



CHAPTER-01

INTRODUCTION

1.0 INTRODUCTION

Highway projects are undertaken with a motive to improve the economic status and social welfare of the people. At the same time, they may also create an adverse impact on the surrounding environment. People and property in the direct path of the road works may be affected. The environmental impact of highway projects include damage to sensitive Eco-systems, soil erosion, changes to drainage pattern and thereby affecting groundwater, interference with animal and plant life, loss of productive agricultural lands, resettlement of people, disruption of local economic activities, demographic changes, accelerated urbanization and increase in air pollution and noise levels. Hence there is a greater importance for careful examination of Highway developmental activities and operations should be planned and executed by considering potential environmental impacts. The Public Works Department of Government of Goa represented by the Secretary, Public Works Department is engaged in the development of National highways on behalf of Ministry of Road Transport and Highways (MoRTH) and as part of this endeavour, the Employer has decided to undertake "Four Laning of existing Goa/Karnataka border- Panaji Goa section of NH4A from Km 84/000 to 153/075(ANMOD TO PANAJI) UNDER NHDP-III".

Public Works Department of Government of Goa engaged M/s Aarvee Associates Architects Engineers & Consultants Pvt. Ltd as the Technical Consultant for preparation of Feasibility Report for, development of the Project.

The project stretch excludes following reaches:

- From chainage 118 Km to 125 Km (Kandepar - Safa Masjid)
- From chainage 143.400 Km to 153.075 Km (Ella - Panaji).

1.1 Objectives

The principle objectives of Environmental Impact Assessment (EIA) and Environment Management Plan (EMP) are:

- To ensure the project complies with the National and State regulatory policies and laws.
- Generation of environmental baseline information related to the proposed



project for various environmental attributes i.e., land, air, water, noise, soil, socio-economic, ecological & bio-diversity of the project.

- To identify and quantify the significance of impacts of various activities of the proposed project with respect to the various environmental attributes.
- To evaluate the impacts on an environmental quality scale.
- To suggest necessary control measures to minimize the adverse affects.
- To outline additional control measures to be adopted for mitigation of adverse impacts. Integration of EMP to bid / contract documents and BoQ items for an effective implementation.
- To prepare a post-project monitoring programme for checking and regulating the environmental quality within the limits stipulated by the Ministry of Environment and Forests (MoEF) / Goa State Pollution Control Board (GSPCB).
- To adopt the best environmental safeguards for an effective implementation.

1.2 Scope Of The Work

The scope of the environmental report is given below:

- Review of National and state level environmental regulatory requirements on environmental aspects, including assisting PWD, Goa in getting necessary clearances from MoEF/ GSPCB in the context of proposed Goa/Karnataka Border to Panaji Goa, if applicable.
- An environmental screening and categorization framework for the proposed project to include the environmental aspects from the planning stage of the project.
- Location of the project stretch with respect to environmentally sensitive areas, and community concerns apart from the technical aspects.
- Conduct environmental analysis of alternatives for highway bypasses and provide specific inputs for analysis of alternatives and decision making.
- Establishing environmental baseline for selected attributes, covering the specific locations along the project alignment – such as major towns, junctions, existing bypasses, proposed bypasses, forest stretches, proposed quarries, borrow areas, sensitive locations (schools, temples, hospitals, archaeological sites etc.).
- To identify potential environmental aspects and detailed environmental



assessment to be carried out as part of Detailed Project Report.

- Impact assessment and prediction with respect to various environmental attributes i.e., land, air, water, noise, soil, socio-economic, ecological & bio-diversity aspects of the project.
- Preparation of Implementable Environmental Management Plan with budgetary provisions and suggesting post project monitoring plan.
- The objectives of such analysis shall be to minimize environmental impacts and provide specific inputs to the project during construction and maintenance.

1.3 Need For Environmental Impact Assessment

Highway developmental activities should be planned and executed after considering the potential environmental impacts. To minimize these adverse impacts that may be created by highway development projects, the techniques of Environmental Impact Assessment (EIA) become necessary. Identification and assessment of potential environmental impacts should be an integral part of the project life cycle. It should commence early in the planning process of the project to enable a full consideration of alternatives and to avoid later delays and complications. This EIA report is prepared for Goa/Karnataka Border to Panaji, Goa project stretch for an existing length of 69.075 Kms (on NH-4A).

1.4 Approach and Methodology

The approach for the preparation of EIA involves the following steps:

Reconnaissance survey is undertaken in order to identify the environmental attributes in and along the project activity. The environmental baseline data in the project impact area was generated from both primary and secondary sources. During the site visits, due importance is given to identify the impacts of the project taking into account the contours of the project passing areas and other surrounding activities. Then, prediction and evaluation of the impacts is based on available mathematical models, empirical assessment and past experience in view of the net cost – benefit. Preparation of an environmental management plan is to reduce the adverse impacts of the project to the barest minimum. Conclusively, quantification of the financial cost of mitigation measures and preparation of a monitoring plan for the implementation of mitigation measures is undertaken.

The methodology adopted is presented in the form of a Flow chart given in Figure -1.1.



1.5 Project Proponent

The Public Works Department plays a major role in the economic, Commercial and tourist development of the State of Goa. Being a service Department, it is entrusted with all the developmental activities like Planning, Design, Construction, Operation and Maintenance of all types of construction works in this State of Goa. The Public Works Department of Government of Goa represented by the Secretary, Public Works Department is engaged in the development of National highways on behalf of Ministry of Road Transport and Highways (MoRTH) and as part of this endeavour, the Employer has decided to undertake "Four Laning of existing Goa/Karnataka border- Panaji Goa section of NH4A from Km 84/000 to 153/070 (ANMOD TO PANAJI) UNDER NHDP-III".

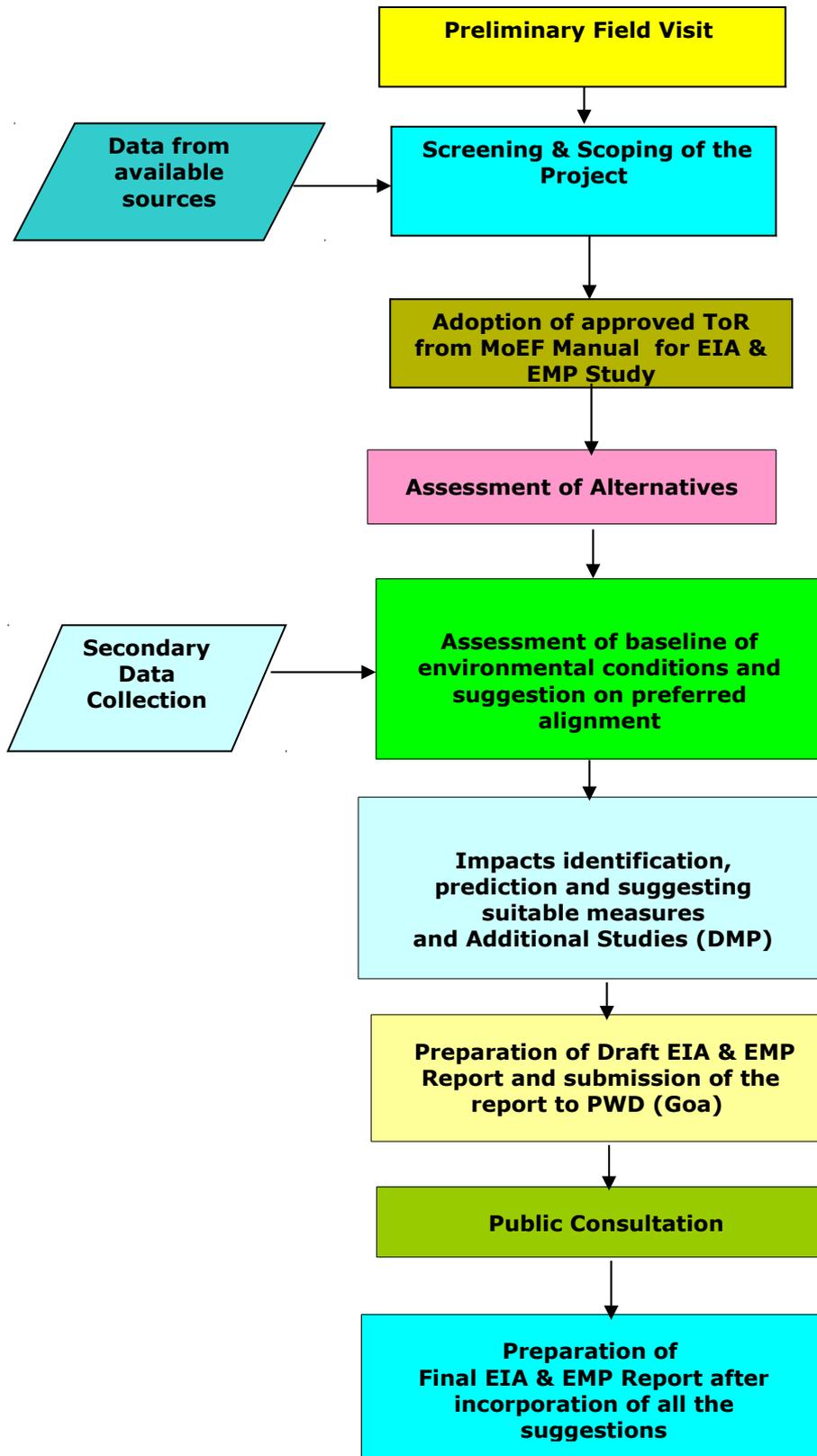


Figure -1.1: Flow Chart Showing the EIA Methodology



1.6 Generic Structure Of Environmental Impact Assessment Document

In terms of the EIA notification of the MOEF dated 14th September 2006, the generic structure of the EIA document shall be as under:

