Initial Environmental Examination

January 2017

IND: Karnataka State Highways Improvement Project III

Kollegal to Hanur Road

Prepared by Project Implementation Unit, KSHIP, Government of Karnataka for the Asian Development Bank

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CURRENCY EQUIVALENTS

(as on 17 January 2017)

Currency Unit	=	Indian Rupee (INR)
INR 1.00	=	$ 0.0147
$ 1.00	=	INR 67.869

ABBREVIATIONS

AADT	:	Annual Average Daily Traffic
ADB	:	Asian Development Bank
ADT	:	Average Daily Traffic
AE	:	Assistant Engineer
AEE	:	Assistant Environmental Engineer
AIDS	:	Acquired Immune Deficiency Syndrome
AM	:	Arithmetic Mean
AP	:	Affected Person
AQ	:	Air Quality
ARAI	:	The Automotive Research Association of India
ASI	:	Archaeological Survey of India
BUA	:	Business-As-Usual
BCCI-K	:	Bangalore Climate Change Initiative – Karnataka
BDL	:	Below Detection Limit
BOD	:	Biological Oxygen Demand
BPL	:	Below Poverty Line
C/L	:	Centre Line
Ca	:	Calcium
CALINE 4	:	California Line Source Dispersion Model Version 4
CBR	:	California Bearing Ratio
CD	:	Cross Drainage
CEF	:	Composite Emission Factor
CEW	:	Corridor East-West
CGWA	:	Central Ground Water Authority
CGWB	:	Central Ground Water Board
CI	:	Chlorine
CO	:	Carbon Monoxide
CoI	:	Corridor of Impact
CPCB	:	Central Pollution Control Board
CPO	:	Chief Project Officer
CPR	:	Common Property Resources
CRN	:	Core Road Network
CRTN	:	Calculation of Road Traffic Noise
Cu	:	Copper
CWC	:	Central Water Commission
dB	:	Decibel
DC	:	District Collector
DFO	:	Divisional Forest Officer
DGRC	:	District Grievance Redress committee
DLRO	:	District Land Revenue Officer
DO	:	Dissolved Oxygen
DO	:	Duty Officer

DPR	:	Detailed Project Report
EA	:	Executive Agency
EAC	:	Expert Appraisal Committee
EC	:	Electrical Conductivity
EHS	:	Environment Health and Safety
EIA	:	Environmental Impact Assessment
EMP	:	Environment Management plan
EO	:	Environmental Officer
EPA	:	Engineering Procurement Annuity
EPA	:	Environment (Protection) Act
EPC	:	Engineering Procurement Construction
ES	:	Environmental Specialist
Fe	:	Iron
GHGs	:	Greenhouse Gases
GIS	:	Geographical Information System
GoI	:	Government of India
GoK	:	Government of Karnataka
GRC	:	Grievance Redress Cell
GRM	:	Grievance Redress Mechanism
GW	:	Ground Water
HDPE	:	High Density Polyethylene
HFL	:	High Flood Level
Hg	:	Mercury
HIV	:	Human Immunodeficiency Virus
HS	:	Homogeneous Section
ICAP	:	Indian Clean Air Program
ICB	:	International Competitive Bidding
IE	:	Independent Engineer
IEE	:	Initial Environmental Examination
IMD	:	India Meteorological Department
IRC	:	Indian Road Congress
IS	:	Indian Standards
IUCN	:	International Union for Conservation of Nature
IVI	:	Important Value Index
KPWD	:	Karnataka Public Works Department
KRDCL	:	Karnataka Road Development Corporation Limited
KSAPCC	:	Karnataka State Action Plan on Climate Change
KSHIP	:	Karnataka State Highways Improvement Project
LA	:	Land Acquisition
LAP	:	Land Acquisition Plan
LAQ	:	Land Acquisition Officer
LHS	:	Left hand Side
LPG	:	Liquid Petroleum Gas
Mg	:	Magnesium
MI	:	Monitoring Indicators
Mn	:	Manganese
MO	:	Medical Officer
MOEF&CC	:	Ministry of Environment, Forest and Climate Change
MoRT&H	:	Ministry of Road Transport and highways
MPN	:	Most Probable Number
MSDS	:	Material Safety Data Sheet

MSL	:	Mean Sea Level
NAAQS	:	National Ambient Air Quality Standards
NABL	:	National Accreditation Board for Testing and Calibration Laboratories
NBWL	:	National Board for Wildlife
NE	:	Not Evaluated
NGO	:	Non-Government Organization
NO_2	:	Nitrogen Dioxide
NOC	:	No Objection Certificate
NPV	:	Net Present Value
NQ	:	Noise Quality
NTU	:	Nephelometric Turbidity Unit
OBC	:	Other Backward Caste
ODR	:	Other District Road
PAF	:	Project Affected Families
PAH	:	Project Affected Households
PAP	:	Project Affected Persons
Pb	:	Lead
PBDPS	:	Performance Based Deferred Payment System
PCC	:	Plain Cement Concrete
PCM	:	Public Consultation Meeting
PCU	:	Passenger Car Unit
PD	:	Project Director
PHH	:	Physically Handicapped Persons
PIA	:	Project Influence Area
PIU	:	Project Implementation Unit
PM	:	Particulate Matter
PP	:	Project Proponent
PPE	:	Personal Protective Equipment
PPM	:	Parts Per Million
PPTA	:	Project Preparatory Technical Assistance
PRC	:	Public Response Centre
PT	:	Performance Target
PTV	:	Percent Time Violation
PUC	:	Pollution under Control
RAP	:	Reclaimed Asphalt Pavement
RCC	:	Roller Compacted Concrete
REA	:	Rapid Environmental Assessment
RHS	:	Right Hand Side
ROB	:	Road Over Bridge
RoW	:	Right of Way
RUB	:	Road Under Bridge
SAR	:	Sodium Absorption Ratio
SC	:	Schedule Caste
SD	:	Standard Deviation
SDO	:	Social Development Officer
SEAC	:	State Level Expert Appraisal Committee
SH	:	State Highway
SIA	:	Social Impact Assessment
SO	:	Safety Officer
SO_2	:	Sulphur Dioxide

SPCB	:	State Pollution Control Board
SPL	:	Sound Pressure Level
ST	:	Schedule Tribes
SW	:	Surface Water
TCS	:	Typical Cross Section
TDS	:	Total Dissolved Solids
TEEMP	:	The Transport Emission Evaluation Model for Projects
USEPA	:	United States Environmental Protection Agency
VDF	:	Vehicle Damage Factor
VEC	:	Valued Environment Component
WHH	:	Women Headed Household
WLPA	:	Wildlife Protection Act
WMM	:	Wet Mix Macadam

WEIGHTS AND MEASURES

Cum	:	Cubic Meter
dB(A)	:	A Weighted Decibel
gm/cm^3	:	Gram per Centimeter Cube
g/km	:	Gram Per Kilometer
ha	:	Hectare
ham	:	Hectare meter
km	:	Kilometer
Km/l	:	Kilometer Per Liter
Km^2	:	Square Kilometer
L_{eq}	:	Equivalent Continuous Noise Level
µg	:	Microgram
$µg/m^3$	:	Microgram Per Cubic Meter
m	:	Meter
mg/kg	:	Milligram per Kilogram
mg/l	:	Milligram per Liter
mg/m^3	:	Milligram Per Cubic Meter
$PM_{2.5}$	:	Particulate Matter of 2.5 Micron size
PM_{10}	:	Particulate Matter of 10 Micron size
Sqm.	:	Square Meter

EXECUTIVE SUMMARY

A. Introduction

1. The Government of Karnataka through the Government of India has received in principal approval for a loan from the Asian Development Bank (ADB) towards Karnataka State Highways Improvement Project –III (KSHIP-III) for developing State Road network adopting innovative financial models under Public Private Partnership (PPP). A pre financial feasibility has been conducted by PIU KSHIP on a Core Road Network of 4,403 km out of which 1,350 km has been selected for Detailed Project Preparation and Implementation under KSHIP-III.

2. In pursuance of the above, Intercontinental Consultants and Technocrats Pvt. Ltd. have been appointed as Consultants by KSHIP to carry out the Preparation of Detailed Project Report and provide Transaction Advisory Services for Karnataka State Highway Improvement Project-III Group II roads in the State of Karnataka to two/four lane with Paved Shoulder Configuration".

B. Objectives of the IEE

3. Following are the objectives of the Environmental Study:

- Determine the category of the project depending on improvement proposal, environmental sensitivity and magnitude of impacts, i.e. screening as per Government of India's regulations and ADB's Safeguard Policy Statement 2009;
- Determine the appropriate extent and type of EA required (IEE or EIA), i.e scoping;
- Determine the requirement of statutory clearances;
- Baseline environmental monitoring and survey;
- Prediction of impacts on relevant environmental attributes and mitigation measures to minimize the impacts; and
- Preparation of IEE Report including EMP.

C. Description of the Project

4. The project road starts from the take-off point of the proposed bypass of NH-209 near Agraharam Village (NH-209 Ch. 345+400) and connect SH-79 after Madhuvanahalli Village near junction with SH 38 and ends at Hanur at Km.85+815 (at junction of SH-79 with MDR). Therefore, total length of the project road is **23.782 km**. The project road is passing through **Chamrajnagar district**. The location of the project road is shown on Index Map at **Figure-E.1**. The Latitude & Longitude of start and end points are $12^0\,10'\,50.58"$N & $77^0\,07'26.77"$E and $12^0\,05'\,13.24"$ N & $77^0 18' 29.66"$ E respectively.

5. The project road forms interstate connectivity and improvement proposal may facilitate increased cross interstate traffic movement as project road connects Tamil Nadu border in Palar. Project road also forms important connectivity to various tourist destinations within the region and along the project road including, Hoganakkal Falls, Gaganachukki and Bharachukki Falls, BR Hills, Talakadu and many other in the region. The proposed improvement proposal for the project road would benefit and improve network mobility in the region.

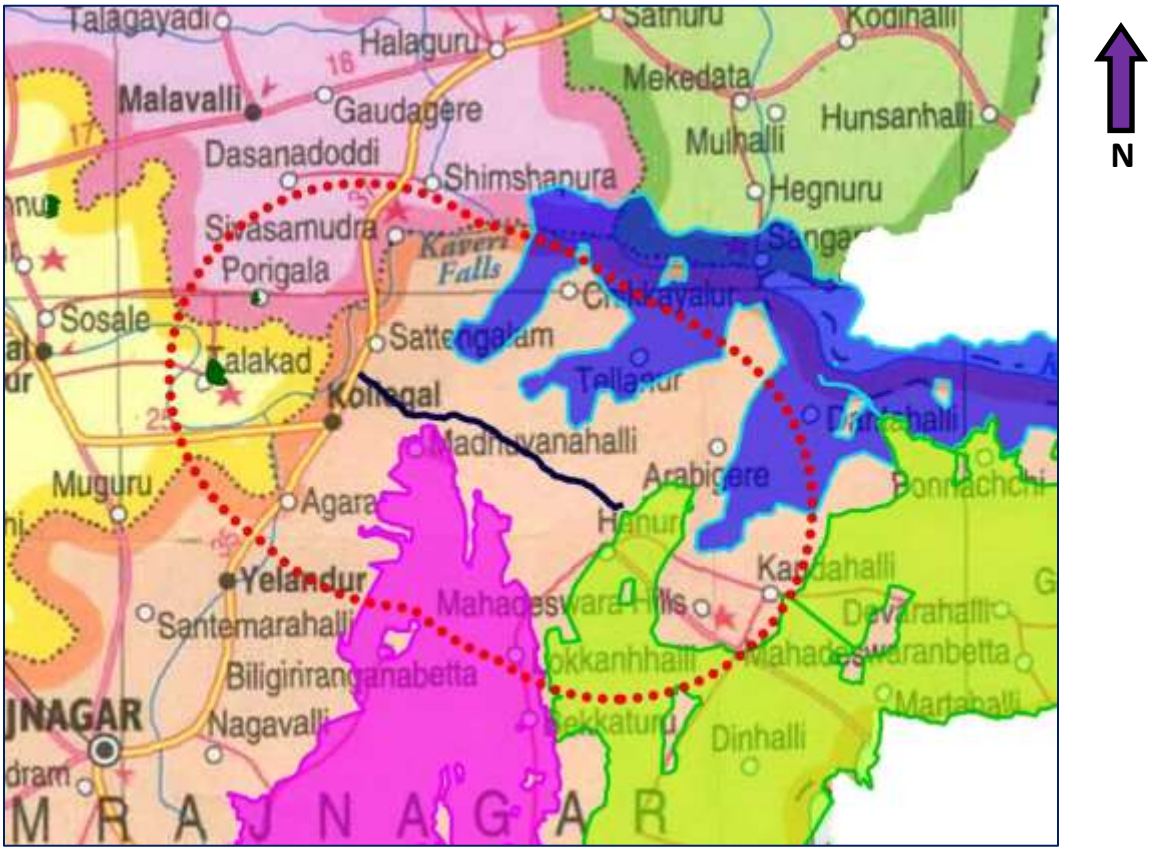


Figure 1: Map Showing location of the Project Road

1. Project Highlights

Table 1: Salient Existing Features of the Project Road

Road stretch	**Kollegal to Hanur**
Road length	**23.782 km**
Start point	Starts from the take-off point of the proposed bypass of NH-209 near Agraharam Village (NH-209 Ch. 345+400)
End point	Ends at Hanur at Ch. Km.85+815 of SH-79 (at junction with MDR)
Districts en-route	Chamrajnagar
Important settlements /villages	Kollegal, Madhuvanahalli, Kamagere, Manglam, Hullepuram & Hanur
Existing carriageway	The existing road is predominantly (Approx. 85% of Project length) Intermediate lane carriageway of 5.5 m width and about 15% of project length is 2-lane carriageway of varying width from 7 m to 9.5 m
Terrain	Plain
Land Use	Mainly agricultural followed by built-up area
Major Bridges	Nil
Minor Bridges	5
Causeways	1 vented causeways

Culverts	49 culverts
ROB & RUB	Nil
Railway Crossing	Nil
Flyover	Nil

2. Annual Average Daily Traffic (AADT)

6. Section-wise AADT obtained is shown in **Table 2** which gives the mode-wise AADT for all the survey locations.

Table 2: Annual Average Daily Traffic at Various Surveyed Location

Location	Survey conducted by	Total Traffic	
		Vehicles	PCUs
Km. 72+100 near Doddinavadi	ICT-2015	5,908	6,624
Km. 72+100 (104+000 in iDeCK study) near Doddinavadi	iDeCK-2014	4,645	5,621
Location near MM Hills	PWD Data, 2015	2,978	4,014

3. Identification of Homogeneous Sections

7. The proposed project road from Kollegal to Hanur, Section of SH-79, involves 1 homogeneous section (**Table.3)**.

Table 3: Homogeneous Sections of the Project Road

Section No.	Sections	Existing Chainage			Design Chainage			
		Start Ch. Km	End Ch. Km	Distance (Km)	Start Ch. Km	End Ch. Km	Distance (Km)	Traffic Volume AADT(PCU) 2015
HS-I	Kollegal to Hanur	61+450	85+815	24.365	0+000	85+770	23.782	6,624

Note: Chainage Equation = Backward Ch. 4+900 = Forward Ch. 66+888

4. Traffic Forecast

8. The projected traffic for each of the homogeneous sections is presented in **Table 4**.

Table 4: Projected Annual Average Daily Traffic on Homogenous Sections I (Kollegal to Hanur)

Vehicle Type	Year							
	2015	2020	2022	2025	2030	2035	2040	2050
Car	1089	1686	1883	2619	3769	5364	7462	13254
Total Jeep/ Van	314	439	484	631	841	1071	1332	1966
Mini Bus	61	74	80	100	127	153	178	231
Bus	601	798	865	1060	1335	1615	1906	2540
Tempo LGV - Freight (3,4 Axle)	514	707	776	991	1285	1629	1944	2752
Tempo LGV - Freight (6 Axle)	13	18	19	22	27	32	37	47
2 Axle Truck	139	180	197	244	313	394	468	661
3Axle Truck	51	63	69	85	107	132	153	210
MAV	16	19	21	28	38	48	61	102
Three Wheeler	303	442	488	646	897	1214	1625	2911

Vehicle Type	Year							
	2015	2020	2022	2025	2030	2035	2040	2050
Two Wheeler	2618	4100	4585	6401	8977	11957	15628	25454
Tractor	6	7	7	7	7	7	7	7
Tractor With Trailer	37	42	43	46	51	56	61	71
Cycle	134	139	140	143	148	156	166	186
Cycle Ricks	0	0	0	0	0	0	0	0
Hand Cart	1	1	1	1	1	1	1	1
Animal Drawn	1	1	1	1	1	1	1	1
Non Tollable	11	11	11	11	11	11	11	11
Non Tollable PCUs	11	11	11	11	11	11	11	11
Total PCUs	**6,624**	**9,337**	**10,267**	**13,401**	**17,965**	**23,396**	**29,771**	**46,609**
Total Vehicles	**5,908**	**8,726**	**9,669**	**13,036**	**17,935**	**23,841**	**31,041**	**50,405**

5. Improvement Proposal

Table 5: Summary of Improvement Proposal

<table>
<tr><td>Proposed RoW</td><td>▪ In urban / built up area: Varies from 16 m to 20 m
▪ In rural / open country area: Varies from 26 m to 28 m depending on the height of embankment</td></tr>
<tr><td>Widening Scheme</td><td>A 2-lane section with 7 m wide carriageway, 1.5 m paved shoulder and 1m granular shoulder on both sides has been proposed except following locations:
<table>
<tr><th colspan="2">Design Ch. Km</th><th rowspan="2">Width of Paved Carriageway (m)</th></tr>
<tr><th>From</th><th>To</th></tr>
<tr><td>74+500</td><td>76+100</td><td>2 x 7.5</td></tr>
<tr><td>77+300</td><td>78+200</td><td>2 x 7.5</td></tr>
<tr><td>83+280</td><td>84+320</td><td>11</td></tr>
<tr><td>84+320</td><td>85+600</td><td>2 x 7.5</td></tr>
</table>
▪ Concentric Widening : 15.277 km
▪ Bypasses : 4.900 km
▪ Realignment : 2.390 km
▪ Curve Improvement : 1.215 km</td></tr>
<tr><td>Bypass</td><td>At one location (4.9 km):
<table>
<tr><th rowspan="2">Location</th><th colspan="2">Existing Ch. Km</th><th colspan="3">Design Chainage</th></tr>
<tr><th>Start</th><th>End</th><th>Start</th><th>End</th><th>Length</th></tr>
<tr><td>Kollegal & Madhuvanahalli</td><td>61+450</td><td>66+888</td><td>0+000</td><td>4+900</td><td>4.900</td></tr>
</table></td></tr>
<tr><td>Realignment</td><td>At two (2) locations, total length is 2.390 km</td></tr>
<tr><td>Bridge</td><td>▪ No major bridge
▪ Existing minor bridges to be Rehabilitated and Widened : 2
▪ Existing minor bridges to be reconstructed : 4
▪ New minor bridge to be constructed : 1</td></tr>
<tr><td>ROB</td><td>Nil</td></tr>
<tr><td>Culverts</td><td>▪ New culverts to be constructed : 26
▪ Culverts to be Rehabilitated and Widened : 5
▪ Culverts to be re-constructed : 25</td></tr>
<tr><td>Pedestrian Underpass</td><td>Based on the pedestrian traffic, an underpass of size 5x3m is proposed at Km. 84+910 in Hanur. The underpass is proposed below the proposed 4-lane section near the bus stand in Hanur</td></tr>
</table>

Road Side Drains	▪ Roadside drains shall be provided on both sides of the embankment ▪ In Rural Section trapezoidal drain sections have been proposed on both sides. ▪ In Urban Sections, lined drains with footpath have been proposed
Bus Bays	20 bus bays at 10 locations
Truck Lay Byes	No truck lay bye has been proposed along the project road
Toll Plaza	Considering traffic flow and Homogeneous section, the location of toll plaza has been proposed at Km 78+400. However as decided, construction of toll plaza will not be taken up during improvement, however land acquisition will be done for the location as per directions from the implementing agency.
Design Speed	The alignment has been largely designed to a design speed of 100 kmph except in built-up. Wherever the Improvement proposal is limited within existing Right of Way, design speed of 80 kmph is adopted to avoid Land Acquisition. Urban Sections are designed for minimum 50 kmph design speed to minimize the R&R & land Acquisition
Road Safety Devices	▪ Road Markings ▪ Road Signs ▪ Roadside Safety Barriers ▪ Pavement Marking and Lighting ▪ Many other safety features as prescribed in applicable codes and standards
Project Cost	▪ Civil Cost : Rs. 108.31 Crore ▪ EMP Cost : Rs. 3.45 Crore ▪ R&R Cost : Rs. 30.81 Crore ▪ Tot Project Expenses : Rs. 193.99 Crore
Project Completion Period	24 months

D. Policy, Legal and Administrative Framework

9. As per the ADB's Safeguard Policy Statement the proposed project has been classified as **Category 'B'** project requiring Initial Environmental Examination (IEE).

10. **Environment Clearance:** The proposed project is the strengthening & widening of existing State Highway. Project road is passing through plain terrain (below 1,000 m MSL) and is not passing through any ecologically sensitive area. **Therefore, Environmental Clearance is not required from Government of India for improvement of SH-79 from Kollegal to Hanur (23.782 Km) in the State of Karnataka**.

11. A summary of various statutory clearances required for the project road is presented in **Table 6**.

Table 6: Statutory Clearances required for the Project Road

Type of Clearance	Name of the Authority	When Required
Tree Felling Permission	Department of Forest, GoK	Before Construction

12. Apart from the clearances for the overall project work, the contractor, before starting the construction work, has to obtain required Clearances / NOCs listed in **Table 7** for operating his equipment and carrying out construction work.

Table 7: Clearances Required to be obtained by the Contractor

Sl. No.	Construction Activity & Type of Clearance Required	Statutory Authority	Statute Under which Clearance is Required
1.	Consent for Establishment of Hot Mix Plant, WMM Plant, Stone Crushers and Batching Plant	▪ Karnataka State Pollution Control Board	▪ Air (Prevention and Control of Pollution) Act, 1981 ▪ Water (Prevention and Control of Pollution) Act, 1974 ▪ The Noise Pollution (Regulation and Control) Rules, 2000
2.	Consent for Operation of Hot Mix Plant, WMM Plant, Stone Crushers and Batching Plant		
3.	Permission for withdrawal of groundwater for construction	▪ Central Ground Water Authority ▪ State Ground Water Board	▪ Environment (Protection) Act, 1986 ▪ Ground Water Rules, 2002
4.	Permission for extraction of sand from river bed	▪ Department of Mines & Geology, Government of Karnataka	▪ Environment (Protection) Act, 1986
5.	Permission for extraction of sand from river bed	▪ District Level Environment Impact Assessment ▪ Authority (DEIAA)	▪ Environment (Protection) Act, 1986
6.	New Quarry and its operation	▪ Department of Mines & Geology, Government of Karnataka ▪ Karnataka State Pollution Control Board	▪ Environment (Protection) Act, 1986 ▪ Karnataka Minor Mineral Concession Rules, 1994 ▪ The Mines Act. 1952 ▪ Mines and Minerals (Development and Regulation) Amendment Act, 2015 ▪ The Explosive Act, 1984 ▪ Air (Prevention and Control of Pollution) Act, 1981 ▪ Water (Prevention and Control of Pollution) Act, 1974
7.	Opening of New Borrow Areas / Quarry	▪ MoEF&CC / SEIAA / DEIAA ▪ Karnataka State Pollution Control Board ▪ District Collector	▪ Environment (Protection) Act, 1986 ▪ Air (Prevention and Control of Pollution) Act, 1981 ▪ Minor Mineral and Concession Rules, 2015
8.	Location and layout of workers camp, & equipment and storage yards	▪ Karnataka State Pollution Control Board	▪ Environment (Protection) Act, 1986; Manufacturing, Storage and Import of Hazardous Chemicals Rules, 1989
9.	Discharges from labour camp	▪ Karnataka State Pollution Control Board	▪ Water (Prevention and Control of Pollution) Act, 1974
10.	Storage, handling and transport of hazardous materials	▪ Karnataka State Pollution Control Board	▪ Hazardous and Other Waste (Management and Trans-boundary Movement) Rules, 2016 ▪ Manufacturing, Storage and Import of Hazardous Chemicals Rules, 1989

Sl. No.	Construction Activity & Type of Clearance Required	Statutory Authority	Statute Under which Clearance is Required
11.	Disposal of Bituminous Wastes	▪ Intimate local civic body to use local solid waste disposal site	▪ Hazardous and Other Waste (Management and Trans-boundary Movement) Rules, 2016
12.	PUC Certificate for all construction vehicles and all machineries	▪ Transport Department of Govt. of Karnataka	▪ The Motor Vehicle Act 1988 ▪ The Motor Vehicles (Amendment) Bill, 2015 ▪ The Central Motor Vehicles Rules, 1989
13.	Installation of DG Set (Consent to Establish)	▪ Karnataka State Pollution Control Board	▪ Air (Prevention and Control of Pollution) Act, 1981 ▪ The Noise Pollution (Regulation and Control) Rules, 2000
14.	Operation of DG Set (Consent to Operate)		
15.	Engagement of Labour - Labour License	▪ Labour Commissioner (Ministry of Labour and Employment)	▪ The Building and Other Construction workers (Regulation of Employment and Conditions of Service) Act 1996 ▪ Contract Labour (Regulation and Abolition) Act 1970 along with Rules, 1971
16.	Engagement of Labour - Social Security - Labour Welfare - Wages	▪ Labour Commissioner (Ministry of Labour and Employment)	▪ The Employees' Provident Fund & Miscellaneous Provisions (Amendment) Act, 1996 ▪ The Personal Injuries (Compensation Insurance) Act, 1963 ▪ The Inter-State Migrant Workmen (Regulation of Employment and Conditions of Service) Act, 1979 ▪ Equal Remuneration Act, 1976 ▪ The Payment of Wages (Amendment) Act, 2005 ▪ The Minimum Wages Act, 1948 ▪ The Minimum Wages (Central) Rules, 1950

13. In addition to the above, Contractor has to obtain:

- Insurance related to 3rd party insurance, Indemnity, Workmen Compensation etc.
- Permission / license to store explosive materials
- Permission from local Panchayat / Municipal body for setting up Construction Camp
- Change of Land Use Certificate from District Land Revenue Officer (DLRO)

E. Description of the Environment

14. The existing environmental conditions of the study area covering an area spread over 15 km on either side of the road, in general and specific environmental features of the study corridor, i.e., 50 m on either side of the existing centerline of the road, in particular, has been studied as described in the subsequent sections.

15. **Seismicity.** The project area is located in the southern India which is moderately active seismic region. The project road is situated in the Zone II (having low seismic intensity) of the Seismic Map of India (as per IS: 1893, Part I, 2002) and therefore has a low risk of potential damage due to earthquake.

16. **Land Use**. The land use pattern in most of the stretch along the project road is agricultural land (69.3%) followed by residential cum commercial area (30.7%).

17. **Soil Quality**. Two (2) sampling locations within the study area were selected for studying soil characteristics. It has been observed that the texture of soil is silty clay with 37-52% silt content and only 28-38% clay content. The pH of the all samples varied between 7.6-8.3, which is above the neutral mark of 7.0 indicating slightly alkaline soil. The organic matter was observed to low and varying in the range of 1.2-1.8%. The sodium absorption ratio is found to be 2.7 to 4.4%, while the nitrogen content of the soil is sufficient. Thus, it can be inferred that the overall fertility status of the soils within the study area is moderate.

18. **Climate and Meteorology**. An automatic weather station was established at Kowdhalli for collection of meteorological data from 1st December to 31st December 2015. Meteorological data of the study area is summarized below:

Table 8: Summary of Meteorological Data of the Study Area

Parameters	December 2015
Maximum Temperature (^{o}C)	33.3
Minimum Temperature (^{o}C)	16.1
Maximum Relative Humidity (%)	90.4
Minimum Relative Humidity (%)	26.2
Total Rainfall (mm)	0
Average Wind Speed (m/sec)	2.8
Calm condition	0.00
Predominant wind direction (blowing from)	North-east
Dry hours (%)	100%

Source: On-site Monitoring during Dec15

19. **Ambient Air Quality**. For drawing up the baseline status of ambient air quality in the study corridor, ambient air quality monitoring has been conducted at 2 representative locations along the project road. Ambient air quality monitoring was conducted in post monsoon season (Oct 15 to Dec 15) at a frequency of twice a week at each station adopting a 24-hours schedule. CO has been measured 1-hourly.

20. 24-hourly monitoring results of $PM_{2.5}$, PM_{10}, SO_2, NO_2 and 1-hourly CO corresponding to air quality stations AQ1 and AQ2 are presented in **Table 9.** The 24-hourly average 98-percentile values of $PM_{2.5}$ and PM_{10} at both locations were observed to exceed the standard. However, the 24-hourly average 98-percentile values of remaining parameters at both the locations were observed to be within the prescribed limit for Industrial, Residential, Rural & other areas as stipulated in the National Ambient Air Quality Standards, 2009. The reason for high particulate concentration may be attributed to the vehicular movement in the poorly maintained roads and local activities.

Table 9: Statistical Analysis of Ambient Air Quality in the Study Area

Pollutant	AAQMS	Location	Mes	Min	Max	SD	p98	PTV^{IND}	PTV^{WB}	Indian Standard
$PM_{2.5}$ ($\mu g/m^3$)	AQ1	Kollegal	22	14.0	72.0	17.5	71.3	27.3	0.0	60
	AQ2	Hanur	22	20.8	74.6	18.5	73.3	40.9	0.0	
	Overall 2 Locations		**44**	**14.0**	**74.6**	**18.0**	**72.5**	**34.1**	**0.0**	
PM_{10} ($\mu g/m^3$)	AQ1	Kollegal	22	21.0	111.0	29.1	110.6	31.8	0.0	100
	AQ2	Hanur	22	30.7	117.0	30.5	116.2	54.5	0.0	
	Overall 2 Locations		**44**	**21.0**	**117.0**	**30.0**	**115.3**	**43.2**	**0.0**	
SO_2 ($\mu g/m^3$)	AQ1	Kollegal	22	10.0	16.2	1.7	16.1	0.0	0.0	80
	AQ2	Hanur	22	10.4	17.2	2.0	17.0	0.0	0.0	
	Overall 2 Locations		**44**	**10.0**	**17.2**	**1.8**	**16.8**	**0.0**	**0.0**	
NO_2 ($\mu g/m^3$)	AQ1	Kollegal	22	16.4	28.0	3.0	27.6	0.0	0.0	80
	AQ2	Hanur	22	19.0	30.2	3.0	29.7	0.0	0.0	
	Overall 2 Locations		**44**	**16.4**	**30.2**	**3.0**	**29.2**	**0.0**	**0.0**	
CO (mg/m^3)	AQ1	Kollegal	22	0.4	0.5	0.0	0.5	0.0	0.0	4
	AQ2	Hanur	22	0.4	0.6	0.0	0.6	0.0	0.0	
	Overall 2 Locations		**44**	**0.4**	**0.6**	**0.0**	**0.6**	**0.0**	**0.0**	

Source: On-site Field Monitoring during Dec15 – Jan 15

AAQMS: Ambient Air Quality Monitoring Station Code, Mes: Number of Measurements, AM: Arithmetic Mean, SD: Standard Deviation, p98: 98-Percentile Value, PTV: Percent time violation with respect to the standard

21. **Ambient Noise Level**. Ambient noise monitoring was conducted at 4 locations, two in residential areas and two at silence zone (**Table 10**).

Table 10: 19 Ambient Noise Levels of the Study Area

Station	Zone	L_{d10}	L_{d90}	L_{deq}	L_{n10}	L_{n90}	L_{neq}	L_{dn}	$L_{eq(24)}$	L_{Min}	L_{Max}
NQ1	Silence	**55.4**	47.1	52.9	48.9	40.4	45.1	64.7	51.5	40.1	**56.8**
NQ2	Silence	52.8	45.4	50.5	43.5	39.5	41.7	60.8	49.0	39.2	53.2
NQ3	Residential	**54.3**	46.9	52.0	43.8	36.2	41.0	62.3	50.4	36.2	**54.7**
NQ4	Residential	53.3	45.9	51.0	44.0	40.0	42.2	61.3	49.5	39.7	53.7

Source: On-site Noise Monitoring during December 2015

Note: Noise Standard in Residential Zone : Day Time: 55 dB(A) Night Time: 45 dB(A)

Noise Standard in Silence Zone : Day Time: 50 dB(A) Night Time: 40 dB(A)

22. The daytime and night time noise equivalent levels in the residential & silence areas show that the ambient noise levels exceeds the stipulated of Noise standards. Highest noise level observed in residential and silence zone is 54.7 dB(A) and 56.8 dB(A) respectively.

23. Ld10 values (highest among the monitored values) are found to be 54.3 dB(A) and 55.4 dB(A) for residential and silence zone respectively, which signifies that measured noise levels exceeded these values in only 10% of the time of measurement duration. The noise levels were recorded sufficiently away from the project road to avoid influence of traffic induced noise. Therefore, it can be inferred that the slightly high noise levels at monitoring locations originates from local activities including domestic.

24. **Surface and Ground Water Quality**. 2 surface water (Pond) and 2 ground water quality monitoring stations (hand-pumps) in the study corridor were selected for the purpose of monitoring, analysis and assessment of water quality (**Table 11**).

Table 11: Details of Surface and Ground Water Quality Monitoring Stations

SN	Station Code	Place	Chainage (Km)	Side	Distance# (m)	Usage
Surface Water						
1	SW1	Pond, Kollegal	62+100	RHS	7.8	Irrigation
2	SW2	Pond, Haruvanapuram	67+820	RHS	6.0	livestock watering
Ground Water						
1	GW1	Kollegal	63+400	RHS	13	Drinking
2	GW2	Hanur	85+160	RHS	10	Drinking

Distance in meter from existing centerline
Source: On-site Water Quality Monitoring in December 2015

25. The water quality results shows the surface waters in the study area are devoid of any extraneous chemical contamination; no toxic or organic constituents are detected in samples. However, all the samples have high coliform count, high BOD levels and low dissolved oxygen indicates discharge of fecal matters and agricultural runoff in the water.

26. The ground water quality of the study area, in general, is hard in nature and the physico-chemical quality at large satisfies the permissible limit as stipulated in Drinking Water Standards of India as well as World Health Organization.

27. **Ecology and Diversity**. The biodiversity study for **Kollegal to Hanur** was carried in the month of December, 2015. Total of 2 sample plots of 100 m x 10 m were laid for the purpose of biodiversity assessment. The GPS co-ordinates and altitude were recorded for each of the sample plots (**Table 12**)

Table 12: GPS Co-ordinates and Altitude for the Sample Plots

Sample Plots	Latitude	Longitude	Altitude (m)	Vegetation Type
1	12˚5' 9"	77˚ 21' 20.1"	644	Shrubby vegetation
2	12˚4' 14.9"	75˚ 28' 16.1"	579	Shrubby vegetation

Source: Bio-diversity Study conducted by ICT in December 2015

28. 64 floral species were identified. Out of which, 22 were tree species, 25 shrubs and 17 herb species. In the present assessment, the Shannon's diversity index for tree species was 2.83, for shrubs was 3.10 and for herbs 2.61. Shannon's diversity index values obtained for different sites was found to be moderate to low when compared to reported values of 3.6 to 5.4 for tropical forests (Knight, 1975) and is nearer to the range (2.557 to 3.375) reported for Permanent Preservation Plots at Western Ghats of Karnataka (Karthik, 2009) and 2.31 to 3.30 for the Western Ghats of Southern Karnataka (Sarkar *et al.,* 2011).

29. The calculated Simpson's index indicated that the shrub diversity was more compared to trees and herbs.

Table 13: Shannon's Diversity Index and Simpson's Index

Flora	Shannon's Diversity Index	Simpson's Index
Tree	2.83	0.06
Shrub	3.10	0.05
Herb	2.61	0.08

Source: Bio-diversity Study conducted by ICT

30. Total 47 faunal species were identified out of which 16 bird species, 29 insects, 1(one) reptile and 1(one) mammal were observed.

31. ***Accipiter badius*** **(Shikra)** is Schedule I species as per Wildlife Protection Act, 1972. Schedule I species are provided absolute protection –offence under these are prescribed the highest penalities. According to IUCN Global Conservation status both the species are under Least Concern (LC) category in the redlist. This species have an extremely large range, and hence does not approach the thresholds for vulnerable under the range size criterion. The population trend appears to be stable; globally there are no major threats to this species. No threatened species reported as per IUCN Red list.

Table 14: Shannon and Simpson Index

Shannon's Diversity Index (H)	Simpson's Index (D)
2.61	0.08

Source: Bio-diversity Study conducted by ICT

32. **Protected Areas:** The project road does not traverse through any National Park, Wildlife Sanctuary or Biosphere Reserve. However Malai Mahadeshwara Wildlife Sanctuary (1.4 km), Cauvery Wildlife sanctuary (4.5 km) and Biligiri Rangaswamy Temple (BRT) Wildlife Sanctuary (700 m) falls within 10 km radius of the project road, therefore the project falls in Eco-sensitive zones of the sanctuaries.

33. **Forests:** The project road does not pass through any Reserved Forest. The forest types located within 15 km radius of the project road are Thorn Scrub, Dry Deciduous, Tropical Moist Deciduous, The Bamboo type forests and The Evergreen Shola.

34. The main species found in this type of forest are *Acacia leucophloea, Acacia sundra, Albizia lebbeck, Albizia amara, Albizia odorotissima, Anogeissus latifolia, Chloroxylon swietenia, Elaeodendron glaucum, Limonia acidissima, Gmelina arborea, Holoptelea integrifolia, Pongamia pinnata, Pterocarpus marsupium, Santalum album* and *Vitex altissima.* The species found along the streams are *Terminalia arjuna, Tamarindus indica, Pongamia glabra, Vitex altissima, Syzygium cumini* and Ficus *sps*.

35. As per Forest Working Plan of Kollegal Forest division Elephant (*Elephas maximus*) and Tiger *(Panthera tigris*) are important fauna of the region, other commonly found wildlife are *Panthera pardus* (Leopard), *Hyaena hyaena* (Stripped Hyaena), *Canis aurens* (Jackal), *Canis lupus* (Wolf), *Hystrix indica* (Porcupine), *Herpestes edwardsi* (Common mangoose), *Lepus nigricollis* (Indian Hare), *Sus scrofa* (Wild Boar), *Manis crassicaudata* (Pangolin)*, Cervus unicolour* (Sambar), *Bos gaurus* (Gaur) *etc*. During Public consultation in the project area the locals informed that Elephant, Panther, deer and wild boars were observed occasionally in the project areas and they damage crops sometimes.

36. **Road side Trees:** The number of roadside trees existing within the row is estimated to be 767, out of which, 344 trees are located in left side and 423 trees are located in right side.

37. **Educational, Medical and Religious Properties**. The number of roadside educational, medical and religious / cultural properties is summarized in **Table 15**.

Table 15: Roadside Educational, Medical and Religious Properties

Items	Total Number
Educational Institutions	29
Medical Amenities	4
Religious Places	21

Source: Field Study conducted by ICT in December 2015

38. **Archaeological Sites**. There are no archaeological sites within 300 m on either side of the project road.

39. **Demographic details of Affected Population**

- The socio-economic information of affected persons (APs) has been collected from the census survey (100%). As per census survey, 448 households are likely to be affected due to the up-gradation of the existing road.
- There are a total of 1,831 APs being affected, which includes 980 (53.52 %) males and 851 (46.48 %) females. The average household size is 4.1 and the sex ratio amongst the APs is 868.
- The majority of the PAHs belong to the Hindu religion (92.63%), 2.01% are Christians and 1.56% are Muslims. However, nearly 3.79% of households did not respond to the question related to religion.
- Out of 448 affected households, 108 households (24.11 %) are from general category, 253 households (56.47 %) are from other backward caste (OBC), 71 household (15.85 %) are from scheduled caste (SC), and 6 household (1.34%) are from scheduled tribe (ST) category
- 25 affected households (5.58%) earn Rs. 30,000 per annum while 204 affected households (45.54%) earn above Rs.1,00,000 annually
- 29.46% affected household are illiterate, 6.47% are up to middle school, 7.81% are below matric, 15.63% APs are Matric (10th standard), 12.05% are educated up to graduate level
- 29.91% households are engaged in agriculture, 2.46% are agriculture labour, 6.92% are daily wage earner, and 32.37% households are carrying out businesses as their main occupation

F. Analysis of Alternatives

40. One bypass & two realignments have been proposed in this section of SH-79 with a total length of 7.290km. The analysis of alternatives has been carried out 'with the project' and 'without the project' scenarios in terms of potential environmental impacts. Further, analysis of alternatives have been done for realignments to avoid the places of congestion, human settlements, environmentally sensitive areas keeping in view traffic condition, obligatory points, geometric designs, congestions and socio economic viability and other environmental aspects of the region.

G. Anticipated Impacts and Mitigation Measures

41. **Environmental Impacts**. A summary of the potential environmental impacts during construction and operation phase along with recommended mitigation measures is summarized in **Table 16**:

Table 16: Summary of Anticipated Impacts and Recommended Mitigation Measures

Area	Impacts	Mitigation Measures
Construction Phase:		
Topography and geology	▪ Disfiguration & change in existing profile of the land due to borrow pits & construction of realignments. ▪ Disturbance on geological setting due to quarrying. ▪ Uncontrolled digging of borrow pits resulting in water accumulation & breeding of vector disease.	▪ Borrow pits will be allowed at only pre-identified locations. ▪ Borrow pits will be restricted to 1 m depth followed by resurfacing of pits. ▪ Road building materials will be procured from approved and licensed quarries. ▪ Suitable seismic design of the road structures will be adopted to mitigate the earthquake impacts.
Soil	▪ Disruption & loss of productive top soil from agricultural fields due to borrow pits ▪ Loosening of top soil & loss of vegetative cover along the road due to excavation & back filling which will lead to enhanced soil erosion.	▪ Adequate measures like drainage, embankment consolidation & slope stabilization will be taken along the road to avoid soil erosion. ▪ Top soils (15 cm) of borrow pit sites will be conserved and restored after excavation is over. ▪ Accidental spills of lubricants/oil and molten asphalt will be avoided by adherence to good practices.
Land use	▪ Generation of solid waste in the form of construction spoils from construction sites. ▪ Changes in existing land use pattern of the proposed ROW for construction of the road. ▪ Proposed ROW in built up area varies from 16 m to 20 m and in rural area it varies from 26 m to 28 m depending on the height of embankment	▪ Earth material generated from excavation of roadways & drainage will be reused during site development. ▪ Construction debris will be disposed of in suitable pre-identified dumping areas. ▪ Dumping areas will be biologically reclaimed. ▪ Construction camp will be provided to avoid indiscriminate settlement of construction workers.
Drainage	▪ Change in drainage pattern of the land. ▪ Increased incidence and duration of floods due to obstruction of natural drainage courses by the road embankment. ▪ Chances of filling of existing drainage courses during earth filling.	▪ Adequate drainage facilities will be provided along the road to facilitate its long life, and to avoid soil erosion & land degradation. ▪ Adequate cross drainage works & structures will be provided for smooth passage of runoff to avoid flooding. ▪ Filling of existing drainage courses will be strictly avoided. ▪ Suitable drainage at construction site & camp will be provided to avoid water stagnation, soil erosion & mosquito breeding.
Water use	▪ Impact on the local water sources due to use of construction water.	▪ Maximum rainwater harvesting and minimum use of existing water sources for construction will be ensured to minimize likely impacts on other users.
Water quality	▪ Increase of sediment load in the run off from construction sites and increase in turbidity in receiving streams/water bodies. ▪ Water pollution due to sewage from	▪ Silt fencing will be provided to reduce sediment load ▪ Oil interceptor to stop and separate the floating oils ▪ Proper sanitation facilities will be provided

Area	Impacts	Mitigation Measures
	construction camps.	in construction camp to prevent health related problems. ▪ All the construction activities will be carried out during dry seasons only. ▪ Rainwater Harvesting Structures and silt fences has been proposed at **7 locations** near water bodies, agricultural land, near settlement area and nala crossing ▪ Apart from provision of the mitigation measures, water quality shall be monitored during construction and operation phases as per environmental monitoring program to understand the effectiveness of mitigation measures suggested
Water body	▪ 13 water bodies are located within the CoI (7 ponds and 6 ditches)	▪ All 7 ponds have been saved. Out of 6 road side ditches, 4 road side ditches will be partially affected. These ditches are small depression (natural or manmade) along the road where water stored during rainy seasons only i.e. 3 to 4 months in a year and in the remaining period of the year i.e. 7 to 8 months, these ditches remain dry. Hence, there will be no significant impact on road side water bodies
Air quality	▪ Deterioration of air quality due to fugitive dusts emission from construction activities and vehicular movement along unpaved roads. ▪ Deterioration of air quality due to gaseous emissions from construction equipment & vehicular traffic. ▪ Deterioration of air quality due to emission from asphalt and hot mix plants.	▪ Construction materials will be stored in enclosed spaces to prevent fugitive emissions. ▪ Truck carrying soil, sand and stone will be duly covered to avoid spilling. ▪ Dust suppression measures such as regular water sprinkling on haul & unpaved roads particularly near habitation ▪ Asphalt and hot mix plants will be located at least 500 m away from inhabited areas & sensitive receptors and 300 m from the road. ▪ Use of Recycled Asphalt Cold Mix Technology to reduce air pollution ▪ Air quality shall be monitored during construction and operation phases as per environmental monitoring program to understand the effectiveness of mitigation measures suggested
Noise level	▪ Increase in noise level due to construction activities like operation of construction equipment & vehicular traffic.	▪ Construction camp and temporary labour sheds will be located away from the immediate vicinity of the construction sites and major road traffic. ▪ PPEs will be provided to construction personnel exposed to high noise levels as preventive measure. ▪ Low noise construction equipment will be used. ▪ Stationary construction equipment will be placed 113 m away from inhabited areas. ▪ Stationary construction equipment will be

Area	Impacts	Mitigation Measures
		placed 200 m away from the silence zones ▪ Construction activities carried out near residential area will be scheduled to the daytime only so that minimum disturbances are caused to people. ▪ Construction of solid Noise barrier and plantation ▪ Noise level shall be monitored during construction and operation phases as per environmental monitoring program to understand the effectiveness of mitigation measures suggested
Floral & Fauna	▪ Approximately **714** trees are required to be felled for the improvement of the road out of total **767** existing trees ▪ No threatened species of flora is falling in the ROW of the project road	▪ **3,793 trees** shall be planted along the road ▪ **335 trees** will be planted along the boundary of noise barrier ▪ Plantation shall be maintained for 5 years ▪ Cooking fuel (LPG/ Kerosene) will be provided to construction workers to avoid cutting / felling of trees for fuel wood. ▪ Soil erosion shall be checked by adopting bio-engineering measures ▪ The Contractor shall ensure that no open fire is done in construction camp as it may lead to fire to surrounding forest causing injury to wildlife ▪ Noise will be kept under control by regular maintenance of equipment and vehicles. No honking board shall be placed near Forest. Noisy activity shall be prohibited during night time
Forest	▪ Proposed project does not involve diversion of forest land	▪ There will be no impact on forest land
Educational, Medical and Religious Properties	▪ Out of 29 educational institutions along the project road, only 1 will be partially affected, i.e., boundary wall will be affected. There will be no impact on school building. ▪ 1 Veterinary Hospital at Kamagere will be fully affected but there will be no impact on remaining 3 medical amenities ▪ None of the religious structures along the project road will be affected	▪ Affected structures will be suitably relocated ▪ Affected utilities like electrical transmission lines, telephone lines, water pipelines, petrol pumps etc. will be suitably shifted by the concerned departments
Construction camp	▪ Influx of construction work-force & suppliers who are likely to construct temporary tents in the vicinity. ▪ Likely sanitation & health hazards & other impacts on the surrounding environment due to inflow of construction labourers.	▪ Temporary construction camps with adequate potable water supply, sanitation & primary health facilities and fuel for cooking will be provided to accommodate construction workers. ▪ It will be ensured that the construction workers are provided fuel for cooking to avoid cutting of trees from the adjoining areas. ▪ Domestic as well as the sanitary wastes from construction camps will be cleared

Area	Impacts	Mitigation Measures
		regularly.
Occupational health & safety	▪ Health & safety related problems to construction workers due to inadequate health & safety measures.	▪ Adequate safety measures complying to the occupational safety manuals will be adopted to prevent accidents/hazards to the construction workers ▪ Periodic health check-up of construction workers will be done.
Road safety	▪ Increase on incidence of road accidents due to disruptions caused in existing traffic movements.	▪ Proper traffic diversion and management will be ensured during construction at the interactions and construction areas. ▪ Reduction of speed through construction zones.
Operation Phase		
Land use and Encroachment	• Change of land use by squatter/ encroachment within ROW and induced development outside the ROW.	• Planning agencies and Collector/ Revenue Officer will be made involved for controlled development and prohibiting squatter/ encroachment within ROW.
Drainage	• Filthy environment due to improper maintenance of drainage.	• Drainage system will be properly maintained.
Water quality	• Chances of contamination of water bodies from road surface run off containing oil spills due to traffic movement & accidents.	▪ Longitudinal roadside drains of sufficient capacity will be provided on both sides of the road to accommodate increased run-off. The out fall for these drains will be the nearby culverts / bridges or natural drainage channel. ▪ Silt fencing will be provided to sediment entering into the water courses. ▪ Contingent actions will be taken for speedy cleaning up of oil spills, fuel and toxic chemicals in the event of accidents. ▪ Regular maintenance of rainwater harvesting structures shall be done during the operation stage to prevent choking of these structures ▪ Monitoring of water quality at specified locations will be conducted at fixed interval
Air quality	▪ Air pollution due to vehicular emission from road traffic.	▪ Truck parking lay-byes and bus bays will be provided at required locations to facilitate smooth traffic flow. ▪ Monitoring of air quality at specified locations will be conducted at fixed interval
Noise level	▪ Noise pollution due to traffic noise.	▪ Monitoring of noise level at specified representative locations will be conducted at fixed interval. ▪ Roadside plantation with suitable species near sensitive receptors and inhabited areas will result in partial noise attenuation. ▪ Maintenance of noise barrier
Flora & fauna	▪ Illegal felling of road side plantation. ▪ Effect on aquatic fauna in case of	▪ Plantation along the ROW will be maintained properly and protected from illegal felling.

Area	Impacts	Mitigation Measures
	accidental spill of oil, fuel & toxic chemicals into water bodies	▪ Contingent actions will be taken in the event accidental spill of oil, fuel & toxic chemicals.
Road safety	• Impacts on human health due to accidents. • Damage of road due to wear & tear.	▪ 20 nos. of Bus Shelters shall be provided along the project road conforming to design standards. ▪ Semi-rigid type / rigid type / flexible type safety barriers shall be provided on the high Embankment Section (where the height of embankment is more than 3.0 m) and along the horizontal curve having radius up to 450m for complete length including transition and 20m further before and after. ▪ Rigid Type such as Concrete Crash Barriers shall be provided on the bridges, isolated structures and its approaches.

42. **Social Impacts**. According to the Land Acquisition Plan (LAP) **29.61 Ha** of land will be acquired for the project, out of which 27.75 Ha. is private land. A summary of the impacts is provided in **Table 17.**

Table 17: Summary of Impact on Structures and Displaced Persons

Sl. No.	Type of Aps	Impact category	Number
1	Titleholders	Land only	209
		Land & Structure	254
		Physically displaced	8
2	Non-Titleholders	Structure	194
		Physically displaced	66
3	Tenants	Structure only	78
4	Employees	Structure only	8
5	Other economically affected (excluding owners physically displaced and tenants)	Structure only	13
	Total number Project Affected Persons (PAPs)	Land only	814
		Structure only	1017
6	Total Households Affected including (Structures, Land, Tenants and Employees)	Land only	209
		Structure	153
		Tenant	78
		Employee	8
7	Total Vulnerable Households Affected	Land	148
		Structure	168
8	Moderately Affected Households (Title-Holder & Non-Title Holders)	Title-Holder & Non-Title Holders	374
9	Marginally Affected Households (Tenant & Employee)	Structure Only	67
10	Physically Displaced Households (Title-Holders)	Structure only	8
11	Physically Displaced Households (Non-titleholders)	Structure only	66

Sl. No.	Type of Aps	Impact category	Number
12	Physically Displaced Affected Families (Title-Holders)	Structure only	11
13	Physically Displaced Affected Families (Non-titleholders)	Structure only	118
14	Moderately Affected Households (Title-Holders)	Structure only	37
15	Moderately Affected Families (Title-Holders)	Structure only	83
16	Marginally Affected Families (Tenant & Employee)	Structure only	116
17	Households Affected by loss of income (Shop owner, Artisans Tenants & Employees)	Structure only	177
18	Households Affected by Land Acquisition	Land only	209
19	Households Affected by Impact on Private Structures (Structures, Tenants & Employees)	Structure only	86
20	Number of trees likely to be affected including (both)	Land and Structure	518
21	CPR affected		2
22	Religious structures affected		0
23	Government structures affected		9

H. Public Consultation

43. The following are the major points of concern of the participants of PCM:

- Stakeholders are concerned about the existing traffic noise and anticipate that increase of traffic flow may lead to increased noise level after project implementation.
- Majority of the stakeholder are concerned with the existing air emission by the present traffic but their opinion in post project scenario is fragmented to a considerable extent.
- Stakeholders are unanimously agreed that the road is accident prone and needs immediate improvement.
- Pedestrian crossing, proper road signage and speed control measures are the most sought after road safety measures by the stakeholders.
- Accident involving wildlife, man-animal conflicts and crop damage by wild animals reported. This may be attributed to the reason that the project road is surrounded by three wildlife sanctuaries.
- School authorities and citizens at large are in favour of introducing speed restriction near the schools.
- The participants did not felt any requirement of animal underpasses as crossing of wild animals are rare.
- Boundary wall acting as noise barriers along the school premises are welcomed by all of the participants. The stakeholders felt construction of boundary will also provide the security to the students and should be implemented before the start of construction activity to safeguard the students from construction noise.

- Participants at large requested for up-gradation of existing bus shelters and installation of water tank near bus shelters.

44. **Consultation in Religious Places:** To assess the requirement of noise barrier in the religious places along the project road, consultations with stakeholders were carried out at 2 religious places along the project road. Overall **90.0%** participants showed reservation against construction of boundary wall due to temple aesthetics and accessibility; while **10%** supported the concept.

I. Environmental Management Plan

45. EMP has been prepared addressing the following issues:

- Stage wise (design & pre-construction stage, construction stage & operation stage) environmental management measures;
- Environmental monitoring program during construction and operation phase including performance indicator, monitoring schedule (parameters, locations, frequency of monitoring & institutional responsibility) and reporting system;
- Institutional set up identified for implementation of the EMP including institutional capacity building and
- Various guidelines such as Top Soil Conservation and Reuse, Siting and Layout of Construction Camp, Slope Stabilization, Management of Borrow and Quarry Area, Sediment Control, Comprehensive Waste Management Plan, Traffic Management Plan, Worker's Safety during Construction, Tree Plantation Strategy, Storage, Handling, Use and Emergency Response for Hazardous Substances, Reporting Formats etc.

46. **Environmental Policy of KSHIP**

- Comply with all applicable environmental legislation and other requirements
- Protecting & conserving natural resources and enhancing the environmental values while preventing pollution and minimizing the impact on the natural environment
- Implement, maintain and continually improve an effective environmental management system
- Apply an approach of "avoid, minimize and mitigate", to the management of environmental impacts associated with road improvement for its Stakeholders
- Develop awareness of environmental management processes, standards and responsibilities among KSHIP employees, consultants, contractor partners etc.
- Be responsive to community and stakeholder views on environmental issues
- Set specific environmental objectives and targets relating to the key environmental aspects of KSHIP activities; measure and report progress in achieving these targets

47. **Environmental Budget**. The budgetary provision for the implementation of the environmental management plan of the project road can be categorized in to two types and is presented below:

- Environmental Management Plan Works to be implemented by the contractor under civil works contracts
- Environmental Management Plan Works to be implemented by the KHSIP

48. A capital cost provision of about **Rs. 3.45 Crore** has been kept towards implementation of environmental management plan. Summary of environmental budget is presented in **Table 18.**

Table 18: Summary of Environmental Budget

Component	Description	To be implemented by	Amount (Rs.)
A.	Mitigation / Enhancement	Contractor	23,616,600
B.	Environmental Monitoring		1,888,000
		Subtotal	***25,504,600***
C.	Forestry	KSHIP	7,888,608
D.	Training & Mobilization		1,040,000
		Subtotal	***8,928,608***
		Grand Total	**34,433,208**

J. Conclusion and Recommendations

49. Conclusion: Most of the adverse impacts of road project during construction period are short term and temporary in nature. These impacts can be minimized through specific engineering solutions. Environment friendly construction methodology has been incorporated into the project design and Environment Management Plan has been prepared to minimize the overall impact on environmental attributes by the proposed project works. Therefore, the proposed project is **unlikely to cause any significant adverse environmental impacts** and no further detailed study is required.

50. Recommendations: Environmental Management Plan has been prepared incorporating various modern technologies and guidelines to reduce the environmental impacts of highway constructions to make it a Green Highway. Therefore, it is recommended to follow the EMP and associated Guidelines during construction and operation phases of the project.

I. INTRODUCTION

A. Project Background

1. The Government of Karnataka (GoK) through the Government of India (GoI) has received in principal approval for a loan from the Asian Development Bank (ADB) towards Karnataka State Highways Improvement Project–III (KSHIP- III) for developing State Road network adopting innovative financial models under Public Private Partnership (PPP). The Executing Agency (EA), the Public Works Department, represented by the Project Director, Project Implementation Unit, Karnataka State Highway Improvement Project (PIU-KSHIP) has already completed a Pre-Financial Feasibility Study for about 4,403 km of select corridors of the Core Road Network (CRN) of the state and based on the outcome of this study, it intends to improve about 1,350 km of state highways under this ADB finance. With a view to this, the EA has engaged a consultant to prepare the Detailed Project Report and carry out Transaction Advisory Services for Karnataka State Highway Improvement Project-III (KSHIP III)", for project roads drawn under Group II.

2. In pursuance of the above, Intercontinental Consultants and Technocrats Pvt. Ltd. have been appointed as Consultants by KSHIP to carry out the Preparation of Detailed Project Report and provide Transaction Advisory Services for Karnataka State Highway Improvement Project-III Group II roads in the State of Karnataka to two/four lane with Paved Shoulder Configuration".

3. The project roads have been divided into packages based on the time lines required for the fulfilment of environmental safeguards as per the MOEF&CC & ADB's Safeguard Policy Statement 2009; project cost and to attract bidders of both large and small scale. Accordingly, the project roads under **Group II** have been divided into **5 packages** as presented in **Table 19**. The Project Roads are shown in the Index Map **(Figure 1).**

Table 19: Package-wise Summary of Project Roads under Group II

Package No.	Project Roads	Length (km)
1	**1A Kollegal to Hanur**	**23.8**
	1B Chintamani to Andhra Pradesh Border	**39.8**
	1C Bengaluru to Magadi and	35.7
	1C Magadi to Kunigal	15.3
2	Magadi to near Somwarpet	165.5
3	Gadag to Honnali	138.2
	Total Length (km)	**418.3**

4. In this report, **Package-1A "Kollegal to Hanur"** has been discussed.

Figure 2: Index Map Showing Package Wise Project Roads

B. Objectives of the Study

5. The main objectives of the Initial Environmental Examination (IEE) study are as follows:

- To determine the category of the project depending on the length, extent of land acquisition, location, environmental sensitivity and the nature and magnitude of its potential environmental impacts, i.e. screening as per Government of India's regulations and ADB's Safeguard Policy Statement 2009;
- To determine the appropriate extent and type of Environmental Assessment (EA) required, i.e scoping;
- To determine whether the project requires environment clearance, forest clearance, wildlife clearance, consents to establish etc. depending on its type of development;
- To establish present environmental conditions of the study area through available data / information supported by field studies, wherever necessary;
- To predict the potential impacts on relevant environmental attributes due to the proposed project and to recommend adequate mitigation measures to minimize / reduce adverse impacts;
- To prepare an Initial Environmental Examination (IEE) report including Environmental Management Plan (EMP).

C. Approach and Methodology

6. The Initial Environmental Examination has been carried out within existing policy, legal and administrative framework considering the applicable environmental legislation, regulations & guidelines of ADB and MOEF&CC.

- **Reconnaissance Survey:** A reconnaissance study has been made for identification of Valued Environment Components (VECs) on proposed project road. Location of environmentally protected areas (National Parks, Wildlife Sanctuaries, Biosphere Reserves, Reserved / Protected Forest, Important Bird Areas, World heritage Sites, Archeological Monuments etc.); surface water bodies; environmentally sensitive receptors (educational institutions, religious structures, medical facilities etc.) along the alignment has been identified during the survey. The Consultant conducted preliminary analysis of the nature, scale and magnitude of the impacts that the project is likely to cause on the environment, especially on the identified VECs.
- **Data Collection & Review:** Secondary data such as Survey of India Topo Sheets, District Planning Maps, Forest Working Plans, booklet of Central Ground Water Board, details of Archaeological Monuments etc. have been collected from various secondary sources. Further, secondary data, which are relevant to understand the baseline as pertaining to physical and biological environments has been collected and reviewed. Applicable environmental legislation, regulations & guidelines of ADB and MOEF&CC has also been reviewed.
- **Environmental Screening & Scoping:** Screening has been conducted with specific consideration such as location of the sub-projects with respect to environmentally sensitive areas and critical issues to be studied in detail as well as provide important feedback to the design / technical team. It helped to modify the designs at locations where impacts had to be avoided and incorporate mitigation measures wherever the impacts were unavoidable due to other

constraints. Based on the screening, scope of the study of the assignment i.e. scoping has been done.

- **Baseline Environmental Monitoring:** To establish the baseline environmental status, monitoring was carried out for various environmental parameters such as meteorology, ambient air quality, ambient noise level, ground & surface water quality and soil quality along the proposed alignment
- **Stakeholder Consultation:** Consultations on environmental issues have been carried out with relevant stakeholders identified through stakeholder analysis.
- **Analysis of Alternatives:** The environmental analysis of alternatives mainly focuses on bypasses, if any, cross-sections, sources of materials from an environmental management perspective.
- **Prediction of Impacts & Mitigation Measures:** Based on the above study potential positive and negative impacts on land environment, air environment, noise environment, water environment and biological environment has been assessed for both construction and operation phase. For each impact predicted, feasible and cost effective mitigation measures has been suggested to reduce potentially significant adverse environmental impacts to acceptable levels.
- **Environment Management Plan:** EMP has been prepared as per the requirements of ADB safeguard policy statement. EMP includes management and redevelopment of borrow areas, quarries, construction camp; rain water harvesting, storm water management practices; enhancement plan for water bodies; requirement of noise barrier, capacity building & training; environmental supervision, monitoring & auditing requirements; bill of quantities etc.

D. Structure of the Report

7. This Initial Environmental Examination Report and Environment Management Plan (Volume-VIII) is a part of the Detailed Project Report of the **Kollegal to Hanur** Project Road under the corridor **CNS 5**.

8. IEE Report has been structured based on ADB's Safeguard Policy Statement 2009. The structure of the IEE Report is as follows:

Volume: VIII (A) **IEE Report and EMP**

Executive Summary

Chapter-1 : Introduction
Chapter-2 : Description of the Project
Chapter-3 : Policy, Legal and Administrative Framework
Chapter-4 : Description of the Environment
Chapter-5 : Analysis of Alternatives
Chapter-6 : Anticipated Environmental Impacts and Mitigation Measures
Chapter-7 : Public Consultation
Chapter-8 : Environmental Management Plan
Chapter-9 : Conclusion and Recommendations

Volume: VIII (B) **Annex**

II. DESCRIPTION OF THE PROJECT

A. Project Location

9. The project road starts from the take-off point of the proposed bypass of NH-209 near Agraharam Village (NH-209 Ch. 345+400) and connect SH-79 after Madhuvanahalli Village near junction with SH 38 and ends at Hanur at Km.85+815 (at junction of SH-79 with MDR). Therefore, total length of the project road is **23.782 km**. The project road is passing through **Chamrajnagar district**. The location of the project road is shown on Index Map at **Figure 2**. The Latitude & Longitude of start and end points are $12^0\ 10'\ 50.58"$N & $77^0\ 07'26.77"$E and $12^0\ 05'\ 13.24"$ N & $77^0 18'29.66"$ E respectively.

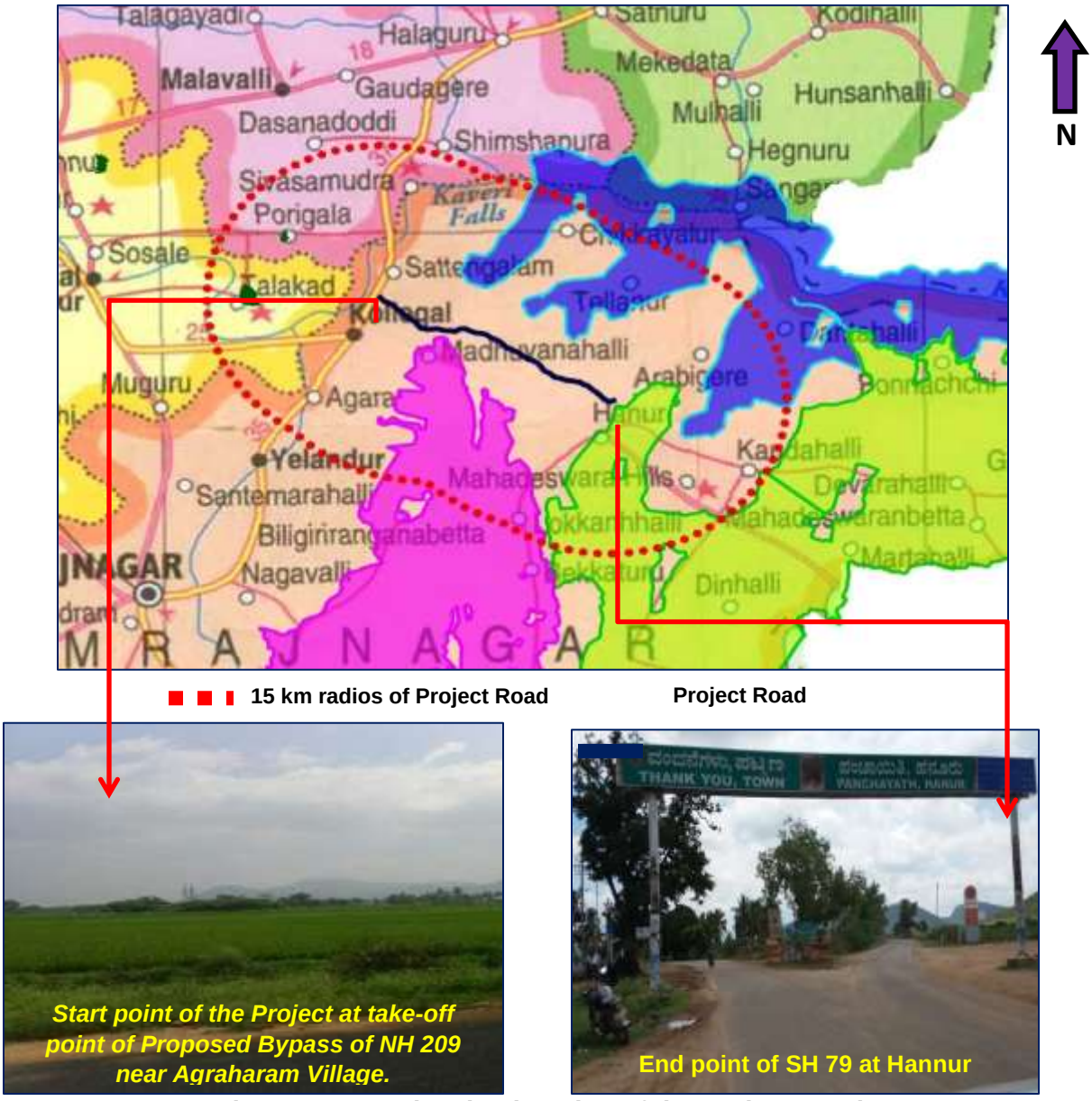


Figure 3: Map Showing location of the Project Road

B. Description of the Project Road

10. The project road forms interstate connectivity and improvement proposal may facilitate increased cross interstate traffic movement as project road connects Tamil Nadu border in Palar. The project road in west at start point further connects prominent cities via a network of State Highways and National highways which include Bengaluru (via NH 209 and also an alternate route via SH 33 and NH 275), Mysuru, Chamrajnagar and also to various towns of Kerala State. The Project road connects NH-209 which in turn connects NH-212 and SH-38. Project road beyond end point in Palar is connected to a network of various National and State Highways, connecting Mettur, Dharmpuri,, Salem, Hosur and also Bengaluru which are also prominent business centres.

