as to minimizing the structure damage, reducing cost of resettlement and easy and faster movement of vehicles. Details of re-alignment is as follows

Sr. No.	Name of Town	Design Chainage		Existing Chainage		Length in Km
		From	To	From	To	
1	Ranipool	0+00	1+400	0+00	2+450	1.40
2	Andheri Khola	5+800	9+700	7+250	12+520	3.90
					Total	**5.30**

f) Soil:

The soil along the alignment of the project is fairly homogenous in nature and character. Soil types vary from silty clay to sandy clay of medium plasticity, plasticity index varying from 7 to 18.The soaked CBR value ranges from 5 to 7.

g) Construction Material and Stones:

The rock deposits are available along or the vicinity of the project road alignment. Besides, cobbles, pebbles and sand deposits are available in the rivers or streams crossing the main alignment. Construction materials for CTB, Cross drainage & Masonry R/Wall etc. works, will be available at local quarry within the project corridor and WMM, DBM & BC material from Teesta River & LANCO Tunnel excavated mug within the project corridor .Water Absorption and AIV of these quarries are within the limit of the Ministry's Specifications. Bitumen, steel and cement will have to be taken from Siliguri.

5. TRAFFIC SURVEY, ANALYSIS & FORECAST

This is to assess the capacity requirements, pavement design, identify present and likely future traffic conditions and to have provisions for future improvements.

From traffic volume counts the following observations are made,

Location	Average daily traffic intensity (PCU)	Average daily traffic intensity (CVD)	peak Hour Traffic Nos/PCU	Peak Hour Traffic ratio in %	Time of Peak Traffic
Ranipool – Pakyong	1385	464	543/768	7.84	11AM -12 AM

(i) There are large numbers of Cars, bus and two wheelers using the road (69.57%).

(ii) Traffic is dominated by the passenger vehicles (cars and two wheelers).

(iii) The heavy vehicle traffic (29.91%) as compared to the passenger traffic (69.57%).

Capacity analysis is fundamental to the planning, design and operation of roads and provides among other things the basis for determining the carriageway width to be provided at any point in a road network with respect to the volume and composition of traffic. It is also a valuable tool for evaluation of the investments needed for future road construction and improvements and for working out priorities between competing Projects. The NH road has been considered for two lanes.

- Therefore, No of commercial vehicles per day for design taking into consideration 7.5% per annum growth rate and a pavement life of 15 years
- After 15 years design life PCU per day : 5885
- Design road capacity (Service volume) for hill road for high curvature (above 200 degrees per Km) for 2 lane ,greater than 4500 PCU
- Hence existing road need to be upgrade for 2 lane standard

6. SALIENT FEATURES OF THE PROJECT

Salient Features

Salient features based on design are as below:

- Length of Project Road Sector 16.167 Km
- The road has a ROW of 24.00 m at open area & 20.00 m at built up area
- The formation width is 12.0m (Km 0.0 to Km 16.167)
- The Highway is designed for 2-lane carriageway of 7.0 m width.
- The Highway is designed with flexible pavement
- Paved shoulders of 1.50 m are provided both sides.
- All structures are matching to 2 lane NH roadway standard.
- Route Alignment: The Project Corridor takes off from Km 80.500 on existing NH 10 at Ranipool in East Sikkim then passes through the 3 Nos of villages & 2 Nos Towns and terminates at Km 16/167 at Paykong Airport Road junction in East District.
- Drains: Lined Drain.
- Landslide: 2 Nos. Major land slide locations.
- Sinking Portion: 2 Locations.
- Damaged road: 2 locations.
- Junctions – 08 Nos., Major Junctions – 4 & Minor Junctions – 4 Nos
- Bridges – 3 Nos. 1 Major bridge over Ranikhola at Ranipool and 2 Nos of Minor bridge over over the Aho Khola & Andheri Khola

- Items for Road Safety, Roadside Amenities and Road Furniture are provided.

a) Cross Section Elements:

The design standards of relevant Indian Roads Congress for Roads and Bridges are adopted for cross section designs of the project road. The earlier items of construction may involve construction of the road formation, cross-drainage works including construction of major bridges for 2-lane standard and protection works. The later stage of the construction will cover the construction of Pavement for double lane (7.00 m wide) NH standard. The proposed cross section element with dimensions is shown in table below:

Sl.No.	Design elements	Dimensions
1	Roadway width	
	At roads and culverts*	12.00 m & 10.80m
	At bridges**	10.50m
2	Carriageway width	7.00 m
3	Cross slopes/Camber at straight reaches	2.5%

**Roadway width is inclusive of side drain and parapet wall/crash barrier (IRC SP: 48)*
***Roadway width is exclusive of kerbs*

b) Road Geometry:

The project corridor passes through steep and mountainous terrain. The design speed adopted is 30km/hour (IRC SP: 48). Along the proposed alignment, there will be no hair-pin bend. However minimum design speed has been considered on technical grounds. The vertical and horizontal alignments of the proposed road can be summarized as shown in table below:

Project Road length	No. of Curves with Design Speed in km/h				No. of Curves with Radius (m)		
	<30	30-40	40-50	>50	<30	30-50	>50
16.167 Km	42	175	0	0	19	85	113

Project road length	Length Distribution (km) and Gradient Class				
	<4%	4%-5%	5%-6%	6%-7%	7%-8%
16.167 Km	5.46 Km	8.567 Km	1.95 Km	0.19 Km	0.0 Km

c) Design of Embankment / Hill Cutting

Considering the physical features, particularly the terrain, soil classification and hill slope line, typical cross-section (Type 1F to Type 21F) have been developed for hill road cutting /embankment building.

Concept Plan of the design of the embankment / hill cutting (stretch-wise) has been developed with specific mention of the formation building methodology / type to be adopted.

d) Land Slide Prone & Sinking Area

Land slide and sinking prone location noticed and subsequence measures are proposed.

Sr.No.	Landslide Location		Disaster Type	Soil/Rock Condition	Landslide Size	
	Start	End			Length	Width
1	6300	6340	Sinking Portion	Soil	40	30
2	7950	8000	Sliding Portion	Soft rock	50	30
3	8500	8700	Sliding Portion	Soft rock	200	30
4	16000	16167	Sinking Portion	Soft rock	167	30

Landslide Countermeasure Work: Gabion toe wall, Vegetation Mat (Steep Slope), Crib Work, Groundwater Drainage Work, Anchor Work & Rock-bolt Work.

e) Dumping area identified on the Proposed Road

It has been estimated that about 14.71 Lakhs cum of spoil will be generated due to widening of this road. Only 6.00% of the spoil will be reused during construction of the road rest will be disposed off in an environmental friendly manner. Consultant has identified 2 disposal sites but which are not sufficient to accommodate the spoil. More sites need to be identified based on consultation with communities.

This remaining earth shall be disposed off in an environmentally suitable manner. Certain guidelines for debris disposal are given below.

- The debris generated shall be disposed of within designated areas only.
- The filled up area shall be used for designated purposes such as: Play ground, Truck Lay-by, short relocation & realignment portion.

There are 3 No. of dumping areas on the Proposed Road

Sr.No.	Chainage		Side	Remarks
	From	To		
1	**6400**	**6500**	**LHS**	**Gabion toe wall & compaction of disposal material**
2	**Topkhani on NH-10**		**RHS**	

f) Pavement Design

It is based upon CVD-464, CBR-5%, Traffic msa -10, Design period – 15 years, VDF-1.5, Annual Growth of traffic rate 7.5% and Design speed 30.00 Km/h. However the proposed pavement composition is based on CBR-5% and msa -20.

Pavement composition is designed as under:

Proposed pavement.

BC	:	40 mm
SAMI	:	Double layer
CT Base in 1-layers	:	170mm
CT Sub base in 2-layers	:	250 mm
Total	:	460 mm

h) Shoulder Design

The carriageway width of 7m and paved shoulder width of 1.5 m on each side shall have the same pavement as the carriageway. The remaining 1.0m on each side shall be used to

accommodate side drain on hill side or parapet/soft shoulder on valley side. In the hill side, depending on the total width of side drain, there is a small width remaining between the wall of side drain and paved shoulder, therefore it is also paved to avoid erosion by surface water

i) Culverts:

The project road traverses through mountainous and steep terrains with several natural drainages such as deep gorges, depressions, etc., where perennial water and rain water runoff are collected. Sometimes the storm runoff is accompanied by large quantities of debris from upstream side of the nallahs. Cross-drainage structures/culverts are required at these locations. From the field survey and investigations and geometric design of alignment the requirement of culverts for the whole length of the project have been identified.

Sr.No.	Type of culvert	Description	Span X Depth	Km 0 to Km 16.167
1	Type -1	Pipe Culvert	1.2 D	13
2	Type - 2	Pipe Culvert	1.2 D	15
3	Type – 1	Box Culvert	2.0 X 2.0	33
4	Type – 2	Box Culvert	3.0 x 3.0	2
			Total	63

h) Slope Protection works:

Adequate Protective structures are proposed for retaining of cut/fill slopes to ensure stability of the road formation at locations where required. The proposed type and length of each structure are shown in the table below:

Sr.No.	Description of Item	Unit	Quantity
1	Retaining Wall 3.00m high	Rm	810.00
2	Retaining Wall 4.00m high	Rm	370.00
3	RCC Retaining Wall 5.00m high	Rm	150.00
4	RCC Retaining Wall 7.00m high	Rm	130.00
5	RCC Retaining Wall 10.00m high	Rm	170.00
6	RCC Retaining Wall 12.00m high	Rm	110.00
7	Breast Wall 2.00m high	Rm	4645.00
8	Breast Wall 3.00m high	Rm	3605.00
9	Gabion Wall 2.00 m high	Rm	460.00
10	Gabion Wall 3.00 m high	Rm	820.00
11	Toe Wall 2.00 m high	Rm	460.00
12	Toe Wall 3.00 m high	Rm	985.00
13	Cut Slope Wall	Rm	3000
14	Seeding and Mulching (Soil Cut Slope)	sqm	30000
15	Vegetation Mat (Steep Slope)	sqm	1400
16	Crib Work (F300)	sqm	300

Sr.No.	Description of Item	Unit	Quantity
17	Crib Work (F500)	sqm	400
18	Groundwater Drainage Work	metre	1500
19	Anchor Work	Rm	200
20	Rock-bolt Work	Rm	150

k) Bridge

S/N	From	To	Super structure	Foundation	Remarks	Length in m	Remarks	
1	720.0	1400.0	PSC	Pile	Ranikhola	680.0	Proposed	Alignment
2	2440.00	2500.00	RCC	Open	Aho Khola	60.0	Existing	Ex.Road
3	6140.00	6160.00	RCC	Open	Andheri Khola	20.0	Existing	Ex.Road

l) Drainage Design

Pavement Drainage includes camber / cross fall of 2.50%.
Slope 3.5 % has been considered for drainage of shoulders.
Roadside drains are designed: Lined drains in case of soils

Sr.No.	Type	Package-1	Remarks
1	Type-1	10763	Ordinary Soil stretch Rocky & Steep Stretch & Catch water drain at box cutting portion
2	Type-2	7967	Built up area

Chutes of the culverts form part of the culvert structure to lead the discharge to the catch-pit or to natural drainage channel.

m) Road Sign, Markings and Furniture

The project design includes (a) Mandatory / Regulatory Signs, (b) Cautionary / Warning Signs and (c) Information Signs.

Route Marker Signs are provided.

KM Stones are included as per type design.

n) Street Furniture

Traffic Safety Posts and Parapet Walls are included.
Traffic Signs Marking & other Road Appurtenances

o) Roadside Amenities

The continuous long distance travel on highways at speed is liable to cause fatigue as also mental tension to the road users. Moreover, the monotony of driving over long sections in the rural areas with no likelihood of any cross traffic brings sense of complacency in many drivers and such distractions could result in serious accidents.

Sr.No.	Description	Nos.	Location
1	Public Toilet	2	Near Ranikhola (Km 1+500 to Km 1+600) & Paykong (Km 16+000 to Km 16+167)
2	Bus Shed	2	
3	Bazar Shed	2	

7. HYDROLOGICAL & DRAINAGE STUDY

The proposed road alignment is located in hilly terrain wherein the water drains to Rani khoola. The shape and size of the catchment with respect to Major River Rani khoola is defined on the ground. The hydrological investigations shall be carried out to collect the data in respect of catchment characteristics, rainfall, stream channel characteristics, design discharge; water way etc. for all bridges and cross drainage works. Topography of hill generates numerous water courses. Uncontrolled water is the primary cause of problems and even failures of complete sections of roadway structures. The proposed road is widening & up-gradation of existing road formation. The requirement of drains has been identified.

8. GEOLOGY OF THE AREA

The soils in the project area are primarily silty sands with gravel and rock fragments. They have been derived from parent rocks such as quartzite, phyllite, schist, phyllitic quartzite and collumial materials. Soils are generally acidic to very acidic.

The area exposes predominantly low grade metamorphite rocks comprising phyllitic rock with minor quartzites. Based on the field observations and microscopic study, rock of this area can be classified into the following (i) Phyllites (ii) Phyllitic quartzite (iii) Fine grained quartzite interbedded within phyllite bands. The rocks are highly jointed with diversity in their orientations.

9. SEISMICITY OF THE AREA

Sikkim is located in Zone-IV according to seismic zoning map. The state of Sikkim is spread on the Himalayan mountain range with two main thrust faults; Main Boundary Thrust (MBT) and Main Central Trust (MCT) crossing the state. Due to continuous thrusting of Indo-Australian plate against Eurasian plate, Sikkim has been a moderately active seismic region in the historical times.

10. DIVERSION OF EXISTING ROAD DURING CONSTRUCTION

For improvement of existing road some stretches localized, relocation and re-grading are proposed. Due to which traffic movement on existing road will be hamper .Therefore temporary diversion of existing road is very much necessary during construction period.

11. MAINTENANCE OF EXISTING ROAD:

The existing road is the main route to provide connectivity between Sub-Division Head Quarters of the East District and Green Field Airport to rest of Sikkim. The minimum construction time provided for completion of the project is 4(four) years during which maintenance by the PIU will be no longer convenient as the site possession is resorted to hand over to the contractor till completion of the project. Under this circumstance, it is inevitable to keep provision for yearly maintenance of the existing road during

construction and hence a provision of Rs.59.54 lakhs per year is made to make the road playable for all type of vehicles without serious interruption of the traffic flow throughout the year.

Scope of Maintenance:

1) Maintenance of Earthen Shoulder (filling with fresh soil).
2) Filling Pot- holes and Patch Repairs with open - graded Premix surfacing, 20mm.
3) Hill Side Drain Clearance.
4) Land Slide Clearance in soil/ rock
5) Clearing Grass and Removal of Rubbish.
6) Maintenance/repair of culvert/Retaining wall.
7) Clearance of culvert before monsoon
8) Removal of land slide

12. ENVIRONMENTAL IMPACT ASSESSMENT

The proposed up-gradation of NH 717 A from Km 0+00 to Km 16+167 in Sikkim will serve Eastern belt of Sikkim state. The preliminary Environmental Impact Assessment does not envisage any Negative Impact. The preliminary study suggests numerous beneficial impacts on the environment.

As there is no new alignment that passes through forest areas, there are no endanger species both in plants and animals, the project will not attract the provision of Forest (Conservation) Act 1980 vide Govt. of India. Ministry of Environment & Forest No. 4-1/97-FC Dt. 18.2.1998.

Nevertheless, all possible measures will be taken to mitigate any adverse environmental impact the project may cause to the environment.

The air pollution due to emission/effluents from the construction machineries will also be negligible. The stream pollution due to spillage from the construction machineries will also be negligible. As the construction work involves widening of existing road formation, no adverse effect will occur on aquatic life system.

The alignment has been adjoined by private land and households, there will be damage to private crops and plantation, further private house will be affected, and hence relief and rehabilitation scheme shall be required and included in the project.

13. LAND ACQUISITION PLANS AND FOREST CLEARANCE

a) Land Acquisition Plans

The alignment passes through private lands, households, gardens and other properties. Up-gradation of this road by widening the formation width and diversion of the alignment, improving the geometry (including gradient) is going to occupy private properties, crops, plantation, houses, etc. Hence, compensation will be provided for the above properties, as well as relief and rehabilitation wherever the local populations are displaced due to dismantling of their houses. For this matter, required fund shall be required for compensation or relief & rehabilitation.

- The alignment plan was submitted to DC, East vide Letter No. 374/PDS/R&P/973 dated 23/06/2015 and Sub sequential Letter No 161/SDO/P dated 16/07/2015 valuation of house along the project corridor submitted an amount of Rs.4,24,28,045.00 for 31 nos houses.
- Shifting of utilities of along project corridor is already carried out for an amount of Rs.28, 461,367.00 via letter No 1 (6) Gen /PSD-I/04/1959, dated 20/01/2016 by Energy & Power Department.

b) Forest Clearance

The Sikkim State Forest authorities conducted a detailed survey of the alignment and the following is the findings of that survey:

1) That the proposed road alignment does not form part of National Park, wild life sanctuary, biosphere reserve, tiger reserve, elephant corridor, etc.
(2) No rare/endangered/unique species of flora and fauna are found in the area.
(3) No protected archeological/heritage site /defense establishment or any other important monument is located in the area.
(4) The requirement of forest land as proposed by the user agency is unavoidable and barest minimum for the project. No alternative for the project exists.
(5) No work in violation of the Forest Act has been carried out.

As per Right of Way of proposed 2 lane standard alignment 26.80 Ha land is required out of which 14.30 Ha existing ROW is already available and 3.24 Ha of forest land at Andheri Khasmal. About 88.80% length of the road passes through land owned/developed by individual land holders under periodic patta and LSC pass, 11.20 % length of the road passes through Reserved Forest & Khasmal Forest. This land will not be available free of cost and also compensation for plantations, crops etc. within the required corridor is to be paid to each individuals.

After due verification and assessment, the Estimate for Net Present Value and Compensatory Afforestation was already duly framed by the concerned Environment and Forest Department. Process for obtaining forest clearance is in the hand of the concerned authority of Government of Sikkim which was submitted to the Ministry of Environment and Forests, Government of India under clause 2.5 of forest clearance 1980.

Tentative estimate of the amount Rs.1, 87, 34,424.00 is already given by the office of the Divisional Forest Office via letter No 1142 dated 20-08-2015

14. MATERIALS, LABOURS AND CONSTRUCTION EQUIPMENTS:

a) Materials:

The rock deposits are available along or the vicinity of the project road alignment. Besides, cobbles, pebbles and sand deposits are available in the rivers or streams crossing the main alignment. Construction materials for GSB, Cross drainage & Masonry R/Wall etc. works, will be available at local quarry within the project corridor and WMM, DBM & BC material from Teesta River & LANCO Tunnel excavated mug within the project corridor .Water Absorption and AIV of these quarries are within the limit of the Ministry's Specifications. Bitumen, steel and cement will have to be taken from Siliguri.

b) Labour:

Local labourers skilled & unskilled are available in plenty. However, where required, imported labourers will also be engaged for road construction works. Since the area is malaria infested, medical assistance with qualified practitioners will be required during the execution of the project. Comparatively higher wages (from the National average) and incentives have to be paid to labourers for the work. It is envisaged that equipment / machine-intensive method would be adopted for proposed construction works.

c) Equipment:

Heavy Machineries like Bull dozers, Excavators, Loaders, Air compressors, Vibratory / Static Road Rollers, Wet-mix plants, Electric generator sets, Motor Graders, Tractor–Rotavators, Hot/batch-mix plants, Paver-finishers, etc. as required for the execution of the work will be arranged by the contractor executing the project.

15. UNIT RATES AND COST ESTIMATES:

The cost estimate for the proposed construction work has been based on the quantities worked out from the design drawings.

a) Unit Rate:

The unit rates for arriving at cost of different components of works are based on Sikkim PWD Schedule of Rates 2012 (for National Highways). For those items of works which are not available in the SOR, separate Analysis of Rates have been carried out and incorporated in this DPR.