- Introduction
- Project Description
- Review of Environmental Regulatory Requirements, Policies & Guidelines
- Analysis of Alternatives (Technology and Site)
- Environmental Baseline Data Study
- Anticipated Environmental Impact & Mitigation Measures
- Additional Studies
- Environmental Management Plan
- Summary & Conclusions
- Disclosure of Consultants engaged



CHAPTER -02

PROJECT DESCRIPTION

2.0 PROJECT DESCRIPTION

Public Works Department (PWD), Government of Goa has decided for the development of "Four Laning of Existing Goa/Karnataka Border – Panaji Goa Section of NH-4A from Km 84/000 to 153/075 on BOT (Toll) basis under NHDP-III (Anmod to Panaji Section)". The Project Highway is a section of NH-4A (Belgaum-Anmod-Ponda-Panaji) between Anmod and Panaji, passing through villages Molem, Sangod, Dharbandora, Piliem, Tiska, Candepar, Curti, Ambegal, Veling, Boma, Banastarim, Corlim, Ella, Velha goa, Ribandar. It is observed that major ghat portion is from Km 84.000(Anmod) to Km 93.000 (Mollem) approximately. From end of the ghat road (Km 93.000) to Ponda the project road is plain to rolling terrain and passing through the forest. From Ponda near Km 126.000 to Km 138.000, the stretch again traverses through mountainous terrain. There after the project road is passing through rolling terrain upto end of the stretch. The entire stretch of NH-4A lies in the states of Karnataka and Goa, it provides an important link between NH-4 and NH-17. It has a great potential of growth in the passenger as well as freight movement in future due to agriculture and industrial growth in the project influence area.

2.1. Location of the Project:

The project corridor runs from South-East to North-West direction. The project stretch of NH-4A starts from Karnataka-Goa border (Anmod) at a chainage of Km. 84.000 and ends at Panaj (Goa) at a chainage of Km. 153.075. The project stretch connects the Capital city Panaji on Western side and Belgaum city in Karnataka state on eastern side. It also links to Vasco Port and Airport via NH-17B and NH-17. The location map is shown in Figure -2.1 and **the location details of the project road is mentioned in Table -2.1.**

Table -2.1: Location details of the project road

Section	Chainage (km)	NH	State	Length (km)
Karnataka/Goa border (Anmod) to Panaji-Goa	Km 84.000 to Km 142.000	NH-4A	Goa	51

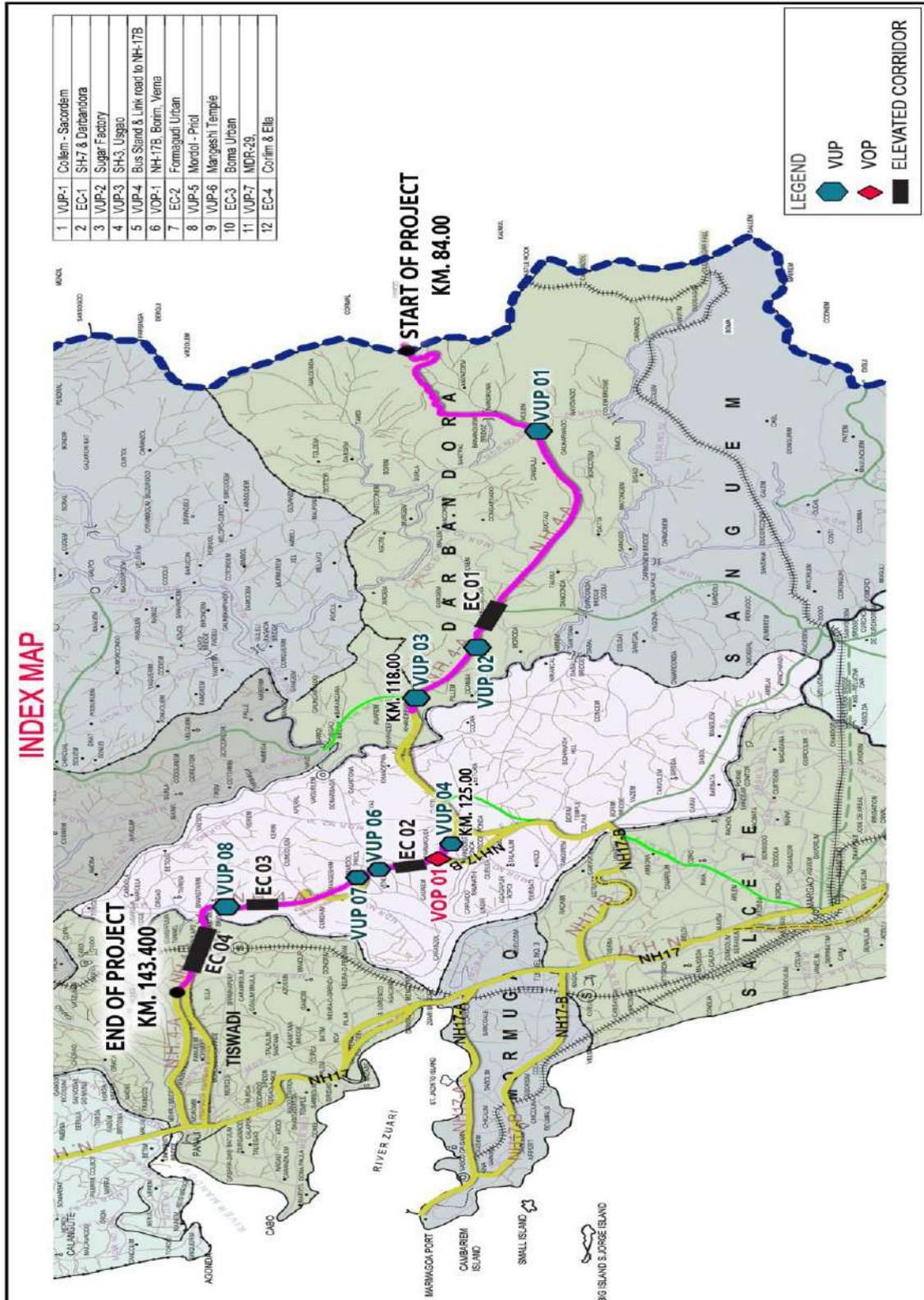


Fig.2.1: Index map showing the project stretch



2.2 Salient and Engineering Features of the Project

The Salient features and engineering features of the project are given in Table -2.2 and Table -2.3.

Table 2.2: Salient Features of the Project road

S.No.	Parameter(s)	Description
1	Location of Project	Located in the State of Goa from Goa/Karnataka Border Km 84.000 to Panaji -Goa Km 153.075 (Anmod-Panaji Section)
2	Terrain	Mix of Hilly Terrain (Ghat Section), Rolling and Plain terrain to some extent.
3	Major Settlement along the Project Stretch	Farmagudi, Boma, Corlim and Ella
4	Rivers/ Streams/ Canals	Cumbarjuva
5	Forest area and Sanctuaries	Reserve and Private Forests Area – 33.17 ha ; Bhagawan Mahaveer Wild Life Sanctuary Area – 31.015 ha
6	Length of the Existing and Proposed Alignment	Existing Alignment is 69.075 Km and Proposed Alignment is 51 Km
7	Existing Carriageway Width	7m in two lane stretches and 14m in four lane stretches
8	Proposed Carriageway width	The Paved Carriageway width shall be 18.0m, except in Built-up locations it is 19.0m
9	Administrative locations	EE, Works Division VII, Patto Panaji, Goa and EE, Works Division XV, Ponda, Goa
10	State	Goa

Table 2.3: Engineering Features of the Project Road

S.No	Parameters	Existing	Proposed
1	Right of Way (RoW)(m)	8 to 35	30 to 45
2	Design Speed	60	100 (60 in WLS)
3	Major Bridges	1	1-New 2 Lane Bridge to be Constructed
4	Minor Bridges	7	7-New 2 Lane bridge to be Constructed



S.No	Parameters	Existing	Proposed
5	No. of Railway Crossings	0	-
6	Railway Over Bridge (ROB)	1	1-New 2 Lane ROB to be Constructed
7	Railway Under Bridge (RUB)	0	-
8	No. of Culverts	SC/Box – 38 HPC - 137	Upgradation as per four lane
9	Pedestrian / Cattle Underpasses	-	-
10	Vehicular Underpasses / Overpasses	-	11
11	Fly Overs	-	5
12	Foot Over Bridges	-	-
13	Bus Bayes	-	20 locations (Both Sides)
14	Truck Lay Bys	-	1 Location (Both Sides)
15	Rest Areas	-	-
16	Toll Plazas	1	1
17	Bypasses / Realignments	1	Not in our Scope
18	Total Number of trees affected	10,000 (Approximately – Tree Enumeration is Pending)	
19	Tree Plantation Proposed (minimum 1:2)	20,000	
20	Land to be Acquired (incl. social Forestry)	136.67 ha	
21	Project Cost	INR 2,130.00 Crores	

2.3 Study of Existing Amenities in the Project Stretch

The study has been conducted to know the existing amenities in the project road. The Chainage wise features like terrain, land-use, pavement type & condition and carriageway width, shoulder type, condition & width, nature of soil, curve geometry, intersection details, location of water bodies, height of embankment or depth of cut, cross drainage structures, existing utility services, general drainage conditions etc., have been recorded. The road inventory has been referenced to the existing kilometer



& hectometer stones established along the roadside.