11. Project road also forms important connectivity to various tourist destinations within the region and along the project road including, Hoganakkal Falls, Gaganachukki and Bharachukki Falls, BR Hills, Talakadu and many other in the region. The proposed improvement proposal for the project road would benefit and improve network mobility in the region.

12. **Carriageway:** The existing road is predominantly (Approx. 85% of Project length) Intermediate lane carriageway of 5.5 m width and about 15% of project length is 2-lane carriageway of varying width from 7 m to 9.5 m.

13. **Terrain:** Project road traverses through plain terrain.

14. **Pavement Condition:** The existing pavement is flexible and the composition of layer predominantly consists of bituminous layers laid over granular base/WMM and granular sub base/river material with boulders/moorum present at some locations. The bituminous surfacing varies in the range of 30 mm to 260 mm and the Granular Base/sub base layer varies from 50 to 410 mm.

15. **Existing Bridges & Culverts:** There is no major bridge, but there are 5 minor bridges, 1 causeway and 49 culverts (5 box culverts, 13 slab culverts and 31 pipe culverts) along the project road.

Table 20: Location of Minor Bridges along the Project Road

S. No.	Existing Ch. Km	Type of Structure		Overall length (m)	Span Arrangement (m)	Overall Width (m)
		Super Structure	Sub structure			
1	71+190	RCC Solid Slab	RCC Wall type with Open footing	15.120	1x4.9 + 1x5.3 + 1x4.9	8.2
2	74+120	Stone Slab	SM Wall type with Open footing	7.520	3 x 2.5	8.2
3	74+410	Stone Slab widened by RCC	SM Wall type with Open footing	12.20	4 x 3	8.2
4	84+300	RCC Solid Slab	RCC Wall type with Open footing	18.820	2 x 9.4	11.90
5	85+380	RCC Solid Slab	SM Wall type with Open footing	26.120	3 x 8.7	12.00

Table 21: Location of Causeways along the Project Road

S. No.	Existing Ch. Km	Remarks
1	69+900	6 Pipes of 3.0m dia. at 3.5m c/c

16. **Major and Minor Junctions:** There are 5 major junctions and 36 minor junctions on the project road.

C. Traffic Study

17. During the pre-feasibility study, traffic surveys were conducted by iDeCK in 2009. As per the terms of reference of this study the Consultants were required to validate these surveys

1. Composition of Traffic

18. The composition of traffic was worked out from the traffic volume count data. The share of passenger traffic is observed to be 84 % in ICT study and 87% in iDeCK study, whereas goods traffic is 16 % and 13 % in ICT and iDeCK study respectively. Share of trucks (including LCV, 2 Axle, 3 Axle and MAVs) is observed to be 12 % in ICT study and 8% in iDeCK study, of total traffic. The share of car and taxi of total traffic is observed to be 23% in ICT study and the same is 25% in iDeCK study. It is also observed that the share of non-motorized traffic is found to be 2% and 4% of the total traffic in ICT and iDeCK studies respectively at the survey location.

19. **Hourly Variation of Traffic:** Traffic volume count was conducted in both directions for successive 15 minutes periods, over 24 hours. The fifteen minute count was compiled to get the hourly variation of traffic for each survey location. Peak hour traffic for all the locations on SH-79 is found to be 6.5 % to 7.0% of the ADT, which is normal for intercity roads.

2. Identification of Homogeneous Sections

20. The proposed project road from Kollegal to Hanur, Section of SH-79, involves 1 homogeneous section (**Table 22**).

Table 22: Homogeneous Sections of Traffic on Project Highway

Section No.	Sections	Existing Chainage			Design Chainage			
		Start Ch. Km	End Ch. Km	Distance (Km)	Start Ch. Km	End Ch. Km	Distance (Km)	Traffic Volume AADT(PCU) 2015
HS-I	Kollegal to Hanur	61+450	85+815	24.365	0+000	85+770	23.782	6,624

3. Annual Average Daily Traffic (AADT)

21. The Annual Average Daily Traffic (AADT) is calculated by multiplying ADT with a seasonality factor. Seasonal variation factors by vehicle types are required to account for variations in the pattern of traffic volume on various sections of the project road over different months or seasons of the year.

22. In this study, the seasonal factor has been derived from the monthly petrol and diesel sale data. The ratio of average monthly petrol and diesel sale data with the sale during August

2015 (the survey month) has been used to determine the seasonal correction factor. The diesel sale data has been used to find the seasonality factor for the freight vehicles, whereas the petrol sale data has been used to calculate seasonality factor for passenger vehicles based on the fuel used by the vehicles in the two categories.

23. The seasonality factors thus obtained are used to convert Average Daily Traffic (ADT) to Annual Average Daily Traffic (AADT) for various survey locations of the project road. Section-wise AADT thus obtained is shown in **Table 23** which gives the mode-wise AADT for all the survey locations.

Table 23: Annual Average Daily Traffic at various Surveyed Location

Location	Survey conducted by	Total Traffic	
		Vehicles	PCUs
Km. 72+100 near Doddinavadi	ICT-2015	5,908	6,624
Km. 72+100 (104+000 in iDeCK study) near Doddinavadi	iDeCK-2014	4,645	5,621
Location near MM Hills	PWD Data, 2015	2,978	4,014

4. Turning Movement Survey

24. Turning Movement Count Surveys were carried out at one location by iDeCK at Km 65+500 (km 99+000, as reported in iDeCK study), in January 2014, which is Y-junction intersecting SH-38 with SH-79.

25. It is observed the total approach volume during morning peak hour at the Y-junction is 602 PCUs, while evening peak hour volume is 548 PCUs. The peak hour proportion is 8% in morning and 6% in evening period.

5. Axle Load Survey

26. The axle load survey has been carried out to work out the Vehicle Damage Factor (VDF) and the axle load spectrum for design of pavement. Axle Load survey was done by ICT in August 2015 at Km. 72+100 near Doddinavadi. The survey was carried out using the electronic static axle load pad at selected location on SH-79 (Kollegal-T.N Border Section) for 24 hours.

27. Based on the survey the VDF for 2-axle trucks has been computed in the range 2.36 - 3.29 while the VDF for 3-axle truck lies in the range 5.82 - 4.63. The VDF for multi- axle vehicle has been calculated to be in the range 6.26 - 6.46. The results indicate low VDF values in UP direction (i.e. towards TN border) and higher values in DN direction.

6. Traffic Forecast

28. After improvement of the project road to a two lane with paved shoulder facility, possibility of traffic being added to the improved road was explored on account of the developments proposed along the project road.

29. The State Government has proposed to boost tourism in the Cauvery basin and the coastal region of the State. The government has decided to constitute a Cauvery River Tourism Development Authority (CRTDA) to develop tourism-related infrastructure in Mandya, Mysore, Chamarajanagar and Kodagu districts. The proposed CRTDA will be tasked with developing tourism from Bhagamandala in Kodagu to Hogenakkal Falls, along the path of the Cauvery. The

development authority will provide accommodation for tourists in Talakad, showcase silk products in Kollegal, illuminate Srirangapatna Fort, and install sound and lighting in Gaganachukki and Bharachukki Falls of Mandya district.1

30. The project road is located in Chamarajanagar district and one of the major tourist attractions in this region is Hogenekkal Falls which is very close to the project road. Connectivity to this location through the project road is proposed to be improved. Also the plan to showcase silk products in Kollegal may attract tourism in the PIA leading to additional developmental traffic along entire length of the project road.

31. Therefore, considering the above proposals the developmental traffic in this section of project road from Kollegal to TN Border has been taken as 5%, for passenger and goods traffic. This additional developmental traffic percentage share has also been considered as share of the normal traffic expected on the project road in the year of opening, 2020.

32. The induced and developmental traffic is expected to be materialized within first two years after improvement of the project road by the year 2020 (COD). This has been assumed to happen in two stages having 50% each, to be realized by 2020 and 2021 respectively. The projected daily traffic for the two homogenous sections of the project road (with five yearly projections) is given in **Table 24.**

Table 24: Projected Annual Average Daily Traffic on Homogenous Sections I (Kollegal to Hanur)

Vehicle Type	Year							
	2015	**2020**	**2022**	**2025**	**2030**	**2035**	**2040**	**2050**
Car	1089	1686	1883	2619	3769	5364	7462	13254
Total Jeep/ Van	314	439	484	631	841	1071	1332	1966
Mini Bus	61	74	80	100	127	153	178	231
Bus	601	798	865	1060	1335	1615	1906	2540
Tempo LGV - Freight (3,4 Axle)	514	707	776	991	1285	1629	1944	2752
Tempo LGV - Freight (6 Axle)	13	18	19	22	27	32	37	47
2 Axle Truck	139	180	197	244	313	394	468	661
3Axle Truck	51	63	69	85	107	132	153	210
MAV	16	19	21	28	38	48	61	102
Three Wheeler	303	442	488	646	897	1214	1625	2911
Two Wheeler	2618	4100	4585	6401	8977	11957	15628	25454
Tractor	6	7	7	7	7	7	7	7
Tractor With Trailer	37	42	43	46	51	56	61	71
Cycle	134	139	140	143	148	156	166	186
Cycle Ricks	0	0	0	0	0	0	0	0
Hand Cart	1	1	1	1	1	1	1	1
Animal Drawn	1	1	1	1	1	1	1	1
Non Tollable	11	11	11	11	11	11	11	11
Non Tollable PCUs	11	11	11	11	11	11	11	11
Total PCUs	**6,624**	**9,337**	**10,267**	**13,401**	**17,965**	**23,396**	**29,771**	**46,609**
Total Vehicles	**5,908**	**8,726**	**9,669**	**13,036**	**17,935**	**23,841**	**31,041**	**50,405**

7. Capacity and Level of Service analysis (ICT Study)

[1] The Hindu-National – Karnataka, July 13, 2014

33. The following guidelines were referred to assess capacity and design service volumes for various lane configurations:

- IRC: 64 – 1990, 'Capacity of Roads in Rural Areas';
- IRC: SP: 73 – 2007, 'Manual of Specifications and Standards for Two-laning of Highways through Public Private Partnership'; and
- IRC: SP: 84 – 2009, 'Manual of Specifications and Standards for Four-laning of Highways through Public Private Partnership'.

34. Referring to the above guidelines, the design service volumes for two lane and four lane highways with paved shoulders are shown in **Table 25.**

Table 25: Design Service Volumes at Different Level of Services

Terrain	Warrants for 2- lane		Design Service volume in PCUs per day			
			2 Lane Highway		4 Lane Highway	
	2-lane with granular shoulder	2- lane with paved shoulder	without paved shoulder	with min. 1.5m wide paved shoulder	LOS 'B'	LOS 'C'
Plain	<8,000	>10,000	15,000	18,000	40,000	60,000
Rolling	<6,500	>8,000	11,000	13,000		
Mountainous and Steep	-	-	7,000	9,000	20,000	30,000
As per standard	IRC: SP:73-2015				IRC:SP:84-2014	
Notes:	Unless otherwise specified in the concession agreement, 6 laning shall be done when total traffic (including traffic on service road, if any) reaches design service volume to LOC 'C' for 4 lane highway.					

35. For a National Highway/ State Highway, two lane configuration is the minimum requirement. In lieu of the above guidelines, the widening proposal for the project road sections of SH-79 has been formulated. The widening proposal based on the IRC: SP: 73-2015 and IRC: SP: 84-2014 is given in **Table 26**.

Table 26: Improvement Proposal Based on IRC Codes

Sl. No	Homogeneous Section (HS)	Existing Chainage (km)		Terrain	Recommendation			
		From	To		2-lane with granular shoulder	2-lane with paved shoulder	4-lane with paved shoulder	6-lane with paved shoulder (at LOS 'B')
1	HS-I	15+200	24+000	Plain	-	2015	2030	-

D. Improvement Proposal

1. Corridor of Impact

36. The land width required for construction of the road is found to be varying between 26-36m depending on the height of embankment. The available RoW is not consistent and varies significantly along the project road. The IRC (73:1980) recommended minimum RoW for State Highways to be 45 in open country and 30 m in built-up areas, which is not available throughout the length of the project road. Wherever this required width is not available, KSHIP is acquiring

only the required width of land for construction to limit the associated social impacts and compensation cost, in turn the project cost.

37. Therefore, the Corridor of Impact (COI) is the proposed construction width, which is varying from **16 to 20 m** in built-up areas and **26 to 28 m** in rural / open country area.

2. Widening Scheme

38. The lane configurations recommended for the project road is as given in **Table 27.** Considering the need to minimize land acquisition, concentric widening of existing carriageway is adopted for majority of the section. The summary of widening is given in **Table 28.**

Table 27: Recommended Lane Configuration

Sl. No.	Stretches (Km)		Length (km)	Lane Configuration	Remarks
	From	To			
1	0+000	4+900	4.900	2 Lane with Paved shoulder	Combined Bypass for Kollegal and Madhuvanhalli
(Ch. Eq. 4+900 = 66+888)					
2	66+888	74+500	7.612	2 Lane with Paved shoulder	--
4	74+500	76+100	1.600	4 Lane built up	Kamagere Village
5	76+100	77+300	1.200	2 Lane with Paved shoulder	--
6	77+300	78+200	0.900	4 Lane built up	Mangala Village
7	78+200	83+280	5.080	2 Lane with Paved shoulder	--
8	83+280	84+320	1.040	2 Lane built up	Hullepura Village
9	84+320	85+600	1.280	4 Lane built up	Hanur town
10	85+600	85+770	0.170	2 Lane with Paved shoulder	--

Table 28 Summary of Widening

Concentric Widening (km)	Curve Improvement (Km)	Realignment (Km)	Bypasses (Km)	Total Length (km)
15.277	1.215	2.390	4.900	23.782

39. Length of the existing road is 24.365 km and after the proposed improvement, length of the project road will be **23.782 km**.

3. Typical Cross Sections

40. Based on the traffic projection, capacity and the design standards, the typical cross-sections applicable for various sections of the project road have been prepared. The typical cross sections are given in **Annex-2.1**. Proposed Cross-sections in urban locations have been customized to suit field conditions and minimize R&R impact and Land Acquisition. The cross-sections in Urban Locations were developed within 16 m and 20 m formation width with 2-Lane Paved shoulder and 4-Lane divided carriageway configuration respectively, without compromising on safety and capacity augmentation requirement of the project road.

41. These typical sections have been prepared separately for various alternatives like reconstruction, rehabilitation, Built-up areas, etc. as follows**:**

Table 29: Details of Typical Cross Sections

TCS-1	Typical Cross Section for 2-Lane with Paved Shoulder (Open Country) – Concentric Widening
TCS-1A	Typical Cross Section for 2-Lane with Paved Shoulder (Open Country) – Concentric Widening
TCS-2	Typical Cross Section for 2-Lane with Paved Shoulder (Open Country) – Realignment/New Construction/Bypass
TCS-2A	Typical Cross Section for 2-Lane with Paved Shoulder (Open Country) – Realignment/New Construction/Bypass
TCS-3	Typical Cross Section for 4-Lane Divided Carriageway (Urban Section) – Concentric Widening Built-Up Section within 20m CoI
TCS-4	Typical Cross Section for 2-Lane with Paved Shoulder (Urban Section) – Concentric Widening Built Up Section with 16m CoI
TCS-5	Typical Cross Section for 2-Lane with Paved Shoulder (Open Country) – Kollegal & Madhuvanhalli Bypass

4. Bypasses and Realignments

42. One bypass & two realignments have been proposed in this section of SH-79 with a total length of 7.290km. The details of the proposed major realignment are as given in **Table 30**.

Table 30 List of Bypass and Realignment of SH-79

Sl. No.	Name of Town/Village	Chainage along Existing Alignment (km)			Chainage along Bypass/Realignment (km)		
		Start	End	Length	Start	End	Length
Bypass							
1	Kollegal & Madhuvanahalli	61+450	66+888	5.438	0+000	4+900	4.900
Realignment							
1	MJB @ 69+900	68+930	70+190	1.260	68+920	70+200	1.280
2	Singanallur	72+540	73+700	1.160	72+550	73+660	1.110

5. Pavement Design

43. **Design of New Flexible Pavements:** Pavement for new construction in widening, bypass / realignment and reconstruction portion is designed based on subgrade strength, material characteristics and design traffic.

44. Kollegal to Hanur road section of SH 79 road section is designed as two lanes with paved shoulder configuration. Traffic estimated for 20 years design life is only 13 MSA and that for 15 years is 9 MSA which are less than minimum design traffic of 20 MSA specified in the 2-lane manual. Therefore, the pavement composition for both 15 years and 20 years design period will be that corresponding to 20 MSA.

45. Flexible pavement is designed for design life of 15 years as well as 20 years for project road section. Pavement compositions for new / widening section have been worked out as per IRC 37-2012. Two pavement composition options are considered for the road section. These are:

- Option-1: using conventional pavement materials
- Option-2: Recycled Asphalt Pavement (RAP) material

46. A comparative study of both the options is also made. For RAP Layer, maximum 30% recycled asphalt materials is considered to be used in the mix out of the total quantity recovered from existing bituminous layer.

47. **Rehabilitation Design of Flexible Pavements:** Rehabilitation (partial /full depth reconstruction and overlay) of pavement of project road are designed by consultant based on the following:

- Existing pavement condition
- Existing subgrade characteristics
- Deflection Survey
- Change in vertical alignment (raising of embankment)
- Economic lead of borrow soil and other construction material and
- Use of alternate material such as RAP, cement treated sub base

48. Various options are taken into consideration for rehabilitation design of flexible pavement which includes partial / full depth reconstruction and overlay design. Best alternative for pavement composition is selected based on availability of material, economic design and engineering judgment.

49. The field investigation of pavement composition and testing of existing pavement materials shows that granular layer thickness is inadequate at most of the places and GSB / WMM material contains more finer materials as specified in standards, hence in partial reconstruction after milling / scarifying existing bituminous layer, existing granular layer will be loosen, spread over proposed area and re-compacted. This will be treated as subgrade with CBR value not lesser than CBR of suitable nearest borrow area.

50. The Summary of Rehabilitation (partial / full depth reconstruction and overlay) of the project road sections are presented in **Table 31** below.

Table 31 Pavement Design for Rehabilitation (HS I)

Design Chainage (Km)		Soil[1]	Design Traffic (MSA)	New Construction						Partial Reconstruction				
From	To			BC	DBM	RAP	WMM	CTSB	GSB	BC	DBM	RAP	CTSB	WMM
0+000	4+900	15	20	40	-	80	-	200	-	40	-	80	200	-
66+888	85+770	15	20	40	-	80	-	200	-	40	-	80	200	-

1 Borrow Soil CBR of Subgrade (%)

6. Bridges

51. There is no major bridge. 2 existing minor bridges will be Rehabilitated and Widened, 4 minor bridges will be reconstructed and 1 new minor bridge will be constructed on RHS carriageway at chainage km 85+380. The details of proposed bridges / structures are presented in **Table 32** and **Table 33**.

Table 32: Details of Minor Bridges to be Rehabilitated and Widened

Sl. No	Existing Ch. Km	Design Ch. Km	Side	Proposed width (m)	Span Arrangement (m)	Type of Structure	
						Super Structure	Sub-Structure
1	84+300	84+230	Both side	16.00	2 x 9.40	RCC Solid Slab	RCC Wall type with Open footing
2	85+380	85+310	Left Side	10.50	3 x 8.7	RCC Solid Slab	RCC Wall type with Open footing

Table 33: Details of Minor Bridges to be Reconstructed / New Proposal

Sl. No	Existing Ch. Km	Design Ch. Km	Proposed width (m)	Span Arrangement (m)	Type of Structure		Remarks
					Super Structure	Sub-Structure	
1	69+900	69+900	16.0	3 x 16.20	RCC Girder & Slab	RCC Wall type with Open footing	Reconstruction
2	71+190	71+170	16.00	2 x 10.80	RCC Solid Slab	RCC Wall type with Open footing	Reconstruction
3	74+120	74+072	16.00	1 x 8.8	RCC Solid Slab	RCC Wall type with Open footing	Reconstruction
4	74+410	74+360 (Skew 45^{o})	16.00	2 x 8.48	RCC Twin Cell Box Structure		Reconstruction
5	85+380	85+310 (Skew 23^{o})	10.50	3 x 8.7	RCC Solid Slab	RCC Wall type with Open footing	New 2 lane bridge for RHS carriageway

7. Railway over Bridge / Railway under Bridge

52. There is no Railway over Bridge/ Railway Under Bridge in the project road.

8. Pedestrian Underpass

53. Based on the pedestrian traffic, an underpass of size 5x3m is proposed at Km. 84+910 in Hanur. The underpass is proposed below the proposed 4-lane section near the bus stand in Hanur.

9. Culverts

54. Considering the adequacy and hydrological requirements, some additional culverts and replacement of some existing culverts have been proposed.

- 26 new culverts proposed to be constructed
- 5 culverts proposed to be Rehabilitated and Widened
- 25 culverts proposed to be re-constructed

10. At-Grade Intersection / Grade Separated Intersection

55. The Project road has 5 Major Junctions and 36 minor junctions. The Major Junctions include Junction with NH 209 bypass at start of the project, SH-38, Junctions with SH-79 at Hanur apart from other junctions. High mast lighting system along with street light poles has been catered for in the design of major intersections.

56. For smooth merging & diverging of cross road traffic, at grade intersections have been proposed at various locations.8 nos. major and 31 nos. minor junctions have been identified and improvement has been proposed

11. Service Road / Slip Road

57. There is no major built up section along the project road and due to very low local traffic in settlement area, provision of service roads have not been made.

12. Road Side Drain

58. Roadside toe drains shall be provided to receive discharge from embankment surface and countryside runoff and carry it safely to the nearest outfall point ensuring safety to the embankment toe, which is the area most vulnerable to erosion / failure. Roadside drains shall generally be provided on both sides of the embankment to safely carry the discharge from the embankment without jeopardizing the safety of the toe resulting safe guard to the pavement from water.

59. In urban section trapezoidal drain sections has been proposed on both side. In urban sections lined drains with footpath has been proposed for safety reasons. The shape and size of the roadside drains has been decided on the basis catchment area and its characteristics to the nearest outfall point.

60. For rural areas, the drains have been proposed as open and trapezoidal with 2(H):1(V) side slope. The minimum bed width and depth of flow at starting section shall be 500 mm and 300 mm respectively. The sections shall be gradually increased in terms of bed width and depth of flow up to the outfall point.

61. Length of lined drain along the project road is 4,820m (2,410 m on either side) and the length of unlined drain is 18,202 m (9,101 m on either side).

13. Footpath

62. Considering the safety of pedestrian traffic, Drain cum footpath has been proposed on both side of the project road in the following location locations.

Table 34: Location of Drain cum Footpath along the Project Road

Sl. No.	Stretch (Km)		Side
	From	To	
1	74500	76100	Both sides
2	77300	78200	Both sides
3	83280	84320	Both sides
4	84320	85600	Both sides

63. **Utilities:** To facilitate utilities along the project road which may include Electric lines and poles, Fiber optics, Waterlines and etc. sufficient space on both sides of the project road will be provided for sections passing through open country. For project road passing through

settlement locations provision of RCC pipes of suitable size along the length of the road below footpath have been proposed. The size of pipes to carry Utilities will be based on settlement size and utilities likely to be carried.

14. Bus Bays

64. 20 Bus bays (10 Locations) on the project road are identified as probable locations to address the need of people living along the stretch. Most of the bus bays have been located close to existing bus stops where ever available. Solar power lighting has been proposed at all the bus bays

15. Truck Lay Byes

65. No truck lay bye has been proposed along the project road.

16. Toll Plaza

66. Considering traffic flow and Homogeneous section, the location of toll plaza has been proposed at Km 78+400. However as decided, construction of toll plaza will not be taken up during improvement, however land acquisition will be done for the location as per directions from the implementing agency.

17. Design Speed

67. The alignment has been largely designed to a design speed of 100 kmph except in built-up. Wherever the Improvement proposal is limited within existing Right of Way, design speed of 80 kmph is adopted to avoid Land Acquisition. Urban Sections are designed for minimum 50 kmph design speed to minimize the R&R & land Acquisition.

18. Additional Land Acquisition

68. According to the Land Acquisition Plan (LAP) **29.61 Ha** of land will be acquired for the project. Out of total 29.61 Ha of land, which is going to be acquired, 27.75 Ha land is privately owned, while remaining 1.86 Ha land is Government / Waste land. The details of land acquisition requirement are summarized in the **Table 35.**

Table 35: Details of Land being acquired for the Project

Sl. No.	Land Details	Acquisition of Land Area (Ha.)	Percentage
1	Private Land	27.75	93.72
3	Govt. Land / Waste Land	1.86	6.28
	Total	**29.61**	**100**

Source: Land acquisition Plan, ICT Pvt. Ltd 2015

E. Road Safety Devices

69. Road safety aspects have been well studied and several safety features like road marking, signage, safety barriers, boundary stones, kilometer stones and hectometer stones, pavement marking and lighting has been proposed as discussed below. The engineering design of the road has also considered IRC codal provisions related to road safety such as:

- IRC: SP: 32-1988 Road Safety for Children
- IRC: SP: 44-1994 Highway Safety Code
- IRC: SP: 55-2001 Guidelines for Safety in Construction Zones
- IRC:119:2015 Guidelines for Traffic Safety Barriers

1. Road Markings

- Road Markings shall comprise of carriageway markings such as longitudinal markings and object markings such as raised pavement markers (Cat's Eyes or Road Studs).
- All markings shall conform to IRC:35-2015 and Raised pavement markers shall be provided as per IRC:SP:73-2015

2. Road Signs

- Three types of Road signs shall generally be provided (such as Mandatory / Regulatory, Cautionary / Warnings, and informatory signs.
- Locations of Signs shall conform to IRC:67-2012 and Section 800 of MoRT&H Specifications

3. Roadside Safety Barriers

70. The following types of Road Safety Barriers shall be provided on the Project Road Sections:

- Semi-rigid type / rigid type / flexible type safety barriers shall be provided on the high Embankment Section (where the height of embankment is more than 3.0 m) and along all curves having radii up to 450m for complete length of curves including transitions and 20m further before and after the curve.
- Rigid Type such as Concrete Crash Barriers shall be provided on the bridges, isolated structures and its approaches, as Median for 4-lane urban section.

4. Boundary Stone, Km Stone and Hectometer Stone

71. Road boundary stones have been proposed all along the project highway to discourage future encroachment into the right of way. Km stone and hectometer stones have been proposed all along the project road as per IRC codal provisions

5. Pavement Marking and Lighting

72. Pavement markings will be done for traffic lane line, edge lines and hatching. The marking will be with hot applied thermoplastics materials. The pavement markings will be reinforced with raised RR pavement markers and will be provided for median and shoulder edge longitudinal lines and hatch markings.

73. Highway lightings including high masts will be provided at intersections in order to improve the night time visibility. All the built up locations as well Underpasses has been proposed lighting arrangements.

F. Sources of Construction Materials

74. Soil and material investigation for a road project is very essential to assess the availability of suitable construction material in the vicinity of the project road. This includes investigation of suitable borrow area for borrowing earth and quarries for stone /aggregate material and also for the other construction materials like cement, steel, bitumen etc.

1. Borrow Areas

75. Potential sources of earth for the construction of embankment and subgrade were identified on either side of project road. The details of proposed borrow areas investigated with their respective locations; corresponding Chainage and lead from nearest point to project road are tabulated in **Table 36**.

Table 36: Location of Proposed Borrow Areas

S. No.	Chainage of Nearest Point on Project Road (km)	Side	Location / Village Name	Lead From Nearest Point on Project Road (km)	Type of Land	Approx. Quantity (m^3)
1	30+300	RHS	Hondaaraballa	3.0	Private	500,000
2	36+100	RHS	Kariyanapura	2.5	Private	2,000,000
3	39+200	RHS	Kamagere	1.0	Private	150,000
4	45+500	RHS	Magla	0.5	Private	750,000
5	48+500	RHS	Changavadi	5.0	Private	300,000
6	52+300	RHS	Bairanatha	4.3	Private	1,350,000
7	58+200	RHS	Kenchiah Nodobdi	0.3	Private	500,000
8	63+400	RHS	Cowdalli	1.0	Private	4,500,000

2. Stone / Coarse Aggregate Material:

76. Two Stone quarries were identified along the project road section and samples were collected and tested. Out of these, one quarry is near to project road and has small lead whereas another quarry is far away from project road and has long leads. It is therefore suggested to use aggregates of quarries with economical lead. The sampling locations, name of quarry /village and approximate lead distances from project site are given in **Table 37.**

Table 37: Location of Stone / Coarse Aggregate Material

S. No.	Chainage of Nearest Point on Project Road (km)	Side	Source and Village Name	Lead From Nearest Point on Project Road (km)	Approx. Quantity (m^3)
1	26+000	LHS	Kallugopalli (Bidadi)	150	5,000,000
2	48+600	LHS	Changavadi	6.4	2,500,000

3. Fine Aggregate Material:

77. Local enquiry suggests that extraction / mining of natural sand is banned in Karnataka state. It is therefore suggested to use manufactured sand which can be obtained by crushing the stone at crusher plant itself, in the pavement construction as well as concreting of the structures. During field investigation two sources of stone dust were identified and presented in **Table 38**.

Table 38: Location of Fine Aggregate Material (Stone Dust)

S. No.	Chainage of Nearest Point on Project Road (km)	Side	Source and Village Name	Lead From Nearest Point on Project Road (km)	Approx. Quantity (m^3)
1	26+000	LHS	Kallugopalli (Bidadi)	150	5,000,000
2	48+600	LHS	Changavadi	6.4	2,500,000

4. Cement

78. Ordinary Portland cement of Grade 43 and 53 are available in and around Bengaluru and Kollegal. Cement shall be conforming to IS: 8112 and / or IS: 12269.

5. Bitumen

79. Bitumen can be procured from ONGC oil refinery from Mangalore, Karnataka, with a lead of about 315 Km from Kollegal and from Chennai Oil refinery with a lead of about 460 Km from Kollegal. For this project road section, design traffic is estimated as less than 30 MSA and hence it is suggested to use VG-30 grade bitumen. The Specification of Bitumen must comply with relevant IS/IRC codes.

6. Steel

80. High strength deformed bars manufactured by various steel manufacturing companies conforming to IS 1786 are available with local stockists in and around T N Pura and Kollegal. Before incorporation into the work, steel shall be got approved by the Engineer.

7. Waste Plastic

81. Waste plastic creates problem to the environment. The waste plastic is definitely a great worry for our country as well as the whole world. If the plastic is not utilized properly, we need to dump it as a waste. There is a generation of more than 10,000 tons of waste plastic in India every day. The waste plastic is recycled in India in an unorganized way. This un-utilized plastic does not degenerate or bio-degrades but will remain as it is for lakhs of years. Therefore, the best way of disposal of waste plastic is its recycling to the maximum extent and waste plastic has great potential for use in bituminous construction as its addition in small dose helps in substantially improving Marshall Properties, fatigue life and other properties. The reason behind extra durability and strength of “plastics roads” is due to the higher melting point of which is created from the plastic additives. Not only does it increase the melting point but also the elasticity of the road. In the turbulent climate of India, roads are severely treated and cause an extensively large drain on the natural resources to maintain. The higher elasticity of the “plastic roads” will be able to survive harsher treatment which will reduce the maintenance costs.

82. Consultant suggests using waste plastic in the bitumen intended for bituminous wearing course. During the course of investigation Consultant have identified one source of Waste plastic within the vicinity project influence area, the address of which is as follows:

K. K. Plastic Waste Management Pvt. Ltd,
No. 50, 1st Floor, Opp. Post Office, Yelachenahalli, Kanakapura Road, Bengaluru - 78
Phone- 91 80 2666 1056/ 2666 1513, Mobile- 98450 78600/ 9880045811
E- mail- kkplasticroads@hotmail.com

G. Project Cost

83. The Project Cost for the project road from Kollegal to Hanur is given as follows:

Table 39: Civil Cost and Project Costs (in INR Cr.)

Length (Km)	Civil Cost	Per Km Civil Cost	EPC Cost	Estimated Project cost	Implementation Expenses	Tot Project Expense	Per Km Total Project Cost
23.782	108.31	4.55	122.39	143.90	50.09	193.99	8.15

All costs in INR Crores

III. POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK

A. Introduction

84. The environmental management and protection policies, regulations and administrative framework governing the project are reviewed in this section. The review includes sector-specific environmental policies and regulations of the Government of India, State Govt. of Karnataka, ADB's Safeguard Policy Statement – June 2009 and the administrative framework of various agencies, such as the Ministry of Environment, Forest and Climate Change (MoEF&CC), the Pollution Control Boards and other bodies associated with the implementation of the proposed project.

B. Policies and Legal Framework

1. Constitutional Provisions

85. The Constitution of India, in Article 48, of Directive Principles of the State, states that "the state shall endeavour to protect and improve the environment and to safeguard forests and wildlife of the country". Further Article 51-A (g), of fundamental duties, emphasizes that, "It shall be the duty of every citizen of India to protect and improve the natural environment including forests, lakes, rivers and wildlife and to have compassion for living creatures". These two provisions of the constitution are the guiding principles for the environmental legislation in India.

2. Applicable Environmental Legislations

86. The Government of India has laid down various policy guidelines, regulations, acts and legislations pertaining to sustainability and protection of the environment and its various components. The Environmental Acts, Notifications, Rules and Amendments applicable for the proposed project include the following:

- Environment (Protection) Act and Rules, 1986
- EIA Notification, 14th September 2006 and its subsequent amendments
- The Water (Prevention and Control of Pollution) Act and Rules, 1974, 1975
- The Air (Prevention and Control of Pollution) Act, Rules and Amendment, 1981, 1982, 1983, 1987
- Forest (Conservation) Act, 1980 and its amendments
- Forest (Conservation) Rules, 2003 and its amendments
- Wildlife (Protection) Act, 1972 and Amended in 2003
- The Biodiversity Act, 2002
- The Karnataka Preservation of Trees Act, 1976
- Construction and Demolition Waste Management Rules, 2016
- Municipal solid Waste (Management and Handling) Rules, 2000
- The Hazardous and Other Waste (Management and Transboundary Movement) Rules, 2016
- Noise Pollution (Regulation & Control) Rules, 2003 and amended in 2010
- Ancient Monuments and Archaeological Sites and Remains (Amendment and Validation) Act, 2010
- Disposal of Fly Ash Notification 2009 and its amendments on 25th January 2016
- ADB Safeguard Policy Statement 2009
- The Motor Vehicles Act, 1988

- The Motor Vehicles (Amendment) Bill, 2015
- Public Liability Insurance Act, 1991

C. Description of Key Environmental Legislations

3. The Environment (Protection) Act, 1986

87. This Act is umbrella legislation designed to provide a framework for the coordination of central and state authorities, established under the Water (Prevention and Control) Act, 1974 and Air (Prevention and Control) Act, 1981. Under this Act, the central government is empowered to take measures necessary to protect and improve the quality of the environment by setting standards for emissions and discharges; regulating the location of industries; management of hazardous wastes, and protection of public health and welfare. Empowered by the EP Act, the MoEF&CC, GoI has issued various notifications regulating the siting of industry and operations, procuring clearance to establish industries and development of projects with appropriate EIA studies, coastal zone regulations and many other aspects of environment through notifications.

4. EIA Notification and its Subsequent Amendments

- As per the Environmental Impact Assessment (EIA) Notification, 14th September 2006 and its amendment up to 17th April 2015, new national /state highway projects as well as expansion of national /state highway require Prior Environmental Clearance.
- Projects have been grouped under Category 'A' requiring clearance from Expert Appraisal Committee (EAC) of MoEF&CC, GoI and Category 'B' requiring clearance from the State / Union territory Environment Impact Assessment Authority (SEIAA). The SEIAA shall base its decision on the recommendations of a State or Union territory level Expert Appraisal Committee (SEAC).
- The concerned Committee (EAC or SEAC) will finalize the TOR on the basis of Form-1, proposed draft TOR & Pre-Feasibility / Feasibility Report.
- Environmental Impact Assessment study is to be carried out strictly as per the TOR provided by the Committee. Public Hearing is required for Category 'A' project.
- Public Hearing is required for road & highway projects **except** expansion of Roads and Highways (item 7 (f) of the Schedule) which do not involve any further acquisition of land

88. List of projects requiring Prior Environmental Clearance is given in the "SCHEDULE" of EIA Notification. As per the Schedule categorization of the highway project is as follow:

Project Activity	Category 'A'	Category 'B'	Conditions if any
Highways 7(f)	i) New National High ways; and ii) Expansion of National Highways greater than 100 km involving additional right of way or land	i) All New State Highway Projects **ii) State Highway Expansion projects in Hilly terrain (above 1,000 m MSL) and or Ecologically Sensitive Areas.**	General Condition shall apply **Note:** Highways include expressways

Project Activity	Category 'A'	Category 'B'	Conditions if any
	acquisition greater than 40m on existing alignments and 60m on re-alignments or by-passes		

89. **General Condition of the EIA Notification:** Any project or activity specified in Category 'B' will be appraised at the Central level as Category 'A', if located in whole or in part within 5 km from the boundary of:

(i) Protected Areas notified under the Wild Life (Protection) Act, 1972 (53 of 1972),
(ii) Critically Polluted areas as identified by the Central Pollution Control Board constituted under the Water (Prevention and Control of Pollution) Act, 1974 (6 of 1974) from time to time,
(iii) Eco-sensitive areas as notified under sub-section (2) section 3 of the Environment (Protection) Act, 1986, and
(iv) Inter-State boundaries and international boundaries;

90. **Conclusions:** The proposed project is the strengthening & widening of existing State Highway. Project road is passing through plain terrain (below 1,000 m MSL) and is not passing through any ecologically sensitive area. **Therefore, Environmental Clearance is not required from Government of India for improvement of SH-79 from Kollegal to Hanur (23.782 Km) in the State of Karnataka**.

5. The Water (Prevention and Control of Pollution) Act and Rules, 1974, 1975

91. This Act represented India's first attempts to comprehensively deal with environmental issues. It was enacted for the prevention and control of water pollution, and the maintaining and restoring of the wholesomeness of water. The Act prohibits the discharge of pollutants into water bodies beyond a given standard, and lays down penalties for non-compliance. The Act was amended in 1988 to conform closely to the provisions of the EPA, 1986. It set up the CPCB (Central pollution Control Board), which lays down standards for the prevention and control of water pollution. At the state level, the SPCBs (State Pollution Control Board) function under the direction of the CPCB and the state government.

92. As per the "Modified Directions under Section 18(1)(b) of The Water ((Prevention and Control of Pollution) Act and Rules, 1974 and The Air (Prevention and Control of Pollution) Act, 1981 regarding Harmonization of Classification of Industrial Sectors under Red / Orange / Green / White Categories" of **Central Pollution Control Board, dated March 07, 2016**, NOC from SPCB is required only for "New Highway Construction Project". Improvement / expansion of existing highway do not fall under any other four categories (Red, Orange, Green and White). Therefore, **NOC (under Water Act) from SPCB will not be required for improvement of existing State Highway 79 (Kollegal to Hanur).** It has also been verified from the Karnataka State Pollution Control Board.

6. The Air (Prevention and Control of Pollution) Act, Rules and Amendment, 1981, 1982, 1983, 1987

93. To counter the problems associated with air pollution, ambient air quality standards were established, under the 1981 Act. The Act provides means for the control and abatement of air pollution. The Act seeks to combat air pollution by prohibiting the use of polluting fuels and substance, as well as by regulating appliances that given rise to air pollution. Under the Act establishing or operating of any industrial plant in the pollution control area requires consent from state boards. The boards are also expected to test the air in air pollution control areas, inspect pollution control equipment, and manufacturing processes.

94. The Air (Prevention and Control of Pollution) Rules formulated in 1982, defined the procedures for conducting meeting of the boards, the powers of the presiding officers, decision-making, the quorum, manner in which the records of the meeting were to be set etc. They also prescribed the manner and the purpose of seeking assistance from specialists and the fee to be paid to them.

95. National Ambient Air Quality Standard (NAAQS) for major pollutants were notified by the CPCB in April 1994 and amended in 16th November 2009 (**Annex-3.1**). To empower the central and state pollution boards to meet grave emergencies, the Air (Prevention and Control of Pollution) Amendment Act, 1987 was enacted.

96. As per the "Modified Directions under Section 18(1)(b) of The Water ((Prevention and Control of Pollution) Act and Rules, 1974 and The Air (Prevention and Control of Pollution) Act, 1981 regarding Harmonization of Classification of Industrial Sectors under Red / Orange / Green / White Categories" of Central Pollution Control Board, dated March 07, 2016, NOC from SPCB is required only for "New Highway Construction Project". Improvement / expansion of existing highway do not fall under any other four categories (Red, Orange, Green and White). Therefore, **NOC (under Air Act) from SPCB will not be required for improvement of existing State Highway 79 (Kollegal to Hanur).** It has also been verified from the Karnataka State Pollution Control Board.

7. Forest (Conservation) Act, 1980 and its amendments

97. The Act came into force with effect from October 25, 1980. This Act provides for the conservation of forests and regulating diversion of forestlands for non-forestry purposes. The basic objective of the Act is, to regulate the indiscriminate diversion of forestlands for non-forestry uses and to maintain a logical balance between the development needs of the country and the conservation of natural resources/ heritage.

98. When projects fall within forestlands, prior clearance is required from relevant authorities under the Forest (Conservation) Act, 1980. For diversion of forestland, the project proponent needs to apply to the State Government. Depending on the area required to be diverted, the proposals are cleared by MoEF Regional or Central Offices provided that the cost of compensatory afforestation, cost of rehabilitation of endangered/rare species of flora/fauna, and the net present value of the forest resources are deposited upfront with the state Forest Department.

8. Forest (Conservation) Rules, 2003 and its amendments

99. These are rules by the Central Government for working and conduct of business outlined under the Forest (Conservation) Act, 1980. As per the Forest (Conservation) Rules, 2003 & its amendment, proposal involving diversion of forest land up to 5 hectares other than the proposal relating to mining and encroachments are decided by the Regional Offices of the MOEF. The

Regional Office of MOEF is competent to process, scrutinize and forward decision on proposal involving diversion of more than 5 ha to 40 ha of forest land along with the recommendation (if any), to MOEF, New Delhi. For proposal involving diversion of more than 40 ha forest land the state Government/ Union Territory would forward the proposal with recommendation to MOEF as per para 2.5(ii) of guidelines issued under Forest (Conservation) Act.

9. Wildlife (Protection) Act, 1972 and Amended in 2003

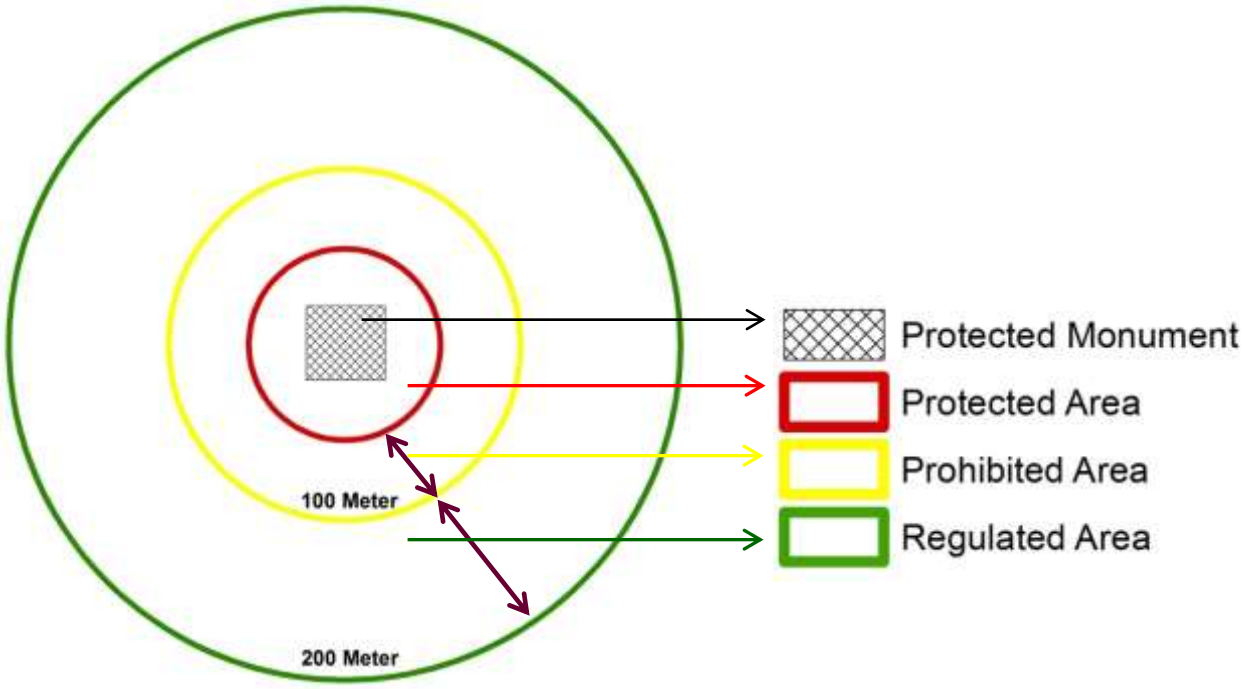
100. This Act empowers the Central and State Governments to establish National Parks and Sanctuaries; to formulate rules and designate authorities for the maintenance of National Parks, Sanctuaries and Zoos; to protect and conserve the flora and fauna. Vide Circular No. 11-9/98-FC dated 4-12-1998 issued by the Asst. Inspector General of Forests states that the Ministry of Environment and Forest has taken a decision not to permit development activities inside National Park/Sanctuaries and Tiger reserves areas that are not in consonance of Section 29 of the Wildlife (Protection) Act, 1972.

10. The Karnataka Preservation of Trees Act, 1976

101. This Act has put restriction on felling of trees in the State unless and until permitted by the Tree Officer. Any person desiring to fell a tree shall apply in writing to the tree officer for permission in that behalf. It further defines clauses for planting adequate number of trees, planting in place of fallen / destroyed trees, preservation of trees and adoption of trees.

11. Ancient Monuments and Archaeological Sites and Remains (Amendment and Validation) Act, 2010

102. This Act provides for the preservation of ancient and historical monuments and archaeological sites and remains of national importance and for the regulation of archaeological excavations and for the protection of sculptures, carvings and other like objects. According to this Act, areas within the radii of 100m and 300m from the “Protected Monument” are designated as “Prohibited Areas” and “Controlled / Regulated Areas” respectively.



103. No development activity (including building, mining, excavating, blasting) is permitted in the “prohibited areas”. Development activities likely to damage the protected monument are not permitted in the “controlled / regulated areas” without prior permission from the Archaeological Survey of India (ASI) if the site/remains/ monuments are protected by ASI or the State Directorate of Archaeology.

104. None of the notified archaeological monuments recognized by the ASI, UNESCO or World Heritage Monuments intercept with the road improvements.

12. Disposal of Fly Ash Notification 2009 and its amendment on 25th January 2016

105. The main objective of the Fly Ash Notification is to conserve the topsoil, protect the environment and prevent the dumping and disposal of fly ash discharged from coal based power plants. The fly ash notification makes essential the use of fly ash in road construction activities.

106. As per the amendment of the Notification dated 25th January 2016 “No agency, person or organization shall, within a radius of **300 kilometres** of a thermal power plant undertake construction or approve design for construction of roads or flyover embankments with top soils; the guidelines or specifications issued by the Indian Road Congress (IRC) as contained in IRC specification No. SP: 58 of 2001 as amended from time to time regarding use of fly ash shall be followed and any deviation from this direction can only be agreed to on technical reasons if the same is approved by Chief Engineer (Design) or Engineer-in-Chief of the concerned agency or organization or on production of a certificate of "fly ash not available” from the Thermal Power Plant(s).

107. The amendment further states that “The cost of transportation of ash for road construction projects within a radius of 100 km from a coal or lignite based thermal power plant shall be borne by the thermal power plant and the cost of transportation beyond the radius of 100 km and up to 300 km shall be shared equally between the user and the thermal power plant”. The time period to comply with the provisions of the amendment by all concerned authorities is 31st December, 2017.

108. One thermal power plants namely Mettur Thermal Power Plant is located within 300 km from the proposed project road. Fly ash will be utilized for construction of road embankment as per IRC Guidelines.

13. ADB Safeguard Policy Statement 2009

109. The Asian Development Bank has defined its Safeguard requirements under its ‘Safeguard Policy Statement 2009 (SPS 2009). The prime objectives of safeguard policy are to: (i) avoid adverse impacts of projects on the environment and affected people, where possible; and (ii) minimize, mitigate, and/or compensate for adverse project impacts on the environment and affected people when avoidance is not possible. This policy requires assessment, mitigation and commitment towards environmental protection. The extent of assessment depends on the category of the project. ADB’s SPS 2009 classify a project depending on following three categories.

- **Category A:** A proposed project is classified as category A if it is likely to have significant adverse environmental impacts that are irreversible, diverse, or

unprecedented. These impacts may affect an area larger than the sites or facilities subject to physical works. An Environmental Impact Assessment is required.

- **Category B**: A proposed project is classified as category B if its potential adverse environmental impacts are less adverse than those of category A projects. These impacts are site-specific, none or very few of them are irreversible, and in most cases mitigation measures can be designed more readily than for category A projects. An Initial Environmental Examination is required.

- **Category C**: A proposed project is classified as category C if it is likely to have minimal or no adverse environmental impacts. No environmental assessment is required although environmental implications need to be reviewed

110. The proposed project cause environmental impacts which are less adverse in nature and few of them are reversible and mitigation measures can be designed more readily for the identified impacts. As per the ADB's Safeguard Policy Statement 2009, the proposed **Kollegal to Hanur** Project corridor having length of **23.782 km** has been classified as **Category 'B'** project requiring Initial Environmental Examination (IEE).

14. Construction and Demolition Waste Management Rules, 29 March, 2016

111. The rules shall apply to everyone who generates construction and demolition waste such as building materials, debris, rubble waste resulting from construction, re-modeling, repair and demolition of any civil structure of individual or organization or authority. This will address the indiscriminate disposal of C&D Waste and enable channelization of the waste for reuse and recycling in gainful manner. Under the Rule, permission for building construction or any other infrastructure activity will not be given unless the waste generators submit specific plans to local authorities on how to dispose the waste.

112. **Responsibility of Waste Generators**

- Every waste generator shall be responsible for collection, segregation of concrete, soil and others and storage of construction and demolition waste generated separately; deposit at collection centre so made by the local body or handover it to the authorized processing facilities, ensure that there is no littering or deposition so as to prevent obstruction to the traffic or the public or drains.
- Waste generators who generate more than 20 tons or more in one day or 300 tons per project in a month shall submit waste management plan and get appropriate approvals from the local authority before starting construction or demolition or remodeling work, segregate the waste into four streams such as concrete, soil, steel, wood and plastics, bricks and mortar; keep the concerned authorities informed regarding the relevant activities from the planning stage to the implementation stage and this should be on project to project basis.
- Waste generators shall pay relevant charges for collection, transportation, processing and disposal as notified by the concerned authorities;

113. **Responsibility of Local Authority (LA)**

- LA shall be responsible for proper management of construction and demolition waste within its jurisdiction including placing appropriate containers for collection of waste, removal at regular intervals, transportation to appropriate sites for processing and disposal.
- LA shall seek detailed plan or undertaking as applicable, from generator of construction and demolition waste and sanction the waste management plan; seek assistance from concerned authorities for safe disposal of construction and demolition waste contaminated with industrial hazardous or toxic material or nuclear waste if any;
- LA shall give appropriate incentives to generator for salvaging, processing and or recycling preferably in-situ;
- LA shall establish a data base and update once in a year, device appropriate measures in consultation with expert institutions for management of construction and demolition waste generated including processing facility and for using the recycled products in the best possible manner

114. **Duties of State Government or Union Territory Administration**

- The Secretary in-charge of development in the State Government or Union territory administration shall prepare their policy with respect to management of construction and demolition of waste within one year from date of final notification of these rules.
- The concerned department in the State Government dealing with land shall be responsible for providing suitable sites for setting up of the storage, processing and recycling facilities for construction and demolition waste.
- The Town and Country planning Department shall incorporate the site in the approved land use plan so that there is no disturbance to the processing facility on a long term basis.
- Procurement of materials made from construction and demolition waste shall be made mandatory to a certain percentage (say 10-20%) in municipal and Government contracts subject to strict quality control.

Table 40: Timeframe for Planning & Implementation

Sl. No.	Compliance Criteria	Cities with population of ≥ 01 million	Cities with population of 0.5-01 million	Cities with population of <0.5 million
1.	Formulation of policy by State Government	12 months	12 months	12 months
2.	Identification of sites for collection and processing facility	18 months	18 months	18 months
3.	Commissioning and implementation of the facility	18 months	24 months	36 months
4.	Monitoring by SPCBs	3 times a year	2 times a year	2 times a year

D. Applicable Indian Road Congress (IRC) Codes

115. Over and above, the project also gives due importance to the road construction standards, norms, guidelines and management procedures prescribed by the Indian Roads Congress (IRC), which includes:

Table 41: Applicable IRC Codes

IRC:SP:108-2015	Guidelines on Preparation and Implementation of EMP
IRC:SP:98-2013	Guidelines for the use of Waste Plastic in Hot Bituminous Mixes
IRC:SP:93-2011	Guidelines on Requirements for Environmental Clearance for Road Projects
IRC:104 1988	Guidelines for EIA of Highway Projects
IRC:SP:21:2009	Guidelines on Landscaping and Tree Plantation
IRC:103 1988	Guidelines for Pedestrian Facilities
IRC: SP: 32-1988	Road Safety for Children
IRC: SP: 44-1994	Highway Safety Code
IRC: SP: 55-2001	Guidelines for Safety in Construction Zones
IRC:10:1961	Recommended Practices for Borrowpits for Road Embankments Constructed by Manual Operation
IRC:56-1974	Recommended Practices for Treatment of Embankment Slopes for Erosion Control
IRC:119:2015	Guidelines for Traffic Safety Barriers
IRC:120:2015	Recommended Practice for Recycling of Bituminous Pavement

E. Clearances Required for the Project

116. A summary of various statutory clearances required for the project road is presented in **Table 42**.

Table 42: Statutory Clearances required for the Project Road

Type of Clearance	Name of the Authority	When Required
Tree Felling Permission	Department of Forest, GoK	Before Construction

117. Apart from the clearances for the overall project work, the contractor, before starting the construction work, has to obtain required Clearances / NOCs listed in **Table 43** for operating his equipment and carrying out construction work.

Table 43: Clearances required to be obtained by the Contractor

Sl. No.	Construction Activity & Type of Clearance Required	Statutory Authority	Statute Under which Clearance is Required
17.	Consent for Establishment of Hot Mix Plant, WMM Plant, Stone Crushers and Batching Plant	▪ Karnataka State Pollution Control Board	▪ Air (Prevention and Control of Pollution) Act, 1981 ▪ Water (Prevention and Control of Pollution) Act, 1974 ▪ The Noise Pollution (Regulation and Control) Rules, 2000
18.	Consent for Operation of Hot Mix Plant, WMM Plant, Stone Crushers and Batching Plant		
19.	Permission for withdrawal of groundwater for construction	▪ Central Ground Water Authority ▪ State Ground Water Board	▪ Environment (Protection) Act, 1986 ▪ Ground Water Rules, 2002
20.	Permission for extraction of sand from river bed	▪ Department of Mines & Geology, Government of Karnataka	▪ Environment (Protection) Act, 1986

Sl. No.	Construction Activity & Type of Clearance Required	Statutory Authority	Statute Under which Clearance is Required
21.	Permission for extraction of sand from river bed	▪ District Level Environment Impact Assessment ▪ Authority (DEIAA)	▪ Environment (Protection) Act, 1986
22.	New Quarry and its operation	▪ Department of Mines & Geology, Government of Karnataka ▪ Karnataka State Pollution Control Board	▪ Environment (Protection) Act, 1986 ▪ Karnataka Minor Mineral Concession Rules, 1994 ▪ The Mines Act. 1952 ▪ Mines and Minerals (Development and Regulation) Amendment Act, 2015 ▪ The Explosive Act, 1984 ▪ Air (Prevention and Control of Pollution) Act, 1981 ▪ Water (Prevention and Control of Pollution) Act, 1974
23.	Opening of New Borrow Areas / Quarry	▪ MoEF&CC / SEIAA / DEIAA ▪ Karnataka State Pollution Control Board ▪ District Collector	▪ Environment (Protection) Act, 1986 ▪ Air (Prevention and Control of Pollution) Act, 1981 ▪ Minor Mineral and Concession Rules, 2015
24.	Location and layout of workers camp, & equipment and storage yards	▪ Karnataka State Pollution Control Board	▪ Environment (Protection) Act, 1986; Manufacturing, Storage and Import of Hazardous Chemicals Rules, 1989
25.	Discharges from labour camp	▪ Karnataka State Pollution Control Board	▪ Water (Prevention and Control of Pollution) Act, 1974
26.	Storage, handling and transport of hazardous materials	▪ Karnataka State Pollution Control Board	▪ Hazardous and Other Waste (Management and Trans-boundary Movement) Rules, 2016 ▪ Manufacturing, Storage and Import of Hazardous Chemicals Rules, 1989
27.	Disposal of Bituminous Wastes	▪ Intimate local civic body to use local solid waste disposal site	▪ Hazardous and Other Waste (Management and Trans-boundary Movement) Rules, 2016
28.	PUC Certificate for all construction vehicles and all machineries	▪ Transport Department of Govt. of Karnataka	▪ The Motor Vehicle Act 1988 ▪ The Motor Vehicles (Amendment) Bill, 2015 ▪ The Central Motor Vehicles Rules, 1989
29.	Installation of DG Set (Consent to Establish)	▪ Karnataka State Pollution Control Board	▪ Air (Prevention and Control of Pollution) Act, 1981 ▪ The Noise Pollution (Regulation and Control) Rules, 2000
30.	Operation of DG Set (Consent to Operate)		
31.	Engagement of Labour - Labour License	▪ Labour Commissioner (Ministry of Labour and Employment)	▪ The Building and Other Construction workers (Regulation of Employment and Conditions of Service) Act 1996 ▪ Contract Labour (Regulation and Abolition) Act 1970 along with Rules, 1971

Sl. No.	Construction Activity & Type of Clearance Required	Statutory Authority	Statute Under which Clearance is Required
32.	Engagement of Labour - Social Security - Labour Welfare - Wages	▪ Labour Commissioner (Ministry of Labour and Employment)	▪ The Employees' Provident Fund & Miscellaneous Provisions (Amendment) Act, 1996 ▪ The Personal Injuries (Compensation Insurance) Act, 1963 ▪ The Inter-State Migrant Workmen (Regulation of Employment and Conditions of Service) Act, 1979 ▪ Equal Remuneration Act, 1976 ▪ The Payment of Wages (Amendment) Act, 2005 ▪ The Minimum Wages Act, 1948 ▪ The Minimum Wages (Central) Rules, 1950

118. In addition to the above, Contractor has to obtain:

- Insurance related to 3rd party insurance, Indemnity, Workmen Compensation etc.
- Permission / license to store explosive materials
- Permission from local Panchayat / Municipal body for setting up Construction Camp
- Change of Land Use Certificate from District Land Revenue Officer (DLRO)

F. Administrative Framework

119. The Government through specific legislations regulates the environmental management system in India. The Ministries / Statutory bodies responsible for ensuring environmental compliance by project promoters include following agencies.

1. Ministry of Environment, Forest and Climate Change

120. The Ministry of Environment, Forest and Climate Change is the nodal agency in the administrative structure of the Central Government for the planning, promotion, co-ordination and overseeing the implementation of India's environmental and forestry policies and programs. The primary concerns of the Ministry are implementation of policies and programs relating to conservation of the country's natural resources including its lakes and rivers, its biodiversity, forests and wildlife, ensuring the welfare of animals, and the prevention and abatement of pollution.

2. Central Pollution Control Board

121. The Central Pollution Control Board (CPCB) basically designs the scheme, procedures and standards to control the water, air & noise pollution, land degradation and hazardous substances and waste management. The executive responsibilities for the industrial pollution prevention and control are primarily executed by the CPCB at the Central level, which is a statutory body. CPCB advise the MoEF&CC on matters concerning prevention, control and abatement of water and air pollution; coordinate the activities of State Pollution Control Boards & provide technical and research assistance; prepare manual, codes, guidelines & standards etc.

3. Karnataka State Pollution Control Board

122. The KSPCB is the government agency responsible for ensuring the compliance to relevant standards related to discharges to the environment. Activities of KSPCB include, planning and execution of State wide program for prevention, control and abatement of water and air pollution; advise the State Government on prevention, control and abatement of water and air pollution and siting of industries; ensure compliance with the provisions of relevant environmental legislation; establish and review local effluent and emission standards; ensure legal action against defaulters; and develop cost effective methods for treatment, disposal and utilization of effluent.

4. Archaeological Survey of India

123. The Archaeological Survey of India (ASI), has been formed for the archaeological researches and protection of the cultural heritage of the nation. Maintenance of ancient monuments and archaeological sites and remains of national importance is the prime concern of the ASI. It regulates all archaeological activities and development works in and around archeological sites in the country as per the provisions of the Ancient Monuments and Archaeological Sites and Remains Act, 1958 as amended by the Ancient Monuments and Archaeological Sites and Remains (Amendment and Validation) Act, 2010 and the rules made there under.

5. National Board for Wildlife

124. The National Board for Wildlife (NBWL) is the apex advisory body in the field of wildlife conservation in the country and is headed by the Prime Minister of India. The NBWL takes decision regarding the impact on wildlife due to road development activities and issues recommendations related to proposed road up-gradation.

IV. DESCRIPTION OF THE ENVIRONMENT

A. Introduction

125. The existing environmental conditions of the study area covering an area spread over 15 km on either side of the road, in general and specific environmental features of the study corridor, i.e., 50 m on either side of the existing centerline of the road, in particular, has been studied as described in the subsequent sections.

B. Location – Districts en-route

126. The project road starts from the take-off point of the proposed bypass of NH-209 near Agraharam Village (NH-209 Ch. 345+400) and connect SH-79 after Madhuvanahalli Village near junction with SH 38 and ends at Hanur at Km.85+815 (at junction of SH-79 with MDR). Therefore, total length of the project road is 23.782 km. The project road is passing through Chamrajnagar district of Karnataka. The location of the project road is shown on Index Map at **Figure 4**.

C. Geology, Topography & Soil

127. Geologically this area is the extension of the rocks of the Mysore plateau nearby constituting a part of Dharwar system. The underlying rock is gneissic in origin. The areas west of the Uduthorai stream in Kollegal have quartz as the under lying rock.

128. Topographically, the district may be classified as partly maidan and general tableland with plain, undulating and mountainous. The southern and eastern ghats in the district converge into group of hills. The landmass of the area forms an undulating tableland and lofty mountain ranges covered with vast forests. Master slope runs from south to north towards Cauvery River. Normally the slopes are covered by debris and colluvium filled channels. The general elevation is 656.58m amsl. The eastern and southern portions of Kollegal taluk form continuous lofty hills such as M.M. hills with an average elevation of 976m amsl having 77 hill ranges. Dodda sampigae is another hill range runs north to south for 6 km in Kollegal taluk. Biligirirangana betta in Yalandur taluk also forms the hill ranges in the district. Dense forest covered in the southern and southwestern taluks, viz., Kollegal, Yalandur, C.R.Nagar and Gundlupet. The Shivanasamudra island and Edacura village towards north of Kollegal taluk forms the important features formed due to meandering and confluence of Cauvery river.

129. The soils of the district are derived from Granitic gneisses and Charnockite rocks. Red soil is present in upland areas and also noticed at the contact of granites and schist. These soils are admixture of sand and silt. Organic matters in these soils are low. The thickness of the soil varies from less than a meter to 6.5m. Black soils are clayey and black in colour, mostly of transported in origin, occurring along depressions where regular irrigation practices are in progress. Mixed type of soils localized at places along the contact of schist and other intrusions. These are derived either from gneisses or schist. These are medium to fine grained and moderately permeable. It contains high moisture content. The thickness varies from 1m to 16.5m.

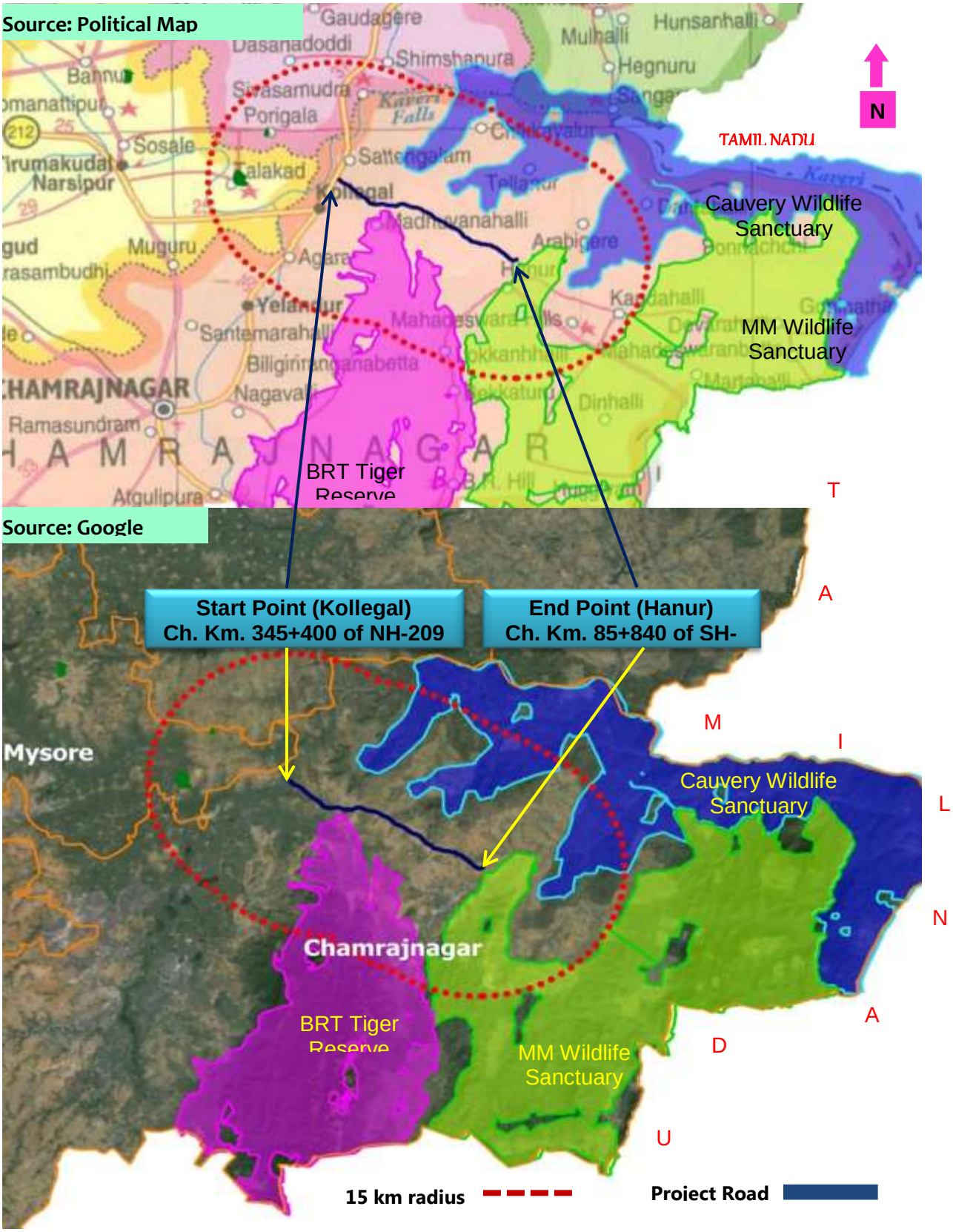


Figure 4: Map showing location of the Project Road

130. A general study of the Kollegal area reveals that major portion of the forest area does not possess soil that can harbor better vegetative growth. The soil is stoney, shallow and lacks in nutrition and therefore cannot be expected to support any better growth than what is existing. However, whenever the soil is deep and fertile, as in some valleys, banks of the rivers & streams; evergreen, semi-evergreen & moist deciduous species are found to grow luxuriantly. Geological map of the study area is presented in **Figure 5.**

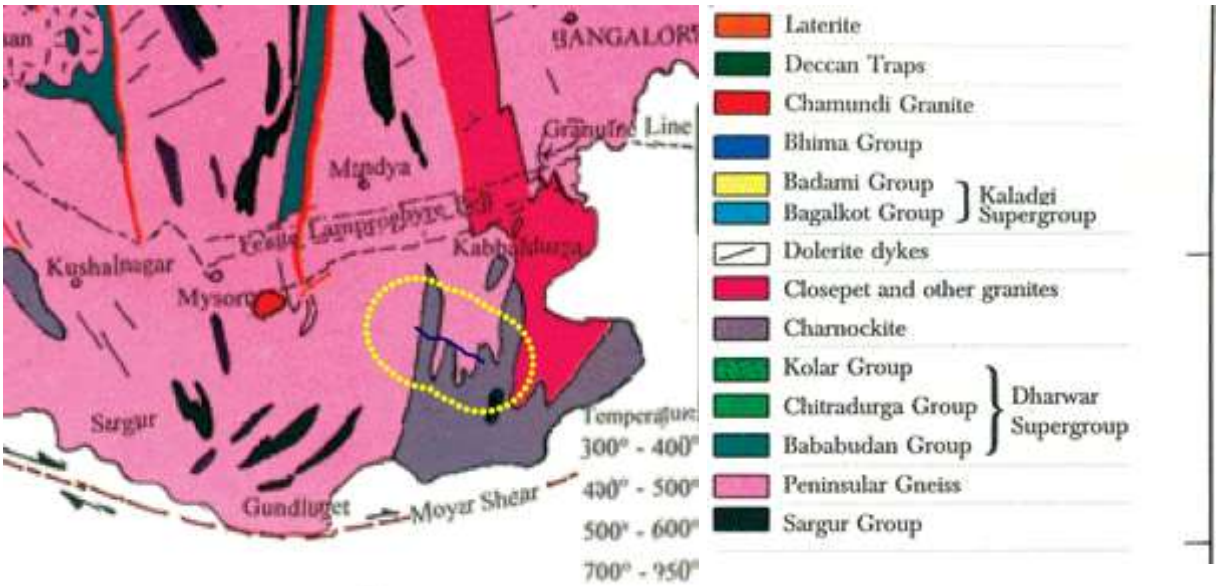


Figure 5: Geological Map of the Study Area

D. Seismicity

131. The project area is located in the southern India which is moderately active seismic region. The project road is situated in the Zone II (having low seismic intensity) of the Seismic Map of India (as per IS: 1893, Part I, 2002) and therefore has a low risk of potential damage due to earthquake.