- Bitumen (modified graded) (Ex-Siliguri)(Basic rate = Rs 30100.0/ MT + 2% CST, Rs 602+4% SKVAT, Rs 1204 + 1% Env Cess (Cost +VAT) Rs. 313 +transportation from Haldia to Singtam (740Km xRs.11) Rs.8140.0= Rs. 40359.00)

- Emulsion (Ex-Singtam) (Basic rate = Rs 22916.0/ MT + 2% CST, Rs 458.3+4% SKVAT, Rs 916.6 + 1% Env Cess (Cost +VAT) Rs. 238.3 +transportation from Haldia to Singtam (740Km xRs.11) Rs.8140.0= Rs32669.20)

- Cement (43 grade) (Ex-Singtam) (Basic rate = Rs 5500.00/ MT + 2% CST, Rs 110.0+14.5% SKVAT, Rs797.50 + 12.5 Rs. ED 687.50 + 1% Env Cess (Cost +VAT) Rs. 63.0 +transportation from Murshidbad to Singtam (467Km xRs.5.6) Rs.2615.2= Rs 9773.20)

- Cold twisted bars (HYSD Fe 500 Bars)(Basic rate = Rs 45700.0/ MT + 2% CST, Rs914.0+4% SKVAT, Rs 1828.0 + 1% Env Cess (Cost +VAT) Rs. 475.3 +transportation from Siliguri to Singtam (90Km xRs.5.6) Rs.504.0= Rs 49421.3)

- Sand & Aggregate from Teesta River.

b) Project Cost:

The total Project cost for civil construction works and other allied charges and the detail of cost breakup is given in the general abstract of cost in the DPR.

ABSTRACT OF COST ESTIMATE

Sr.No.	Items of work	Total quantity	Unit	Amount (Rs)
	CONSTRUCTION COST			
1	Formation Cutting	16.17	Km	
a.	Jungle Clearance etc			678,993.00
b.	Formation Works	1471472.00	Cum	311,967,874.76
2	Protection Works	15715.00	Rm	273,048,242.15
3	Cross Drainage Works	63.00	Nos	92,471,710.71
4	Pavement Works	16.17	Km	299,082,797.61
5	Km Stones & Road Signs	149.00	Nos	7,266,168.00
6	Road Safety Measures	1500.00	Rm	5,454,000.00
7	Development of Junction		LS	52,882,120.68
8	Bridge Work		LS	432,210,770.84
9	General Items		LS	14,342,301.55
A	**TOTAL OF (1 to 9)**		**Rs**	**1,489,404,979.30**
B	Escalation for 5 years @ 5%		Rs.	372,351,244.83
C	**Civil Cost**		**Rs.**	**1,861,756,224.13**
D	Contingency (2.8% of C)		Rs.	52,129,174.28
E	**TOTAL (C+D)**		**Rs.**	**1,913,885,398.41**
F	Construction Supervision Charge (3 % of C)		Rs.	55,852,686.72
G	Quality Control Charge (0.25% of C)		Rs.	4,654,390.56
H	Road Safety Audit Charge (0.25% of C)		Rs.	4,654,390.56
I	Maintenance for 4Years (0.5%+1.5%x3=5% of C)		Rs.	93,087,811.21
J	Escalation (15% of C)		Rs.	279,263,433.62
K	Agency (NHIDCL) Charge (3 % of C)		Rs.	55,852,686.72
	TOTAL PROJECT COST		**Rs.**	**2,407,250,797.80**
	Say		**Rs.**	**2,407,300,000.00**
	Project Cost per Km		**Rs.**	**148,871,416.07**
	Civil cost per km		**Rs.**	**118,360,259.64**

16. IMPLEMENTATION SCHEDULE

(a) Contract packaging :
The whole project is divided into single packages as given below.

Package No	Package description		Length (km)	Cost (Rs in cr.)	Remarks
	From	To			
Package-1	0.00	16.167	16.167	240.73	Including 1.4 Km length of Ranipool Bye Pass & Bridge over Ranikhola

b) Procurement / Implementation Strategies:

The general conditions of Contract will be as per Standard Bidding Document of Ministry of Shipping, Road Transport and Highways, Government of India, works.

c) Phasing of Construction:

The total cost of the project is Rs 240.73 Cr. which covers costs for formation work, Slope protection and cross drainage works, construction of bridges and pavement works. Construction period of 42 months has been proposed, considering the quantum of activities to be performed including mobilization period needed and four intervening rainy seasons in between.

The project is proposed for commencement during the financial year 2017-2018 with target completion by the year end of 2021-2022. Since the project will be executed through a period of three and half years there will be cost escalation during the period of construction. Considering the rate of price escalation at an average rate of 5% per annum compounded annually after the initial year, the cost of construction and physical and financial phasing of the project is given in the table below:

Sr.No	Year	Cumulative Physical Target (%)	Cumulative Cost (Rs in crores)
1	2017 -18	15	36.11
2	2018 -19	45	108.33
3	2019 - 20	80	192.58
4	2020 - 21	100	240.73

12. TENDER DOCUMENTS:

a) General Conditions of Contract:

The general conditions of Contract will be as per Standard Bidding Document of Ministry of Shipping, Road Transport and Highways, Government of India, works.

b) Technical Specifications:

The Technical Specifications shall be the "SPECIFICATIONS FOR ROAD AND BRIDGE WORKS" FIFTH REVISION 2013, of the Ministry of Road Transport and Highways, Government of India.

c) Project Drawings:

The Project Drawings as produced in Volume –IV of this Detailed Project Report.


CHINA
CHINA
NEPAL
BHUTAN
SIKKIM
WEST BENGAL
N
GYAMCHONA
KM 33.38
HEMATOP
KERANG
KM 19.25
DONKYALA
PHOGE
KM 5.40
GIAGONG
KM 21.38
ZADONG
CHOPTA
KM 0.00
YUMESAMDONG
KM 50.224
JAKTHANG
KALEP
KM 58.10
YUMESAMDONG (S)
KM 37.73
SAMDONG
KISHONGLA
ZEMA III
KM 40.30
YUMTHANG
KM 23.68
DOMBANG
KM 4.17
PHIMKARULA
LACHEN
KM 27.80
CHATTEN
KM 33.00
BANSOI
KM 18.62
PHYAGU
PATALA KM 22.24
BUMP IV KM 8.45
KATAO KM 32.00
TOLUNG
TANKRALA
TOLUNG GOMPA
SATYA BOWL
RANGMARANGE
KM 2.50
SUBRANG
CHUNGTHANG
KM 95.50/0.00
MALLONG
LINGDEM
SANKLANG
KM 6.24
MANUL
KM 74.10
NAKCHOK
CHOLA
MANGAN
KM 66.10
KARSANG
DOGRA LAKE
NATHULA
SHERATHANG
MADONGLA
DIKCHU
KM 32.70
TAMZE
SADA
PHENENGLA
KM 7.00
GANGTOK
MS 17
MENLA
PHAMTAM
TRY JUNCTION
RAJDHANI KM 5.30
RAIGARH
BHEEM BASE KM 7.98
KUPUP
KM 179.1
GANGTOK BYPASS
9TH MILE BYPASS
RANIPOOL
KM 80.60
LAXMAN CHOWK KM164.70
JUNGJING
RABANGLA
GYALSHING
NH - 510
NH - 710
PAKYONG
ROLEP
SINGTAM
KM 61.00
RORATHANG
KM 45.00
LEGSHIP
DAMTHANG
NAMCHI
RONGLI
KM 122.00
ZULUK KM 146.33
PADAMCHEN KM135.40
RANGPO
KM 52.00
REHNOK
KM 97.00
ARITAR
115.00
NAYABAZAR
NH - 710
RISHI
KM 92.00
RACHELA KM 95.00
TANGTA KM 70.00
MELLI
KM 33.90
PAYONG
KM 26.00
ALGARHA KM 70.30
LABHA
THODE
KM 63.00
KALIMPONG
KM 16.00
ROUTE NO - I
TEESTA
KM 28.90
ROUTE NO - II
NH - 10
ROUTE NO - III
KAPHER
KM 33.00
JALDHAKA
KM 33.00
CHUIKHIM
GURUBATHANG
KM 13.10
LEGEND
SARDP-NE ROADS UNDER BRO
SARDP-NE ROADS UNDER SIKKIM PWD
NH UNDER WB PWD
OTHER ROADS UNDER BRO
PROPOSED ALTERNATE HIGHWAY UNDER NHIDCL
PROPOSED ALTERNATE HIGHWAY UNDER BRO
PROPOSED ALTERNAT HIGHWAY UNDER SIKKIM PWD
RIVER / NALLAH
STATE BOUNDARY
INTERNATIONAL BOUNDARY
SEVOKE
KM 25.00 /0.00
NH - 31
NH31
KM 2.00
DAMDIM
KM 27.00
KHUNIAMORE
KM 54.00/0.00
BAGRAKOT
KM 0.00
CHALSA
KM 47.00
NH31
BINAGURI
NH - 31
SILIGURI
KM 0.00
NH31C
TO GUWAHATI
TO KAKRIVITA
TELIPARA
KM 103.00
NJP
KM 10.00
BIHAR MORE
TO BAGDOGRA

SECTION – 1

INTRODUCTION

1.1 INTRODUCTION:

Sikkim, the Himalayan state has been merged in the Indian Union to become 22nd state in 1975. It is one of the most picturesque regions of Asia. The bowl like, mountain girdled state in the eastern Himalayas bordered on the west by Nepal, on the north by Tibet, on the east by Bhutan and the south by Darjeeling district of the West Bengal, lies between 27° to 28° north latitude and 88° to 89° east longitudes. The Sikkim is the youngest and small hill state of India having an area of 7096 Sqkm. Sikkim is surrounded by important mountain ranges. The Chola range of mountains on its east forms the watershed between it and Bhutan on one side and Chumbi valley of Tibet on the other. The well-known Singalila ridge is of the great Himalayas peaks. Sikkim is divided into four districts. The most populated area is the Eastern district, which contains the capital town Gangtok followed by Southern and Western districts. The northern district is sparsely populated because of its inhospitable climate and steep ridges. Lying along the slopes of Himalayas between Tibet and plain of India, cut off from the rest of the world by mighty mountains, Sikkim's scenic beauty has no parallel in the East, Sikkim's historic past, mystic religion, sublime monasteries and age old rituals have an attraction hardly to be found anywhere else in the world. Sikkim is mountainous terrain with cliffs and valleys. Dominating both legend and landscape is the mighty massif of Khangchendzonga known to the outside world as Kanchenjunga; it is the third highest peak in the world, towering at 8550 meters. Sikkim is drained by number of Perennial Rivers. However, the two main river systems are Teesta and Rangit. The other entire stream eventually joins one or the other. Rangit also joins the Teesta just near the border between Sikkim and West Bengal at Melli. Besides the river, there are number of lakes and hot springs which add to the beauty of the region. The important hot springs are Phut sachu, Raeong sachu, Yumthang and Momay.

The Ministry of Roads Transport and Highway, Govt. of India has prioritized to take up for up gradation and improvement of NH 717 (A) from Km 0/00 to Km 19/100 to 2-lane NH Standard in Sikkim. The existing road has steep gradient and sharp curves/zigs at various stretches. It is of single lane road with formation width of 6.00 m to 6.50 m without conforming any standard / specification. As a result, the heavily loaded trucks and large sized vehicles find it difficult to pass through these stretches safely.

The Project Corridor take-off point at km 78/100 (i.e. located at out skirt of Ranipool town toward Singtam) on Sevok-Gangtok section of NH-10 and runs towards North to South direction passing through a number of towns/villages like Ranipool - Aho – Yangtam – Panchwati – Pakyong within East District.

The existing highway NH 717 (A) has steep gradient and sharp curves / zigs at various stretches. It is of intermediate lane standard / specification. As a result, the heavily loaded trucks and large sized vehicles find it difficult to pass through these stretches safely. Since this road is the lifeline and main route of the east Sikkim, it is very essential to construct NH 717 A highway conforming to National Highway Standards (Fig.1).

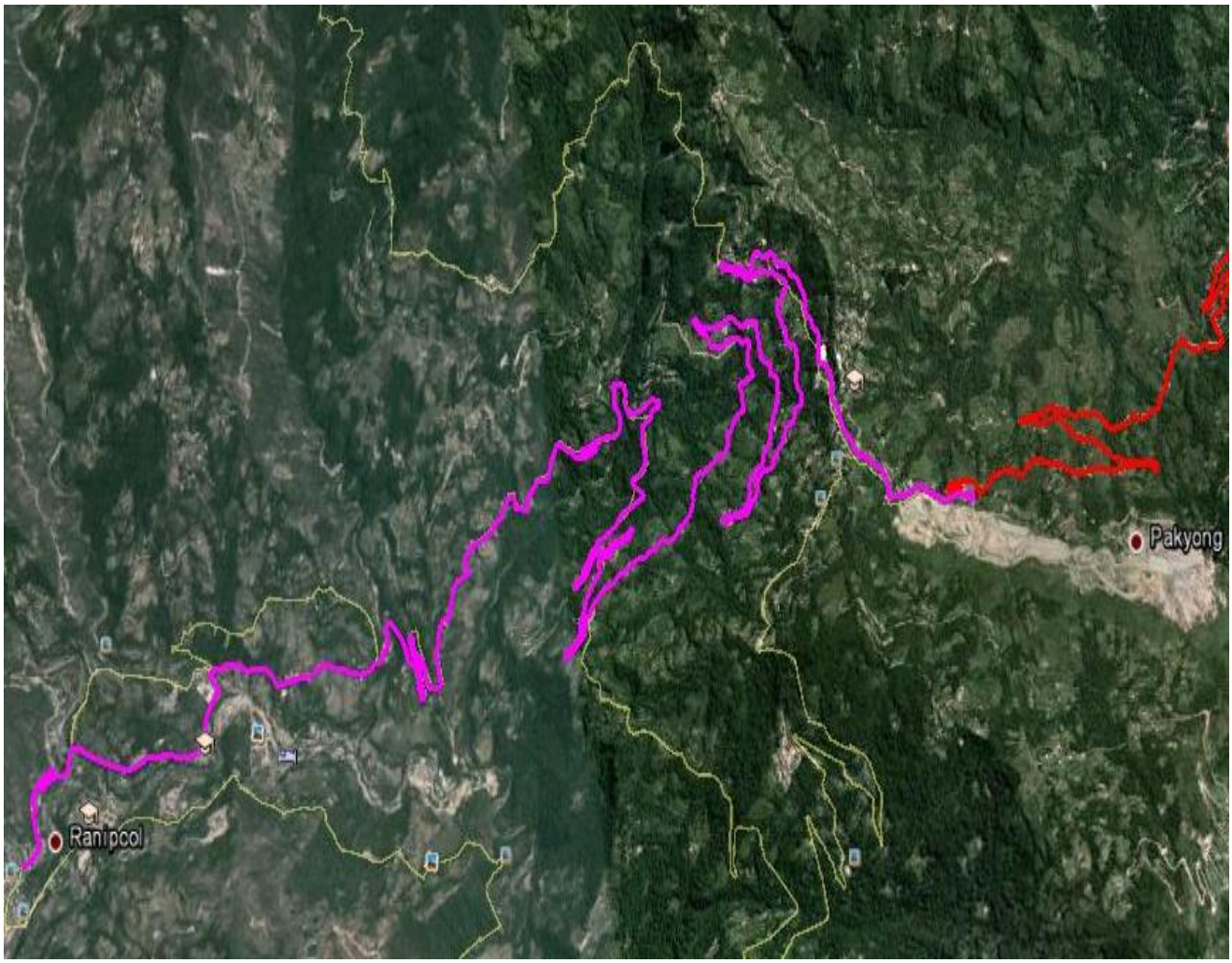


Fig. 1: Location MAP showing existing and proposed Highway

1.2 PROJECT BACKGROUND

The initial stretch of existing / present NH-717 A passes through heavily built-up areas which shall involve costly Land Acquisition and serious resettlement problems for improvement. Due to these reasons, it was felt absolutely necessary to re-align the existing initial stretch of the NH 717 A between km 0/00 – 2/45 by shifting the existing take-off point at km 80/60 to a proposed new take-off point at km 78/100 (i.e. located at out skirt of Ranipool town toward Singtam) on Sevok-Gangtok section of NH-10. The proposed alignment is realigned from the existing road from Km 7/250 to Km 12/520 to bypass the Sinking & Sliding Portion. The proposed realignment take off points are very near due to which, it will not affect and deprive the connectivity with villages and hence, the villagers would be the beneficiaries with the proposed alignment. The proposed re-alignment does not pass through heavily built-up area and would involve much less L.A cost as well as resettlement problem as compared to the existing alignment. The re-alignment also passes through an area with a much better topographical as well as soil conditions. The re-alignment also passes through an area with a much better topographical as well as soil conditions. Hence, apart from the reduction in distance between Pakyong Airport and Capital City Gangtok by Km 2.5, which would greatly

benefit for the public in terms of vehicle operating cost and travel time, the proposed re-alignment is technically far better and financially cost effective in the long run.

The existing NH717 (A) was constructed during the reign of Chogyal, the then King of Sikkim and has a total length of 19.10 Kms .The road alignment passes through frequently cultivated land, Forest plantation & habitation etc. The road was constructed to provide connectivity to East Districts of Sikkim. **The road was upgraded to the status of National Highway in the year 2016.** No substantial improvement of the road other than routine normal repairing works have been carried out since the road was declared a National Highway. The pavement work and the permanent works of retaining wall and cross drainage structures were done at the time of construction as per ODR standards and the width of the cross drainage structures are also only 6.0 m. Most of the retaining wall /wing wall had been collapsed and the road formation width also breaches at many stretches.

1.3 SCOPE OF THE PROJECT

Up-gradation of the existing road, having formation width of about 6.50m, to a formation width of 12.0m, construction of pavement work for the entire length, culverts and permanent works at essential places, widening and improvement of blind curve portion, realignments at the portions where steep gradients have to be avoided, construction of pucca side drains at needy stretches, and installation of traffic/informatory sign and Kilometre.

1.4 PROJECT ROAD

The stretches of the road under this report is between 00/00 Km to 19/10 Km of NH 717-A as per existing chainage required for up gradation & improvement to standard 2 lane. In this portion of proposed highway, about 88.80 % length of road passes through heavily built-up areas & private land which involve costly Land Acquisition and serious resettlement problems in the existing road. The existing alignment also passes through steep terrains which are unstable and landslide prone area at many locations which could also posed serious problems in future.

1.5 THE NAME OF VILLAGE ALONG PROJECT ROAD:

The name of the villages, located nearby the project road corridor, which will be directly influenced by the project road are listed below –

Sr.No.	Existing Chainage		Village Name	Design Chainage		District
	From	To		From	To	
1	0	3000	Ranipool	0	1950	East
2	3440	4500	Aho	2350	3350	East
3	5000	6200	Yangtam	3850	5000	East
4	12550	13200	Panchwati	9700	10350	East
5	14460	19100	Pakyong	11600	16167	East

1.1 REPORT STRUCTURE

The Detail Project Report is presented in the following format

VOLUME I - MAIN REPORT

		Executive Summary
Section 1	:	Introduction
Section 2	:	Socio-Economic Profile
Section 3	:	Engineering Surveys and Investigations
Section 4	:	Geology of the Project Area
Section 5	:	Design Standards and Specifications
Section 6	:	Engineering Designs and Construction Proposals
Section 7	:	Environmental Impact Assessment
Section 8	:	Materials, Labours and Equipments
Section 9	:	Quantities and Project Costs.
Section 10	:	Implementation Programme.
Section 11	:	Maintenance of Existing Road

VOLUME II - DESIGN REPORT

Section -1	:	Design of Road Features, Pavement Composition, Cross Drainage Structures and Slope Protection Works.
Section 2	:	Hydrology and Drainage Study
Section 3	:	Soil Investigation Report
Section 4	:	Traffic Study and Survey
Section 5	:	Inventory Survey

VOLUME III - DETAIL ESTIMATES

VOLUME IV – PROJECT DRAWINGS

VOLUME V – LAND ACQUISITION AND UTILITY RELOCATION DETAILED

CHAPTER – 02

SOCIO ECONOMIC PROFILE

2.1 INTRODUCTION

The project road is between Ranipool to Paykong NH-717-A, in East district of Sikkim State.

Project Location:

- Country : India
- State : Sikkim
- District : East Sikkim
- Road Name : NH-717 (A)
- Project Road Length : 16.167 Kms

Project State: Sikkim

Sikkim State is bordering the eastern Himalayas bordered on the west by Nepal, on the north by Tibet, on the east by Bhutan and the south by Darjeeling district of the West Bengal.