2.3.1 Terrain & Land use

Terrai is classified by the general slope of the country across the highway alignment. Based on this criteria, major part of project stretch traverses through Hilly terrain and some part of the project stretch passes through Rolling and Plain terrain. Below Figure shows the typical plain terrain along the project stretch.

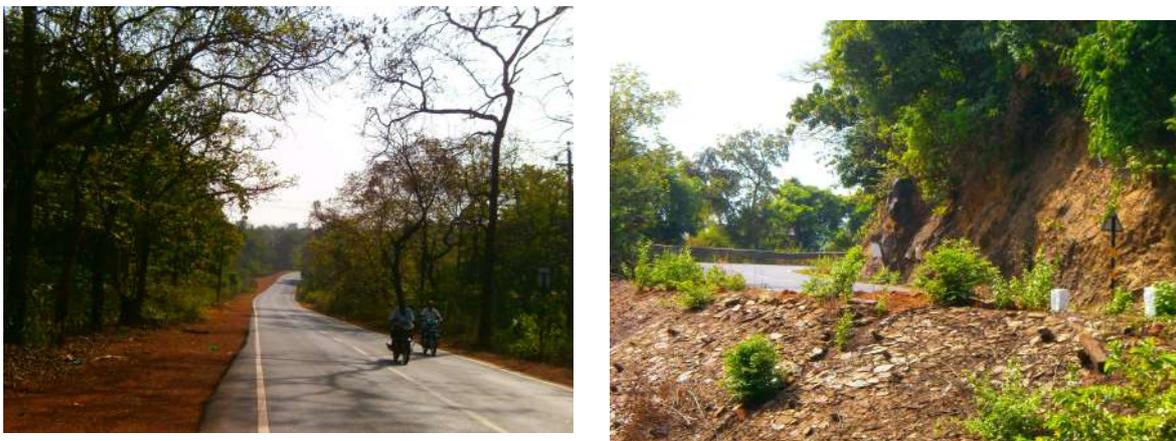


Fig. 2.2: Plain, Rolling & Mountainous Terrain

The project stretch passes through hilly terrain and majority of adjoining land is Forest. Some of the stretch where industrial places and junction locations are built up. The important crops grown along the project stretch are Cashew, Rice and Areca. The type of land use pattern that exists along the project stretch is presented below.

Table-2.4: Land Use Pattern

S.No.	Type of Land	Percentage of Road length
1	Forest	42.09
2	Agricultural	49.16
3	Built-up	7.07
4	Barren	0.84

2.3.2 Carriageway Width

The existing 2 lane flexible pavement with paved & earthen shoulders, where the stretch is to be widened into four lane. The width of carriageway was measured at every 100m interval from beginning to end of the project road. Width of shoulders on either side was measured separately along with carriageway measurements. The



existing two lane carriageway width is 7.0m and at few parts of the stretch are existing with 4-lanning road also. The existing carriageway along the project highway is given below

S. No.	Existing Chainage (Km)		Length (m)	Lane Configuration
	From	To		
1	84.000	118.450	34450	2 lane carriageway
2	125.000	133.500	8500	2 lane carriageway
3	133.500	136.300	2800	4 lane carriageway
4	136.500	143.400	6900	2 lane carriageway

2.3.3 Shoulder

The earthen shoulder is observed on either side of the carriageway with varying width of 0.3m to 2.0m and paved shoulder exists of around 0.5 to 2.5m on entire project stretch except at some locations of built-up areas.

2.3.4 Bypasses

No bypasses have been proposed in the Project.

2.3.5 Service Roads/Slip Roads:

As the project is taken up for 4-lane with paved shoulders, built up sections have been proposed with 17 service roads. There are about 8.24 Km service road, 6.805 Km slip road and 3.725 Km Slip & Service road. The details of the service roads along the project stretch are given in the Table -2.5.

Table 2.5: List of service roads along the project stretch

S.No	Existing Chainage (km)		Design Chainage (km)			Slip/Service Road
	From	To	From	To	Length	
1	96.170	96.970	96.300	97.080	0.780	Slip Road
2	102.700	103.300	102.550	103.100	0.550	Slip Road
3	108.600	110.700	108.400	110.600	2.200	Slip & Service Road
4	112.250	113.300	112.050	113.080	1.030	Slip Road
5	114.000	114.950	113.750	114.750	1.000	Slip Road
6	116.000	118.000	115.350	117.350	2.000	Service Road
7	125.000	125.600	125.000	125.600	0.600	Slip Road
8	125.600	126.220	125.600	126.220	0.620	Slip Road
9	126.220	127.700	126.220	127.700	1.480	Service Road
10	129.980	130.690	130.250	130.960	0.710	Slip Road
11	130.690	133.000	130.960	131.710	0.750	Service Road
12	133.000	133.890	131.710	132.600	0.890	Slip Road
13	135.000	136.500	133.865	135.390	1.525	Slip & Service Road
14	136.700	138.300	135.390	137.100	1.710	Service Road



S.No	Existing Chainage (km)		Design Chainage (km)			Slip/Service Road
	From	To	From	To	Length	
15	138.700	139.400	137.100	137.725	0.625	Slip Road
16	140.300	140.700	139.600	141.070	1.470	Service Road
17	140.700	141.400	141.070	141.900	0.830	Service Road

2.3.6 Vehicular and Pedestrian Underpasses:

VUP's, LVUP's for four laning of road have been proposed at major At-grade Intersections as shown in Table 2.6.

Table – 2.6: Proposed VUP/LVUP

Sl No.	Existing Chainage (Km)	Design Chainage (Km)	Span / Opening (m)	Underpass	Remarks
1	96.612	96.610	1 x 20.0 x 5.5	VUP	MDR-33
2	102.950	102.830	1 x 10.5 x 4.5	LVUP	Local
3	112.630	112.427	1 x 20.0 x 5.5	VUP	Sugar Factory
4	114.380	114.160	1 x 20.0 x 5.5	VUP	SH-3
5	126.375	125.380	1 x 20.0 x 5.5	VUP	Link road to NH-
6	131.800	130.630	1 x 12.0 x 5.5	VUP	Mardol-Priol
7	133.410	132.164	1 x 20.0 x 5.5	VUP	Mangesh Temple Road
8	135.616	134.370	1 x 20.0 x 5.5	VUP	Local
9	138.950	137.750	1 x 20.0 x 5.5	VUP	MDR-29
10	142.650	141.200	1 x 10.5 x 4.5	LVUP	Urban, near ROB
11	144.080	142.600	1 x 40.0 x 5.5	VUP	MDR-1, Railway Station Road

2.3.7 Toll Plazas

The Existing Toll Plaza will be modified as per the requirements of the proposed project. The fee levied and collected for use of a National highway shall be due and payable at the toll plazas. The toll revenue has been calculated considering the existing and proposed projects from the toll plaza at the following location as shown below.

Table – 2.7: Location of Toll Plazas and their tolling lengths

Package	Toll Plaza Location	Existing Chainages (km)			Bypass Length if any (km)
		From	Bypass Length if any (km)	Length	
Total Package	Km 96.500 (Mollem)	84.000	143.400	59.4	-



2.3.8 Major Bridges

There is only 1 major bridge existing on the project highway. The configuration is given in Table – 2.8.

Table – 2.8: Details of Major Bridges

S. No.	Existing Chainage (Km)	Width (m)	Span Arrangement & Total Length (m)	Type of Structure		
				Foundation	Sub Structure	Super Structure
1	139+212	12.0	1 x 51.0 + 4 x 52.0 + 1 x 51.0	Well	RCC Pier and abutment	PSC Box Girder

2.3.9 Minor Bridges

There are 7 minor bridges along the project highway. The configuration of minor bridges are given below in Table – 2.9.