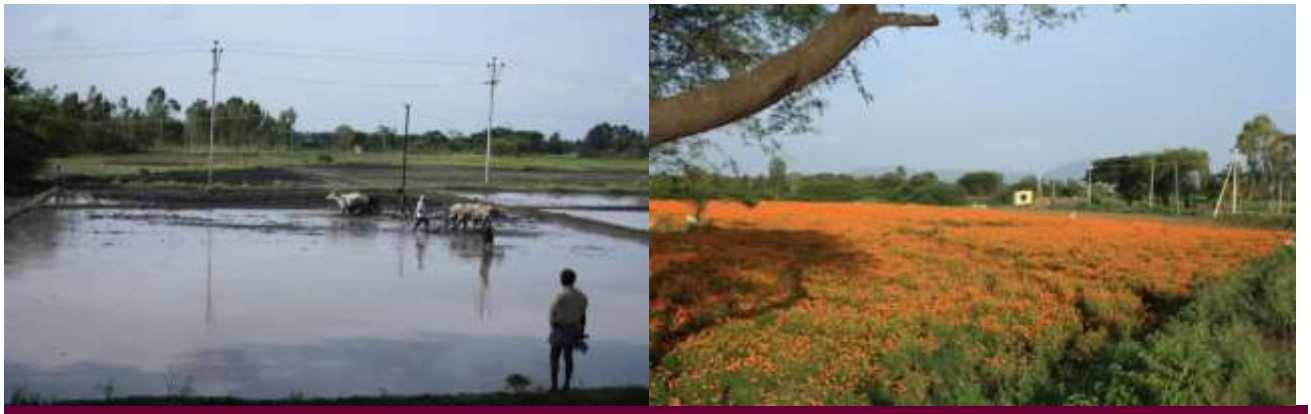
E. Drainage and River System

132. Drainage is controlled by topography. The project area is located in the Cauvery River basin system. The drainage of the area is a combination of both parallel and dendritic. Cauvery River is closest to the road at its start point and flows northwards, perpendicular to the project road. The drainage channels mostly east bound and joins with bigger tributaries like Kuttakere Halla, Kirapati Halla, Anmadiyan Halla, Bare Halla, Tatte Halla etc. which joins Cauvery River.

F. Agriculture and Irrigation Practices

133. The Cropping Pattern in the district reveals that about 53% of the Gross Cropped Area is under cereals (mostly Paddy, Ragi, Maize & Jowar), 25% under pulses, 11% under oil seeds and the remaining under plantation / horticulture crops, sugarcane, mulberry, vegetables, etc. Crops like fruits (Mango, Lime, Sapota, Grapes, Guava etc.), vegetables (Tomato, Brinjal, Carrot, Cabbage, Potato, Beans, Chillies etc.) plantation crops (Areca, Coconut, Betelvine, Tamarind etc.) and flowers (Meri Gold, Rose, Jasmine, etc.,) are grown in the district.

134. The net sown area comprises 31.05% of the total geographical area, in which 6.95% of the area is being sown more than once. As per the records about 8% of the net sown area is irrigated through surface water source, and about 23% of the area is irrigated through ground water. As per the census records, the district has 22307 minor irrigation schemes, of which 7328 pertains to dugwells, 14879 tube wells, 96 surface water flow schemes and 4 lift irrigation schemes.



Agricultural activity along the Project Road

G. Land Use

1. Method of Data Preparation

135. The land use/land cover has been presented in the form of a map prepared by using Survey of India Topographical sheet no. 57H/4, 57H/8 and 58E/5 (1:50000 scale) and satellite images. The map data has been processed using geo-processing software ArcGIS and Erdas Imagine software supported with ground truth verification. Area and distance calculations have been carried out using the software after geo-referencing the interpreted data with the help of the topographical maps. The land use map of the study area covering 15 km on either side in **1:50,000 scale** is provided in **Annex 4.1** and a compressed version is 1:100,000 scale is shown in **Figure 6** below. The topographical sheets, as mentioned above, superimposed with the project road alignment and its 15 km radius are provided in **Annex 4.2**.

2. Land use within Corridor of Impact

136. Agriculture is the main land use with very few small scale industries along project road. Commercial activities is only noted when alignment passes through settlements. The land use pattern in most of the stretch along the project road is agricultural land (69.3%) followed by residential cum commercial area (30.7%). Within ROW the land use is mainly open land with trees by the side of the earthen shoulder.

3. Land Use within the Study Area

137. The land use classification within approximately **15 km** area of the project site is summarized in **Table 44** and major land use types are graphically presented in **Figure 5**. Majority of the land is under agrarian use (55%), followed by forest (33%) and barren scrub (3.6%).

Table 44: Area Statistics of Land Use Map

Land Use Classes	Sq. km	(%)
Agriculture, Cropland	775.4	55.1
Fallow	18.7	1.3
Plantation	6.1	0.4
Barren Scrub	51.2	3.6
Unculturable/Wasteland	10.6	0.8
Built-up Area	31.8	2.3
Forest	459.8	32.8
Major Road	3.1	0.2
Sandy Area	4.7	0.3
Water Body/River/ Canal	45.2	3.2

Source: Field Survey and interpretation of Satellite Imagery by ICT, December 2015

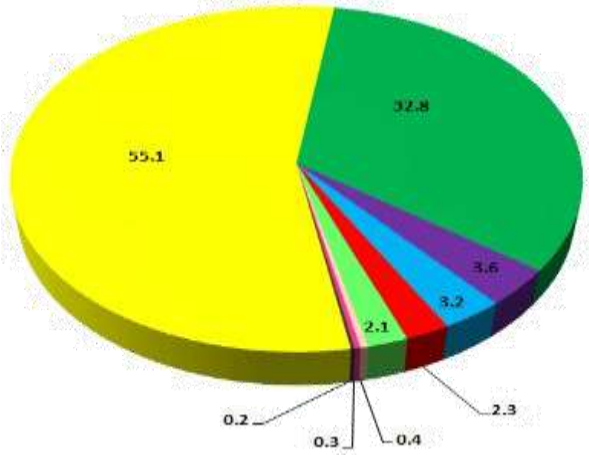


Figure 6: Land Use Pattern in the Study Area

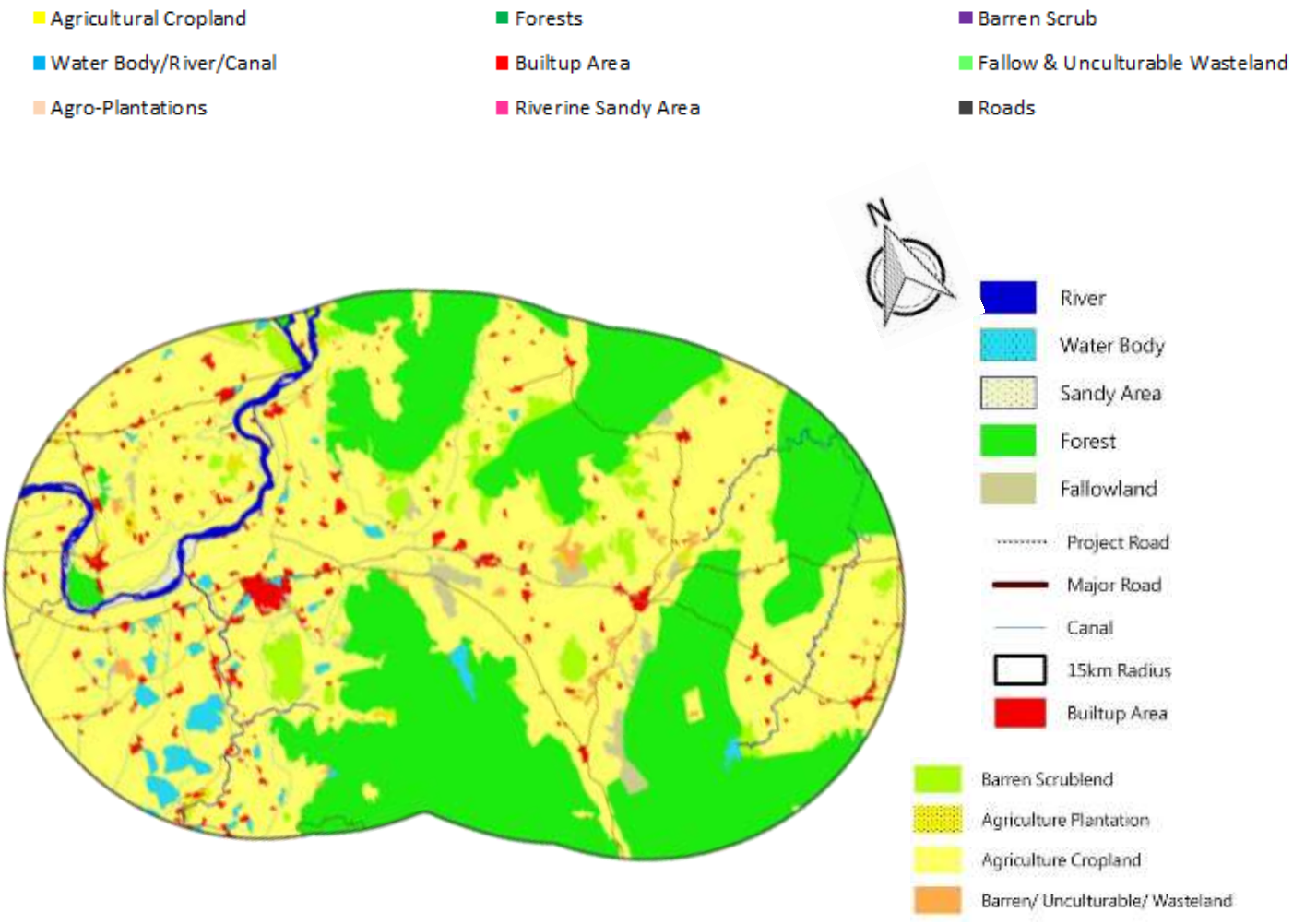


Figure 7: Land Use map of 15 km radius of the project area

H. Soil Quality

138. Soil quality is the capacity of the soil to function within the ecosystem boundaries to sustain biological productivity, maintain environmental quality and promote plant and animal growth.

1. Soil Monitoring Stations

139. The physico-chemical characteristics of soils within the study area were examined by obtaining soil samples from selected points and analyzing the same. Details of the sampling stations are provided in **Table 45.**

Table 45: Details of Soil Monitoring Stations

SN	Station Code	Place	Chainage (Km)	Side	Distance# (m)	Area category
1	SQ1	Kollegal	62+000	RHS	36	Agriculture
2	SQ2	Hanur	82+000	LHS	40	Agriculture

Source: Field Survey in December 2015

Distance in meter from existing centerline

140. M/s TUV-SUD South Asia Pvt. Ltd (A NABL Accredited & MoEF Recognized laboratory) was engaged for collection and analysis of Soil samples. The samples were collected by ramming a core-cutter into the soil up to a depth of 90 cm. Two (2) sampling locations within the study area were selected for studying soil characteristics.

Photographs of Soil Sampling

2. Soil Characteristics of the Study Area

141. While characterizing soil samples, analytical methods for various parameters have been adopted from M. L. Jackson and SSA series (USA) Volume I and II and applicable IS Codes.

142. The physico-chemical characteristics of the soils in the study area, as obtained from the analysis of the soil samples, are presented in **Table 46** & **Table 47**. The results are compared with standard soil classification**.**

Table 46: Sand, Silt, Clay & Soil Porosity

Sl. No.	Location Code	Sand (%)	Silt (%)	Clay (%)	Porosity (%)	Soil Texture
1	SQ1	18	52	23	42	Silty clay
2	SQ2	25	37	38	36	Silty clay

Source: Field Survey in December 2015

Table 47: Physico-Chemical Characteristics of Soil in the Study Area

SN	Parameters	Unit	Location Code	
			SQ1	SQ2
1	pH	-	7.56	8.28
2	Colour	-	Normal	
3	Bulk Density	gm/cm^3	1.28	1.44
4	Electrical Conductivity	ms/cm	830	741
5	Moisture	%	10.1	16.6
6	Potassium as K	mg/kg	1690	1907
7	Nitrogen as NO3-N	mg/kg	168	333
8	Phosphorous as P	mg/kg	45.2	70
9	Chloride (Cl–)	mg/kg	209.4	266
10	Sodium	mg/kg	330	539.2
11	SAR	-	2.7	4.43
12	Lead	mg/kg	8.44	8.2
13	Sodium Sulphate	mg/kg	115.4	68
14	Organic Matter	%	1.8	1.2
15	Iron as Fe	%	3.66	3.27
16	Infiltration Rate	mm/hr.	14	10
17	Sulphate as SO4	mg/kg	78	46
18	Calcium as Ca	mg/kg	103.2	53.6

Source: Field Survey in December 2015

143. It has been observed that the texture of soil is silty clay with 37-52% silt content and only 28-38% clay content. The pH of the all samples varied between 7.6-8.3, which is above the neutral mark of 7.0, indicating slightly alkaline soil which can hold excess calcium and molybdenum salts and are generally low in iron and boron nutrients. This kind of soil is suitable for growing cereals such as wheat, oat and barley, subject to availability of water while most of the other crops including corn and soybeans require slight pH correction towards the lower rages. The studied pH range also indicates the suitability of the soils for optimum growth of blue green bacteria, which fixes atmospheric nitrogen and also supports growth of other bacteria, Actinomycetes (range 6.5-9.5), which boost the fertility status of the soil.

144. The Electrical conductivity was very moderate, varies between 741-830 μs/cm, which indicates high salinity status of the soil. This moderate conductivity values also limits growth of soil microorganisms. Exchangeable potassium, sodium, calcium and magnesium were found to be low. The organic matter was observed to low and varying in the range of 1.2-1.8%. The sodium absorption ratio is found to be 2.7 to 4.4%, while the nitrogen content of the soil is sufficient. Thus, it can be inferred that the overall fertility status of the soils within the study area is moderate.

I. Climate and Meteorology

1. Climatic Conditions of the Study Area

145. The climate of the study is quite moderate throughout the year with fairly hot summer and cold winter. March to May is summer months, while June to September is the southwest monsoon period. October and November is the post monsoon season with moderate rainfall, followed by dry winter months of December to February.

146. Past meteorological data of nearest IMD Observatory Mysuru (50 km) which is deemed to be representative to the study area, has been collected for the period of 1951-1984 to establish the baseline climatic conditions of the area. The key parameters of collected meteorological data have been summarized in **Table 48** below.

Table 48: Summaries of Climatological Data (Based on IMD Records of 1951-80)

Parameter	IST	Monthly Range	Annual Mean/Total
Mean Daily Maximum Temperature (°C)		27.2 Jul – 34.3 Apr	29.5
Mean Daily Minimum Temperature (°C)		16.4 Jan – 21.5 Apr	19.3
Relative Humidity (%)	0830	67 Feb – 85 Jul	79
Total Rainfall (mm)		1.9 Jan – 166.5 Oct	788.9
Wind Speed (km/h)		8.3 Oct - 14.4 Jul	11.1
Cloud Cover (all cloud oktas)	0830	2.0 Mar-5.4 Jul	4.0
	1730	2.6 Feb – 6.1 Jul	4.5

Source: Climatological Data of Mysuru, Indian Meteorological Department

147. **Temperature**. A semi-arid climate, characterized by typical monsoon, tropical weather with hot summers and mild winters is observed in the study area. Past climatic data show that March & April are usually the hottest month with the mean daily maximum temperature around 34°C.

148. With the onset of the monsoon early in June, there is appreciable drop in day temperature but that of night temperature is remains same. January is recorded to be the coldest month with the mean daily minimum temperature varying between 16.4°C. The monthly ambient temperature profile in the study area is presented in **Figure 8**.

149. **Rainfall & Relative Humidity.** Normal annual rainfall is around 788 mm. Historical data shows that moderate rains occur in the month of November due to NE monsoon. The southeast monsoon contributes around 41 percent of the annual rainfall. The North East Monsoon yields around 29 percent and the balance of around 30 percent results from the pre-monsoon and winter.

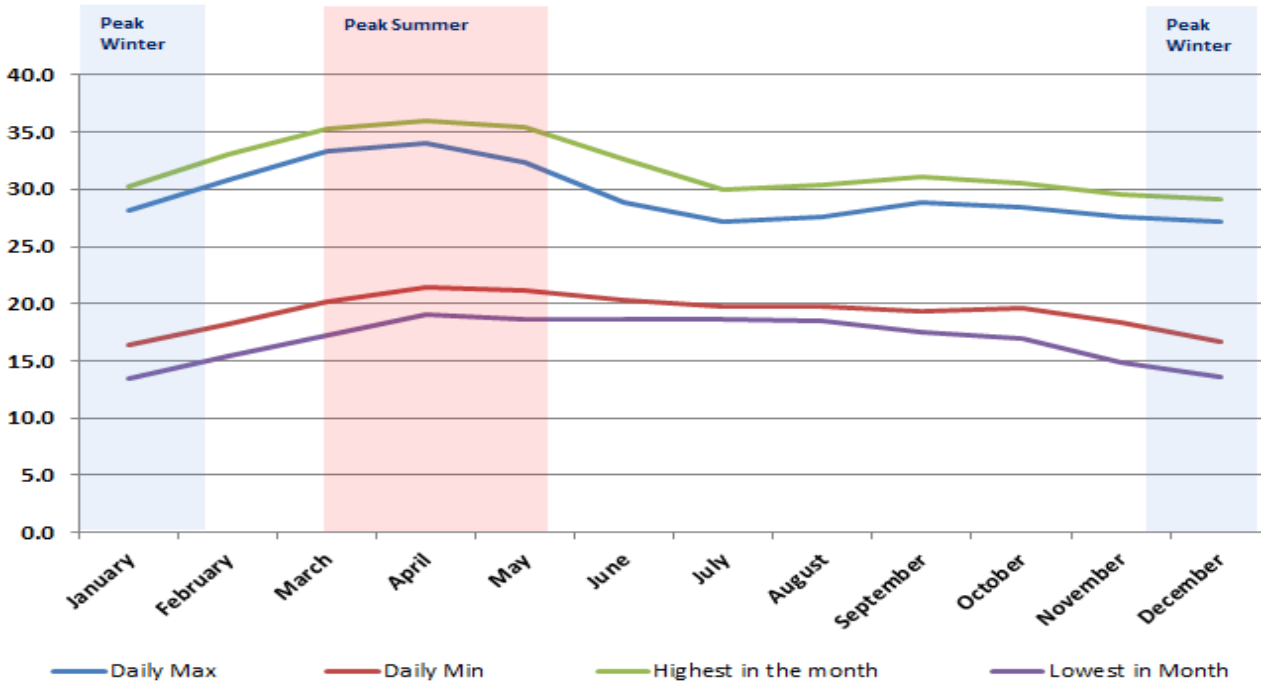


Figure 8 Monthly Ambient Temperature Profile

150. The average monthly rainfall, relative humidity and wind speed data and bar projections denoting incremental frequency and high/low values are provided in **Table 49.** July and October are the wettest months with 8 days rainy days on average. On seasonal basis dry season rainfall is most inconsistent whereas the monsoon rainfall is least inconsistent. The rainfall profile in the study area is presented in **Figure 9.**

Table 49: Monthly Rainfall, Wind Speed and Relative Humidity of Mysore

Months	Monthly Rainfall (mm)	No of Rainy Days	Mean Wind Speed (kmph)	Relative Humidity (%)	
				0830 Hours	1730 Hours
January	1.9	0.2	11	74	37
February	5.2	0.4	10.6	67	27
March	8.5	0.5	9.3	71	25
April	61.0	3.9	8.5	75	35
May	148.3	7.4	10.2	79	51
June	72.7	5.6	14.1	81	65
July	80.4	8.0	14.4	85	71
August	63.7	5.7	13.5	85	68
September	106.2	6.3	10.9	85	64
October	166.5	8.9	8.3	85	64
November	58.0	3.6	10.2	79	56
December	16.5	1.1	11.9	77	48
Total	**788.9**	**51.6**	**11.1**	**79**	**51**

Source: Climatological Data of Mysore, Indian Meteorological Department

151. **Wind Speed.** Average winds speed is high in monsoon north east monsoon and winter months, while in March witness lowest wind speed. The wind speed profile in the study area is presented in **Figure 9.**

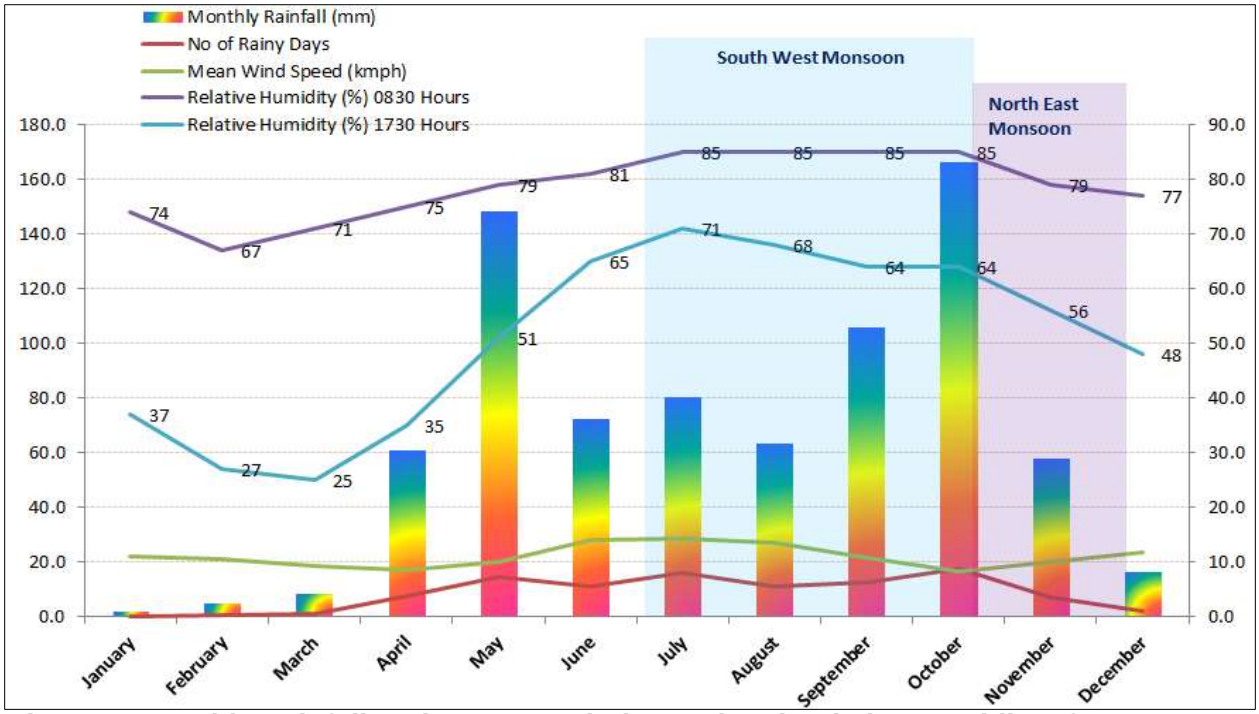


Figure 9: Monthly Rainfall, Rainy Days, Wind Speed and Relative Humidity of Mysore IMD

Table 50: Numbers of days with Extreme Weather Condition- Mysore IMD

	Weather Phenomena					Visibility#				
Months	Rain more than 0.3 mm	Hail	Thunder	Fog	Dust Strom	Up to 1 km	1-4 km	4-10 km	10-20 km	Over 20 km
January	0.5	0.0	0.0	0.3	0.0	0.2-0	4-0	21.7-2	2.2-22.5	2.9-6.5
February	0.6	0.0	0.1	0.4	0.0	0.4-0	4.8-0.4	19.8-3.3	1.9-18.9	1.1-5.4
March	1	0.0	0.7	0.4	0.0	0.3-0	3.8-0.5	19.8-1.2	4.2-22.6	2.9-6.7
April	5.9	0.0	3.1	0.0	0.0	0-0	1.7-0.4	24.4-1.2	3-21.9	0.9-6.5
May	10.1	0.0	5.7	0.0	0.0	0-0	2.8-1.3	23.2-3.8	3.4-21.3	1.6-4.6
June	10.3	0.0	0.9	0.0	0.0	0.2-0	2.2-2.6	23-3.2	2.4-21.4	2.2-2.8
July	14.9	0.0	0.2	0.0	0.0	0-0	1.8-2.2	24.6-4.6	2.4-21.4	2.2-2.8
August	13.3	0.0	0.2	0.0	0.0	0.1-0	1.1-1.5	23.7-3.1	4.2-23	1.9-3.4
September	10.3	0.0	1.3	0.0	0.0	0-0.1	1.5-0.4	23.8-2	2.9-23.8	1.8-3.7
October	12.2	0.0	2.5	0.1	0.0	0.2-0	2.4-1.3	21.4-1.7	4.4-23.8	2.6-4.2
November	5.4	0.0	0.7	0.5	0.0	0.3-0	3.6-1.3	22.5-1.3	1.9-23.1	1.7-4.3
December	2	0.0	0.2	0.5	0.0	0.1-0	3.3-0.3	21.6-3.4	3.7-22.4	2.3-4.9
Annual Mean	86.5	0.0	15.6	2.2	0.0	1.8-0.1	33-12.2	269.5-30.8	36.6-266.1	24.1-55.8

Source: Climatological Data of Mysore, Indian Meteorological Department
Hyphenated values refers to the visibility at 0830 hours and 1730 hours

152. High summer temperature over 38°C occurs occasionally in the month of April. Highest temperature has been recorded to be 39.4°C in April 1917. Moderately low temperatures had

been recorded during winter months, the lowest being 10.6°C in December 1945. Thunder storms occur in April-May and also in September-October but dust storm and hails have not been recorded.

153. On an average, the study area received 0.3 mm or more rainfall in 86.5 days in a year. Occurrence of fog in winter is occasional. **Table 50** shows the extreme weather data with bar projections denoting incremental frequency.

2. On-site Meteorological Monitoring

154. An automatic weather station was established at Kowdhalli for collection of meteorological data from 1st December to 31st December 2015. The meteorological monitoring station was positioned in accordance with the Kollegal-TN Border road section as per the then available packaging plan; however, the road section was divided into two packages, Kollegal to Hanur (package 21a) and Hanur to TN Border.

155. M/s TUV-SUD South Asia Pvt. Ltd (A NABL Accredited & MoEF Recognized laboratory) was engaged for collection of on-site meteorological data. The location details and meteorological monitoring parameters measured through the meteorological station are provided in **Table 51.**

Table 51: Location of Meteorological Station and Monitored Parameters

Parameters	Frequency	Location	Latitude & Longitude
Hourly Wind Speed, Wind Direction, Relative Humidity, Temperature & Rainfall	Hourly data	Kowdhalli	12°03'58.30"N 77°26'29.00"E

Source: Field Survey during Dec 2015

156. The weather station is equipped with sensors for temperature, relative humidity, wind speed, wind direction, atmospheric pressure, solar radiation and rain fall mounted on a tripod stand. The station consists of a weatherproof enclosure, which contains the data logger & power supply and having a solar panel. The data stored in a pocket-sized data shuttle from where the data downloaded in the computer.

157. After downloading the data has been processed. The daily average of meteorological parameters like temperature, relative humidity, wind speed, wind direction and rain fall is presented in **Annex-4.3** and summarized in **Table 52.**

158. **Meteorological Monitoring Results.** A maximum temperature of 33.3°C and minimum temperature of 16.1°C was observed during the monitoring period. Daily fluctuations in maximum and minimum temperature are presented graphically in **Figure 10**.

Table 52: Summary of Meteorological Data of the Study Area

Parameters	Dec 2015
Maximum Temperature (^{o}C)	33.3
Minimum Temperature (^{o}C)	16.1
Maximum Relative Humidity (%)	90.4
Minimum Relative Humidity (%)	26.2
Total Rainfall (mm)	0
Average Wind Speed (m/sec)	2.8
Calm condition	0.00

Parameters	Dec 2015
Predominant wind direction (blowing from)	North-east
Dry hours (%)	100%

Source: On-site Monitoring in Dec 2015

159. The minimum temperature during study period shows a consistent inclining trend from early December to January. December is considered as month having lowest night time temperature in the area.

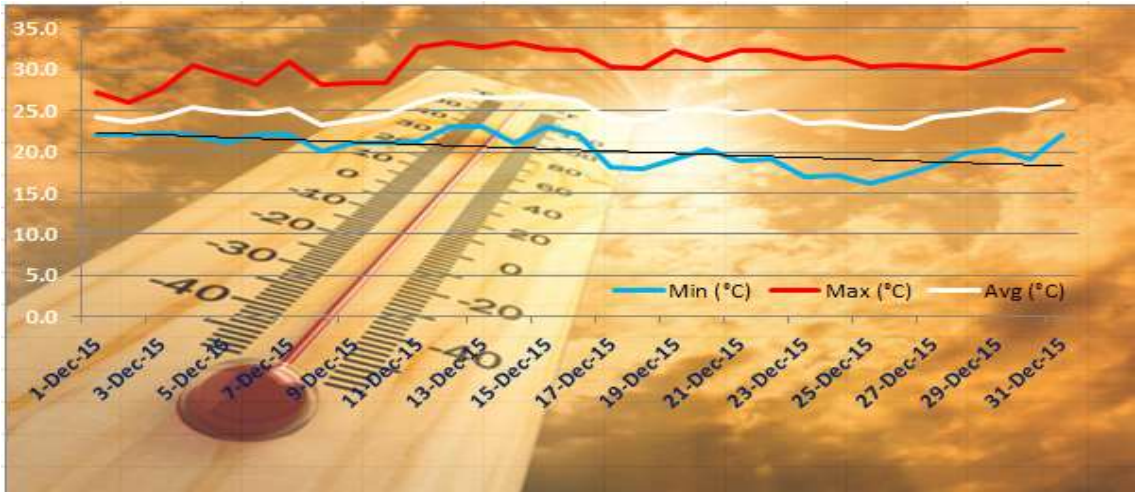


Figure 10: Daily Fluctuation of Temperature in the Study Area

160. Maximum wind speed monitored was found to be 1.6 m/sec while the average wind speed was 0.6 m/sec. The wind speeds show a consistent upward trend towards the month of January. The predominant wind direction (blowing from) was North East. Daily fluctuation of wind speed during the monitoring period is shown in **Figure 11**.

161. Maximum Relative humidity during the monitoring period is found to be around 90.4% while the average relative humidity was about 71.7%. The period was dry; no rainfall has been received during the monitoring period. The wind rose diagram of the study area is presented in **Figure 12**.

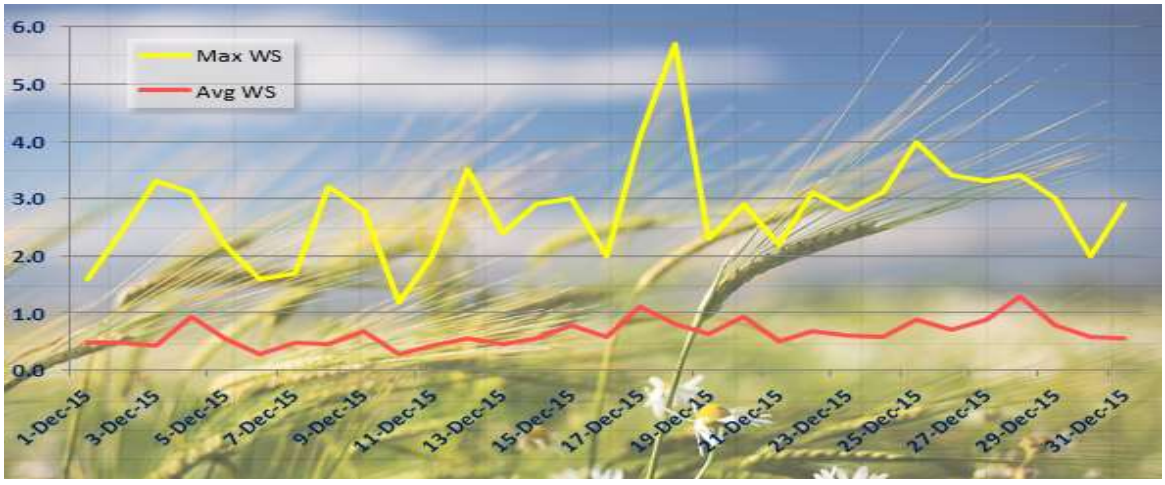


Figure 11: Daily Fluctuation of Wind Speed in the Study Area

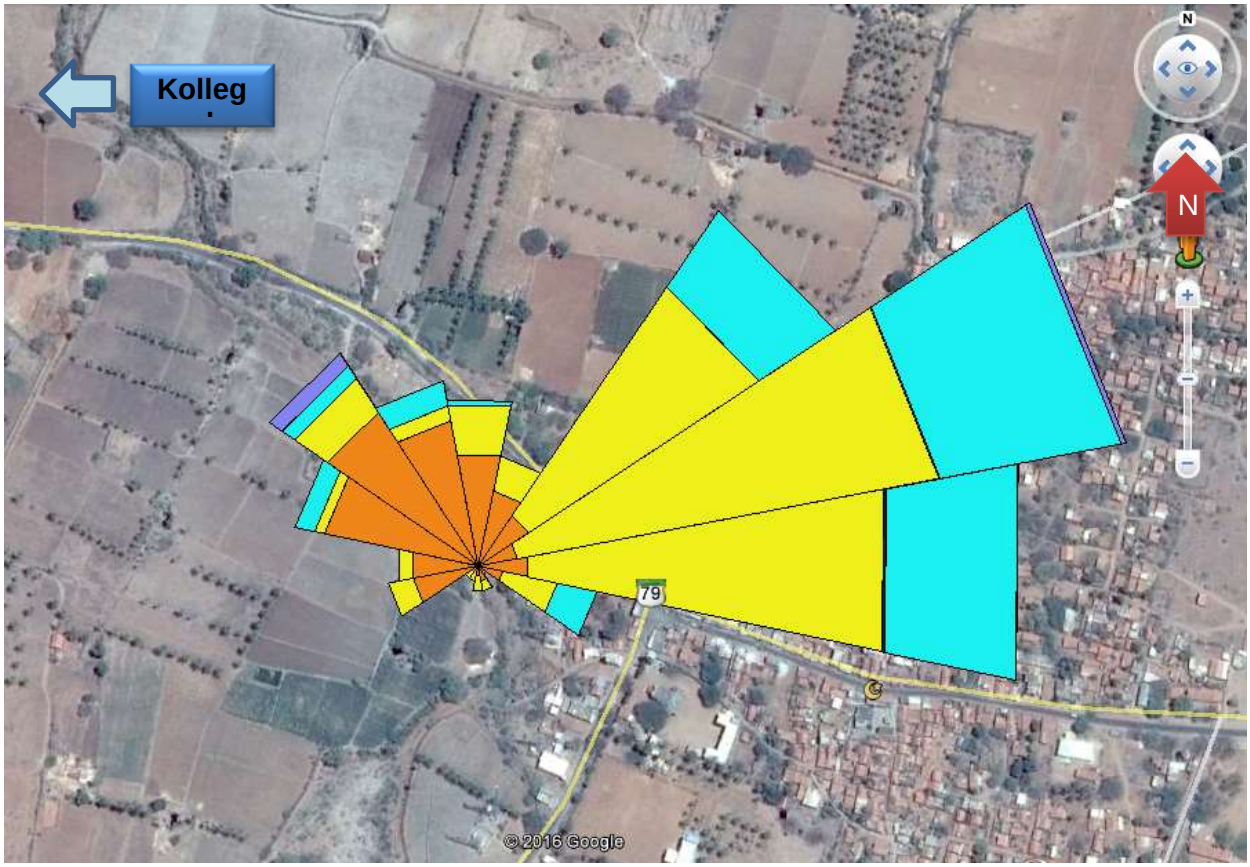


Figure 12: Wind Rose Diagram of the Study Area

J. Ambient Air Quality

1. Ambient Air Quality Monitoring Stations

162. M/s TUV-SUD South Asia Pvt. Ltd (A NABL Accredited & MoEF Recognized laboratory) was engaged for ambient air quality monitoring. Two sampling stations were set up for monitoring ambient air quality within the study area. The locations of the monitoring stations were selected so as to accord an overall idea of the ambient air quality scenario in the study area. Logistic considerations such as accessibility, security, and availability of reliable power supply etc. were considered while finalizing the locations of such stations. The locations of the ambient air quality monitoring stations in the study area are given in **Table 53**.

Table 53: Details of Ambient Air Quality Monitoring Stations

SN	Station Code	Place	Existing Ch. Km	Side	Distance# (m)	Area category
1	AQ1	Kollegal	62+000	LHS	36	Residential & Agricultural
2	AQ2	Hanur	82+000	RHS	40	Residential & Agricultural

Source: On-site Field Monitoring during Oct 15 – Dec 15
Distance in meter from existing centerline

2. Parameters Monitored & Monitoring Period

163. Monitoring was conducted in respect of the following parameters:

- Particulate matter of size less than 2.5 micron or $PM_{2.5}$
- Particulate matter of size less than 10 micron or PM_{10}
- Sulphur Dioxide (SO_2)
- Nitrogen Dioxide (NO_2)
- Carbon monoxide (CO)

Air Quality Monitoring at Kollegal

Air Quality Monitoring at Hanur

164. Ambient air quality monitoring was conducted in post monsoon season (Oct 15-Dec 15) at a frequency of twice a week at each station adopting a 24-hours schedule. CO has been measured 1-hourly. Ambient air quality monitoring methodology has summarized in **Table 54.**

Table 54: Methodology for Ambient Air Quality Monitoring

Parameter	Sampling Frequency	Sampler Name, Model & Make	Measurement Methods
$PM_{2.5}$	24-hourly twice a week	Fine Particulate Sampler of Envirotech	Gravimetric
PM_{10}		Respirable Dust Sampler of Envirotech	Gravimetric
SO_2			Colorimetric (EPA modified West & Gaeke Method)
NO_2			Colorimetric (Arsenite modified Jacobs & Hochheiser Method)
CO	1-hourly twice a week	-	Non Dispersive Infra Red (NDIR) Spectroscopy Technique

Source: NABL & CPCB Guidelines on Air Quality Analysis

3. Monitoring Results

165. Parameter-wise analyses of monitoring results are provided in **Table 37** to **41**. Monitoring station-wise as well as overall statistical analysis comprising of minimum, maximum,

arithmetic mean, standard deviation and 98-percentile of the ambient air quality are shown in **Table 55.**

166. National ambient air quality standards are reproduced in **Annex-3.1**. The detailed on-site twice a week 24-hourly monitoring results of $PM_{2.5}$ PM_{10} SO_2 NO_2 and 1-hourly CO corresponding to air quality stations AQ1 and AQ2 are presented in **Annex-4.4.**

a. Particulate Matter of Size less than 2.5 micron or $PM_{2.5}$

Table 55 Summary of $PM_{2.5}$ levels in Study Area

Station Code	Station Location	Area Category	$PM_{2.5}$ (µg/m^3)			
			Range	Mean	98%tile	NAAQ Standard
AQ1	Kollegal	Residential & Rural	14.0-72.0	48.0	71.3	60
AQ2	Hanur		20.8-74.6	50.8	73.3	
Overall of 2 locations			**14.0-74.6**	**49.4**	**72.4**	

Source: On-site Field Monitoring during Oct 15-Dec 15

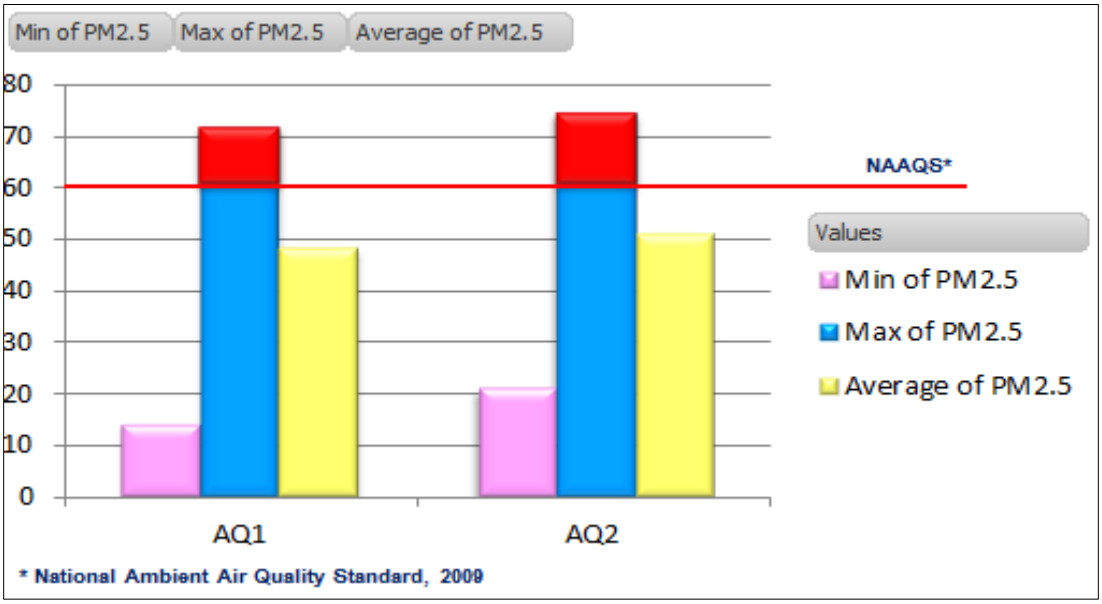


Figure 13: Variation in $PM_{2.5}$ Levels

167. Arithmetic mean of the 24-hourly average values of $PM_{2.5}$ varied station-wise between 48-50.8 µg/m^3 with overall mean of both stations being 49.4 µg/m^3. The 24-hourly average 98-percentile values of $PM_{2.5}$ (max 73.3 µg/m^3 at AQ2) at both locations were observed to exceed the limit of 60 µg/m^3 for Industrial, Residential, Rural & other areas as stipulated in the National Ambient Air Quality Standards, 2009. The percentage violations of exceedance are calculated to be 27.3 and 40.9 for AQ1 and AQ2 respectively (**Table 56**).

b. Particulate Matter of Size less than 10 micron or PM_{10}

168. Arithmetic mean of the 24-hourly average values of PM_{10} varied station-wise between 82-88.1 µg/m^3 with overall mean of both stations being 85.0 µg/m^3. The 24-hourly average 98-percentile values of PM_{10} (max 116.2 µg/m^3 at AQ2) at both locations were observed to exceed

the stipulated limit of 100 μg/m^3 for Industrial, Residential, Rural & other areas. The percentage violations of exceedance are calculated to be 31.8 and 54.5 for AQ1 and AQ2 respectively (Table 56).

Table 56: Summary of PM_{10} levels in Study Area

Station Code	Station Location	Area Category	PM_{10} (μg/m^3)			
			Range	Mean	98%tile	NAAQ Standard
AQ1	Kollegal	Residential & Rural	21.0-111.0	82.0	110.6	100
AQ2	Hanur		30.7-117.0	88.1	116.2	
Overall of 2 locations			**21.0-117.0**	**85.0**	**115.3**	

Source: On-site Field Monitoring during Oct 15-Dec 15

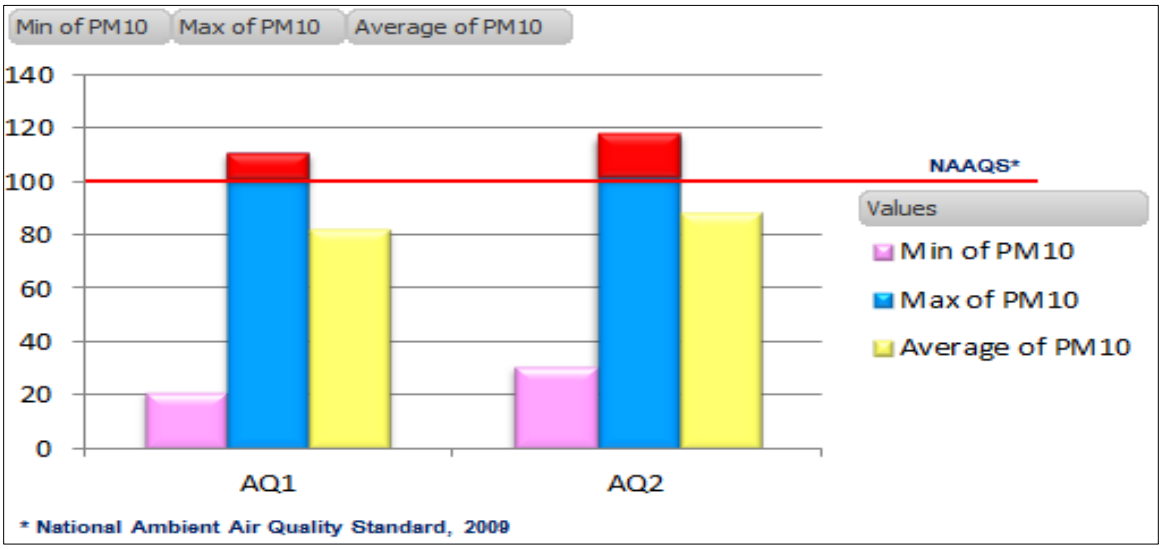


Figure 14: Variation in PM_{10} Levels

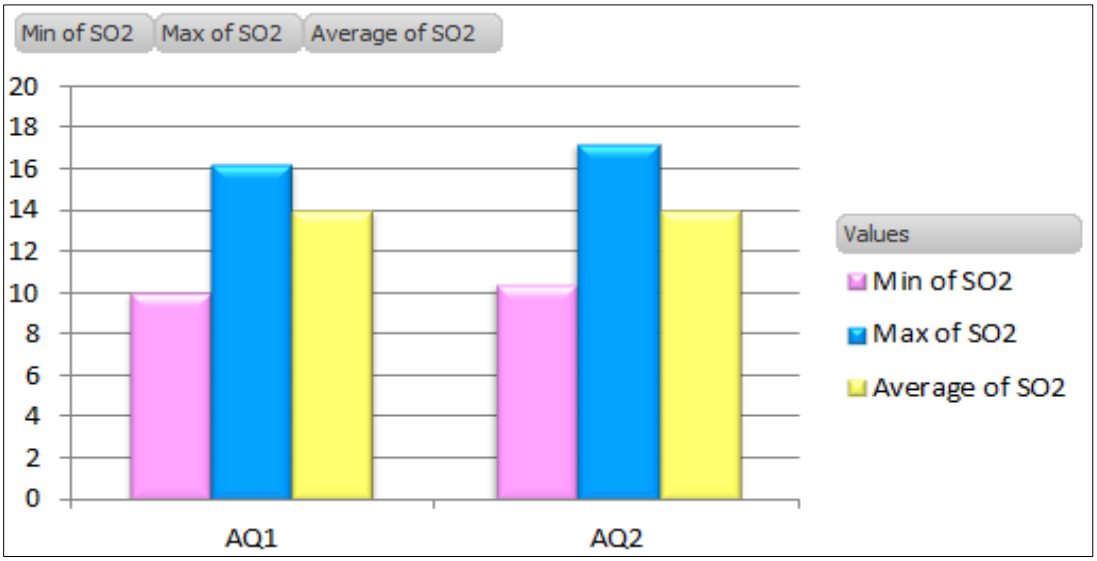
c. Sulphur Dioxide (SO2)

169. Arithmetic mean of the 24-hourly average values of SO_2 for both stations is found to be 14.0 μg/m^3. The 24-hourly average 98-percentile values of SO_2 (max 17.0 μg/m^3 at AQ2) at both locations were observed to be within the limit of 80 μg/m^3 for Industrial, Residential, Rural & other areas as stipulated in the National Ambient Air Quality Standards, 2009.

Table 57: Summary of SO_2 levels in Study Area

Station Code	Station Location	Area Category	SO_2 (μg/m^3)			
			Range	Mean	98%tile	NAAQ Standard
AQ1	Kollegal	Residential & Rural	10.0-16.2	14	16.1	80
AQ2	Hanur		10.4-17.2	14	17.0	
Overall of 2 locations			**10.0-17.2**	**14**	**16.8**	

Source: On-site Field Monitoring during Oct 15 – Dec 15



d. Nitrogen Dioxide (NO_2)

Table 58: Summary of NO_2 levels in Study Area

Station Code	Station Location	Area Category	NO_2 (µg/m^3)			
			Range	Mean	98%tile	NAAQ Standard
AQ1	Kollegal	Residential & Rural	16.4-28.0	23.7	27.6	80
AQ2	Hanur		19.0-30.2	23.7	29.7	
Overall of 2 locations			**16.4-30.2**	**23.7**	**29.2**	

Source: On-site Field Monitoring during Oct 15-Dec 15

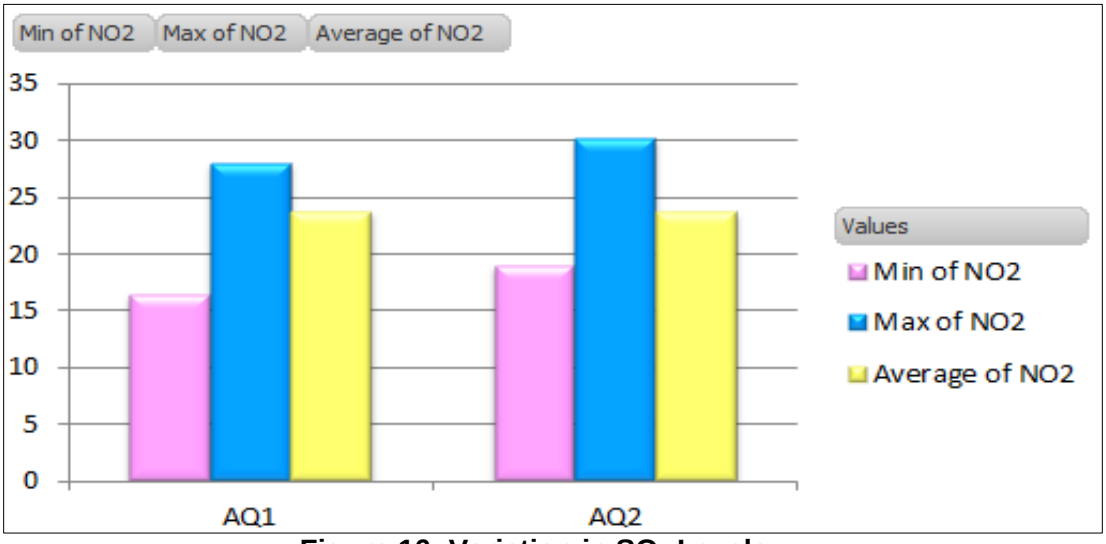


Figure 16: Variation in SO_2 Levels

170. Arithmetic mean of the 24-hourly average values of NO_2 for both stations is found to be 23.7 µg/m^3. The 24-hourly average 98-percentile values of NO_2 (29.7 µg/m^3 at AQ2) at both locations were observed to be within the limit of 80 µg/m^3 for Industrial, Residential, Rural & other areas as stipulated in the National Ambient Air Quality Standards, 2009.

e. Carbon monoxide (CO)

Table 59: Summary of CO levels in Study Area

Station Code	Station Location	Area Category	CO (mg/m^3)			
			Range	Mean	98%tile	NAAQ Standard
AQ1	Kollegal	Residential & Rural	0.4-0.5	0.4	0.5	4
AQ2	Hanur		0.4-0.6	0.5	0.6	
Overall of 2 locations			**0.4-0.6**	**0.5**	**0.6**	

Source: On-site Field Monitoring during Dec15 – Jan 16

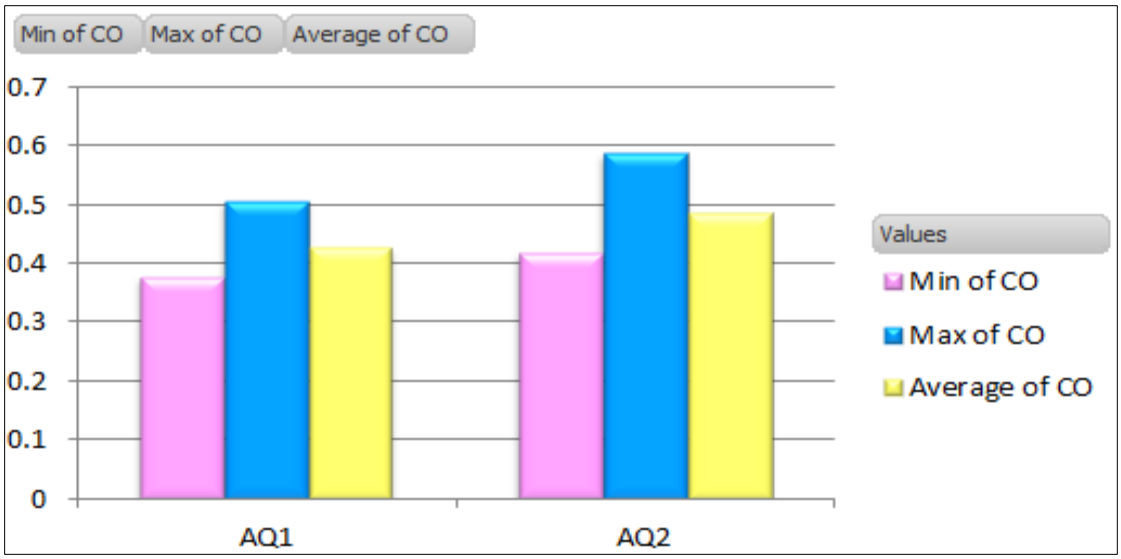


Figure 17: Variation in SO_2 Levels

171. Arithmetic mean of the 24-hourly average values of CO varied station-wise between 0.4-0.6 mg/m^3 with overall mean of the both stations being 0.5 mg/m^3. The 24-hourly average 98-percentile values of CO (max 0.5 mg/m^3 at AQ2) at both locations were observed to be within the limit of 4 mg/m^3 for Industrial, Residential, Rural & other areas as stipulated in the National Ambient Air Quality Standards, 2009.

Table 60: Statistical Analysis of Ambient Air Quality in the Study Area

Pollutant	AAQMS	Location	Mes	Min	Max	SD	p98	PTV^{IND}	PTV^{WB}
$PM_{2.5}$ ($\mu g/m^3$)	AQ1	Kollegal	22	14.0	72.0	17.5	71.3	27.3	0.0
	AQ2	Hanur	22	20.8	74.6	18.5	73.3	40.9	0.0
		Overall 2 Locations	**44**	**14.0**	**74.6**	**18.0**	**72.5**	**34.1**	**0.0**
PM_{10} ($\mu g/m^3$)	AQ1	Kollegal	22	21.0	111.0	29.1	110.6	31.8	0.0
	AQ2	Hanur	22	30.7	117.0	30.5	116.2	54.5	0.0
		Overall 2 Locations	**44**	**21.0**	**117.0**	**30.0**	**115.3**	**43.2**	**0.0**
SO_2 ($\mu g/m^3$)	AQ1	Kollegal	22	10.0	16.2	1.7	16.1	0.0	0.0
	AQ2	Hanur	22	10.4	17.2	2.0	17.0	0.0	0.0
		Overall 2 Locations	**44**	**10.0**	**17.2**	**1.8**	**16.8**	**0.0**	**0.0**
NO_2	AQ1	Kollegal	22	16.4	28.0	3.0	27.6	0.0	0.0

Pollutant	AAQMS	Location	Mes	Min	Max	SD	p98	PTV^{IND}	PTV^{WB}
($\mu g/m^3$)	AQ2	Hanur	22	19.0	30.2	3.0	29.7	0.0	0.0
	Overall 2 Locations		**44**	**16.4**	**30.2**	**3.0**	**29.2**	**0.0**	**0.0**
CO (mg/m^3)	AQ1	Kollegal	22	0.4	0.5	0.0	0.5	0.0	0.0
	AQ2	Hanur	22	0.4	0.6	0.0	0.6	0.0	0.0
	Overall 2 Locations		**44**	**0.4**	**0.6**	**0.0**	**0.6**	**0.0**	**0.0**

Source: On-site Field Monitoring during Oct 15 – Dec 15

AAQMS: Ambient Air Quality Monitoring Station Code, Mes: Number of Measurements, SD: Standard Deviation, p98: 98-Percentile Value, PTV^{IND}: Percent time violation with respect to the Indian standards; PTV^{WB}: Percent time violation with respect to the World Bank Standards

172. As evident from **Table 60** and the discussion above, the air quality at the monitored locations exceeds National Standards for particulate matters but well within the limits for gaseous pollutants. No industrial sources of air emission are observed along the project road. The reason for high particulate concentration may be attributed to the vehicular movement in the poorly maintained roads and local activities.

K. Ambient Noise Level

1. Noise Monitoring Stations

173. To assess the background noise levels in the study area ambient noise monitoring was conducted at four locations. The stations were selected judiciously based on the following considerations:

- Obstruction free exposure of equipment
- Away from temporary noise generating sources to monitor true background levels
- Accessibility of the location during day and night
- Security and safety of the instrument

174. M/s TUV-SUD South Asia Pvt. Ltd (A NABL Accredited & MoEF Recognized laboratory) was engaged for ambient noise monitoring. The locations of the ambient noise level monitoring stations in the study area are given in **Table 61.**

Table 61: Details of Noise Monitoring Stations

SN	Station Code	Place	Chainage (Km)	Side	Distance # (m)	Area category
1	NQ1	RC Mission Higher Primary School, Kollegal	61+850	LHS	40	Silence
2	NQ2	Urdu Primary School, Madhuvanahalli	67+750	RHS	20	Silence
3	NQ3	Kamagere Village	75+200	RHS	32	Residential
4	NQ4	Hanur Village	85+050	RHS	35	Residential

Source: On-site Noise Monitoring during December 2015

Distance in meter from existing centerline

2. Methodology of Noise Monitoring

175. Ambient noise level or sound pressure levels (SPL) are measured by a continuous sound level meter having built in facilities to read noise level directly in dB(A). Since loudness of sound is important for its effects on people, the dependence of loudness upon frequency is

taken into account by the A-weighting filters in-built in the noise meter which gives a direct reading of approximate loudness.

176. A-weighted equivalent continuous sound pressure level (Leq) values were computed from the values of A-weighted SPL measured with the noise meter. Noise measurement was conducted as per IS:4954 as adopted by CPCB. Ambient noise level monitoring was carried out during December 2015.

3. Ambient Noise Levels in the Study Area

177. The ambient noise levels of the study area are presented in **Table 62.** Ambient air quality standards in respect of noise are reproduced in **Annex-3.1**.

Table 62: Ambient Noise Levels of the Study Area

Station	Zone	L_{d10}	L_{d90}	L_{deq}	L_{n10}	L_{n90}	L_{neq}	L_{dn}	$L_{eq(24)}$	L_{Min}	L_{Max}
NQ1	Silence	**55.4**	47.1	52.9	48.9	40.4	45.1	64.7	51.5	40.1	**56.8**
NQ2	Silence	52.8	45.4	50.5	43.5	39.5	41.7	60.8	49.0	39.2	53.2
NQ3	Residential	**54.3**	46.9	52.0	43.8	36.2	41.0	62.3	50.4	36.2	**54.7**
NQ4	Residential	53.3	45.9	51.0	44.0	40.0	42.2	61.3	49.5	39.7	53.7

Source: On-site Noise Monitoring during December 2015

Note: Noise Standard in Residential Zone : Day Time: 55 dB(A) Night Time: 45 dB(A)
Noise Standard in Silence Zone : Day Time: 50 dB(A) Night Time: 40 dB(A)

178. The daytime and night time noise equivalent levels in the residential & silence areas show that the ambient noise levels exceeds the stipulated of Noise standards. Highest noise level observed in residential and silence zone is 54.7 dB(A) and 56.8 dB(A) respectively.

179. Ld10 values (highest among the monitored values) are found to be 54.3 dB(A) and 55.4 dB(A) for residential and silence zone respectively, which signifies that measured noise levels exceeded these values in only 10% of the time of measurement duration. The noise levels were recorded sufficiently away from the project road to avoid influence of traffic induced noise. Therefore, it can be inferred that the slightly high noise levels at monitoring locations originates from local activities including domestic.

L. Surface Water Bodies, Rivers and Water Quality

180. The project road does not cross any river but crosses a number of canals and nalas en-route, which have been provided in **Table 63**. There are 19 water bodies (pond and ditch) on either side of the project road; out of which, 12 are located on the right side and 7 are located on the left side of the project road. These water bodies get filled up during the rainy seasons and act as a natural rainwater store. List of water bodies located along the project road, their distances from the existing centerline and use of water are provided in **Table 64.**

Table 63: List of River, canal and causeway crossings en-route

SN	Description	Village	Existing Ch. km	Design Ch. Km
1.	Canal crossing	Madhuvanahalli	-	2+800
2.	Canal crossing	Doddinduvadi	69+900	69+900
3.	Canal crossing	Doddinduvadi	71+165	71+165
4.	Canal crossing	Kamagere	76+200	76+170
5.	Nala crossing	Hanur	84+300	84+230
6.	Nala Crossing	Hanur	85+350	85+300

Source: Field Survey conducted by ICT Pvt. Ltd.

Table 64: List of Water Bodies along the Project Road

SL	Particular	Existing Ch. km	Design Ch. Km	Distance[1] (m)	Side	Village	Use of Water	Length[2] (m)
1.	Pond	61+550	-	RHS	12.5	Kollegal	No use	#
2.	Pond	62+100	-	RHS	7.8	Kollegal	Crop Irrigation	#
3.	Pond	64+900	-	RHS	11.0	Siddaiahanpura	Crop Irrigation	#
4.	Pond	66+645	4+680	RHS	7.3	Madhuvinahalli	Crop Irrigation	85.0
5.	Pond	67+820	67+800	RHS	6.0	Haruvanapuram	Livestock Watering	30.0
6.	Pond	69+500	69+500	LHS	9.2	Haruvanapuram	Crop Irrigation	65.0
7.	Pond	74+000	73+960	LHS	7.6	Singanallur	Livestock Watering	20.0
8.	Pond	74+850	74+815	RHS	158.0	Kamagere	Crop Irrigation	*
9.	Pond	76+060	76+030	LHS	21.7	Konagarahalli	Domestic excluding drinking, Crop Irrigation	33.0
10.	Pond	77+500	77+460	RHS	50.9	Manglam	Crop Irrigation	*
11.	Pond	77+550	77+500	RHS	42.7	Manglam	Crop Irrigation	*
12.	Ditch[3]	78+100	78+060	LHS	10.7	Manglam	No use	34.0
13.	Ditch[3]	78+750	78+700	RHS	5.9	Manglam	Livestock watering	40.0
14.	Ditch[3]	78+750	78+700	LHS	6.2	Manglam	Crop Irrigation	66.0
15.	Ditch[3]	80+100	80+060	RHS	6.7	Manglam	Livestock watering	47.0
16.	Ditch[3]	80+185	80+145	RHS	8.8	Manglam	No use	20.0
17.	Pond	83+300	83+250	RHS	38.7	Hullepuram	Crop Irrigation	*
18.	Pond	83+300	83+260	LHS	36.5	Hullepuram	Crop Irrigation	*
19.	Ditch[3]	83+325	83+280	LHS	12.1	Hullepuram	No use	10.0

Source: Field Survey in December 2015

Notes: * Not located adjacent to the project road # realignment / bypass

1 Distance in meter from existing centerline 2 Length in meter of Water Bodies along Project Road

3 Refers to small roadside ditches

Pond at Ch. Km 69+500 on LHS

Pond at Ch. Km 76+060 on LHS

Ditch at Ch. Km 78+750 on LHS

Pond at Ch. Km 83+300 on LHS

1. Surface Water Quality Monitoring Stations

181. Surface water bodies are important in local context and therefore, their water quality needs to be monitored to assess the impacts of the project. M/s TUV-SUD South Asia Pvt. Ltd (A NABL Accredited & MoEF Recognized laboratory) was engaged for collection of surface water samples and analysis. For generating data on surface water quality parameters and drawing up the baseline scenario, 2 surface water quality monitoring stations were selected for sampling. Details of the location of Surface Water Quality Stations are provided in **Table 65**.

Table 65: Details of Surface Water Quality Monitoring Stations

S N	Station Code	Place	Existing Ch. Km	Side	Distance# (m)	Usage
1	SW1	Pond, Kollegal	62+100	RHS	7.8	Irrigation
2	SW2	Pond, Haruvanapuram	67+820	RHS	6.0	livestock watering

Distance in meter from existing centerline

* 50 m from centerline of the bridge on upstream direction

Source: On-site Water Quality Monitoring in December 2015

182. Water samples (grab samples) were collected once in the month of December 2015 from both locations and analyzed for physical, chemical and bacteriological parameters as per established standard methods and procedures.

Photographs of Surface Water Sampling

183. All the basic precautions and care were taken during the sampling to avoid contamination. Analysis of the samples was carried out as per established standard methods and procedures prescribed by the CPCB, e.g. relevant IS Codes (IS:2488 (Part-1 to 5) "Methods for Sampling and Testing of Industrial Effluents"), and "Standard Methods for Examination of Water and Wastewater" published by APHA.

2. Surface Water Quality in the Study Area

184. Details of water quality monitoring results of the surface water bodies are presented in **Table 66.** The salient water quality parameters are statistically analyzed and presented **Table 67** depicting minimum, maximum, arithmetic mean and standard deviation. The percent time violations (PTV) i.e. the percentages of time the water quality parameters violate the permissible standards are also depicted therein.

Table 66: Salient Surface Water Quality Features

SN	Parameter	Range	AM	SD	PTV
1.	pH	7.37-7.4	7.4	0.015	0%
2.	DO (mg/l)	5.7-5.8	5.8	0.050	100%
3.	BOD (3 days at 27°C) (mg/l)	6-7	6.5	0.500	100%
4.	TDS (mg/l)	180-184	182.0	2.000	0%
5.	Total hardness (mg/l as $CaCO_3$)	90.2-94.1	92.2	1.950	0%
6.	Nitrate nitrogen (mg/l as NO_3)	1.2-1.5	1.4	0.150	0%
7.	Iron (mg/l as Fe)	0.1-0.171	0.1	0.036	0%
8.	Fluoride (mg/l as F)	BDL	-	-	-

Source: On-site Water Quality Monitoring in December 2015

AM- Arithmetic mean, SD- Standard deviation, BDL- Below detection limit, PTV- Percent time violations over permissible limits* (maximum) stipulated for Inland Surface Waters (Class D) i.e. fish culture and wildlife propagation (IS:2296).

185. Temperature remained around 19°C in all samples. pH values were above the neutral mark (7.37-7.4) which were within the tolerance limit of 6.5-8.5. The slight alkalinity of the surface water may be associated with predominantly alkaline soil of the region. Conductivity varied between 218-272 μmhos/cm with TDS ranging between 180-184 mg/l. Such low values

of conductivity and TDS in all samples indicate that the water is marginally mineralized and devoid of any industrial discharges.