Location	Approx 27 deg. North 88 deg. East
Area	7,096 sq.kms
State Population (As per 2011 Census)	607,688 (Male 3,23,070; Female 2,87,507)
Sex ratio (2011 Census)	957 females/1000 males
Density of population	86 per sq. km
Capital	Gangtok
District, Areas & District Capitals	East District (954 sq. km) -Gangtok, West District (1166 sq. km) - Gyalshing ,South District - Namchi North District (4226 sq.km) - Mangan
No. of Sub-Divisions	9 (Gangtok, Pakyong, Rongli, Namchi, Soreng, Gyalshing, Rabongla, Mangan, Chungthang)
Climate	Tropical, Temperate and Alpine
No. of Zilla Panchayat ward	100
No. of Gram Panchyat	163 units
No. of Revenue Blocks	454
Other Important towns	Jorethang, Singtam, Rangpo, Pakyong,Rhenock, Melli, Chungthang and Soreng
Languages Spoken	Nepali, Bhutia, Lepcha, Limboo, Magar, Gurung, Sherpa, Tamang, Newari, Sunuwar (Mukhia).
Main occupations	Farming, Government and pvt. services
Contractors and Government Employees. Per Capita Income	Rs. 88,137/- (2011)
Domestic product	Rs. 1717 crores (2005-06)
Religions	Hinduism, Buddhism and Christianity

Urban Population	11.07%
% below poverty line	19.2 (in 2005-06)
Death Rate:	4.5 (in 2005-06 per 1000)
Infant Mortality rate	26 (in 2013 per 1000)
State Day (the day Sikkim Became a part of India)	16th May 1975
State Animal	Red Panda (Ailurus fulgens)
State Bird	Blood Pheasant (Ithaginis cruentus)
State Flower	Nobile Orchid (Dendrobium nobile)
State Tree	Rhododendron (Rhododendron niveum)
Percentage of literacy	82.2 % (2011)

2.2 TOPOGRAPHY

The total geographical area of Sikkim State is about 7096 sq. km. The maximum horizontal length from north to south is about 112 Km. whereas the maximum width from east to west is 90 Km. The Tibetan Plateau on the north, Nathula and other passes on the north east, Bhutan on the south east, Darjeeling district of West Bengal on the south and Singalila range of Nepal from the boundaries of this picturesque Himalayan State. It is a hill state having no plain area. The altitude above mean sea level varies from 213 m in the south to over 8500 m in the northwest. The Khangchedzonga, the third highest peak in the world at an elevation of about 8550 m adorns the state with its beautiful range covered with shining snow. Gangtok, the capital is about 1677 m above mean sea level. The northern part of the state is cut into deep escarpments. The northern part is not populated except in Lachung and Lachen valleys. Southern Sikkim is, however, more open and fairly well cultivated.

2.3 RIVERS

The river Teesta is one of the main Himalayan Rivers, which originates in the glaciers of Sikkim at an elevation of over 8500 m above mean sea level. River rises in mountainous terrain and is formed mainly by the union of two hill streams Lachen Chu and Lachung Chu at Chungthang in North Sikkim. After the confluence of Lachen Chu and Lachung chu at Chungthang, the river gradually increases in width and takes a wide flowing down to Singhik, dropping in elevation from 1550 m to 750 m. At Singhik, the river receives one of the its major tributaries, the Talung chug on its right. Talung Chu originates from the Talung glaciers, which are the part of theKhangchendzonga range. From Singhik, the rivers flow towards Dikchu in a very deepvalley and drops from 750 m to 550 m. From Dikchu the river flows in a big curve againdown to the Singtam with a drop of about 200 m. The Rongnichu, which drains theChangu lake area, joins Teesta from left at Singtam and the river receives Rangpo Chuat Rangpo. After Rangpo, Teesta start widening rapidly and is joined by the great Rangit at Melli bazar on Sikkim – West Bengal border.

2.4 CLIMATE

Climate of the study area is of Tropical Monsoon type, with moderate to hot summer, long rainy season and a short spell of cold weather. The maximum and minimum temperatures are 37.4^{0}C and 7.8^{0}C respectively. Maximum and minimum humidity are 89.74% & 58.19%, respectively. The total annual rainfall is around 3200 mm.

2.5 LAND USE

The abutting land use pattern of the project road is predominantly agricultural and/or open land type for throughout the stretch except at a few urban/semi-urban settlements, commercial, industrial areas and BSF camp areas.

2.6 COMMUNICATION

By Air
Bagdogra is the nearest airport for Sikkim. There are regular scheduled flights operated by the Indian airlines and other private airlines between Kolkata & New Delhi, the capital of West Bengal and Bagdogra and also between New Delhi and Bagdogra. Jeep & taxis are available outsides Bagdogra airport for Gangtok. Gangtok is 124 kms from Bagdogra and the journey takes about 4 hours by jeep and 5 hours by bus. Sikkim Helicopter Service is also available from siliguri and other important places in Sikkim.

By Rail /Road
The closest railway stations are Siliguri junction, (Metre Gauge) which is 114km away and New Jailpaiguri (Broad Gauge), which is 125km away. A number of trains are available for Kolkata, Delhi, Guwhati and other important cities of India. Besides jeep taxis, Sikkim National Transport and other private buses ply regularly between Sikkim and Siliguri.

Sikkim Road Network: It consists of 2947.95 kms with road categories mentioned below:

Road Category	**Length (kms)**
National Highway	309.00
State highways	203.03
Major District roads	740.15
Other District Roads	1131.37
BRO Roads	564.40
Total	2947.95

Details of existing road is given in Table : 2.1 given below

Table : 2.1 ROAD NETWORK IN THE STATE OF SIKKIM

S/N	NAME OF ROAD	Category	Status	Length (in km)
1	Manpur Namchi	MDR	BT	19.24
2	Namchi Damthang	SH	BT	12.75
3	Namchi Phong	MDR	BT	17.42
4	Phongla Mamring	MDR	BT	25.12
5	Phongla Bermoik	MDR	BT	18.87
6	Melli-Nayabazar	SH	BT	26.96
7	Nayabazar-Namchi	SH	BT	20.06
8	Goskhan Dara-Sirwani Bridge	SH	BT	2
9	Simchuthang-Pabong-Tarku	SH	BT	14
10	Pabong-Simchuthang Yangang	MDR	BT	18
11	Ravangla-Yangang-Makha	MDR	BT	36

12	Sirwani Bermoik	MDR	BT	10
13	Legship-Rabongla	SH	BT	25
14	Tarku-Rabongla (GLVC)	SH	BT	20
15	Tarku-Damthang	SH	BT	19.09
16	Damthang-Rabongla	MDR	BT	12.36
17	Gyalshing-Pelling	MDR	BT	8.22
18	Gyalshing-Tikjuk	MDR	BT	1.8
19	Legship-Gyalshing	SH	BT	14.78
20	Legship (Gangtok more)- Tashiding Gumpa Phatak	MDR	BT	11.51
21	Yuksom Phatak - Tashiding Gumpa Phatak	MDR	BT	18.33
22	Reshi - Legship	SH	BT	9.71
23	Rimbi-Yuksom	MDR	BT	21.62
24	Pelling-Rimbi	MDR	BT	12
25	Rimbi-Khecheperi	MDR	BT	9.33
26	Kaluk- Dentam	MDR	BT	19
27	Pelling - Dentam	MDR	BT	17.39
28	Nayabazar Budang Soreng via Malabasey	MDR	BT	10.12
29	Nayabazar Budang Soreng via Chakung	MDR	BT	24.48
30	Nayabazar Reshi	SH	BT	14.3
31	Soreng Kaluk	MDR	BT	15.51
32	Nayabazar- Daramdin- Pureytar	MDR	BT	28.52
33	Soreng-Sombarey	MDR	BT	17.61
34	Sombarey Hilley	MDR	BT	25.33
35	Rumtek- Rey- Ranka	MDR	BT	9.72
36	Ranka Sichey	MDR	BT	11.21
37	Gangtok Rumtek Sang	MDR	BT	24.33
38	Penlong Tintek	MDR	BT	16.21
39	Gangtok-Rongyek-Bhusuk-Assam Lingzey	MDR	BT	21
40	TNA Upper Gate to Raj Bhawan Gate I	MDR	BT	0.6
41	Zero Point to Raj Bhawan Gate II	MDR	BT	1.24
42	Approach road to Enchey from Mintokgang	MDR	BT	1.37
43	Approach road to Enchey Monastery from JN road via Chandmari	MDR	BT	1.21
44	Roads In and Around VIP Complex	MDR	BT	1.53
45	Approach road to Forest Colony from Farukh Pan Dokan	MDR	BT	0.19
46	Approach road to Hon'ble Chief Justice Bunglow from Farukh Pan Dokan	MDR	BT	0.38
47	Approach road to Tathangchen School from Guards Ground	MDR	BT	0.33
48	Approach road to DGP Bunglow/TTI Boys Hostel from Ridge	MDR	BT	0.85
49	Ribge Park to Bhanu Path via White Memorial Hall	MDR	BT	0.17
50	Palace Gate to Dukit Pan Dokan	MDR	BT	0.06
51	Approach road to Sikkim Press	MDR	BT	0.36
52	Tshuklakhang to Guards Ground	MDR	BT	0.23
53	Approach road to DC's Bunglow	MDR	BT	0.09

54	Approach road to RIR Station/SP's Bunglow	MDR	BT	0.11
55	Sonam Gyatso Marg to NH 31A via High Court	MDR	BT	0.21
56	DC road from Jeewan Theeng Marg	MDR	BT	0.28
57	Palzor Stadium to District Court (Dr. B.R. Ambedkar Road)	MDR	BT	2.15
58	Palzor Stadium to Indira Bye Pass	MDR	BT	1.23
59	Tri Junctyion to Sichey Co-Operative Society at Middle Sichey	MDR	BT	0.93
60	Palzor Stadium to Police Barrack	MDR	BT	0.18
61	Basilal Petrol Pump to Diesel Power House	MDR	BT	0.57
62	Approach Road to Arithang from Shere Punjab Hotel	MDR	BT	1.18
63	Rai Cottage to Arithang	MDR	BT	0.24
64	Power Secretariat to Deorali via Kashiraj Pradhan Marg	MDR	BT	0.84
65	Approach road to Syari Housing Colony from Deorali	MDR	BT	0.84
66	Approach road to Chorten Complex from Deorali	MDR	BT	0.67
67	Approach road to SITCO from NH 31 A below Deorali	MDR	BT	0.09
68	Approach road to Defence Auditorium from NH 31- A	MDR	BT	0.45
69	Approach road to Bhai School from Khangi Petrol Pump	MDR	BT	0.75
70	Approach road to ICAR Complex from Convoy Groung	MDR	BT	0.14
71	Approach road to Store Complex at 5th Mile Tadong	MDR	BT	1.24
72	Pakyong-Machong	MDR	BT	15
73	Rongli-Rorathang	MDR	BT	9.3
74	Singtam - Cheworebotey	MDR	BT	11
75	Cheworebotey - Pendam	MDR	BT	5
76	Rangpo - Duga Pendam	MDR	BT	15
77	Khamdong Linzey - Tintek	MDR	BT	26
78	Sang - Dipudara	MDR	BT	14
79	Approach Road to Goshkhan Dara	SH	BT	0.06

***Notes MDR = Major district road .SH= Sate highway & BT = Black top**

2.7 PROJECT ROAD: NH 717 A

The Project Corridor take-off point at km 78/100 (i.e. located at out skirt of Ranipool town toward Singtam) on Sevok-Gangtok section of NH-10 and runs towards North to South direction passing through a number of towns/villages like Ranipool - Aho – Yangtam – Panchwati – Pakyong within East District.

- The Projected road alignment passes through frequently open land & cultivated land.

- The height of the road at various locations varies from 821 m at Ranipool , 1365 m at Paykong Town, above mean sea level (MSL).

- The list of the habituated places along the road for the commutation & use are presented in Table No. 2.2 given below:

Sr.No.	Existing Chainage		Village Name	Design Chainage		District
	From	To		From	To	
1	0	3000	Ranipool	0	1950	East
2	3440	4500	Aho	2350	3350	East
3	5000	6200	Yangtam	3850	5000	East
4	12550	13200	Panchwati	9700	10350	East
5	14460	19100	Pakyong	11600	16167	East

Table No: 2.2 Lists of Town along & nearby Proposed Road

General Project Area

The alignment of the project road passes through North to South (Ranipool in East District to Paykong in East District) direction. The whole length of the project road will be fresh cutting of mountainous as steep terrain with broken contours. The alignment of the project road traverses through frequently cultivated lands & open land .At some places the project corridor is within few kilometers of natural forest and virgin land of thick undergrowth of evergreen bushes and creeping plants.

The altitude of the project corridor is 821m. – 1365 m from MSL a height from mean sea level at the take off point at Ranipool Town and end point Paykong Town. The average annual rainfall in the project area is 3200 mm and is also within the affected area of cyclonic storm and is frequented by cyclone from Bay of Bengal.

Man power needed for the project implementation will be taken from the area nearby the project. However, skilled labour will have to be taken from other towns and cities. Moreover, the working season for road project work is clash with the harvesting season of the people in the area.
More man power may also be needed depending upon the quantum of the requirement. The project road is also a highly malaria infested area; proper medical facilities will be required.

Problems and Challenge Areas

Based on the ground study, reconnaissance & survey and the data collected from PWD Sikkim & other dept. have gained appreciation of the technical and project management problems and have insight of the challenge areas of the project. The general appreciation of the thrust areas are described in the following paragraph.

Accessibility:

To visualize the problems that may be encountered in the development of road network in Sikkim, it is necessary to understand the topographical features of the State with particular reference to its location in the Indian sub-continent. NH-10 under development by Border Roads Organization is the main road link with Siliguri through which the entire need of this State in terms of food grains, construction materials and consumer goods are met.

Seismic Effect: The entire state of Sikkim is earthquake prone and falls under seismic Zone IV with reference to IRC-6. All structures need to be designed with seismic effect as per stipulations in IRC-6.

Land Slide: There is no major potential land slide in the Project road. However, there are four land slides areas.

Plantation: There is thick growth of green vegetation along the Project road.

Stone for Road Construction: While extracting stones for WMM, the quality material should be selectively chosen. If these quarries are used for the complete road, lead for the whole road may be substantial.

Water: In general, water available in the area has been found suitable for use in the road construction work. However, water is not available at all places and has to be transported from the local water points to the construction sites.

Work force: Mostly local people are agriculturists. Road construction requires tradesmen of sorts, skilled labourers and unskilled labourers. Manpower may need to be brought from other part of the country however local manpowers will be utilized for unskilled work such as labourd ,cook, watchman etc. It requires planning and organization for recruitment, training, induction and maintenance including provision of campage, food supplies, medical, welfare activities, etc. Independent facilities are necessitated to cater for the increased workforce.

Contractors: Though small supply Contractors are available in this part of Sikkim, the bulk of the requirement is initially to be augmented from outside. The stone crushers have to be installed for meeting the project requirements.

2.8 PROJECT AREA SOCIAL LIFE

History of Sikkim:

The culture of any place is often depicted through its cuisine, people, religion, language, art & crafts, music and dance. In Sikkim, a perfect blend of all these attributes to make a distinct culture of its own. Not only this, Sikkim embraces a synthesis of various communities along with their practiced religions. Sikkim culture has also been imbibed from the neighboring countries without compromising on its own individuality.

The modern history of Sikkim begins from 1642 A.D. with the coronation of Phuntsog Namgyal as the first Chogyal or king of Sikkim in a tranquil pine covered hill in Yuksom Norbugang in West Sikkim.
The Namgyals were scions of the Mi-nyak House in Kham in Eastern Tibet. It is said that there were three brothers, chiefs of Kham Mi-nyak. A letter dropped from heaven directed the middle brother to go south towards Sikkim where his descendents were fated to rule. It was in Sakya that his eldest son single-handedly raised the pillars of the Sakya monastery and earned himself the sobriquet of 'Khye Bumsa'(the strength of a lakh of men)

Khye Bumsa also earned himself the hand of the daughter of the Sakya hierarch and settled in Chumbi Valley, which remained, for a long time, the epicenter of the later kingdom of Sikkim.

Long troubled by the fact that he and his wife were issueless, Khye Bumsa sought

the blessings of the Lepcha chieftain Thekongtek who was reputed to be able to grant the boon of progeny. Khye Bumsa's wife subsequently bore him three sons. Later Khye Bumsa and Thekong Tek swore the historic pact of eternal friendship at Kabi Longtsok in North Sikkim.
Khye Bumsa's third son Mipon Rab succeeded his father. He, in turn, was succeeded by his fourth son Guru Tashi who moved to Gangtok. Meanwhile Thekongtek passed away and the Lepchas who started fragmenting into small tribes turned to Guru Tashi for leadership and protection. The Sikkim Coronation book describes Guru Tashi as the 'first ruler of Sikkim who paved way for a regular monarchy'.

Five generations later, it was Phuntsog Namgyal who was consecrated as the first Denjong Gyalpo or the king of Sikkim by the three great Lamas who came from the North, West and South to Yuksom Norbugang in West Sikkim in 1642 A.D. The event, predicted as it was by Guru Rinpoche, was the 'Naljor Chezhi' or the meeting of the four yogic brothers or the four saints or four sages.

It was preordained that three saints of great repute from different parts of Tibet make their way to Bayul Demajong (Sikkim) to discharge their responsibility of upholding and propogating the essence of Dharma in the hidden land of Demajong. Thus it was that Lhatsun Namkha Jigme, Kathog Kuntu Zangpo and Gnadak Sempa Phuntsog Rigzin made their way to Sikkim separately, and through impenetrable routes.This historical congregation of the three holy Lamas is called Yuksom, which in Lepcha means the 'Three Superior Ones'.

Lhatsun Chenpo impressed on the other two that they were all Lamas and needed a layman to rule the kingdom righteously. He further pointed out that, 'In the prophecy of Guru Rinpoche, it is written that four noble brothers shall meet in Demajong and arrange for its government. We were three of those who came from the North, West and South'. As for the East, he quoted the oracular guide book Rinchen Lingpa which mentioned, 'One of my four avatars will be like a lion, the king among beasts, who will protect the kingdom by his bravery and powers'. The book also mentioned that, 'One named Phuntsog from the direction of Gang will appear'.

So Lhatsun Chenpo deputed a hermit called Togden Kalzang Thondup and a layman called Passang to lead a party to Gangtok in invite the person bearing the name of Phuntsog to come to Yuksom Norbugang. After several adventures, the party came to Gangtok where they met Phuntsog milking his cows. Phuntsog invited them in and bade them partake of fresh cow's milk and told them his name was Phuntsog. He saw the invitation of the three Lamas as a most fortuitous event and lost no time in setting out for Yuksom Norbugang with his entire retinue of followers, officers and household establishment.

The coronation took place in the Chu-ta or water horse year in 1642A.D. Thus Phuntsog Namgyal was installed on the throne of Sikkim with the title of 'Chogyal' or king who rules with righteousness, with both spiritual and temporal powers. While the three Lamas spread Buddhism in Sikkim, Phuntsog Namgyal started consolidating his kingdom Twelve generations of Chogyals ruled over Sikkim for over 300 years. tumultuous change in 1972-73. In 1975 the 16th, 1975 Sikkim was formally inducted as

Sikkim People

Sikkim has an interfusion of diverse commu specimen of harmony between people from communities are the Lepchas, Bhutias and I by the plainsmen, who have settled there, o

Sikkim Cuisine

Sikkim has a blend of cultures and traditior

of this state. The bizarre combination of various cuisines has resulted into a specific cuisine, which is now called as cuisine of Sikkim. Today, Sikkim boasts of its own dietary culture that comprises food habits and some special recipes.

Sikkim Languages

Language is undoubtedly a crucial medium to communicate. Sikkim is a multi-lingual state, where people of many communities reside harmoniously. Nepali can be termed as the major spoken language in Sikkim. However, English is also frequently used, though it is mainly spoken in municipal areas.