Table – 2.9: Details of Minor Bridges

S. No.	Existing Chainage (Km)	Width (m)	Span Arrangement & Total Length (m)	Type of Structure		
				Foundation	Sub Structure	Super Structure
1	93.873	7.60	1 x 7.4 (Skew)	Open	PCC Abutments & Piers	RCC Solid Slab
2	93.913	7.60	5 x 5.80	Open	PCC Abutments & Piers	RCC Solid Slab
3	94.470	8.60	1 x 18.0	Open	PCC Abutments & Piers	RCC Girder
4	97.753	15.90	1 x 6.0	Open	PCC Abutment & Piers	RCC Box
			1 x 4.50	Open	PCC Abutment & Piers	RCC Solid Slab
5	115.813	8.80	1 x 12.0	Open	PCC Abutment & Piers	RCC Girder
6	131.711	11.80	1 x 14.3	Open	PCC Abutment & Piers	RCC Girder
7	133.592	20.20	1 x 6.60	Open	PCC Abutment & Piers	RCC Solid Slab

2.3.10 Villages and Towns

The project stretch passes through important places like Farmagudi, Boma, Corlim and Ella. Further there are more number of villages and hamlets with less density along



the project stretch and the list of villages and their locations in each section are given in the below table 2.10.

Table 2.10: List of Villages and towns

S. No.	Name of Township	Location (Km)		Length (m)
		From	To	
1	Mollem	96.300	96.900	0.6
2	Dharbandora	108.600	110.200	1.6
3	Pratapnagar	113.700	114.300	0.6
4	Dhatwada	115.500	116.700	1.2
5	Kurdsagar	116.700	118.000	1.3
6	Ponda	125.000	125.400	0.4
7	Shivnery	126.000	126.400	0.4
8	Farmagudi	126.400	127.100	0.7
9	Mardol	130.300	131.000	0.7
10	Cundaim	134.100	135.000	0.9
11	Boma	135.000	136.400	1.4
12	Muslimwada	136.400	137.100	0.7
13	Dulaphi-Corlim	138.800	139.200	0.4
14	Corlim	139.200	141.300	2.1
15	Ella	141.300	141.900	0.6

2.3.11 Road Geometry

It is observed that the project highway has a straight and curved alignments and traverses through a mix of hilly, highly rolling and plain terrains. All the horizontal curves confirm to acceptable geometric standards in terms of super elevation. The project stretch has horizontal and vertical curves at various locations in the stretch and the same will be addressed in the current up gradation proposal.

2.3.12 Major Junctions

Along the project corridor, a number of access roads from adjacent towns / villages lead to the existing highway, which may necessitate provision of at grade intersections and flyovers. The Traffic profile along the sections under study is as given in Table-2.11. and the list of major junctions identified are given in Table-2.12.



Table 2.11: Summary of Annual Average Daily Traffic (AADT)

Vehicle Type	Anmod-Panaji		
	Km 96.600	Km 133.000	Km 140.000
Tollable Traffic (vehicles)	2734	9830	17545
Tollable Traffic (PCU's)	5120	15032	22893
Total Traffic (Vehicles)	3253	14664	29100
Total Traffic (PCU's)	5389	17498	28748

Table.2.12: Major Traffic Junctions along the Project Corridor

S. No.	Location		Type	Category of Cross Road			
	From Km	To Km		NH	SH	MDR	Others
1	96.600		X - Junction			MDR-33	
2	101.500		T - Junction				Other
3	102.950		T - Junction				Other
4	109.000		T - Junction		SH-7		
5	112.630		X - Junction				Other
6	114.450		Y - Junction		SH-3		
7	116.000		Y - Junction				Other
8	126.450		Y - Junction	Link Road to NH-17B			
9	127.100		Y - Junction	NH-17B			
10	127.800		Staggered				Other
11	131.350		T - Junction				Other
12	131.700		X - Junction			MDR-31	
13	133.400		Y - Junction				Other
14	134.600		X - Junction				Other
15	135.550		T - Junction				Other
16	139.000		T - Junction			MDR-29	
17	140.400		Staggered				Other

(NH: National Highway, SH: State Highway, MDR: Major District Road)



2.3.13 Terrain Junctions:

The design speed given in the below table 2.13 shall be adopted for various conditions as per IRC: SP: 84-2014.

Table – 2.13: Design Speed

Nature of Terrain	Cross slope of the country (per cent)	Design Speed (kmph)	
		Ruling	Minimum
Plain & Rolling	Upto 25	100	80
Mountainous & Steep	More than 25	60	40

2.3.14 ROB/RUB along the Project Corridor:

The project stretch consists of 1 ROB and no RUB's existing in the proposed sections.

2.3.15 Existing Alignment

It is observed that the project highway has a straight and curved alignments and traverses through a mix of hilly, highly rolling and plain terrains. All the horizontal curves confirm to acceptable geometric standards in terms of super elevation. The project stretch has horizontal and vertical curves at various locations in the stretch and the same will be addressed in the current up gradation proposal.

2.3.16 Right of Way:

The Right of Way pillars were observed at few locations along the project stretch. The Right of Way details shall be ascertained from the revenue records to clarify on the exact land availability for construction of 4/6-lane. Since it is passing through Wild Life Sanctuary, Forest, an urban section acquiring 60 m land will be difficult, in that case development will be made within the available right of way or in minimum right of way. Considering the above constraints TCS is developed. Proposed Right of Way (PROW) details as given in the table no. 2.14.

Table-2.14: Proposed Right of Way (PROW) details

S. No.	Existing Chainage (Km)			PROW	Remarks
	From	To	Length		
1	84.000	96.000	12.000	26	Forest/WLS land
2	96.000	118.000	22.000	45	Open/Industries Land
3	126.120	127.670	1.550	45	VUP @ Km 125.380 to Bus-stand & Road to NH-17B
4	127.670	128.470	0.800	30	Formagudi Built-up area
5	128.470	136.720	8.250	45	Open Land
6	136.720	138.600	1.880	30	Boma Built-up area



7	138.600	141.400	2.800	45	Open Land
8	141.400	144.300	2.900	30	Old Goa, Corlim & Ella Built-up area

Additional land acquisition shall be proposed based on the project requirements and in line with ToR/PWD, Goa guidelines. Some of the existing road assets/facilities along project road may need to be re established based on the various up-gradation proposals. Based on the field verification the existing RoW varies from 8.0 to 10.0 m in Ghat area, 12.0 to 30 m in rural and urban area.

- Additional Land Acquisition
- Bus bays and lay bays (if required)
- Underpasses and Service roads (if required)
- Proposed Bypasses
- Realignment Under sections
- Toll Plaza
- Rest Areas

2.4 Traffic Study Report

The road network has been thoroughly studied during the reconnaissance stage. There are four existing toll plazas along the project corridor. In order to capture the entire traffic it may be necessary to allow more toll plazas or change the existing locations. In order to assess the requirement of setting up additional/ new toll plazas, the Consultants have carried out Classified Traffic Volume Count surveys at 3 strategic points as given below.

- Mollem, Km. 96.600
- Mardol, Km. 133.000
- Old Goa, Km. 140.000

On NH-4A Trained personnel monitored the TVCs round the clock for 7 days. To capture the traffic and travel characteristics of predominant category of vehicles, Origin-Destination surveys by Road side Interview (RSI) method and Number Plate (NP) method are conducted along the project stretch. Origin-Destination and commodity movement surveys for Anmod-Panaji section are conducted at 2 locations namely Km. 96.600, Km. and Km. 140.000 on NH-4A was conducted for a period of 24 hours.



The traffic is projected for a design period of 30 years and the pavement is designed for the same. In order to assess the future traffic, based on present traffic, traffic surveys were carried out and analysis was done as per the stipulation of TOR. The present annual average daily traffic pertaining to the year 2015-16 and the projected traffic for the year 2045 - 46 is presented in Table -2.15.



Table-2.15: Traffic Projections

Year	2W	3W	Cars/Jeep	BUS	Mini Bus	2 Axle	3 Axle	M Axle	Over sized	LCV	M. LCV	Tractor	Cycle	Total Traffic in Numbers	Total Traffic In PCU's
Km 96.600 at Mollem															
2015	513	1	1339	188	31	336	328	151	0	279	82	0	2	3249	5424
2020	706	1	2117	315	45	429	418	192	0	356	105	0	2	4642	7464
2025	949	2	3271	382	63	547	534	246	0	454	134	0	2	6584	10246
2030	1252	2	4941	527	87	698	681	314	0	579	171	0	2	9254	13996
2035	1613	3	7293	708	117	891	869	400	0	740	218	0	2	12854	18983
2040	2059	4	10517	930	153	1138	1109	511	0	944	278	0	3	17646	25528
2045	2627	4	14819	1192	196	1452	1416	652	0	1205	355	0	3	23923	33997
Km 133.000 at Mardol															
2015	4751	53	6164	231	82	1254	418	257	3	888	532	1	0	14664	17583
2020	6540	68	9745	333	118	1601	534	328	4	1134	680	1	0	21122	24713
2025	8793	86	15060	469	167	2043	681	418	5	1447	867	2	0	30087	34566
2030	11601	110	22746	646	229	2607	869	534	6	1846	1107	2	0	42368	48022
2035	14948	141	33572	868	308	3328	1109	682	8	2357	1413	3	0	58818	66081
2040	19078	180	48417	1140	405	4247	1416	870	11	3008	1803	4	0	80684	90038



Year	2W	3W	Cars/Jeep	BUS	Mini Bus	2 Axle	3 Axle	M Axle	Over sized	LCV	M. LCV	Tractor	Cycle	Total Traffic in Numbers	Total Traffic In PCU's
2045	24349	229	68221	1462	519	5421	1807	1110	13	3839	2301	4	0	109413	121369
Km 140.000 at Old Goa															
2015	11418	76	12804	496	654	941	360	267	6	938	1078	2	2	29100	29662
2020	15717	97	20245	715	943	1201	459	341	8	1197	1376	3	2	42383	42905
2025	21133	124	31287	1008	1329	1533	586	435	10	1528	1757	3	2	60843	61405
2030	27882	158	47257	1388	1830	1957	748	556	13	1950	2242	4	2	86134	86853
2035	35925	201	69752	1866	2460	2497	955	709	17	2489	2862	6	2	119942	121117
2040	45850	257	100599	2450	3230	3187	1219	905	21	3177	3652	7	3	164828	166632
2045	58518	328	141748	3142	4142	4068	1555	1155	27	4054	4661	9	3	223774	22612



2.5 Requirement of the Natural Resources for the Project

The major requirement of the natural resources such as borrow earth, moorum, aggregates, sand, cement, HYDS bars, bitumen, water etc., for the rehabilitation and upgradation of Anmod-Panaji section for an existing length of 69.075 km. The requirement of the natural resources (construction materials) are given in Table -2.16.