186. Dissolved oxygen levels are found to be in the range of 5.7-5.8 mg/l, which is slightly lower than the Class A(6.0 mg/l) but higher than Class D (4.0 mg/l) Surface water quality standards. BOD ranges from 6-7 mg/l while COD ranges are found be 17-25.2 mg/l. Such moderate values of BOD and COD signifies presence of decomposable and oxidizeable organic matter in the water resulting increase of oxygen demand and thereby, lowering of dissolved oxygen levels. Total hardness values were observed to vary in the range of 90.2-94.1 mg/l and are well within the prescribed total hardness limit of 300 mg/l for Class A surface water. Oil & grease and nitrates remain undetected in all samples.

187. Chloride and sulphate contents were 15.3-17.3 mg/l and 2.3-3.0 mg/l respectively. While calcium content varied between 24.0-25.1 mg/l, magnesium ranged between 7.3-8.0 mg/l. Levels of iron was 0.1-0.17 while arsenic, chromium, cadmium, copper, manganese, zinc and mercury are found to be low detectable limit. All of the samples are found to be high in total coliform while one sample has fecal coliforms and therefore not suitable for human use in any manner.

Table 67 Surface Water Quality Analysis Results

SN	Parameters	Units	SW1	SW2	Limits#
1.	pH	-	7.37	7.4	6.5-8.5
2.	Temperature	^{O}C	19.4	19.2	-
3.	Conductivity	µmhos/cm	218	272	-
4.	Colour	Hazen			10
5.	Turbidity	NTU	5.7	7.4	-
6.	Total Hardness as $CaCO_3$	mg/l	90.2	94.1	300
7.	Total Dissolved Solids	mg/l	184	180	500
8.	Total Suspended Solids	mg/l			-
9.	Sodium as Na	mg/l	20.7	18	-
10.	Potasium as K	mg/l	1.6	2.5	-
11.	Calcium as $CaCO_3$	mg/l	24	25.1	200
12.	Magnesium as $CaCO_3$	mg/l	7.3	8	100
13.	Dissolved Oxygen	mg/l	5.8	5.7	6
14.	COD	mg/l	17	25.2	-
15.	BOD 3 days at $27^{o}C$	mg/l	6	7	2
16.	Chloride as Cl	mg/l	15.3	17.2	250
17.	Sulphate as SO_4	mg/l	3	2.3	400
18.	TKN as N	mg/l	<1.0	<1.0	-
19.	Nitrate as NO_3	mg/l	1.5	1.2	20
20.	Iron as Fe	mg/l	0.17	0.1	0.3
21.	Manganese as Mn	mg/l	<0.05	<0.05	0.5
22.	Cadmium as Cd	mg/l	<0.003	<0.003	0.01
23.	Total Arsenic as As	mg/l	<0.005	<0.005	0.05
24.	Total Chromium as Cr	mg/l	<0.05	<0.05	0.05
25.	Copper as Cu	mg/l	<0.05	<0.05	1.5
26.	Mercury as Hg	mg/l	0.003	0.003	0.001
27.	Lead as Pb	mg/l	<0.01	<0.01	0.1
28.	Zinc as Zn	mg/l	<0.02	0.043	15
29.	Boron as B	mg/l	<0.05	<0.05	-
30.	Fluoride as F	mg/l	<0.1	<0.1	1.5
31.	Chlorine	mg/l	<0.2	<0.2	-

SN	Parameters	Units	SW1	SW2	Limits#
32.	Phenolic Compound	mg/l	<0.001	<0.001	0.002
33.	Phosphate as PO_4	mg/l	0.2	<0.1	-
34.	SAR	mg/l	1.1	0.9	-
35.	Total Coliform	MPN/100ml	900	220	50
36.	Fecal Coliform	MPN/100ml	240	Absent	-
37.	Anionic detergent as MBAS		<0.2	<0.2	-

Source: On-site Water Quality Monitoring in December 2015
Tolerance Limit as per IS:2296 (Class-A)

188. The water quality results shows the surface waters in the study area are devoid of any extraneous chemical contamination; no toxic or organic constituents are detected in samples. However, all the samples have high coliform count, high BOD levels and low dissolved oxygen indicates discharge of fecal matters and agricultural runoff in the water. Agricultural runoff, exfoliated biomass and animal wastes can be attributed for presence of organic materials in the water, which utilizes dissolved oxygen while decomposing. This has resulted lowering of available DO and high BOD.

M. Ground Water Quality in the Study Area

189. Ground water has been found to be an important source for catering to the local needs of water consumption for various purposes, mainly domestic, in the villages and towns. Therefore, any kind of deterioration in the quality of ground water owing to the developmental activities will pose threat to the village population and attention needs to be paid towards maintaining the quality of water using all possible tools such as monitoring with spontaneous remedial suggestions, if required. Since the ground water is used without treatment by a large portion of population for drinking purpose and domestic use, the quality of ground water is of more concern.

1. Ground Water Quality Monitoring Stations

190. M/s TUV-SUD South Asia Pvt. Ltd (A NABL Accredited & MoEF Recognized laboratory) was engaged for collection of ground water samples and analysis. Two (2) ground water quality monitoring stations comprising hand operated tube wells (hand-pumps) in the study area were identified for the monitoring and assessment of ground water quality. The details of ground water quality monitoring stations are provided in **Table 68.** Ground water samples were collected once in the month of December 2015 from all stations and analyzed for physical, chemical and bacteriological parameters as per established standard methods and procedures.

Table 68 Ground Water Quality Monitoring Stations

SN	Station Code	Place	Chainage (Km)	Side	Distance# (m)	Usage
1	GW1	Kollegal	63+400	RHS	13	Drinking
2	GW2	Hanur	85+160	RHS	10	Drinking

Source: On-site Water Quality Monitoring in Dec 2015
Distance in meter from existing centerline

Photographs of Ground Water Sampling

2. Ground Water Quality in the Study Area

191. The salient features of ground water quality monitoring results are provided in **Table 69** and detailed monitoring results are presented in **Table 70**.

Table 69 Salient Ground Water Quality Features

SN	Parameter	Range	AM	SD	PTV
1.	pH	7.3-7.3	7.3	0.0	0
2.	TDS (mg/l)	634-1355	994.5	360.5	0
3.	Total hardness (mg/l as $CaCO_3$)	341-651	496	155.0	50
4.	Chloride (mg/l as Cl^-)	69-247	158	89.0	0
5.	Iron (mg/l as Fe)	0.131-0.131	0.131	0.0	0

Source: On-site Water Quality Monitoring in December 2015

N- No of measurements, AM- Arithmetic mean, SD- Standard deviation, BDL- Below detection limit; PTV- Percent time violations over permissible limits* (maximum) stipulated for drinking water (IS:10500-2012).

192. Both of the samples exhibited limited variation of temperature, which are the typical characteristics of ground water. There has been no fluctuation in pH level (7.3) of the analyzed samples, which is marginally above the neutral mark but within the permissible limits of 6.5-8.5 stipulated in drinking water quality standards (IS 10500:2012).

193. Total hardness values for the samples were observed to high (341-651 mg/l), with one sample having higher values than both desirable limits (200 mg/l) and permissible limits (600mg/l) of drinking water quality standards. Chloride varied between 69-247 mg/l, Sulfate content varied between 18-78 mg/l, Calcium content varied between 86.4-156 mg/l and magnesium varied between 30.4-63.4 mg/l for the samples. Heavy metals remain undetected in the samples. The fluoride levels are also found to be in 0.3 in both samples but within the stipulated standards.

Table 70: Ground Water Quality Analysis Results

SN	Parameters	Units	GW1	GW2	Indian Standard[1]		WHO Limits
					Desirable	Permissible	
1.	pH	-	7.3	7.3	*6.5-8.5*	*No relaxation*	-

SN	Parameters	Units	GW1	GW2	Indian Standard[1]		WHO Limits
					Desirable	Permissible	
2.	Temperature	^{O}C	19.4	20	-	-	-
3.	Conductivity	µmhos/cm	941	2006	-	-	-
4.	Turbidity	NTU	2.4	3.4	*1*	*5*	-
5.	Total Hardness as $CaCO_3$	mg/l	341	651	*200*	*600*	-
6.	Total Alkalinity as $CaCO_3$	mg/l	317	590.2	*200*	*600*	-
7.	Total Dissolved Solids	mg/l	634	1355	*500*	*2000*	-
8.	Sodium as Na	mg/l	39.6	15	-	-	-
9.	Potassium as K	mg/l	1.3	16	-	-	-
10.	Calcium as Ca	mg/l	86.4	156	*75*	*200*	-
11.	Magnesium as Mg	mg/l	30.4	63.4	*30*	*100*	-
12.	Chloride as Cl	mg/l	69	247	*250*	*1000*	-
13.	Sulphate as SO_4	mg/l	18	78	*200*	*400*	-
14.	Nitrate as NO_3	mg/l	10.1	17	*45*	*No relaxation*	*50*
15.	Iron as Fe	mg/l	<0.05	0.131	*0.3*	*No relaxation*	-
16.	Manganese as Mn	mg/l	<0.05	0.365	*0.1*	*0.3*	-
17.	Cadmium as Cd	mg/l	<0.003	<0.003	*0.003*	*No relaxation*	*0.003*
18.	Total Arsenic as As	mg/l	<0.005	<0.005	*0.01*	*0.05*	*0.01*
19.	Total Chromium as Cr	mg/l	<0.05	<0.05	*0.05*	*No relaxation*	*0.05*
20.	Copper as Cu	mg/l	<0.05	<0.05	*0.05*	*1.5*	*2*
21.	Mercury as Hg	mg/l	<0.001	<0.001	*0.001*	*No relaxation*	*0.006*
22.	Lead as Pb	mg/l	<0.01	<0.01	*0.01*	*No relaxation*	*0.01*
23.	Zinc as Zn	mg/l	0.071	9.4	*5*	*15*	-
24.	Boron as B	mg/l	<0.05	0.093	*0.5*	*1*	*2.4*
25.	Fluoride as F	mg/l	0.3	0.3	*1*	*1.5*	*1.5*
26.	Total Coliform	MPN/100ml	Absent	Absent	*Absent*	*Absent*	*Absent*

Source: On-site Water Quality Monitoring in December 2015

1 Refers to Drinking Water Quality Standards as stipulated in IS- 10500:2012

194. From above it can be concluded all parameters were generally within the tolerance limits for drinking water except hardness. Therefore, the ground water quality of the study area, in general, is hard in nature and the physico-chemical quality at large satisfies the permissible limit as stipulated in Drinking Water Standards of India as well as World Health Organization.

3. Ground Water Availability

195. **Chamrajanagar** district is located in the southern tip of Karnataka. Almost 48% of the total geographical area of the district is covered by forests / hills. Groundwater resource estimation of the district indicates that the net ground water availability for future irrigation development is 11,930 HAM, and the balance of ground water irrigation potential is 13,826 HA.

196. **60% of the area in Kollegal taluk**, 17% and 10% area of Gundlupet and CR nagar taluks falls under **Over Exploited** Category. Kollegal taluk is the largest, where in 70% of the total area is predominately hilly comprising of undulating and rugged terrain where the run off is high. Drinking water scarcity exists in number of the villages of Kollegal taluk. In Kollegal Taluk, bore well forms the main means of rural water supply and increasingly more popular for irrigation needs. There are 2,308 bore wells fitted with hand pumps, 253 bore wells used for piped water supply schemes, 213 as mini water supply schemes through which ground water

developed for drinking water supply. For irrigation purpose, there are 48,133 dug wells, 1,554 shallow bore wells. (*Source: Ground Water Information Booklet of CGWB*)

N. Ecology and Biodiversity

1. Introduction

197. The project road traverses through predominantly agricultural land and few settlements. The flora species along the road comprised of *Tamarindus indica* (Tamarind), *Ficus religiosa* (Peepal), *Syzygium cumini* (Jamun), *Ficus benghalensis* (Banyan), *Azadirachta indica* (Neem), *Acacia nilotica* (Babool) *Peltophorum pterocarpum* (Copper pod), *Pongamia pinnata* (Karanj), *Delonix regia* (Gulmohar), *Dalbergia sisoo* (Sheesam) *Terminalia catappa* (Almond), *Cassia siamea* (Kassod), *Muntingia calabura* (Gasa Gase), *Samanea saman (Rain Tree*), *Thespesia populnea* (Paras pipal), *Polyalthia longifolia* (Ashok) and *Eucalyptus sps* (Eucalyptus).

198. Shrubs and herbs along road side comprise of Lantana camara (Lantana), Calotropis gigantea (Aak), Zizyphus sps (ber), Prosopis juliflora (Vilayati Kikar) Nerium odorum (Nerium) Carissa spinarum (Wild Karanda), Xanthium stumarium (Common Cocklebur), Tabernaemontana divaricata (Jasmine), Kleinia grandiflora (Illaikalli), Bougainvillea spectabilis (Bougainvillea), Ricinus communis (Castor bean), Ipomea carnea (Besharam),Parthenium hysterophorus (Congress grass), etc.

199. Tree species grown in agricultural land comprised of *Mangifera indica* (Mango), *Cocus nucifera* (Coconut), *Psidium guajava* (guava), *Musa paradisiaca* (Banana), *Annona squamosa* (Sitaphai) and *Artocarpus heterophyllus* (Jack fruit). The major crops grown are *Eleusine coracana* (Ragi), *Zea maize* (Maize). Pulses such as *Cajanus indicus* (red gram), *Dolichos lablab* (broad bean). *Saccharum officinarum* (Sugarcane) is also cultivated.

View of Trees along Project Road

2. Road Side Trees

200. The number of roadside trees within existing row is estimated to be 767. Side and girth size wise distribution of existing trees are provided in **Table 71.** Chainage wise detailed survey data is provided in **Annex 4.5.**

Table 71: Number of Trees along the Project Road

Side	No of Trees in Girth Class (in cm)					Total
	<30	31-59	60-119	120-180	>180	
RHS	56	109	183	53	22	423
LHS	56	104	105	35	44	344
	112	**213**	**288**	**88**	**66**	**767**

Source: Field Survey conducted by ICT Pvt. Ltd.

3. Green Tunnels and Giant Trees

201. **Green tunnels** are formed along the road at some locations. These tunnels provide shade, reduce heat effect, reduce glaring of road and provide overall cooling. Species observed in the green tunnel mainly includes *Ficus benghalensis* (Banyan), *Mango (Mangifera indica), Ficus religiosa*, (Pipal), *Azadirachta indica* (Neem) and *Tamarindus indica* (Tamarind). The stretches will be impacted due to widening activity. The location of green tunnel is given in **Table 72** and also marked in map in **Annex 4.6**

Table 72: Location of Green Tunnels along Kollegal to Hanur Road

Sl. No.	GPS Reading		Existing Chainage Km		Design Chainage Km		Length (m)
	Start Point	End Point	From	To	From	To	
1	12° 9'6.08"N 77°11'10.95"E	12° 9'7.11"N 77°11'14.01"E	70+075	70+170	70+085	70+180	0.095
2	12° 7'32.56"N 77°14'22.04"E	12° 7'29.15"N 77°14'26.02"E	76+775	79+935	76+740	76+900	0.160
3	12° 5'11.76"N 77°18'25.79"E	12° 5'13.56"N 77°18'30.71"E	85+690	85+845	85+645	85+800	0.155
Total Length of Green Tunnel							**0.410**

View of Green Tunnel along Kollegal to Hannur

202. **Giant Trees:** Field survey was conducted to identify the location of giant trees. 38 giant trees are found along the project road, out of which 18 trees are on the left side and 20 trees are on the right side. Details of the giant trees i.e., Chainage, side, distance from existing centerline of the road, species and girth size is presented in **Table 73.**

View of Giant Trees along the Project Road

Table 73: List of Giant Tree along the Project Road

Sl.No	GPS	Design Chainage (km)	Side	Distance from CL(m)	Species	Girth size (m)
1	737936.01, 1344281.20	70+100	RHS	4.5	Mango	6.2
2	737954.26,1344288.93	70+120	RHS	5.5	Mango	5.5
3	737956.30,1344300.58	70+125	LHS	4.9	Mango	5.6
4	737970.76,1344295.22	70+135	RHS	6	Jamun	5
5	737979.94&134297.51	70+150	RHS	5.5	Jamun	4.9
6	737985.82,1344313.33	70+150	LHS	6.5	Jamun	4.3
7	738003.63,1344325.36	70+160	LHS	7.3	Mango	4.2
8	738006.99,1344313.91	70+165	LHS	7.5	Jamun	3.3
9	738014.66,1344313.9	70+170	LHS	7.7	Jamun	3.2
10	738063.71 ,1344322.75	70+230	LHS	7.6	Jamun	6.6
11	738321.15,1344344.44	70+490	RHS	4.3	Jamun	4
12	738333.32,1344344.51	70+510	RHS	4.4	Mango	4.7
13	738366.66,1344352.11	70+530	RHS	4.6	Mango	3.4
14	739934.41,1343876.35	72+180	LHS	8.2	Peepal	7.3
15	739969.48,1343860.41	72+220	LHS	11	Peepal	4.4

Sl.No	GPS	Design Chainage (km)	Side	Distance from CL(m)	Species	Girth size (m)
16	741176.12,1343226.94	73+600	RHS	4.8	Neem	4
17	741385.83,1343099.97	73+800	RHS	6.4	Gulmohar	3.5
18	741421.94,1343079.28	73+880	LHS	7.2	Tarmarind	5.8
19	741467.17,1343047.42	73+940	LHS	5.9	Tarmarind	4.2
20	741472.02,1343040.33	73+950	LHS	6.2	Tarmarind	4.3
21	742022.30,1342499.58	74+720	RHS	6.7	Peepal	3.4
22	742124.21,1342427.58	74+850	RHS	8.7	Tarmarind	5
23	744680.88,1341012.69	77+820	RHS	6.2	Peepal	5
24	744850.20,1340820.50	78+070	LHS	6.3	Peepal	4.9
25	744903.00,1340747.53	78+150	RHS	7.3	Peepal	3.9
26	745006.77,1340597.83	78+340	RHS	6.4	Peepal	4
27	745391.55,1340140.77	78+940	RHS	8.2	Banyan	11
28	746103.14,1339651.36	79+815	RHS	8.1	Banyan	4.2
29	746264.83,1339557.65	79+980	LHS	7.8	Banyan	4.6
30	746299.92,1339552.74	80+010	LHS	8.6	Banyan	4.3
31	746395.12,1339552.56	80+120	RHS	6	Peepal	4.4
32	747045.74,1339325.15	80+820	RHS	6	Banyan	4.6
33	747449.79,1339219.43	81+250	RHS	6.2	Banyan	3.7
34	748440.32,1339030.8	82+250	LHS	5.3	Banyan	8.5
35	748483.75,1339008.60	82+300	LHS	4.9	Banyan	7.8
36	749689.34,1338171.60	83+780	LHS	6	Tarmarind	3.36
37	750147.34,1337781.35	84+400	LHS	8.1	Tarmarind	4.8
38	750132.27,1337769.11	84+400	RHS	9.6	Tarmarind	5.6

4. Biodiversity Survey

203. Biodiversity study of project road was carried in the month of December, 2015 to study the flora and fauna of the project area. Two Sample plots of 100 m x 10 m were laid for the purpose of biodiversity assessment in adjoining forest area. The data collected on the number of individuals present in each species, for both flora and fauna, were subjected to further analysis. Importance Value Index (IVI), Shannon Diversity Index and Simpson's Index were calculated. The GPS co-ordinates and altitude were recorded for each of the sample plots are provided in **Table 74.**

Table 74: GPS co-ordinates and altitude for the Sample plots

Sample Plots	Latitude	Longitude	Altitude (m)	Vegetation Type
1	12˚5' 9"	77˚ 21' 20.1"	644	Shrubby vegetation
2	12˚4' 14.9"	75˚ 28' 16.1"	579	Shrubby vegetation

Source: Biodiversity Study conducted by ICT Pvt. Ltd.

a. Floral Composition

204. Primary data on the floral composition was recorded in both plots, floral species were botanically identified to the species level by using local flora (Saldanha and Ramesh,1984; Gurudev, 2002) and other field guides separately for trees, shrubs and herbs; and their scientific names and individual numbers were recorded during field survey for further analysis. 64 floral species were identified. Out of which, 22 were tree species, 25 shrubs and 17 herb species (Plate 1, 2 & 3).The list of floral species along with the status as per International Union for Conservation of Nature (IUCN), red list of threatened species is provided in the Table 75.

Table 75: List of Flora recorded during Survey

SN	Species Name	Common Name	IUCN category
1.	*Acacia catechu*	Black cutch	NE
2.	*Acacia nilotica*	Babool	NE
3.	*Albizia amara*	Chujjalu	NE
4.	*Albizia lebbeck*	Siris	NE
5.	*Albizia odoratisima*	Kaadu baage	NE
6.	*Anogeissus latifolia*	Dindalu	NE
7.	*Atalantia monophyla*	Kadimbe,	NE
8.	*Azadirachta indica*	Neem	NE
9.	*Bauhinia recemosa*	Kachnar	NE
10.	*Boswellia serrata*	Guggula mara	NE
11.	*Buchanania lanzan*	Chironji, Charoli	NE
12.	*Butea monosperma*	Beej Palash	NE
13.	*Canthium dicoccum*	Hatteranike, Abalu	NE
14.	*Cassia fistula*	Golden Shower	NE
15.	*Cassia siamea*	Kassod tree	NE
16.	*Cassia spectabilis*	Yellow shower	Least Concern
17.	*Chloroxylon swietenia*	Urugalu	Vulnerable
18.	*Dalbergia paniculata*	Takoli	NE
19.	*Delonix regia*	May flower	Least Concern
20.	*Diospyros melanoxylon*	Beedi leaves	NE
21.	*Diospyros montana*	Jagalaganti	NE
22.	*Ficus religiosa*	Pipal tree	NE
Shrubs			
23.	*Agave americana*	American aloe	Least Concern
24.	*Argyreia cuniata*	Kallana gida	NE
25.	*Calotropis procera*	French Cotton	NE
26.	*Canthium parviflorum*	Kadbar	NE
27.	*Cardiospermum halicacabum*	Balloon plant	NE
28.	*Carissa carandas*	Crane berry	NE
29.	*Cassia auriculata*	Anval	NE
30.	*Cassia montana*	Mountain cassia	NE
31.	*Datura innoxia*	Datura	NE
32.	*Dodonaea viscosa*	Hop-bush	NE
33.	*Erythroxylum monogynum*	Bastard sandal	NE
34.	*Jatropha curcas*	Physic nut	NE
35.	*Lantana camara*	Ghaneri	NE
36.	*Opuntia dillenii*	Nagphana	NE
37.	*Prosopsis juliflora*	Indian Mesquite	NE
38.	*Pterolobium hexapetalum*	Baadubakka	Least Concern
39.	*Randia dometorum*	Blue berry	NE
40.	*Securinega virosa*	Dalme	NE
41.	*Sida acuta*	Blue okra	NE
42.	*Sida cordifolia*	Bala panchaang	NE
43.	*Sida rhombifolia*	Queensland hemp	NE
44.	*Solanum indicum*	Ban Tobacco	NE
45.	*Tarenna asiatica*	Paapatige gida	NE
46.	*Tephrosia purpuria*	Sarapunkha	NE
47.	*Ziziphus oenoploea*	Kakal-ber	NE
Herbs			
48.	*Acaranthus aspera*	Prickly Chaff-flower	NE
49.	*Asparagus racemosus*	Shathaavari	NE

SN	Species Name	Common Name	IUCN category
50.	*Cassia tora*	Coffee Cassia	NE
51.	*Cynodon dactylon*	Bermuda grass	NE
52.	*Cyanotis tuberosa*	Dew grass	NE
53.	*Dolicus falcutus*	Kaduhurali	NE
54.	*Evolvulus alsinoides*	English speedwheel	NE
55.	*Hemidesmus indicus*	Nannari	NE
56.	*Hybanthus enneaspermum*	Ratanpurus	NE
57.	*Leucas aspera*	Chhota-halkusa	NE
58.	*Mimosa pudica*	Touch me not	Least Concern
59.	*Ocimum americanum*	Jangali-tulsi	NE
60.	*Phyllanthus amarus*	Bhumi-amla	NE
61.	*Phyllanthus maderaspatensis*	Hazarmani	NE
62.	*Phyllanthus urinariea*	Hazarmani, Kempu kirunelli	NE
63.	*Spilanthes acmella*	Toungue cleaner	NE
64.	*Tridax procumbens*	Coat buttons	NE

Status as per IUCN Red list, NE : Not Evaluated

Source: Biodiversity Study conducted by ICT Pvt. Ltd.

Plate 1: **tree species**. a. *Albizia amara* *b. Cassia fistula* *c*. *Bauhinia racemosa*

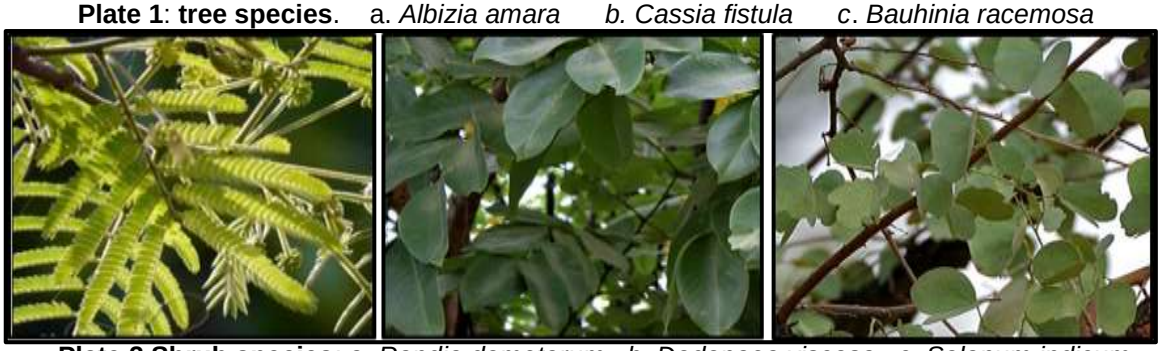


Plate 2 Shrub species*: a. Randia dometorum b. Dodonaea viscosa , c. Solanum indicum*

Plate 3 Herb species: a. *Cyanodon dactylon b. Cyanotis tuberosa, c. Phyllanthus amarus*

205. Importance Value Index (IVI) indicates the population structure of species since, it takes collective account of structural parameters such as relative density and frequency of the species. The results of biodiversity study are presented in **Table-A.4.7.1, Table- A.4.7.2** and **Table-A.4.7.3** of **Annex 4.7** for trees, shrubs and herbs respectively. *Acacia nilotica* was found to be dominant in with 17.87 IVI and the least was observed for *Canthium dicoccum* and *Atalantia monophyla* with 4.20. According to the species abundance calculated for the tree species, inferred that *Boswellia serrata* was having highest abundance value of 16.0 compared to other species, this is ascribable to the fact that, the species though not distributed equally, the number of individual were more.

206. *Securinega virosa*was dominating species with an IVI of 14.15 among the shrub species identified and the least IVI (3.94) was observed for Cassia *auriculata, Cassia montana* and *Datura innoxia*. The species abundance for individual shrubs revealed that *Lantana camara* was having highest abundance value of 11.0. *Phyllanthus maderaspatensis* was found to be dominating with an IVI of 23.15. The species abundance was calculated for herb species and it is prudent to mention that *Phyllanthus maderaspatensis* was having highest abundance value of 17.0 compared to other herb species.

207. **Shannon's Diversity index**: Diversity index is used to characterize the species abundance relationship in a community. The simple measure of species diversity is Shannon's diversity index. It is estimated by using the formula:

$$\mathbf{H' = -\sum_{i=1}^{S}[(ni/N)\ ln\ (ni/N)]}$$

Where,
H = the Shannon diversity index
ni = Number of individuals belonging to the i^{th} species,
N= Number of individuals in the sample,
S = Number of species encountered
∑ = sum from species 1 to species S

208. Diversity index can be used to characterize the species abundance relationship in a community. The simple measure of species diversity is Shannon's diversity index. The estimated Shannon's diversity index is presented in **Table 76**.

Table 76: Shannon's Diversity Index

S. N.	Flora	Shannon's Diversity Index
1	Tree	2.83
2	Shrub	3.10
3	Herb	2.61

209. In the present assessment, the Shannon's diversity index for tree species was 2.83, for shrubs was 3.10 and for herbs 2.61. Shannon's diversity index values obtained for different sites was found to be moderate to low when compared to reported values of 3.6 to 5.4 for tropical forests (Knight, 1975) and is nearer to the range (2.557 to 3.375) reported for Permanent Preservation Plots at Western Ghats of Karnataka (Karthik, 2009) and 2.31 to 3.30 for the Western Ghats of Southern Karnataka (Sarkar *et al.,* 2011).

Simpson's index: It is also called concentration of dominance; it was calculated by following formula: $D = \sum_{i=1}^{s}(\pi)^2$

210. Where, π is proportion of important value of the i[th] species ($\pi = n_i/N$, ni is the important value index of i [th] species and N is the important value index of all the species). It is noteworthy that 0 ≤ D ≤ 1, with values near zero corresponding to highly diverse or heterogeneous ecosystems and values near one corresponding to more homogenous ecosystems. Lower Simpon's values are an indicator of higher diversity. The calculated Simpson's index indicated that the shrub diversity was more compared to trees and herbs (**Table 77**).

Table 77: Simpson's Index

S. N.	Flora	Simpson's Index
1	Tree	0.06
2	Shrub	0.05
3	Herb	0.08

Source: Biodiversity Study conducted by ICT Pvt. Ltd

b. Faunal Composition

211. Primary data on the fauna was collected along proposed project road. In each plot, faunal species were identified based on direct sightings and indirect evidences such as call, foot prints if any, nesting etc. Based on the identification; scientific name, common name and individual numbers were recorded for further analysis.

212. Total **47 faunal** species were identified out of which 16 bird species, 29 insects, 1(one) reptile and 1(one) mammal were observed (Plate 4).The status of fauna is provided as per Schedule list of Wildlife Protection Act and IUCN redlist category is presented in **Table 78.**

Table 78: List of Fauna Species identified in the Project Area

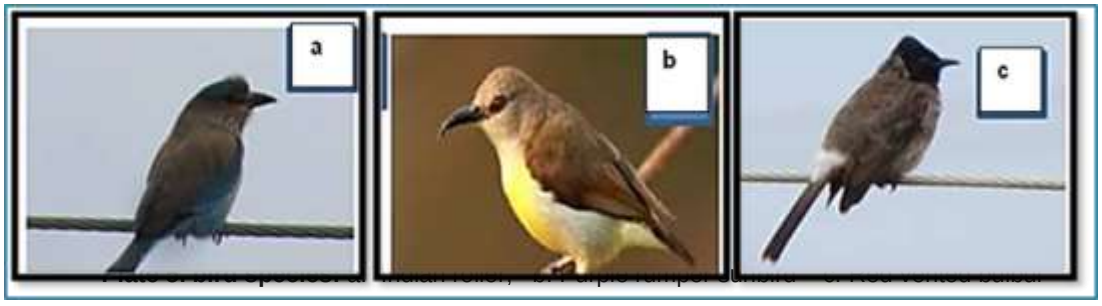
SN	Species Name	Common Name	IWPA Schedule	IUCN Redlist
Mammals				
1.	Bonnet macaque	*Macaca radiata*	Schedule II	Least Concern
Reptile				
2.	Garden lizard	*Calotes versicolour*	NA	Least Concern
Birds				
3.	Ashy drango	*Dicrurus leucophaeus*	Schedule IV	Least Concern
4.	Asian brown flycatcher	*Muscicapa davurica*	Schedule IV	Least Concern
5.	Asian palm swift	*Cypsiurus balasiensis*	Schedule IV	Least Concern
6.	Button quail	*Turnix suscitator*	Schedule IV	Least Concern
7.	Common hoopoe	*Upupa epops*	Schedule IV	Least Concern
8.	Indian roller	*Coracias benghalensis*	Schedule IV	Least Concern
9.	Jungle babler	*Turdoides striatus*	Schedule IV	Least Concern
10.	Oriental turtle dove	*Streptopelia orientalis*	Schedule IV	Least Concern
11.	Pied bushchat	*Saxicola caprata*	Schedule IV	Least Concern
12.	Purple rumper sunbird	*Nectarinia zeylonica*	Schedule IV	Least Concern
13.	Red vented bulbul	*Pycnonotus cafer*	Schedule IV	Least Concern
14.	Red wattled lapwing	*Vanellus indicus*	Schedule IV	Least Concern
15.	Shikra	*Accipiter badius*	Schedule I	Least Concern
16.	Spotted owlet	*Athene brama*	Schedule IV	NE
17.	Thick billed flowerpecker	*Dicaeum agile*	Schedule IV	Least Concern
18.	White cheeked barbet	*Megalaima viridis*	Schedule IV	Least Concern
Insects				
19.	Angled castor	*Ariadne ariadne*	NA	NE
20.	Carpenter bee	*Xylocopa Violacea*	NA	NE
21.	Chocolate pansy	*Junonia iphita*	NA	NE

SN	Species Name	Common Name	IWPA Schedule	IUCN Redlist
22.	Common emigrants	*Catopsilia pomona*	NA	NE
23.	Common evening brown	*Melanitis zitenius*	NA	NE
24.	Common four ring	*Ypthima huebneri*	NA	NE
25.	Common indian crow	*Euploea core*	NA	NE
26.	Common jay	*Graphium doson*	NA	NE
27.	Common jezebel	*Delias eucharis*	NA	NE
28.	Common leopard	*Phalanta Phalanta*	NA	NE
29.	Common pierrot	*Castalius rosimon*	NA	NE
30.	Common tree brown	*Lethe rohria*	NA	NE
31.	Crimson rose	*Atrophaneura hector*	NA	NE
32.	Damson fly	*Ischnura hecterostica*	NA	NE
33.	Dandaid eggfly	*Hypolimnas misippus*	NA	NE
34.	Dark blue tiger	*Tirumala septentrionis*	NA	NE
35.	Dark grass blue	*Zizeeria krsamdra*	NA	NE
36.	Dragon fly	*Sympetrum flavolum*	NA	NE
37.	Fulvouspied flat	*Psuedocoladenia dan*	NA	NE
38.	Grasss jewel	*Freyeria trochylus*	NA	NE
39.	Lemon pansy	*Junonia lemonias*	NA	NE
40.	Lime butterfly	*Papilio demoleus*	NA	NE
41.	Nigger	*Orsotrioena medus*	NA	NE
42.	Painted lady	*Vanessa cardui*	NA	NE
43.	Paris peacock	*Papillio paris*	NA	NE
44.	Plain tiger	*Danaus chrysippus*	NA	NE
45.	Small grassyellow	*Eurema brigitta*	NA	NE
46.	White orange tip	*Ixias marianne*	NA	NE
47.	Yellow orange tip	*Ixias pyrene*	NA	NE

Source: Biodiversity Study conducted by ICT Pvt. Ltd.

NA- Not Applicable under Wildlife Schedule according to Wildlife Protection Act 1972

NE- Not Evaluated as per the IUCN Red List of Threatened Species



213. ***Accipiter badius* (Shikra) is Schedule I** species as per Wildlife Protection Act, 1972. Schedule I species are provided absolute protection –offence under these are prescribed the highest penalities. According to IUCN Global Conservation status both the species are under Least Concern (LC) category in the redlist. This species have an extremely large range, and hence does not approach the thresholds for vulnerable under the range size criterion. The population trend appears to be stable; globally there are no major threats to this species. No threatened species reported as per IUCN Red list.

214. **Analysis of Primary Data:** Relative Frequency (RF), Relative density (Rd), Importance value index (IVI) and Abundance for overall faunal species were calculated and provided in

Table-A.4.7.4 of Annex 4.7. In the present investigation, among the faunal diversity, the bird species were abundant. Shannon and Simpson index is given in the **Table 79**.

Table 79: Shannon and Simpson Index

Shannon's Diversity Index	Simpson's Index
2.61	0.08

Source: Biodiversity Study conducted by ICT Pvt. Ltd.

5. Protected Areas

215. The project road does not traverse through any National Park, Wildlife Sanctuary or Biosphere Reserve. However Malai Mahadeshwara Wildlife Sanctuary (1.4 km), Cauvery Wildlife sanctuary (4.5 km) and Biligiri Rangaswamy Temple (BRT) Wildlife Sanctuary (700 m) falls within 10 km radius of the project road, therefore the project falls in Eco-sensitive zones of the sanctuaries. The location of the protected areas and the project road is shown in **Figure 17.**

a. Malai Mahadeshwara Wildlife Sanctuary (MM WLS)

216. Malai Mahadeshwara Wildlife Sanctuary was notified under Wildlife Protection Act**,** 1972 and Amendment 2006, vide FEE/90/FWL/2013 dated 07-05-2013, covering an area of 906.187 sq.km.

View of Malai Mahadeshwara WLS

217. Sri Mahadeshwara temple is located on the Malai Mahadeshwara Hills is very famous and sacred. It is an important pilgrimage place situated about 80 Km from Kollegal town and attracts pilgrims from all over South India. The forests are inhabited by a variety of animals, birds and reptiles. Elephants (*Elephas maximus*), are the most prominent species. Other species found are of Guar (Indian bison), Sambar, Spotted Deer, Jackal, Sloth Bear, Porcupine, Tiger, Leopard and Wild Dogs.

218. Soligas and Lingayats are the dominant communities in the MM Hills. These forest dwelling communities depend on Forest for supplementary food, especially during droughts and in the shortfall of agriculture produce.

b. Cauvery Wildlife Sanctuary (CWS)

219. Cauvery Wildlife sanctuary was declared vide G.O.No.AHFF/4/FWL/87 dated 14-01-1987, covering an area of 1027.530 sq.km across the Chamrajnagar, Mandya and Ramanagara districts of Karnataka. The Cauvery Wildlife Sanctuary located on the banks of the river Cauvery running through as distance of 101 km forms a part of Eastern Ghats.River. The area is highly undulating. The lowest point being the river Cauvery at Hogenakal with an altitude of 254 m above MSL and the highest point is "Ponnachi Betta" with an altitude of 1514 m above MSL in the middle of the Sanctuary.

View of River Cauvery inside Wildlife Sanctuary

220. The sanctuary of harbours variety of faunal life, about 22 species of large mammals and 10 species of reptiles and 41 species of birds (over 280 bird species listed in recent survey, 2014). Fauna classified under schedule I of Wildlife Protection Act namely Indian Elephant (*Elephas maximus*), Gaur (*Bos gaurus)*, Leopard (*Panthera pardus*), Four horned antelope (*Tetracerus quadricornis*), Mouse deer (*Tragulus kanchil*) etc. are found. Spotted deer (*Axis axis*), Sambar (*Cervus unicolor*), Barking Deer *Muntiacus muntjak*) are found in large number.

221. Cauvery is a perennial river, making it an important ecosystem for aquatic fauna, predominant species being Crocodile (*Crocodylus palustris*) found in Schedule I of Wildlife Protection Act, Otters *(Lutra lutra)* and Masheer Fish (*Tor putitora*). There are many tanks and checkdams created inside the sanctuary which are mostly seasonal and act as water sources for faunal population of the sanctuary. A dam built across erakyam halla near Gopinatham village is a major source of water

222. There are a number of low hills, rocky knobs and out crops of rocks along the length of the river Cauvery, also has several waterfalls along its stretch. The central and eastern parts of the sanctuary are well forested, Hogenakal falls (Smoking rock in Kannada), Mekedatu (Goats leap), Sangam (The point where the Arkavathi river joins the Cauvery) and Muthathi (The religious place where lord Anjaneya temple is situated) are of cultural, historical and tourist interest.

223. There are eight enclosure villages inside the Sanctuary, and 30 villages are within 5kms radius of the Sanctuary. activities. Problem of man and animal conflict has arisen along the boundary areas of the sanctuary where it is abutted by agricultural fields. Wild animals like elephants and wild boar usually raid the field crops thus destroying the only source of food of villagers. Steps have to be taken up by the authorities to lessen the crop raides by the wild animals. The people are employed for fire protection as well as forestry works within the Sanctuary. For the welfare of the tribes eco development committees have been formed to carry out the forestry operations by involving them in eco-development program.

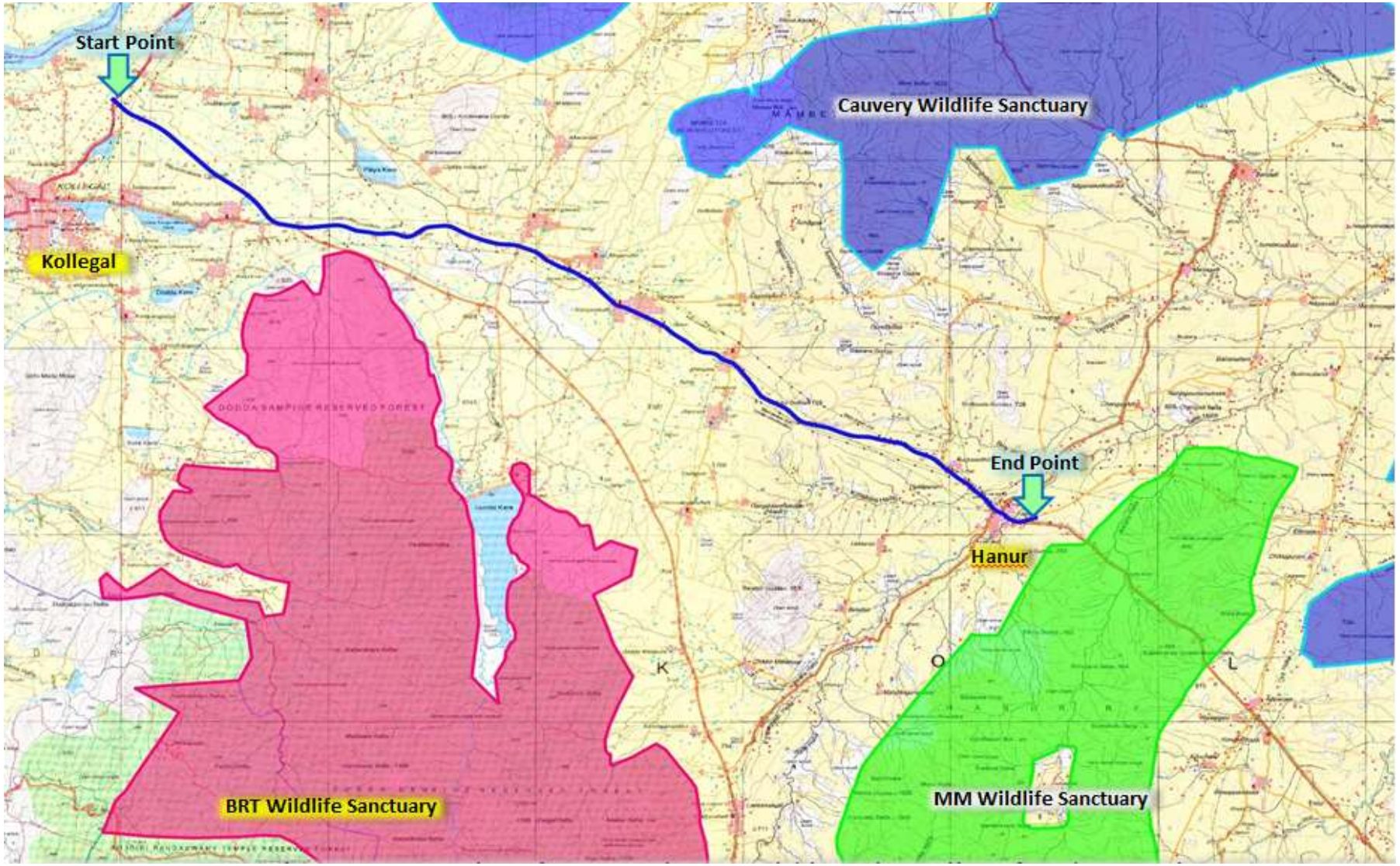


Figure 18: Locations of Protected Areas within 15 km radius of the Project Road

c. BRT Wildlife Sanctuary & Tiger Reserve

224. The Biligiri Rangaswamy Temple (BRT) Wildlife sanctuary was notified under WLP Act, 1972, dated 14-01-1987, covering an area of 539.520 sq.km in Chamarajanagar district and is spread across the three taluks of Yelandur, Kollegal, and Chamarajanagar. The sanctuary has been recognized as Tiger Reserve in 2011. The sanctuary derives its name "BILIGIRI" from the white rocky cliff over which on the tabletop is a temple of the Lord Vishnu locally known as Rangaswamy.

225. The sanctuary, ~35 km long north-south and ~15 km wide east-west forms a connecting link between with Eastern Ghats and Western Ghats, allowing animals to move between them and facilitating gene flow between populations of species in these areas. The sanctuary serves as an important biological bridge for the biota of the entire Deccan plateau. Thus, the biota of BRT sanctuary can be expected to be predominantly of Western Ghats in nature with significant proportion of eastern elements as well.

226. The hill ranges, within the sanctuary raise as high as 1200 m above the basal plateau of 600 m and run north-south in two ridges. The wide range of climatic conditions along with the altitude variations within the small area of the sanctuary have translated it into a highly heterogeneous mosaic of habitats such that we find almost all major forest vegetation types - scrub, deciduous, riparian, evergreen, sholas and grasslands.

227. The most conspicuous mammals in the BR Hills are the herds of Wild Elephants, other mammals include tiger, leopard, wild dog, jungle cat, sloth bear, civets, mongooses, Malabar giant squirrel, giant flying squirrel, porcupine, common langur, bonnet macaque, wild pig, gaur, sambar, spotted deer, barking deer, four horned antelope, etc

228. The Soligas are forest tribe inhabiting the Biligiri Rangana (BR) Hills and other hilly parts of Chamarajanagar district. The forest is the source of livelihood for them. .

6. Forests

229. The project road does not pass through any Reserved Forest. However, the forest types located within 15 km radius of the project road is described as under:

230. The Forests of Kollegal have diversity in their species composition as well as forest types, mainly due to change in altitude from place to place. The following forest types are present in the area:

i. Thorn Scrub
ii. Dry Deciduous
iii. Tropical Moist Deciduous
iv. The Bamboo type forests and
v. The Evergreen Shola

231. Thorn Scrub forests are found in areas of relatively lower elevation. The common species occurring are Albizia amara, Acacia leucophloea, Zizyphus sps, Chloroxylon swietenia, Azadirachta indica, Tamarindus indica, Vitex altissima, Phyllanthus emblica , Acacia sundre, Anogeissus latifolia, Sapindus emarginatus, Wrightia tinctoria and Terminalia chebula

232. Dry Deciduous type**:** includes two type of forests

a) **Hardwickia type:** The most dominant species in this type of forest is *Hardwickia binata*, locally called Karachi or Kamara. This occurs in areas with elevation below 2500 feet. The main associates are *Anogeissus latifolia, Boswellia serrata*, *Chloroxylon swietenia,* and *Dendrocalamus strictus*

b) **Dry Mixed type:** The main species found in this type of forest are *Acacia leucophloea, Acacia sundra, Albizia lebbeck, Albizia amara, Albizia odorotissima, Anogeissus latifolia, Chloroxylon swietenia, Elaeodendron glaucum, Limonia acidissima, Gmelina arborea, Holoptelea integrifolia, Pongamia pinnata, Pterocarpus marsupium, Santalum album* and *Vitex altissima.* The species found along the streams are *Terminalia arjuna, Tamarindus indica, Pongamia glabra, Vitex altissima, Syzygium cumini* and Ficus *sps*.

233. Tropical Moist Deciduous forests are usually found above an altitude of 900 meters, in areas of M.M.Hills. The most common species are *Pterocarpus marsupium, Tectona grandis*, *Terminalia sps, Mangifera indica* and *Dalbergia latifolia.*

234. M.M.Hills Wildlife Range and Hanur Wildlife Range constitute the bamboo type forests. The main species are *Dendrocalamus strictus* and *Bambusa arundinacea. Dendrocalamus strictus* (Medar bamboo) is widely distributed throughout the division

235. Evergreen Shola are found in the M.M.Hills reserved forests. The Shola forests are surrounded by *Lantana* and grasses and are very vulnerable to fire hazards. The list of flora provided by Forest Department is given in **Annex 4.8 (Table – A.4.8.1)**

236. As per Forest Working Plan of Kollegal Forest division Elephant (*Elephas maximus*) and Tiger *(Panthera tigris*) are important fauna of the region, other commonly found wildlife are *Panthera pardus* (Leopard), *Hyaena hyaena* (Stripped Hyaena), *Canis aurens* (Jackal), *Canis lupus* (Wolf), *Hystrix indica* (Porcupine), *Herpestes edwardsi* (Common mangoose), *Lepus nigricollis* (Indian Hare), *Sus scrofa* (Wild Boar), *Manis crassicaudata* (Pangolin)*, Cervus unicolour* (Sambar), *Bos gaurus* (Gaur) *etc*. The list of wildlife provided by Forest Department is given in **Annex 4.8 (Table – A.4.8.2)**

237. During Public consultation in the project area the locals informed that Elephant, Panther, deer and wild boars were observed occasionally in the project areas and they damage crops sometimes.

O. Educational, Medical and Religious Properties

238. ***Educational Institutions:*** 29 educational institutions are located on either side of the project road; out of which, 14 are located on the right side and 15 are located on the left side of the project road. Chainage wise list of educational institutions along with distance from the center line of the project road are given in **Table 80**.

Table 80 List of Educational Institutions along the Project Road

S. N.	Description	Village	Existing Ch. km	Design Ch. Km	Side	Distance# (m)
1.	Jss Mahila College Kollegal	Kollegal	61+650	*	RHS	107.11
2.	St. Francis Assissi High School	Kollegal	61+700	*	LHS	29.10
3.	FMM Sisters Assumption Convent	Kollegal	61+780	*	LHS	46.20
4.	RC Mission Higher Primary School	Kollegal	61+850	*	LHS	15.47

S. N.	Description	Village	Existing Ch. km	Design Ch. Km	Side	Distance# (m)
5.	Seventh-Day Adventist Hostel For Boys And Girls	Kollegal	62+400	*	LHS	116.74
6.	Seventh-Day Adventist School For Speech & Hearing Impaired	Kollegal	62+560	*	LHS	54.67
7.	Urdu Primary School	Madhuvinahalli	65+785	*	RHS	20.68
8.	Govt. Primary School	Madhuvinahalli	65+750	*	RHS	4.51
9.	Govt. Higher Primary School	Madhuvinahalli	65+800	*	RHS	6.34
10	Govt. Lower Primary School	Madhuvinahalli	66+050	*	LHS	17.16
11	Govt. High School	Madhuvinahalli	66+500	*	RHS	115.16
12	Govt. High School	Doddinduvadi	72+500	72+500	LHS	213.98
13	Govt. High School	Singanallur	73+400	*	LHS	73.78
14	Govt. Degree College for Giirls	Singanallur	74+200	74+155	RHS	22.46
15	Jagat Guru Sri Sukumar Swami High School	Kamagere	74+700	74+665	RHS	12.07
16	Govt. Higher Primary School	Kamagere	74+875	74+840	RHS	11.10
17	Aided Mission Higher Primary School	Kamagere	75+600	75+565	RHS	25.00
18	Seventh Day Advantist Higher Primary School	Konagarahalli	75+860	75+820	RHS	30.57
19	Holy Cross Hospital And School of Nursing	Konagarahalli	76+000	75+950	RHS	16.51
20	St. Francis Xavier School	Konagarahalli	76+020	75+970	LHS	13.55
21	Myrada Davinson Training Centre	Manglam	76+644	76+600	LHS	76.72
22	St. Margaret's Girls Composite PU College	Manglam	76+700	76+680	LHS	181.65
23	Govt. High School	Manglam	77+300	77+300	LHS	11.10
24	Govt. Higher Primary School	Manglam	77+530	77+490	LHS	12.00
25	Hostel	Manglam	80+560	80+500	LHS	32.00
26	GV Gouda College	Hullepuram	83+400	83+360	RHS	15.00
27	College Hall	Hullepuram	83+665	83+625	RHS	12.64
28	Sri Vivekananda School	Hullepuram	83+860	83+800	RHS	55.86
29	Govt. Model Higher Primary School	Hanur	85+050	85+000	LHS	12.40

(*Source: Field Survey conducted by ICT Pvt. Ltd.*)

Distance in meter from existing centerline; * bypass / realignment proposed

Jagat Guru Sri Sukumar Swami High School at Ch. Km 74+700 on RHS (Kamagere Village)

Govt. Higher Primary School School at Ch. Km 77+530 on LHS (Manglam Village)

St. Francis Church at Ch. Km 76+000 on LHS (Konagarahalli Village)

Aiyappa Swamy Temple at Ch. Km 84+330 on LHS (Hannur)

239. ***Religious Places:*** 21 religious places are located on either side of the project road, out of which 8 religious places are located on the right side and 13 are located on the left side of the project road. Chainage wise list of religious places along with distance from the center line of the project road are given in **Table 81**.

Table 81: List of Religious Places along the Project Road

S. N.	Description	Village	Existing Ch. km	Design Ch. Km	Side	Distance# (m)
1.	Ebenezerhall Church	Kollegal	61+500	*	LHS	7.29
2.	Brhmeshwara Temple	Siddaiahanpura	63+380	*	RHS	17.66
3.	Nag Dev Temple	Madhuvinahalli	64+935	*	RHS	5.39
4.	Mosque	Madhuvinahalli	65+670	*	LHS	11.01
5.	Temple	Madhuvinahalli	65+790	*	RHS	76.36
6.	Male Mahadeshwara Temple Kurju	Madhuvinahalli	65+785	*	LHS	16.83
7.	Male Mahadeshwara Temple	Madhuvinahalli	65+770	*	LHS	29.20
8.	Sri Satyanarayan Temple	Madhuvinahalli	66+340	*	RHS	13.75
9.	Mahadeswara Davesthanam	Haruvanapuram	69+485	69+485	LHS	21.57
10.	Sri Katavaspeswara Temple	Singanallur	73+350		LHS	52.09
11.	Dadam Tai Temple	Kamagere	74+930	74+900	RHS	18.00
12.	Epiphany Luthran Church	Kamagere	75+365	75+330	LHS	11.00
13.	Brethren Assembly	Kamagere	75+550	75+515	RHS	24.00
14.	Sda Church- Kamagere	Konagarahalli	75+885	75+845	RHS	31.66
15.	St. Francis Church	Konagarahalli	76+000	75+950	LHS	13.00
16.	Idgah	Manglam	77+460	77+420	RHS	60.59
17.	Idgah	Hullepuram	83+240	83+200	LHS	74.97
18.	Mahadeswara Temple	Hullepuram	83+340	83+300	LHS	29.32
19.	Mini Worship Place	Hullepuram	83+340	83+300	LHS	12.00
20.	Idgah	Hanur	84+200	84+160	LHS	25.23
21.	Aiyappa Swamy Temple	Hanur	84+330	84+290	LHS	11.00

(*Source: Field Survey conducted by ICT Pvt. Ltd.*)

Distance in meter from existing centerline, * bypass / realignment proposed

240. ***Medical Facilities:*** There are 2 primary health centres, 1 hospital and 1 veterinary hospital along the project road; out of which 3 are located on the right side and remaining 1 is located on the left side of the project road. Chainage wise list of medical facilities along with distance from the center line of the project road are given in **Table 82.**

Table 82 List of Medical Facilities along the Project Road

S. N.	Description	Village	Existing Ch. km	Design Ch. Km	Side	Distance# (m)
1.	Primary Health Centre	Madhuvinahalli	65+750	*	RHS	31.85
2.	Primary Health Centre	Kamagere	74+800	74+765	RHS	11.25
3.	Veterinary Hospital	Kamagere	74+910	74+875	LHS	10.00
4.	Govt. Hospital	Hanur	84+850	84+800	RHS	16.64

(*Source: Field Survey conducted by ICT Pvt. Ltd.*)

Distance in meter from existing centerline, * bypass / realignment proposed

Primary Health Centre at Ch. Km 74+800 on RHS (Kamagere)

Govt. Hospital at Ch. Km 84+850 on RHS (Hannur)

P. Archaeological sites

241. There are no archaeological sites within 300 m on either side of the project road.

Q. Demographic Details of Affected Population

1. Total Affected Households

242. As detailed in **Table 83** below, 448 households are likely to be affected due to the project. As per the census survey, 153 structures households, 209 land owners households, 78 tenants and 8 employees households will be losing their livelihood under the proposed widening of the road.

Table 83: Number of Affected Households

Sl.No.	Type of Households	Number of Households	Number of Families*
1	Structure Owners	153	311
2	Tenants	78	137
3	Employees	8	9
4	Land Owners	209	403
	Total	**448**	**860**

*Source: Census Survey 2015-1; *Family as defined in RFCTLARRA, 2013.*

2. Number of Affected Persons (APs)

243. As detailed in **Table 84** below, 1831 APs will be affected due to the loss of land, structures and assets and income, which includes 53.52% males and 46.48% females. The average household size is 4.1 and the sex ratio amongst the APs is 868.

Table 84 Number of Affected Persons

Sl. No.	Categories of APs	Number of Affected Persons	Percentage (%)
1	Male	980	53.52
2	Female	851	46.48
	Total	**1,831**	**100**

Source: Census Survey 2015-16

3. Religious Category

244. Social customs and traditions play a major role in determining the socio-economic development as well as occupational pattern. The majority of the PAHs belong to the Hindu religion (92.63%), 2.01% are Christians and 1.56% are Muslims. However, nearly 3.79% of households did not respond to the question related to religion. The trend shows that Hindu communities dominate the project road. **Table 85** delineates the religious categories of the affected households.

Table 85 Religious Categories of PAHs along the Project Road

Sl. No.	Religious Group	No. of Households	Percentage (%)
1	Hindu	415	92.63
2	Christian	9	2.01
3	Muslim	7	1.56
4	NA/NR	17	3.8
	Total	**448**	**100**

Source: Census Survey, 2015-16

4. Social Categories

245. As per the census survey of all of the 448 affected households, the social stratification of the project area shows that 24.11% are from general category, 56.47 % are from other backward class (OBC), 15.85 % are from scheduled caste (SC) and 1.34 % are from scheduled tribe (ST) category. The details of social categories in the project area are presented in **Table 86**.

Table 86 Social Categories of the PAHs

Sl. No.	Type of Social Category	No. of Households	Percentage (%)
1	General	108	24.11
2	Other Backward Class	253	56.47
3	Scheduled Caste	71	15.85
4	Scheduled Tribe	6	1.34
5	NA/NR	10	2.23
	Total	**448**	**100**

Source: Census Survey 2015-16

5. Annual Income

246. The census data revealed that 25 affected households (5.58 %) earn income that is up to Rs. 30,000. Most households (45.54 %) earn above Rs.100,000 annually, while 21.88 %

households did not respond. The average income level of households is summarized in **Table 87**.

Table 87: Annual Income Level of the Affected Households

Sl. No.	Annual Income	No. of Households	%
1	24001-30000	25	5.58
2	30001 to 40000	25	5.58
3	40001 to 50000	17	3.79
4	50001 to 60000	19	4.24
5	60001 to 70000	5	1.12
6	70001 to 80000	32	7.14
7	80001 to 90000	12	2.68
8	90001 to 100000	11	2.46
9	Above 100000	204	45.54
10	NA/NR	98	21.88
Total		**448**	**100**

Source: Census Survey 2015-16

6. Educational Status

247. A significant percentage of the head of affected households (29.46%) are illiterate, 6.47% are up to middle school, 7.81% are below matric, 15.63% APs are Matric (10th standard), 12.05% are educated up to graduate level as summarized in **Table 88.**

Table 88: Educational Status of Affected Population

Sl. No.	Type of Educational Category	No. of Head of Household	Percentage
1	Illiterate	132	29.46
2	Litterate	22	4.91
3	Up to middle (7th standard)	29	6.47
4	Below Matric (Below 10th standard)	35	7.81
5	Matric (10th standard)	70	15.63
6	Up to graduate	54	12.05
7	Above Graduate	33	7.37
7	NA/NR	73	16.3
Total		**448**	**100**

Source: Census Survey 2015-16

7. Occupational Status

248. The findings of census survey revealed that out of 448 affected households, 29.91% households are engaged in agriculture, 2.46% are agriculture labour, 6.92% are daily wage earner, and 32.37% households are carrying out businesses as their main occupation. The details of occupational status of affected households are summarized in **Table 89.**

Table 89 Occupational Status of Affected Households

Sl. No.	Occupation	No. of Households	Percentage
1	Agriculture	134	29.91
2	Agriculture Labour	11	2.46
3	Daily Wage Earner & Labour	31	6.92
4	Private Employee	20	4.46
5	Rural Artisan	1	0.22
6	Service	19	4.24

Sl. No.	Occupation	No. of Households	Percentage
7	Unemployed	12	2.68
8	Business	145	32.37
9	NA	75	16.74
Total		**448**	**100**

Source: Census Survey 2015-16

8. Women Headed Households

249. Out of 448 affected households, there are 41 women headed households. From the field notes it is found that these households are characterized by higher number of dependents and the economic standing is also poor.

Table 90: Number of Women Headed Households

Sl. No.	Properties	No. of Women Headed Household	Percentage (%)
1	Land	26	86.36
2	Structure	15	13.64
	Total	**41**	**100**

Source: Socio Economic Survey, 2015-16

V. ANALYSIS OF ALTERNATIVES

A. General

250. In the present chapter, development study of existing road (SH-79) has been considered for the improvement keeping in mind the environmental aspects associated. The analysis of alternatives has been carried out 'with the project' and 'without the project' scenarios in terms of potential environmental impacts. Further, analysis of alternatives have been done for realignments to avoid the places of congestion, human settlements, environmentally sensitive areas keeping in view traffic condition, obligatory points, geometric designs, congestions and socio economic viability and other environmental aspects of the region.

251. One bypass & two realignments have been proposed in this section of SH-79 with a total length of 7.290km. The details of the proposed major realignment are tabulated below:

Table 91 List of Bypass and Realignment of SH-79

Sl. No.	Name of Town/Village	Chainage along Existing Alignment (km)			Chainage along Bypass/Realignment (km)		
		Start	End	Length	Start	End	Length
Bypass							
1	Kollegal & Madhuvanahalli	61+450	66+888	5.438	0+000	4+900	4.900
Realignment							
1	MJB @ 69+900	68+930	70+190	1.260	68+920	70+200	1.280
2	Singanallur	72+540	73+700	1.160	72+550	73+660	1.110

252. The study and analysis has been based upon Google Aerial view and ground verification of the possible alignments. A 2-lane highway with 7 m wide carriageway, 1.5 m wide paved shoulder and 1.0 m granular shoulder on both sides with proposed ROW of minimum 26 m has been proposed for all the realignments.

B. "With" and "Without" Project Scenarion

253. The proposed project Road forms interstate connectivity and improvement proposal may facilitate increased cross interstate traffic movement as project road connects Tamil Nadu border in Palar.

254. The project road in west at start point further connects prominent cities via a network of State Highways and National highways which include Bengaluru (via NH 209 and also an alternate route via SH 33 and NH 275), Mysuru, Chamrajnagara and also to various towns of Kerala State. The Project road connects NH-209 which in turn connects NH-212 and SH-38. Project road beyond end point in Palar is connected to a network of various National and State Highways, connecting Mettur, Dharmpuri,, Salem, Hosur and also Bengaluru which are also prominent business centres.

255. Project road also forms important connectivity to various tourist destinations within the region and along the project road including, Hoganakkal Falls, Gaganachukki and Bharachukki Falls, BR Hills, Talakadu and many other in the region. The proposed improvement proposal for the project road would benefit and improve network mobility in the region.

256. Further, the State Government has proposed to boost tourism in the Cauvery basin and the coastal region of the State. The government has decided to constitute a Cauvery River Tourism Development Authority (CRTDA) to develop tourism-related infrastructure in Mandya, Mysore, Chamarajanagar and Kodagu districts. The proposed CRTDA will be tasked with developing tourism from Bhagamandala in Kodagu to Hogenakkal Falls, along the path of the Cauvery. The development authority will provide accommodation for tourists in Talakad, showcase silk products in Kollegal, illuminate Srirangapatna Fort, and install sound and lighting in Gaganachukki and Bharachukki Falls of Mandya district.[2]

257. The project road is located in Chamarajanagar district and one of the major tourist attractions in this region is Hogenekkal Falls which is very close to the project road. Connectivity to this location through the project road is proposed to be improved. Also the plan to showcase silk products in Kollegal may attract tourism in the PIA leading to additional developmental traffic along entire length of the project road.

258. Keeping this in view, the site conditions and the scope of development of the area, the 'with' and 'without' project scenarios have been compared as shown in **Table 92**. By looking at the table it can be concluded that "with" Project Scenario, with positive / beneficial impacts will greatly enhance social & economic development of the region and improve the environment, when compared to the "without" project scenario, which will further deteriorate the existing environment and quality of life. Hence the "With" project scenario with some reversible impacts is an acceptable option rather than the "Without" project scenario. The implementation of the project therefore will definitely be advantageous to improve the environmental quality of the sub-region besides to achieve an all-round development of the economy and progress of the region.

259. If the project is not implemented, the existing bad pavement of the corridor will deteriorate further. Increased air pollution, due to bad road condition, slow moving traffic and congestion will increase. Noise levels will rise due to deterioration of the pavement as well as increased honking. Without the improvement, the traffic would continue to pose a safety risk for the road users. There is little increase in the pollution levels during construction. Dust and particulate matter during construction will affect the air quality on a short-term basis. However, Potential benefits of the proposed road improvements are substantial and far reaching both in terms of the geographical spread and time.

260. Implementation of the project will be a definite advantage to Karnataka State in order to achieve all-round development of its economy and progress for its people. It will provide mitigation not only for air & noise level but will also provide other appropriate mitigative measures such as roadside plantation, arboriculture & landscaping and other short term reversible negative impact on environment.

Table 92 :"With" and "Without" Project Scenario

With Project		**Without Project**	
Impacts		**Impacts**	
Positive	**Negatives**	**Positive**	**Negative**
• With the improvement of road surface, the traffic congestion due to obstructed movement of vehicles will be minimized and thus wastage of fuel and	• Minor changes in land use pattern • Loss of some properties and livelihood	Nil	• Increase in travel time • Increase in fuel consumptions • Increase in dust pollution & vehicular emission

[2] The Hindu-National – Karnataka, July 13, 2014

With Project		Without Project	
Impacts		Impacts	
Positive	**Negatives**	**Positive**	**Negative**
emissions from the vehicles will be reduced reducing air pollution • Improvement in ecology through road side plantation • Enhanced trade and commerce. • The dust clouds associated with vehicles movement on tracks/earth roads will also be eliminated. • Providing better level of service in terms of improved riding quality and smooth traffic flow. • Reduction in accident rate • Reduced transportation costs and increased access to markets • Access to new employment opportunities • Employment to local workers during the execution of the project • Better access to health care centers and other social services • Improved quality of life • Strengthening of local economies and local industries.	• Removal of vegetative cover along the road • Increase in air pollution due to increased vehicular traffic • Short term increase in dust due to earth work during construction at micro-level • Increase in noise pollution during construction phase		• Increase in accident rate • Overall economy of the State will be affected. • Further deterioration of the project road • Increased vehicle operation cost • Reduced employment/ economic opportunities • Arrest of possible significant enhancement and economic development of the region • Land degradation, dust pollution and damage to agricultural land, contamination in water bodies due to vehicles traveling along multiple tracks on the open ground • In absence of the project, it will be difficult for the state to finance such a massive improvement of the road infrastructure from its own resources.

C. Analysis of Alternatives

1. Combined Bypass for Kollegal and Madhuvanahalli

261. Stat of project road was proposed from the existing Junction of SH-79 with NH-209 at Kollegal (Km 61+450). As we move towards the TN Border from the junction, there is an existing water body abutting the project road from Km. 61+700 up to Km. 64+400. i.e. for a length of 2.7 kms. Apart from this, existing settlement on LHS from Ch. 61+800 to Ch. 61+900 are abutting the project road and connected through service road. The plinth levels of the houses are about 3-4m lower than the existing project road. The Proposed cross sections of 2 lane with paved shoulder is able to be fit into at this location with acquisition of the existing pond by road side with the construction of retaining wall structures on both sides. Impact on pond will not be permitted from environment consideration.

262. There are sharp curves along the project road which do not meet the codal provisions. There is an “S” Bend in the alignment at Ch. 63+400 with curve radius of 40 m and 60 m. From Ch. 64+500 to Ch. 66+300 (1.8 kms long), existing alignment passes through the settlement town of Madhuvanhalli. There is a 90° bend at Ch. 65+150 where improvement will be difficult as it has built-up pucca structures mostly commercial and residential on both sides. Apart from above, the existing geometry of the town is not as per guidelines as the radius of existing alignment is as low as 45m. During initial social screening, local people also favoured bypass.