Sikkim Religions

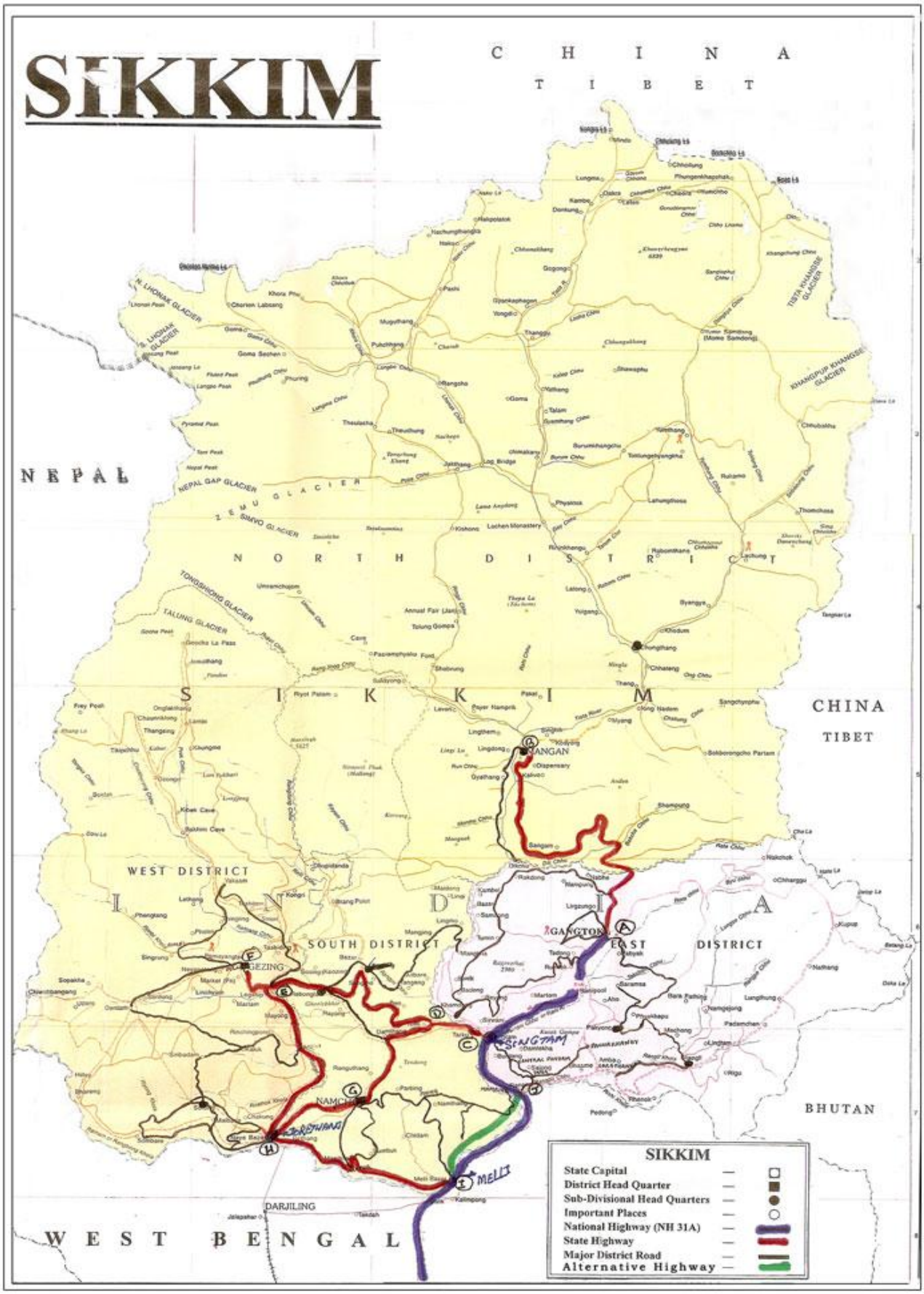
The Sikkimese are highly devout people and religions play a major role in Sikkim. Buddhism and Hinduism are the two major religions of Sikkim. Perhaps, Buddhism comes into view as the predominant religious practice in Sikkim. Though, Hinduism is the actual religion that is followed by the majority of people.

Sikkim Art and Craft

Sikkim is renowned for its dazzling and appealing beauty. The charm of this state is ever enticing and no one can remain abstain from its allure. In fact, Sikkim is resplendent with not only its natural beauty but with its art and craft too. The cultural richness of Sikkim is visible in its quality handicrafts.

Sikkim Dances

The cultural heritage of Sikkim is expressed in its traditional folk dances. Sikkim is domiciled by many ethnic castes and tribes; each of them has its own interesting folk dances. These folk dances and music have become an inseparable part of Sikkim Culture.


SIKKIM
C H I N A
T I B E T
NEPAL
N O R T H D I S T R I C T
S I K K I M
CHINA
TIBET
GANGTOK
EAST DISTRICT
WEST DISTRICT
SOUTH DISTRICT
I N D I A
GEZING
NAMCHI
RAVANGLA
MELLI
DARJILING
BHUTAN
W E S T B E N G A L
SIKKIM
State Capital
District Head Quarter
Sub-Divisional Head Quarters
Important Places
National Highway (NH 31A)
State Highway
Major District Road
Alternative Highway

SECTION – 3

ENGINEERING SURVEYS AND INVESTIGATIONS

3.0 ENGINEERING SURVEYS AND INVESTIGATIONS

3.1 TOPOGRAPHICAL SURVEY

a) General

Topographical survey was performed in order to set up a digital terrain model of the area. The survey covered a strip of 30-40 m width with cross sections taken at 20 m intervals.

Topographical surveys included the following:

Control Point Survey
Traversing
Cross-section Survey
Establishing Bench Mark

b) Methodology for Topographical Survey

Topographical survey was carried out with Total Station, Auto level and checked with GPS, state-of-the art instruments. The survey methodology involved the following sequential steps:

Control Points: Establishing control points in the form of temporary bench marks (TBM) at 1 km intervals (approx.) on ground and running traverse along tentative alignment using Total Stations. Reference Pillars consisting cement concrete pillars with central nail point; have been fixed at every 200m to 250m intervals depending upon safe site location.

Traversing: Connecting all control points with one or more Benchmarks using precision Auto Level and Total Station.

Cross-section: Taking detailed cross sections at 20 m interval using Total Station. The main features captured in the cross-sections were:

- *all natural ground break-point within the Right-of-Way (ROW)*
- *Property lines within ROW.*

Cross-sections were also taken along intersecting roads to a distance of 200 m for major roads and 50 m for minor roads. 3-point cross-sectional data 100 m upstream and downstream of waterways were also gathered.

The data for each survey point were recorded in terms of Northing and Easting and Elevation to an accuracy of 1 mm.

Establishing Bench Mark: Due to non-availability of Survey of India reference bench mark, bench mark elevation was carried from Singtam Johar Bridge BM pillar. Based on this reference BM, TBMs were established along the proposed road alignment, using auto levels and double leveling method.

In addition, all TS stations were also leveled. Permanent cement concrete pillars were established at 1 km interval.

Chainage Marking : The project road has been marked with chainages on center of pavement at 50 m apart in straight and at 10 m in curve portions. The chainage marking on the road enabled proper inventory of all the items required for design and act as reference points for cross sections.

c) Topographical Survey

Based on the Control / traverse station fixed along the stretch for horizontal and vertical control,

surveys using total station were carried out to collect co-ordinate data (Northing and Easting) of all topographical points. The details covered included:

- Road centerline of regrading stretch and trace-cut centerline of re-alignment stretches.
- Left and right edges of existing road pavements
- Connecting roads
- Ground points on both sides of Road centerline and trace-cut centerline for exact computation of quantity.
- Trace-cut in hard rock area is for reference as the alignment points were not approachable due to vertical rock formation.

All man-made features have been surveyed including:

- Water sources including hand pumps, wells, etc.
- CD structures including culverts, bridges, etc
- Slope protection structures such as Retaining wall and Breast walls
- Buildings, huts, boundary walls, etc
- Electric pole, telephone poles , mobile tower etc.

All natural topographical features have been surveyed both in regrading and realignment stretches:

- Streams, channels and water sources
- Ponds and water bodies

Survey for Cross Sections

In order to provide proper design and quantity estimation, cross section survey has been carried out. The cross section survey included collection of elevation and other relevant heights in the corridor width. It contained the topographical survey which is utilized to create a proper Digital Terrain Model (DTM) so as to enable design of road geometrics, plan and profile, cross sections and quantity computations for various items including earth work, sub-grade and pavement.

Plan and Profile

The plan shows the recommended centerline of the regrading and realignment stretches, existing and proposed carriageway structures, drainage courses, intersections, electric and telephone poles, control traverse stations, proposed location of CD works in regrading and realignment stretches. Hill valley sides along with all the villages and habitats coming in proposed route.

The longitudinal section shows the average existing ground level (left and right), the existing centerline levels, the proposed road level, the gradient, details of horizontal alignment and location of cross drainage structures along with cross roads, etc.

3.2 TRAFFIC SURVEYS

In order to establish the traffic characteristics of the project roadway the following traffic surveys were carried out:

i) Classified Traffic Volume Count
ii) Intersection Turning Movement Count Survey
iii) Origin-destination Survey

The methodology of traffic surveys and analysis of results have been presented in "Traffic Surveys and Analyses" in Volume II.

3.3 GEOTECHNICAL INVESTIGATION

Investigation was undertaken to characterise the soil forming the sub-grade by collecting samples by digging pits along the proposed road. Information regarding the top soil strata along the new proposed alignment was also collected.

Laboratory investigations were performed on collected soil samples, according to relevant Indian Standards to determine the engineering properties, namely:

i) Particle size distribution
ii) Atterberg limits
iii) Field density
iv) Field moisture content
v) Compaction characteristics
vi) 4-day soaked CBR

Soil investigation results and analyses have been presented in detail in "Design Report" section.

3.4 MATERIALS INVESTIGATION

Material survey of the area around the project road was conducted to identify the sources of suitable materials which can be used for construction. Samples collected from various sources were tested for their engineering properties and assessed for their suitability to be used in new construction.

Field investigations were performed to gather following information:

i) Identification of suitable sources of granular material for base course.
ii) Testing of physical properties of collected material for granular materials.
iii) Testing of engineering properties for stone aggregates for use in WMM, DBM,BC and cement concrete.

3.5 HYDROLOGICAL INVESTIGATION

Hydrological investigations were carried out for economical design of cross drain structures. These investigations included performance of existing structures, assessment of discharge, HFL and other data as required for design.

Local enquiries were also made regarding HFL and watermarks were observed. For detailed study, site conditions, survey data, meteorological data were studied. Survey for taking cross sections, long sections of existing rivers and drains were carried out as per IRC code requirements.

3.6 ROAD –SIDE GEOTECHNICAL INVESTIGATION

Trial pits were excavated at 5 km intervals in a staggered manner to carry out investigation of field density and moisture content, in-situ CBR, laboratory CBR under control condition and sub grade soil properties.

3.7 ALIGNMENT OPTIONS

3.7.1 Introduction

The objective of the Route alignment study is to determine various alternative alignment options and to identify relative acceptable and preferable alignment. With a view to appreciate the feasibility and relative strength, weakness of the alternative proposals marked on the topo-sheets, and site evaluation of the same have been carried out. This was manifested through identifying the problems, shortcomings along with probable route.

The Project Road from Km 0.00 to Km 32.50 has road geometrics is not upto NH Standards. For the up-gradation of the road to the National Highway Standards, the existing gradients & radius have

to be improved for safe and smooth flow of traffic. However, in many stretches, the gradients are very steep and the road has to be realigned. Based on the reconnaissance and other surveys, it is identified that more or less the complete road has to be reshaped. In this effort, there are two situations for improvement of the road geometric:

- Realignment Sections
- Regrading Sections

Re-alignment Sections

The existing road geometric in certain stretches cannot be brought within the permissible level of the road geometric of the National Highway Standards due to several considerations. In view of that, the realignment has been resorted to. We have studied a number of options before finalizing the realignment sections.

Re-grading Sections

The balance portion of the road after realignment is to be regraded in order to remove kinks, undulations, unevenness and fast changing gradients so as to bring the geometrics to the parameters of the National Highway Standards. Efforts have been made to adopt the existing road level in stretches. However, it is to bring it within the parameters of the prescribed geometric standards. In view of that the existing road is to be adopted by cutting, filling and widening as well as by relocation more or less in the same area.

3.7.2 Critical Factors in Alignment Selection

The critical factors to be considered in the selection of the alignment are as follows:

The alignment should meet the geometric standards, particularly the gradients and curvature.
It should avoid acquisition of commercial and residential establishments.
It should avoid costly land acquisition.
It should be as directional as possible, i.e. least distance.
It should facilitate smooth traffic dispersal.
It should be environment friendly.
It should have minimum provision of structures.
During the detailed topographical survey, the existing road centre line has been marked on the ground and details surveys have been obtained on the existing road. However, in hard rock and hazardous areas the trace-cut is serving as reference line only.

3.7.3 METHODOLOGY

The Methodology Adopted Is Described As Follows :

Step – 1: Contour Map Study

Contour sheets are very important for fixing the alignment of the road and to design the road geometric, particularly in the hill road. Based on the contours, approximate alignment options have been studied taking into account the level difference between take-off and the terminal points. This exercise was done with a view to have an approximate understanding of the alignment options. The alignment marked on the contour sheets are planned to achieve the required length

Step-2: Satellite Image Study
Satellite image is very useful for fixing of the new alignment. Satellite image gives three dimension picture of the project area. Based on the contours, clear view of water channel & terrain condition, approximate alignment option has been studied. This exercise was done with a view to have a better understanding of the alignment option.

Step-3: Fly Level Survey

After the detailed study of the contour sheets and the available data, fly level survey of the entire road was carried out by using Auto Levels and the support instruments in order to generate the road profile. The gradients of various alignment options were generated in the shape of strip plan showing gradient of proposed road.

Comparative Statement for Option Study Airport Road

Sr. No.	Description	Option-1	Option-2	Option-3	Option-4	Remarks
	At Ranipool (Intial Stretch)					
1	Take off point	From Ranipool Bridge right bank of Rani khoola	Agriculture college approach road which 700m form Ranipool Bridge	Science centre approach road road which 2100m form Ranipool Bridge	Industrial area approach road which 1300m form Ranipool Bridge	To Bye pass the heavily built-up Ranipool Bazar Portion
2	Length of alignment	2800 m	2000 m	1400m	800	Follow the Rani khoola RHS Bank then behind the SARAMSA Garden in Option-1
3	Ending point	Km 3.4	Km 2.48	Km 2.48	Km 1.28	On Existing Ranipool – PaKyong road
4	Length of Bridge	(1400+30+42)m	(200+30+42)m	(680+60+20)m	(200+30+42)m	
5	Nos of Bridge	3	3	3	3	1 new bridge & 2 Existing Bridge
6	Alignment passes through	Along the Rani Khoola	Agr Coll. Land & NH 31A Built up portion	Smile Land NH 31A Built up portion	Industrial Area NH 31A Built up portion	Op-2 to Op-4 Land cover building
7	Compensation & LA	Very small	Required	Required	Required	
	At Sinking Portion from Km 7.80 to Km 12.50					
8	Take off point	Km 7.40	Km 7.40	Km 7.40	Km 7.40	Near the 4th Bridge
9	Length of alignment	3.54 Km	3.54 Km	3.54 Km	3.54 Km	Bye the Sinking & Sliding Portion
10	Ending point	Km 12.57	Km 12.57	Km 12.57	Km 12.57	At Pakyong short cut route
11	Total Length of Road	18.70 Km	19.20 Km	18.00 Km	19.36 Km	Including all diversion
12	Total Length of Bridge	1472 m	272 m	322 m	272 m	Including 3rd & 4th existing
13	No of Cross Drainage	90	106	106	106	
14	Rm Protection work	3000	4900	4900	4900	
15	Compensation	Minimum	High	High	High	
16	Geometry	Very good	Zig-zag road	Very good	Zig-zag road	
17	Land acquisition	Very small	Very high	Very small	Very high	
Recommended option No-3						

CHAPTER – 4

Geology of the Project Area

4.1 GEOLOGY OF SIKKIM

The preliminary geological survey of the locations of all the structures on the ground was carried out after site visits. The site-specific geological data were collected and utilized in the design of various component of the project. The survey of the nearby area was also carried out to co-relate the geology of the project area.

The engineering geological investigations are the most important basis for assuming the design considerations for the tunnel system. The geological conditions in the area are considered for the design of the tunnel system to find the best location, orientation, shape and dimension of the tunnel. The location and orientation has been selected after preliminary geological investigations. Geological investigation involved-

- Topo Map and Satellite Imaginary studies
    - Digitization of Topographic Maps
    - Land Use, Drainage and Landslides studies with the help of GIS work
- Geological Survey
    - Geological mapping for overall project area and detailed geological map of the tunnel portal with the help of handy GPS, DGPS, Total Station and Geological Instruments.

The Indian State of Sikkim is mainly located in the watershed of the Tista River .Through the foothills of the Himalaya, the Tista and its tributaries have deeply eroded the terrain. Landslide occurrences are quite common in the Sikkim Himalaya; the main reasons for this phenomenon are attributed to the geology of the area and the high intensity of rainfall. Apart from these reasons, recent development, particularly road and housing construction have aggravated the incidence of landslides and subsidence problems **(Mehrotra et al., 1996)**. Geologically, Precambrian rocks cover a major portion of the Sikkim Himalaya and are represented by the following four major rock formations, listed from youngest to oldest **(Raina and Srivastava, 1981)**:

- Everest Pelitic Formation
- Sikkim Group
- Chungthang Formation
- Kanchenjunga Gneiss Group

The Sikkim Group of rocks consists of low to medium grade metamorphic and meta sedimentary rocks. East Sikkim is mainly dominated by rocks of the lower metamorphic grades, mainly chlorite schist, sericite schist, and quartz schist. These rocks have a phyllitic appearance. The region of central and eastern Himalaya near the Tista River is characterised by large-scale thrust movements from the northwest towards the southeast. The East Sikkim Himalaya is mainly traversed by two thrusts called the Chungthang Thrust and the Main Central Thrust (MCT), both trending in a NW–SE direction **(Mehrotra et al., 1996)**. The MCT is a well-known tectonic boundary between sedimentary and crystalline rocks, separating the Lesser and Greater Himalaya. It is characterized by crushed rock and fracture zones. The Nepal–Sikkim Himalaya and adjacent foredeep area are dominated by conjugate strike–slip faults that face the wedges of the Indian shield. Rocks of this terrain are characterised by intense folding, metamorphism, and thrusting in a number of tectonostratigraphic units, which exhibit inversion in stratigraphic succession as well as in metamorphic grading.

The area lying on the Eastern Himalaya represents the Gorubathan Sub-group under the Daling Group of Middle to Late Proterozoic age, as per the mostly adopted stratigraphic classification based on the geological works of Ray (1989), Ravishankar et al (1989) and Acharyya et al (1989). It is represented by the lithounits of chlorite quartz schist, chlorite schist. / phyllite with or without sericite, quartz sericite schist, sericite quartz schist, slaty phyllite/slates and quartzite. It forms a part of the northern limb of the Rangpo-Chu antiform. The rocks have attained metamorphism up to lower green schist facies.

4.2 SOIL STRATIFICATION

The soils of this area is in general have derived from parent rocks such as Quartzite, Phyllite, Schist, Phyllitic quartzite and colluvial materials. Soils are generally acidic to very acidic. Occasional dark soils are found due to extensive existence of phyllitic and schists. The soil of this area can be classified mainly mixed sandy loam and loamy sandy soils, sometimes mixed with pebble size sliding particles of existing rocks.

The presence of phyllites makes the slopes of the region prone to erosion and weathering. The possibility of erosion of soil and the reduction of mineral content is increased by excessive rainfall. Such geology is susceptible to natural disasters like landslides. The kind of soil prevalent in the north-eastern state of Sikkim is suitable for deciduous and evergreen forests. The soil does not have a high content of organic matter. The soil is not rich in minerals. The presences of these kinds of rocks have turned the soil of these regions brown and clayey. Due to chemical and physical weathering the low to medium metamorphic rock some outcrops in the proposed area are highly disintegrated and weathered. This has resulted into soil formation on the top layers and the thickness of the loose top soil formation varies between 1 and 2 m at different localities. The soils are primarily silty sands with gravel and rock fragments. Occasionally, the top stratum is also bouldery. The immediate rock strata below the top soil cover, is also highly fractured and

weathered. Several sets of joints are present due to which the rock mass slides at many places due to instability.

4.3 DETAILED GEOLOGY FOR SINKING AREA

Sinking and sliding is one of the major problems in hilly terrain like Sikkim. Landslides occur frequently in the Himalayan State of Sikkim, India. This is due to the high intensity of rainfall that not only contributes to rapid erosion and weathering of the rock mass, but also increases groundwater levels causing reduction in the stability of natural slopes. These factors, coupled with the increase in human activity associated with urban development, have contributed to increased instability of slopes in the region. Corrective and preventive measures to be adopted in a landslide or a landslide-prone area must be based on a detailed integrated geological and geotechnical investigation. In analyzing a landslide, it is important to determine what factors have controlled the formation of the rupture surface and the movement on that surface. This requires an engineering analysis of the stability of the landslide mass and analysis of the changes in geologic and meteorologic conditions that are correlated with landslide activity. This report describes only the geological investigations among the above said investigations for the case of sinking of Airport road, but geotechnical investigations needs to exact support of the stability of the road.