Table -2.16: Requirement of the Material Resources for the Project

S.No.	Construction Material	Quantity	Unit
1	Borrow Earth	3,145,986	Cum
2	Moorum	212,141	Cum
3	Aggregates	1,398,701	Cum
4	Sand	339,452	Cum
5	Cement	234,308	Cum
6	HYSD Bars	7,411	Cum
7	Bitumen	1,654	Tons
8	Emulsion	198.51	Tons
9	water	1,164,327	Kilo Litres

Borrow earth, moorum, sand and aggregate will be taken from operational licensed borrow areas and quarries located around nearby areas. Steel, cement, bitumen, emulsion etc., would be sourced from authorized vendors. The water will be extracted from the nearest water bodies / ground water after getting formal approval from the irrigation and ground water departments. The mass-haul diagram showing the list of borrows areas, aggregates, and sand is given **Annexure -1**.



CHAPTER -3

REVIEW OF ENVIRONMENTAL REGULATORY REQUIREMENTS, POLICIES & GUIDELINES

3.0 REVIEW OF ENVIRONMENTAL REGULATORY REQUIREMENTS, POLICIES & GUIDELINES

3.1 Applicability of National, State and Local environmental norms

The proposed up gradation of two to four laning of Anmod to Panaji Section of NH-4A in the state of Goa is attracting various National, State, regional and World Bank environmental laws, rules and regulations. These regulations and rules are helpful in impact mitigation and improvement of the environment. The environmental assessment study will be carried out as per the requirement of the National/State/World Bank environmental guidelines. The applicability of the regulatory norms is given in Table – 3.1.

Table – 3.1: Applicability of Environmental Regulatory Norms for Highway Projects

Project	Project Components	Applicability of Environmental Laws, Policies and Notifications	Remarks
Four Laning of existing Goa/Karnataka Border-Panaji Goa Section of NH-4A from Km 84.000 to Km 153.075 in the state of Goa on BOT (Toll) basis under NHDP-III	<ul style="list-style-type: none">Right of WayLand AcquisitionProtected Social Forestry throughout the Right of Way (RoW)	The Environment (Protection) Act, 1986 and further notifications issued under this Act.	Any act during implementation causing damage to environment As per the Environment (Protection) Act (EP) 1986, ambient noise levels are to be maintained as stipulated by the Central Pollution Control Board (CPCB) for different categories of areas like, commercial, residential and silence zones, etc., during sub-project construction and operation. Section -3 (2)(iii & iv).
	<ul style="list-style-type: none">QuarriesBorrow Areas	Water (Prevention and Control of Pollution) Cess Act, 1977 including Rules	Applicable to all activities, which discharge effluents as a result of process or operations.



Project	Project Components	Applicability of Environmental Laws, Policies and Notifications	Remarks
(Anmod to Panaji Section)	<ul style="list-style-type: none"> • Establishment of Hot Mix Plants and Batchmix Plants • Sensitive Locations (Schools, hospitals, etc) • Archaeological Sites 	Water (Prevention and Control of Pollution) Act, 1974 – as amended in 1978 & 1988.	Section 3 (2)(a) of the Act and Cess to the Govt. of India as per Table -I & II for consumption of water for domestic, commercial and industrial purposes.
		Forest (Conservation) Act, 1980 – as amended till 2015.	Applicable if the project involves any activities in the reserved forests, village forests, protected forests and other areas as declared by the state Government. Forest Conservation Act –Chapter –2.4 and Chapter –3.0.
		Wildlife Protection Act, 1972, amended till 2014. The Wildlife (Protection) Rules, 1995.	The act prohibits picking, uprooting, damaging, destroying, acquiring any specified plant from any forest land. It bans the use of injurious substances, chemicals, explosives that may cause injury or endanger any wildlife.
		Coastal Regulation Zone (CRZ) Notification 1991 as amended till January 2011	
		The Hazardous Wastes (Management And Handling) Rules, 1989 and subsequent amendments thereof till 2016.	Materials such as heavy metals, toxic inorganic, oils, emulsions, spent chemicals and Metal-finishing wastes emanating during construction and operation shall be stored and disposed of as per the Rules. Rule 17, 18 & 19 of the Act.



Project	Project Components	Applicability of Environmental Laws, Policies and Notifications	Remarks
		The Public Liability Insurance Act, 1991.	Act enables the people to access legal aid to claim compensation in the event of an accident occurred while handling any hazardous substance. So insurance needs to be taken up by the project implementing agencies or contractors. PLI Act: Act 6 of 1991 as amended by Act 11 of 1992.
		World Bank Operational Directive and Operational Policies for Environmental Impact Assessment (4.01), Operational Policy on cultural property (4.11) and forestry (4.36) for highways up gradation projects.	Applicable in preparation of Environmental assessment report, protection of cultural property, forest clearances etc. WB OD and OP – 4.01, 4.11 & 4.36
		Ministry of Environment & Forests (MoEF) EIA Notification (New) issued on 14th September, 2006 and subsequent amendments thereof till date.	Applicable
		Noise Pollution (Regulation and Control) Rules, 2000	Applicable Under Rule 3(1) & 4 (1) - Clause 2, 3 & 6.



Project	Project Components	Applicability of Environmental Laws, Policies and Notifications	Remarks
		Land Acquisition Act 1894 Land Acquisition, Rehabilitation and Resettlement Act, 2013	Applicable. To set out rules for the acquisition of land by Government.
		Motor Vehicles Act, 1988 Rules of Road Regulations, 1989	Applicable. To enforce highway codes during construction and operation.

3.2 Requirements of Environmental Clearance

Environmental Impact **Assessment** (EIA) Notification issued on 14th September 2006 (amended) by the MoEF, Govt., of India and as per the amended Notification of the MoEF on 22nd August 2013 on Highway projects. New, expansion or modernization of any activity falling within the 32 categories of developmental and industrial activities shall be undertaken in any part of India only after it has been accorded environmental clearance by the MoEF in accordance with the procedures specified in the notification. Among the 32 categories listed in Schedule -1 of Notification, the proposed Four Laning of existing Goa/Karnataka Border-Panaji Goa Section of NH-4A from Km 84.000 to Km 153.075 in the state of Goa on BOT (Toll) basis under NHDP-III (Anmod to Panaji Section) project will not attract the Environmental Clearance from MoEF, as the project is less than 100 Km length (See Box -1).

As per the amended Notification on 22nd August, 2013, the highways improvement/up gradation project of this magnitude needs to prepare the EIA/EMP report as per the model ToR given in MoEF website in order to safeguard the interests of the environment and it will also acts as an environmental guide to the Project Proponent & Environment Interested Groups/ NGOs. The World Bank operational policies also suggest having an environmental assessment and management frame work in all the development projects.

Box -1:

Categorization of projects and activities



- i) All projects and activities are broadly categorized into two categories-Category A and Category B
- ii) Category A: Expansion of National Highways greater than 30 Km involving additional right of way greater than 20m involving land acquisition.
- ii) Category B: All State Highway Projects & State Highway expansion projects in hilly terrain (above 1000m AMSL)
- iii) & / or ecologically sensitive areas.
- iv) All projects or activities included as Category 'A' shall require prior environmental clearance from the Central Government in the MOEF on the recommendations of an Expert Appraisal Committee (EAC).
- v) All projects or activities included as Category 'B' will require prior environmental clearance from the State/Union territory Environment Impact Assessment Authority (SEIAA).

Amended Notification:

As per the amended Notification of the MoEF on 22nd August 2013 on Highway projects - "Expansion of National Highways greater than 100 Km involving additional Right of Way or land acquisition greater than 40 m on existing alignment and 60 m on re-alignments or bypasses".

The proposed highway up gradation / improvement project needs to get approvals from Goa State Pollution Control Board (GSPCB) are i.e., No Objection Certificates (NOC), Consent for Establishment (CFE) and Consent for Operation (CFO) for establishment and operation of Hot mix plants, batch mix plants, quarries etc. during the construction phase of the project.