263. NHAI is proposing a new bypass of NH-209 for Kollegal town The bypass starts from the North side of Kollegal town. The approx. location of start of bypass is 731245.86E and 1347631.92N. This proposed bypass intersects SH-79 on the west side of the Kollegal town and ends on the south side of the Kollegal town. Considering the above constraints and the proposed bypass of NH-209 being planned by NHAI, three options for a combined bypass of Kollegal town and Madhuvanhalli settlement have been explored as shown in **Figure 19** and comparison of the three bypass options on various parameters are given in **Table 93.**

- Bypass Option I: Bypass on LHS of existing road
- Bypass Option II: Bypass on RHS of existing road along Kabini Right Bank Canal Bypass Option III: Bypass on RHS of existing road.

Table 93: Comparison of the three bypass options

Factor	Bypass - Option I	Bypass - Option II	Bypass - Option III	Existing Alignment
Bypass Length (Km)	4.900	14.700	12.692	--
Length of corresponding Existing Road to be Bypassed (Km)	5.438	12.296	12.296	5.394
Net Increase in Project Length due to Proposed Bypass (km)	-0.538	2.404	0.396	--
Use of Proposed bypass of NH-209	Yes (5.5kms)	No	No	--
Geometrics	Good	Good, but alignment is on Bank of Kabini Right Bank Canal (KRBC) for a length of 6 km and will cross the canal at 5 to 6 locations	Good, but alignment is on Bank of Kabini Right Bank Canal (KRBC) for a length of 2.5 km.	Poor Geometry, on RHS existing water body for a length of 2.7 km and passing through congested Madhuvanhalli village
Change in Land Use	High	High	High	Low
Impact on Water Bodies	Nil	Nil	Nil	High
Trees to be felled	Low	Low	Low	High
Land Acquisition (Hectare)	14.805	44.1	38.076	6.95
Bridges/ structures.	Nil	10	5	NIL
Junctions	Nil	3	3	1
Length of Safety Measures (Crash Barrier) Required (m)	Nil	5000	5000	4900
Construction Cost (Crs.)	17.09	58.8	44.42	13.48

264. It can be seen from above that Option 1 has better geometry and lesser R&R impact and is well connected with proposed NH-209 bypass. Since in Option I the existing NH-209 bypass is being used the cost of the proposed bypass is much less than the other two bypass options. Option II and option III alignment is on the banks of the Kabini Right Bank Channel (KRBC) for a length of 5 Km. Due to poor geometry of the canal, the proposed alignment will cross the canal at 5 to 6 locations because of which additional structures shall be required.

265. Based on the above consideration **Option I is recommended.**

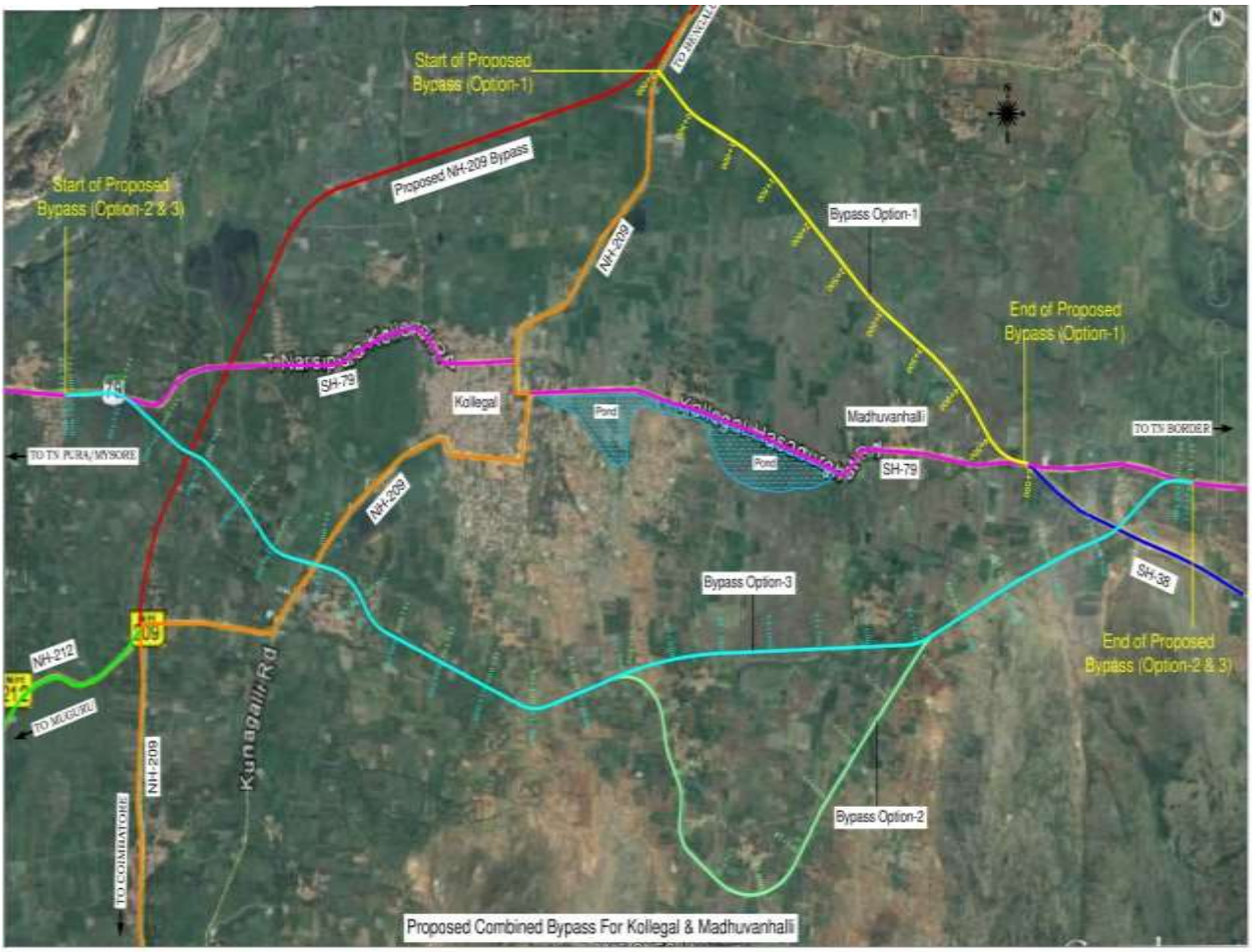


Figure 19: Various Options of Combined Bypass for Kollegal and Madhuvanahalli Bypass

2. Realignment near Major Bridge @ Ch. 69+900

266. Existing bridge at Ch. 69+900 is proposed to be reconstructed due to inadequate hydraulics. Existing Bridge is on S-curve with horizontal curve radii of 100m to 300m and the existing embankment height is about 2.5m. New Bridge is to be constructed parallel to existing road to accommodate traffic management during construction. Hence, to improve safety of the road users, geometric improvement in form of realignment between Km. 68+920 to Km 70+200 is proposed which is designed for a speed of 80kmph. The proposed realignment on google Imagery is shown in **Figure 20.**

Figure 20: Proposed Realignment near Major Bridge @ 69+900

3. Realignment (Singanallur)

267. The project road passes through the settlement area of Singanallur at Ch. 73+300. There is a sharp S Curve along the alignment with a radius of 100m and 170m with a short distance of 23m in between the curves. There are two minor roads connecting the S- Curve length. The improvement of existing alignment was not possible for 50kmph design speed without large scale R&R impact. Further there is no set back distance from properties on the RHS reducing visibility of traffic from other side. It will be a black spot in the project road if not realigned.

268. Thus the section from Ch. 73+200 to Ch. 73+500 has very poor horizontal geometry. Hence, to improve the safety of road users; geometric improvement in form of realignment has been proposed between Ch. 72+550 to Ch. 73+660. Further due to the realignment, the road length has also been reduced by 50m. The proposed realignment on google Imagery is shown in **Figure 21.**

Figure 21: Proposed Singanallur Realignment

VI. ANTICIPATED ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

A. Introduction

269. The proposed project will have impacts on the environment in two distinct phases. During the construction phase which may be regarded as temporary or short-term; the other during the operation stage which will have long term effects. The negative impacts can be reduced or minimized only if proper safeguards are put in place during the design and construction stage itself. These can include reducing pollutant discharge from the harmful activities at source or protecting the sensitive receptor. An effective mitigation strategy will utilize a combination of both options to arrive at practically implementable measures. Conscious efforts have been worked out to minimise any adverse impacts on the various environmental and social components. Where the impacts on various environmental components have been unavoidable, mitigation measures have been worked out.

B. Land Environment

1. Topography & Geology

270. **Construction Phase:** The impacts on existing topographical setting originate primarily from embankment preparation and opening up borrow pits to fulfill the requirement of huge quantity of earth material. Disfiguration of land may result from unplanned opening up of borrow pits / quarry sites. Aggregate and sand will be procured from the authorized suppliers and prevalent rules will be followed for borrowing of soil. Hence the impact on geology of the region is insignificant.

271. **Impacts:**

- Disfiguration & change in existing profile of the land due to realignment
- Disfiguration of topography due to indiscriminate digging of borrow pits
- Uncontrolled digging of borrow pits resulting in water accumulation & breeding of vector disease
- Disturbance on geological setting due to quarrying
- Establishment of Construction Camp

272. ***Seismological Characteristics of the Area:*** The project road is in Zone-II (having low seismic intensity) of the seismic map of India (as per IS:1893, Part-1, 2002), and therefore it will have a low risk of potential damage due to earthquake.

273. ***Road Building Materials:*** During road construction mainly stone aggregates & bitumen will be required for pavement, while stone aggregates, sand & cement will be required for concrete making for rigid pavement, bridges, culverts, urban drains etc. Diesel will be required to run construction equipment. Stone aggregates and sand will be brought from the pre-identified quarry areas. The contractors usually depend on the local commercial suppliers for obtaining various construction materials. Active existing sources are most likely to be used with cost and the quality considerations. The estimated raw materials requirement during construction stage is given in **Table 94**.

Table 94: Raw Materials requirement during Construction

Sl. No.	Item & Unit	Quantity	Mode of Transport	Source
1.	Blue metal (m^3)	1,50,000	Truck	Pre-identified quarry areas
2.	Sand (m^3)	1,00,000	Truck	Pre-identified quarry areas
3.	Cement (MT)	9,200	Truck	Local traders
4.	Bitumen (MT)	5,000	Truck	Refinery
5.	Diesel (liters)	3,000	Tanker	Local petrol pumps
6.	Steel (MT)	1,320	Truck	Local traders
7.	Earth (m^3)*	7,50,000	Truck	Identified Borrow areas / generated from cutting

274. ***Construction of Borrow Areas:*** about **7**,50,000 cubic meter of earth materials is to be used for the project road. This has to be obtained from earth generated through cutting of the road or from the existing borrow areas. Quantity of earth material likely to be generated through cutting operation is 2,20,000 Cum. Therefore, 5,30,000 Cum earth will be required from the borrow area. The details of proposed borrow areas investigated with their respective locations; corresponding chainage and lead from nearest point to project road are tabulated in **Table 95**.

Table 95: Location of Proposed Borrow Areas

S. No.	Chainage of Nearest Point on Project Road (km)	Side	Location / Village Name	Lead From Nearest Point on Project Road (km)	Type of Land	Approx. Quantity (m^3)
1.	30+300	RHS	Hondaaraballa	3.0	Private	500,000
2.	36+100	RHS	Kariyanapura	2.5	Private	2,000,000
3.	39+200	RHS	Kamagere	1.0	Private	150,000
4.	45+500	RHS	Magla	0.5	Private	750,000
5.	48+500	RHS	Changavadi	5.0	Private	300,000
6.	52+300	RHS	Bairanatha	4.3	Private	1,350,000
7.	58+200	RHS	Kenchiah Nodobdi	0.3	Private	500,000
8.	63+400	RHS	Cowdalli	1.0	Private	4,500,000

275. If contractor decides to open new borrow area, Environment Clearance and is to be obtained from concerned authority. Opening of new borrow areas could lead to the formation of large depression. If no proper measures are taken, there could be loss of fertile top soil and loss of agriculture crops.

276. ***Establishment of Crushers:*** Contractor will be required to establish a number of crushers along the project road. It is the responsibility of the contractor to obtain statutory clearance (such as NOC from SPCB etc.) from concerned authorities before start of stone crushing operation. The maintenance and management of access road / haul road could be a major impact. It is appropriate to consider the environmental implications in the selection of crusher areas since poor maintenance may create dust pollution, contribute to noise pollution, water pollution as well as loss of natural resources.

277. **Mitigation Measures:** All construction works are directly related to the land environment. Therefore, contractor needs to prepare / follow several mitigation / management plan / guidelines for various construction activities. These guidelines are listed below and detailed out in “Part-B Annexes of IEE & EMP”.

- Guidelines for Siting and Layout of Construction Camp (Annex-8.2)

- Guidelines for Siting, Operation and Re-Development of Borrow Areas (Annex-8.4)
- Guidelines for Siting, Operation and Re-development of Quarrying and Stone Crushing Operations (Annex-8.5)
- Guidelines for Siting and Management of Debris Disposal Site (Annex-8.7)
- Guidelines for Preparing Comprehensive Waste Management Plan (Annex-8.8)

278. Some of the important provisions are given below:

- Earthquake resistance structures with seismic restrainers are being planned to be constructed under the project. Design of all structures like bridges and CD structures have taken the area's seismic characteristics into account.
- Opening up new borrow pits will be in accordance with the IRC: 10-1961 specifications. Topsoil from the new borrow pits should be preserved and reused in restoring the pits to the satisfaction of the Independent Engineer (IE). Opening up of new borrow pits will be restricted to 1 m depth followed by resurfacing of pits with top soil (15 cm).
- No borrow pits will be allowed in the forest land.
- Uncontrolled digging of borrow pits will be avoided to prevent water accumulation in abandoned pits which results in breeding ground of vector disease.
- Road building materials will be procured from existing approved and licensed quarries only where crusher is already operating. Therefore, mitigative measure for the environmental impacts due to quarrying and rehabilitation plan of the quarries is the responsibility and scope of the licence holder of the quarry.
- On owner's choice, borrow pits will be converted to water bodies (pond) with proper landscaping (i.e. rectangular in shape, proper sloping and plantation on the bank) which will add scenic beauty in those localities.

279. **Operation Phase**: During operation phase of the project road, no impact is anticipated on the topography and geology of the area.

2. Soil

280. **Impacts: Soil Erosion.** Erosion of topsoil can be considered a moderate, direct and long term negative impact resulting from construction and maintenance of the road. Erosion problems may occur on newly constructed slops and fills depending on the soil type, angle of slope, height of slope and climatic factors like wind (direction, speed & frequency) and rain (intensity & duration). In the project road, embankment will be raised for a length of 18.962 km, out of which height of embankment is more than 3.0 m for a length of 0.760 km. Slope protection measures (stone pitching or turfing with Coir Geotextile & Vetiver grasses) form part of good engineering practice and therefore, it has been incorporated into the EMP.

281. **Construction of Bridges & Culverts:** Along the corridor reconstruction / widening of a number of bridges (7 minor bridges) and culverts (56) is planned. Construction of bridges involves excavation for construction of the foundation and piers. If the residual spoil is not properly disposed of, increased sedimentation may take place during the monsoon. During the construction period, some amount of drainage alteration and downstream

282. **Soil Contamination:** Contamination of the soil may take place from the following activities at the construction zones, construction labour camps and other auxiliary facilities

required for the construction. Details of the activities from which contamination may occur are given below:

- Scarified bitumen wastes, excess production of bituminous product
- Debris generation due to dismantling of structures
- Maintenance of the machinery and operation of the diesel pumps, diesel generator sets, diesel storage and during transportation
- Operation of hot mix plant
- Storage and stock yards of bitumen and
- Form various activities in the labour camps

283. **Mitigation Measures:**

- The top soil from all sites including road side widening and working area, cutting areas, quarry sites, borrow areas, construction camps, haul roads in agricultural fields (if any) and areas to be permanently covered shall be stripped to a specified depth of 15 cm and stored in stock piles for reuse. At least 10% of the temporary acquired area shall be earmarked for storing top soil. Contractor has to strictly follow the "Guidelines for Tor Soil Conservation and Reuse" as given in Annex-8.1.
- **Slope Stabilization:** Adequate measures like adequate drainage, embankment consolidation & slope stabilization will be taken along the road to avoid soil erosion. The slopes have been restricted to 1 vertical : 2 horizontal for most of the sections. Soil erosion through embankments will be prevented and controlled by stone pitching or turfing with Coir Geotextile & Vetiver grasses. Bio-engineering is the technique of utilizing vegetation in addressing geotechnical problems. Environmental uncertainties are prompting engineers to favour bioengineering measures. Vegetation as an aid to artificial methods in controlling surficial soil erosion is gaining larger acceptability among engineers all over the world. Growth of appropriate vegetation on exposed soil surface is facilitated by use of natural geotextiles such as Coir Geotextiles. Properly designed Coir Geotextiles lay on slopes or any other exposed soil surface provides a cover over exposed soil lessening the probability of soil detachment and at the same time reduces the velocity of surface runoff, the main agent of soil dissociation. Natural geotextiles bios-degrade quicker than man-made counterpart, but facilitate growth of vegetation quicker and better due to its inherent characteristics. Road slope stabilization can range from allowing native grass (Vetiver grass) to re-establish on a disturbed slope to building an engineered wall. Guideline on Slope Stabilization is given in Annex-8.3A.

284. **Recycling of Bituminous Surface:** Kollegal to Hanur road section of SH-79 road section is designed as two lanes with paved shoulder configuration. Traffic estimated for 20 years design life is only 13 MSA and that for 15 years is 9 MSA which are less than minimum design traffic of 20 MSA specified in the 2-lane manual. Therefore, RAP has been proposed for Kollegal to Hanur Section of SH-79.

285. The bituminous pavement rehabilitation alternatives are mainly overlaying, recycling and construction. In the recycling process the material from deteriorated pavement, known as Reclaimed Asphalt Pavement (RAP), is partially or fully reused in fresh construction. Some of the advantages associated with pavement recycling are:

- Preservation of environment

- Reduction in greenhouse gases emission
- Conservation of energy
- Conservation of fresh aggregates and binder
- Minimization of health hazards
- Minimization of cost of construction
- Preservation of existing pavement geometrics etc.

286. Recycled Asphalt Pavement (RAP) material is found suitable for pavement construction and proposed in this project. Existing bituminous layer will be milled and used in RAP mix comprising 20 -30% of RAP and 70-80% of fresh aggregate depending on the grading. 6,490 Cum of bituminous surface generated from the existing road surface will be utilized. Various methods for recycling of bituminous pavement are given in **Annex-8.3B**.

- **Disposal of Bituminous Waste:** no bituminous waste will be generated for disposal.
- Accidental spills of lubricants / oil and molten asphalt will be avoided by following the "Guideline for Storage, Handling, Use and Emergency Response for Hazardous Substances" as given in Annex-8.11.
- Oil Interceptor shall be provided for wash down, refueling areas and accidental spill of oil and diesel.
- Vehicle parking area of the construction camp will be made impervious using 75 mm thick P.C.C. bed over 150 mm thick rammed brick bats. The ground will be uniformly slopped towards to adjacent edges towards the road. A drain will take all the spilled material to the oil interceptor.

3. Land Use

287. **Construction Phase:** Widening of existing road will lead to change in land use pattern of areas adjacent to the road that comes under the proposed ROW. The existing land adjacent to the road at present is mainly of agricultural use with some roadside residential & commercial plots which will need to be acquired for widening of the road.

288. Preparatory activities like clearing of ROW, construction of temporary construction camps and godowns, storage of construction materials etc. will be confined within the camp & ROW. This will not hamper the land use aspects outside ROW. However, indirectly there may be some change in the land use pattern of the proximate area due to influx of construction work-force and supplier who are likely to construct temporary tents in the vicinity.

289. **Impacts:**

- Loss of agricultural land due to land acquisition for the road
- Changes in existing land use pattern of the ROW for construction of the road

290. **Mitigation Measures:**

- Earth material generated from excavation of roadways & drainage will be reused to the maximum possible extent as filling material during site development.
- The small amount of construction debris and surplus excavated material will be disposed of by mechanical transport in suitable pre-identified (jointly by project proponent & local administration) dumping areas in tune with the local condition to avoid land degradation & water logging due to indiscriminate dumping.
- Identification, operation and redevelopment of dumping areas will be as per the

Guideline provided in Annex-8.7.

- Construction camp will be provided for construction personnel to avoid indiscriminate settlement of construction workers & labourers.
- Regular inspection of haul roads and construction site will be carried out to ensure regular and timely removal of construction debris to the designated dumping sites.
- Construction activities will be kept confined to ROW only.

291. **Operation Phase:** In the operation phase, the temporarily modified land use pattern such as temporary construction camps / tents would be dismantled. The road, after completion of its development, would consist of neat landscape to lead to a pleasing outlook.

292. The existing road passes through mainly agricultural field and some congested stretches of residential / commercial areas. The safe & quicker accessibility would result in increased scope of commercial, industrial and residential development along the project corridor. Squatter settlement and encroachment along the project road is very likely to take place unless proper controlled measures are adopted.

293. **Impacts:**

- Likely change of land use due to squatter / encroachment within ROW
- Likely change of land use due to induced roadside development outside the ROW

294. **Mitigation Measures:**

- Immediately after the construction phase, it is necessary to ensure that no further deterioration or major land use changes such as ribbon development takes place in a manner that will jeopardize the interests of the State.
- Squatter development along the project shall be strictly avoided by proper regulation and vigilance.
- Land use control measures will be prepared & administered to avoid occurrence of induced development as far as possible.
- Planning agencies and Collector/ Revenue Officer will be made involved for controlled development and prohibiting squatter / encroachment within ROW.

C. Water Environment

1. Drainage & Hydrological Flow

295. The project road runs through plain terrain. There is no river crossing in the project stretch but the project road crosses canal at 4 locations and natural drainage channel / nala at two locations. During heavy rainfall these natural drainage channels carry swift flow. As the existing CD structures and bridges will be suitably augmented & additional CD structures will be constructed, it will not obstruct the water flow in the channels. Therefore, no impact on drainage is envisaged.

296. **Impacts:**

- Change in drainage pattern of the land around realignment
- Increased incidence and duration of floods due to obstruction of natural drainage courses by the road embankment
- Chances of filling of existing drainage courses during earth filling

- There may be potential drainage impacts relating to the establishments of construction camps and various plants such as hot mix plant, batching & asphalt mixing plants etc. drainage impacts at these locations may result in loss of top soil.

297. **Mitigation Measures:**

- Adequate roadside drains will be provided along the road to facilitate its better maintenance and increase in the life of the carriageway. This will also help in avoiding soil erosion and land degradation due to water stagnation on the either side of the road.
- Detailed drainage survey and hydrological investigations have been carried out and accordingly capacity of existing drainage works & cross drainage (CD) structures have been duly augmented, wherever necessary, to accommodate high discharges to avoid flooding & formation of water pool
- All bridges have been designed for a return period of 100 years
- Structures which fail against 100 years flood have been recommended for replacement with a new one.
- Adequate new drainage works & cross drainage (CD) structures have been provided for smooth passage of runoff to avoid flooding
- Filling of existing drainage courses will be strictly avoided
- Construction works of culverts and bridge (cross drainage structures) are taken up during the lean flow periods in summer to minimize the impacts on drainage.
- Construction work near natural drainage channels / low lying areas have to be carried out in such a way that flow of water is not blocked and even if it has to be blocked then the contractor must ensure that the local communities are informed about the same in advance
- Suitable drainage at construction site & camp will be provided to eliminate the chances of formation of stagnant water pools that leads to soil erosion & breeding of mosquitoes

2. Drinking Water Sources

298. **Impacts**: 1 hand pump, 8 well and 1 water tank will be affected.

299. **Mitigation Measures:**

- Affected hand pump, bore well and open well shall be relocated in such a manner that it should not hamper the access to drinking water.
- Construction will not be started until all drinking water sources are replaced with new ones.
- Supply water is the main sources of drinking water in the project area. Therefore, no major impact is envisaged on the user.

3. Water Use

300. **Impacts:** During construction period water is required for compaction of embankment, dust suppression, concrete making and domestic use in construction camp. The estimated tentative water requirement during construction stage is given in **Table 96**.

Table 96: Breakup of Fresh Water Requirement during Construction

SN	Purpose	Quantity (KL)
1.	For road construction:	5,84,000
	a) Construction related to earthwork	
	b) Construction of GSB	
	c) Construction of WMM	
	d) Bridges, culverts, retaining walls & other structures	
2.	Dust suppression	5,000
3.	For drinking & other household purpose #	11,000
	Total	**6,00,000**

301. **Mitigation Measures:**

- Minimum use of water from existing sources for construction purpose will be ensured to minimize likely impacts on other users
- The contractor will arrange water required for construction in such a way that the water availability and supply to nearby communities remain unaffected.
- If new tube-wells are to be bored, due to the non-availability of water required for construction, prior sanctions and approvals by the Ground Water Department has to be obtained by the Contractor
- Wastage of water during the construction should be minimized

4. Water Quality

302. **Construction Phase Impacts:**

- During construction phase, leakage of POL could lead to an increase in water pollution level of the region. Anticipated potential impacts are due to spillage of construction materials, such as, cement, POL, bitumen etc. falling in to the drainage channels from workshops, construction camps, quarry/ borrow areas etc. of the Contractor.
- Accident involving hazardous materials (bitumen) may cause pollution but the occurrence of large scale spillage of bitumen is extremely rare.
- Increase of sediment load in the run off from construction sites and increase in turbidity in receiving streams/water bodies
- Water pollution due to sewage from construction camps

303. **Mitigation Measures:**

- Quality of construction wastewater emanating from the construction site will be controlled through suitable drainage system with silt traps for arresting the silt / sediment load before its disposal into the main natural drainage system around the site
- Proper sanitation facilities will be provided at the construction site to prevent health related problems due water contamination
- An effective traffic management plan is to be implemented to avoid any accidental spillage of hazardous materials.
- All the construction and preparatory activities including construction of culverts and bridges will be carried out during dry seasons only
- The CD structures should not be drained to the agricultural and horticultural farms or to the immediate vicinity of houses of the villagers.
- The fuel storage and vehicle cleaning area shall be stationed at least 500m away

from the nearest drain / water body

- Provision for oil interceptors shall be made at all the construction camps / workshop areas to separate the oil and grease waste generated from servicing of equipment and vehicles used in the construction
- The unlined roadside drains in rural stretches carrying storm water will be connected to the nearest natural drainage channel, water bodies with silt traps.
- Water Quality Monitoring: Apart from provision of the mitigation measures, water quality shall be monitored to understand the effectiveness and further improvement in designs in reducing the concentration of pollutants. The monitoring plan shall be functional in construction as well as in operation stages. The frequency, duration and responsibility will be as per the Environmental Monitoring Plan (Table-8.3 of Chapter-8). The maximum desirable limits as per the water quality standards are given in Annex-3.1 and the monitored values should correspond with the table. All deviated results shall be reported to Sr. Environmental Specialist of the Independent Engineer for remedial measures. It should be ensured that no construction camps or stockyards are set up near rivers, irrigation canals and water bodies to prevent oil spills.
- Silt Fencing: Silt fencing will be provided to prevent sediments from the construction site entering into the nearby watercourses. The silt fencing consists of geo textile with extremely small size supported by a wire mesh mounted on a panel made up of angle / wooden frame and post. The frame will be installed at the edge of the water body along which construction is in progress. It is proposed to install silt trap at the edge of all water bodies located along the project road, major and minor bridge locations. Further, silt fence will be mounted in guiding drains at a distance of 3 to 5 m in the upstream direction depending on the gradient of the guiding drains. However location of silt traps will depend on contractor's proposal for site facilities and work sites and should be provided in the contractor's proposals. This will be checked by Sr. Environmental Specialist of the Independent Engineer and monitored by PIU. Drawing of typical silt trap is given in Annex-8.22.
- Oil Interceptor: Oil and grease from road run-off is another major concern during construction as well as operation. During construction, discharge of oil and grease is most likely from workshops, oil and waste oil storage locations, vehicle parking areas of the contractor camp. Therefore, location of Oil Interceptors has been considered such that each construction camp having refueling stations, oil and lubricants storage places will have one oil interceptor to stop & separate the floating oils. The arrested products shall be disposed as per MoEF&CC and CPCB guidelines. However the number of interceptors shall increase as the situation demands or during the accidental spillages. Actual number will be decided by the Contractor with the consent of Sr. Environmental Specialist of the Independent Engineer. Drawing of typical Oil Interceptor is given in Annex-8.23.
- Ground Water Recharge Pit/ Rainwater Harvesting Structures and silt fences have been proposed near water bodies and local stream crossings to improve the water table in this region and conserve water bodies. It has been observed from the past meteorological data of IMD, total number of rainy days in the project area is 51.6 days and total annual rainfall is 788.9 mm.
- Ground Water Recharge Pit has been proposed at 7 locations (Table 79). However, the locations of proposed ground water recharge will be reviewed by the Sr. Environmental Specialist of the Independent Engineer and finalized in consultation with EMPIU. These locations should be permanent which shall be handed over to the local civic bodies at the end of the project so that the water

shortages can be reduced to a certain extent. Lump sum cost provision has been provided in the EMP. Typical drawing of ground water recharge pit is given in Annex-8.24.

Table 97: Proposed Location of Ground Water Recharge Pit

Design Ch. Km	Village	Description
2+800	Madhuvinahalli	Agricultural area in the bypass
70+300	Chkkinduvadi	Agricultural area
74+600	Konagarahalli	Near settlement area
76+100	Manglam	Near Water body
78+800	Annapuram	Near Water body
84+200	Hanur	Near Nala crossing
85+325	Hanur	Near settlement and Nala Crossing

304. **Operation Phase:** Widening will result in increase of surface run-off due to more paved road surface. It will have adverse impact on ground water recharging if measures are not taken during the design stage.

305. **Impacts:**

- Increase of surface run-off due to more paved road surface
- Filthy environment due to improper maintenance of drainage
- Chances of contamination of water bodies from road surface run off containing oil spills due to traffic movement & accidents

306. **Mitigation Measures:**

- Longitudinal roadside drains of sufficient capacity will be provided on both sides of the road to accommodate increased run-off. The out fall for these drains will be the nearby culverts / bridges or natural drainage channel. Silt fencing will be provided to sediment entering into the water courses.
- Contingent actions will be taken for speedy cleaning up of oil spills, fuel and toxic chemicals in the event of accidents.
- Regular maintenance of rainwater harvesting structures shall be done during the operation stage to prevent choking of these structures.
- Regular monitoring of water quality at specified representative locations will be conducted at fixed interval.

5. Water Bodies

- Corridor of Impact (COI) is the proposed construction width, which is varying from 16 to 20 m in built-up areas and 26 to 28 m in rural / open country area. There are 13 water bodies (7 ponds and 6 ditches), which are located within the COI (Table 80).
- All 7 ponds have been saved. Out of 6 road side ditches, 4 road side ditches will be partially affected. These ditches are small depression (natural or manmade) along the road where water stored during rainy seasons only i.e. 3 to 4 months in a year and in the remaining period of the year i.e. 7 to 8 months, these ditches remain dry. Hence, there will be no significant impact on road side water bodies.

Table 98: List of Water Bodies Located within the COI

SL	Particular	Existing Ch. km	Design Ch. Km	Distance# (m)	Side	Village	Affected Status	Remarks
20.	Pond	61+550	-	RHS	12.49	Kollegal	Not Affected	
21.	Pond	62+100	-	RHS	7.75	Kollegal	Not Affected	
22.	Pond	64+900	-	RHS	11.05	Siddaiahanpura	Not Affected	
23.	Pond	66+645	4+680	RHS	7.27	Madhuvinahalli	Not Affected	
24.	Pond	67+800	67+800	RHS	6.02	Haruvanapuram	Not Affected	
25.	Pond	69+500	69+500	LHS	9.24	Haruvanapuram	Not Affected	
26.	Pond	74+000	73+960	LHS	7.56	Singanallur	Not Affected	
27.	Road side Ditch	78+100	78+060	LHS	10.72	Manglam	Partially Affected	Toe wall provided
28.	Road side Ditch	78+750	78+700	RHS	5.92	Manglam	Partially Affected	
29.	Road side Ditch	78+750	78+700	LHS	6.16	Manglam	Not Affected	Toe wall provided
30.	Road side Ditch	80+100	80+060	RHS	6.67	Manglam	Partially Affected	
31.	Road side Ditch	80+185	80+145	RHS	8.83	Manglam	Partially Affected	To save the Banyan Tree
32.	Road side Ditch	83+325	83+280	LHS	12.11	Hullepuram	Not Affected	

Source: Field Survey in December 2015
Distance in meter from existing centerline;

Partially Affected
Road Side Ditch at Ch. Km 78+100 (LHS)

Partially Affected
Road Side Ditch at Ch. Km 78+750 (RHS)

Partially Affected
Road Side Ditch at Ch. Km 80+100 (RHS)

Partially Affected
Road Side Ditch at Ch. Km 80+185 (RHS)

307. ***Enhancement of Water Body.*** Enhancement measures have been proposed for roadside pond located at Hullepuram village at design chainage km 83+260 on the left side of the project road (**Table 99**). The pond water is utilized for irrigation purpose and also utilized in the temple located adjacent to the pond.

Table 99: Water Body Proposed for Enhancement

SL	Particular	Existing Ch. km	Design Ch. Km	Distance# (m)	Side	Village
1.	Pond	83+300	83+260	36.54	LHS	Hullepuram

308. Followings have been proposed as a part of enhancement:

a) Deepening of the water body up to 2 m (earth excavation)
b) Stabilization of the slope using Vetiver Grass
c) Phyco-Remediation of water using NUALGI
d) Turfing of surrounding area of the water body
e) Sitting arrangement with RCC Precast Benches with back support
f) Pathway with Interlocking Paver Blocks & sand filling
g) Approach Road
h) Oil interceptor

View of the Water Body (Pond) proposed for Enhancement

309. ***Phyco-Remediation using NUALGI***. During the site visit, algal growth is observed in few ponds along the project road and local villagers also informed that the quality of water of these ponds is very poor. Therefore, Phyco-Remediation using NUALGI is proposed to improve the water quality of the following ponds, which also include the pond proposed for enhancement in Table 100.

Table 100: Water Bodies Proposed for Phyco-Remediation

SL	Particular	Existing Ch. km	Design Ch. Km	Distance (m)	Side	Village	Use of Water
1	Pond	74+000	73+960	LHS	7.56	Singanallur	Livestock Watering
2	Pond	76+060	76+030	LHS	21.73	Konagarahalli	Domestic except drinking, Crop Irrigation
3	Pond	83+300	83+260	LHS	36.54	Hullepuram	Crop Irrigation

Source: Field Survey in December 2015

310. Phyco- remediation is the use of algae to remediate polluted waters. Among all the algae, diatoms are the most prolific photosynthesizes because of their silica shells, which are translucent. This helps the diatoms to photosynthesize even in low light conditions.

311. The “NUALGI Technology” is based on providing micro nutrients required for diatom algae growth to speed up the nutrient removal in stagnant water and converting these nutrients to fish biomass. NUALGI contains micronutrients along with silica which is required for diatom growth. During photosynthesis, diatoms consume Nitrates and Phosphorous, as also uses up CO_2 from the atmosphere. In the process, they release oxygen (pure oxygen in water) to almost saturation levels, which will help the water body regain its original levels of Dissolved Oxygen. The absorption of CO_2 will also mitigate the water acidification and pH levels would move towards more basic levels. The high levels of DO would set up a chain of benefits, primarily it promotes aerobic bacteria which would digest the excess nutrients in water and convert them into the base constituents. Such high levels of DO would also oxidize the heavy metals which would precipitate out of water, where other bacterial strains would consume them.

312. NUALGI will also trigger growth of Zooplanktons, which consume diatom algae. The zooplanktons are consumed by fish, thus ensuring that the diatom algae exits the water as fish biomass and does not decay in water like other cellulose algae. This will lead to environmentally friendly way of converting the excess nutrients to fish biomass.

313. Guideline on Phyco-Remediation of Water using NUALGI is given in **Annex-8.26** and a Typical Enhancement Plan for road side pond / water bodies is given in **Annex-8.27**. Cost of enhancement is covered in the EMP budget.

D. Air Environment

1. Construction Phase

314. Particulate matter would be the predominant pollutant affecting the air quality during the construction phase as it is likely to generate considerable quantities of dust, especially during dry condition. Dust will be generated mainly during excavation, backfilling, hauling & transportation activities through unpaved haul roads, loading/ unloading & transportation of construction materials, spilling of material during transportation, and open storage of fine construction materials.

315. Undesirable gaseous pollutants will be generated mostly by the automobile traffic and construction machineries. Pollutants of primary concern include $PM_{2.5}$ and PM_{10}. However, suspended dust particles may be coarse and will be settled within a short distance of construction area. Therefore, impact will be temporary and restricted within the closed vicinity along the road only. Further, this would not lead to any tangible effect, as the expected traffic volume is low. Operation of hot mix plants and Asphalt plants will cause emission of fumes and gases.

316. **Impacts:**

- Deterioration of air quality due to fugitive dusts emission from construction activities like excavation, backfilling & concreting, and hauling & dumping of earth materials & construction spoils, and vehicular movement along unpaved roads.
- Deterioration of air quality due to gaseous emissions from construction equipment & vehicular traffic

- Deterioration of air quality due to emission from asphalt and hot mix plants
- Emission of Carbon monoxide, sulfur-di-oxide, nitrogen oxides etc. will be generated from the hot mix plant

317. **Mitigation Measures:**

Dust Control:

- Proper and prior planning and appropriate sequencing and scheduling of all major construction activities will be done, and timely availability of infrastructural supports needed for construction will be ensured to shorten the construction period vis a vis reduce pollution.
- Construction materials will be stored in covered godowns or enclosed spaces to prevent the windblown fugitive emissions.
- Truck carrying soil, sand and stone will be duly covered to avoid spilling.
- Adequate dust suppression measures such as regular water sprinkling on unpaved haul roads & vulnerable areas of the construction sites from trucks or other suitable means will be undertaken to control fugitive dust during material handling & hauling activities particularly near habitation especially in the dry seasons.

Emission Control:

- Use of Recycled Asphalt Cold Mix Technology: Most bituminous mixes are produced at a very high temperature (nearly 160°C), mainly because bitumen is very viscous at low temperatures and cannot coat the aggregates, unless heated to high temperatures. Technologies are available, which can facilitate the coating at low temperatures by increasing the surface area of bitumen or by reducing the surface tension at the aggregate bitumen interface with use of certain additives, thereby making the mixing possible at much lower temperature, saving energy and releasing less pollutants in the atmosphere. It is proposed to follow IRC Guideline on the subject.
- During construction period, all activities are to adhere to the contractual obligations and all clearances and approvals such as 'Consent to Establish' and 'Consent to Operate' shall be obtained from the Karnataka State Pollution Control Board under Air Act. All vehicles operating for the Contractor, Supervision Consultants and PIU shall obtain Pollution under Control (PUC) certificate.
- All required clearances are to be obtained from the Karnataka State Pollution Control Board and the Mining Department for establishing quarries, borrow areas and crushers. Contractor should submit copy of such clearances to EMPIU & IE before start of activities.
- Asphalt and hot mix plants will be located at least 500 m away from inhabited areas and sensitive receptors such as school, hospital, temple etc. as well as 300 m from the road. A written agreement with the land owner clearly specifying the terms and conditions of opening, operation and closing activities of the Contractor must be part of the management plan
- Pollution control devices such as cyclone separators /scrubbers shall be installed to control emissions from hot mix plants, crushing units and concrete batching plants. Height of the stacks shall be as per the statutory requirements.
- It will be ensured that all the construction equipment & vehicles are in good working condition, properly tuned and maintained to keep emissions within the

permissible limits and engines turned off when not in use to reduce pollution.

318. **Air Quality Monitoring:** Apart from provision of the mitigation measures, air quality shall be monitored. The monitoring plan shall be functional in construction as well as in operation stages. The frequency, duration and responsibility will be as per the Environmental Monitoring Plan (Table-8.3 of Chapter-8). The maximum desirable limits as per the National Ambient Air Quality Standards are given in **Annex-3.1** and the monitored values should correspond with the table. All deviated results shall be reported to IE for remedial measures.

2. Operation Phase

319. **Prediction of Impacts.** Vehicular emission will be the principle source of pollution during operation stage. Quantitative assessment for predicted level of pollutants concentration has been done using ISC-AERMOD, a recommended model by USEPA for prediction of air quality from point, area and volume sources. AERMOD is a long range dispersion model based on Gaussian dispersion which incorporates the Pasquile-Gifford (P-G) dispersion parameters for estimating horizontal cross wind and vertical dispersion. In ISC-AERMOD software, the line sources are characterized either are area source or volume sources. After drawing the road alignment of particular traffic segment and putting the information related to carriageway width, vertical dimension, source elevation, base elevation and release height, the model converts the road alignment to volume source. The model simulates the effect of emissions from continuous/variable volume sources on neighborhood air quality. The model is an hour-by-hour steady state Gaussian model which takes into account special features like Terrain adjustments, Gradual plume rise, Buoyancy-induced dispersion, Complex terrain treatment, etc.

320. **Emission Rate:** Composite Emission factors were calculated to assess the contribution of the vehicles in air emission based on the emission factors developed for Indian road conditions by "The Automotive Research Association of India (ARAI)", Pune in its study for "Emission Factor Development for Indian Vehicles" as a part of Ambient Air Quality Monitoring and Emission Source Apportionment Studies under Air Quality Monitoring Project - Indian Clean Air Program (ICAP). Composite Emission Factor (CEF) represent the various vehicular emission pollutant for different types of vehicles (viz. two wheelers, three wheelers, Cars, Commercial vehicle, Buses etc.) used in India as requirement of AERMOD.

321. **Meteorological Data:** The primary factors affecting transport and dispersion of pollutants are wind and stability. The winds are caused by differences in pressure between areas of the atmosphere. Differences in pressure cause air to move from high-pressure areas to low-pressure areas. Wind speed can affect the pollutant concentration in a selected area. In general, the higher the wind speeds, the lower the pollutant concentration. The winds dilute pollutants and rapidly disperse them throughout the near areas. In the present case, meteorological data of winter season (December 2015) generated through primary survey has been used for prediction of the impacts.

322. **Homogeneous Traffic Sections:** The proposed project road from Kollegal to Hanur, Section of SH-79, involves 1 homogeneous section as detailed under:

- Homogeneous Traffic Section I: Ch. 61+450 to 85+815 (existing Ch. Km)

323. **Predicted Ground Level Concentrations:** The prediction of maximum ground level concentration on each traffic sections for CO, NO_x and particulate matters have been carried out

using AERMOD for the base year 2015, start year of operation 2020 and design life ending year 2040. The predicted levels are plotted in isopleths and superimposed on a gridded topographical sheet within 10 km radius of the volume source to simulate the dispersion of pollutants. The predicted concentration range is shown in color scale on the right of each isopleths, which are presented in **Figure 22 to 30.**

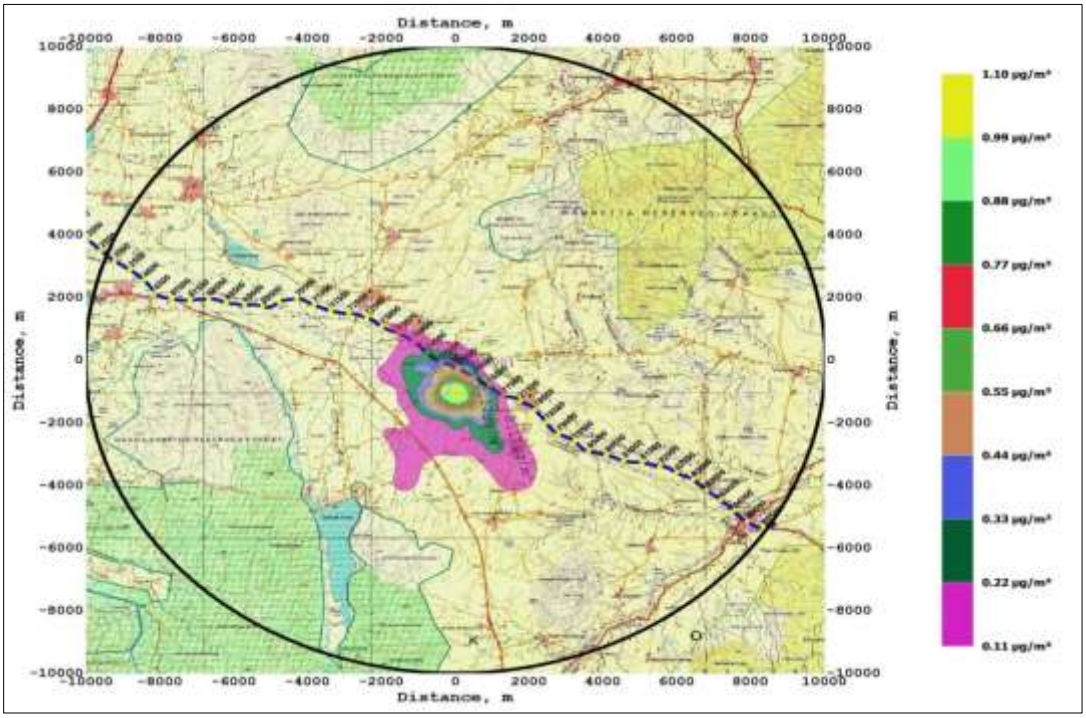


Figure 22: Predicted CO Levels in Traffic Section I for the Base Year 2015

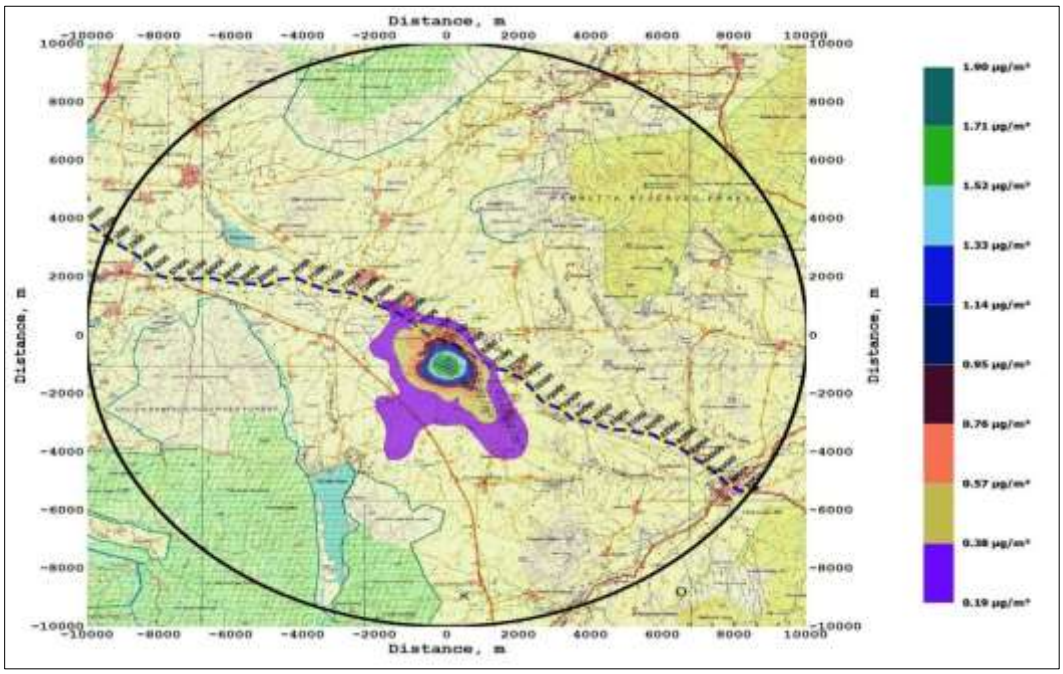


Figure 23 Predicted CO Levels in Traffic Section I for the Year of Operation 2020

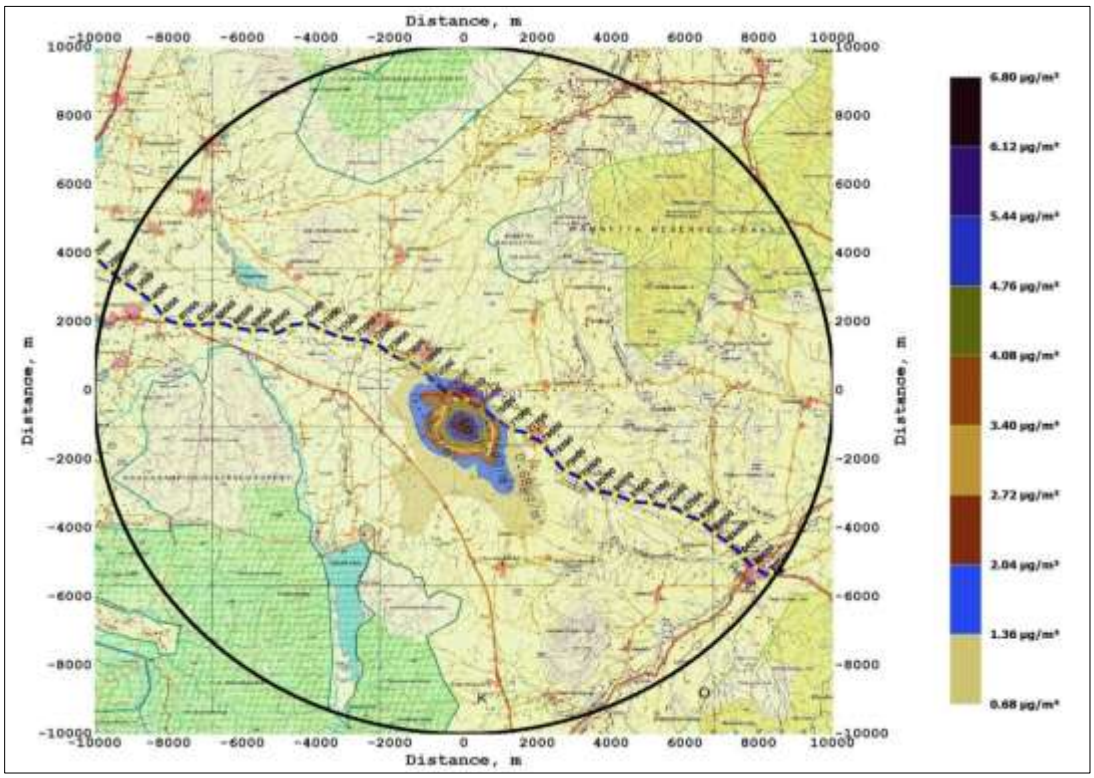


Figure 24 Predicted CO Levels in Traffic Section I for the Year 2040

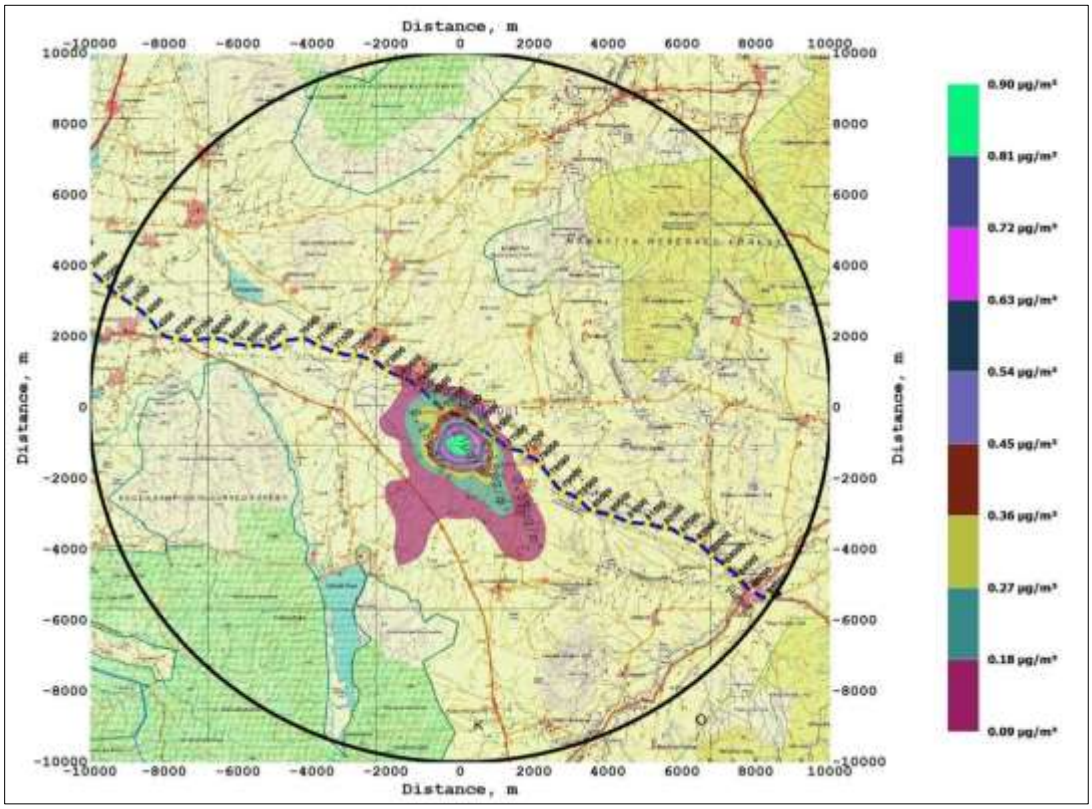


Figure 25 Predicted NO_x Levels in Traffic Section I for Base Year 2015

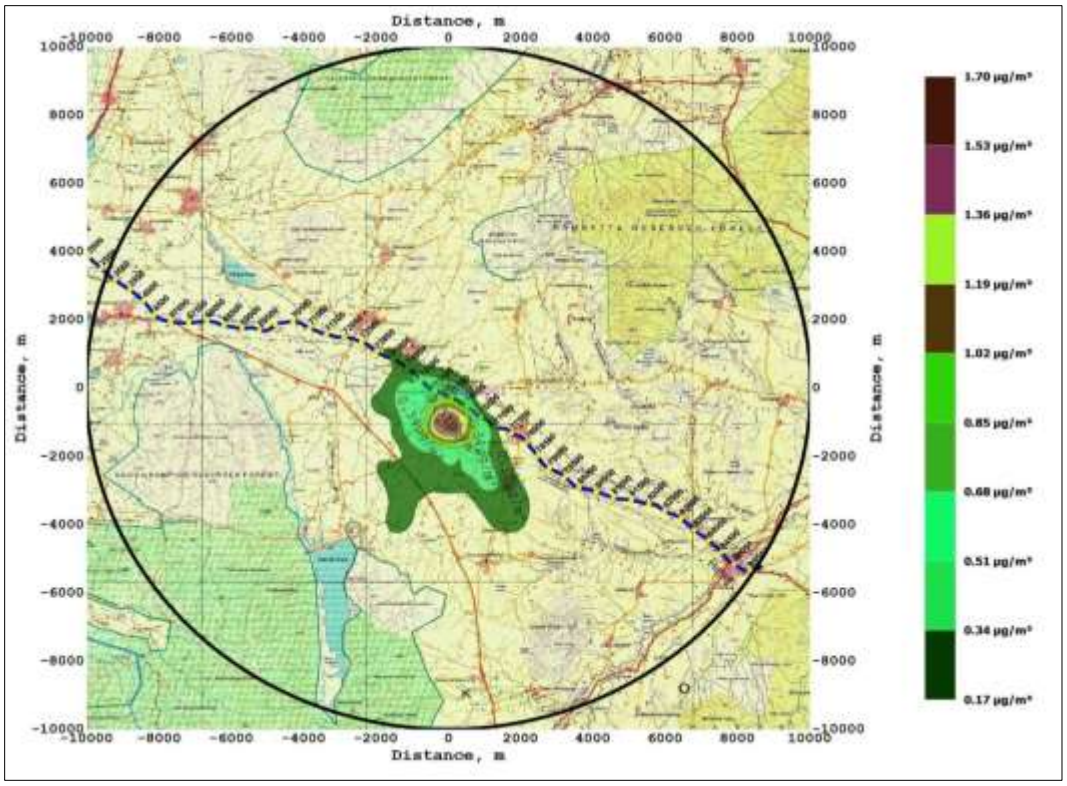


Figure 26 Predicted NO_x Levels in Traffic Section I for the Year of Operation 2020

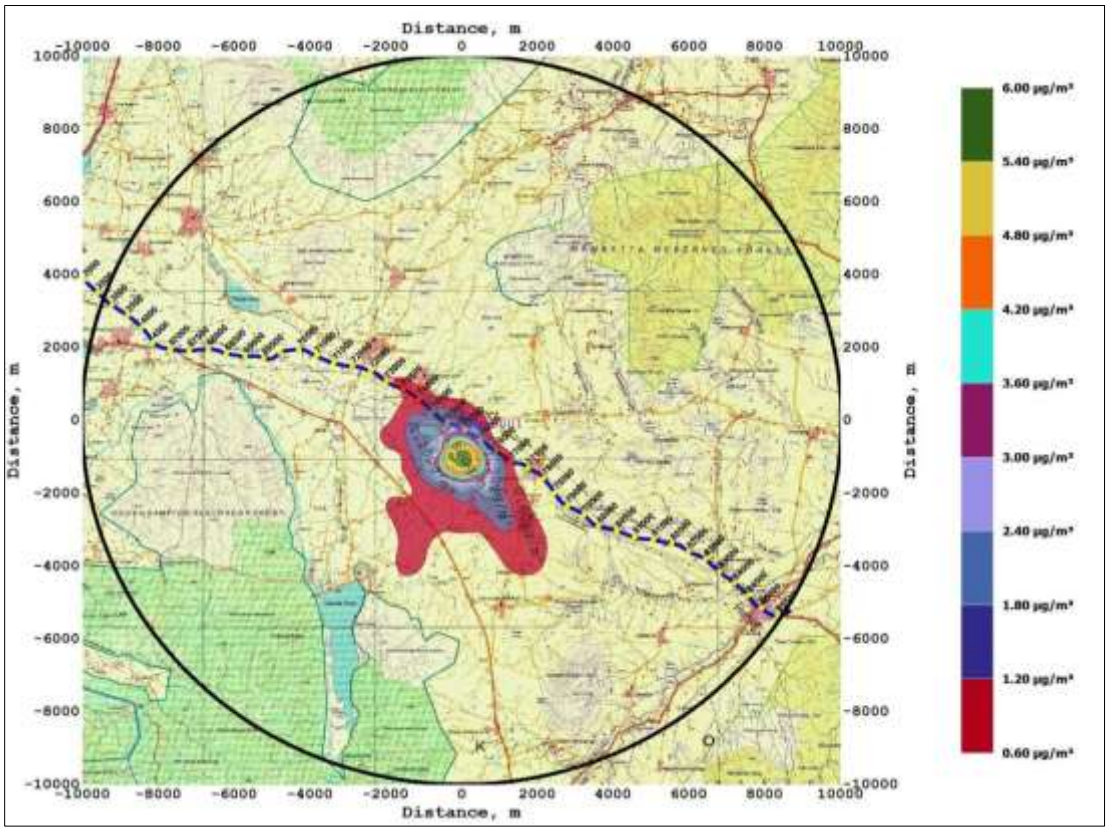


Figure 27 Predicted NO_x Levels in Traffic Section I for the Year 2040

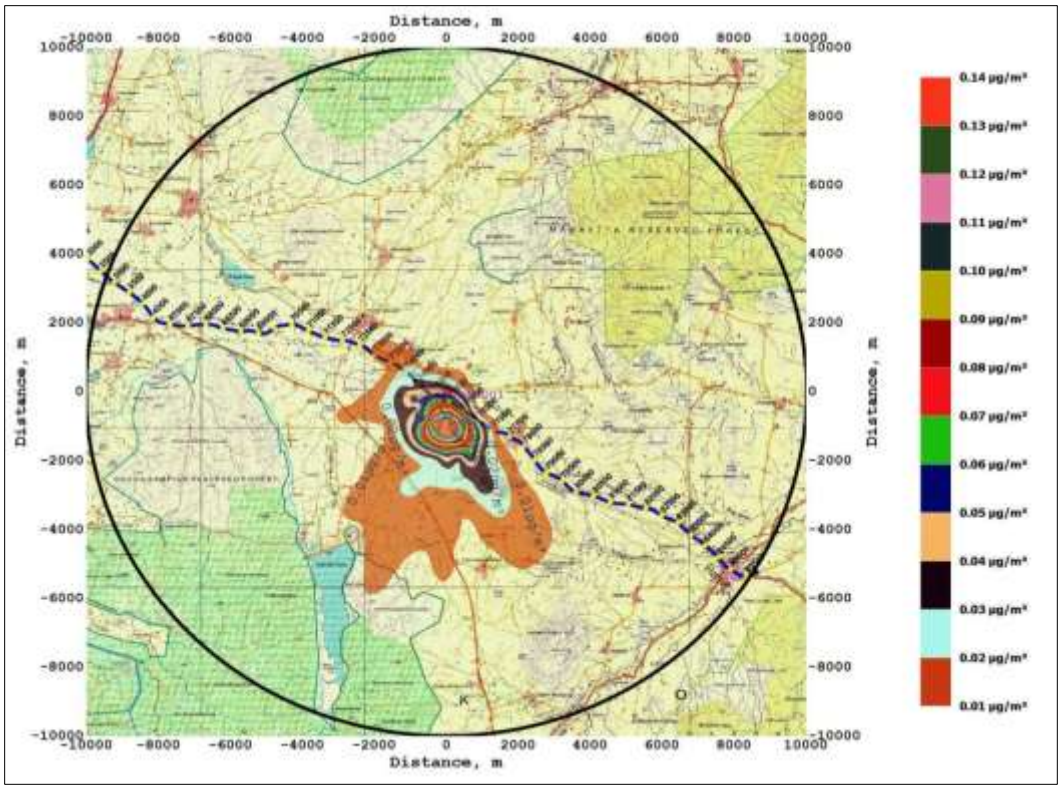


Figure 28 Predicted PM Levels in Traffic Section I for Base Year 2015

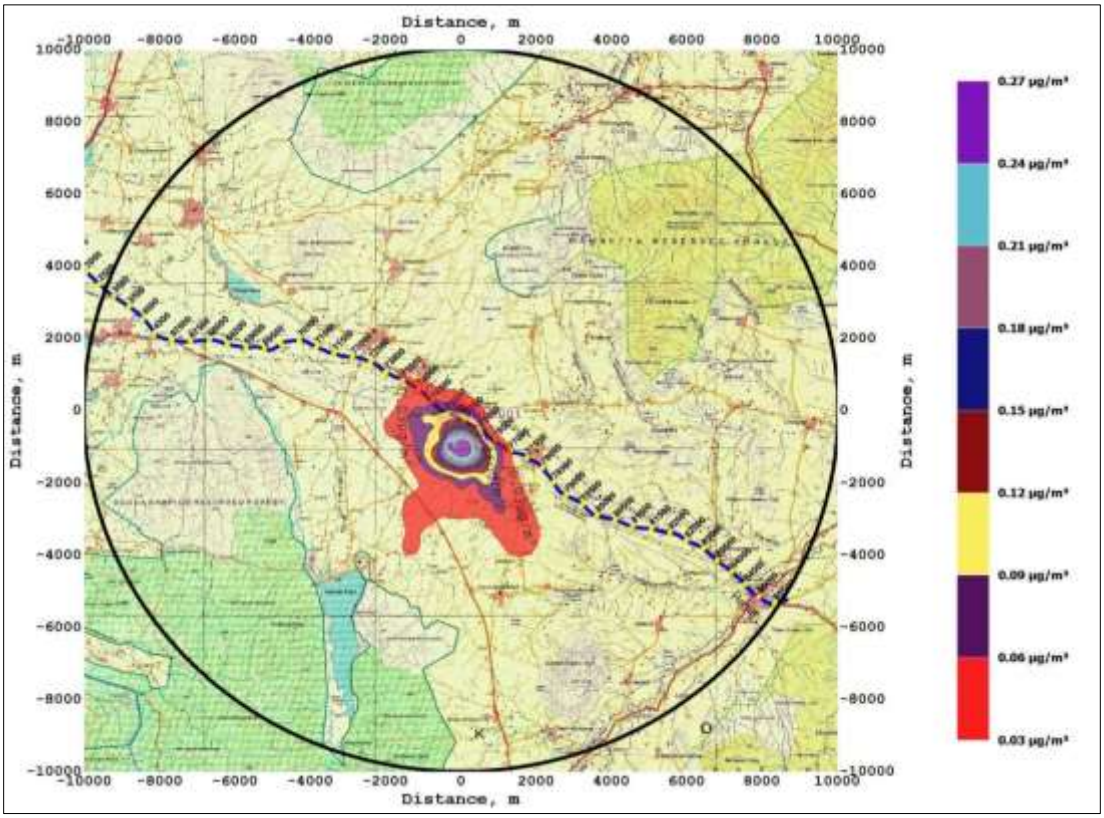


Figure 29 Predicted PM Levels in Traffic Section I for the Year of Operation 2020

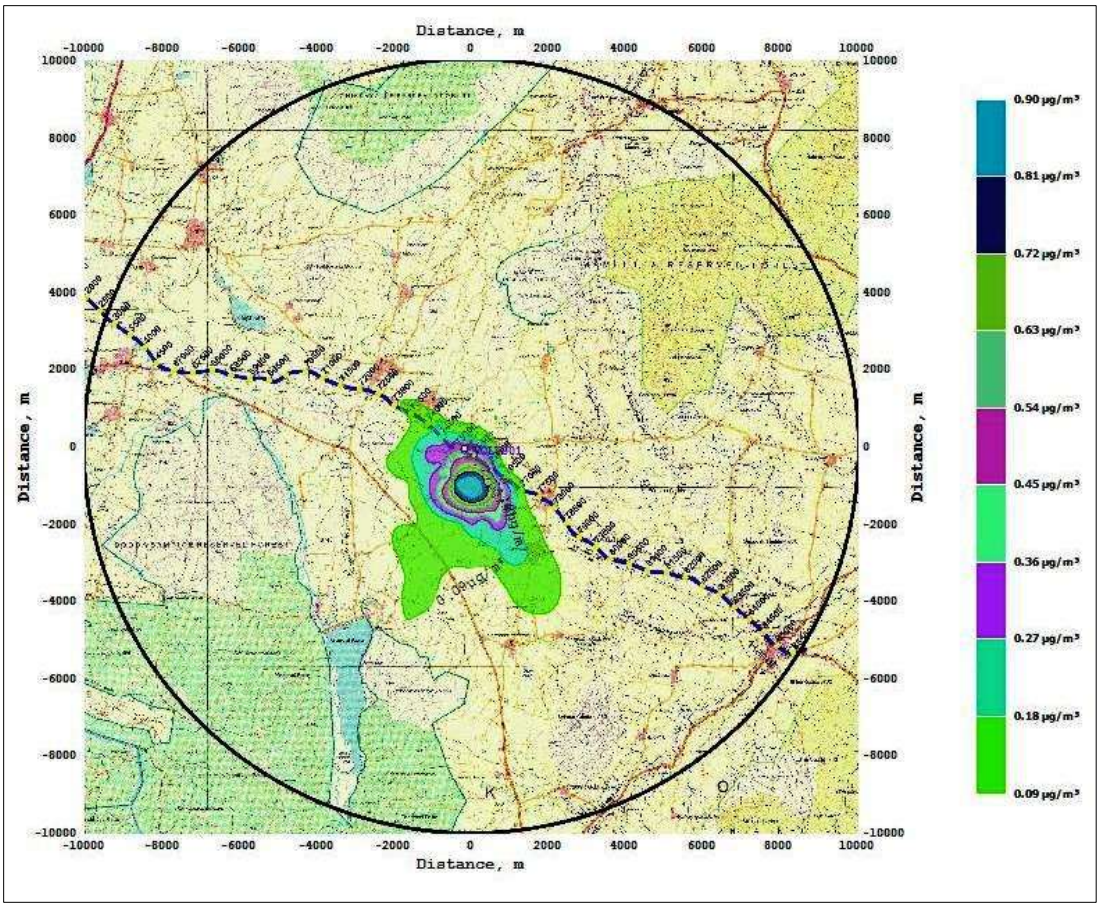


Figure 30 Predicted PM Levels in Traffic Section I for the Year 2040

324. **Prediction Results.** Analyses of modeling results ascertain that the predicted level of concentrations for all parameters along the project road in the homogeneous sections is within the prescribed range. However, the pollutant concentrations and its spread (dispersion) increase consistently with the increase in traffic volume. It can be observed from the isopleths that dispersion of gaseous pollutants have wide geographical spread in comparison to the particulate matters, as the it tends to settle down owing to gravitional forces.