The Airport road from Ranipool to Pakyong consists of several smaller to larger sinking zone. They were having problems because of poor drainage. Due to this poor draining problems, water passes through the roads. The lithounits are mainly schist / phyllite. The rocks have attained metamorphism up to lower green schist facies.

The Airport roads sinking are characterized as composite rock / soil slide-debris flow, in which the slope movements were initiated by sliding on the bedding or schistosity of the rock mass followed by flow of the displaced material. The average slope of the landslide is varying from 25° to 36°. The Main sinking zone starts from CH-8.4 upto CH-10.7. Initially near to CH-8.4 the amount of slip is about 1.5 m with an average sink rate of 5 cm/yr, at CH-9.2 the sink rate is about 15 cm/yr and finally at CH-10.5 the area got maximum sink with an average sink rate of 35 cm/yr. This earth movement affects the surface which preserves by BROKEN BREAST WALL, ROAD DAMAGED, BENDING TREES and also Damage of local houses. Except this large sink/slide remaining smaller sink/slide can be protected by proper drainage and good protection work (like Gabion wall & Retaining wall down hill side & breast wall & catch water drain upstream side along with proper line channel of natural nallah), but this large sink can only protected after knowing the actual story behind it. So, without geotechnical investigation it will be difficult to design the protection work for this large sinking zone.

(Figures are attached bellow)

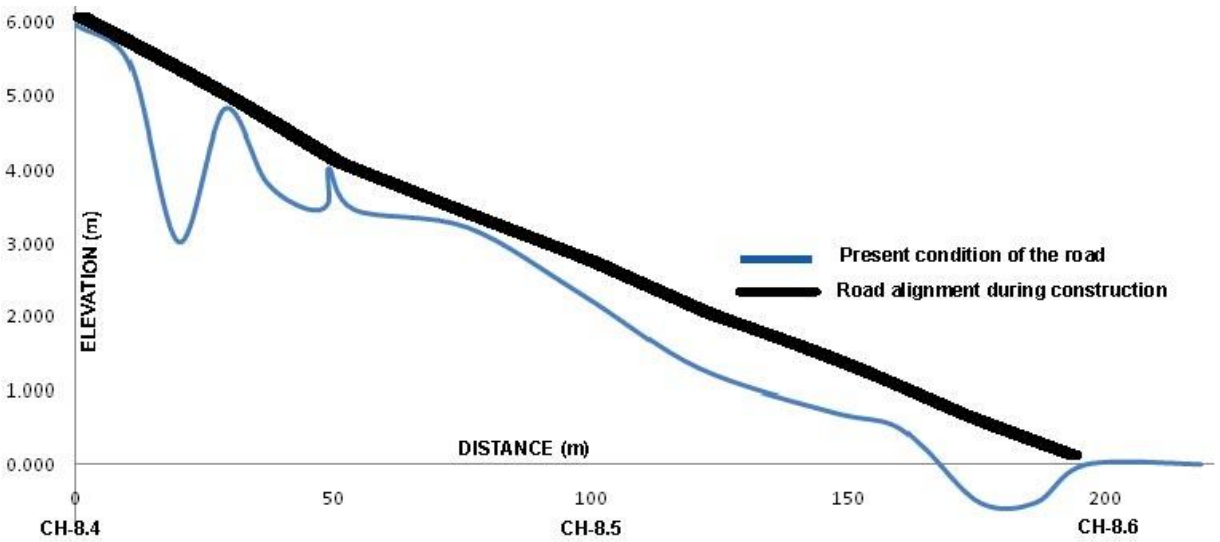


Fig: Surface topography of the Sinking zone at CH-8.4 showing the displacement of the road after sink

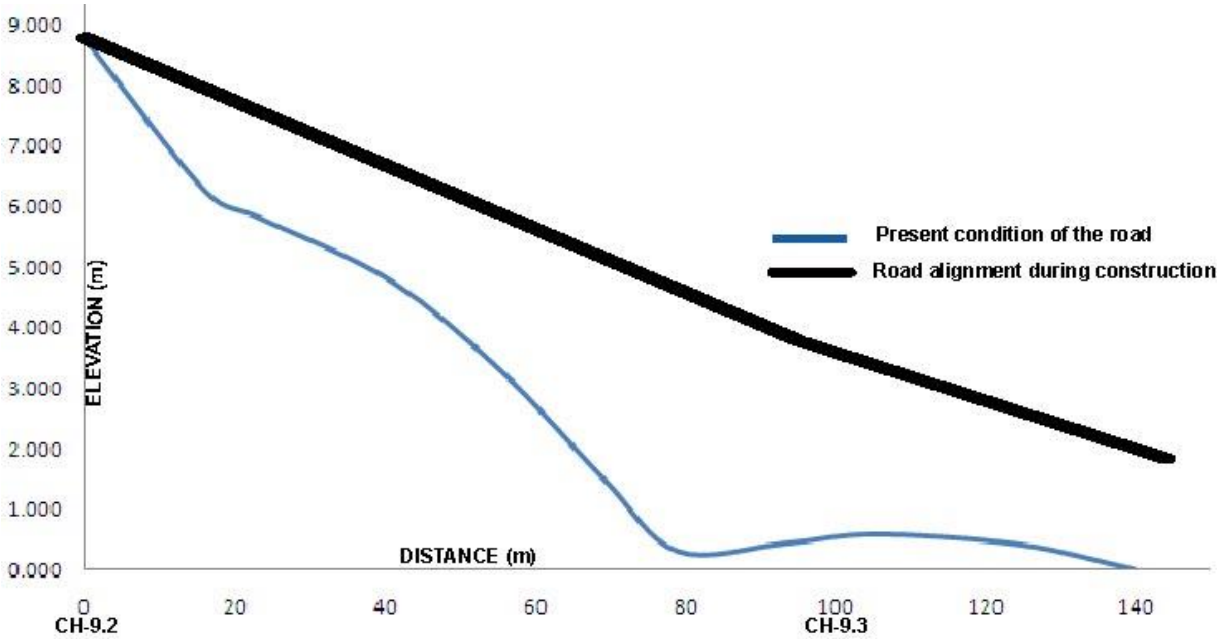


Fig: Surface topography of the Sinking zone at CH-9.2 showing the displacement of the road after sink.

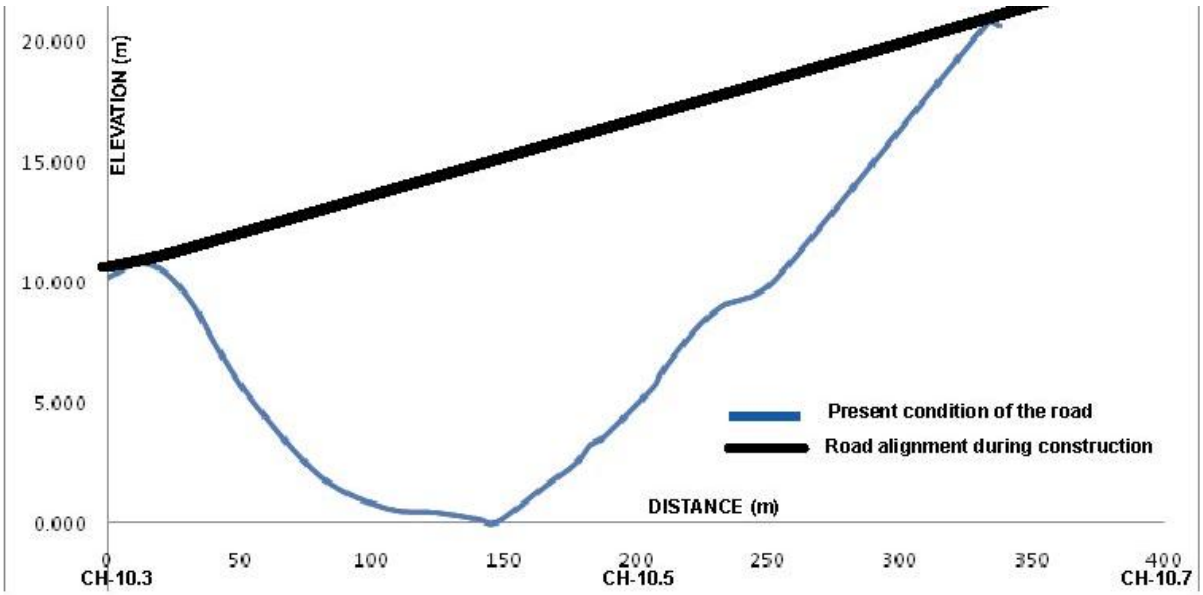


Fig: Surface topography of the Sinking zone at CH-10.3 showing the displacement of the road after sink.

4.4 PAST SEISMICITY OF THE AREA

Sikkim is located in zone IV according to seismic zoning map (**Fig: 3**). The state of Sikkim is spread on the Himalayan mountain range with the two main thrust faults, Main Boundary Thrust (MBT) and Main Central Thrust (MCT) crossing the state (Dasgupta et al. 2000). Due to continuous thrusting of Indo- Australian plate against the Eurasian plate, Sikkim has been a moderately active seismic region in the historical times (De and Kayal 2003; Nath et al. 2000). The significant earthquakes to have caused shaking in the region in the last 50 years include the 19 November 1980 Sikkim earthquake of Mb 6.0, and 21 August 1988 Bihar-Nepal earthquake of Mb 6.5 and February 14, 2006 (Mw 5.3) (*www.usgs.gov*).

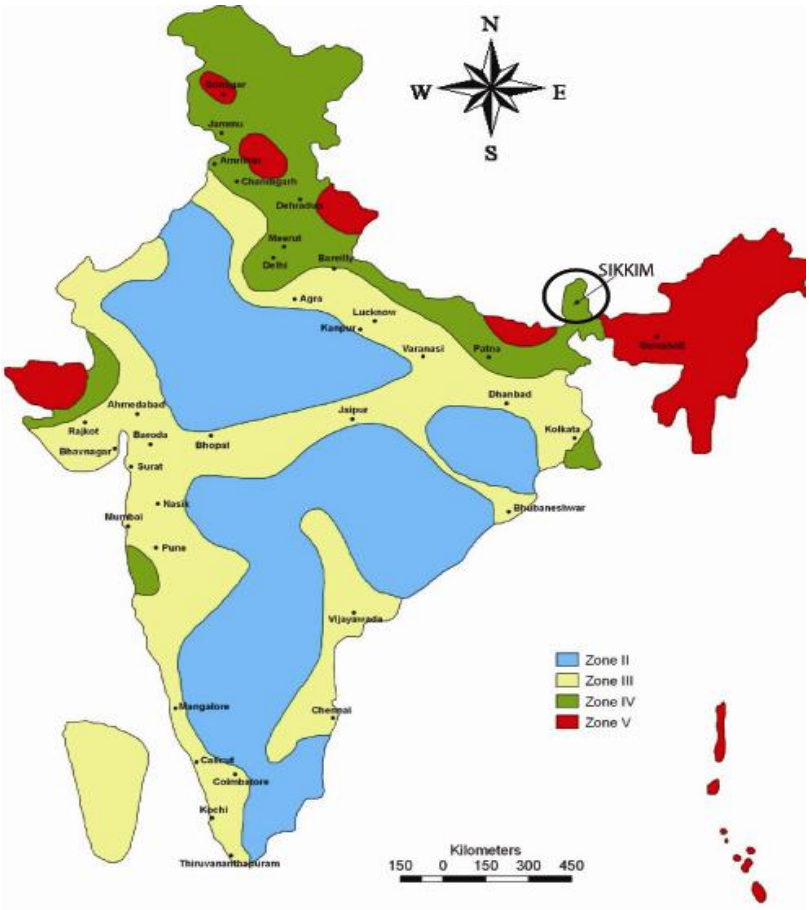


Fig-7: Seismic zoning map of India showing location of Sikkim in zone IV (BIS 2011, New Delhi)

The most recent earthquake (reported as Mw 5.3 by USGS and as ML 5.7 by IMD) occurred in the state of Sikkim on February 14, 2006 at 06:25:23 a.m. local time. The earthquake's epicenter and focal depth were reported from two different sources as, (i) at 27.35°N 88.35°E, near Ralang (South Sikkim), with a focal depth of 30 km (*www.usgs.gov*), and (ii) at 27.7°N 88.8°E, near Lachung (North Sikkim), with a focal depth of 33 km. Two Indian Army soldiers died in landslides after the ground shaking at Sherathang near Nathula in Sikkim; there were no reports of any other fatalities. The earthquake caused damage to heritage structures as well as modern buildings. Both masonry and reinforced concrete buildings showed poor performance. The damage seen in and

around Gangtok was clearly disproportionate to the size of the earthquake, which was a moderate 5.7 on the Richter scale. This very clearly establishes the high level of seismic vulnerability of the region.

Considering the high seismic hazard in Sikkim, chances of moderate earthquakes will be possible in near future, it is evident that the project area is very close to seismically active zone in the vicinity of MCT. Therefore, it is essential to adopt suitable seismic coefficient in the design for various structures of the project. Suitable design for the tunnel can be withstand any future devastating earthquake.

Recently a strong earthquake of magnitude 6.8 on Richter scale was observed on 18.09.11 at 18:11 hrs. Its epicenter was noticed near Sikkim – Nepal border ,about 68Km north West of Gangtok.

SECTION - 5

DESIGN STANDARDS AND SPECIFICATIONS

DESIGN PHILISOPHY

Up-gradation of the existing road, having formation width of about 6.50m, to a formation width of 12.0m, construction of pavement work for the entire length, construction of culverts and permanent works at essential places, widening and improvement of blind curve portion, realignments at the portions where steep gradients have to be avoided, construction of pucca side drains at needy stretches, and installation of traffic/informatory sign and Kilometer stones.

The project road will have two-lane carriageway facility. The design philosophy that will be followed embodies the following:

- The facility should be of National Highway Standards
- The facility must meet the needs for development activities in the region.
- Travel should be safe, with in-built engineering features
- The facility should be aesthetically pleasing and should not be visually intrusive
- The facility should meet the environmental conditions

Design Standards for the highway requirements have been framed for providing the desirable level of service and safety. For this Project it is proposed to follow Design Standards given in IRC Standards, Codes, Guidelines and Special Publications besides MORT&H circulars and specifications as applicable to National Highways.

GEOMETRIC DESIGN STANDARDS

For this Highway Project, Geometric Design Standards shall be as per the following:

- IRC: 73-1980 shall be generally followed.
- IRC: SP: 19-2001: Manual for survey, investigations and preparation of road projects.
- IRC: 52: Recommendations about the Alignment survey and Geometric Design of Hill Roads (Second Revision).
- IRC-SP-48-1998: Hill Road Manual

Altitude of the road

Altitude of the Project Road lies between 821.0 m to 1365.0 m above the MSL

- **Terrain Classification:**

Terrain as pertinent to the road structure is classified as given in the following table:

Terrain	Cross Slope (%)
Plain	0 - 10
Rolling	> 10 upto 25
Mountainous	> 25 upto 60
Steep	> 60

This Road Corridor is generally in mountainous terrain.

Design Speed:

Sr/No	Mountainous Terrain		Steep Terrain	
	Ruling	Minimum	Ruling	Minimum
1.	50	40	40	30

The ruling design speed should generally be the criterion for correlation of the various design features.
Minimum design speed may be adopted in sections where site conditions or economic do not permit a design based on the ruling design speed. The adopted design speed is 30 Km/hr.

Cross Section Elements:

- **Right of Way (ROW)**

IRC: 73-1980 Table recommends the following land width for National Highways:

ROW Width

Sn	Road Classification	Mountainous and Steep Terrain	
		Open areas	Built-up areas
		Normal	Normal
1	National & State Highways	24	20

The existing ROW along the project road is not uniform. . The width of ROW 24 m and 20 m have been adjusted to accommodated the public concerser provided. However there are stretches where the ROW has been temporarily encroached. However, for improvement of junctions, relocation, etc, design will be as per functional requirement. Additional land acquisition shall be kept to the minimum for these areas

- **Roadway Details**

- **Total Road Width**

Total roadway width shall be 12.00 m**.**

- **Carriageway Width**

The National Highway shall be designed as a 2- lane carriageway. The width of two lane shall be 7.0 m.

- **Shoulder**

The carriageway width of 7m and paved shoulder width of 1.5 m on each side shall have the same pavement as the carriageway. The remaining 1.0m on each side shall be used to accommodate side drain on hill side or parapet/soft shoulder on valley side. In the hill

side, depending on the total width of side drain, there is a small width remaining between the wall of side drain and paved shoulder, therefore it is also paved to avoid erosion by surface water

- **Cross-Slope**

Each carriageway shall have cross slope of 2.50 per cent
The shoulder shall have a slope of 3.5 per cent.

- **Stopping Sight Distance:**

Sufficient stopping distance is made available for drivers to stop their vehicles when faced with an unexpected obstruction in the carriageway. The safe stopping sight distance, overtaking sight distance as recommended in the manual is as below:

Minimum Recommended Sight Distances

Speed (Km/h)	Safe Stopping Sight Distance (m)	Intermediate Sight Distance (m)
20	20	40
25	25	50
30	30	60
35	40	80
40	45	90
50	60	120

Horizontal Alignment:

- **Superelevation**

No super elevation is proposed when its value obtained is less than the road camber e.g. radii beyond which super elevation is not proposed are as mentioned below:

Radius Beyond Which Super elevation Not Required

Design Speed (km/hr)	Radii (Meters) For Camber of					
	Proposed as per IRC: SP: 48-1998	4%	3%	2.5%	2%	1.7%
20		50	60	70	90	100
25		70	90	110	140	150
30		100	130	160	200	240
35		140	180	220	270	320
40		180	240	280	350	420
50		280	370	450	550	650

- **Radius**

Radii for horizontal curves corresponding to ruling minimum and absolute minimum design speeds are as given below:

Minimum Radius for National Highways
(As per IRC: SP: 48-1998)

Mountainous Terrain		Steep Terrain	
Ruling Min Radius (m)	Absolute Minimum Radius (m)	Ruling Min Radius (m)	Absolute Minimum Radius (m)
80	50	50	30

There will be corresponding speed limit in case the radii are less than the above due to hill physical features and economic consideration.

Widening of Pavement at Curves
At sharp horizontal curves, it is necessary to widen the carriageway to facilitate safe passers of vehicle. Extra width to be provided on horizontal curve is given below (refer clause 6.8.5 of IRC: SP: 48: 1998).

Radius of Curve (m)	**Upto 20^o**	**20^o to 40^o**	**41^o to 60^o**	**61^o to 100^o**
Extra width (m) 2 Lane	1.5	1.5	1.2	0.90

Wherever the radius is less than the specified minimum design speed, the transition curve, superelevation and pavement widening will be introduced. This will minimize the intrusion of vehicles on to adjacent lanes, tend to encourage uniformity of speed and increase vehicle speed at the curves.

- **Transition Length**

Transition length is given in Table below:

Transition Length of Curve
(As per IRC: SP: 48-1998)

Curve Radius (m)	**Design Speed Km/h**				
	50	**40**	**30**	**25**	**20**
15				NA	30
20				35	20
25			NA	25	20
30			30	25	15
40		NA	25	20	15
50		40	20	15	15
55		40	20	15	15
70	NA	30	15	15	15
80	55	25	15	15	NR
90	45	25	15	15	
100	45	20	15	15	
125	35	15	15	NR	
150	30	15	15		
170	25	15	NR		

Curve Radius (m)	Design Speed Km/h				
	50	**40**	**30**	**25**	**20**
200	20	15			
300	15	NR			
400	15				
500	NR				

NA-Not Applicable and NR- Transition not required

Vertical Alignment:

- **Codal Provisions**

The gradients to be maintained in the design are as per following guidelines:

Codal Reference	Clause No.
IRC : SP-48 – 1998, Hill Road Manual	12.2.1
IRC : SP-52-2001, Recommendations about Alignment Survey and Geometric Design of Hill Roads	6.9.1.3

- **Gradients for Different Terrain**

SL. No	Terrain	Ruling Gradient	Limited Gradient	Exceptional Gradient
1	Steep terrain up to 3,000 m height above mean sea level	6 % (1 in16.7)	7 % (1 in 14.3)	8 % (1 in 12.5)

- Gradients upto the ruling gradient may be used as a matter of course in design (Ref. Clause No. 6.9.1.4 of IRC-SP: 48 – 1998).