3.3 Forest Clearances

Forest (Conservation) Act, 1980 (amended in 1988) enacted by Government of India, restricts the de-reservation of forests for use of non-forest purposes. According to the Act, State Government requires prior approval of GoI for the use of forest land for non-forest purposes (means the breaking up or clearing of any forest land) or for assigning least to any private person or agency not controlled by government. The Forest (Conservation) Rules, 2003 issued under this Act, provide specific procedures to be followed for conversion of forest land for non-forest purposes.

Limited sub-projects may require acquisition of forest land. The forest land conversion will follow the "Guidelines for Diversion of Forest Lands for Non-Forest Purpose" under Forest (Conservation) Act, 1980. Compensatory afforestation is one of the most important conditions stipulated for diversion of forest land. The conditions of forest diversion proposals are summarized in Table -3.2.



Table -3.2: Conditions of Forest Diversion Proposals

S. No.	Condition of Forest Diversion	Submission of Proposal and seeking permission from
1	Diversion of forest land for small development and public utility projects up to 5 hectares	State Government may authorize the Nodal Officer or any other Officer to submit the proposals directly to the Regional Offices.
2	Diversion of forest land up to 40 hectares and proposals for clearing of naturally grown trees for reforestation	Regional Office of the MoEF, Southern Zone, Bangalore.
3	All other proposals (> 40 hectares)	The Secretary, Ministry of Environment & Forests, Government of India.

The other conditions of Forest diversion are:

- Compensatory afforestation is compulsory for conversion.
- Afforestation will be done over an equivalent area of non-forest land.
- As far as possible, the non-forest land for compensatory afforestation should be identified contiguous to or in the proximity of Reserved Forest or Protected Forest. If non-forest lands are not available in the same district other non-forest land may be identified elsewhere in the state.
- Where non-forest lands are not available, compensatory afforestation may be carried out over degraded forest twice in extent to the area being diverted.
- Conversion of forest lands that are part of National Parks/Sanctuaries and Tiger Reserve areas (notified under Indian Wildlife (Protection) Act, 1972) is not permitted. In exceptional case, the State Government requires consent of the National Board of Wildlife for obtaining approval of the State Legislature for de-notification of the area as a sanctuary.
- Cutting of trees in non-forest land, irrespective of land ownership, also requires permission from the State Forest Department. Afforestation to the extent of two trees per each tree felled is mandatory.

The proposed up gradation of two to four laning of existing Goa/Karnataka Border-Panaji Goa Section of NH-4A from Km 84.000 to Km 153.075 in the state of Goa on BOT (Toll) basis under NHDP-III (Anmod to Panaji Section) involve forest area. Section I: Km 84.000 to Km 96.000 stretch is passing through wild life sanctuary where as a few patches in Km 96.000 to Km 153.075 stretch comes under Reserve forest. Reserve & Private Forest Area is assessed to be 33.17 ha and Bhagwan Mahaveer Wild Life



Sanctuary Area is assessed to be 31.01 ha. Hence, Forest land acquisition is greater than 40 ha. Permission to be obtained from MoEF&CC, New Delhi.

3.3.1 Bhagwan Mahaveer Wild Life Sanctuary Clearance Requirements:

This protected area located in the Western Ghats of South India, in Sanguem taluk, Goa along the eastern border with Karnataka with an area of 240 sq.km. Initially, it was notified as a Sanctuary (Molem Wildlife Sanctuary) in 1967. Subsequently an area of 107 sq.km. of the said Sanctuary was notified as the Molem National Park in 1978. Later, the name was changed to Bhagwan Mahaveer Wildlife Sanctuary and National Park. It is located between 15°15'30" to 15°29'30" N and 74°10'15" to 74°20'15" E.

The area is situated near the town of Molem, 57 kilometres east of Panaji, the state capital of Goa. National Highway 4A divides it into two parts and the Mormugao - Londa railway line passes through the area. The Section I - stretch of the project is passing through wild life sanctuary from Km. 84.000 to Km 96.000 and the sanctuary area assessed to be diverted is 31.01 ha, hence, the NOC / permission is required from the State Board of Wildlife (SBWL) and National Board of Wildlife (NBWL). At this juncture, the Consultant is in the process of collection of data and preparation of the Wild Life Sanctuary clearance proposal, which will be submitted to the Deputy Conservator of Forests, Bhagwan Mahaveer wildlife division, Panaji and subsequently to the SBWL, Goa and NBWL, New Delhi.

3.3.2 Coastal Regulation Zone (CRZ) Clearance

As per the CRZ Notification 1991 and subsequent amendments till January 2011, the coastal stretches of seas, bays, estuaries, creeks, rivers and backwaters which are influenced by tidal action (in the landward side) up to 500 metres from the High Tide Line (HTL) and the land between the Low Tide Line (LTL) and the HTL as Coastal as Regulation Zone; and imposes with effect from the date of this Notification, the restrictions on the setting up and expansion of industries, operations or processes, etc. in the said Coastal Regulation Zone (CRZ).

In the project, creek is falling at Kumbarjuwa canal along chainage 134.30 Km to 139.1 Km from Banastari Bridge at Dulab to Bhoma in Ponda Taluka. As per the NIO, Goa study:

- Dense mangrove are seen along this bank. (Plates 22A, 22B, 23A, 23B, 24A, & 24B) (Fig. 2G).
- Coconut plantation is seen along the marsh land (Plate 25B).



- The chainage from 136.7 Km to 138.8 Km falls in CRZ area, hence it attract CRZ legislation.

As per the Notification, the project stretch is falling under CRZ -I as; "National parks, marine parks, sanctuaries, reserve forests, wildlife habitats and other protected areas under the provisions of Wild Life (Protection) Act, 1972 (53 of 1972), the Forest (Conservation) Act, 1980 (69 of 1980) or Environment (Protection) Act, 1986 (29 of 1986)"

The procedure for CRZ clearance of permissible activities of the proposed project will be followed as per the Notification. At this juncture, the Consultant is already submitted the Form-1 along with CRZ map covering 7Km radius around the project site. The CRZ map indicating the CRZ-I, II, III and IV was done through the MoEF & CC empanelled agency namely National Institute of Oceanography, Goa. The NIO, Goa has prepared CRZ map along with the report as per the requirements of the MoEF&CC.

3.4 Other Permissions/Clearances

The project proposes to Four Laning of existing Goa/Karnataka Border-Panaji Goa Section of NH-4A in the state of Goa, where the investments intervene with various other utilities already in place. In such areas the project implementing agency will ensure the following clearances before initiating the works.

- Permission from I& CADD for new and widening cases and to draw water during the construction period.
- All the borrow areas, quarries, sand mines proposed to be utilized in the project shall get the permissions from respective departments /owners.
- Permission for breaking or shifting of public utilities like sewer lines or water pipe lines from water supply and sewerage boards.
- Permission and clearance from electricity board for shifting/ moving of streetlights and transformers during widening of roads or construction of fly over or pedestrian ways or any other likely sub projects.



CHAPTER -04

ANALYSIS OF ALTERNATIVES

4.0 ANALYSIS OF ALTERNATIVES

Proposed project is not having any bypasses except for realignments between the stretch from Km 84.000 to Km 96.000 (Section 1). Thorough analysis of various alternatives for realignment & widening of the project road is evaluated considering various features such as Techno-economic feasibility, Geometric alignment, Construction time, Environment & social aspects etc. The alternative analysis is mainly aimed to mitigate the adverse social & environmental impacts in the project and make technically feasible, economic & financially viable and social & environmentally acceptable alternative.

Map studies and detailed investigations of the influence area were carried out for identifying the existing road network, land use pattern and industrial activities along the project corridor. Different alignment options are considered, evaluated and recommendations are presented in Table – 4.1. The improvement scheme of the options are mentioned below. For the purpose of horizontal design, the project road is divided into various sections out of which Section – I needs realignment.

Section – I: Km 84.000 to 96.000 (Mountainous/Steep terrain)

The Project Highway starts with mountainous/steep terrain form at Km 84+000 near Goa/Karnataka border. Existing alignment has substandard horizontal as well as vertical geometry due to steep terrain from Km 84.000 to Km 94+000. There are hairpin bends, where the speed is about 20 kmph.

The consultants have studied in details for improving the horizontal geometry of existing 2 lane carriageway as well as new 2 lane carriageway in consultation with the PWD, Goa. The stretch under consideration is passing through wild life sanctuary. Hence, following options were studied for improvement proposal.

Option – 1: Widening on hill side

Hard rock outcrop is visible in this stretch. For widening new carriageway on hill side requires blasting operations and frequent closing of live traffic. Further, blasting may pose sever impact on wild life in surrounding area.

There are locations, where landslides also observed in this stretch. Widening on hill



side may result in heavy breast walls.

Option – 2: Widening on Valley side without improving the existing

Widening on valley side do not requires closing live traffic. It will have minimum impact on wild life, since it do not requires any blasting operations.

Widening new carriageway on valley side requires construction of either retaining wall or via-duct to support new carriageway.

To have minimum impact on local environment and ease of construction, the consultants have proposed via-duct for the new carriageway. It be independent of existing carriageway (no common median) and will comply with geometric standards stipulated in 4 laning manual.