325. **Caline 4 Model:** Caline-4 has high applicability in Indian Scenario and is a recommended model by USEPA for prediction of air quality from line sources like highway projects. Quantitative assessment for predicted level of pollutants concentration has been done using Caline-4 Model Ver. 2011,

326. CALINE4 (Caltrans, 1989) is a fourth-generation line source Gaussian plume dispersion model that predicts carbon monoxide (CO) impacts near roadways. Its purpose is to help planners protect public health from the adverse effects of excessive CO exposure. The Caltrans publication, Transportation Project-Level Carbon Monoxide Protocol (CO Protocol) recommends the use of CALINE4 when a proposed transportation project requires a more detailed analysis than initial screening analysis. The 2011 version of caline-4 can also be used for prediction of NO_x and PM_{10}. Pollution Control Authorities/ Regulatory Agencies in India using CALINE- 4 to predict the future air quality trends along highways/roads from vehicular traffic for regulatory purposes.

327. CALINE-4 model employs a mixing zone concept to characterize pollutant dispersion in the proximity of roadways. The model employs source strength, meteorology, site geometry and site characteristics as input parameters and predicts pollutant concentrations for receptors located within 150 meters either side of the roadways. The CALINE-4 model allows roadways to be broken into multiple links that can vary in traffic volume, emission rates, height, width, etc. CALINE-4 is capable of specifying links at heights above grade (z = 0), links as bridges (allowing air to flow above and below the link) and links as parking lots (which should be defined by the user as having a height of zero). Also, unlike CAL3QHCR, CALINE-4 is capable of analyzing the dispersion of pollutants in wind speeds of less than 1 m/s. in CALINE-4 the concentration at a point with coordinates (x,y,z) is calculated based on the following equation:

$$C(x,y,z,H) = \frac{Q}{2\pi u \sigma z \sigma y} * \left[\exp - \left(\frac{y^2}{2\sigma y^2} \right) \right] \left[\exp \frac{-(z-H^2)}{2\sigma z^2} \right] + \exp \left[\frac{-(z+H^2)}{2\sigma z^2} \right]$$

Where:
C = Concentration of the pollutant in air [m/L3]
Q = Rate of chemical emission [m/T]
U = Wind speed in X direction [L/T]
óy = Standard deviation in y direction [L]
óz = Standard deviation in z direction [L]
y = Distance along a Horizontal axis perpendicular to the wind [L]
z = Distance along a vertical axis.[L]
H = effective stack height [L]

328. Emission Rate, Meteorological Data and Homogeneous Traffic Sections are same with that of ISC=AERMOD model.

329. **Receptors:** The complete road alignment has been drawn with respect to UTM co-ordinates. A set of link receptors were taken at various receptor locations within each section at a distance of 10 m, 30 m, 50 m, 100 m, 150 and 200 m both sides from edge of the carriageway to know the dispersion of pollutant from the road.

330. **Predicted Ground Level Concentrations:** The prediction of maximum ground level concentration on each road section has been carried out. The prediction for CO was conducted for 8-hourly concentrations, whereas for NO_2, SO_2 and PM_{10}, it was conducted for 24 hourly concentrations. Predicted concentrations on one homogenous section of the project road for CO, NO_2, and PM_{10} and their spread around the road sections have been presented in **Figure 31** to **Figure 33.**

331. **Prediction Results.** Analyses of modeling results ascertain that the predicted level of concentrations for all parameters along the project road in two homogeneous sections are within the prescribed range. However, the pollutant concentrations are estimated to increase after 2030 within 30 m from the road edge.

332. The tree plantation and habitat improvement activities included in the project scope will help to check air pollution. Road signage at regular intervals to remind motorists to maintain their vehicles and minimize fuel consumption may be posted. Raising awareness amongst

drivers on good driving practices to reduce fuel consumption and promote road safety may also be carried out. As part of the routine maintenance works good riding conditions of the road surface will be maintained to reduce dust and vehicular pollution.

333. **Conclusions:** In the existing scenario, due to lesser carriageway width, the average vehicle speed is low, which results in traffic congestions causing more exhaust gas emissions. In the post-project scenario, improved road conditions and congestion free traffic movement will reduce emissions. It is also expected that over the period, the fleet/fuel type will significantly improve contributing significantly in emission reduction

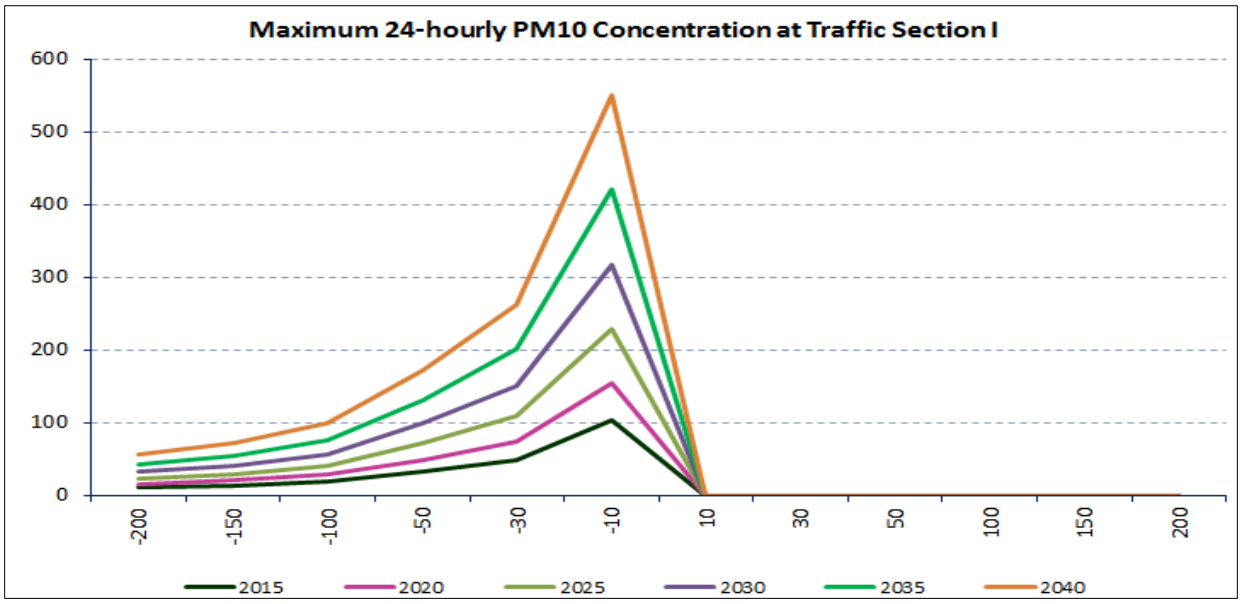


Figure 31: Maximum 24 Hourly PM_{10} Concentration at Traffic Section-I

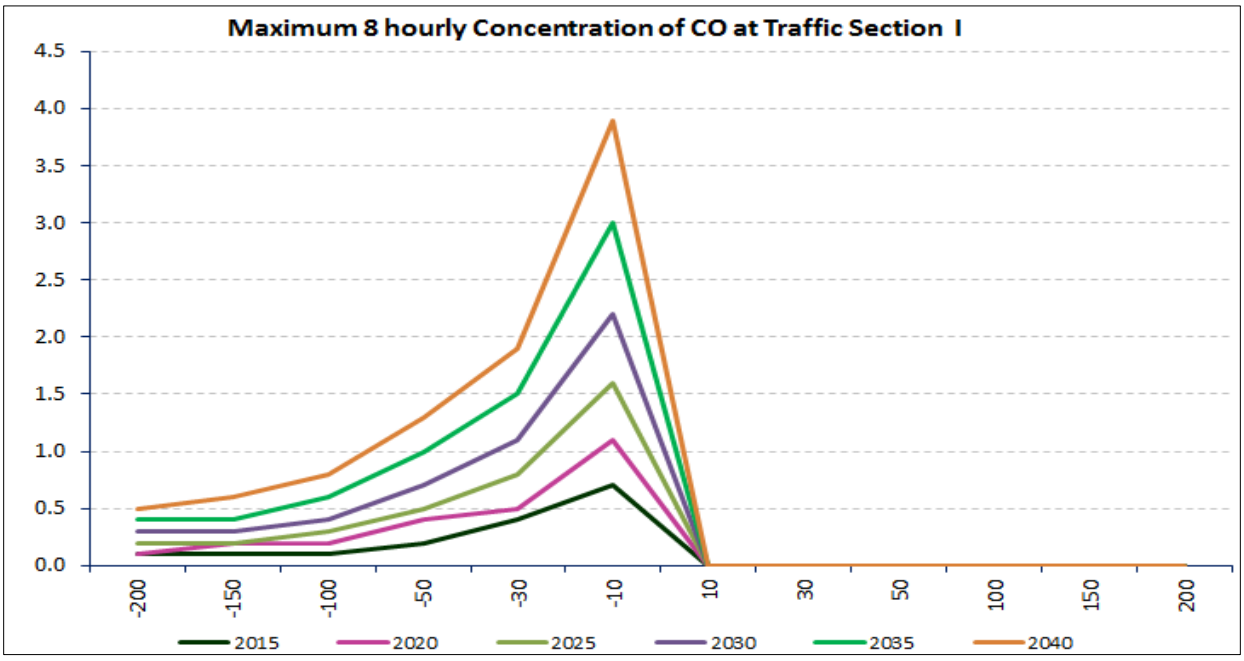


Figure 32: Maximum 24 Hourly CO Concentration at Traffic Section-I

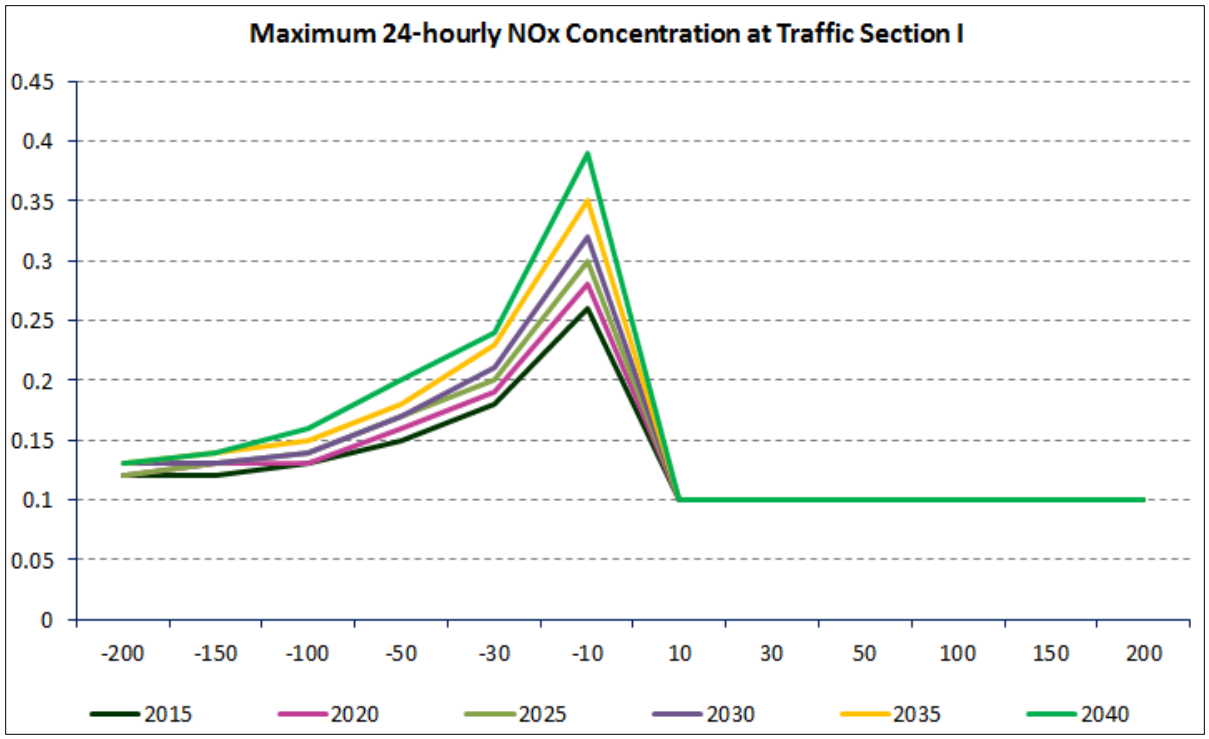


Figure 33: Maximum 24 Hourly NO_X Concentrations at Traffic Section-I

334. **<u>Mitigation Measures</u>**

- Vehicular emission will be controlled through enforcement of laws and public awareness. It will be ensured that all the vehicles have vehicular emission within the permissible limits.
- Truck parking lay-byes and bus bays will be provided at required locations to facilitate smooth traffic flow vis a vis reduce air pollution.
- Regular monitoring of ambient air quality at specified representative locations will be conducted at fixed interval.
- Road side plantation along the road will act as sink of air pollutants. Pollution resistant species, which can grow in high pollutants concentrations and absorb pollutants will be planted as proposed under Greenbelt Development Plan
- The designed road surface will generate lesser dust due to the paved shoulders in settlement areas.
- Improvement in road surface condition and traffic capacity will reduce the local congestion in the built up areas and provide a smooth traffic flow.
- The net air quality impacts during the operation phase would be reduced after widening and improvement of the project.

E. Noise Environment

1. Construction Phase

335. During the construction phase, noise will be generated due to movement of vehicles, and operation of light & heavy construction machineries including pneumatic tools (hot-mixer, dozer, tipper, loader, excavator, grader, scraper, roller, concrete mixer, generator, pump, vibrator, crane, compressor etc.) that are known to emit sounds with moderate to high decibel value.

336. Noise generated from sources mentioned above will be intermittent and mostly during daytime. Moreover, villages / settlements being mostly away from the road, no significant impact on local people is apprehended, as the noise will generally die down by the time it reaches them. However, the workers are likely to be exposed to high noise levels that may affect them.

337. **Impacts:** Increase in noise level due to construction activities like operation of construction equipment & vehicular traffic.

338. Operation of construction machinery will lead to rise in noise level to the range between 80-95 dB(A). The magnitude of impact from noise will depend upon types of equipment to be used, construction methods and also on work scheduling. Typical noise level of various activities associated with highway projects is presented below.

Table 101: Typical Noise Level of Various Highway Construction Activities

Sl. No.	Construction Activity	Noise Level dB(A)
1.	Grading & Clearing	84
2.	Excavation	89
3.	Foundations	88
4.	Erection	79
5.	Finishing	84

Note: Measured at Leq assuming 70 dB(A) ambient noise level

339. General conclusion can be based on the types of construction work anticipated, the likely equipment required and their associated range of noise levels. Typical noise level of principal construction equipment is presented below.

Table 102: Typical Noise Level of Construction Equipment

Clearing		**Structure Construction**	
Equipment	**Noise Level dB(A)**	**Equipment**	**Noise Level dB(A)**
Bulldozer	80	Crane	75-77
Front end loader	72-84	Welding generator	71-82
Jack hammer	81-98	Concrete mixer	74-88
Crane with ball	75-87	Concrete pump	81-84
		Concrete vibrator	76
Excavation & Earth Moving		Air compressor	74-87
Bulldozer	80	Pneumatic tools	81-98
Backhoe	72-93	Bulldozer	80
Front end loader	72-84	Cement & dump trucks	83-94
Dump truck	83-94	Front end loader	72-84
Jack hammer	81-98	Dump truck	83-94
Scraper	80-93	Paver	86-88
Grading & Compaction		**Landscaping and Cleanup**	
Grader	80-93	Bulldozer	80
Roller	73-75	Backhoe	72-93
Paving		Truck	83-94
Paver	86-88	Front end loader	72-84
Truck	83-94	Dump truck	83-94
Tamper	74-77	Paver	86-88

Source: U.S. Environmental Protection Agency, Noise from Construction Equipment and Operations. Building Equipment and Home Appliance. NJID.300.1. December 31, 1971

340. The construction noise is generally intermittent and depends on the type of operations, location and function of the equipment and the equipment usage cycle, it attenuates quickly with increases in distance. The noise level generated from a source will decrease with distance as per the following empirical formula (inverse square law).

$$SPL2 = SPL1 - 20Log_{10}(r_2/r_1)$$

where, SPL1 and SPL2 are the sound pressure levels at distance r_1 and r_2 respectively.

341. Considering the stationary construction equipment as a point source generating 90 dB(A) at a reference distance of 2 m, computed minimum distance required from the stationery source to meet the permissible noise limits during day time for different land use categories are given in **Table 103**.

Table 103: Minimum Distance Required from Stationary Noise Source

Category	Permissible Limits in Day Time (CPCB)	Distance Required (m)
Silence zone	50 dB(A)	200
Residential	55 dB(A)	113
Commercial	65 dB(A)	36
Industrial	75 dB(A)	11

342. From the above table it may be noted that residence within 113m from the road will be exposed to a noise higher than the permissible limit. The impacts will be significant on construction workers, working close to the machinery.

343. **Mitigation Measures:**

- Construction camp and temporary labour sheds will be located away from the immediate vicinity of the construction sites and major road traffic.
- Protective gears such as ear plugs or ear muffs will be provided to construction personnel exposed to high noise levels as preventive measure (Annex-8.10).
- Low noise construction equipment will be used.
- It will be ensured that all the construction equipment & vehicles used are in good working condition, properly lubricated & maintained to keep noise within the permissible limits and engines turned off when not in use to reduce noise.
- Stationary construction equipment will be placed 113 m away from inhabited areas.
- Stationary construction equipment will be placed 200 m away from the silence zones i.e. educational institutions, medical amenities and religious places
- Construction activities carried out near residential area will be scheduled to the daytime only so that minimum disturbances are caused to people.
- “Silence zones will be demarcated and road signs prohibiting the use of horns (No Honk Zone) will be displayed at residential areas, sensitive locations and silence zones
- Noise barrier will be constructed in all educational institutions to minimize the impact of traffic noise.
- Noise Monitoring: The effectiveness of mitigation measures and further improvement in designs to reduce the noise level due to construction and operation activity shall be monitored. The frequency, duration and monitoring plan shall be functional in construction as well as in operation stages as per the Environmental Monitoring Plan (Table-8.3 of Chapter-8). Ambient Air Quality

Standards with respect of Noise are given in Annex-3.1 and the monitored values should correspond with the table. All deviated results shall be reported to IE, for remedial measures.

2. Operation Phase

344. The significance of operational noise impacts commensurate with the number of sensitive structures and sensitive areas that exist along the project roads. As stated in chapter IV, the project road is mainly passes through agricultural land (67.9%) followed by residential & commercial area (24.9%) and only residential area (7.3%). The sensitive structures comprising schools, temples, mosques and health centers located along the project road has been discussed in Section-4.15 of Chapter-IV. After removal and shifting of the directly impacted sensitive structures, the sensitive structures that will be remaining on either side of the road which will be exposed to noise generated by future traffic plying on the improved road.

345. **Source of Noise**. During the operational phase, movement of traffic, traffic congestion, pedestrian interferences and increase in use of horns will be the prime source of noise. The noise levels at nearby schools, religious place may cause nuisance and irritation.

346. **Vehicle Noise and Road Surface Influence on Tire/Road Noise[3] .** There are many sources of noise when a vehicle travels down a roadway. Vehicle manufactures have made efforts to reduce tire/road noise and drive train noise. If a vehicle is in a good operating condition and has a reasonably good exhaust system, then the effect that power and drive train noise has on the overall noise level will be negligible at moderate to high speeds. There is a "cross-over speed" where tire / road noise begins to dominate the overall noise level of a vehicle. This speed lies in the range of 30-50 km/h for automobiles and 40-70 km/h for trucks [Sandberg 1992]. It has been found that the noise level increases with the increase in the speed (**Figure 34**).

347. There are several pavement parameters, which affect the amount that the road surface contributes to the generation of tire / road noise. These parameters include the texture, age, thickness, and binder material of the pavement. The overall texture of the pavement has a significant impact on tire / road noise levels. Studies performed by the Washington State Department of Transportation to evaluate how tire / road noise changes with pavement age. These studies have shown that asphalt pavements start out quieter than cement concrete pavements, but the asphalt pavements exhibit an increase in noise levels over time [Chalupnik and Anderson 1992]. Another reason for the increase in noise levels is due to an increase in stiffness from traffic loading. Finally, as the asphalt surface wears over time, the coarse aggregate becomes exposed which causes an increase in noise.

[3] U.S. Department of Transportation, Federal Highway Administration

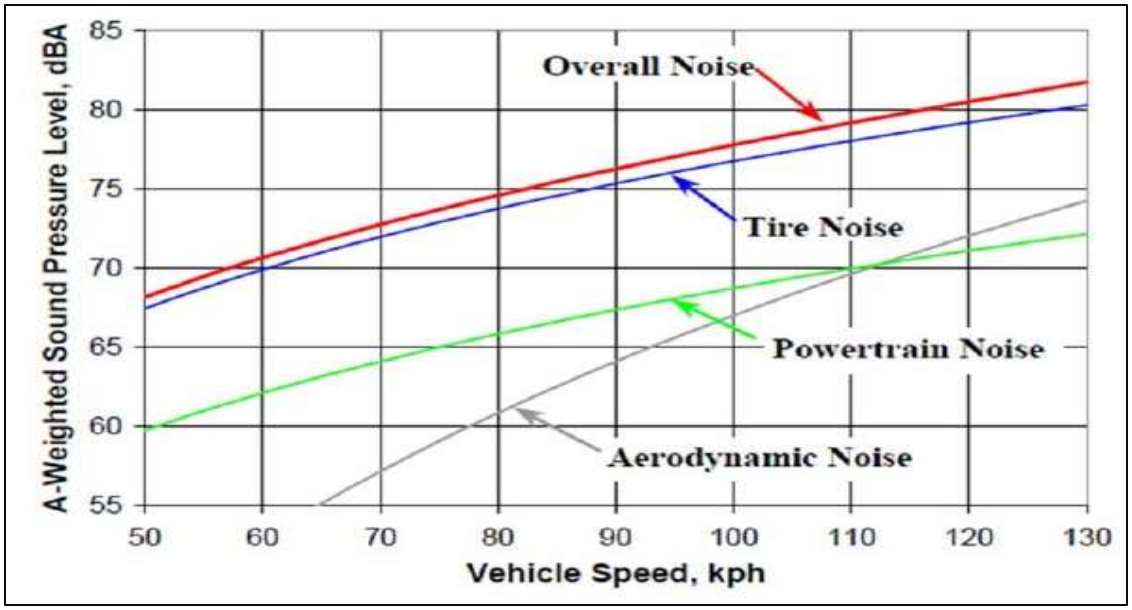


Figure 34: Comparison of Noise Level Separated by Component [Donovan, 2007]

348. **Prediction of Impacts.** Long-term noise level increase was assessed with respect to the sensitive receptors for the years 2015, 2020 and 2040 using the CRTN Model.[4] Noise barrier has been proposed in 10 educational institutions and 1 government hospital. List of sensitive receptors where noise barrier has been proposed along with height and length of noise barrier is tabulated below:

Table 104: Proposed Noise Barriers

Sl. No.	Particulars	Village	Design Ch.	Dist. (m)	Height of Noise Barrier (m)	Length of Noise Barrier (m)
1.	Govt. Degree College for Giirls	Singanallur	74+155	22.46	3.0	120
2.	Jagat Guru Sri Sukumar Swami High School	Kamagere	74+665	12.07	3.0	95
3.	Govt. Higher Primary School	Kamagere	74+840	11.10	3.0	110
4.	Aided Mission Higher Primary School	Kamagere	75+565	25.00	3.0	60
5.	Seventh Day Advantist Higher Primary School	Konagarahalli	75+820	30.57	3.0	50
6.	Holy Cross Hospital and School of Nursing	Konagarahalli	75+950	16.51	3.0	150
7.	St. Francis Xavier School	Konagarahalli	75+970	13.55	3.0	75
8.	Govt. Higher Primary School	Manglam	77+490	12.00	3.0	150
9.	GV Gouda College	Hullepuram	83+360	15.00	3.0	130
10.	Govt. Model Higher Primary School	Hanur	85+000	12.40	3.0	280
11.	Govt Hospital	Hanur	84+800	16.64	3.0	120
Total Length of Noise Barrier						**1,340**

[4] [4] CRTN predicts noise in terms of the L_{10} index, for the 18 hours between 06:00 and 24:00. The equation $LA_{eq,\,1h} = 0.94 \times L_{A10,1h} + 0.77$ dB was used to convert L_{10} to L_{Aeq} (*Abbot, P. G. and Nelson, P. M. Converting the UK Traffic Noise Index LA10,18h to EU Noise Indices for Noise Mapping. Project Report PR/SE/451/02).*

349. **Input Parameters:** Total vehicle flow for the projected period is obtained from the traffic projections. Minimum design speed of 80 km/hr is considered for operation phase. Apart from that, year-wise % of heavy vehicle, gradient, road surface, absorbent ground cover, distance from edge of the carriageway and source / receiver height difference are the other input parameters.

350. **Output:** To reduce traffic induced noise, noise barrier in the form of solid boundary wall is proposed. Height and length of the noise barrier and estimated reduction in noise level after construction of the noise barrier is given in **Table 105** and results of CRTN model is graphically presented (**Figure 35 to 36**) and Noise Contours near the sensitive receptors is shown in **Figure 37** for 1 sensitive receptor for the year 2015, 2020 and 2040.

Table 105 Sensitive Receptor Wise Predicted Noise Levels[5]

Year→	2015	2020	2025	2030	2035	2040
Govt. Degree College for Girls, Singanallur						
Traffic Noise in dB(A)	67.2	71.3	72.8	74.1	75.1	76.1
Noise at Receptor w/o Noise Barrier dB(A)	63.8	67.9	69.4	70.7	71.7	72.7
Noise at Receptor with Noise Barrier dB(A)	47	51.1	52.6	53.9	54.9	55.9
Reduction (dBA)	-16.8	-16.8	-16.8	-16.8	-16.8	-16.8
Jagat Guru Sri Sukumar Swami High School, Kamagere						
Traffic Noise in dB(A)	67.2	71.3	72.8	74.1	75.1	76.1
Noise at Receptor w/o Noise Barrier dB(A)	66.8	70.9	72.4	73.7	74.7	75.7
Noise at Receptor with Noise Barrier dB(A)	53	57.1	58.6	59.9	60.9	61.9
Reduction (dBA)	-13.8	-13.8	-13.8	-13.8	-13.8	-13.8
Govt. Higher Primary School, Kamagere						
Traffic Noise in dB(A)	67.4	71.6	73	74.3	75.3	76.3
Noise at Receptor w/o Noise Barrier dB(A)	66.2	70.4	71.8	73.1	74.1	75.1
Noise at Receptor with Noise Barrier dB(A)	52.3	56.5	57.9	59.2	60.2	61.2
Reduction (dBA)	-13.9	-13.9	-13.9	-13.9	-13.9	-13.9
Aided Mission Higher Primary School, Kamagere						
Traffic Noise in dB(A)	67.7	71.8	73.3	74.6	75.6	76.6
Noise at Receptor w/o Noise Barrier dB(A)	63.8	67.9	69.4	70.7	71.7	72.7
Noise at Receptor with Noise Barrier dB(A)	49.5	53.6	55.1	56.4	57.4	58.4
Reduction (dBA)	-14.3	-14.3	-14.3	-14.3	-14.3	-14.3
Seventh Day Adventist Higher Primary School, Konagarahalli						
Traffic Noise in dB(A)	67.5	71.6	73.1	74.4	75.4	76.4
Noise at Receptor w/o Noise Barrier dB(A)	62.6	66.7	68.2	69.5	70.5	71.5
Noise at Receptor with Noise Barrier dB(A)	49.7	53.8	55.3	56.6	57.6	58.6
Reduction (dBA)	-12.9	-12.9	-12.9	-12.9	-12.9	-12.9
Holy Cross Hospital And School of Nurshing, Konagarahalli						
Traffic Noise in dB(A)	67.4	71.5	73	74	75.3	76.3
Noise at Receptor w/o Noise Barrier dB(A)	65.9	70	71.5	72.8	73.8	74.8
Noise at Receptor with Noise Barrier dB(A)	52.3	56.4	57.9	59.2	60.2	61.2
Reduction (dBA)	-13.6	-13.6	-13.6	-13.6	-13.6	-13.6
St. Francis Xavier School, Konagarahalli						
Traffic Noise in dB(A)	67.4	71.5	73	74.3	75.3	76.3
Noise at Receptor w/o Noise Barrier dB(A)	65.6	69.7	71.2	72.5	73.5	74.5

[5] Since CRTN Model predicts noise in terms of L_{10} index, the corresponding equation $LA_{eq,\ 1h}$ = 0.94 x $L_{A10,1h}$ + 0.77 dB to convert L_{10} to L_{Aeq} will result to lower values of noise. For example, instead of the 76.1 dB (A) predicted traffic noise (L_{10}) in Govt. Degree College for Girls, Singanallur in 2040, the $LA_{eq,\ 1h}$ is only equivalent to 72.3 dB (A).

Year→	2015	2020	2025	2030	2035	2040
Noise at Receptor with Noise Barrier dB(A)	52.2	56.3	57.8	59.1	60.1	61.1
Reduction (dBA)	-13.4	-13.4	-13.4	-13.4	-13.4	-13.4
Govt. Higher Primary School, Manglam						
Traffic Noise in dB(A)	67.2	71.3	72.8	74.1	75.1	76.1
Noise at Receptor w/o Noise Barrier dB(A)	67.4	71.5	73	74.3	75.3	76.3
Noise at Receptor with Noise Barrier dB(A)	52.7	56.8	58.3	59.6	60.6	61.6
Reduction (dBA)	-14.7	-14.7	-14.7	-14.7	-14.7	-14.7
GV Gouda College, Hullepuram						
Traffic Noise in dB(A)	67.2	71.3	72.8	74.1	75.1	76.1
Noise at Receptor w/o Noise Barrier dB(A)	62.8	66.9	68.4	69.7	70.7	71.7
Noise at Receptor with Noise Barrier dB(A)	50.7	54.8	56.3	57.6	58.6	59.6
Reduction (dBA)	-12.1	-12.1	-12.1	-12.1	-12.1	-12.1
Govt. Model Higher Primary School, Hanur						
Traffic Noise in dB(A)	67.2	71.3	72.8	74.1	75.1	76.1
Noise at Receptor w/o Noise Barrier dB(A)	63.5	67.6	69.1	70.4	71.4	72.4
Noise at Receptor with Noise Barrier dB(A)	50.5	54.6	56.1	57.4	58.4	59.4
Reduction (dBA)	-13	-13	-13	-13	-13	-13
Govt. Hospital, Hanur						
Traffic Noise in dB(A)	67.6	71.7	73.3	74.5	75.5	76.5
Noise at Receptor w/o Noise Barrier dB(A)	68.1	72.2	73.7	75	76	77
Noise at Receptor with Noise Barrier dB(A)	54	58.1	59.6	60.9	61.9	62.9
Reduction (dBA)	-14.1	-14.1	-14.1	-14.1	-14.1	-14.1

351. Height of noise barrier has been proposed 3 m. It has been observed that, in the year 2030, the value of noise at the receptor will increase substantially from the base year (2015). However, to maintain the noise level at the receptors, the barrier height should be increased by 0.5 m in the year 2035 (height 3.5 m) and further 0.5 m in 2040 (height 4.0 m). It is recommended that the foundation of the noise barrier should be made in such a way that it can bear the load of incremental heights in future, if required.

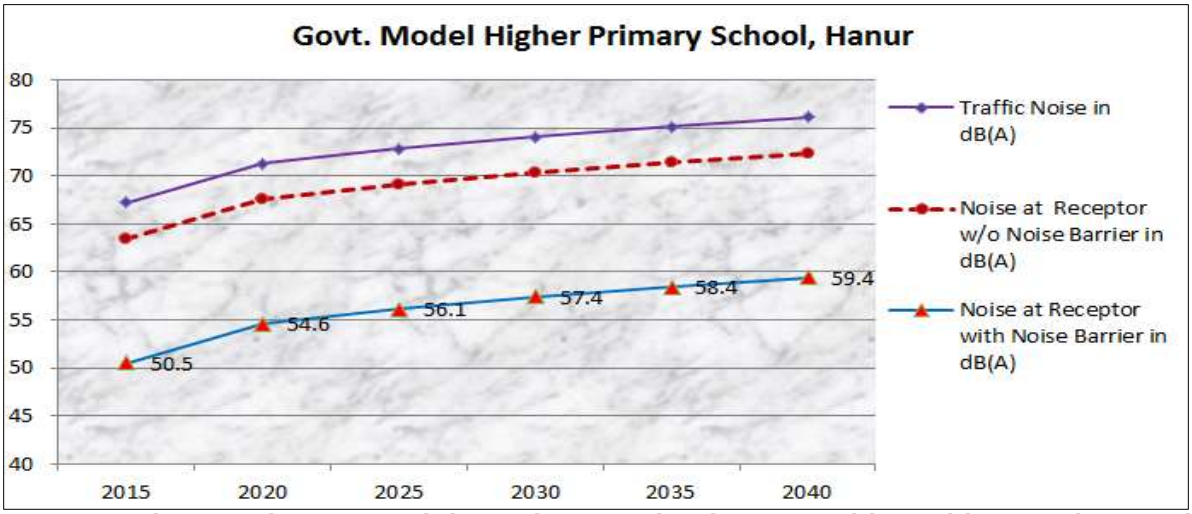


Figure 35: Noise Level at Govt. Higher Primary School, Hanur with & without Noise Barrier

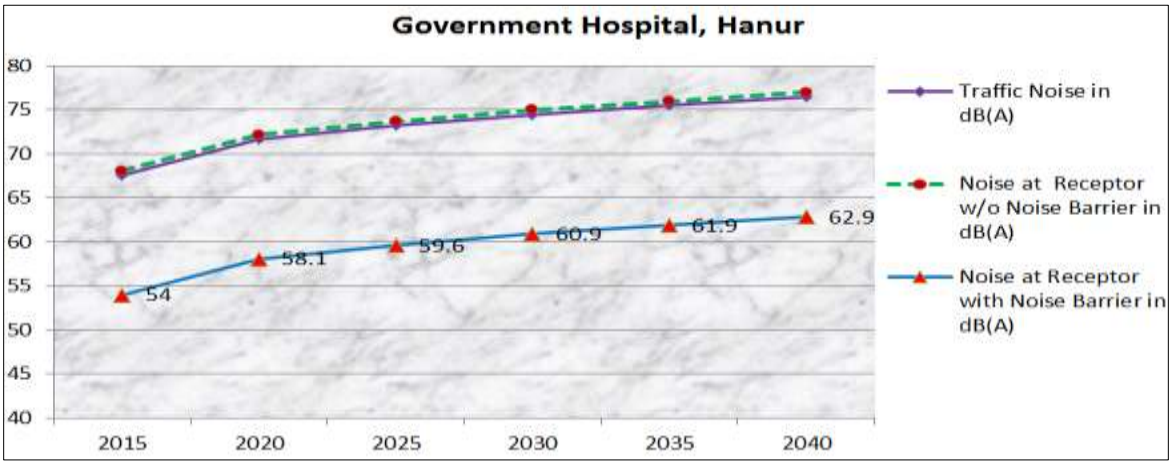


Figure 36: Noise Level at Govt. Hospital, Hanur with & without Noise Barrier

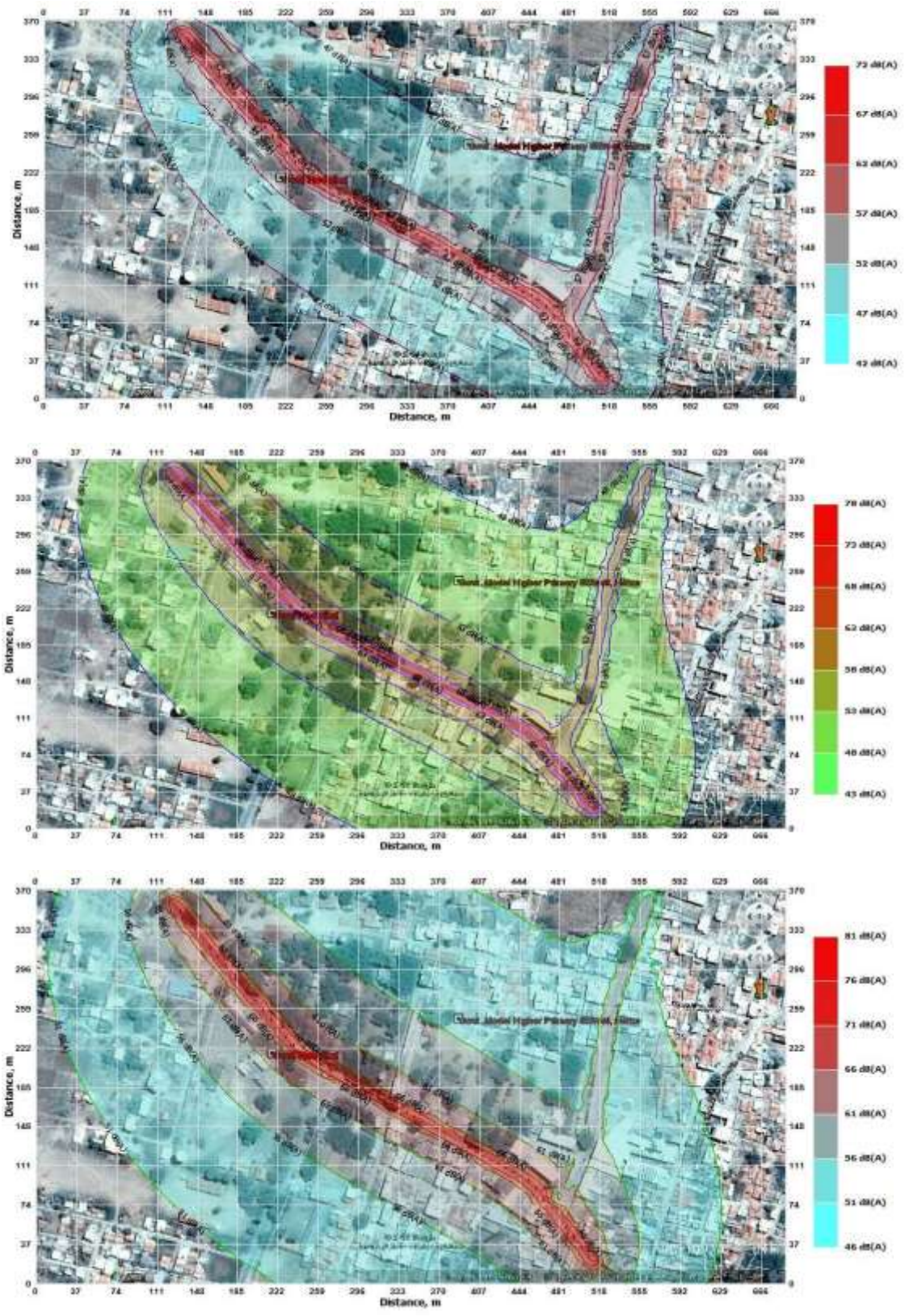


Figure 37: Noise Contour at Govt. Higher Primary School, Hanur

3. Noise Barrier

352. To reduce traffic induced noise, noise barrier in the form of solid boundary wall is proposed for sensitive receptors. The noise barrier wall shall be constructed by excavation of foundation, laying of brick masonry wall, plastering and painting. It is also proposed to plant shade and flowering trees within the boundary of the sensitive receptors, between the building line and the compound wall (**Figure 38**). Creepers may be planted in consultation with the local forest officials to give an aesthetic look. Drawing of typical noise barrier is given in **Annex-8.25**.

Figure 38: View of Solid Boundary Wall with Trees and Creepers

4. Various Noise Barrier Materials

353. Noise barriers are a necessary structure along the highway to protect the sensitive receptors from excessive road noise. There are many different materials from which noise barriers can be constructed such as brick, concrete, plastic, wood, mixed type (existing wall, top up with dense fibre/polyethylene wall) high density fibre/polyethylene etc. Each of the materials used to construct noise barrier has advantages and disadvantages both acoustically and aesthetically.

354. Several studies have been conducted to identify the noise barrier material that produced the greatest noise reduction. It can be concluded from literature review that:

- Absorptive wall materials absorbed more sound energy than a standard reflective material
- Concrete noise abatement walls yields a mean insertion loss of 18.54 dB, which is maximum in comparison to the other materials such as Fiberglass (17.35 dB), Wood (13.60 dB) Acoustic Fabric Fence materials (11.62 dB), Earthen Berms (12.93 dB) etc.

355. However, keeping in view the policy of KSHIP and cost effectiveness, brick has been proposed as a material for construction of noise barrier. In KSHIP – II, brick wall has been constructed as noise barrier and effectiveness of the barrier is discussed in ***Section 6.5.2.5***. In the year 2035, the noise level at the receptor will increase about 4 dB(A) from the base year (2015). Therefore, to maintain the noise level at the receptors, construction of concrete wall may be considered in the year 2035.

356. **Mitigation Measures**

- Vehicular noise & use of horns will be controlled through enforcement of laws and public awareness. It will be ensured that all the vehicles are using proper horn as per norms to keep noise within the permissible limits.
- Silence zones will be demarcated and road signs prohibiting the use of horns will be displayed at residential areas, sensitive locations and silence zones.
- Regular monitoring of noise level at specified representative locations will be conducted at fixed interval.
- Roadside plantation with suitable species near sensitive receptors and inhabited areas will result in partial noise attenuation.
- Maintenance of noise barrier

5. Experience on Noise Barrier installed under KSHIP-II

357. The Karnataka State Highways Improvement Project has taken up improvements of 831 km of State Highways in the state with financial assistance from the World Bank under the Second Karnataka State Highways Improvement Project (KSHIP–II) at a cost of US$ 350 Million. Under the project, the existing single / intermittent roads are to be strengthened and widened to 2 way carriage way with paved / unpaved shoulders on either side. The civil works were taken up under (i) Engineering Procurement Construction (EPC) contract in five packages for 268.9 Kms of roads and (ii) Engineering Procurement Annuity (EPA) contract in four packages for 562 Kms of roads.

358. As part of the road up-gradation / improvements, KSHIP had constructed noise barriers at selected sensitive receptor locations like schools, colleges, hospitals, temples among others at various chainage along roads under EPC packages. A study was conducted by KSHIP to assess the effectiveness of such constructed noise barriers and accordingly 8 selected sensitive receptor locations, which are either on almost road side or very close to road and have maximum exposure to traffic of the road for most hours of the day were selected.

359. In order to determine the effectiveness of noise barriers, ambient noise levels were recorded on either side of the noise barrier i.e. at the edge of noise barrier towards roadside and at the nearest wall of the sensitive receptor, but away from noise barrier, falling in the same straight line and perpendicular to road. The noise levels monitored at these noise barrier locations were carried out over 8 hours during the daytime (6 a.m. to 10 p.m.) as per the stipulated guidelines.

360. The test results of the ambient noise levels monitored at these noise barrier locations along with the minimum, maximum and mean values recorded during the monitoring period are summarized in **Table 106.**

Table 106: Summary of Noise Level Monitoring Results at selected Noise Barriers

Name of Link & Link No	Monitoring Date	Sampling Location	Monitoring Duration	Monitoring in front of Barrier (Road Side)	Monitoring behind Noise Barrier	% Reduction
				Leq* dB (A) (Mean)	Leq* dB (A) (Mean)	
Hangal-Tadasa, M7D	13.03.2012	Govt. School	2.00 to 10.00 p.m.	67.06	**55.05**	17.91

Name of Link & Link No	Monitoring Date	Sampling Location	Monitoring Duration	Monitoring in front of Barrier (Road Side)	Monitoring behind Noise Barrier	% Reduction
				Leq* dB (A) (Mean)	Leq* dB (A) (Mean)	
Haveri(NH4) - Hangal, T8	14.03.2012	Govt. School, Aladakatti	10.00 a.m. to 7.00 p.m.	70.41	**62.51**	11.22
Dharwad-Saundatti, 21B	16.03.2012	Govt. School, Heriahulligere	9.00 a.m. to 5.00 p.m.	65.64	**59.18**	9.84
Devadurga-Kalmala, 13B	20.03.2012	Govt. Primary School, Kakaragal	9.00 a.m. to 5.00 p.m.	60.31	**56.78**	5.85
Thinthini-Devadurga, 13A	21.03.2012	Govt. Higher Primary School, Yaragudda	9.00 a.m. to 5.00 p.m.	61.34	**58.22**	5.09
Chowdapur-Gulbarga, 6C	22.03.2012	Govt. Urdu Higher Primary School, Gubbur	10.00 to 6.00 p.m.	63.36	**58.2**	8.14
Hindgnala cross-Chintamani By pass, 67B	09.04.2012	Govt. Higher Primary School, & High School, Talagavara	9.00 a.m. to 5.00 p.m.	72.64	**57.3**	21.12
Hoskote - Hindgnala Cross,67A	11.04.2012	Govt. High School, Dodda Hulluru	9.00 a.m. to 5.00 p.m.	68.34	**59.6**	12.79

*dB(A) Leq denotes the time weighted average of the level of sound in decibels on scale A which is relatable to human hearing.

361. An assessment of the recorded noise levels given in Table 88, monitored on either side of the noise barriers as mentioned above indicate a reduction in noise levels up to 21%, which can be attributed to the effectiveness of noise barrier. The histograms depicting the ambient noise levels on either side of the noise barriers, monitored along selected roads under EPC packages receptors along with percentage reduction in noise levels due to noise barriers are presented in **Figure 39**.

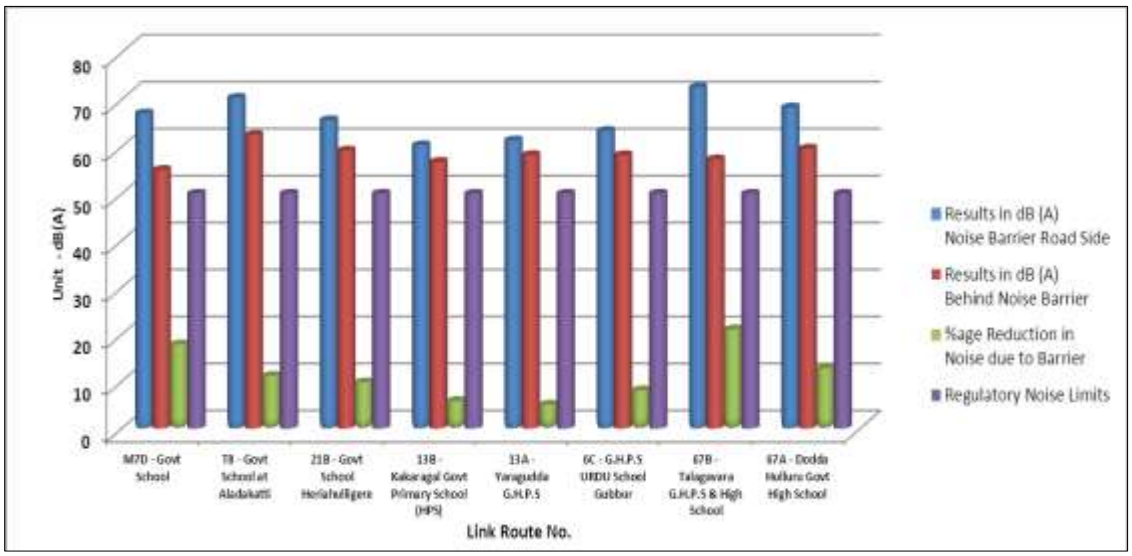


Figure 39: Noise Level Monitoring Results at Selected Noise Barrier Locations

F. Flora

1. Construction Phase

362. **Impacts:**

- Loss of flora due to felling of trees along the ROW
- No threatened species of flora is falling in the ROW of the project road
- Deposition of fugitive dust on pubescent leaves of nearby vegetation may lead to temporary reduction of photosynthesis. Such impacts will, however, be confined mostly to the initial periods of the construction phase and in the immediate vicinity of the construction area.
- In the long term, compensatory afforestation and Green belt development will enhance environment of the project area.

363. **Felling of Roadside Trees:** Efforts were made to minimize the number of trees to be felled. Considering the need to minimize land acquisition, concentric widening of existing carriageway (2 lane with paved shoulder and 4 land divided carriageway) is adopted for majority of the section Approximately 714 trees are required to be felled for the improvement of the road. However, this number may reduce and actual number of trees to be felled can be determined only after the completion of joint inspection with the Forest Department. Trees species abutting the project road mainly comprise of *Ficus benghalensis* (Banyan), *Ficus religiosa*, (Peepal), *Azadirachta indica* (Neem), *Pongammia pinnata* (Karanj), *Syzigium cumini* (Jamun), *Eucalyptus teriticornis* (Eucalyptus), *Tamarindus indica* (Tamarind) *etc. G*irth-size wise distribution of trees to be felled along both side of the road is presented in **Table 107.**

Table 107: Girth Size wise distribution of trees to be felled

Side	No of Trees in Girth Class (in cm)					Total
	<30	**31-59**	**60-119**	**120-180**	**>180**	
RHS	48	95	168	50	22	383
LHS	55	98	105	35	38	331
	103	**193**	**273**	**85**	**60**	**714**

364. **Green Tunnel:** Efforts were made to save green tunnel along the project road and this issue was also discussed during public consultation. To minimise the impacts on residential, commercial, religious and educational structures as well as to minimise the acquisition of fertile agricultural land, concentric widening has been proposed. Further, efforts were made to restrict the widening within the existing ROW. Most of the trees along with project road are located within 1-1.5 m from the existing blacktop. Therefore, to minimise the social impacts, green tunnel could not be saved in Kollegal to Hanur road but most of the giant trees will be saved.

365. **Mitigation Measures**

- Avoid cutting the giant trees to the extent possible
- The proposed improvement as far as possible is within the existing (ROW) avoiding land acquisition except for locations having inadequate width, realignments with geometric improvements, provision of highway facilities. Out of the total 23.782 km length of project road 15.277 km involves concentric widening, so the land acquisition is minimized and it will require limited vegetation clearing within the ROW only.
- It shall be ensured that trees located outside ROW shall not be felled.
- The trees required to be felled shall be identified, marked and verified by Forest department. Felling of trees shall be done only after obtaining Tree Felling

Permission from competent authority. No threatened species of flora is reported in the ROW. The trees planted along the roads are common in distribution and found throughout the region.

- **Roadside Plantations:** To mitigate the adverse impact due to the felling of the roadside trees plantations shall be done. One row of tree shall be planted on both sides of the project road outside drain line where space is available. In urban sections, 16 m to 20 m ROW has been proposed to minimize social impact, where no space is available for plantation. Chainage wise length of the project road, where no space available for plantation is presented in Table 108

Table 108: Chainage wise Length where no space available for Plantation

Design Ch. Km		Length (km)	Cross Section Type	Description
From	To			
74+500	76+100	1.600	TCS-3	4 land divided carriageway (Urban Section)
77+300	78+200	0.900	TCS-3	4 land divided carriageway (Urban Section)
83+280	84+320	1.040	TCS-4	2 lane with paved shoulder (Urban Section)
84+320	85+600	1.280	TCS-3	4 land divided carriageway (Urban Section)
Total Length (Km)		**4.82**		

366. Total length of the project road is **23.782 km** and effective length available for plantation is **18.962 km**. PIU-KSHIP has an arrangement with the Forest Department to plant the trees. In KSHIP-II, per km 200 trees (10 m interval on either side) were planted and the same system will be followed in KSHIP-III. Therefore, in 18.962 km stretch, **3,793 trees** shall be planted on both sides of the project road. Detail of plantation provided in Tree Plantation Strategy (**Annex-8.12**).

367. 335 trees will be planted along the boundary of noise barrier at 4 m interval (total length of noise barrier is 1.340 km)

- Total number of trees will be planted : **4,128 trees (1:5)**
  - ❖ Road side plantation : 3,793 trees
  - ❖ Plantation along the noise barrier : 335 trees

- The Karnataka Preservation of Trees Act, 1976 shall be abided. Trees in non-forest/ agriculture land shall be felled only after obtaining permission from competent authority.
- Species suggested for plantation are provided in the Table 109.

Table 109: Tree Species suggested for Plantation

S. No	Species	Value	Visitors*
1.	*Tamarindus indica*	Nectar, Fruits	I,B,M
2.	*Butea monosperma*	Nectar, Dust & Pollution Control	I,B,M
3.	*Ficus microcarpa*	Fruit	I,B,M
4.	*Mangifera indica*	Nectar, Fruits & Pollution Control	I,B,M
5.	*Phoenix sylvestris*	Nectar, Fruits	I,B,M
6.	*Pongamia pinnata*	Nectar, Dust & Pollution Control	I,M
7.	*Syzigium cumini*	Nectar, Fruits	I,B,M
8.	*Ziziphus mauritiana*	Fruit	B,M

* I – Insects, B – Birds, M – Mammals

- The plantation shall be maintained for 5 years. Dead saplings shall be replaced

to maintain the survival percentage of 90%.

- Horticultural trees such as Mango, Custard Apple, Papaya, Pomegranate etc. may be distributed to farmers in affected villages freely as part of Corporate Social Responsibility (CSR) to compensate the loss of horticultural trees in the area.
- To enhance the visual and landscape near water bodies, plantation is suggested. Species such Terminalia arjuna, Syzigium cumini etc. and flowering plants such as Champa, Jasmine, Rose etc. can be planted.
- Oil seed species / Bio fuel trees species such as Pongamia Pinnata, Azadirachta Indica, Simarouba Glauca, Madhuca Indica / Latifolia, Calophyllum Inophyllum also suggested for Plantation
- Native indigenous trees species shall be used as far as practicable, strictly avoiding any exotic (but popular) species like Eucalyptus sp. that can have far-reaching adverse effects on the ecology and water regime of the area.
- Soil erosion shall be checked by adopting bio-engineering measures.
- Construction camps shall be located away from Forest areas and movement of labours shall be monitored by Independent Engineer and Contractor.
- LPG/ Kerosene shall be provided by the Contractor for cooking.
- The impact on flora will be concentrated within the ROW of the road and cutting of trees or clearing of vegetation outside ROW shall be strictly prohibited.

2. Operation Phase

368. **Impacts:** Illegal felling of road side plantation

369. **Mitigation Measures:**

- Plantation along the ROW will be maintained properly
- Plantation along the ROW will be protected from illegal felling

G. Fauna

1. Construction Phase

370. **Impacts:**

- Wildlife can survive if the landscapes they live in remain intact. The clearing of land and felling of trees will directly cause loss of habitat to avifauna and wildlife dwelling in the area.
- The proposed project does not involve diversion of forest land
- The domestic fauna in the area will also face problem in movement due to construction activity.

371. **Mitigation Measures**

- The Contractor shall ensure that all the people at construction site abide by the law prohibiting hunting of wildlife. Poaching will be strictly banned and any incidence of poaching of wildlife by workforce shall be reported to the Forest / Wildlife Department
- All staff / workers will be instructed not to chase or disturb if any wildlife seen near the project area. The incidence of sighting wildlife near project site should be reported to Forest Department.
- Noise will be kept under control by regular maintenance of equipment and vehicles. Noisy activity shall be prohibited during night time.

- Trees located outside ROW will not be felled.
- Implementing sediment and erosion controls during construction will minimize adverse Impacts of water bodies. Construction activity will be avoided near water bodies during rainy season.
- Existing and proposed culverts and minor bridges along the project stretch will facilitate the movement / crossing of wildlife in the area.
- Plantation of fruit bearing species will support the future demand of the fauna dwelling in the project area. It will provide additional habitats to avifauna dwelling in the area.
- Impact on availability of fodder due to loss of trees and agricultural area shall be negligible on domestic fauna.
- Overall the impact will be insignificant on fauna of the project area.

2. Operation Phase

372. **Impacts:**

- Effect on aquatic fauna in case of accidental oil spill & toxic chemical release find its way into the water bodies.
- Illegal felling of road side plantation

373. **Mitigation Measures:**

- Contingent actions will be taken for speedy cleaning up of oil spills, fuel and toxic chemicals in the event of accidents
- Plantation along the ROW will be protected from illegal felling

H. Protected Area

374. The project road does not traverse through any National Park, Wildlife Sanctuary or Biosphere Reserve. However Malai Mahadeshwara Wildlife Sanctuary, Cauvery Wildlife sanctuary and Biligiri Rangaswamy Temple (BRT) Wildlife Sanctuary falls within 15km radius of the project road, therefore the project falls in Eco-sensitive zones of the sanctuaries.

375. **Conservation Threats:** The project road does not traverse through Malai Mahadeshwara, Cauvery and Biligiri Rangaswamy Temple wildlife sanctuaries. The project road will not cause any fragmentation or diversion of wildlife habitat. No construction activity is envisaged within the sanctuaries. The improvement of project road will not have any adverse impact on the wildlife habitat. The threats identified to the wildlife in the sanctuaries are:

i. Poaching of wild animals, specially Bull Elephants
ii. Illegal Cattle grazing
iii. Fire hazard during summer months
iv. Encroachment of Forest lands
v. Cutting trees for timber and firewood
vi. Lack of perennial waterholes
vii. Soil erosion
viii. Disease and pests
ix. Man and animal conflict

376. Wildlife awareness program shall be conducted during Construction phase to sensitise the PIU and Contractor staff at site about the importance of wildlife and ecological value of the

area. Poaching will be strictly prohibited; movement of labours shall be monitored by supervision consultant.

I. Reserved Forest

377. The proposed project does not involve diversion of reserved forest land. Hence, there will be **no impact on reserved forest**.

J. Induced Cumulative Impact

378. According to the ADB Environment Safeguards Sourcebook cumulative impact is described as: “The combination of multiple impacts from existing projects, the proposed project and anticipated future projects that may result in significant adverse and / or beneficial impacts that cannot be expected in the case of a stand-alone project.” The sourcebook also describes induced impacts as: “Adverse and / or beneficial impacts on areas and communities from unintended but predictable developments caused by a project, which may occur at later or at a different location.

379. Economic activities supporting transport like fuel stations, automotive repair shops, lodging, and restaurants are expected to increase with increase of traffic and induce development in the project area. Increase in agro-industrial activities are also expected to take advantage of improved access to urban centers where there are higher demand and better prices for agricultural products. The project area has good infrastructure for industrialization. Hence the project will accelerate industrial activities and induce development significantly. Further the increased industrial activities will significantly reduce migration. The improved road will provide better connectivity and result in (i) Reduction in travel time (ii) better mode and frequency of transport (iii) access to quality health care facilities, educational and other infrastructural facilities (iv) enhanced tourism activities in the area and state which in many terms will boost the local economy (v) better investment climate for industries creating more employment opportunities to local people.

380. In terms of environment safeguard issues the improved road surface is expected to result in less dust and noise due to traffic plying on the damaged roads. However, the increased traffic due to the improved road will generate more air pollution due to vehicle exhaust and noise. The smoother road conditions will also result in increase of traffic speeds, hence creating more risks for accidents amongst traffic users as well as the local communities in the project area. Improvement in local economic conditions can also result in unorganized and illegal establishment of settlements and businesses along the roads creating new problems of waste and pollution. To address these potential problems relevant local authorities will have to monitor developments and strictly enforce rules.

381. For addressing the impacts of air pollution and noise, regular maintenance of the road surface, maintenance and monitoring of newly planted trees, noise barriers have been included in the EMP for implementation during operation stage. For addressing safety related impacts, regular maintenance of the road furniture including safety related furniture, has been included in the EMP for implementation during operation stage. Relevant local authorities will need to monitor developments locally and strict enforce rules on location for establishment of new business and houses along the improved road.

382. Information on other development projects in and around the project area was not available. Hence, it is difficult to assess cumulative impacts from other projects which may get implemented in the project area.

K. Climate Change Impacts and Risks

1. Climate Change Mitigation

383. The Transport Emissions Evaluation Model for Projects (TEEMP)[6] developed by Clean Air Asia[7] was utilized to assess the CO_2 gross emissions with and without the project improvements. The main improvement from the project that was considered for the model are better surface roughness with initially 2.5 m/km which may deteriorate over a period but not less than 3.1 m/km and widening of roads from 2 lane to 4 lane divided highway with paved shoulder configuration. These were translated into impacts on traffic speed and hence fuel consumption. The model also allows for the inclusion of impacts related to traffic congestion with and without project through provisions for inserting data on the traffic numbers, lane width, number of lanes and volume / capacity saturation limit.

384. Information that was fed into the model for projecting the CO_2 emissions were:

i) The project will rehabilitate and widen **23.782 km** of the SH-79 from Kollegal to Hanur, which will has only one Homogeneous sections: HS-I.
ii) The road configuration will change from 2 lane to 2 lane with paved shoulder with carriageway width of 7.0 m and will have an asphalt bituminous surface.
iii) Existing road roughness varies from 4.7 m/km to 6.0 m/km and will be improved to 2.5 m/km, which may further reach up to 3.1 m/km during 5 years of road operations and hence will be resurfaced after every 5 years.
iv) Construction will take place over a period of 24 months in 2017-19 and road operations will begin in 2020.
v) The design life of the road is 20 years (2020 to 2039)
vi) Other improvements include the repair or reconstruction of damaged culverts, introduction of lined longitudinal and cross drains for the road and removal of irregularities on the existing vertical profile and road safety appurtenances.

385. Traffic forecasts were taken from the detailed project report. Maximum PCU for 4.0 lane divided highway with paved shoulder were considered as 80,000 in consistent to IRC guidelines. The volume / capacity saturation limit was taken at 2.0 for optimum travel speed and fuel consumption. Emission factors were mostly taken from the CBCP / MOEF (2007) Draft Report on Emission Factor Development for Indian Vehicles, the Automotive Research Association of India, and C. Reynolds et.al (2011) Climate and Health Relevant Emissions from in-Use Indian for three-wheelers rickshaw as follows:

[6] TEEMP is an excel-based, free-of-charge spreadsheet models to evaluate emissions impacts of transport projects.

[7] A network of 250 organizations in 31 countries established by the Asian Development Bank, World Bank, and USAID to promote better air quality and livable cities by translating knowledge to policies and actions that reduce air pollution and greenhouse gas emissions from transport, energy and other sectors.

Table 110: CO2 Emission Factors

Vehicle Type	Gasoline	Diesel
2-Wheel	2.28 kg/l	
3-Wheel		2.63 kg/l
Cars/ Jeeps	2.59 kg/l	2.68 kg/l
LCV		3.21 kg/l
Bus		3.61 kg/l
HCV		3.50 kg/l

386. It was assumed that in Homogeneous Section-I, 2-wheelers and 3-wheelers have average trip distance of 1/3rd of the total road length and all other vehicles do use the entire length as average trip distance. Furthermore, 2-wheelers and 3-wheelers constitute 100% and 90%, respectively of the total local traffic. It has also been assumed that over the time, the fleet composition will change and the assumptions taken for the same are as follows:

Table 111: Emission Standards of Fleet (%)

Vehicle Type	Current Scenario				Year 2039		
	Pre-Euro	Euro I	Euro II	Euro III	Euro I	Euro II	Euro III
2-Wheel		50%	50%		30%	70%	-
3-Wheel	80%	20%			40%	60%	
Cars/ Jeeps		40%	40%	20%		40%	60%
LCV/Bus/HCV		70%	20%	10%	10%	40%	50%

387. Emissions from road construction were estimated by using the emission factor for rural/ urban roads, by using ADB - Carbon footprint 4 (http://www.adb.org/documents/reports/estimating-carbon-footprints-road-projects/default.asp), which is equivalent to 109,600 kg CO2/km of road construction. ,

2. Estimated Carbon Emissions

388. The proposed road upgrading resulting to surface roughness and road capacity improvements have implications in CO_2 emissions. Improved roughness results to higher speed and lesser emissions while increase road users increases emissions. These factors are further affected by traffic congestion once the volume/capacity saturation limit.

389. CO_2 emissions will also result from the processing and manufacturing of raw materials needed to upgrade the project road and in the case of project, to upgrade and strengthen the road length of approximately 23.782 km, total CO_2 emissions will be of the order of 2,606.5 tons.

Table 112: Estimated Total CO2 Emissions during Road Construction

Road Section	Length (km)	Emission Factor (ton CO2/km)	CO2 Emission (tons)
HS-I	23.782	109.6	2606.5
Total	**23.782**		**2606.5**

390. The design life of roads is 20 years. Total CO_2 emission at Business-As-Usual scenario was estimated at **1,474.63** tons/year, without and with-induced traffic are **3,403.46** tons / year and **3,994.18** tons / year respectively. These values are below the 100,000 tons per year

threshold[8] set in the ADB SPS 2009. Therefore it is not necessary to implement options to reduce or offset CO_2 emissions under the project. The project's section-wise CO_2 emission intensity indicators are provided below:

Table 113: Section-wise Project CO2 Emissions Intensity Indicators

Road Sections	Particular	CO2 emission		
		Business-As-Usual	Project (without Induced Traffic)	Project (with Induced Traffic)
HS-I	tons/km	1,240.12	2,862.22	3,359.00
	tons/year	1,474.63	3,403.46	3,994.18
	tons/km/year	62.01	143.11	167.95
	g/t km	45.22	58.38	55.99
	g/tkm	117.69	160.75	155.03

391. Overall Project's CO2 emission intensity indicators are provided below:

Table 114: Project CO2 Emissions Intensity Indicators

Particular	CO2		
	Business-As-Usual	Project (without Induced Traffic)	Project (with Induced Traffic)
tons/km	1,240.12	2,862.22	3,359.00
tons/year	1,474.63	3,403.46	3,994.18
tons/km/year	62.01	143.11	167.95
g/t km	45.22	58.38	55.99
g/tkm	117.69	160.75	155.03

392. The with-project scenarios will be have higher CO_2 emissions. Furthermore, with project scenarios (both without and with induced traffic), there will be increase in the CO_2 emission levels over the time due to the increase in the traffic volume, however, the emissions will be controlled by maintaining the road roughness below 3.0 m/km during the entire project life as well as enhanced capacity of the road. This will result in annual CO_2 emissions of the project road much below the threshold limit of 100,000 tons/year.

3. Climate Risks and Adaptation needs

393. In today's world, climate change is considered the most serious global challenge. Changes in the atmosphere have been detected that could drastically alter the climate system and the balance of ecosystems. Atmospheric changes are linked to an increase in greenhouse gases (GHGs), chiefly on account of anthropogenic releases attributed to fossil fuel consumption, land use changes, deforestation etc. Research has established that carbon dioxide (CO2) levels in the atmosphere have risen by 35% since the pre-industrial era. Rising CO2 concentrations increase the energy retention of Earth's atmosphere, leading to a gradual rise of average temperatures and global warming. Sector specific climate risks screening has been done based on secondary sources to analyze impact on road components due to likely change in climatic variables, mainly temperature and precipitation.

394. **Temperature:** A warming trend in Karnataka for the period June to September was observed by Bangalore Climate Change Initiative – Karnataka (BCCI-K) (2011). As per Karnataka State Action Plan on Climate Change (KSAPCC), districts of northern interior Karnataka (Bidar, Bijapur, Gulbarga, Yadgir and Raichur) experienced an increase of both the

[8] Page 38, Appendix I, footnote 10 of SPS 2009

minimum and the maximum temperature by ≥ 0.6°C over the last 100 years. In terms of magnitude this finding is 0.1°C higher than the 0.5°C annual increase IMD observed over the past 100 years for most parts of the country. The study also projects further warming: 1.7°C to 2.2°C by the 2030s. The projected increase of annual average temperatures for the northern districts is higher than the southern districts.

395. The project road is located in Chamrajnagar district of Karnataka. As per the KSAPCC, projected minimum temperature increases are slightly above those of the maximum temperatures (**Table 115**).

Table 115: Projected change in annual temperature for 2021-50 compared to 1961-90

Districts	Projected change tAVG in °C	Projected change tMIN in °C	Projected change tMAX in °C
Chamrajnagar	1.96	2.03	1.94

Source: Karnataka State Action Plan on Climate Change, March 2012

396. **Precipitation:** Out of the average annual rainfall in Karnataka, the state receives 80% during the southwest monsoon period, 12% in the post-monsoon period, 7% in summer and only 1% in winter. The windward side of the Western Ghats, which is the coastal region, records 3,350 mm of rainfall during the southwest monsoon while on the leeward side rainfall drops to 600- 700 mm. BCCI-K (2011) assessed trends based on daily weather data from Indian Meteorology Department (IMD) for the period 1901 to 2008. The study observed a decline in annual rainfall from 1,204 mm during 1901-1950 to 1,140 during 1951-2008. however that IMD Bangalore, who provided the baseline data for the BCCI-K study, disagrees with the conclusion that rainfall in Karnataka has been declining.