- The limiting gradients may be used where the topography of a place compels this course or where the adoption of gentler gradients would add enormously to the cost. In such cases, the length of continuous grade steeper than the ruling gradient should be as short as possible. (Ref. Clause No. 6.9.1.5 of IRC-SP:48 – 1998).

- Exceptional gradients are meant to be adopted only in very difficult situations and for short lengths not exceeding 100 m at a stretch. Successive stretches of exceptional gradients must be separated by a minimum length of 100 m having gentler / flatter gradient (Ref. Clause No. 6.9.1.6 of IRC-SP:48 – 1998).

- *Vertical Curves*

Minimum length of Vertical Curve (As per IRC: SP: 48-1998)

Design speed km/h	Maximum Grade Change (Percent) Not Requiring A Vertical Curve	Minimum Length Of Vertical Curve (m)
35	1.5	15
40	1.2	20
50	1.0	30

The actual length for the vertical curve shall however be provided as per IRC: 73–1980

GEOTECHNICAL DESIGN

Earth Embankment

i) The fill material, compaction and other requirements shall conform to IRC: 36-1970. Where these specifications are in variance with the MORT&H specifications, the later shall govern and accordingly followed.

ii) Side slope of 2:1 is provided

Side Slopes Formation in Cutting

The following values are adopted as per IRC: SP: 48:1998 Clause 7.4.

Side Slope in Cutting

Sl.No.	*Item*	*Slopes of Cutting*
1	Ordinary Soil / Heavy Soils	1 : 2
2	Ordinary / Soft Rock	1 : 4
3	Hard rock	80^0 to 90^0

(Explanation: The slope 1: 2 signifies 1 in the horizontal direction and 2 in the vertical)

4.4 ROAD FURNITURES

Km Stones :

Km Stones, 200m stones and 5^{th} km stones shall be provided as per Codal provisions.

Road Signs:

All signs shall be placed on the valley side of the road. Where extra emphasis is warranted, they may be duplicated on the right hand side as well as per IRC: 67-1977. The extreme edge of the sign shall be not less than 2 m from the edge of the carriageway.

Road Marking:

Provisions shall be made for center line marking with ready mixed road marking paint conforming to IS: 164

Safety Barriers:

Guardrails shall be provided on approaches to bridges.

4.5 PAVEMENT DESIGN

Design for flexible pavement has been carried out in accordance with the latest version of IRC: 37-2001.

Drainage

- An effective drainage system for drainage of road shall be designed as per stipulations of IRC SP: 42-1994.

- The road side channel will be trapezoidal and V shape of adequate capacity to carry 100% surface runoff of drainage area of highway ROW. It will be drained to the nearest available natural water course. We propose to adopt semi trapezoidal section as space is a not a constraint and it is more efficient and economical. This will be lined drain to drain out in the open field or to the defined outfall points. Semi trapezoidal shaped lined drain will also be adopted in the hard rock hill sections.

- The superstructure of bridges shall be drained with suitable drainage spouts.

Traffic Safety Measures

The design layout and materials chosen for the safety barrier shall suitably blend with the surrounding and shall further conform to MORT&H circulars and shall be finalized in consultation with and approved by PWD.

Culverts

- All Cross- Drainage structures shall be classified as culverts, minor bridges & major bridges depending on the length of the structure as per IRC standards. Structures up to 6m length fall into the category of culverts, more than 6m but up to 60m in length as minor bridges and beyond 60m length as major bridges.

- The deck width is required to be kept the same as that of the roadway for 2-lanes

- The bridge components shall be designed at least carry one lane of Class 70R for every two lanes with one lane of Class A for the remaining lanes, if any, or one lane of Class A for each lane.

- Entire project area falls under Zone-IV of seismic zone as provided in IRC: 6-2000 Clause 222

- The list of IRC codes given below but not limiting to shall be referred during formulation of the design and drawings of bridges.

List of IRC Codes

IRC: 5-2015	Standard Specification & Code of practice for Road Bridges. Section – I General Features of Design (Seventh Revision)
IRC: 6-2014	Standard Specification & Code of practice for Road Bridges. Section – II Loads & Stresses (Fourth Revision)
IRC: 18-2000	Design Criteria for Pre-stressed Concrete Road Bridges (Post- Tensioned Concrete) (Third Revision)
IRC: 21-1997	Standard Specification & Code of practice for Road Bridges. Section – III Cement Concrete Plain & Reinforced (Second Revision)
IRC: 22-1986	Standard Specification & Code of practice for Road Bridges. Section – VI Composite Construction (First Revision)
IRC: 24-2001	Standard Specification & Code of practice for Road Bridges. Section – V Steel Road Bridges (Second Revision)
IRC: 45-1972	Recommendations for Estimating the Resistance of soil below the maximum Scour Level in the Design of Well Foundations of Bridges.
IRC: 73-1980	Geometric Design standards for Rural (Non-Urban) Highways.
IRC: 78-1983	Standard Specification & Code of practice for Road Bridges. Section – VII Foundation & Substructure (First Revision)
IRC: 83-1987	Standard Specification & Code of practice for Road Bridges. Section – IX Bearings, Part-II Elastomeric Bearings
IRC: 83-1987	Standard Specification & Code of practice for Road Bridges. Section – IX Bearings, Part-II POT,POT CUM PTFE, PIN Bearing
IRC: 89-1997	Guidelines for Design & Construction of River training & control works for road bridges.
IRC:SP:33-1989	Guidelines on supplemental Measures for Design, Detailing & Durability of Important Bridge Structures.

Design loads

- **Dead Loads:**

Apart from all the actual dead loads, irrespective of the type of wearing coat and crash barrier proposed, the structure shall be designed to allow for

- Wearing coat load = 2 kN/m^2.
- RCC Railing as per Standard Drawing

- **Live Loads:**

The bridge shall be designed to carry one lane of Class 70R for every two lanes with one lane of Class A for the remaining lanes, if any, or one lane of Class A for each lane.

- **Seismic Effects:**

(i) Basic horizontal seismic co-efficient - As per zone IV
(Table 5 & fig 11 of IRC: 6–2000)

(ii) Importance Factor - 1.5
Reinforcement detailing of structures shall conform to the provisions of IS 13920

Loading due to RCC Railing: **As per Standard Drawing**

- **Temperature Effect:**

(i) Temperature stresses to be worked out as per Clause 218 of IRC: 6 – 2000.

For design of structure the temperature range to account for temperature effect shall be:

In the present case t = +/- 25^0 C

(ii) The superstructures shall also be designed for effects of distribution of temperature across the deck depth. For calculation of thermal forces effect of 'E' value of concrete should be taken as 50% of the instantaneous value as to account for effects of creep on thermal strains.

- **Differential Settlement:** 6 mm with instantaneous E value of concrete. This will be deemed to cover lifting of superstructure also.

TECHNICAL SPECIFICATIONS

The work will be executed as per MORT&H Specifications for Road & Bridge Works 5th Revision 2013

SECTION – 6

ENGINEERING DESIGN AND CONSTRUCTION PROPOSALS

6.1 GENERAL

This chapter deals with detailed design of various elements of project road, based on the findings of survey and investigations and design standards in the preceding chapters. The proposals include provision for the major items as given in Table.

Project Proposals – Major Items

Sl No.	Item
1	Site Clearance
2	Earthwork
3	Pavement Works
4	Slope Protection Works
5	Culverts
6	Bridges
7	Miscellaneous Works
8	Facilities for Engineers
9	Provision for land Acquisition & Forest Clearance

6.2 CROSS SECTION ELEMENTS & ALIGNMENT

a) Cross Section Elements

Hill road cross-section has the usual components of carriageway, shoulder and longitudinal drain and parapet/railing requirements. The carriageway and shoulder widths are governed by the traffic volume expected on the road. Other components are functions of traffic safety and surface run-off requirements. Roadway, however, is defined as the total width of carriageway and shoulder.

Design Standards for Cross-section Elements

Sl. No.	Design Elements	Dimension in m
1.	Roadway width (including culverts)*	12.00 & 10.8
2	Roadway width at Bridges **	12.90
3	Carriageway width	7.00
4	Cross-slopes / camber (%)	2.5

* Roadway width are including width of side drain and parapet wall

** Roadway width is Overall Width between outermost faces of the railing.

b) Geometric Design

The general alignment of the road under this project is as:

NH 717 (A) Highway from Km 0 /000 to 16/167 Km as per design Chainage

Existing alignment : 10.867 Km

Re-alignment : 5.300 Km

Total length of proposed road : 16.167 Km

Road is designed for 2-Lane (12.00 m roadway with 7.00 m carriageway).

Gradient, being the most important parameter, has been the guiding factor. Ruling gradient less than 6.0% has been achieved in most point of the road and the maximum gradient being 6.5 % from Km 15+ 017 to Km 15+232 (215.0 m) due built-up stretch.

c) Realignment of existing road:

For improvement of existing road some stretches, relocation and re-grading are proposed due to which traffic movement on existing road would be disturbed. Permanent diversion will be included in the design as to minimizing the structure damage, reducing cost of resettlement and easy and faster movement of vehicles.

For improvement of existing road some stretches relocation and re-grading are proposed due to which traffic movement on existing road would be disturbed. Permanent diversion will be included in the design as to minimizing the structure damage, reducing cost of resettlement and easy and faster movement of vehicles.

Sr. No.	Name of Town	Design Chainage		Existing Chainage		Length in Km
		From	To	From	To	
1	Ranipool	0+00	1+400	0+00	2+450	1.40
2	Andheri Khola	5+800	9+700	7+250	12+520	3.90
					Total	**5.30**

d) Horizontal Alignment

The project corridor passes through steep and mountainous terrain. The design speed adopted is 30km/hour (IRC SP: 48). Along the proposed alignment, there will be no hair-pin bend. However minimum design speed has been considered on technical grounds. The vertical and horizontal alignments of the proposed road can be summarized as shown in table below:

Project Road length	No. of Curves with Design Speed in km/h				No. of Curves with Radius (m)		
	<30	30-40	40-50	>50	<30	30-50	>50
16.167 Km	42	175	0	0	19	85	113

Vertical Alignment/Gradient

Gradient, being the most important parameter, has been the guiding factor. Ruling gradient (less than 6.0%) has been achieved, the maximum gradient being 6.5 % at few selected stretch.

Summary of Proposed Vertical Alignment

Project road length	Length Distribution (km) and Gradient Class				
	<4%	4%-5%	5%-6%	6%-7%	7%-8%
16.167 Km	5.46 Km	8.567 Km	1.95 Km	0.19 Km	0.0 Km

6.3 Traffic Design Capacity

The width of a pavement is decided on the basis of the traffic volume it can efficiently carry. Traffic studies have been carried out in the vicinity of the project road and produced in this report.

6.4 Design of Embankment / Hill Cutting

Considering the physical features, particularly the terrain, soil classification and hill slope line, typical cross-section (Type 1F to Type 21 F) have been developed for hill road cutting / embankment building.
Concept Plan of the design of the embankment / hill cutting (stretch-wise) has been developed with specific mention of the formation building methodology / type to be adopted.

Compaction of disposal material

Spreading & Compaction of Roadway cutting and excavation from drain and foundation of other structures surplus material in layers not exceeding 300mm thickness at selected displosal location by Dozer at least four passes including construction of approach road to dumping site.

6.5 Pavement Proposal

The provision for pavement includes different layers of sub-base, base, and surfacing course as appropriate throughout the whole stretch of the road.

Cement Treat Sub-base (CTB): 250mm thick sub-base layer of crushed stone aggregate has been proposed. The sub-base course has been extended up to full width of the formation. Bottom layer 12.0 m & top layer 10.0 m

Extra quantities for widening at curves, major and minor junction locations are calculated separately and final quantities are worked out.

Cement Treat Base (CTB): 170mm thick base layer of CTB is proposed for 10.0m width.

#SAMI in double layer and 40mm thick of Bituminous Concrete as surfacing course has been proposed.

6.6 Pavement Design

It is based upon CVD-464, CBR-5%, Traffic msa -20, Design period – 15 years, VDF-1.5, Annual Growth of traffic rate 7.5% and Design speed 30.00 Km/h. However the proposed pavement composition is based on CBR-5% and msa -10.
Pavement composition is designed as under:
Proposed pavement.

BC	:	40 mm
SAMI	:	2 layer
CT Base in 1-layers	:	1700mm
CT Sub Base in 2-layers	:	250 mm
Total	:	460 mm

Shoulder Design

The carriageway width of 7m and paved shoulder width of 1.5 m on each side shall have the same pavement as the carriageway. The remaining 1.0m on each side shall be used to accommodate side drain on hill side or parapet/soft shoulder on valley side. In the hill side, depending on the total width of side drain, there is a small width remaining between the wall of side drain and paved shoulder, therefore it is also paved to avoid erosion by surface water

6.7 Culverts:

The project road traverses through mountainous and steep terrains with several natural drainages such as deep gorges, depressions, etc., where perennial water and rain water runoff are collected. Sometimes the storm runoff is accompanied by large quantities of debris from upstream side of the nallahs. Cross-drainage structures/culverts are required at these locations. From the field survey and investigations and geometric design of alignment the requirement of culverts for the whole length of the project have been identified.

Sr.No.	Type of culvert	Description	Span X Depth	Km 0 to Km 16.167
1	Type -1	Pipe Culvert	1.2 D	13
2	Type - 2	Pipe Culvert	1.2 D	15
3	Type – 1	Box Culvert	2.0 X 2.0	33
4	Type – 2	Box Culvert	3.0 x 3.0	2
			Total	63

6.8 Slope Protection works:

Adequate Protective structures are proposed for retaining of cut/fill slopes to ensure stability of the road formation at locations where required. The proposed type and length of each structure are shown in the table below:

Sr.No.	Description of Item	Unit	Quantity
1	Retaining Wall 3.00m high	Rm	810.00
2	Retaining Wall 4.00m high	Rm	370.00
3	RCC Retaining Wall 5.00m high	Rm	150.00
4	RCC Retaining Wall 7.00m high	Rm	130.00
5	RCC Retaining Wall 10.00m high	Rm	170.00
6	RCC Retaining Wall 12.00m high	Rm	110.00
7	Breast Wall 2.00m high	Rm	4645.00
8	Breast Wall 3.00m high	Rm	3605.00
9	Gabion Wall 2.00 m high	Rm	460.00
10	Gabion Wall 3.00 m high	Rm	820.00
11	Toe Wall 2.00 m high	Rm	460.00
12	Toe Wall 3.00 m high	Rm	985.00
13	Cut Slope Wall	Rm	3000
14	Seeding and Mulching (Soil Cut Slope)	sqm	30000

Sr.No.	Description of Item	Unit	Quantity
15	Vegetation Mat (Steep Slope)	sqm	1400
16	Crib Work (F300)	sqm	300
17	Crib Work (F500)	sqm	400
18	Groundwater Drainage Work	metre	1500
19	Anchor Work	Rm	200
20	Rock-bolt Work	Rm	150

6.9 DRAINAGE & BRIDGE DESIGN

Pavement Drainage includes camber / cross fall of 2.50%.

Slope 3.5 % has been considered for drainage of shoulders.

Roadside drains are designed as Lined drains.

Sr.No.	Type	Package-1	Remarks
1	Type-1	10763	Ordinary Soil stretch Rocky & Steep Stretch & Catch water drain at box cutting portion
2	Type-2	7967	Built up area

Chutes of the culverts form part of the culvert structure to lead the discharge to the catch-pit or to natural drainage channel.

6.10 BRIDGE WORK

S/N	From	To	Super structure	Foundation	Remarks	Length in m	Remarks	
1	720.0	1400.0	PSC	Pile	Ranikhola	680.0	Proposed	Alignment
2	2440.00	2500.00	RCC	Open	Aho Khola	60.0	Existing	Ex.Road
3	6140.00	6160.00	RCC	Open	Andheri Khola	20.0	Existing	Ex.Road

6.11 ROAD SIGN AND MARKINGS

The project design includes (a) Mandatory / Regulatory Signs, (b) Cautionary / Warning Signs and (c) Information Signs , Route Marker Signs are provided .KM Stones are included as per type design.

6.12 STREET FURNITURE

Traffic Safety Posts and Parapet Walls are included.

Traffic Signs Marking & other Road Appurtenances

6.13 DIVERSION OF EXISTING ROAD DURING CONSTRUCTION

For improvement of existing road some stretches localized, relocation and re-grading are proposed. Due to which traffic movement on existing road will be hamper .Therefore temporary diversion of existing is very much necessary during construction period.

6.14 MAINTENANCE OF EXISTING ROAD:

The existing road is the main route to provide connectivity between Sub-Division Head Quarters of the East District and Green Field Airport to rest of Sikkim. The minimum construction time provided for completion of the project is 4(four) years during which maintenance by the PIU will be no longer convenient as the site possession is resorted to hand over to the contractor till completion of the project. Under this circumstance, it is inevitable to keep provision for yearly maintenance of the existing road during construction and hence a provision of Rs.59.54 lakhs per year is made to make the road playable for all type of vehicles without serious interruption of the traffic flow throughout the year.

Scope of maintenance:

1) Maintenance of Earthen Shoulder (filling with fresh soil).
2) Filling Pot- holes and Patch Repairs with open - graded Premix surfacing, 20mm.
3) Hill Side Drain Clearance.
4) Land Slide Clearance in soil/ rock
5) Clearing Grass and Removal of Rubbish.
6) Maintenance/repair of culvert/Retaining wall.
7) Clearance of culvert before monsoon
8) Removal of land slide

6.15 ROADSIDE AMENITIES

The continuous long distance travel on highways at speed is liable to cause fatigue as also mental tension to the road users. Moreover, the monotony of driving over long sections in the rural areas with no likelihood of any cross traffic brings sense of complacency in many drivers. and such distractions could result in serious accidents.

Sr.No.	Description	Nos.	Location
1	Public Toilet	2	Near Ranikhola & Paykong
2	Bus Shed	2	
3	Bazar Shed	2	

6.16 DESIGN OF INTERSECTION/JUNCTIONS

Provisions have been made for the improvement of road junctions along the project road. Based on the survey there are 8 junctions/ intersections as mentioned below:-
These Junctions needed major improvement as compared

Sr.No.	Design Chainage	Side	Remarks	Shape	Type
1	60	RHS	Take off point Junction with NH-10	Y	Major
2	1410	LHS	Junction with existing NH -717A	Y	Major
3	5800	LHS	Take off point 2nd diversion	T	Minor
4	9700	LHS	Merging with Existing NH-717A	Y	Minor
5	13640	LHS	junction with Rolep Road	Y	Major
6	14280	LHS	junction with Village Link road	Y	Minor
7	15080	LHS	Junction with Noapgaon approach road	Y	Minor
8	16167	LHS	Junction with existing NH -717B	T	Major

1.0 Junction at Ch. 0+00

Location : Junction with NH-10 Take off

Shape : Y-Shape

Design : This junction is designed as a simple meeting point with open space for the traffic. Regulation by rotary or traffic island is considered suitable.

2.0 Junction at Ch. 1+410

Location : Merging with Existing NH-717A

Shape : Y-Shape

Design : This junction is designed as a simple meeting point with open space for the traffic. Regulation by rotary or traffic island is considered suitable.

3.0 Junction at Ch.5+800

Location : Take off point 2nd diversion

Shape : Y -Shape

Design : This junction is designed as a simple meeting point with open space for the traffic. Regulation by rotary or traffic island is not considered suitable.

4.0 Junction at Ch. 9+700

Location : Merging with Existing NH-717A

Shape : Y -Shape

Design : This junction is designed as a simple meeting point with open space for the traffic. Regulation by rotary or traffic island is not considered suitable.

5.0 Junction at Ch. 13+640

Location : Junction with Rolep Road

Shape : Y -Shape

Design : This junction is designed as a simple meeting point with open space for the traffic. Regulation by rotary or traffic island is not considered suitable.

6.0 Junction at Ch. 14+280

Location : junction with Village Link road

Shape : Y -Shape

Design : This junction is designed as a simple meeting point with open space for the traffic. Regulation by rotary or traffic island is not considered suitable.