Option – 3: Widening on Valley side with realignments

Cost of viaduct is directly proportional to the length of via-duct. The consultants have studied in detail for feasibility of shortening the length of via-duct within permissible gradients. After detailed study at site, based on the topographical survey and preliminary design of vertical alignment, it was identified that from Km 89 to Km 92 can be connected with smooth geometry within permissible gradients. Based on above three options, Option 3 is most feasible, even though the construction cost is higher than the options 1&2. Merits and demerits for the proposed options of re-alignment are given in the table no. 4.1.

Table – 4.1: Merits and Demerits

Description	Option-1	Option-2	Option-3
Traffic Management	Road closure during blasting and removal of debris operations	Road closure while forming ramps on the valley side	Road closure while forming ramps on the valley side
Stability issues	It would not be possible to cut hill to the required slope since that would disturb road on the hill side. Thus, adequate slope stabilizing structures are to be provided to prevent landslides.	Existing slopes on hill side are to be stabilized. Construction of viaduct may not involve any stability related concerns.	Existing slopes on hill side are to be stabilized. Construction of viaduct may not involve any stability related concerns



Description	Option-1	Option-2	Option-3
Structures involved	Breast Walls, Soil Nails etc. may be required for ensuring slope.	Viaduct structure; earth retaining structures	Viaduct structure; earth retaining structures
Environmental & Social issues	<p>This option would involve disturbing of hill slopes in the Bhagwan Mahaveer wild life sanctuary.</p> <p>Complete origin forest will be disturbed</p> <p>During construction phase, silting is lesser compared to other two options</p> <p>Getting Forest clearances from MoEF & CC and Wildlife clearance from National Board of Wildlife (NBWL), New Delhi.</p> <p>No major habitation is existing in the proposed alignment</p>	<p>This option would involve disturbing of fringes of hill slopes in the Bhagwan Mahaveer wild life sanctuary.</p> <p>Partially origin forest will be disturbed</p> <p>During construction phase, Erosion will take place and result in silting of the streams</p> <p>Getting Forest clearances from MoEF & CC and Wildlife clearance from National Board of Wildlife (NBWL), New Delhi.</p> <p>No major habitation is existing in the proposed alignment</p>	<p>This option would involve disturbing of fringes of hill slopes in the Bhagwan Mahaveer wild life sanctuary.</p> <p>Partially origin forest will be disturbed</p> <p>During construction phase, less Erosion will take place and result in silting of the streams</p> <p>Getting Forest clearances from MoEF & CC and Wildlife clearance from National Board of Wildlife (NBWL), New Delhi.</p> <p>No major habitation is existing in the proposed alignment</p>
Extra Forest Land to be acquired	<p>26.4 hectares.</p> <p>This option would involve disturbing of hill as the complete widening on hill side and the entire land will be occupied.</p> <p>In this option revegetation of forest cover will not be possible as additional 2 lanes will land on hills.</p>	<p>26.6 hectares.</p> <p>This option would involve insignificant disturbance of hill as the new 2 lane will come on valley side and the land required is only at pier locations.</p> <p>In this option the above land is utilized for construction project. After the construction, the vegetation of forest cover will be reinstated except at pier locations which is the nominal area.</p>	<p>25.4 hectares.</p> <p>This option would involve insignificant disturbance of hill as the new 2 lane and some existing 2 lane realignments will come on valley side and the land required is only at pier locations.</p> <p>In this option the above land is utilized for construction project. After the construction, the vegetation of forest cover will be reinstated except at pier locations which is the nominal area.</p>
Geometric alignment	Will follow the existing alignment; Substandard curves will remain.	Will follow the existing alignment; Substandard curves will remain.	Two sharp sub-standard curves will be improved.



Description	Option-1	Option-2	Option-3
Construction time	Less compared to other two options	Viaduct formation will be time consuming.	Slightly more time compared to option 2 since substructure height will be higher.
Cost in Crores	Rs. 272 Cr.	Rs. 1093 Cr.	Rs 1126 Cr.

Recommended Option

Since, the project stretch falls in wild life sanctuary, Option-3 which involves minimum acquisition of the forest land falling in wild life sanctuary and improvement of the existing alignment to the proper geometric standards is recommended.

The alignment options were discussed with the competent authority (Ministry) in the presence of PWD officials at Delhi on 02/02/2016. The alignment Option-3 is approved by Authority vide letter no. RW/NH/37015/14/2016/NHDP-IV A, dated 26.02.2016.



Consultancy Services for Four Lining of existing Goa/Karnataka Border-Panaji Goa Section of NH-4A from Km 84.000 to Km 153.075 in the state of Goa on BOT III (Anmod to Panaji Section)

Environmental Impact Assessment & Environmental Management Plan



CHAPTER -05

DESCRIPTION OF THE ENVIRONMENT

5.0 ENVIRONMENTAL BASELINE STUDIES

This chapter provides an overall description of the existing environmental status in the study region. Studies will be undertaken to generate baseline data within a 10 Km radius study region along the proposed project on micro-meteorology, air quality, ground and surface water quality, noise levels, land environment including soil quality, geomorphology, land-use pattern, forest cover, biological environment and socio-economic status of the population, etc. From these inputs, possible significant impacts are identified. Impacts are quantified and an appropriate Environmental Management Plan is prepared to manage and mitigate these impacts.

As a primary requirement of EIA process, the EIA report has been prepared based on the standard ToR given in the "EIA Guidance Manual for Highways" by MoEF, dated February 2010.

The Baseline Data was collected covering Summer Season from January 2016 to April 2016. M/s. Vison Labs, Hyderabad (A laboratory Recognized by Ministry of Environment & Forests, Government of India, S.O. 1680 (E), Dated 01.07.2019) was engaged for the field study of air, water, noise, soil etc. The environmental attributes covered for the study include ambient air quality, ground and surface water quality, noise levels, land environment including soil quality, land-use pattern, forest cover, biological environment, socio-economic and health status of the population, demography and quality of life. The primary and secondary data of the stated parameters were collected and analyzed. The Team of Experts from M/s. Aarvee Associates, approved by Quality Council of India (QCI) - National Accreditation Board for Education and Training (NABET), visited the site during the study period.

5.1 Site and its Environs

The reconnaissance survey and subsequent field studies are carried out in the study area and the major aspects emphasized with respect to the geographical, geology & soil, hydro-geology, river basins, forests & wildlife sanctuaries, transportation, socio-economic aspects, industries, and climatological conditions of the region are collected and analyzed. The details of the same are given below:



5.1.1 Geographical features

This section contains a detailed description on existing environment of the proposed project area including physical and biological environment particularly in the study area. The project area passes through two districts namely North Goa and South Goa in state of Goa.

Geography of Goa:

Goa encompasses an area of 3,702 km² (1,429 sq.mi). It lies between the latitudes 14°53'54" N and 15°40'00" N and longitudes 73°40'33" E and 74°20'13" E. Most of Goa is a part of the coastal country known as the Konkan, which is an escarpment rising up to the Western Ghats range of mountains, which separate it from the Deccan Plateau. The highest point is the Sonsogor, with an altitude of 1,167 metres (3,829 ft). Goa has a coastline of 101 km (63 mi).

Goa's main rivers are Mandovi, Zuari, Terekhol, Chapora kushavati river and the Sal. The Mormugao harbour on the mouth of the River Zuari is one of the best natural harbours in South Asia. The Zuari and the Mandovi are the lifelines of Goa, with their tributaries draining 69% of its geographic area. These rivers are some of the busiest rivers in India. Goa has more than forty estuarine, eight marine and about ninety riverine islands. The total navigable length of Goa's rivers is 253 km (157 mi).

5.1.2 Geology & Soil Characteristics

Geology: Geologically the state constitutes the northwesterly extension of the granitoid-greenstone terrain of Karnataka, comprising rocks of Precambrian age viz., gneisses, migmatites, granitoids, granites, schists, meta-volcanics (both acid and basic), meta-greywackes, banded ferruginous quartzites associated with manganese phyllites / argillites, limestones, dolomites and thin bands of quartzite intruded by granite and maficultramafic complex. Deccan Trap is exposed on the NE border of Goa. Peninsular Gneisses are well exposed in Anmod Ghat section along the Panaji-Ponda- Londa highway. Qupem in central Goa and Chauri in the south, when Ranebennur Subgroup of Shimoga belt further extend north and northwesterly into Goa in response to the variation in their litho-spectrum and in accordance to the stratigraphic guidelines, they are assigned with the local name called 'Goa Group' which is further divided into four formations. The rocks of Peninsular Gneissic Complex and Goa Group are intruded by maficultramafic complexes.

Soil:

Most of Goa's soil cover is made up of laterites rich in ferric-aluminium oxides and



reddish in colour. Further inland and along the riverbanks, the soil is mostly alluvial and loamy. The soil is rich in minerals and humus, thus conducive to agriculture.

South Goa

Soils of the district can be classified into 4 types namely (i) Laterite soil (ii) Saline soil (iii) Marshy soil and (iv) Alluvial soil:

(i) Lateritic soil is the major soil type in the district. It is highly porous & permeable, slightly acidic with low pH values, low in organic matter, Calcium and Phosphorus.