397. Increased temperature and precipitation will have following impacts:

- **High Precipitation Impacting Roads /Bridge /Embankment:** Heavy rains can cause disruption of the road networks, decreased accessibility, erosion of roads and embankments, surface water drainage problems, slope failures, landslides, among others. Increased river flow resulting from precipitation and storminess may result in damages to bridges, pavements, and other road structures. Bridge / culvert capacities are reduced or exceeded, causing upstream flooding to occur.
- **High Temperature Impacting Road Stability:** Extreme heat, combined with traffic loading, speed and density can soften asphalt roads, leading to increased wear and tear. It is likely that there would be concerns regarding pavement integrity such as softening, traffic-related rutting, embrittlement, migration of liquid asphalt. Additionally, thermal expansion in bridge expansion joints and paved surfaces may be experienced.
- **Earthquake:** The project road is situated in the Zone II (having low seismic intensity) of the Seismic Map of India (as per IS: 1893, Part I, 2002) and therefore has a low risk of potential damage due to earthquake. Relevant IS codes have been adopted in designing the structures to sustain the magnitude of earthquake corresponding to Seismic zone II.
- **Forest Fire:** As per “Karnataka State Action Plan on Climate Change (KSAPCC)”, vast tracts of forest fall victim to forest fires every year. Rising temperatures and reduced top soil moisture due to increased evapotranspiration, the forest fire risk will escalate in the future.

398. **Drought**: As per KSAPCC, Karnataka ranks second in India after Rajasthan. 54% of the geographical area is drought prone, affecting 88 of 176 taluks and 18 of the 30 districts. The taluks of the northern drought-prone districts have in general, more years of moderate and severe drought than the taluks in the southern districts. Study of BCCI-K (2011) indicates that most northern districts of Karnataka would have 10-80% increased drought incidences.

399. Increased drought frequency may lead to increased susceptibility to consolidation of the substructure with (unequal) settlement, more generation of smog, and unavailability of water for compaction work.

400. **Cyclone:** It can be concluded from the analysis of past meteorological data that cyclone, dust storms are extreme rare in the study area. Impact of cyclone is likely to be low.

401. **Flood:** The study area does not have flood problem. CWC in association with IMD and Ministry of Surface Transport (MOST) has prepared Flood Estimation Reports for small and medium catchments for each hydro meteorologically homogeneous 26 sub-zones. The project area is falling in sub zones 3(h) and 3(i). All structure have been designed for 50 year return period with anticipated risk of rarer flood generally of next higher frequency i.e. 100 year return period flood on the designed structures. Roadside toe drains shall be provided to receive discharge from embankment surface and countryside runoff and carry it safely to the nearest outfall point ensuring safety to the embankment toe, which is the area most vulnerable to erosion / failure.

402. Key engineering measures taken to address flood risks in the design are: i) increase in embankment height, ii) construction of new side and lead away drains, iii) construction of new culverts and widening of existing ones and iv) widening of bridges. As shown in **Table 116**, costs for taking these measures add up to a total of **Rs. 7.95 crores**. This is approximately 7.3% of the total civil works costs. It must be pointed out that these measures would have been considered anyway in the conventional design as the issue of flooding is a threat to the sustainability of the road. However, these measures also contribute to adaptation of the roads for future increases in precipitation. This risk screening and risk identification exercise has helped to ensure that the project road with climate risks have adequate risk mitigation or adaptation measures. Provisions have also been made in the bidding documents for the contractor to prepare contract package specific EMP's based on the final detailed design to address a range of issues including climate related risks and vulnerabilities and accordingly incorporate required costs in the BOQ.

Table 116: Details of Climate Adaptation Measures with Cost Implications

Roads/Details	**Kollegal to Hanur**
Cross Drainage Structures	
Increase in Length in proposed culverts (in meter)	14.9
Cost Impact (Rs. Crore)	***1.27***
Increase in Length of Bridges (in meter)	21
Cost Implication (Rs. Crore)	***1.35***
Embankment	
Total length of Embankment (in meter)	18962
Increase in Height (in meter)	0.6-1 m
Cost Implication for increasi (Rs. Crore)	***4.01***
Roadside drains	
Lined built-up (m)	4820
Unlined open (m)	18202

Cost Implication increasing depth (Rs. Crore)	**1.32**
Total Cost (Rs. Crore)	**7.95**

L. Social Impacts

1. Educational, Medical and Religious Properties

403. **Impacts:** Roadside amenities, religious and cultural properties generally include:

- Educational institutions (schools & colleges)
- Medical amenities (hospitals & health centers)
- Religious properties (temples, mosques, Church etc.)

404. Due to additional land acquisition & widening of the road, there will be some impact on the roadside educational, medical and religious places. In few cases the impacts will be total (e.g. the main structure has to be demolished), and in few cases the impacts will be partial (e.g. only boundary wall and/or part of the structure has to be demolished) depending on the distance of the structure from the road. The impacts on roadside amenities, religious and cultural properties are summarized in **Table 117**.

Table 117: Number of Roadside Educational, Medical and Religious Properties Affected

Items	Number of Educational, Medical and Religious Properties			
	Fully Affected	**Partly Affected**	**Not Affected**	**Total**
Educational Institutions	0	1	28	29
Medical Amenities	1	0	3	4
Religious Places	0	0	21	21

- Out of 29 educational institutions along the project road, only 1 will be partially affected, i.e., boundary wall will be affected. There will be no impact on school building.
- 1 Veterinary Hospital at Kamagere will be fully affected but there will be no impact on remaining 3 medical amenities
- None of the religious structures along the project road will be affected. Details of affected properties are presented in Table 118.

Table 118: List of affected Educational and Medical Properties

S. N.	Description	Village	Existing Ch. km	Proposed Ch. Km	Side	Distance# (m)	Affected Status
Educational Institutions							
1.	Govt. Model Higher Primary School	Hanur	85+050	85+000	LHS	12.40	Partially Affected
Medical Amenities							
1.	Veterinary Hospital	Kamagere	74+910	74+875	LHS	10.00	Affected

Distance in meter from existing centerline

405. **Mitigation Measures:**

- Affected structures will be relocated
- The amount of compensation will be equivalent to the replacement cost for the structures.

2. Impact on Land

406. According to the Land Acquisition Plan (LAP) **29.61 Ha** of land will be acquired for the project, out of which 27.75 Ha is private land. The details of affected land are presented in the **Table 119.**

Table 119: Type of Land Affected

Type of land		No. Ha.
Private	Agriculture/Non-irrigated	27.75
	Subtotal	**27.75**
Public	Government	1.86
	Subtotal	**1.86**

3. Ownership of Land being acquired for the Project

407. Out of total 29.61 Ha of land, which is going to be affected, 27.75 ha (93.72%) land is privately owned, while remaining 1.86 ha (6.28%) land belongs to Government / Waste land. The details of land acquisition requirement are summarized in the **Table 120.**

Table 120 Details of Land being acquired for the Project

Sl. No.	Land Details	Acquisition of Land Area (Ha.)	Percentage
1	Private Land	27.75	93.72
2	Forest Land	0.0	0.00
3	Govt. Land / Waste Land	1.86	6.28
Total		**29.61**	**100**

Source: Land acquisition Plan, ICT Pvt. Ltd 2015

4. Impacts on Structure in the Project Area

408. After considering the mitigation measures, 164 assets including government and common property resources (CPRs) are likely to be affected. Out of total 164 affected properties, 153 (93.29%) are private structures owned by 45 titleholders households and 194 non-titleholder households, while 9 structures are government properties, out of which 2 are mini water tanks and 2 are bus shelters, 1 hand pump, 2 pump houses, 1 school compound wall, 1 veterinary hospital ,and 2 structures are common properties. The details of affected properties are presented in the **Table 121**.

Table 121 Details of Affected Structures

Sl. No.	Structure/ properties in the Affected Area	Number of Affected Properties	Fully affected	Percentage
1	Private Structures	153	55	93.29
2	Government Structures	9	7	5.49
3	Community Structures excluding religious structures	2	1	1.22
4	Religious structures	0	0	0.0
	Total	**164**	**63**	100

Source: Census Survey 2015-16

5. Impacts on Private Structures

409. As per the census survey, 153 private properties are likely to be affected due to the road improvement project. These private properties are residential, commercial and residential-cum-commercial. 55 private structures are fully affected and rest 98 private structures will be partially affected and will remain viable for use. Both partially and fully affected structures are owned by

88 title-holders and 57 non-titled holders. Details on the loss of private assets are given in **Table 122**.

Table 122 Impact on Private Structures

Sl. No.	Type of Private Property	Total No. of Structures	Partially affected Structures	Fully affected Structures	Total affected HHs (including Tenants & Employees)	Total affected Families (including Tenants & Employees	No. of affected Persons (including Tenants & Employees
1	Residential	58	33	25	62	133	290
2	Commercial	57	32	25	113	205	456
3	Res-Cum-Commercial	33	28	5	56	103	240
4	Boundary wall	5	5	0	8	16	31
Total		**153**	**98**	**55**	**239**	**457**	**1017**

Source: Census Survey 2015-16

6. Legal Ownership of the Properties/ Structures

410. The improvement of the existing road is proposed within proposed CoI of minimum 26 m in open section, whereas in 2 lane rural section the CoI is customized to 16mtrs, and in 4 lane urban section the CoI is customized to 20 m. The likely impact on Titleholders and Non-Titleholders were assessed through the census survey undertaken within CoI of the project road. The details of ownership of properties are presented in **Table 123**.

Table 123: Details of Ownership of Properties

Sl. No.	Type of Properties	No. of Households		Total	Percentage
		Titleholder	Non-Titleholder		
1	Residential	17	45	62	25.94
2	Commercial	15	98	113	47.28
3	Res-cum-commercial	13	43	56	23.43
4	Boundary Wall	0	8	8	3.35
Total		**45**	**194**	**239**	**100**

Source: Census Survey 2015-16

7. Severity of Impact on Households Losing Structures

411. The analysis of impact on the scale of severity reveals that out of 239 private structures, 165 structures are partially affected (up to 25%), while 74 structures are fully affected, leading to physical displacement. The intensity of impact is further classified in the **Table 124.**

Table 124: Intensity of Impact on Structures

Sl. No.	Scale of Impact	To the scale of 25 %	No. of Household	Percentage
1	Fully Impacted	(More than 25%)	74	30.96
2	Partially Impacted	(Less than 25%)	165	69.04
Total			**239**	**100**

Source: Census Survey 2015-16

8. Loss of Livelihoods

412. Out of 177 total households losing their livelihood, 49 are fully affected and 128 are partially affected commercial households. Majority of them are owners and conducting commercial activities in these structures (50.85%) but some of them are tenants who have

taken the premises on rent for commercial purpose (44.07%). The details of economic impact as per the category of affected households are presented in **Table 125.**

Table 125: Loss of Livelihoods

Sl. No.	Loss	Partially affected Households	Fully affected Households	Total affected Households	Percentage
1	Owners of Shop	60	30	90	50.85
2	Artisans	1	0	1	0.56
3	Tenants	59	19	78	44.07
4	Employees	8	0	8	4.52
Total		**128**	**49**	**177**	**100**

Source: Census Survey 2015-16

9. Impacts on Common Property Resources

413. There are 2 CPR properties affected along the project road which includes 2 aralikatte, Out of 9 government properties affected 2 are mini water tanks, 2 bus shelters, 2 Pump house, 1 School Compound Wall, 1 Veterinary Hospital and 1 hand pump. The summary of CPRs affected along the project is presented in **Table 126.**

Table 126 Types of CPRs and Government Properties likely to be affected

Sl. No.	Types of Properties	Items	Total
1	A. The Other Community Properties (CPRs)	Aralikatte	2
2			
Sub-total			**2**
6	B. Religious Properties	-	0
Sub-total			**0**
7	C. Government Properties	Bus Shelter (BS)	2
8		Hand Pump (HP)	1
		Pump house	2
9		Mini water tank	2
10		School Compound Wall	1
11		Veterinary Hospital	1
Sub-total			**9**
Total			**11**

Source: Census Survey 2015-16

10. Key Effects on Assets and Displaced Persons

414. A summary of the impacts based on the Census survey of likely to be impacted structures and Land owners is provided in **Table 127.**

Table 127 Summary of Impact on Structures and Displaced Persons

Sl. No.	Type of APs	Impact category	Number
1	Titleholders	Land only	209
		Land & Structure	254
		Physically displaced	8
2	Non-Titleholders	Structure	194
		Physically displaced	66
3	Tenants	Structure only	78
4	Employees	Structure only	8

Sl. No.	Type of APs	Impact category	Number
5	Other economically affected (excluding owners physically displaced and tenants)	Structure only	13
6	Total number Project Affected Persons (PAPs)	Land only	814
		Structure only	1017
7	Total Households Affected including (Structures, Land, Tenants and Employees)	Land only	209
		Structure	153
		Tenant	78
		Employee	8
8	Total Vulnerable Households Affected	Land	148
		Structure	168
9	Moderately Affected Households (Title-Holder & Non-Title Holders)	Title-Holder & Non-Title Holders	374
10	Marginally Affected Households (Tenant & Employee)	Structure Only	67
11	Physically Displaced Households (Title-Holders)	Structure only	8
12	Physically Displaced Households (Non-titleholders)	Structure only	66
13	Physically Displaced Affected Families (Title-Holders)	Structure only	11
14	Physically Displaced Affected Families (Non-titleholders)	Structure only	118
15	Moderately Affected Households (Title-Holders)	Structure only	37
16	Moderately Affected Families (Title-Holders)	Structure only	83
17	Marginally Affected Families (Tenant & Employee)	Structure only	116
18	Households Affected by loss of income (Shop owner, Artisans Tenants & Employees)	Structure only	177
19	Households Affected by Land Acquisition	Land only	209
20	Households Affected by Impact on Private Structures (Structures, Tenants & Employees)	Structure only	86
21	Number of trees likely to be affected including (both)	Land and Structure	518
22	CPR affected		2
23	Religious structures affected		0
24	Government structures affected		9

M. Steps for Minimizing Adverse Impacts

415. Social impacts, in particular impacts on very congested areas and sensitive structures (i.e. clusters, community and religious structures), were minimized to the extent possible through the following steps:

416. The CoI was reduced to 16 to 20 m in built-up areas and 26 to 28 m in rural / open country area. The social team weighed up the alternative alignment options proposed by the design team through field visits and consultations and discussed with design team best options to avoid or minimize adverse impact on large number of households and sensitive sites. Suggestions offered by road residents were considered. These minimization efforts resulted in:

- Avoiding sensitive/religious sites by adjusting the alignment;

- Minimizing impacts on structures by using realignments/bypasses;
- Fixing the speed in the built up areas including schools and hospitals as per local needs and problems of the people;
- Deciding the rural and settlement location road cross-sections based on field surveys and likely impact on the people

Table 128: Mitigation Measures Taken

Sl. No.	Chainage	Name of the Settlement	Type of Impact	Mitigation measure
1	Ch. 0+000 to 4+900	Kollegal & Madhuvanahalli	Residential , Commercial, CPRs, Government Structure	Saved by providing bypass
2	Ch. 72+550 to73+660	Singanallur	Residential , Commercial, CPRs, Government Structure	Saved by providing the realignment

N. Rehabilitation and Resettlement

417. The resettlement cost estimate for the RP includes compensation for structure at replacement cost without depreciation, compensation for livelihood loss, resettlement assistances and cost of RP implementation. The total resettlement cost for the project is **INR 30.81 Crores**. The EA will provide the necessary funds for compensation for land and structures and R&R assistance. The EA will ensure timely availability of funds for smooth implementation of the RP.

O. Employment and Trading Opportunities

418. It is estimated that a substantial construction personnel including skilled, semi-skilled and unskilled labourers employed by various contractors will work at site during the peak period of construction phase. Since most of sizeable labour force will be drawn from neighbourhood, no change in demographic profile is anticipated. Only for a few skilled personnel, brought to site from outside the locality, proper housing/ accommodation would be provided in the construction camps. Due to employment opportunities, some competition for workers during construction phase is therefore anticipated.

419. The construction materials like stone chips and sand will be procured locally from identified quarry sites. The other important materials like cement, steel will be procured through various local sources. Thus there is a possibility of generation of local trading opportunities, though temporary.

420. **Mitigation Measures:**

- Most of the unskilled construction labourers will be recruited from the local areas to create some employment opportunities and sense of wellbeing among local people. This will also reduce social tension of migration.
- Some of the construction materials like stone chips & sand will be procured locally. Thus there is a possibility of generation of local trading opportunities, though temporary.

P. Migration

421. From the view point of employment of migrant skilled workers the project is small. Therefore no social tension is expected due to very small number migrant skilled workers. As the construction phase has a very short time span in comparison to the operation phase, it would not have any long term effect. Moreover the different groups of people engaged in different construction activities will leave the place after specified time span.

Q. Construction Camp

422. **Impacts:**

- Influx of construction work-force & supplier who are likely to construct temporary tents in the vicinity
- Likely sanitation & health hazards & other impacts on the surrounding environment due to inflow of construction labourers
- Generation of solid and liquid waste from construction camp

423. **Mitigation Measures:**

- Temporary construction camps at designated & demarcated sites with adequate sanitation, drinking water supply & primary health facilities.
- Proper accommodation will be provided in the locality for the migrant construction engineers & officers.
- Most of the construction work is labour intensive. As most of the job will be done by contractors, it will be ensured that the contractor's workers are provided with adequate amenities, health & sanitation facilities in the camp by the contractor. Such facilities shall include potable water supply, sanitary facilities, solid waste collection & disposal system, primary health facilities, day care facilities and temporary electrification (if possible). (Annex-8.2)
- It will be ensured through contract agreement that the construction workers are provided fuel for cooking to avoid cutting of trees for fuel wood from the adjoining areas.
- Domestic as well as the sanitary wastes from construction camp will be cleared regularly

424. **Waste Management**

- The Contractor should provide separate garbage bins in the camps for bio-degradable, non-biodegradable waste and ensure that these are regularly emptied and disposed-off in safe and scientific manner.
- The disposal of kitchen waste and other biodegradable matter will be disposed in approved landfills through arrangement with local civic bodies
- Noon-biodegradable waste like discarded plastic bags, paper and paper products, bottles, packaging material, gunny bags, metal containers, strips and scraps of metal etc. and other such materials will be sold /given out for recycling or disposed in approved landfills through arrangement with local civic bodies.
- No incineration or burning of wastes should be carried out.
- Effluent treatment system like septic tank with soak pits provided for toilets should be sited, designed, built and operated in such a way that no health hazard occurs and no pollution to the air, ground or adjacent watercourses takes place.
- Soak pits must be provided to collect waste water from bathrooms and kitchen.
- Septic tank must be provided for toilets and the sludge should be cleared by municipal exhausters.

R. Occupational Health and Safety

425. **Impacts:**

- Health & safety related problems to construction workers due to inadequate health & safety measures

426. **Mitigation Measures:**

- Adequate safety measures complying with the occupational safety manuals will be adopted by the contractor to prevent accidents/hazards to the construction workers
- A road safety, traffic management and accident management plan is to be prepared by the Contractor prior to the start of the construction activity
- Periodic health check-up of construction workers will be done by the contractor
- Personal protective equipment will be provided to the construction workers (Annex-8.10)

S. Road Safety

1. Construction Phase

427. **Impacts:**

- Increase on incidence of road accidents due to disruptions caused in existing traffic movements

428. **Mitigation Measures:**

- Proper traffic diversion and management will be ensured during construction at the intersections and construction areas. Proper warning signs will be displayed at the construction sites (Annex-8.9)
- Reduction of speed through construction zones

2. Operation Phase

429. **Impacts:**

- Impacts on human health due to accidents
- Damage of road due to wear & tear

430. **Mitigation Measures:**

- 20 nos. of Bus Shelters shall be provided along the project road conforming to design standards.
- Semi-rigid type / rigid type / flexible type safety barriers shall be provided on the high Embankment Section (where the height of embankment is more than 3.0 m) and along the horizontal curve having radius up to 450m for complete length including transition and 20m further before and after.
- Rigid Type such as Concrete Crash Barriers shall be provided on the bridges, isolated structures and its approaches.
- Three types of Road signs shall generally be provided (such as Mandatory / Regulatory, Cautionary / Warnings, and informatory signs.
- Locations of Signs shall conform to IRC:67-2012 and Section 800 of MoRT&H Specifications.
- Periodical inspection of the road will be conducted to detect anomalies in

pavement

- Disposal of solid waste/ municipal waste along the side of the road should be avoided. The accumulated wastes should be disposed at approved landfill sites. Where such sites are not available within reasonable lead distance, KSHIP should encourage the local municipal / panchayat authorities to identify and develop new landfill sites away from the project for disposal of solid wastes.
- The ambulance services to transport serious cases to the district hospital will be introduced and maintained so that serious accident cases can be transported immediately to the nearest district hospital

T. Positive and Beneficial Impacts

1. Construction Phase

- Employment opportunities due to recruitment of local labourers
- Trading opportunities due to procurement of some construction materials locally
- Clean up operations, landscaping and plantations

2. Operation Phase

- Increase in road traffic & transportation activities due to faster accessibility
- Time saving due to faster movement of traffic
- Fuel saving due to faster movement of traffic
- Reduction of air pollution
- Reduction of number of accidents
- Reduction of vehicle operating cost
- Better facilities to road users e.g. bus bay, truck lay-byes etc.

VII. PUBLIC CONSULTATION

A. Approach of Public Consultation Meeting

431. Well planned public consultation meeting can lead to reduced financial risks of time and cost over-run, legal disputes, and negative publicity, direct cost savings, increased market share through good public image, and enhanced social benefits to the affected local communities. Public Consultation Meeting (PCM) provides an opportunity for the general public, private and community bodies to know the environmental and social impacts as a result of project implementation. Thus, the meeting is held open to all general public who are concerned with the project during the initial stage.

432. Major purpose of the public consultation of environmental issues in the IEE study is to appraise the stakeholders on potential environmental impacts and collect their feedback so that adequate safeguards can be considered during the planning phases.

B. Methodology

433. **Arrangement:** Major settlements located close to project roads were selected for conducting public consultation. Venue for the meeting was fixed at local schools in agreement with the school administration. Affected communities and potential stakeholders such as local residents, panchayat members, school teachers etc. were invited to attend the meeting. Effort was made to make the gathering representative of the local population directly or indirectly affected by the potential impacts. During the meetings, no person is prevented from entering and /or leaving the PCM as he / she shall so desire.

434. **Discussions, Questions and Answers:** In the meeting, the participants were explained the proposed improvement proposal and potential environmental impacts due to the project. Thereafter, a session for question and answer was kept to facilitate interaction with the stakeholders, exchange of information, & direct communication and collect their opinion on the environmental issues.

435. **Collection of Feedback:** A feedback questionnaire in local language (Kanada) has been prepared and distributed among the participants at the end of the meetings (**Annex-7.1**). Participants were encouraged to provide their opinion through the feedback questionnaire, however it was kept voluntary. Some of the participants could not fill the form as they could not read or write. The issues broadly covered in questionnaire included the following topics

1. Disturbance due to present traffic scenario with respect to environmental pollution and road safety
2. Anticipation of disturbance due to the improvement proposal with respect to environmental pollution and road safety
3. Expectation on road safety measures in the improvement proposal
4. Accidents and conflicts involving wildlife, if any
5. Preference of avenue trees, if any

Photographs of Public Consultation Meetings

436. **Record of the Meeting:** General information of the participants such as Name, gender, and name of the village the participant belongs to along with their signature was recorded during the public consultation meetings and is attached in the report as **Annex 7.2**. Registration was kept voluntary. With exception of few isolated cases, almost all of the participants registered themselves.

C. Meeting Schedules and Venue

437. The public consultation meeting schedule for the project road in provided in **Table 129**.

Table 129: Public Consultation Meeting Schedule

SN	Date	Time	Venue	Location Coordinates
PCM-1	9 Dec 2015	01:45 p.m.	Govt. Higher Primary School, Kamagere	12° 8’3.10”N 77°13’28.38”E
PCM-2	14 Dec 2015	10:35 a.m.	Govt. Model Higher Primary School, Hanur	12° 5'18.47"N 77°18'8.46"E
PCM-3	14 Dec 2015	12:15 p.m.	Govt. Higher Primary School, Manglam	12° 7'22.23"N 77°14'43.94"E

D. Analysis of Collected Feedback

1. Stakeholders and women participants

438. A total of 181 stakeholders participated in 3 public consultation meetings. Meeting at Govt. Model Higher Primary School at Hanur had the highest number of participants including women participants. The percentage of women participation varied between 19%-58% in these public meetings, with overall participation in all meetings being 41%. Gender-wise distribution of participants is provided in **Table 130.**

Table 130: Gender wise Distribution of Participants in PCMs

SL	Location	Female	Male	Total
PCM-1	Govt. Higher Primary School, Kamagere	13	21	34
PCM-2	Govt. Model Higher Primary School, Hanur	51	37	88
PCM-3	Govt. Higher Primary School, Manglam	11	48	59
	Total	**75**	**106**	**181**

439. Providing written opinion on environmental issues was kept voluntary in the public consultation meetings. Responses of the participants, who volunteered to provide written feedback, have been analyzed in subsequent sections and distributions of respondents in various PCMS are summarized in **Table 131**. Overall, 52% of women and 45% of men responded with written response.

Table 131 Gender wise Distribution of Respondents given written feedback

SL	Location	No of responses			% of response w.r.t. total participants		
		Female	Male	Total	Female	Male	Total
PCM-1	Govt. Higher Primary School, Kamagere	8	8	16	61.5%	38.1%	47.1%
PCM-2	Govt. Model Higher Primary School, Hanur	25	20	45	49.0%	54.1%	51.1%

SL	Location	No of responses			% of response w.r.t. total participants		
		Female	Male	Total	Female	Male	Total
PCM-3	Govt. Higher Primary School, Manglam	6	20	26	54.5%	41.7%	44.1%
Total		**39**	**48**	**87**	52.0%	45.3%	48.1%

2. Perception on Noise Pollution Issues

440. About 86% respondents felt that traffic induced noise pollution could be disturbing. About 67% respondents scaled present traffic noise as highly disturbing while another 14% viewed it as moderately disturbing. About 52% of the respondents expected the traffic volume to increase after project implementation. About 47% of the respondents anticipated increased noise level either to be high or moderate after project implementation, while 41% respondents expect reduction in traffic noise after the project implementation. It may be interesting to note that the a considerable majority of participants anticipated that noise menace due to honking will be reduced after the project implementation due to improved road features. The perception of the participants with respect to noise pollution is detailed in **Table 132**.

Table 132 Perception of Participants on Noise Pollution due to Traffic

1 Do you feel disturbed due to traffic noise	**Yes**	**86.2%**			No	**13.8%**
If yes, then Degree of Impact	*High*	*Moderate*	*Low*	*Insignificant*	*Can't Say*	*Not Applicable*
Disturbance from Noise of present traffic	66.7%	13.8%	3.4%	2.3%	-	*13.8%*
Disturbance from Honking of present traffic	60.9%	14.9%	6.9%	3.4%	-	*13.8%*
2 Increase in traffic volume after project implementation	51.7%	8.0%	19.5%	3.4%	17.2%	-
3 Do you anticipate change in noise level due to the project?	**Increase**	47.1%	Decrease	41.4%	No Change	11.5%
If anticipated increase, then Degree of Impact	*High*	*Moderate*	*Low*	*Insignificant*	*Can't Say*	*Not Applicable*
Increase in noise after project implementation	33.3%	12.6%	1.1%	-	-	*52.9%*
Increase in honking after project implementation	19.5%	17.2%	6.9%	2.3%	1.1%	*52.9%*
Disturbance due to construction machinery & vehicles	20.7%	8.0%	9.2%	3.4%	5.7%	*52.9%*

441. PCM wise variation of response on noise pollution is presented in **Table 133**. It may be observed that about 45% of the respondents in PCM 2 at Hanur felt disturbed by traffic noise. This could be linked with the fact that the school where PCM was conducted has roads on its two sides and local bus terminus is loctated adjacent to the eastern boundary of the school. The responses on traffic related noise menace is also higher than the others. The respondents at large, has also expressed concern on the honking noise of the vehicles. Respondents at Kamagere (PCM 1) did not expect high traffic noise after the project is implemented.

Table 133: PCM wise Variation of Response on Noise Pollution

Parameters➢	**Disturbance from traffic noise**	**Annoyance from existing traffic noise**	**Annoyance due to honking**	**Anticipated increase in Traffic Volume**	**Anticipated annoyance from future traffic noise**
Category➢	Disturbed	High	High	High	High
PCM-1	17.2%	17.2%	16.1%	4.6%	4.6%
PCM-2	44.8%	35.6%	29.9%	18.4%	11.5%
PCM-3	24.1%	13.6%	14.9%	8.0%	9.2%
Total	**86.2%**	**66.7%**	**60.9%**	**31.0%**	**25.3%**

3. Perception on Air Pollution Issues

442. About 71% of the respondents felt that traffic induced air pollution could be disturbing. Further, about 53% respondents scaled present air pollution and dust levels due to traffic as highly disturbing while other 3% and 8% respondents viewed the same as moderately and low disturbing respectively. 90% of them could not identify any other sources of air pollution in vicinity. About 3% respondents opined that open drain and burning of crop residues also contribute to air pollution.

Table 134 Perception of Respondents on Air Pollution due to Traffic

4 Do you feel disturbed due to air pollution	**Yes**	**71.3%**			**No**	**28.7%**
If yes, then Degree of Impact	*High*	*Moderate*	*Low*	*Insignificant*	*Can't Say*	*Not Applicable*
Disturbance due to air emissions from present traffic	52.9%	3.4%	8.0%	-	6.9%	*28.7%*
Disturbance due to dust due to present traffic	49.4%	4.6%	9.2%	-	8.0%	*28.7%*
5 Any other sources of Air Pollution other than traffic	-	2.3%	1.1%	6.9%	89.7%	-
6 Change in air quality due to the project?	Deteriorate	**51.7%**	Improve	28.7%	No Change	19.5%
If anticipated increase, then Degree of Impact Ø	*High*	*Moderate*	*Low*	*Insignificant*	*Can't Say*	*Not Applicable*
Increase in air pollution due to increased traffic	27.6%	16.1%	4.6%	3.4%	-	*48.3%*
Increase in dust due to increased traffic	31.0%	9.2%	6.9%	4.6%	-	*48.3%*
Increase in dust due to construction activity	21.8%	10.3%	3.4%	5.7%	10.3%	*48.3%*

443. It is noteworthy that only about 29% of the respondents anticipated improved air quality after project implementation due to better road conditions while about 20% of them could not anticipate any change in air quality in future with respect to the present condition. Majority (52%) of the respondents anticipated air quality to deteriorate due to increased traffic flow in post project scenario. The perception about dust pollution due to future traffic movement is remains low among the respondents in comparison to the present traffic conditions. The perception of the respondents with respect to air pollution is detailed in **Table 135.** PCM wise variation of response on air pollution is presented in **Table 136**. It may be observed that about 18% of the respondents in PCM 2 at Hanur village disturbed by the traffic emissions, where roads are located on two sides of the school. The anticipated air emission and dust pollution during construction and operation phases varied little among the respondents.

Table 135 PCM wise Variation of Response on Air Pollution

Parameters➢	Emission from present Traffic	Dust from Traffic Movement	Emission from Future Traffic	Dust due Future Traffic Movement	Emission from Construction machinery
Category➢	High	High	High	High	High
PCM-1	18.4	16.1	4.6	4.6	4.6
PCM-2	18.4	17.2	17.2	18.4	9.2
PCM-3	16.1	16.1	5.7	8.0	8.0
Total	**52.9**	**49.4**	**27.6**	**31.0**	**21.8**

4. Perception on Road Safety Issues

444. Most of the respondents opined that (77%) that the road at the present condition is accident prone and requested to take immediate steps for its improvement. About 37% of the respondents feared that construction period may lead to further increase of accidents and adequate safety measures must be enforced.

Table 136: Perception of Respondents on Road Safety Issues

Perception on Road Accidents	%
Is the road accident prone?	77.0
Anticipation of increased road accidents in construction phase?	36.8
Choice of People on Road Safety Measures	
Speed Breaker	58.6
Pedestrian crossing	80.5
Road signage	75.9
Improved emergency services	66.7
Police Patrol	56.3
Speed Cameras	67.8
Road safety education camps	72.4
Driver Awareness Programs	74.7

445. 81% of the respondents wanted pedestrian crossings at important junctions and popular movement locations like schools, hospitals and temples etc. while 59% of them felt speed breakers are required at these locations to avoid accidents. The respondents shared their concern that the present road signage is insufficient and the proposed improvement proposal should provide proper road signage (76%). 56% respondents viewed regular police patrol can also curb the accident rate while another 68% were of the opinion that speed cameras should be installed at important junctions and considered it as the most effective tool to nab the offenders responsible for over speeding causing fatal accidents. About 72% of the respondents opined that regular road safety education camps and Driver Awareness Programs can also bring down accident rates. The perception of the respondents regarding safety issues is detailed in **Table 118.** Overall, the participants were unanimous over the requirement of road safety features and requested to provide the best possible features in the proposed road.

5. Perception on Ecology and Biodiversity Issues

446. Over 86% respondents reported sighting of wild animals in the project area. Out of them only 7% said prevalence of sighting is high, while 18.4% respondents ranked the sighting prevalence as moderate. About 70% of the respondents reported that they experienced crop damage by some time or other by wild animals. However, accidents involving wildlife is reported by only 5.7% respondents while injury to human life by wild animals are reported by 17.2%

respondents. No wildlife accident spots were identified by the respondents. Respondents reported that major wildlife observed in the project area involves elephant, panther, fox, deer, rabbit and wild boars. Respondents opined that flowering and fruit being trees like mango and tamarind should be selected for median plantations. The perception of the respondents regarding ecology and biodiversity issues is detailed in **Table 137.**

Table 137: Perception of Respondents on Ecology & Biodiversity Issues

Indicators	**%**
Are wild animals sighted in your area?	86.2%
Frequency of Sighting wild animals	*High – 6.9%* *Moderate – 18.4%* *Low - 17.2%*
Crop damage by wild animals	70.1%
Accident involving wildlife	5.7%
Incident on man wildlife conflict	17.2%
Poaching / wildlife trafficking incident in nearby locality	No
Frequently sighted wild animals	Elephant, Panther & Wild boar
Frequent Wildlife accident spots, if any	Nil
Preferred tree species in agricultural land boundaries	Neem, Coconut and Eucalyptus
Preferred species for roadside plantation	Neem, Mango & Tamarind

E. Outcome of the Public Consultation Meeting

447. The following are the major points of concern of the participants of PCM:

1) Stakeholders are concerned about the existing traffic noise and anticipate that increase of traffic flow may lead to increased noise level after project implementation.
2) Majority of the stakeholder are concerned with the existing air emission by the present traffic but their opinion in post project scenario is fragmented to a considerable extent.
3) Stakeholders are unanimously agreed that the road is accident prone and needs immediate improvement.
4) Pedestrian crossing, proper road signage and speed control measures are the most sought after road safety measures by the stakeholders.
5) Accident involving wildlife, man-animal conflicts and crop damage by wild animals reported. This may be attributed to the reason that the project road is surrounded by three wildlife sanctuaries.
6) School authorities and citizens at large are in favour of introducing speed restriction near the schools.
7) The participants did not felt any requirement of animal underpasses as crossing of wild animals are rare.
8) Boundary wall acting as noise barriers along the school premises are welcomed by all of the participants. The stakeholders felt construction of boundary will also provide the security to the students and should be implemented before the start of construction activity to safeguard the students from construction noise.
9) Participants at large requested for up-gradation of existing bus shelters and installation of water tank near bus shelters.

F. Consultation in Religious Places

448. To assess the requirement of noise barrier in the religious places along the project road, consultations with stakeholders were carried out. Local devotees, temple owner or trustees and devotees visiting the temples were informed about the impending development.

449. Two temples, as detailed in **Table 138** were selected for such consultation based on its local importance and relative proximity with the proposed alignment.

Table 138 List of Temples Identified for Consultation

S.N.	Description	Village	Existing Ch. km	Design Ch. Km	Side	Distance# (m)
1.	Mahadeswara Temple	Hullepuram	83+340	83+300	LHS	29.32
2.	Aiyappa Swamy Temple	Hullepuram	84+330	84+290	LHS	11.00

Distance in meter from existing centerline

Location of Consultations at Religious Places along Kollegal – Hanur Road

450. **Outcome of Consultation at Religious Places:** The response of the participants varied regarding installation of noise barrier, as detailed in **Table 139** below. While participants at Mahadeswara temple of Hullepuram village unanimously (100%) ruled out any requirement of boundary wall for mitigating traffic noise, but 18.2% stakeholders at Aiyappa Swamy Temple of the same village welcomed the move. Overall 90% participants showed reservation against construction of boundary wall due to temple aesthetics and accessibility; while those supported the concept (**10%**) were delighted to get a wall constructed around the property at government's expenses as a part of big ticket public expenditure.

Table 139: Outcome of the Consultation at Religious Places

S. N.	Description	No. of participants	Type of Participants	Response of Participants regarding Noise Barrier			
				Yes	%	No	%
1.	Mahadeswara Temple	9	Devotees	0	0%	9	100%
2.	Aiyappa Swamy Temple	11	Devotees	2	18.2%	9	81.8%
Overall Response				**2**	**10%**	**18**	**90%**

Photographs of Consultation at Religious Places

VIII. ENVIRONMENTAL MANAGEMENT PLAN

A. Introduction

451. Environmental Management Plan (EMP) is the key to ensure a safe and clean environment. The desired results from the environmental mitigation measures proposed in the project may not be obtained without a management plan to assure its proper implementation & function. The EMP envisages the plans for the proper implementation of management measures to reduce the adverse impacts arising out of the project activities.

B. Stage Wise Environmental Management Measures

452. The EMP includes a list of all project-related activities at different stages of project (design & pre-construction stage, construction stage and operation & maintenance stage), remedial measures, reference to laws/ guidelines, monitoring indicators & performance target and a clear reporting schedule. The EMP sets a time frame to all proposed mitigation and monitoring actions with specific responsibility assigned to the proponents, the contractors and the regulatory agencies to implement the project and follow-up actions defined. Stage wise management measures are tabulated below:

Table 140: Stage Wise Environmental Management Plan

Environmental Issues/ Component	Remedial Measures	Reference to laws/ guidelines	Location	Monitoring Indicators (MI) / Performance Target (PT)	Monitoring Methods	Institutional Responsibility	
						Implementation	Supervision
A. DESIGN AND PRE-CONSTRUCTION STAGE							
1. Alignment							
1.1 Pavement damage and inadequate drainage provisions in habitat areas	▪ Soaked CBR value of sub grade is recommended to be 15 %. ▪ Overloading to be checked ▪ Raised embankment and provision of roadside drainage to prevent damage to pavement due to water logging on the road and also inconvenience caused to ▪ Provision of adequate no. of cross drainage structures. ▪ Increase (vent and height) in waterway of existing structures. ▪ Roadside drains have been proposed with suitable outfalls. The Length of lined drain along	Design requirement IRC:37-2012 IRC: 58-2015	Entire stretch; Embankment raised for a length of **18.962 km** **Roadside drains** Roadside drains shall be provided on both sides of the embankment. In urban sections lined drains with footpath has been proposed for safety reasons.	MI: Design and number of cross and side drains, slab/box culverts, and Hume pipes PT: Design and numbers are in accordance with site needs	Review of detail design documents & drawings and comparison with site conditions	Design Consultant	KSHIP

Environmental Issues/ Component	Remedial Measures	Reference to laws/ guidelines	Location	Monitoring Indicators (MI) / Performance Target (PT)	Monitoring Methods	Institutional Responsibility	
						Implementation	Supervision
	the project is 4,820 m on either side (i.e. 2 x 2,410 = 4,820 m) and the length of unlined drain is 18,202 m on either side (i.e. 2 x 9,101 = 18,202 m). ▪ Considering the adequacy and hydrological requirements, some additional culverts and replacement of some culverts have been proposed. ▪ 26 new culverts proposed to be constructed ▪ 5 culverts proposed to be Rehabilitated and Widened ▪ 25 culverts proposed to be re-constructed		For rural areas, the drains have been proposed as open and trapezoidal with 2(H):1(V) side slope as per IRC: SP: 73-2015 (Clause 6.2.4). The minimum bed width and depth of flow at starting section shall be 500 mm and 300 mm respectively. For list of bridges, **Please refer Table 2-13** and **Table 2-14** of Chapter-2 of IEE Report				
1.2 Safety along the proposed alignment	▪ The project road is having substandard horizontal geometry in some sections. At few locations Horizontal curve having radius less than 200m with a design speed of less than the minimum 80 kmph stipulated in code along the project road. To improve safety of road users, realignment have been considered at two locations as part of geometric improvement ▪ Safety barriers shall be provided on the high Embankment Section (where the height of embankment is more than 3.0 m) ▪ Provision of retro-reflective warning sign boards near school, hospital and	Design requirement Vertical geometry will be based on IRC-SP:73-2015 IRC:SP:84-2014 IRC SP 87 2013 IRC: 37-2012	Entire stretch At embankment height >3.0 m total length = **0.760 km** <u>Horizontal Curve:</u> Please refer Annexure-1.2 of Volume-II Design Report <u>Vertical Alignment:</u> Please refer Annexure-1.3 of Volume-II Design Report	<u>MI</u>: number and location of Semi-rigid type / rigid type / flexible type safety barriers, warning sign boards <u>PT</u>: numbers and location are in accordance with site needs	Review of design documents and drawings and comparison with site conditions	Design Consultant	KSHIP

Environmental Issues/ Component	Remedial Measures	Reference to laws/ guidelines	Location	Monitoring Indicators (MI) / Performance Target (PT)	Monitoring Methods	Institutional Responsibility	
						Implementation	Supervision
	religious places ▪ Highway lightings including high masts will be provided at intersections in order to improve the night time visibility. All the built up locations as well Underpasses has been proposed lighting arrangements. ▪ Signs and marking viz., cat's eyes, delineators, object markers, hazard markers, safety barriers at hazardous locations ▪ Horizontal and vertical geometry as per IRC Specification						
2. Natural Hazards							
2.1 Flooding / Water-Logging	▪ Provision of adequate number of CD structures. Additional culverts have been proposed. ▪ All CD structures designed for 50year HFL return period and bridges designed for 100 year HFL return period ▪ Water ways of bridges and culverts have been increased. ▪ Roadside drains also provided ▪ Embankment height raised along low lying/ potential water logged areas ▪ Improvement in existing culverts/ Bridges to increase their carrying capacity.	Design requirement	Entire stretch	MI: Design and numbers of cross & side drains, slab/box culverts Hume pipes, road embankment height, design and number of bridges PT: Design and numbers are in accordance with site needs	Review of design documents and drawings and comparison with site conditions	Design Consultant	KSHIP
3. Loss of Land and Assets							
3.1 livelihood loss to affected persons	▪ Road improvement work to be accommodated within available ROW to the extent possible. ▪ Social Impact Assessment and Resettlement Plan to be	The Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and	Throughout the corridor	MI: Payment of compensation and assistance to PAFs as per RAP	Check LA records; design drawings vs land plans;	KSHIP & implementing NGO	KSHIP

Environmental Issues/ Component	Remedial Measures	Reference to laws/ guidelines	Location	Monitoring Indicators (MI) / Performance Target (PT)	Monitoring Methods	Institutional Responsibility	
						Implementation	Supervision
	undertaken as per National Policy and ADB' guidelines. ▪ Complete all necessary land and property acquisition procedures prior to the commencement of civil work. ▪ Adhere to the Land Acquisition procedures in accordance to Entitlement Framework. ▪ Compensation and assistance as per project Resettlement Action Plan (RAP) ▪ Income restoration as per RAP ▪ Preference in employment and petty contracts during construction to affected persons ▪ Constitute Grievance Redressal Cell (GRC) as per RAP	Resettlement Act, 2013. and ADB's Involuntary Resettlement Policy. Contract Clause for preference to local people during employment.		Number of complaints / grievances related to compensation and resettlement PT: Minimal number of complaints / grievances. All cases of resettlement and rehabilitation if any are resolved at GRC level. No case referred to arbitrator or court.	Interview with affected persons Check status of employment given to local people during construction		
4. Felling of Trees							
4.1 Loss of trees 4.2 Loss of habitat of avifauna	▪ Geometric adjustments made to minimize tree felling ▪ Tree clearing within ROW would be only those required for enabling construction or to reduce accident. Trees to be felled shall be clearly marked. ▪ Obtain tree felling permission from State Forest Department ▪ Tree felling is to proceed only after all the legal requirements including attaining of In-principle and Formal Clearances from the State Forest Department are completed and subsequently a written order is issued to the Contractor. ▪ Stacking, transport and storage of the wood will be done as per the relevant norms. Systematic corridor level documentation for	▪ Forest Conservation Act, 1980 ▪ The Karnataka Preservation of Trees Act, 1976 ▪ Environmental Policy of KSHIP	Throughout the corridor Total number of affected trees=**714** LHS: 331 RHS: 383	MI: Number and location of geometric adjustments made to avoid tree cutting, budget amount allocated for additional plantation PT: Unnecessary tree felling along the project road avoided; Budget allocation is adequate	Review final design. Check budget provision for additional plantation.	- Design Consultant (incorporated in DPR), - Contractor (joint inspection, marking of trees, follow up for clearance) - KSHIP & - Forest Department	KSHIP & Forest Department

Environmental Issues/ Component	Remedial Measures	Reference to laws/ guidelines	Location	Monitoring Indicators (MI) / Performance Target (PT)	Monitoring Methods	Institutional Responsibility	
						Implementation	Supervision
	the trees to be felled and those saved will be maintained by the PIU.						
5. Shifting of Utilities							
5.1 Disruption of utility services to local community	▪ All telephone and electrical poles/wires and underground cables should be shifted before start of construction in any construction zone ▪ Bore wells, water supply pipelines and hand pumps located within the proposed RoW should be shifted before start of construction in any construction zone ▪ Necessary permission and payments should be made to relevant utility service agencies to allow quick shifting and restoration of utility services ▪ Local people must be informed through appropriate means about the time of shifting of utility structures and potential disruption of services if any	Project requirement	Throughout the corridor	MI: Number of complaints from local people, number, timing and type of notifications issued to local people, time taken to shift utilities PT: No. of complaints should be 0. Effective and timely notification. Minimal time for utility shifting	Interaction with concerned utility authorities and local public	Contractor/ KSHIP / Utility company	KSHIP / IE
B. CONSTRUCTION STAGE							
1. Air Quality							
1.1 Dust Generation due to construction activities and transport, storage and handling of construction materials	▪ Transport, loading and unloading of loose and fine materials through covered vehicles. ▪ Paved approach roads. ▪ Storage areas to be located downwind of the habitation area. ▪ Water spraying on the unpaved haulage roads and other dust prone areas. ▪ Provision of PPEs to workers.	- MORT&H Specifications for Road and Bridge works - The Air (Prevention and Control of Pollution) Act, 1981 and - Central Motor and Vehicle Act	Throughout project corridor	MI: PM10 level measurements Complaints from locals due to dust PT: PM10 level< 100 µg/m^3; Number of complaints should be zero.	Standards CPCB methods; Observations; Public consultation; Review of monitoring data maintained by contractor	Contractor	KSHIP / IE

Environmental Issues/ Component	Remedial Measures	Reference to laws/ guidelines	Location	Monitoring Indicators (MI) / Performance Target (PT)	Monitoring Methods	Institutional Responsibility	
						Implementation	Supervision
		1988 - Environmental Policy of KSHIP					
1.2 Emission of air pollutants (HC, SO_2, NO_2, CO etc,) from vehicles and use of equipment and machinery	▪ Regular maintenance of machinery and equipment. ▪ Contractor to submit PUC certificates for all vehicles / equipment / machinery used for the project and maintain a record of the same during the contract period. ▪ Batching, WMM, HMP and crushers at downwind (1km) direction from the nearest settlement. ▪ These plants shall be used after obtaining consent to establish & consent to operate from SPCB ▪ Only Crushers licensed by the SPCB shall be used ▪ Hot mix plant should be fitted with dust extraction unit ▪ SPM value at a distance of 40 m from a unit located in a cluster should be less than 500 g/m^3. The monitoring is to be conducted as per the monitoring plan. ▪ DG sets with stacks of adequate height and use of low sulphur diesel as fuel. ▪ LPG should be used as fuel source in construction camps instead of wood ▪ Air quality monitoring as per Environmental Monitoring Program ▪ Contractor to prepare traffic management and dust suppression plan duly approved	The Air (Prevention and Control of Pollution) Act, 1981(Amended 1987) and Rules 1982; Environmental Policy of KSHIP	Batching & Asphalt Mixing Plants, Hot Mix Plant, Crushers, DG sets locations	MI: Levels of HC, SO_2, NO_2, and CO. Status of PUC certificates PT: To keep SO_2 and NO_2 levels less than 80 $\mu g/m^3$. PUC certificate of equipment and machinery is up to date	Standards CPCB methods Review of monitoring data maintained by the Contractor	Contractor	KSHIP / IE

Environmental Issues/ Component	Remedial Measures	Reference to laws/ guidelines	Location	Monitoring Indicators (MI) / Performance Target (PT)	Monitoring Methods	Institutional Responsibility	
						Implementation	Supervision
	by IE & KSHIP						
2. Noise							
2.1 Disturbance to local residents and sensitive receptors due to excessive noise from construction activities and operation of equipment and machinery	▪ All equipment to be timely serviced and properly maintained. ▪ Construction equipment and machinery to be fitted with silencers and maintained properly. ▪ Only IS approved equipment shall be used for construction activities. ▪ Near school, noisy construction activities shall be carried out after closing of school and in the weekends / holidays only ▪ Carry out noisy operations intermittently to reduce the total noise generated ▪ Manage smooth traffic flow to avoid traffic jams and honking. ▪ Restrict construction near residential and built up areas to daylight hours. ▪ Construction of noise barrier at sensitive receptors ▪ Initiation of multi-layered plantation, to serve as mitigation option for operation phase ▪ Honking restrictions near sensitive areas ▪ Noise limits for construction equipment such as compactors, rollers, front loaders, concrete mixers, cranes (moveable) etc. shall not exceed 75 dB(A) at a distance of 11 m from its source ▪ PPEs to workers ▪ Noise monitoring as per Environmental Monitoring	Legal requirement Noise Pollution (Regulation and Control) Rules, 2000 and amendments Thereof; Environmental Policy of KSHIP	Throughout project section especially at construction sites, residential and identified sensitive locations. Refer **Table No. 4.33** and **4.35** of Chapter-4 of IEE for information on sensitive receptors.	MI: day and night Noise levels. Number of complaints from local people PT: Zero complaints or no repeated complaints by local people. Average day and night time noise levels are within permissible limits for work zone areas	As per Noise rule, 2000 Consultation with local people Review of noise level monitoring data maintained by contractor Observation of construction site	Contractor	KSHIP / IE

Environmental Issues/ Component	Remedial Measures	Reference to laws/ guidelines	Location	Monitoring Indicators (MI) / Performance Target (PT)	Monitoring Methods	Institutional Responsibility	
						Implementation	Supervision
	Program						
3. Land & Soil							
3.1 Land use Change and Loss of productive / topsoil	▪ Non-agricultural areas to be used as borrow areas to the extent possible. ▪ If using agricultural land, top soil to be preserved and laid over either on the embankment slope for growing vegetation to protect soil erosion. ▪ **Guideline on Top Soil Conservation** and Reuse is given in **Annex-8.1** ▪ Hot-mix plants, batching plants, construction camps shall be located at least 500m away from habitation and 1000 m away from forest & wildlife area ▪ Land for temporary facilities like construction camp, storage areas etc. shall be brought back to its original land use ▪ Detailed site selection criteria for **Construction Camp** given in **Annex-8.2** should be followed. ▪ Details of sites identified for Construction Camp should be reported to the Sr. Environmental Specialist of IE for approval in the format as given in **Annex-8.13** and format for setting up Construction Camp is given in **Annex-8.14** ▪ Details of sites identified for establishment of Hot-mix/ Batch mix Plants should be reported to the Sr. Environmental Specialist of IE for approval in the format	Project requirement Annex-8.1 Guidelines on Top Soil Conservation and Reuse Annex-8.2 Guidelines for Siting and Layout of Construction Camp	Throughout the project section Land identified for construction camp, storage areas, hot-mix plant, batching plant etc.	MI: Location of Construction Camp, Storage Areas, Hot-mix Plant, Batching Plant Top soil storage area PT: Zero complaints or disputes registered against contractor by land owner	Visit of construction camp, plant sites; review of the reports submitted by the contractor	Contractor	KSHIP / IE

Environmental Issues/ Component	Remedial Measures	Reference to laws/ guidelines	Location	Monitoring Indicators (MI) / Performance Target (PT)	Monitoring Methods	Institutional Responsibility	
						Implementation	Supervision
	as given in **Annex-8.15**						
3.2 Slope failure and Soil erosion due to Construction activities, earthwork, and cut and fill, stockpiles etc.	▪ Bio-turfing of embankments to protect slopes. ▪ Slope protection by providing frames, dry stone pitching, masonry retaining walls, planting of grass and trees. ▪ Side slopes of all cut and fill areas will be graded and covered with stone pitching, **Coir Geo-Textile, grass (Vetiver grass)**. Care should be taken that the slope gradient shall not be greater than 2:1. ▪ The earth stock piles to be provided with gentle slopes to soil erosion. ▪ Please refer **Annex-8.3** regarding **Guideline on Soil Stabilization**	IRC: 56 -1974 recommended practice for treatment of embankment slopes for erosion control Clause No. 306 and 305.2.2 MORT&H Annex-8.3 Guidelines on Soil Stabilization	Throughout the project road	MI: Occurrence of slope failure or erosion issues PT: No slope failures. Minimal erosion issues	Review of design documents and site observation	Contractor	KSHIP / IE
3.3 Borrow Area Management	▪ Obtain EC from SEIAA before opening any new borrow area. ▪ Comply to EC conditions ▪ Non-productive, barren lands, upland shall be used for borrowing earth with the necessary permissions/consents. ▪ Follow IRC recommended practice for borrow area (IRC:SP:108:2015) for identification of location, its operation and rehabilitation ▪ Borrow areas not to be dug continuously. ▪ To the extent borrow areas shall be sited away from habitated	IRC Guidelines on Borrow Areas; Environmental Protection Act and Rules,1986; Water Act 1974; Air Act 1981 Annex-8.4 Guidelines on Siting, Operation and Re-development of Borrow Area Environmental Policy of KSHIP	Borrow sites location	MI: Existence of borrow areas in inappropriate unauthorized locations. Poor borrow area management practices. Number of accidents. Complaints from local people. PT: No case of non-compliance to conditions stipulated by	Review of design documents and site observations Compare site conditions with EC conditions by SEIAA	Design Consultant and Contractor	KSHIP / IE

Environmental Issues/ Component	Remedial Measures	Reference to laws/ guidelines	Location	Monitoring Indicators (MI) / Performance Target (PT)	Monitoring Methods	Institutional Responsibility	
						Implementation	Supervision
	areas. ▪ Depths of borrow pits to be regulated and sides not steeper than 25%. ▪ Topsoil to be stockpiled and protected for use at the rehabilitation stage. ▪ At least 10% of the acquired area shall be kept for stockpiling of fertile topsoil. The piles shall be covered with gunny bags / tarpaulin. ▪ Slope of stockpile shall not exceed 1:2 (V:H) and edge of pile shall be protected by silt fencing ▪ Transportation of earth materials through covered vehicles. ▪ Borrow areas shall be leveled with salvaged material or other filling materials which do not pose contamination of soil. Else, it shall be converted into fish pond. ▪ Detailed site selection criteria, operation of borrow area and redevelopment plan given in **Annex-8.4**. ▪ Details of identified sites should be reported to the Sr. Environmental Specialist of IE for approval in the **Format** given in **Annex-8.16** and reporting format for establishment of borrow area given in **Annex-8.17**			SEIAA in clearance letter. Zero accidents. Zero complaints.			
3.4 Quarry Operations	▪ Aggregates will be sourced from existing licensed quarries. ▪ Copies of consent / approval /	IRC Guidelines on Quarry Areas; Environmental	Quarry area locations	MI: Existence of licenses for all quarry areas from	Review of design documents,	Contractor	KSHIP / IE

Environmental Issues/ Component	Remedial Measures	Reference to laws/ guidelines	Location	Monitoring Indicators (MI) / Performance Target (PT)	Monitoring Methods	Institutional Responsibility	
						Implementation	Supervision
	rehabilitation plan for a new quarry or use of existing source will be submitted to IE & KSHIP. ▪ The contractor will develop a Quarry Redevelopment plan, as per the Mining Rules of the state and submit a copy of the approval to EA. ▪ Obtain environmental clearance from SEIAA in case of opening new quarry ▪ Quarrying shall be done only after obtaining proper permit or license from the Department of Mining and quarrying operation shall comply with the requirements of the State Pollution Control Board. ▪ Detailed site selection criteria, operation of quarry area and redevelopment plan given in **Annex-8.5**. ▪ Details of identified sites should be reported to the Sr. Environmental Specialist of IE for approval in the **Format** given in **Annex-8.18**	Protection Act and Rules,1986; Water Act 1974; Air Act 1981 Annex-8.5 Guidelines on Siting, Operation and Re-development of Quarry Area Environmental Policy of KSHIP		which materials are being sourced Existence of a Quarry Redevelopment Plan PT: Quarry license is valid; No case of non-compliance to consent /permit conditions and \ Air quality meets the prescribed limit	contractor documents and site observation; Compliance to EC conditions in case of opening new quarries		
3.5 Compaction of soil and impact on quarry haul roads due to movement of vehicles and equipment	▪ Construction vehicles, machinery, and equipment to be stationed in the designated ROW to avoid compaction. ▪ Approach roads / haulage roads shall be designed along the barren and hard soil area to reduce the compaction. ▪ Transportation of quarry material to the dumping site through heavy vehicles shall be done through existing major roads to the extent possible to	Design requirement	Parking areas, Haulage roads and construction yards.	MI: Location of approach and haulage roads; Presence of destroyed / compacted agricultural land or land which has not be restored to its original condition PT: Zero occurrence of	Site observation	Contractor	KSHIP / IE

Environmental Issues/ Component	Remedial Measures	Reference to laws/ guidelines	Location	Monitoring Indicators (MI) / Performance Target (PT)	Monitoring Methods	Institutional Responsibility	
						Implementation	Supervision
	restrict wear and tear to the village /minor roads. ▪ Land taken for construction camp and other temporary facility shall be restored to its original conditions			destroyed / compacted land and undestroyed land			
3.6 Contamination of soil due to leakage / spillage of oil, bituminous and non-bituminous debris generated from demolition and road construction	▪ Construction vehicles and equipment will be maintained and refueled in such a fashion that oil / diesel spillage does not contaminate the soil. ▪ Fuel storage and refueling sites to be kept away from drainage channels. ▪ Unusable debris shall be dumped in ditches and low lying areas. ▪ To avoid soil contamination **Oil-Interceptors** shall be provided at wash down and refueling areas. ▪ Waste oil and oil soaked cotton / cloth shall be stored in containers labeled 'Waste Oil' and 'Hazardous' sold off to MoEF / SPCB authorized vendors ▪ Non-bituminous wastes to be dumped in borrow pits with the concurrence of landowner and covered with a layer of topsoil conserved from opening the pit.	Design requirement	Fuelling station, construction sites, and construction camps and disposal location.	MI: Quality of soil near storage area Presence of spilled oil or bitumen in project area PT: Soil test conforming to no – contamination; No sighting of spilled oil or bitumen in construction site or camp site	Site observation	Contractor	KSHIP / IE
4. Water Resources							
4.1 Sourcing of water during Construction	▪ Requisite permission shall be obtained for abstraction of groundwater from Central Groundwater Authority and State Ground Water Board ▪ Where surface water sources	CGWA Guidelines	Throughout the Project section	MI: Approval from competent authority; Complaints from local people on water availability	Checking of documentation; Talk to local people	Contractor	KSHIP / IE

Environmental Issues/ Component	Remedial Measures	Reference to laws/ guidelines	Location	Monitoring Indicators (MI) / Performance Target (PT)	Monitoring Methods	Institutional Responsibility	
						Implementation	Supervision
	are to be tapped, arrangements shall be made by contractor that the water availability and supply to nearby communities remain unaffected. ▪ The possible sources could be abandoned ponds, tanks or wells, specially created tanks or ponds nearby perennial rivers subject to approval of village & local administration. ▪ Water intensive activities not to be undertaken during summer season. ▪ Provision of water harvesting structure to augment groundwater condition in the area			PT: Valid approval from Competent Authority. Zero complaints from local people.			
4.2 Disposal of water during construction	▪ Provisions shall be made to connect roadside drains with existing nearby natural drains.	Design requirement	Throughout the Project section	MI: Condition of drainage system in construction site; Presence / absence of water logging in project area. PT: Existence of proper drainage system. No water logging in project area	Standards methods; Site observation and review of documents	Contractor	KSHIP / IE
4.3 Alteration in Surface Water Hydrology	▪ Existing drainage system to be maintained and further enhanced. ▪ Provision shall be made for adequate size and number of cross drainage structures especially in the areas where	Design requirement,	Near all drainage channels, River /Nallah crossings etc.	MI: Proper flow of water in existing streams and rivers PT: No complain of water shortage by downstream	Review of design documents Site observation	Contractor	KSHIP / IE

Environmental Issues/ Component	Remedial Measures	Reference to laws/ guidelines	Location	Monitoring Indicators (MI) / Performance Target (PT)	Monitoring Methods	Institutional Responsibility	
						Implementation	Supervision
	land is sloping towards road alignment. ▪ Road level shall be raised above HFL level wherever road level is lesser than HFL. ▪ Culverts reconstruction shall be done during lean flow period. In some cases these minor channels may be diverted for a very short period (15-30 days) and will be bring back to its original course immediately after construction.			communities. No record of overtopping / water logging			
4.4 Siltation in Water Bodies due to construction activities / earthwork	▪ Embankment slopes to be modified suitably to restrict the soil debris entering water bodies. ▪ Silt fencing shall be provided along ponds within the direct impact zone intercepting highway to prevent siltation in water bodies. ▪ Sediment / silt should be collected and stockpiled for possible reuse as surfacing of slopes where they have to be re-vegetated. ▪ Earthworks and stone works to be prevented from impeding natural flow of rivers, streams and water canals or existing drainage system. ▪ **Guideline for Sediment Control** is given in **Annex-8.6**	Design requirement; Worldwide Best Practices; Annex-8.6 Guideline for Sediment Control	Near all water bodies/ waterway Refer **Table No. 4.21** of Chapter-4 of IEE for information on Water Bodies along the project road	MI: Presence/absence of siltation in rivers, streams, nala, ponds and other water bodies in project area; water quality monitoring PT: No records of siltation due to project activities. Surface water quality tests confirm to turbidity and TSS limit	Field observation	Contractor	KSHIP / IE
4.5 Deterioration in Surface water quality due to leakage from	▪ No vehicles or equipment should be parked or refueled near water-bodies, so as to avoid contamination from fuel	The Water (Prevention and Control of Pollution) Act, 1974 and	Water bodies**;** refueling stations; construction camps.	MI: Water quality of ponds, streams, rivers and other water bodies in	Conduction of water quality tests as per the Environmental	Contractor	KSHIP / IE

Environmental Issues/ Component	Remedial Measures	Reference to laws/ guidelines	Location	Monitoring Indicators (MI) / Performance Target (PT)	Monitoring Methods	Institutional Responsibility	
						Implementation	Supervision
vehicles and equipment and waste from construction camps.	and lubricants. ▪ Oil and grease traps and fuelling platforms to be provided at re-fuelling locations. ▪ All chemicals and oil shall be stored away from water and concreted platform with catchment pit for spills collection. ▪ All equipment operators, drivers, and warehouse personnel will be trained in immediate response for spill containment and eventual clean-up. Readily available, simple to understand and preferably written in the local language emergency response procedure, including reporting, will be provided by the contractors ▪ Construction camp to be sited away from water bodies. ▪ Wastes must be collected, stored and taken to approve disposal site only. ▪ Water quality shall be monitored	amendments thereof; Environmental Policy of KSHIP		project Presence of oil floating in water bodies in project area PT: Surface water quality meets freshwater quality standards (IS:2296)	Monitoring Plan Field observation		
5. Flora and Fauna							
5.1 Vegetation loss due to site preparation and construction activities	▪ Restrict tree cutting up to toe line considering safety to road users. ▪ Roadside trees to be removed with prior approval of competent authority. ▪ **3,793 trees** shall be planted on both sides of the project road ▪ **335 trees** are proposed to be planted along the boundary	Forest Conservation Act 1980; IRCSP:21and IRCSP:66 Environmental Policy of KSHIP	Throughout project corridor Additional Plantation near Sensitive receptors, river banks, borrow areas, quarry area etc.	MI: ROW width; Number of trees for felling; Compensatory plantation plan and Number of trees replanted. PT: Additional compensatory afforestation done	Review of relevant documents; Tree cutting permit; Compensatory plantation plan; Meeting with villagers; Field Observations	Contractor	KSHIP / IE

Environmental Issues/ Component	Remedial Measures	Reference to laws/ guidelines	Location	Monitoring Indicators (MI) / Performance Target (PT)	Monitoring Methods	Institutional Responsibility	
						Implementation	Supervision
	of noise barrier ▪ Trees will be planted as per the Tree Plantation Strategy given in **Annex-8.12** ▪ Total Compensatory Plantation will be **1:5** ▪ Local villagers to be employed for plantation activities. Employment preference to be given to women ▪ Regular maintenance of all trees planted. ▪ Provision of LPG in construction camp as fuel source to avoid tree cutting. ▪ Plantation of trees on both sides of the road where technically feasible. ▪ Integrate vegetation management (IVM) with the carriage way completely clear of vegetation. ▪ Additional plantation near sensitive receptors, river banks to minimize noise & air pollution and to check erosion. ▪ Controlled use of pesticides / fertilizers			by contractor. Number of trees planted. Tree survival rate is at least 70%.			
6. Construction Camp							
6.1 Impact associated with location	All camps should be established with prior permission from SPCB. Camps to maintain minimum distance from following: # 500 m from habitation # 1000 m from forest areas where possible # 500 m from water bodies where possible # 500 m from through traffic route	Design Requirement The Water (Prevention and Control of Pollution) Act,1974and its amendments thereof Annex-8.2 Guidelines for	All construction camps	MI: Location of camp sites and distance from habitation, forest areas, water bodies and through traffic PT: Distance of camp site is less than 500m from	On site observation Interaction with workers and local community	Contractor and EO	KSHIP / IE

Environmental Issues/ Component	Remedial Measures	Reference to laws/ guidelines	Location	Monitoring Indicators (MI) / Performance Target (PT)	Monitoring Methods	Institutional Responsibility	
						Implementation	Supervision
		Siting and Layout of Construction Camp		listed locations			
6.2 Worker's Health in construction camp	▪ The location, layout and basic facility provision of each labor camp will be submitted to IE and approved by EA. The contractor will maintain necessary living accommodation and ancillary facilities in functional and hygienic manner. ▪ Adequate water and sanitary latrines with septic tanks with soak pits shall be provided. ▪ Contractor to provide a full-fledged dispensary. The number of beds shall be as per the requirement of the labour license ▪ Contractor to conduct workshop on HIV / AIDS for all his laborers at all his camps at least once in a quarter ▪ Contractor shall conduct monthly health check-ups of all his laborers in his camps through registered medical practitiioner ▪ Waste disposal facilities such as dust bins must be provided in the camps and regular disposal of waste must be carried out. ▪ The Contractor will take all precautions to protect the workers from insect and pest to reduce the risk to health. This includes the use of insecticides which should comply with local regulations. ▪ No alcoholic liquor or prohibited drugs will be imported	The Building and Other Construction workers (Regulation of Employment and Conditions of Service) Act 1996 and The Contract Labour (Regulation & Abolition) Act, 1970 The Water (Prevention and Control of Pollution) Act,1974 and amendments thereof Environmental Policy of KSHIP and provision of ISO:14001:2004	All construction camps	MI: Camp health records. Existence of proper first aid kit in camp site. Complaints from workers. PT: No record of illness due to unhygienic conditions or vectors. Zero cases of STD. Clean and tidy camp site conditions.	Camp records Site observation Consultation with contractor workers and local people living nearby	Contractor	KSHIP / IE