7.0 Junction at Ch. 15+080

Location : Junction with Noapgaon approach road

Shape : Y -Shape

Design : This junction is designed as a simple meeting point with open space for the traffic. Regulation by rotary or traffic island is not considered suitable.

8.0 Junction at Ch. 16+167

Location : Junction with existing NH -717B

Shape : Y-Shape

Design : This junction is designed as a simple meeting point with open space for the traffic. Regulation by rotary or traffic island is considered suitable.

SECTION: 7

ENVIRONMENTAL IMPACT ASSESSMENT

7.1 INTRODUCTION

The environmental assessment process endeavors to mitigate and prevent undesirable impacts of developmental activities. It is in no way intended to hamper socio-economic development but to guide project proponents in making the right investment in land, manpower, technology and mitigation measures to ensure that projects have the least possible impacts on the environment.

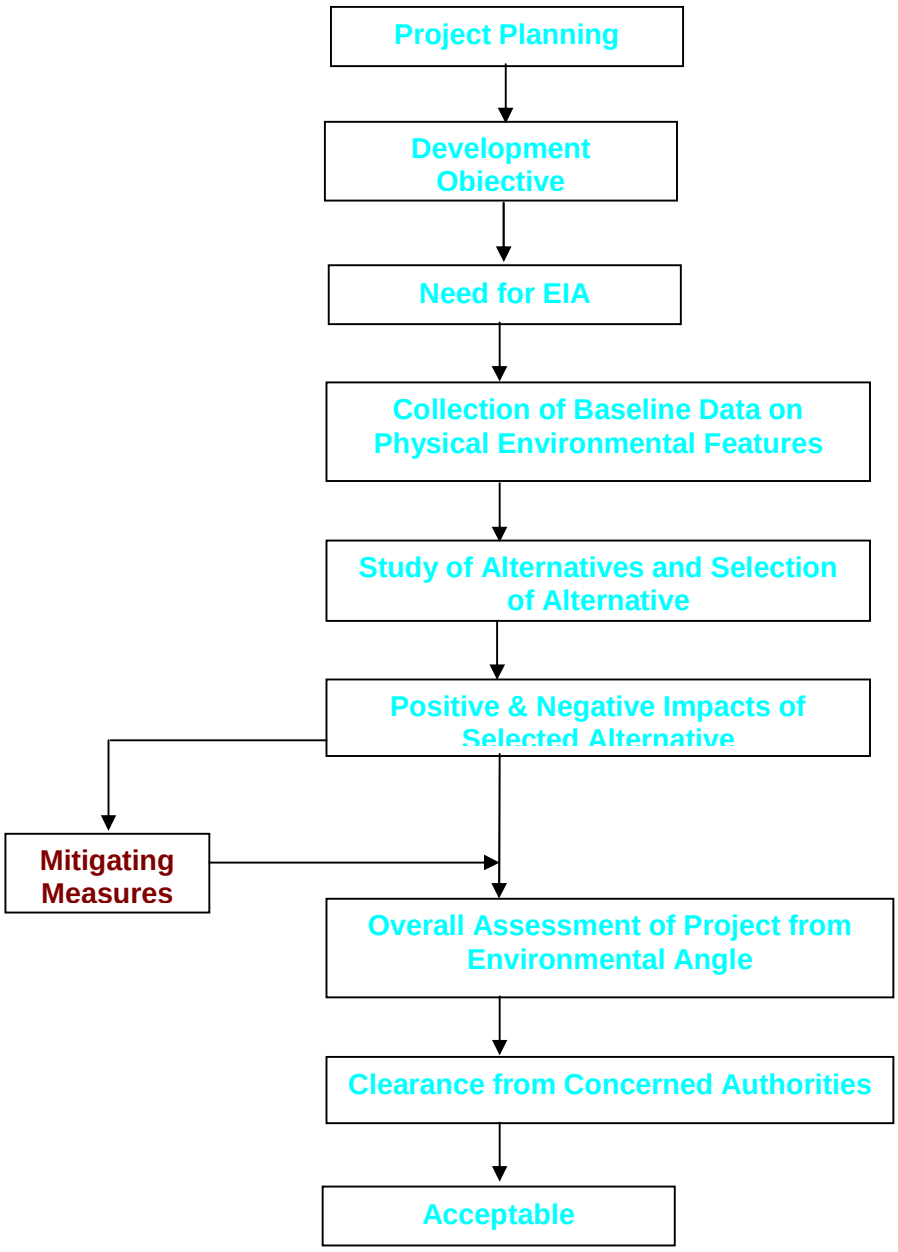
Environmental study for road projects involves several steps, starting from clear understanding of the development objectives, collection of base line data, and evaluation of alternatives to overall assessment of the environmental impact of the selected alternative. The involved activities are:

- Collection of base line data and physical environmental features
- Study of alternatives and selection of alternative
- Positive and negative impacts of selected alternative
- Mitigation measures
- Overall assessment of project from environmental angle
- Filing of application for environmental clearance
- Clearance from the concerned authorities
- Project implementation

The above activities are given in the flow diagram of environmental assessment of the project.

Salient features are extracted hereunder:

- Baseline data collection
- Physical and Environmental features
- Beneficial Impact
- Negative Impacts
- Some Environmental Parameters Associated with the Project
- Initial Environmental Assessment



Flow Diagram for Environmental assessment of Road Projects

7.2 NEED FOR ENVIRONMENTAL STUDY

The existing NH-717 (A) takes off at Km 80.500 on existing NH 10 at Ranipool in East Sikkim and runs towards North to South direction passing through a number of towns/villages like Ranipool - Aho – Yangtam – Panchwati – Pakyong within East District.

The initial stretch of existing / present NH-717 A passes through heavily built-up areas which shall involve costly Land Acquisition and serious resettlement problems for improvement. Due to these reasons, it was felt absolutely necessary to re-align the existing initial stretch of the NH 717 A between km 0/00 – 2/45 by shifting the existing take-off point

at km 80/60 to a proposed new take-off point at km 78/100 (i.e. located at out skirt of Ranipool town toward Singtam) on Sevok-Gangtok section of NH-10. The proposed alignment is realigned from the existing road from Km 7/250 to Km 12/520 to bypass the Sinking & Sliding Portion. The proposed realignment take off points are very near due to which, it will not affect and deprive the connectivity with villages and hence, the villagers would be the beneficiaries with the proposed alignment. The proposed re-alignment does not pass through heavily built-up area and would involve much less L.A cost as well as resettlement problem as compared to the existing alignment. The re-alignment also passes through an area with a much better topographical as well as soil conditions. The re-alignment also passes through an area with a much better topographical as well as soil conditions. Hence, apart from the reduction in distance between Pakyong Airport and Capital City Gangtok by Km 2.5, which would greatly benefit for the public in terms of vehicle operating cost and travel time, the proposed re-alignment is technically far better and financially cost effective in the long run.

This work will include improvement of gradient, re-alignment, pavement, retaining walls, culverts etc. In order to improve the gradient of this road, some stretches of the road will have to be re-aligned whereas some existing stretches can be improved to conform to single lane specification in respect of its gradient, curves, super elevations etc.

In view of the above, there is a requirement to have the environmental study of the project road which contains the following elements:

- Preliminary Or Initial Examination And Environmental Analysis
- Environmental Impact Assessment
- Environmental Management Action Plan

The Environmental Assessment and Environmental Management Action Plan are applicable in case the initial environmental examination indicates that there is potential to determine the environmental impact and thereby to have the environmental design.

7.3 COLLECTION OF BASELINE DATA

Data Collection during Reconnaissance

The data collection to be conducted during reconnaissance period which includes road factors, terrain and traffic factors, land-use, environmental factors. The data collection proforma has been developed and the information is below mention

Data Collection during Reconnaissance

1	Climatic / Meteorological Data	
	• Rainfall	• 3200 mm per year
	• Temperature max & minimum	• 28° C to 8° C
	• Humidity	• Moderate

	• Wind speed & wind direction	• Moderate
2	Land use in the area	Frequently cultivated jhum land
3	Cut and fill sections	Cut section only
4	Vegetation in the area	Growth rapid
5	Nearby ecological sensitive area – forest, reserve forest, wild life sanctuary, wet land	Ref. forest clearance
6	Geology of the area	Soil to Hard rock
7	Religious structure near the alignments	Ref. L.A. Plan
8	Heritage Cultural, Historical Structure In Nearby Area	Not Available
9	Community structure – near the alignment – Community Well, Hand Pump, Community Pond, Panchayat Bhawan, etc.	Nil
10	School, College, Hospital In The Nearby Area	Nil
11	Traffic on the road & traffic projection	Traffic survey Data
12	Connectivity of the alignment – tourist importance, connected to industrial, towns & cities, school, college, hospital, markets. and port	Ranipool - Aho – Yangtam – Panchwati – Pakyong within East District
13	Report of HIV & AIDS in the area	Not noticed in the Area
14	Source of stone, cement, sand, etc.	Refer quarry chart
15	Source of construction water	Available
16	Status of surface water bodies – pond, river, stream in the nearby area	Not affected
17	Status of groundwater	Very deep being hilly area
18	Disposal area / sites near the alignment to accommodate surplus earth	Disposal sites available
19	Selection of borrow area in the nearby area	Not required
20	Is the alignment acting as embankment in between agricultural lands	No
21	Source of fly ash for road construction in the area	N.A.
22	Population (Direct & Indirect) served by the road	-

23	Importance of the road to the connecting habitations	For providing economical upliftment.
24	Analysis of alternatives for alignment selection	Suitable and best alignment selected
25	Analysis of alternatives for selection of material for road construction	Materials lead surveyed
26	Air quality in the area	Good
27	Water quality in the area	Good
28	Road safety analysis	Cautionary/ informatory boards have been considered for provision crash barriers at sharp or blind curves, parapets over retaining walls
29	Road drainage	Culverts of different spans and side drains provided
30	Soil quality	Ordinary Soil and soil mixed with Boulders to Hard Rock
31	Nature of terrain	Mountainous to steep
32	Any flood hazard	Nil
33	Erosion potential	Erosion potential taken care of by providing Breast wall and vegetation turfing
34	Demarcation of Land slide prone areas	Nil
35	Major & minor rivers – Hydrology	Nil
36	Land to be acquired	Ref L.A
37	Nature of the land	Government Land
38	Displacement of house holds	Ref. L.A. Plan
39	Population composition – demography	Lepchas, Bhutias and Nepalese

Physical and Environmental Features

In order to have a complete assessment of the project, the physical and environmental features are brought out as follow

Physical and Environmental Features

Sn	Particulars	Selected Alternative
1	Length (Kms)	
	• Improvement of Existing Road to Single - lane	10.867 Km
	• Re alignment of Existing Road	5.300 Km
2	Terrain (Plain rolling / hilly)	Hilly
3	Land width Proposed (m)	24 m /12 m

Sn	Particulars	Selected Alternative
4	Category of land proposed to be acquired (ha	
	• Forest Land	3.24 Ha
	• Agricultural land	18.00 Ha
	• Habited area	5.55 Ha
	• Swampy land	Nil
5	Displacement of households (Nos)	31
6	Cut Sections	
	• Length in cut (Km)	14.5 Km
	• Maximum depth of cut at centre line(m)	20 m
7	Fill Sections	
	• Length in fill (Km)	2.039 Km
	• Maximum height of fill (m)	3-6 m
8	Vegetation : No. of trees exceeding 30 cm in girth to be cut	Ref. forest clearance
9	Flood hazard (encroachment on flood plain)	Nil
10	Erosion potential	Ref. Sl.No. 33 of table -1
11	Landslide potential	Nil
12	Stretch in geologically unstable area	Nil
13	Drainage and adverse impact on water flow	Adequate provision has been made
14	Number of major river crossings (exceeding 60 m)	Nil
15	No. of road intersections	08
16	No. of railway crossings	Nil
17	Schools, colleges, hospitals falling enroute	Ref. L.A. Plan
18	Number and type of utilities requiring relocation	Ref. L.A. Plan
19	Possibility of providing wayside amenities	nil
20	Air quality (very poor, poor, fair, good)	Good
21	Noise level	Good
22	Estimated Cost	Rs 240.73 Cr.

Beneficial Impact for Highway Project

The beneficial Impact for the proposed Project is given as follows. It is observed that the analysis of the Environmental Impact indicates that this project road has much positive impact on the socio-economic aspects and the development of the region.

Beneficial Impacts for Highway Project :	
Employment Opportunity to People	Yes. Project offers good employment opportunity to skilled / unskilled workers
Enhancement of Local Industry, Agriculture and Handicrafts	Yes. Good reduction in vehicle operating cost and time of communication will have positive impact.
Income from Visitors and Taxes	Yes. Passenger and freight traffic will increase to enhance income and taxes
Enhancement of Rural Development through quick and easy transportation of building materials	Yes.
Transporting, Processing and Marketing of agricultural products	Yes. Fast and economical movement of products
Opening up of opportunities for new occupations	Yes. Fast and economical movement will open opportunity for new occupations.
Approach to quick services and safety	Yes. Time saving due to short length and improved road geometric.
Improved quality of life for people and so on	Yes. Project will substantially contribute to improvement in the quality of life in South & West district.

Negative Impact

Environmental Study with respect to the Negative Impact has also been considered and an analysis is placed as follows. There is no visible negative impact of this project road on spoiling and destroying environmental issues and features of the region and the project influence area.

Negative Impacts for Highway Project:	
Erosion and sediment discharge	No. Proposed Road mostly passes through stable hill slope, soft & hard rock area which will keep in control the erosion and sediment discharge.
Poor drainage resulting in rail / road / highway damage and leading to flooding problems and degradation f water resources. Formation of new gullies	No. Adequate provision has been made for drainage and quick discharge of run-off. There are 606.00 culverts.
Increase in concentration of runoff causing surface water pollution	No Route alignment is made in a manner to ensure quick discharge of run-off. There will be no ponding up or any surface water pollution
Clearing of roadside vegetation for fire-wood, grazing, cultivation and urbanisation	There are no new village on this route and hence will not have impact of in-discriminate use of

	forest products. On the contrary, the road will provide LPG at cheaper rate to the existing village and deforestation will be reduced.
Increase in traffic litter, noise and dust pollution	No. There will be no dust pollution. There is no traffic concentration point to cause noise pollution.
Air quality affected by vehicular exhaust smoke with reference to SPM, NOx, CO, HC and lead	No. Air quality will not be affected as the route passes through open area.
Spell of toxic and hazardous chemicals from the carriers using the highway for transportation of such material	No
Transfer of vector diseases	No
Effect on wildlife through habitat loss and encroachment	No. The road does not pass through wildlife habitat.

Some Environmental Parameters associated with the Environmental Project

The basic environmental parameters have been broadly brought out and are tabulated as follow

Table No. 5 : Some Environmental Parameters Associated with Transportation Sector Project

Sr.No.	Environmental Parameters	Remarks
1	Surface Water Quality	Good; Not going to be effected
2	Air Quality	Good; Not going to be effected
3	Seismology / Geology	Hard Rock area Good girth of vegetation in soil mixed with boulder area
4	Erosion	Nil
5	Land Quality	Fertile
6	Fisheries	Nil
7	Forests	Medium to Dense Forest mainly of bamboo forest.
8	Terrestrial Wildlife	Nil
9	Noise	No
10	Land use	Individual owned agricultural land with minor irrigation.
11	Aesthetics	Beautiful and scenic
12	Industries	Nil
13	Resettlement	Nil There is no habitation requiring relocation
14	Archaeological / Historic	Nil
15	Significance	Economical concern
16	Public Health	Not effected
17	Socio-Economic	Good prospects

SECTION - 8

MATERIALS, LABOURS AND EQUIPMENTS

8.1 MATERIALS:

This chapter covers the details of test and investigation carried out for evaluating the characteristics of the sub-grade along the project corridor to establish the basis for the design of various elements of the road including pavement and sub grade, embankment and structures.
The main task carried out for soil and material investigation includes:

- Collection and Review of available soil data from various division of Sikkim
- Soil classification along the proposed road
- Investigation of sub grade soil
- Investigation of construction material including identification and inspection of potential source of construction material and extraction sites; testing and evaluating of construction material for suitability for project road construction.
- Geo-technical investigation for bridges and other structures.
- Pit test for foundation of structures

Investigations
The detailed investigations include both field and laboratory testing. Field work covered field density test, sub-grade soil sampling by excavating test pits, identification of rock sources and soil borrow sources/ quarries within reasonable short haulage distances of the project road. Test pits were also excavated wherever necessary to obtain samples for testing.
Appropriate laboratory tests were carried out on the representative samples of the soil and material obtained during field investigations to determine relevant engineering properties.
Standard Test Procedures
The following standard test procedures were followed for field testing, soil sampling and laboratory testing:
Type of Test

S. No	Type of Test	Adopted as per
1	Field Density using Sand Replacement Method	IS:2720 Part 28
2	Water Content	IS: 2720 Part 2
3	Atterberg limits	IS: 2720 Part 5
4	Sieve Analysis	
(a)	Natural Soil	IS: 2720 Part 4
(b)	Rock aggregate	IS: 2386 Part 1
5	Heavy Compaction Test	IS: 2720 Part 8
6	CBR	IS: 2720 Part 16
7	Soundness by Sodium Sulphate (Na_2So_4)	IS: 2386 Part 5
8	Aggregate Impact Value	IS: 2386 Part 4
9	Specific Gravity and Water Absorption of Coarse Aggregate	IS: 2386 Part 3

Notations

CBR	:	California Bearing Ratio
LL	:	Liquid Limit
PL	:	Plastic Limit
PI	:	Plasticity Index
NP	:	Non – Plastic
MDD	:	Maximum Dry Density
OMC	:	Optimum Moisture Content
FMC	:	Field Moisture Content
FDD	:	Field Dry Density
DCP	:	Dynamic Cone Penetration

Soil Classification

In case of hill road, the soil classification of the hill face (hill/ valley side) plays an important part. Soil classifications consist of the following:

- Ordinary Soil
- Soft Rock
- Hard Rock

The classification is mostly done visually. The classification is tabulated as follows:

Sr.No.	Chainage		Classification of Soil in %			Remarks
	To	From	Ordinary soil	Ordinary rock	Hard rock	
1	0	1	40	45	15	Soil Mixed Boulder
2	1	2	39	45	16	Soil Mixed Boulder
3	2	3	36	47	17	Soil Mixed Boulder
4	3	4	37	45	18	Soil Mixed Boulder
5	4	5	36	46	18	Soil Mixed Boulder
6	5	6	38	42	20	Soil Mixed Boulder
7	6	7	36	43	21	Soil Mixed Boulder
8	7	8	35	45	20	Soil Mixed Boulder
9	8	9	36	45	19	Soil Mixed Boulder
10	9	10	38	42	20	Soil Mixed Boulder
11	10	11	35	44	21	Soil Mixed Boulder
12	11	12	37	43	20	Soil Mixed Boulder
13	12	13	36	44	20	Soil Mixed Boulder
14	13	14	36	43	21	Soil Mixed Boulder
15	14	15	39	41	20	Soil Mixed Boulder
16	15	16	37	43	20	Soil Mixed Boulder

Inspection of Rock Quarry Areas

The rock deposits are available along or the vicinity of the project road alignment. Besides, cobbles, pebbles and sand deposits are available in the rivers or streams crossing the main alignment. Construction materials for GSB, Cross drainage & Masonry R/Wall etc. works, will be available at local quarry within the project corridor and WMM, DBM & BC material from Teesta River & LANCO Tunnel excavated mug within the project corridor .Water Absorption and AIV of these quarries are within the limit of the Ministry's Specifications. Bitumen, steel and cement will have to be taken from Siliguri.

8.2 LABOURS:

Hilly regions are generally sparsely populated. Sikkim is also one of the lowliest populated states of India and population density in the vicinity of the project road is lowest in Sikkim.
Local as well as imported labourers will be engaged for road construction works. Since the area is malaria infested, medical assistance with qualified practitioners will be required during the execution of the project. Comparatively higher wages (from the National average) and incentives have to be paid to labourers for the work. It is envisaged that equipment / machine intensive method would be adopted for proposed construction works.

8.3 EQUIPMENT AND MECHANICAL RESOURCES

Taking into account the above factors and to make the construction cost-effective, the activities which can be mechanized to a great extent are given below :

a) All earthwork activities to be done by using dozers and graders except earthwork in filling for embankment, which will be very little, can be done manually.
b) All rock cutting works to be done by using air-compressors, wagon-drills, etc. Blasting operations to be done by adopting modern blasting techniques.
c) Operations like spreading, grading in ordinary soil to be done by using appropriate type of motor graders.
d) Dozers with rippers for ripping all types of soft rocks. This would minimize use of compressors and blasting material.
e) Use of front end loaders for loading operations particularly at quarries and crusher points for increasing the utility of dump-trucks.
f) Use of water-distributors for proper watering and moisture control of various layers formation filling, sub-base and base activities. Suitable sprinkles to be used for each activity.
g) Use of suitable type of compactors for various activities.
h) Centrally operated multi-output primary and secondary crushers to be adopted for operation of large quarries for better gradation, quality and production control. Suitable vibro-screens are also to be used at quarry points for production of natural granular materials to the required gradations.
i) For bituminous works, hot mix plants, bitumen heating plants, asphalt distributors, spreaders, pavers, gritters and power operated brooms can be usefully deployed.
j) In large scale concreting works truck mixers can be used. In case of major bridge construction activity at one location, concrete pumps can be used.
k) For protective works backhoes, berm rollers/plate vibrators can be deployed for controlled excavation and proper compaction.

For the project road, being a trunk route leading to another country, high quality standard required to be achieved in execution of the Work. Therefore, in order to ensure high level of quality control, deployment of modern construction equipment i.e., Hot Mix Plant (HMP – 30/45 TPH), Paver Finisher with Sensor Devise and Vibratory Road Rollers, etc. have been proposed. Minimum requirement of machinery for the project has been listed in Table.

LIST OF PLANT AND MACHINERY

Sn	Description of Machine	Number
1	Dozer D-50-A 15	2
2	Dozer D-80-A 12	2
3	Hydraulic Excavator of 1 cum bucket	8
4	Front end Loader 1 cum bucket capacity	4
5	Motor grader	2
6	Tipper-5 cum	40
7	Road Roller	2
a	Vibratory RR Compactor	2
b	Tandem Vibratory Roller	2
c	Pneumatic Tyred Roller	2
d	Static Road Roller – 8 -10 tonne	2
e	Vibratory Earth Rammer / Plate Compactor	4
8	Primary & Secondary Crusher with Vibratory Screen (50 TPH)	2
9	Stone Crusher (6/8 TPH)	4
10	Bitumen Pressure Distributor	1
11	Water Bounded Macadam Plant	1
12	Generator Set 160 KVA	2
13	Generator Set 50 KVA	1
14	Generator Set 30 KVA	1
15	Generator Set 11.25 KVA	2
16	Portable Generator Set (1.5 KVA)	4
17	Water Tanker	10
18	Tractor	5
19	Air Compressor	8
20	Mixer for WBM	1
21	Bitumen Pressure Distributor	1
22	Hot mix Plant (30/45 TPH)	1
23	Mini Hot mix Plant	1
24	Paver Finisher with Sensor Device	1
25	Bitumen Boiler Oil Fired	1
26	Batch type concrete mixer of min. 200 litres capacity with automatic water measuring system and integral weigher	1
27	Concrete Pump of 30 cum capacity	N/A
28	Concrete Bucket	N/A
29	Prestressing Jack with Pump & Access	N/A
30	Grout Agitator and Pump	N/A
31	Welding Machine Sets	2
32	Oxy-acetylene Torch	2

Sn	Description of Machine	Number
33	Winch Machines	2
34	Grab Shackles and Clamshell buckets crane operated	1
35	Shear legs	1
36	Heavy duty dewatering pumps	N/A
37	Jack Hammer	2
38	Needle Vibrator	2
39	Plate Vibrator / Screed Vibrator	1
40	Rock Cutter	2
41	Crane of 35 ton capacity	1
42	Plate compactor	4
43	Casting truss for span construction	N/A
45	Work shop	1
46	Testing and measuring equipments for Field Laboratory	1 Lot

SECTION - 9

QUANTITIES AND PROJECT COSTS

9.1 General

The cost estimate presented in this Section is based on the detailed proposals given in Section 6. It is envisaged that the project would involve site clearance, construction of new formation in cutting, slope protection works, cross-drainage structures and bridges, pavement and road furniture etc. The detailed cost estimate presented in this report has been worked out using quantities of different items of works derived from the detailed design, drawing and unit rates.

9.2 Estimation of Quantities

In arriving at the quantities, the following items of civil works have been computed for the total length of the road :

* Earthwork Works
* Slope Protection Works
* Culverts Works
* Bridge Works
* Pavement Works
* Road appurtenances

Detailed estimate of quantities and costs are presented in "Volume – III: Cost Estimate" of the report. Methodology followed for various items are based on Technical Specifications of Ministry of Road Transport and Highways (MoRTH) for material laying, its quality, measurements, etc. and it has been illustrated in brief in the subsequent paragraphs.

a) Earthwork :

Earthwork quantities in cutting and small quantities of filling are calculated by highway design software MxRoad for the entire length of the project road. The formation cutting consists of earth cutting to get a formation width of double lane standard. Through cutting has also been proposed in some locations especially in curves where the existing alignment has been followed to ease the curves while going round spurs. Embankment s has also been proposed at some stretches.

The classification of soil in cutting has been made in three categories :

Soil : includes ordinary soil, hard, soil mixed with boulder
Ordinary Rock not requiring blasting
Hard Rock requiring blasting.

Locations along the road alignment passing along the above given three were noted down during field surveys and total quantities of earthwork in cutting has been worked out accordingly.

b) Slope Protection Works :

Quantities for retaining walls, breast walls, parapet walls, toe walls, etc. have been worked out based on the design proposals. Gabion walls have also been proposed at specified locations and quantities have been worked out.

c) Culverts & Bridges:

Quantities of culverts and bridges have been worked out for all the stretches of the road based on the structure proposed at each location of cross-stream or river. The proposal also

includes quantity for construction of chutes to protect the adjoining areas from further erosion.

d) Pavement :

The provision for pavement includes different layers of sub-base, base, and surfacing course as appropriate throughout the whole stretch of the road.

Cement Treat Sub-base (CTB): 250mm thick sub-base layer of crushed stone aggregate has been proposed. The sub-base course has been extended up to full width of the formation. Bottom layer 12.0 m & top layer 10.0 m

Extra quantities for widening at curves, major and minor junction locations are calculated separately and final quantities are worked out.

Cement Treat Base (CTB): 170mm thick base layer of CTB is proposed for 10.0m width.

#SAMI in double layer and 40mm thick of Bituminous Concrete as surfacing course has been proposed.

e) **Road Appurtenances**

Road appurtenances include provision for road signs and markings, etc.

9.3 Unit Rates

The unit rates for arriving at cost of different components of works are based on Sikkim PWD Schedule of Rates 2012 (for National Highways). For those items of works which are not available in the SOR, separate Analysis of Rates have been carried out and incorporated in this DPR.

- Bitumen (modified graded) (Ex-Siliguri)(Basic rate = Rs 30100.0/ MT + 2% CST, Rs 602+4% SKVAT, Rs 1204 + 1% Env Cess (Cost +VAT) Rs. 313 +transportation from Haldia to Singtam (740Km xRs.11) Rs.8140.0= Rs. 40359.00)

- Emulsion (Ex-Singtam) (Basic rate = Rs 22916.0/ MT + 2% CST, Rs 458.3+4% SKVAT, Rs 916.6 + 1% Env Cess (Cost +VAT) Rs. 238.3 +transportation from Haldia to Singtam (740Km xRs.11) Rs.8140.0= Rs32669.20)

- Cement (43 grade) (Ex-Singtam) (Basic rate = Rs 5500.00/ MT + 2% CST, Rs 110.0+14.5% SKVAT, Rs797.50 + 12.5 Rs. ED 687.50 + 1% Env Cess (Cost +VAT) Rs. 63.0 +transportation from Murshidbad to Singtam (467Km xRs.5.6) Rs.2615.2= Rs 9773.20)

- Cold twisted bars (HYSD Fe 500 Bars)(Basic rate = Rs 45700.0/ MT + 2% CST, Rs914.0+4% SKVAT, Rs 1828.0 + 1% Env Cess (Cost +VAT) Rs. 475.3 +transportation from Siliguri to Singtam (90Km xRs.5.6) Rs.504.0= Rs 49421.3)

- Sand & Aggregate from Teesta River.

9.4 Construction Cost Items

For construction of project road, the cost items include various elements, which added together, will give the total cost. The elements of the cost considered for the project are under the following major heads :

* Site Clearance

* Earthwork
* Pavement Works
* Slope Protection Works
* Culverts Works
* Miscellaneous Works
* Provisional Sum

Based on the unit rate of various items as per rates adopted as mentioned earlier and quantities calculated, a detailed cost estimate has been prepared under the above mentioned major heads.

The total Project cost for civil construction works and other allied charges is **Rs. 253.00 Cr**.

ABSTRACT OF COST ESTIMATE

Sr.No.	Items of work	Total quantity	Unit	Amount (Rs)
	CONSTRUCTION COST			
1	Formation Cutting	16.17	Km	
a.	Jungle Clearance etc			678,993.00
b.	Formation Works	1471472.00	Cum	311,967,874.76
2	Protection Works	15715.00	Rm	273,048,242.15
3	Cross Drainage Works	63.00	Nos	92,471,710.71
4	Pavement Works	16.17	Km	299,082,797.61
5	Km Stones & Road Signs	149.00	Nos	7,266,168.00
6	Road Safety Measures	1500.00	Rm	5,454,000.00
7	Development of Junction		LS	52,882,120.68
8	Bridge Work		LS	432,210,770.84
9	General Items		LS	14,342,301.55
A	**TOTAL OF (1 to 9)**		**Rs**	**1,489,404,979.30**
B	Escalation for 5 years @ 5%		Rs.	372,351,244.83
C	**Civil Cost**		**Rs.**	**1,861,756,224.13**
D	Contingency (2.8% of C)		Rs.	52,129,174.28
E	**TOTAL (C+D)**		**Rs.**	**1,913,885,398.41**
F	Construction Supervision Charge (3 % of C)		Rs.	55,852,686.72
G	Quality Control Charge (0.25% of C)		Rs.	4,654,390.56
H	Road Safety Audit Charge (0.25% of C)		Rs.	4,654,390.56
I	Maintenance for 4Years (0.5%+1.5%x3=5% of C)		Rs.	93,087,811.21
J	Escalation (15% of C)		Rs.	279,263,433.62
K	Agency (NHIDCL) Charge (3 % of C)		Rs.	55,852,686.72
	TOTAL PROJECT COST		**Rs.**	**2,407,250,797.80**
	Say		**Rs.**	**2,407,300,000.00**
	Project Cost per Km		**Rs.**	**148,871,416.07**
	Civil cost per km		**Rs.**	**118,360,259.64**

SECTION – 10

IMPLEMENTATION PROGRAMME AND CONTRACT PACKAGING

10.1 GENERAL

The proposed widening to 2-lane, re-alignment and geometric improvement of NH 717 A under this report is from Km 0+00 to Km 16+167 of existing chainage in Sikkim . This road will serve as connectivity between Capital City Gangtok to Paykong Airport & Sub-Division Head Quarters of the East District. The area is mountainous and steep. It is single lane road with formation width about 6.5 m without conforming any standard / specification.

It will serve one of the major routes for East District of Sikkim. Up-gradation of the existing road, having formation width of about 6.50m, to a formation width of 12.0m, construction of pavement work for the entire length, culverts and permanent works at essential places, widening and improvement of blind curve portion, realignments at the portions where steep gradients have to be avoided, construction of pucca side drains, and installation of traffic/informatory sign and Kilometre.

The alignment passes through steep mountainous terrain and crosses deep gorges, streams and rivers at many locations all throughout the entire length. The entire project area experiences very heavy rainfall averaging about 3200.00 mm per year. The monsoon period also lasted about 5 to 6 months starting from May to October in a year. The available working season is very limited and is at most not more than 7 months in a year. The remaining 5 months period of the year is not suitable for working due to monsoon rain.

10.2 CONTRACT PACKAGING AND PROCUREMENT STRATEGIES

The entire length of the proposed widening to 2-lane, re-alignment and geometric improvement, pavement, permanent work, road safety measures, road furniture etc is proposed to be in single packages.

Procurement of various construction materials will be within the state as well as from other state too. Cement, steel for permanent work and bitumen will be from Siliguri respectively. The remaining construction material is available locally.

The whole project is divided into single packages as given below.

Package No	Package description		Length (km)	Cost (Rs in cr.)	Remarks
	From	To			
Package-1	0.00	16.167	16.167	240.73	Including 1.4 Km length of Ranipool Bye Pass & Bridge over Ranikhola

The implementation of the project is proposed to be taken up through capable contractors through national competitive bidding adopting Ministry's Standard Bidding Document prescribed and approved for MORT&H works which will facilitate selection of experience and capable contractors.

10.3 IMPLEMENTATION STRATEGIES

The total cost of the project is Rs 240.73 Cr. which covers costs for formation work, Slope protection and cross drainage works, construction of bridges and pavement works. Construction period of 42 months has been proposed, considering the quantum of activities to be performed including mobilization period needed and four intervening rainy seasons in between.

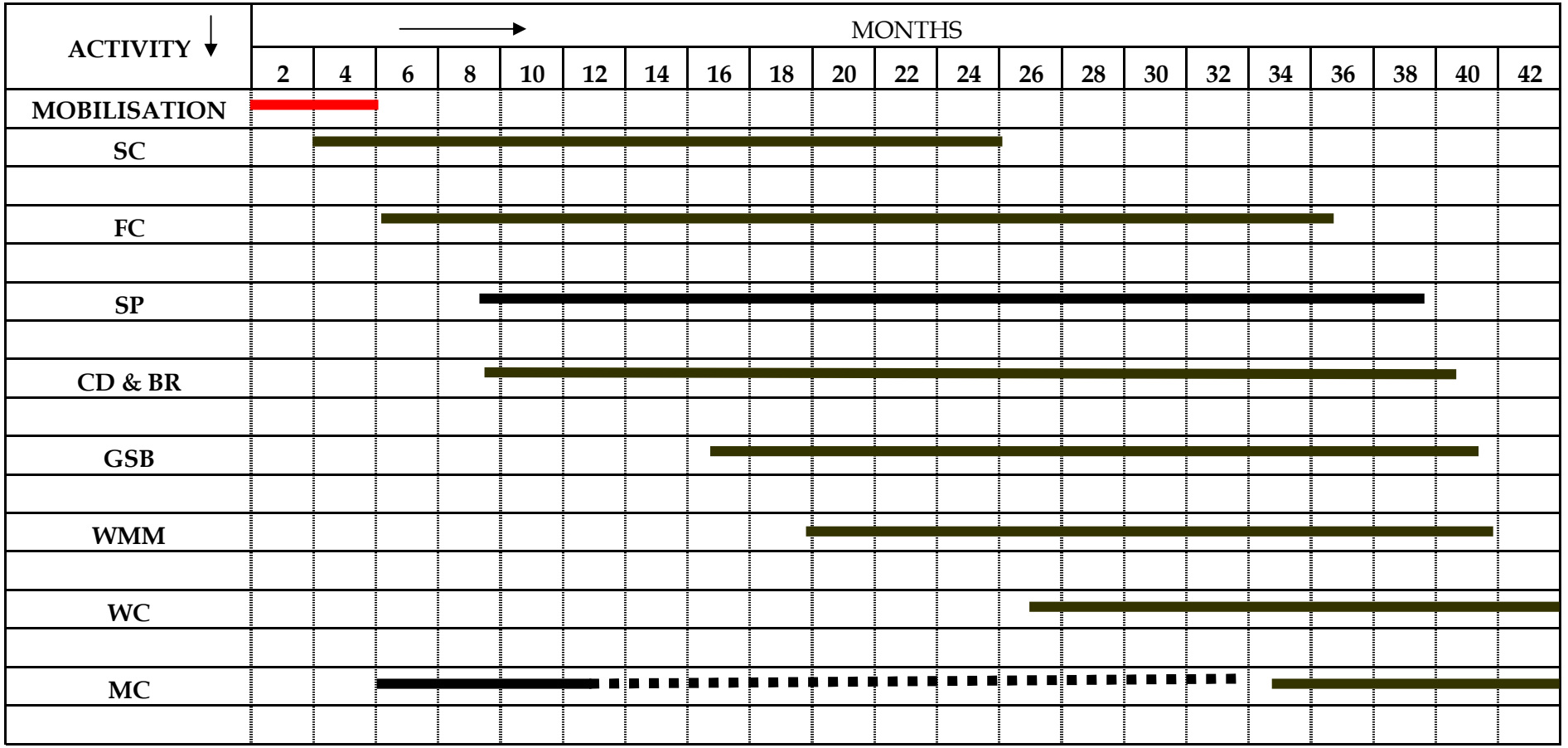
The project is proposed for commencement during the financial year 2017-2018 with target completion by the year end of 2021-2022. Since the project will be executed through a period of three and half years there will be cost escalation during the period of construction. Considering the rate of price escalation at an average rate of 5% per annum compounded annually after the initial year, the cost of construction and physical and financial phasing of the project is given in the table below:

Sr.No	Year	Cumulative Physical Target (%)	Cumulative Cost (Rs in crores)
1	2017 -18	15	36.11
2	2018 -19	45	108.33
3	2019 - 20	80	192.58
4	2020 - 21	100	240.73

Depending on the time usually taken for according necessary sanction by the Ministry, it may be possible to commence the Construction of the project by beginning of 2018 i.e. by June /2018. The projected implementation schedule is given in the form of Bar Chart in the next page.

IMPLEMENTATION SCHEDULE (ROADS)

From Date of Start



SC = Site Clearance

CD = Cross Drainage Work

FC = Formation Cutting

GSB = Granular Sub Base

WMM = Wet Mix Macadam

WC = Wearing Coat

MC = Miscellaneous

SP = Slope protection work

SECTION - 11

11.1 MAINTENANCE OF EXISTING ROAD:

The proposed widening to 2-lane, re-alignment and geometric improvement of NH 717 (A) under this report is from Km 0+00 to Km 16+167 of existing chainage in Sikkim. This road will serve as connectivity between Capital City Gangtok to Paykong Airport & Sub-Division Head Quarters of the East District. The area is mountainous and steep. It is single lane road with formation width about 6.5 m without conforming any standard / specification.

It will serve one of the major routes for East District of Sikkim. Up-gradation of the existing road, having formation width of about 6.50m, to a formation width of 12.0m, construction of pavement work for the entire length, culverts and permanent works at essential places, widening and improvement of blind curve portion, realignments at the portions where steep gradients have to be avoided, construction of pucca side drains, and installation of traffic/informatory sign and Kilometre.

The area is mountainous and steep. It is single lane road with formation width about 6.5 m without conforming any standard / specification.

It will serve one of the major routes for East District Sikkim. The minimum construction time provided for completion of the project is 4.0 (four) years during which maintenance by the PIU will be no longer convenient as the site possession is resorted to hand over to the contractor till completion of the project. Under this circumstance, it is inevitable to keep provision for yearly maintenance of the existing road during construction and hence a provision of Rs.59.54 lakhs per year is kept to make the road payable for all type of vehicles without serious interruption of the traffic flow throughout the year.

11.2 SCOPE OF MAINTENANCE:

1) Maintenance of Earthen Shoulder (filling with fresh soil).
2) Filling Pot- holes and Patch Repairs with open - graded Premix surfacing, 20mm.
3) Hill Side Drain Clearance.
4) Land Slide Clearance in soil.
5) Clearing Grass and Removal of Rubbish.
6) Maintenance/repair of culvert/Retaining wall.

11.3 DIVERSION OF EXISTING ROAD DURING CONSTRUCTION

For improvement of existing road some stretches localized, relocation and re-grading are proposed .Due to which traffic movement on existing road will be hampering.

1) Formation cutting for diversion of existing road (6.0 m wide).
2) Sub-base course level 100 mm thick GSB Gr-1
3) Base course level 150 mm thick CTB
4) Wear course 20 mm thick MSS
5) Earthen shoulder.

11.4 SCOPE OF DIVERSION OF EXISTING ROAD DURING CONSTRUCTION :

1) Maintenance of Earthen Shoulder (filling with fresh soil).
2) Filling Pot- holes and Patch Repairs with open - graded Premix surfacing, 20mm.
3) Hill Side Drain Clearance.
4) Land Slide Clearance in soil.
5) Clearing Grass and Removal of Rubbish.
6) Maintenance/repair of culvert/Retaining wall.
7) Clearance of culvert before monsoon
8) Removal of land slide