Environmental Issues/ Component	Remedial Measures	Reference to laws/ guidelines	Location	Monitoring Indicators (MI) / Performance Target (PT)	Monitoring Methods	Institutional Responsibility	
						Implementation	Supervision
7. Management of Construction Waste / Debris							
7.1 Selection of Debris Disposal Sites	▪ Unproductive / wastelands shall be selected for dumping sites away from residential areas and water bodies ▪ Dumping sites must be having adequate capacity equal to the amount of debris generated. ▪ Public perception and consent from the village Panchayats has to be obtained before finalizing the location. ▪ **Guideline for Siting and Management of Debris Disposal Site** is given in **Annex-8.7** ▪ Details of identified debris disposal site should be reported to the IE for approval in the **Format** given in **Annex-8.19**	Design Requirement; Annex-8.7: Guideline for Siting and Management of Debris Disposal Site, Environmental Policy of KSHIP	At all Dumping Sites	MI: Location of dumping sites Number of public complaints. PT: No public complaints. Consent letters for all dumping sites available with contractor	Field survey and interaction with local people. Review of consent letter	Contractor	KSHIP / IE
7.2 Reuse and disposal of construction and dismantled waste	▪ The existing bitumen surface shall be utilized for paving of cross roads, access roads, and paving works in construction sites and camps, temporary traffic diversions and haulage routes. ▪ All excavated materials from roadway, shoulders, verges, drains, cross drainage will be used for backfilling embankments, filling pits, and landscaping. ▪ Unusable and non-bituminous debris materials should be suitably disposed-off at pre-designated disposal locations, with approval of the concerned authority. The bituminous wastes	Design Requirement; Annex-8.8: Guideline for Preparing Comprehensive Waste Management Plan	Throughout the project corridor	MI: Percentage of reuse of existing surface material Method and location of disposal site of construction debris PT: No public complaint and consent letters for all dumping sites available with contractor or IE	Contractor records Field observation Interaction with local people	Contractor	KSHIP / IE

Environmental Issues/ Component	Remedial Measures	Reference to laws/ guidelines	Location	Monitoring Indicators (MI) / Performance Target (PT)	Monitoring Methods	Institutional Responsibility	
						Implementation	Supervision
	shall be disposed in secure landfill sites only in environmentally accepted manner. ▪ Unusable and surplus materials, as determined by the Project Engineer, will be removed and disposed off-site. ▪ Guideline for Preparing **Comprehensive Waste Management Plan** is given in **Annex-8.8**						
8. Traffic Management and Safety							
8.1 Management of existing traffic and safety	▪ Temporary traffic diversion shall be planned by the contractor and approved by the 'Engineer'. ▪ The traffic control plans shall contain details of diversions; traffic safety arrangements during construction; safety measures for night time traffic and precautions for transportation of hazardous materials. Traffic control plans shall be prepared in line with requirements of IRC's SP 55 document'. ▪ The Contractor will ensure that the diversion / detour are always maintained in running condition, particularly during the monsoon to avoid disruption to traffic flow. ▪ On stretches where it is not possible to pass the traffic on the part width of existing carriageway, temporary paved diversions will be constructed. ▪ Restriction of construction activity to only one side of the existing road.	Design requirement and IRC: SP: 27 -1984; IRC:SP: 32 -1988 Road Safety for Children (5-12 Years Old); IRC:SP: 44 -1994 Highway Safety Code IRC: SP: 55 -2001; Guidelines for Safety in Construction Zones; IRC:53:2012 Road Accident recording The Building and other Construction workers Act 1996 and Factories Act	Throughout the project corridor especially at intersections.	MI: Traffic Management Plan. Presence/ absence of safety signs, clear traffic demarcations, flag men etc. on site. Complaints from road users. Number of traffic accidents PT: No complaints. No accidents due to poor traffic management. Traffic signs, demarcation lines etc. present in appropriate locations on site	Review Traffic Management Plan; Field observation of traffic management and safety system Interaction with people in vehicles using the road	Contractor	KSHIP / IE

Environmental Issues/ Component	Remedial Measures	Reference to laws/ guidelines	Location	Monitoring Indicators (MI) / Performance Target (PT)	Monitoring Methods	Institutional Responsibility	
						Implementation	Supervision
	▪ The contractor shall inform local community of changes to traffic routes, and pedestrian access arrangements with assistance from "Engineer". ▪ Use of adequate signage to ensure traffic management and safety. Conduct of regular safety audit on safety measures. ▪ Guideline for Preparing **of Traffic Management Plan** is given in **Annex-8.9**	1948 **Annex-8.9** Guideline for Preparing of Traffic Management Plan					
8.2 Pedestrians, animal movement	▪ Temporary access and diversion, with proper drainage facilities. ▪ Access to the schools, temples and other public places must be maintained when construction takes place near them. ▪ All structures having vertical clearance above 3m and not catering to perennial flow of water may serve as underpass for animals	Same as above	Near habitation on both sides of schools, temples, hospitals, graveyards, Construction Sites, Haulage roads and diversion sites.	MI: Presence/ absence of access routes for pedestrians. Road signage. Number of complaints from local people PT: Easy access to schools, temples and public places. Zero complaints	Field observation Interaction with local people	Contractor	KSHIP / IE
8.3 Safety of Workers and accident risk from construction activities	▪ Contractors to adopt and maintain safe working practices. ▪ Usage of fluorescent and retro refectory signage, in local language at the construction sites ▪ Training to workers on safety procedures and precautions. ▪ Mandatory appointment of safety officer. ▪ All regulations regarding safe scaffolding, ladders, working platforms, gangway, stairwells, excavations, trenches and safe means of entry and egress shall	Same as above **Annex-8.10** Guideline to Ensure Worker's Safety during Construction Environmental Policy of KSHIP and provision of ISO:14001:2004	Construction sites	MI: Availability of Safety gears to workers Safety signage Training records on safety Number of safety related accidents PT: Zero fatal accidents. Zero or minor non-fatal	Site observation Review records on safety training and accidents Interact with construction workers	Contractor	KSHIP / IE

Environmental Issues/ Component	Remedial Measures	Reference to laws/ guidelines	Location	Monitoring Indicators (MI) / Performance Target (PT)	Monitoring Methods	Institutional Responsibility	
						Implementation	Supervision
	be complied with. ▪ Provision of PPEs to workers. ▪ Provision of a readily available first aid unit including an adequate supply of dressing materials. ▪ The contractor will not employ any person below the age of 18 years ▪ Use of hazardous material should be minimized and/or restricted. ▪ Emergency plan (to be approved by engineer) shall be prepared to respond to any accidents or ▪ Accident Prevention Officer must be appointed by the contractor. ▪ Other provisions to ensure **Worker's Safety during Construction** should be followed as per **Annex-8.10.** ▪ Guidelines for **Storage, Handling**, Use and Emergency Response for **Hazardous Substances** is given in **Annex-8.11.** ▪ The Safety Checklist given in **Annex-8.20** should be submitted to IE on monthly basis ▪ Reporting format for road safety measures during Construction given in **Annex-8.21** should be submitted to IE before start of construction. ▪ On occurrence of any accident or injury, the safety officer should submit an accident report to the IE as per the format given in IRC:53-2012 "Road Accident Reporting"			accidents.			
8.4 Accident risk to	▪ Restrict access to construction	Same as above	Construction sites	MI: Safety signs	Site inspection	Contractor	KSHIP / IE

Environmental Issues/ Component	Remedial Measures	Reference to laws/ guidelines	Location	Monitoring Indicators (MI) / Performance Target (PT)	Monitoring Methods	Institutional Responsibility	
						Implementation	Supervision
local community	sites only to authorized personnel. ▪ Physical separation must be provided for movement of vehicular and human traffic. ▪ Adequate signage must be provided for safe traffic movement ▪ Provision of temporary diversions and awareness to locals before opening new construction fronts.			and their location; Incidents of accidents; Complaints from local people PT: Zero incident of accidents. Zero complaints.	Consultation with local people		
9. Site Restoration and Rehabilitation							
9.1 Clean-up Operations, Restoration and Rehabilitation	• Contractor will prepare site restoration plans, which will be approved by the 'Engineer'. • The clean-up and restoration operations are to be implemented by the contractor prior to demobilization. • All construction zones including river-beds, culverts, road-side areas, camps, hot mix plant sites, crushers, batching plant sites and any other area used/affected by the project will be left clean and tidy, to the satisfaction of the Environmental officer. • All the opened borrow areas will be rehabilitated and 'Engineer' will certify	Project requirement Annex-8.2 Annex-8.4 Annex-8.5 Annex-8.7 Environmental Policy of KSHIP and provision of ISO:14001:2004	Throughout the project corridor, construction camp sites and borrow areas	MI: Condition of camp sites, construction sites and borrow areas. Presence / absence of construction material / debris after completion of construction works on construction site. PT: Clean and tidy sites. No trash or debris left on site. Site restored and leveled.	Site observation Interaction with locals; Issue completion certificate after restoration of all sites are found satisfactory	Contractor	KSHIP / IE
C. OPERATION AND MAINTENANCE STAGE							
1. Air Quality							
2.1 Air pollution due to due to vehicular movement	▪ Roadside tree plantations shall be maintained. ▪ Regular maintenance of the road will be done to ensure good	Environmental Protection Act, 1986; The Air (Prevention and	Throughout the Corridor	MI: Air quality monitoring as per post project Environmental	As per CPCB requirements	PIU / Pollution Monitoring Agency	KSHIP

Environmental Issues/ Component	Remedial Measures	Reference to laws/ guidelines	Location	Monitoring Indicators (MI) / Performance Target (PT)	Monitoring Methods	Institutional Responsibility	
						Implementation	Supervision
	surface condition ▪ Air quality monitoring. If monitored parameters exceeds prescribed limit, suitable control measures must be taken. ▪ Signages shall be provided reminding them to properly maintain their vehicles to economize on fuel consumption. ▪ Enforcement of vehicle emission rules in coordination with transport department or installing emission checking equipment	Control of Pollution) Act, 1981 Environmental Policy of KSHIP		Monitoring Program PT: Levels are equal to or below baseline levels given in the IEE report	Site inspection		
2. Noise							
2.1 Noise due to movement of traffic	• Effective traffic management and good riding conditions shall be maintained • Speed limitation to 20 km/hour and honking restrictions near sensitive receptors • HORN PROHIBITED sign to be placed near educational institutions and medical facilities • Noise monitoring. If monitored value exceeds prescribed limit, suitable control measures must be taken. • Maintenance of noise barriers near sensitive receptors with the help of local community • The effectiveness of multilayered plantation should be monitored. • Create awareness amongst the residents about likely noise levels from road operation at different distances, the safe noise limits and easy to implement noise reduction measures while	Noise Pollution (Regulation and Control) Rules, 2000 and amendments thereof Environmental Policy of KSHIP	Sensitive receptors as identified in the IEE Report	MI: Noise monitoring as per post project Environmental Monitoring Program PT: Levels are equal to or below baseline levels given in the IEE report	Noise monitoring as per noise rules , 2000 Discussion with people at sensitive receptor sites	PIU / Pollution Monitoring Agency	KSHIP

Environmental Issues/ Component	Remedial Measures	Reference to laws/ guidelines	Location	Monitoring Indicators (MI) / Performance Target (PT)	Monitoring Methods	Institutional Responsibility	
						Implementation	Supervision
	constructing a building near road						
3. Land & Soil							
3.1 Soil erosion at embankment during heavy rainfall.	▪ Periodic checking to be carried to assess the effectiveness of the stabilization measures viz. turfing, stone pitching etc. ▪ Soil quality monitoring. If monitored parameters exceeds prescribed limit, suitable control measures must be taken. ▪ Necessary measures to be followed wherever there are failures	Project requirement	At bridge locations and embankment slopes and other probable soil erosion areas. Soil quality monitoring from different land use area along the project road such as agricultural area, residential area and low lying areas	MI: Existence of soil erosion sites; Number of soil erosion sites soil quality monitoring as per post project Environmental Monitoring Program PT: Zero or minimal occurrences of soil erosion	On site observation As per CPCB requirements	PIU	KSHIP
4. Water Resources / Flooding and Inundation							
4.1 Siltation	▪ Regular checks shall be made for soil erosion and turfing conditions for its effective maintenance.	Project requirement	Near surface Water bodies	MI: Water quality monitoring as per post project Environmental Monitoring Program PT: No turbidity of surface water bodies due to the road	Site observation	PIU	KSHIP
4.2 Water logging due to blockage of drains, culverts or streams	▪ Regular visual checks and cleaning of drains shall be done along the alignment to ensure that flow of water is maintained through cross drains and other channels / streams. ▪ Monitoring of water borne diseases due to stagnant water bodies	Project requirement	Near surface Water bodies	MI: Presence/ absence of water logging along the road PT: No record of overtopping/ Water logging	Site observation	PIU	KSHIP

Environmental Issues/ Component	Remedial Measures	Reference to laws/ guidelines	Location	Monitoring Indicators (MI) / Performance Target (PT)	Monitoring Methods	Institutional Responsibility	
						Implementation	Supervision
5. Flora							
5.1 Vegetation	▪ Planted trees, shrubs and grasses to be properly maintained. ▪ The tree survival audit to be conducted at least once in a year to assess the effectiveness	Forest Conservation Act 1980 Environmental Policy of KSHIP	Project tree plantation sites	MI: Tree/plants survival rate PT: Minimum rate of 70% tree survival	Records and field observations. Information from Forestry Department	Forest Department / PIU	KSHIP
6. Maintenance of Right of Way and Safety							
6.1 Accident Risk due to uncontrolled growth of vegetation	▪ Efforts shall be made to make shoulder completely clear of vegetation. ▪ Regular maintenance of plantation along the roadside ▪ No invasive plantation near the road.	Project requirement	Throughout the Project route	MI: Presence and extent of vegetation growth on either side of road. Number of accidents. PT: No accidents due to vegetation growth	Visual inspection Check accident records	PIU	KSHIP
6.2 Accident risks associated with traffic movement.	▪ Traffic control measures, including speed limits, will be forced strictly. ▪ Further encroachment of squatters within the ROW will be prevented. ▪ No school or hospital will be allowed to be established beyond the stipulated planning line as per relevant local law ▪ Monitor / ensure that all safety provisions included in design and construction phase are properly maintained ▪ Highway patrol unit (s) for round the clock patrolling. Phone booth for accidental reporting and ambulance services with	IRC:SP:55	Throughout the Project route	MI: Number of accidents Conditions and existence of safety signs, rumble strips etc. on the road Presence/absence of sensitive receptor structures inside the stipulated planning line as per relevant local law PT: Fatal and non-fatal accident rate is reduced after	Review accident records Site observations	PIU	KSHIP

Environmental Issues/ Component	Remedial Measures	Reference to laws/ guidelines	Location	Monitoring Indicators (MI) / Performance Target (PT)	Monitoring Methods	Institutional Responsibility	
						Implementation	Supervision
	minimum response time for rescue of any accident victims, if possible. ▪ Tow-way facility for the breakdown vehicles if possible			improvement			
6.3.Transport of Dangerous Goods	▪ Existence of spill prevention and control and emergency responsive system ▪ Emergency plan for vehicles carrying hazardous material	-	Throughout the project stretch	MI: Status of emergency system – whether operational or not PT: Fully functional emergency system	Review of spill prevention and emergency response plan Spill accident records	PIU	KSHIP

EA: Executing Agency, KSHIP: Karnataka State Highways Improvement Authority, EO: Environmental Officer, IRC: Indian Road Congress, IE: Independent Engineer, SPCB: State Pollution Control Board,

The “Project engineer” or “the engineer” is the team of Independent Engineer (IE) responsible for approving the plans, engineering drawing, release of payments to contractor etc. on behalf of the employer (KSHIP). It is usually the team leader of the IE that takes the responsibility of signing approval documents on behalf of the IE team. The “environmental officer” is the environmental specialist under the IE who is responsible for providing recommendations to the IE team leader for approving activities specific to environment safeguards on behalf of “the engineer”.

C. Environmental Policy of KSHIP

453. **The Karnataka State Highways Improvement Project** (KSHIP), a unit of KPWD, Government of Karnataka, implements improvement in the State's road network to provide safe and efficient road access, that will enhance community livelihood and support economic prosperity in the State.

454. KSHIP seeks to achieve balanced and sustainable outcomes with responsible environmental leadership in all the projects it implements. For achieving the above, KSHIP aims to:

- Comply with all applicable environmental legislation and other requirements
- Protecting & conserving natural resources and enhancing the environmental values while preventing pollution and minimizing the impact on the natural environment
- Implement, maintain and continually improve an effective environmental management system
- Apply an approach of "avoid, minimize and mitigate", to the management of environmental impacts associated with road improvement for its Stakeholders
- Develop awareness of environmental management processes, standards and responsibilities among KSHIP employees, consultants, contractor partners etc.
- Be responsive to community and stakeholder views on environmental issues
- Set specific environmental objectives and targets relating to the key environmental aspects of KSHIP activities; measure and report progress in achieving these targets

455. This policy is established in line with the Vision and Environmental Policy of the KPWD, Government of Karnataka.

D. Emergency Response Plan

456. Project Proponents shall prepare site specific Emergency Response Plans to face and address any emergency situation with respect to vehicular accidents, heavy floods and spillage of oil or other hazardous materials. Copy of emergency plan may be circulated in local language to affected villages. A consultation may also be formed regarding discussion on Emergency Response Plan with local populace. A communication flow chart may also be drafted for easy understanding of information flow during emergency situation. It requires establishing and developing a communication and response system to minimize the impacts of these situations and also minimize the time required to respond to these situations in order to safeguard people, property and environmental resources. Contractor shall submit approved Accident Safety and Hazardous Chemical Spill Management Plan. The plan should also have details of detours in case of emergency. The Emergency Contact Information of concerned local authorities should be displayed at suitable locations along the road particularly in accident prone zones and sensitive locations

E. Grievance Redressal Mechanism

457. A project-specific grievance redress mechanism (GRM) will be established to receive, evaluate, and facilitate the resolution of affected person's (AP's) concerns, complaints, and grievances about the social and environmental performance at the level of the project. The

GRM will aim to provide a time-bound and transparent mechanism to voice and resolve environmental concerns linked to the project. The GRM will provide an accessible and trusted platform for receiving and facilitating the resolution of APs' grievances related to the project. The multi-tier GRM for the project is outlined below, each tier having time-bound schedules and with responsible persons identified to address grievances and seek appropriate persons' advice at each stage as required.

458. Project area-wide public awareness campaigns will ensure that knowledge of the grievance redress procedures is generated. The PIU, with the assistance of RP Implementation NGO will conduct awareness campaigns to ensure that general public, including poor and vulnerable households are made aware of the grievance redress procedures.

459. **Grievance Redress Process:** KSHIP PIU has a well-established and functioning grievance redress system. The same system will be followed for this project.

460. **Registering complaints:** Complainants will have the flexibility of conveying grievances/suggestions by registering in the compliant registers placed at contract site offices, SDO & DO offices or by e-mail, or by post, or by registering online of KSHIP website. PIU established a public response centre (PRC) helpline specifically addresses the issues arising out of project implementation. Compliant can be registered via any of the following means:

(i) Through Public Response Center Help Line 24/7: ◦
- Land Line Number: 080-23205995
- Cell No: 9482079947
- Skype ID: Kshipprc
- WhatsApp: 9482079947
- Email: kshipprc@vindhyainfo.com

(ii) Through Facebook: www.facebook.com/pwd.KSHIP

(iii) register online at (http://www.kship.in/pms/Pub/CHM/frmComplaintNewEn.aspx)

461. The complaint received at PRC helpline is recorded and transferred to concerned official based on the nature of complaint. Environmental related complaints/grievances are forwarded to the Environmental Specialist of the PIU. ES will review the complaint and forward to the concerned DO for redress. DO will take necessary action on the complaint and if the corrective action is to be taken by the contractor, DO will instruct the contractor to do so. It is required to address the complaint in 28 days, and inform the compliant about redress and the action taken.

462. Following process is followed for the complaints received at the site offices. Careful documentation of the name of the complainant, date of receipt of the complaint, address/contact details of the person, location and nature of the problem will be undertaken. In case of grievances that are immediate and urgent in the perception of the complainant, the contractor's EHS officer and the Project Manager, and personnel from the PIU engineers on-site will provide the most easily accessible or first level of contact for the quick resolution of grievances. Contact information of responsible officers and contractor staff will be posted at all construction sites in visible locations. The grievance redress process will have following levels:

- **1st Level Grievance:** The complaint will be reviewed by concerned AEE and forwarded to the contractor for immediate resolution of the issue on-site and will be required resolve the issue within 7 days of receipt of a complaint/grievance.

IEs Environmental Management Specialist (EMS) will provide guidance as required by site staff.

- **2nd Level Grievance:** All grievances that cannot be redressed within 7 days at the 1st level will be dealt by at Executive Engineer, DO, with the assistance of IE EMS. If the issue is not resolved in 7 days at EE level, will be brought to the notice of the PIU head office. The Environmental Specialist of PIU will resolve the grievance within 14 days of receipt of a complaint/grievance.
- **3rd Level Grievance:** If the grievance is not resolved at above two levels within 28 days will be referred to the District Grievance Redress Committee (DGRC) headed by the Deputy Commissioner. DGRC will have following members: Assistant Commissioner, independent member from any reputed institution appointed by DC and EE of concerned DO (as member secretary). DGRC meets at the district headquarter as required, and resolve the matter within 30 days of receipt at DGRC.

463. The PIU Environmental Officer (SO) will have the overall responsibility for timely grievance redressal on environmental issues and for registration of grievances, related disclosure, and communication with the aggrieved party. The project GRM notwithstanding, an aggrieved person shall have access to the country's legal system at any stage. That is the choice of the complainant, and can run parallel to accessing the GRM and is not dependent on the negative outcome of the GRM

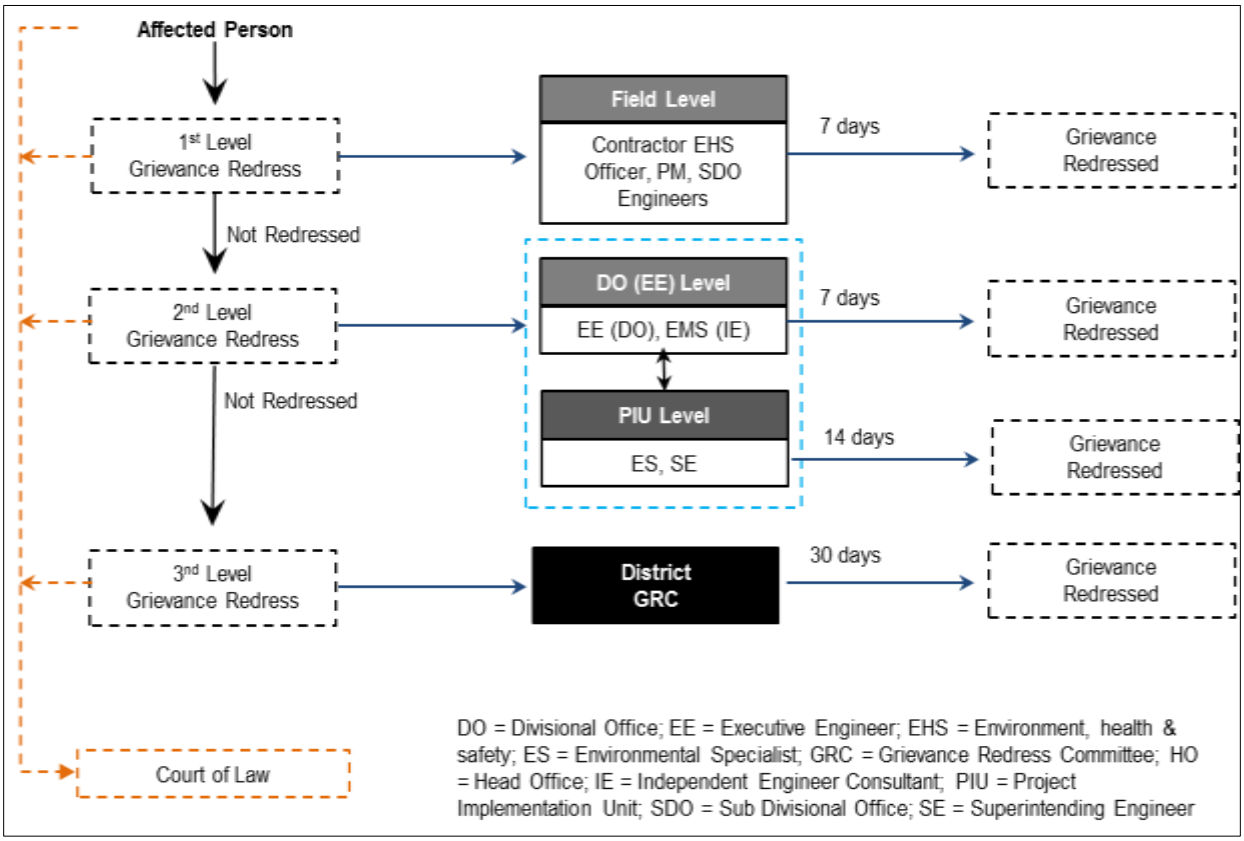


Figure 40: Grievance Redress Process

464. In the event that the established GRM is not in a position to resolve the issue, the affected persons can also use the ADB Accountability Mechanism through directly contacting (in

writing) the Complaint Receiving Officer at ADB headquarters or the ADB India Resident Mission. The complaint can be submitted in any of the official languages of ADB's Developing Member Countries. The ADB Accountability Mechanism information will be included in the Project Information Document to be distributed to the affected communities, as part of the project GRM.

465. **Record-keeping:** The PIU will keep records of grievances received, including contact details of the complainant, the date the complaint was received, the nature of the grievance, agreed corrective actions and the date these were affected and the final outcome. The number of grievances recorded and resolved and the outcomes will be displayed/disclosed on PIU website, as well as reported in monitoring reports submitted to ADB on a semi-annual basis.

466. **Periodic Review and Documentation of Lessons Learned:** The Project Director will periodically review the functioning of the GRM and record information on the effectiveness of the mechanism, especially on the project's ability to prevent and address grievances.

467. **Costs:** All costs involved in resolving the complaints (meetings, consultations, communication and reporting/information dissemination) will be borne by the PIU.

F. Environmental Monitoring Program

468. The purpose of the environmental monitoring program is to ensure that the envisaged purpose of the project is achieved and results in desired benefits to the target population. To ensure the effective implementation of the EMP, it is essential that an effective monitoring program be designed and carried out. The broad objectives are:

- To evaluate the performance of mitigation measures proposed in the EMP
- To evaluate the adequacy of Environmental Impact Assessment
- To suggest improvements in management plan, if required
- To enhance environmental quality
- To satisfy the legal and community obligations

469. The environmental monitoring plan contains:

- Performance Indicators
- Environmental Monitoring Program
- Reporting Formats
- Necessary Budgetary Provisions

1. Performance Indicators

470. The physical, biological and social components identified to be particularly significant in affecting the environment at critical locations have been suggested as Performance Indicators. The Performance Indicators shall be evaluated under three heads as:

a) Environmental condition indicators to determine efficiency of environmental management measures in control of air, noise, water and soil pollution.
b) Environmental management indicators to determine compliance with the suggested environmental management measures
c) Operational performance indicators that have been devised to determine

efficiency and utility of the proposed mitigation measures

471. The Performance Indicators and monitoring plans prepared are presented in **Table 141**.

Table 141 Performance Indicators

S.N.	Details	Indicators	Stage	Responsibility
A.	**Pre-Construction Stage: Environmental Management Indicators and Monitoring Plan**			
1.	Location of construction camps have to be identified and parameters indicative of environment in the area has to be reported. Reporting format is given in Annex-8.13	Construction camp	Pre-construction	Contractor
2.	Location of borrow areas have to be finalized and parameters indicative of environment in the area has to be reported. Reporting format is given in Annex-8.16	Borrow areas	Pre-construction	Contractor
3.	Location of Quarry and Stone Crusher sites have to be finalized and parameters indicative of environment in the area has to be reported. Reporting format is given in Annex-8.18	Quarry and Stone Crusher sites	Pre-construction	Contractor
4.	Locations for Debris Disposal Site have to be identified and parameters indicative of environment in the area has to be reported. Reporting format is given in Annex-8.19	Debris Disposal Site	Pre-construction	Contractor
5.	Progress of tree removal marked for cutting is to be reported	Site clearing	Pre-construction	Contractor
B.	**Construction Stage: Environmental Condition Indicators and Monitoring Plan**			
1.	The parameters to be monitored as per frequency, duration & locations of monitoring specified in the Environmental Monitoring Program prepared (Refer **Table-8.3**)	Air quality	Construction	Contractor through NABL approved monitoring agency
		Noise level	Construction	Contractor through NABL approved monitoring agency
		Ground Water quality	Construction	Contractor through NABL approved monitoring agency
		Surface Water quality	Construction	Contractor through NABL approved monitoring agency
		Soil quality	Construction	Contractor through NABL approved monitoring agency

S.N.	Details	Indicators	Stage	Responsibility
2.	Progress of measures suggested as part of the strategy is to be reported	Tree plantation	Construction	Contractor
3.	Contractor shall report implementation of the measures suggested for topsoil conservation to Sr. Environmental Specialist of IE	Top Soil Conservation	Construction	Contractor
4.	Contractor shall report implementation of the measures suggested for slope stabilization and sediment control to Sr. Environmental Specialist of IE	Slope Stabilization and Sediment Control	Construction	Contractor
5.	Contractor shall report implementation of the measures suggested for waste management to Sr. Environmental Specialist of IE	Waste Management Plan	Construction	Contractor
6.	Contractor shall report implementation of the guideline to ensure worker's safety during construction to Sr. Environmental Specialist of IE	Worker's Safety during Construction	Construction	Contractor
C.	**Operation Stage: Management & Operational Performance Indicators**			
1.	The number of trees surviving during each visit will be compared with the number of saplings planted	Survival rates of trees	Operation	Sr. Environmental Specialist of IE up to construction period, and then Environmental Cell of PIU, KSHIP over a period of 5 years
2.	Sr. Environmental Specialist of IE and PIU will undertake joint site visit with the Contractor to determine whether the Borrow areas, Quarry areas, Debris disposal site have been rehabilitated in line with Guidelines	Rehabilitation of Borrow areas, Quarry area, Debris Disposal site	Operation	Sr. Environmental Specialist of IE and PIU / KSHIP
3.	The PIU will visit sensitive locations along with the environmental monitoring agency (responsible for monitoring of noise levels during operation stage) to check the efficiency of the noise barriers	Utility of noise barriers for sensitive receptors	Operation	PIU / KSHIP

2. Monitoring Schedule

472. The detail monitoring schedule during construction and operation stages are presented in **Table 142**. For each of the environmental condition indicator, the monitoring program specifies:

- Parameters to be monitored
- Location of the monitoring sites
- Frequency and duration of monitoring
- Institutional responsibilities for implementation and supervision

Table 142: Environmental Monitoring Program

Environment Component	Project Stage	Environmental Monitoring Program			Institutional Responsibility	
		Parameters	Location	Frequency	Implementation	Supervision
Air Quality	Construction[9]	PM_{10}, $PM_{2.5}$, SO_2, NO_2, CO, HC	At 2 locations: Wherever the contractor decides to locate the Batching & Asphalt Mixing Plants, Hot Mix Plant, Crushers, DG sets locations	Twice in a season at one day interval for 3 seasons (except monsoon) Construction work should be in full swing during monitoring Duration: 24 hours	Contractor through NABL approved monitoring agency	IE / PIU
		PM_{10}, $PM_{2.5}$, SO_2, NO_2, CO,	At 3 locations: - Madhuvanahalli - Kamagere - Hanur	Twice in a season at one day interval for 3 seasons (except monsoon) Construction work should be in full swing during monitoring Duration: 24 hours	Contractor through NABL approved monitoring agency	IE / PIU
	Operation[10]	PM_{10}, $PM_{2.5}$, SO_2, NOx, CO,	At 3 locations: - Madhuvanahalli - Kamagere - Hanur	Once in a season for 3 seasons (except monsoon) Duration: 24 hours	PIU through NABL approved monitoring agency	PIU/KSHIP
Noise Level	Construction	Noise level in dB(A)	At equipment yard and Stone Crusher Unit	4 times a year (in each season) Duration: 24 hours	Contractor through NABL approved monitoring agency	IE / PIU
		Noise level in dB(A)	At 4 locations: - Madhuvanahalli - Kamagere - Manglam - Hanur	4 times a year (in each season) Duration: 24 hours	Contractor through NABL approved monitoring agency	IE / PIU
	Operation	Noise level in dB(A)	At 4 locations: - Madhuvanahalli - Kamagere - Manglam - Hanur	Once in every three years Duration: 24 hours	PIU through NABL approved monitoring agency	PIU / KSHIP

[9] Construction period is 24 months
[10] Monitoring in Operation Phase will be conducted in every 3 years for 10 years

<table>
<tr><th>Environment Component</th><th>Project Stage</th><th colspan="3">Environmental Monitoring Program</th><th colspan="2">Institutional Responsibility</th></tr>
<tr><th></th><th></th><th>Parameters</th><th>Location</th><th>Frequency</th><th>Implementation</th><th>Supervision</th></tr>
<tr><td>Ground Water Quality</td><td>Construction</td><td>Physical, Chemical & Biological parameters as per IS 10500:2012

However, IE may include additional parameters</td><td>At 4 locations:
- Madhuvanahalli
- Kamagere
- Manglam
- Hanur</td><td>4 times a year</td><td>Contractor through NABL approved monitoring agency</td><td>IE / PIU</td></tr>
<tr><td></td><td>Operation</td><td>Physical, Chemical & Biological parameters as per IS 10500:2012</td><td>At 4 locations:
- Madhuvanahalli
- Kamagere
- Manglam
- Hanur</td><td>Twice in every three years (Pre-monsoon & post-monsoon)</td><td>PIU through NABL approved monitoring agency</td><td>PIU / KSHIP</td></tr>
<tr><td>Surface Water Quality</td><td>Construction</td><td>Please refer Table-4.24 of Chapter4 of the IEE Report</td><td>At 5 locations:<table><tr><th>Design Ch. Km</th><th>Village</th></tr><tr><td>69+500</td><td>Haruvanapuram</td></tr><tr><td>76+030</td><td>Konagarahalli</td></tr><tr><td>83+300</td><td>Hullepuram</td></tr><tr><td>84+230</td><td rowspan="2">Nala Crossing , Hanur</td></tr><tr><td>85+300</td></tr></table></td><td>4 times a year</td><td>Contractor through NABL approved monitoring agency</td><td>IE / PIU</td></tr>
<tr><td></td><td>Operation</td><td>Please refer Table-4.24 of Chapter4 of the IEE Report</td><td>At 5 locations:<table><tr><th>Design Ch. Km</th><th>Village</th></tr><tr><td>69+500</td><td>Haruvanapuram</td></tr><tr><td>76+030</td><td>Konagarahalli</td></tr><tr><td>83+300</td><td>Hullepuram</td></tr><tr><td>84+230</td><td rowspan="2">Nala Crossing , Hanur</td></tr><tr><td>85+300</td></tr></table></td><td>Twice in every three years (Pre-monsoon & post-monsoon)</td><td>PIU through NABL approved monitoring agency</td><td>PIU / KSHIP</td></tr>
<tr><td>Soil</td><td>Construction</td><td>pH, Conductivity, Organic matter, N, P, Na, K, Pb</td><td>At 4 locations: Wherever the contractor decides to locate the Hot Mix Plant; construction camp; remaining 2 will be from different land use area along the project road such as agricultural area and residential area</td><td>Once in a year</td><td>Contractor through NABL approved monitoring agency</td><td>IE / PIU</td></tr>
<tr><td></td><td>Operation</td><td>pH, Conductivity, Organic matter, N, P, Na, K, Pb</td><td>2 will be from different land use area along the project road such as agricultural area and residential area</td><td>Once in every three years</td><td>PIU through NABL approved monitoring agency</td><td>PIU / KSHIP</td></tr>
<tr><td>Soil Erosion</td><td>Construction</td><td>Visual observation & turbidity test</td><td>Visual observation at high embankments sites such as bridge location, culvert locations, embankment area etc.</td><td>Pre-monsoon and post-monsoon season</td><td>Environmental Specialist, Hydrologist, and Material Specialist of Construction Supervision Consultants & Contractor</td><td>IE / PIU</td></tr>
<tr><td>Haul Road</td><td>Construction</td><td>Maintenance of haul roads,</td><td>Haul roads & hauling mode</td><td>At least twice a day i.e. midday and evening</td><td>Contractor</td><td>IE / PIU</td></tr>
</table>

Environment Component	Project Stage	Environmental Monitoring Program			Institutional Responsibility	
		Parameters	**Location**	**Frequency**	**Implementation**	**Supervision**
		generation of dust.				
Plantation	Construction	Plantation	- Side of the carriageway - Along boundary wall of the schools – Noise Barrier	Once in fortnightly; Comparison should be done for every six months	State Forest Department / PIU	PIU / KSHIP
	Operation	Growth of roadside plantation	Side of the carriageway	Assess growth every year for initial five years	PIU	PIU / KSHIP

Note: 1) Construction period is 24 months

2) Monitoring in Operation Phase will be conducted every 3 years for 10 years.

Note: Karnataka has the following four seasons in the year:

- Winter Season : January to February
- Summer Season : March to May
- Monsoon Season : May to September
- Post-monsoon : October to December

3. Reporting System

473. Reporting system for the suggested monitoring program operates at two levels:

- Reporting of environmental management indicators
- Reporting for operational performance indicators at the PIU level

474. Environmental monitoring involves regular checking of the environmental management issues detailed in the EMP and to ascertain whether the mitigation measures are achieving their objectives, according to the EMP, with the progress of the works. It provides the necessary feedback for project management to keep the program on schedule will still achieving the expected outcomes. The contractor, IE and PIU are three components of the reporting system for environmental conditions and management indicators. The reporting system to be followed in construction phase is presented in **Table 143.**

- The reporting system will start with the Contractor who is the main executor of the implementation activities. The contractor will report to the Sr. Environmental Specialist of IE who in turn shall report to the PIU. The Contractor will submit monthly and quarterly environmental compliance reports along with formal monthly and quarterly reporting to the IE.
- The IE will submit separate quarterly environmental monitoring reports to PIU in addition to submission of the summary of the activities of the month in the formal monthly report including any deviations and corrective actions.
- PIU will be responsible for preparation of the targets for identified non-compliances
- A full record of construction activities will be kept as a part of normal contract monitoring system. Reporting and Monitoring Systems for various stages of construction and related activities have been proposed are to ensure timely and effective implementation of the EMP.

475. During the operation phase, the supervision as well as reporting responsibilities will lie with the KSHIP site offices and overall supervision will be the responsibility of Environmental Specialist at KSHIP head office in Bengaluru. .

Table 143: Reporting System during Construction Phase

Item	Contractor	Independent Engineer		PIU to oversee compliance monitoring
		Supervision	Reporting to PIU	
Construction Stage				
Monitoring of construction site and construction camp	Before start of Work	Regular	Quarterly	Regular
Pollution Monitoring	As per Environmental Monitoring Program	As per the Schedule	Quarterly	Quarterly
Debris Disposal Area	Weekly	As required	Quarterly	Quarterly
Monitoring of Enhancement Activities	Regular	Regular	Quarterly	Quarterly
Top Soil Conservation & Slope Stabilization	Weekly	Weekly	Monthly	Quarterly
Borrow Area /Quarry Area / Debris Disposal Area	Regular	Weekly	Monthly	Quarterly
Tree felling	Weekly	Weekly	Monthly	Quarterly
Tree Plantation	Monthly	Monthly	Monthly	Quarterly

G. Institutional/Implementation Arrangements

1. Institutional Arrangement

476. Project Implementation Unit (PIU) is responsible for implementation of all the mitigation and management measures suggested in EMP and also make sure that the statutory requirements are not violated during the pre-construction, construction and operation stages of the project.

477. The Chief Project Officer (CPO) heads KSHIP. He will be responsible for the successful implementation of the Project. The Chief Engineer is also the Project Director (PD) in the KSHIP set up for the implementation of the project. The PD is assisted by PIU, Technical / Environment and LAQ / R&R wings at the head office. Various wings are functioning under PIU such as Technical, Environment, LAQ, Administration and Accounts.

478. An Environmental Management Plan Implementation Unit (EMPIU) has been created in Project Implementation Unit (PIU) and a Sr. Environmental Specialist Environment has been positioned for the overall functioning of the EMPIU. The main activities of the EMPIU can be divided into two categories i.e. forestry and environment. Forestry related activities include diversion of forest land, compensatory afforestation, avenue plantation, plantation in oxbow land etc. while environment related activities include statutory clearances, implementation of EMP through Contractor, Grievance Redress, training etc. An Assistant Conservator of Forest (ACF), Range Forest Officer (RFO) and Deputy RFO, assist the Sr. Environmental Specialist for forestry related activities. For environment related activities, 2 Assistant Executive Engineer (AEE) and 2 Assistant Engineer (AE) has been proposed for KSHIP-III. Position of one AEE and one AE are already sanctioned while another position of AEE and EE are to be sanctioned.

479. Project Director will be heading the overall functioning of the PIU. The Executive Engineers (EEs) and supporting staff as employer's representatives nominated for the project will be responsible for the implementation of the project under the divisions. The Sr. Environmental Specialist of the EMPIU will look after the forestry and environmental issues during the project preparation, implementation and operation with the assistance of the Sr. Environmental Specialist of the Independent Engineer (IE). The contractor will be responsible for implementation of the EMP in the field. The "Contractors" herein mean the agency hired for execution of the construction works for the respective packages. Organizational setup of for PIU is illustrated in the Figure 40.

2. Implementation Arrangements

480. The KSHIP is responsible for the implementation of the provisions made within the EMP through Independent Engineer (IE) with the help of project offices. The services of Independent Engineer will be procured to assist the site offices for monitoring the environmental aspects of the project during implementation. The IE will have a multi-disciplinary team and will also have an environmental management team having intermittent input of a senior level Environmental Specialist supported by middle level full time Environmental Specialists (one for each packages). This team will ensure compliances of mitigation measures and all statutory requirements during implementation and operation of project.

481. ***Independent Engineer (IE).*** The Independent Engineer, to be procured through ICB shall assist the KSHIP with the implementation of project, once the project documents are ready. The Environmental Specialist of the IE shall be the key personnel to ensure the successful implementation of EMP provisions. Since ICB procurement is envisaged, the selected IEs are expected to have the necessary professional(s) to tackle the issues that the project is likely to bring up. The Environmental Specialist of the Independent Engineer will be a key position, which can be leveraged to ensure that the Contractor complies with the various EMP requirements.

482. The EMP prepared for the Project road, needs to be followed during the implementation of the civil works. The EMP is integrated in the technical specification and contract documents.

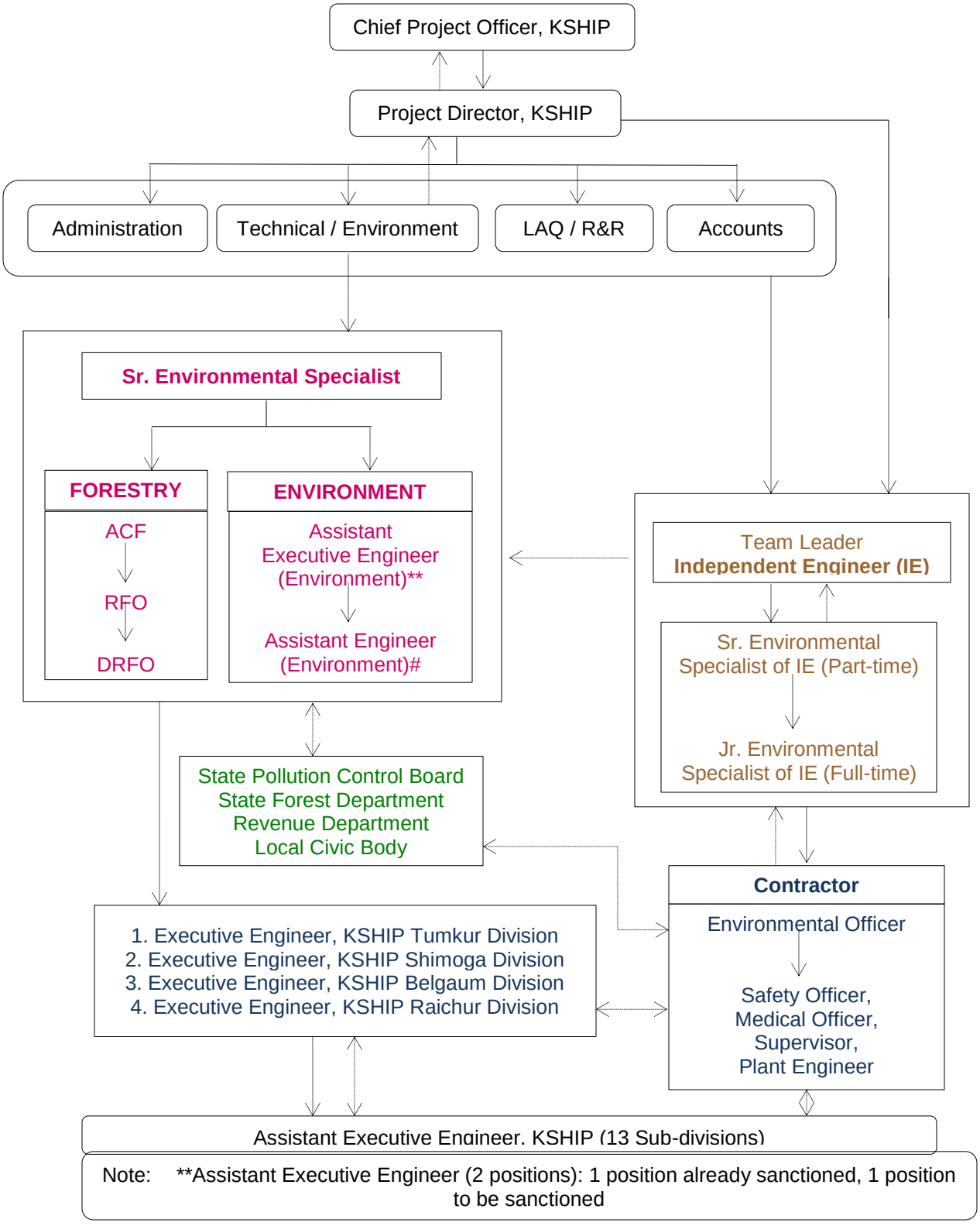


Figure 41 Implementation Arrangement

483. Qualification and Responsibilities of **Senior Environmental Specialist** of IE:

Qualifications & Experience

- Postgraduate in Environmental Management / Environmental Science / Ecology / Environmental Planning / degree in Civil Engineering with PG / specialisation in environment.
- 15 years of total experience with a minimum of 10 years in the preparation and implementation of EMP of highway projects and an understanding of environmental, health and safety issues.
- Prior practical experience in Highways projects funded by Multilateral Agencies

Roles & Responsibilities

- The key responsibility of the Environmental Specialist will be the successful implementation of the EMP
- In addition, he / she will update KSHIP on the progress of environmental protection and / or enhancement works as envisaged in the EMP
- Supervise and monitor the implementation of EMP by the Contractor
- Review and approve site-specific environmental mitigation / enhancement designs worked out by the Contractor based on the EMP prepared during project preparation
- Review and recommend the Contractors' Implementation Plans for approval (with any changes that may be necessary) to ensure compliance with the environmental provisions of the Contract
- Monitor tree plantation programs and the periodic Environmental Monitoring (air, noise, water, soil and biodiversity) programs to ensure compliance with the statutory requirements and the EMP
- Hold regular meetings with Contractor and provide update to KSHIP regarding the progress of environmental works
- Prepare and submit Monthly, Quarterly, Semi-annual and Annual Environmental report to KSHIP
- Develop and organise environmental training programmes to upgrade the skills within the staff of the environmental cell and the Contractors
- Document and develop good practices during project implementation for wider dissemination

484. The project will require continuous environmental supervision from the IE's side. Since the Sr. Environmental Specialist for IE projects are to be deployed on intermittent basis, it is required to have fulltime Jr. Environmental Specialist to assist the key professional. Field Engineers supervising the construction works also needs to be trained on environmental aspects, who then shall apprise the Team Leader and the Sr. Environmental Specialist of any significant development on environment

485. Qualification and Responsibilities of **Junior Environmental Specialist** of IE (Sub Professional):

Qualifications & Experience

- Postgraduate in Environmental Management / Environmental Science / Ecology / Environmental Planning / Environmental Engineering
- 7 years of experience with a minimum of 3 years in the preparation and or

implementation of EMP of highway projects and an understanding of environmental, health and safety issues
- Prior practical experience in multilateral funded projects in highways sector would be an advantage

Roles & Responsibilities
- The key responsibility of the Environmental Specialist will be the successful implementation of the EMP
- In addition, he / she will update the Key Environmental Specialist & the TL of IE on the progress of environmental protection and / or enhancement works as envisaged in the EMP
- Regularly supervise and monitor the implementation of EMP by the Contractor
- Verify the extent of environmental compliance of the Contractor regularly
- Monitor tree plantation programs and the periodic Environmental Monitoring (air, water, noise, soil & biodiversity) Programs to ensure compliance with the statutory requirements and the EMP
- Interact & hold regular meetings with Contractor Environmental Officers in implementation of the EMP
- Assist the Key Environmental Specialist in preparation of monthly, Quarterly, Semi-annual and Annual Environmental reports
- Assist the Key Environmental Specialist in documenting good practices during project implementation for wider dissemination
- Regularly monitor the approved site-specific environmental mitigation / enhancement designs based on the EMP prepared

486. **Contractor.** Execution of works will be the responsibility of the PBDPS Contractor (Performance based Deferred Payment System Contractor). The Contractor may himself be the executioner of the project or might decide to sublet some part to petty contractor. The contractor shall be responsible for both the jobs done by the petty contactor (if Sublet) as well by him. In both the cases the Contractor will implement the environmental measures. This has been done with a view to ensure that road construction and environmental management go together. The Contractors shall employ a full time Environmental Officer whose qualification and responsibilities shall be as stated below:

487. Qualification and Responsibilities of **Environmental Officer (EO)** of Contractor:

Qualifications & Experience
- Postgraduate in Environmental Management / Environmental Science / Zoology / Botany / Ecology / Environmental Planning / Environmental Engineering
- 5 years of experience with a minimum of 2 years in the implementation of EMP of highway projects and an understanding of environmental, health and safety issues
- Prior practical experience in multilateral funded projects in highways sector would be an advantage

Roles & Responsibilities
- The Environmental Officer shall report directly to the Resident Construction Manager / Project Manager of the Contractor so that the pertinent environmental issues that he raises are promptly dealt with.
- He shall also have a direct interaction with the Environmental Specialist of the IE.
- Monitor / implement measures laid out in the EMP and or as directed by the IE

for the work executed both by petty contractors and the contractor.

- Implement tree plantation programs (if under Contractor's scope) and conduct periodic Environmental Monitoring (air, water, noise, soil & biodiversity) Programs to ensure compliance with the statutory requirements and the EMP
- Provide key inputs in the development of the Contractors' implementation plan for all construction activities, including haulage of material to site, adhering to the requirements of the EMP and getting approval of the IE on the same before start of works.
- Ensure that the regulatory permissions required for the construction equipment, vehicles and machinery (given in the EMP) have been obtained and are valid at all times during the execution of the project.
- Prepare / fill up the environmental and safety related compliances as per daily, weekly, fortnightly, monthly, quarterly, semi-annual checklists in the EMP
- Prepare Safety Plans, Debris & Waste disposal Plan, Emergency Response Plans and Quarry Management and other safety, health and environment related Plans for approval of the IE.
- Identify locations for siting construction camps and other plants, machinery, vehicles and equipment, as well as locations for storage and disposal of wastes, both from the construction camps and from the site and obtain approval for the same from the IE.
- Detail out site-specific environmental mitigation and enhancement measures and obtain approval of the IE for the same
- Carry out the measurements of environmental mitigation and / or enhancement works and prepares bills for the same for approval and payment through the IE.
- Ensure that the safety of the workers and other site users is not compromised during construction
- Ensure that adequate monitoring facilities are available for collecting samples of all discharges from the Contractor's plants, equipment and camps
- Verify the extent of environmental compliance at sites from where the Contractor is procuring the material – Borrow Area, Quarries, Crushers or even sand and suggest appropriate mitigation measures, if required

3. Penalty Clause:

- For not employing a full time Environmental Officer (EO), the contractor shall be levied a fine of Rs. 2,000/ every day from his invoice
- The EO shall be approved by the Client
- In case of non-notified absence of the EO (absence to be notified to the authority in writing) for more than 15 days from site, a fine of Rs. 2,000 per day to be levied on the contractor. Eligibility of leave due to the EO shall be as per standard guidelines of the organization.

488. The environmental officer shall have an environmental, health and safety team to help him in implementing the EMP. These team members may / may not report to him / her directly but shall apprise him of all the incidents and mark a formal report of any incident having an impact on the Health, Environment and Safety issues.

- **Safety Officer (SO):** The safety officer shall on day to day basis interact and assist the EO in implementation of the safety features mentioned in the EMP. He shall also assist the EO in the preparation & submission of safety plans.

- **First Aider / Medical Officer (MO):** The first aider / medical officer shall interact and assist the EO in implementation of the health features mentioned in the EMP

- **Duty Officers (DO) /Supervisors:** The Duty Officers shall on day to day basis, take the necessary mitigation measures as per the directions of the EO, SO & MO and monitor the project facilities and report to the EO on activities that adversely affect the environment in the vicinity.

- **Plant Engineer:** The Plant Engineer has the responsibility of managing and controlling the hot mix plant, crusher unit and fleet of vehicles. He shall ensure that the environment is not degraded at his plant site. Even though the EO shall routinely monitor to detect any negative issues due to operations and bring it to the knowledge of Plant manager for taking rectification works. In case of emergency the Plant Engineer shall immediately notify the EO for necessary actions.

H. Institutional Capacity Building

489. Construction industry of India is an important indicator of the development as it creates investment opportunities across various related sectors. The industry is fragmented, with a handful of major companies involved in the construction activities across all segments; medium sized companies specializing in niche activities; and small and medium contractors who work on the subcontractor basis and carry out the work in the field. In the absence of any institutional mechanism for skill formation, construction workers continue to be trained by the traditional master craftsmen. Apart from its inadequacy in quantitative terms, the traditional system neither utilizes new technologies and work methods, nor does it absorb the benefits of research and development.

490. Therefore, for successful implementation of EMP it is important to orient contractor's supervisory staff as well as key field staff towards environmental issues of highway project, implementation of mitigation measures, green construction technology and sustainable environment to safeguard natural resources and environment. The Environmental Specialist / Engineers at PIU and Independent Engineer are also responsible for the implementation of the EMP, need to be trained. To ensure the success of the proposed implementation set up, there is need for training and skill up-gradation. Hence, considering the requirement, the following training program is suggested.

1. Training Components

491. The environmental training should encompass the following:

- Understanding of the relevant environmental regulations and their application to the project;
- Environmental & Social Issues in Highway Projects
- Road Safety and Road Safety Audit for Highways
- Mainstreaming Biodiversity in Road Transportation Projects for Promoting Smart Green Infrastructure
- Mitigation measures of noise generated from construction equipment
- Environmental Monitoring during Construction stage and Operation stage
- Green Highways & Green Infrastructure

- Use of Waste Plastic in Road Construction
- ISO 14001:2004 Environmental Management System

2. Training Program

492. A training program needs to be worked out incorporating the project needs as well as the intermediate-term capacity building needs of the PIU, IE and Contractor. The program should consist of a number of training modules specific to target groups. The training would cover the basic principles and postulates of environmental assessment, mitigation plans and program implementation techniques, monitoring and management methods and tools. Looking into the potential requirements of each of the target groups, several training component has been suggested.

493. Given below is a list of Training Institutes (**Table 144**) which can be contacted for providing training in various issues related to environmental management as identified in the training component.

Table 144 List of Training Institutes

SN	Name of Training Institute
1.	Indian Academy of Highway Engineers (IAHE) (Ministry of Road Transport & Highways, Govt. of India) A-5, Institutional Area, Sector-62, NH-24 Bypass, NOIDA-201301 (UP) Telephone: 0120-2400085 - 86, 2405006 - 09, Course Coordinator: Shri. M. Riten Kumar Singh(JointDirector) Email: iahe.training@gmail.com
2.	Wildlife Institute of India Post Box # 18, Chandrabani, Dehadun 248 001 Uttarakhand Email: dwii@wii.gov.in Phone: 0135-2640910, 0135-2640114, 0135 2646102 Fax: 0135-2640117
3.	Central Road Research Institute (CRRI) P.O. CRRI, Delhi-Mathura Institute, New Delhi – 110 025 Shri. T. K. Amla, Chief Scientist, Head & Course Organizer Phone: 011 26921939 Email: tkamla.crri@nic.in
4.	Centre for Innovations in Public Systems (CIPS) Administrative Staff College of India, College Park Campus Road No. 3, Banjara Hills, Hyderabad – 500 034 Phone: 040 667 20720 Fax: 040 667 20721 E-mail: chakrapani@cips.org.in
5.	Kerala Forest Research Institute An Institute of Kerala State Council for Science, Technology and Environment Peechi P.O, Thrissur District - 680653 Kerala Phone: 0487 2690100; Fax: 0487-2690111

SN	Name of Training Institute
6.	National Environmental Engineering Research Institute (NEERI) Nehru Marg, Nagpur – 440020, Maharashtra Phone: 0712 2249885-88; 2249970-72 URL: http://www.neeri.res.in
7.	I. Envirotech Instruments Pvt. Ltd. Manufacturers of Air Pollution Monitoring Instruments A-271,Okhla Industrial Area, Phase-1, New Delhi-110020 Phones: 011 26813887, 26814139 Fax: 011 26811833 Email: envirotech@vsnl.com
8.	Centre for Science and Environment 41, Tughlakabad Institutional Area, New Delhi-110062 Phone: 011 29955124, 29956110, 29956394, 29956399 Fax: 011 29955879 Email: cse@cseindia.org
9.	TUV India PVT Ltd 801, Raheja Plaza 1, L.B.S. Marg, Ghatkopar (West) Mumbai – 400086 Phone: +91 22 66477096/ 98, +91 22 66477009 Email: infoindia@tuv-nord.com
10.	SGS India - South 28B/1, 28B/2, 2nd Main Road, Ambattur Industrial Estate Chennai, Tamil Nadu, 600 058 Phone: +91 (0) 44 6608 1600 /1700 / 1800, +91 (0) 87 54 44 6594 (Regional Branch Manager)

J. Environmental Budget

494. The budgetary provision for the implementation of the environmental management plan of the project road can be categorized in to two types and is presented below:

- Environmental Management Plan Works to be implemented by the contractor under civil works contracts
- Environmental Management Plan Works to be implemented by the KHSIP

495. A capital cost provision of about **Rs. 3.45 Crore** has been kept towards implementation of environmental management plan. Summary of environmental budget is presented in **Table 145.**

Environmental Management Plan
Works to be implemented by the Contractor under Civil Works Contracts (Bill of Quantities)

A. Mitigation / Enhancement Budget

Component	Stage	Item	Unit	Quantity	Cost# (Rs.)	Total Cost (Rs.)
Topography & Geology	Construction	Establishment of Construction Camp	Sq. ft	Area required 100 Sq.ft/ labour; No. of labours: 100 Total area required = (100 x 100) = 10,000 sq.ft	300	3,000,000
Soil	Construction	Slope stabilization	Covered under Engineering Cost			
Air	Construction	Dust suppression with sprinkling of water;	Trip	3 trips per day x 300 days in a year for 2 years = 1,800 trips	500	900,000
Water	Construction	Provision of water supply facilities for the construction camps	Month	24	10,000	240,000
Water	Construction	Provision of sewage and sanitation facilities for the construction camps, including maintenance for 2 years	Month	24	10,000	240,000
Water	Construction	Provision for Oil Interception Chambers in construction yard near to 1) vehicle parking, fueling and washing area and 2) Hot Mix Plant	No.	1 units in a construction yard x 2 locations = 2	10,000	20,000
Water	Construction	Construction of Sedimentation Tanks in construction yard near to 1) Concrete mix plant and 2) Hot mix plant	No.	1 units in a construction yard x 2 locations = 2	50,000	100,000
Water	Construction	Silt fencing near water bodies, low lying areas and areas identified by the IE	Meter	650	850	552,500
Water	Construction	Ground Water Recharge Pit / Rainwater Harvesting Structures	No.	7	62,800	439,600
Water	Construction	Enhancement of water body at 1 location as per specification given in the Pond Enhancement Plan	No.	1	63,07,000	6,307,000

Component	Stage	Item	Unit	Quantity	Cost# (Rs.)	Total Cost (Rs.)
		(Annex-8.27) and described in Section-6.3.5.1 of Chapter-6				
Water	Construction	Phyco-Remediation of water body using NUALGI as per details provided in Annex-8.26	Liter	67.5	9,000	607,500
Noise	Construction	Construction of noise barrier at sensitive receptors along the project road (for details please refer Section 6.5.2 of Chapter-6)	Meter	1,340	7,500	10,050,000
Vegetation loss	Construction	Provision of fuel in the construction camp	No.	4 commercial LPG Cylinder per month x 24 months = 96 cylinders	1,500	144,000
Solid Waste Management	Construction	Clearing garbage from construction camp and construction site	Month	24	4,000	96,000
Safety of Workers	Construction	Providing PPE to the labours during the construction	Cost/ person	100	1,200	120,000
Health Checkup	Construction	Provision for biannual health checkups	No.	100 persons x 4 checkups = 400	2,000	800,000
Resettlement & Rehabilitation	Construction	Compensation for structure including affected religious structures, livelihood loss, resettlement assistances & RP implementation	Covered under Engineering Cost			
					Total	**23,616,600**

Note: 1) Construction period is 24 months/ 2 years

basis of unit cost is the Consultant's past experience in similar projects

B. Environmental Monitoring Budget

Parameters	Stage	Frequency	No. of Locations	No. of Samples	Unit Cost/ Sample# (Rs.)	Total Cost (Rs.)
Ambient Air Quality	Construction	Twice in a season for 3 seasons (except monsoon)	5	60	4,000	240,000
	Operation	Once in a season for 3 seasons (except monsoon)	3	27	4,000	108,000
Noise Level	Construction	4 times a year (in each season)	4	32	2,000	64,000
	Operation	Once in every three years	4	12	2,000	24,000
Ground Water Quality	Construction	4 times a year (in each season)	4	32	7,000	224,000
	Operation	Twice in every three years (Pre-monsoon & post-	4	24	7,000	168,000

Parameters	Stage	Frequency	No. of Locations	No. of Samples	Unit Cost/ Sample# (Rs.)	Total Cost (Rs.)
		monsoon				
Surface Water Quality	Construction	4 times a year (in each season)	5	40	7,000	280,000
	Operation	Twice in every three years (Pre-monsoon & post-monsoon	5	30	7,000	210,000
Soil Quality	Construction	Once in a year	4	8	5,000	40,000
	Operation	once in every three years	2	6	5,000	30,000
Transportation of samples to the laboratory	Construction	Immediately after sampling	-	-	Lump sum	200,000
	Operation	Immediately after sampling	-	-	Lump sum	300,000
					Grand Total	**1,888,000**

Note: 1) Construction period is 24 months/ 2 years
2) Monitoring in Operation Phase will be conducted every 3 years for 10 years.
basis of unit cost is the Consultant's past experience in similar projects

C. Forestry Budget

Component	Stage	Item	Unit	Quantity	Cost# (Rs.)	Total Cost (Rs.)
Avenue Plantation	Construction	Plantation of trees (one row) on either side of the project road at 10 m interval & its maintenance for 5 years (200 trees / km on both sides) ▪ Road side plantation 3623 trees ▪ Plantation in community area, schools etc.: 3,587 trees	Nos.	4,128	1,911	7,888,608
					Total	**7,888,608**

D. Training & Mobilization Budget

Component	Stage	Item	Unit	Quantity	Cost# (Rs.)	Total Cost (Rs.)
Training and Mobilization	Construction & Operation	Training of Environmental staff of KSHIP involved in the project, staff of construction supervision consultant, contractor, and collaborating Government agencies	Training cost per person	4 persons @ 2 trainings per year	40,000 per training	640,000
Facilities and Equipment	Construction & Operation	Infrastructure facility (such as computer, printer, scanner, internet etc.) for the team at PIU who will be responsible for monitoring of the implementation of EMP	Set	2	200,000	400,000
					Total	**1,040,000**

basis of unit cost is the Consultant's past experience in similar projects

Table 145: Summary of Environmental Budget

Component	Description	To be implemented by	Amount (Rs.)
A.	Mitigation / Enhancement	Contractor	23,616,600
B.	Environmental Monitoring		1,888,000
		Subtotal	***25,504,600***
C.	Forestry	KSHIP	7,888,608
D.	Training & Mobilization		1,040,000
		Subtotal	***8,928,608***
		Grand Total	**34,433,208**

IX. CONCLUSION & RECOMMENDATIONS

A. Conclusion

496. The proposed project (**Kollegal to Hanur**) includes strengthening and widening of existing State Highway (SH-79). One new bypasses (4.9 km) and realignments are proposed at two locations (total 2.390 km) for improving the road geometrics and meet the project objectives. The length of the project road is **23.782 km**. Project road traverses mainly through plain terrain.

497. The existing road is to be widened to standard 2-lane with paved shoulder configuration based on the traffic projection. A 2-lane section with 7 m wide carriageway and 1.5 m wide paved shoulder and 1m granular shoulder on both sides with proposed ROW of minimum 26 m has been proposed for all the bypasses & realignments.

498. As per ADB Environmental Assessment Guidelines 2003 and ADB Safeguard Policy Statement 2009, proposed project is **"Category B"** project. The Initial Environmental Examination (IEE) Report attempts to identify significant potential environmental impacts associated with the construction and operational phases of the proposed road project. Apart from positive impacts road projects could also generate some adverse direct and indirect environmental impacts. Direct environmental impacts are usually due to construction activities, while indirect environmental impacts are usually related to the operation of improved roads.

499. Most of the adverse impacts of road project during construction period are temporary in nature. These impacts can be minimized through specific engineering solutions. Environment friendly construction methodology has been incorporated into the project design and Environment Management Plan has been prepared to minimize the overall impact on environmental attributes by the proposed project works. Therefore, it is **unlikely to cause any significant adverse environmental impacts** and no further detailed study is required.

500. As per the Government of India regulation, Environmental Clearance is not required for the proposed project. However, Tree Felling Permission from State Forest Department will be required before start of construction.

B. Recommendations

501. Conservation and **Ecosystem Management** has vital role to minimize the impact of highway construction. Maintaining natural flows of rivers, streams etc. without changing the gorge of flow at highway site also contribute to conservation of ecosystem.

502. The use of **Recycled Asphalt Cold Mix** in lieu of Hot Mix Asphalt (HMA) is one of the practices to reduce the lifecycle energy in highway construction. Recycled Asphalt Pavement (RAP) materials generated out of the existing distressed bituminous layers are proposed to be used as the base layer. The single most important justification for use of this technology is that it reduces the emission of greenhouse gases and controls thereby global warming. This would earn tradable carbon credit. Secondly, the technology is quite compatible with Reclaimed Asphalt Pavement technology, which saves the requirement of fresh aggregates and reduces the environmental hazard associated with dumping of damaged pavement materials. The fumes from Hot Mix Asphalt are known to be potential health hazards, especially for the construction workers. Construction at normal air temperature of the mix avoids this health hazard.

503. **Bio-engineering** is the technique of utilizing vegetation in addressing geotechnical problems, which is the only environment friendly and sustainable technology to control soil erosion and slope stabilization in highway project.

504. **Waste plastic** creates problem to the environment. The best way of disposal of waste plastic is its recycling to the maximum extent and waste plastic has great potential for use in bituminous construction. Plastics increase the melting point of the bitumen as well as its addition in small dose helps in substantially improving Marshall Properties, fatigue life and other properties. Use of this technology can not only strengthens the road construction but also increases the road life, and also help to improve the environment.

505. As discussed above, the Environmental Management Plan has been prepared incorporating various modern technologies and guidelines to reduce the environmental impacts of highway construction to make it a Green Highway. Therefore, it is recommended to strictly follow the EMP and associated Guidelines during construction phase and operation phase of the project.

Green Highway considerations at Construction Stage

- Use of Waste Plastic in Road Construction
- Use of Recycled Asphalt Cold Mix Technology
- Slope stabilization using Coir Geotextile and Vetiver Grass
- Phyco-Remediation of water using NUALGI
- Native indigenous trees species with large canopy cover shall be planted. One sq. m. of green canopy absorb 0.2 kg of CO_2 and other waste gases.
- Preservation of fertile top soil
- Adequate number to cross drainage structures proposed to maintain natural flows of streams without changing the gorge of flow at highway site
- Rainwater Harvesting Structures to improve ground water level
- Provision of LPG in construction camp as fuel source
- Utilization of low electrical equipment viz. CFL, LED etc. in construction camp
- Utilization of solar panels in camps, offices and execution sites
- Disposal of hazardous and non-hazardous waste from construction site and reporting its environmental compliances to concerned authorities
- Use of CNG vehicles
- Reduction in fuel consumption & lower down fuel demand in machinery & vehicles