(ii) Saline soil in the district occurs in the flood plains of Zuari, Sal, Saleri, Talpona and Galjibagh rivers in Salcete, Marmugao, Quepem and Canacona taluks. It also occurs to a very limited extent in Sanguem taluk. The soil is deep, poorly drained and less permeable. It is saline, high in pH and contains humus and organic matter.

(iii) Marshy soil occurs to a large extent in Salcete taluk and towards the western part of Canacona taluk. It also occurs in Marmugao taluk. This type of soil occurs in low-lying water logged and tidal affected areas.

(iv) Alluvial soil occurs as very thin strip along the coastline towards western part of Salcete taluk and also a limited exposure occurs in Canacona taluk. It is reddish brown to yellowish, coarse grained and confined to narrow valleys of rivers. It is well drained, acidic with low pH and organic content.

North Goa

Soils of the district can be classified into 3 types namely (i) Laterite soil (ii) Saline soil and (iii) Alluvial soil:

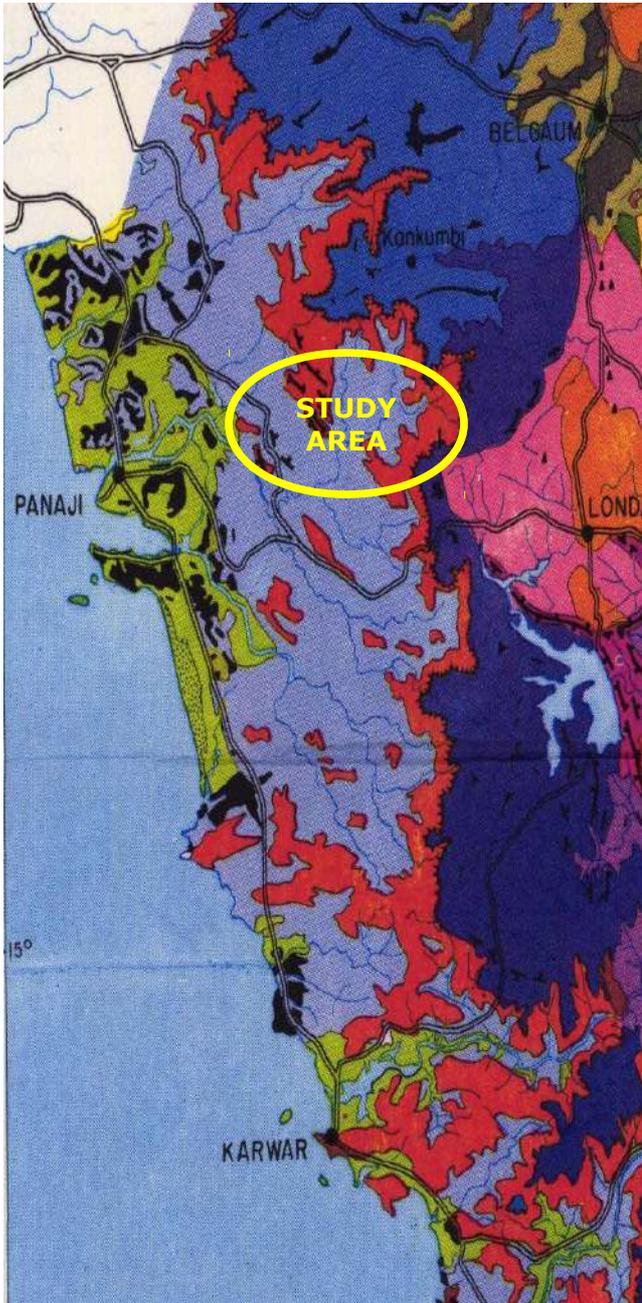
(i) Lateritic soil is the major soil type in the district. It is highly porous & permeable, slightly acidic with low pH values, low in organic matter, Calcium and Phosphorus.

(ii) Saline soil in the district occurs in the flood plains of Zuari and Mandovi rivers in Tiswadi, Bardez and Ponda taluks. It also occurs in Pernem taluk. The soil is deep, poorly drained and less permeable. It is saline, high in pH and contains humus and organic matter.

(iii) Alluvial soil occurs as very thin strip along the coastline towards western part of the district. It is reddish brown to yellowish, coarse grained and confined to narrow valleys of rivers. It is well drained, acidic with low pH and organic content.



Source: Reconnaissance soil map of forest area, by the French Institute, Pondicherry & Forest Dept, Govt of



MORPHO-PEDOLOGICAL LANDSCAPE		GEOLOGY	WEATHERING PROCESS	SOIL TYPES *									
TYPE	SUB-TYPE			FRENCH CLASSIFICATION (sub-class, group)	SOIL TAXONOMY (subclass, group)								
COASTAL AREA	Fluvio-litoral formations.	1 Alluvium	LIFE or no evidence	Skeletal and poorly developed soils on recent material. Mangrove soils.	Psamment, Fluvent, Aquents.								
	Dissected hilly interland.	2 Laterite capped mesas, hills.				Ferralsols and skeletal eroded soils. Ferrallitic soils moderately or strongly desaturated in B horizon: typic, reworked, rejuvenated, frequently indurated.	a) Tropepts. Not soils. b) Ustalfs: Plinthustalfs; Tropepts; Dystrypepts; Ustols; Haplustols.						
WESTERN GHATS	Escarpment of the Ghats and residual hills in the coastal area.	3 Various rocks of the Archaean complex.	ALLITIZATION AND MONOSIALLITIZATION 1:1 layer clays associated with iron and aluminium oxy-hydroxides	Ferrallitic soils weakly desaturated in B horizon: rejuvenated. Poorly developed soils. Lithosols.	Tropepts: Eutropepts, Dystrypepts; Ustols: Kandustepts, Kanthaplustepts; Ustalfs: Paleudustepts; Ustols; Not soils.								
	Strongly dissected high level.	4 Rounded crests, slopes and Appalachian ridges.				Ferrallitic soils highly or moderately desaturated in B horizon: reworked, impoverished, brunified and acidified soils. Ferrallitic soils strongly or moderately desaturated in B horizon: rejuvenated, reworked.	Ustalfs: Kanthaplustepts; Ustols: Kanthaplustepts, Paleustepts, Haplustepts. b) Tropepts: Dystrypepts.						
KARNATAKA PLATEAU	Partially dissected intermediate levels.	5 Basalts.	FERRALLITIC ZONE 1:1 layer clays associated with iron and aluminium oxy-hydroxides	Ferrallitic soils weakly or moderately desaturated in B horizon: reworked, rejuvenated.	a) Not soil, Tropepts. b) Tropepts: Dystrypepts, Ustropepts. Ustols: Kandustepts.								
	Hills.	6 Gneisses and granites.				Ferrallitic soils weakly or moderately desaturated in B horizon: impoverished, reworked.	Tropepts: Dystrypepts; Ustols: Kanthaplustepts; Ustalfs: Haplustepts.						
	Strongly dissected intermediate levels.	7 Gneisses and granites.						Ferrallitic soils weakly or moderately desaturated in B horizon: rejuvenated, reworked.	Tropepts: Dystrypepts; Ustols: Kanthaplustepts, Kandustepts.				
	Low level.	8 Gneisses.								a) Ferrallitic soils weakly, moderately or strongly desaturated in B horizon: impoverished, reworked. b) Poorly developed hydromorphic soils.	a) Humults: Haplohumults; Ustults: Rhodustepts; Tropepts: Eutropepts. b) Fluvents.		
	Degraded intermediate levels with concave concave relief.	9 Gneisses.										a) Ferrallitic soils weakly desaturated in B horizon: reworked. b) Ferrallitic soils moderately desaturated in B horizon: reworked, reworked, Lithosols.	Ustalfs: Haplustepts, Kanthaplustepts. b) Ustalfs: Haplustepts; Not soils.
	Smooth relief.	10 Gneisses and rare grasses Sandstones.											
Rejuvenated intermediate levels with concave concave relief.	11 Gneisses.	Soils intergraded between Ferrallitic and Ferrallitic soils.	Ustalfs: Rhodustepts, Paleustepts; Tropepts: Ustropepts.										
Residual reliefs.	12 Gneisses.			Brown Eutrophic Tropical soils; Red Ferrallitic soils; Lithosols.	Tropepts: Ustropepts; Ustols: Argustepts, Haplustepts; Not soils.								
Dissection relief on the Deccan Traps.	13 Basalts.					a & b) Brown Vertic soils and Brown Eutrophic Tropical soils; poorly developed soils. c) Vertisols.	a) Tropepts: Ustropepts. b) Tropepts: Ustropepts; Ustols.						
Palaeoplain.	14 Basalts.							Red Ferrallitic soils.	Ustalfs: Paleustepts, Rhodustepts, Haplustepts; Tropepts: Ustropepts.				
Clayey basins.	15 Various rocks of the Archaean complex.									Vertisols; Brown Vertic soils.	Tropepts: Ustropepts; Ustols: Paleustepts.		
Clayey terraces.	16 Gneisses and rare grasses.												

Karnataka.

Figure -5.1: Soil map of the Goa State demarcated with the study area

5.1.3 Minerals

The State of Goa is endowed with Mineral Resources. Iron ore, Manganese ore, Bauxite are minerals of economic importance. Besides there are minor minerals like Basalt,

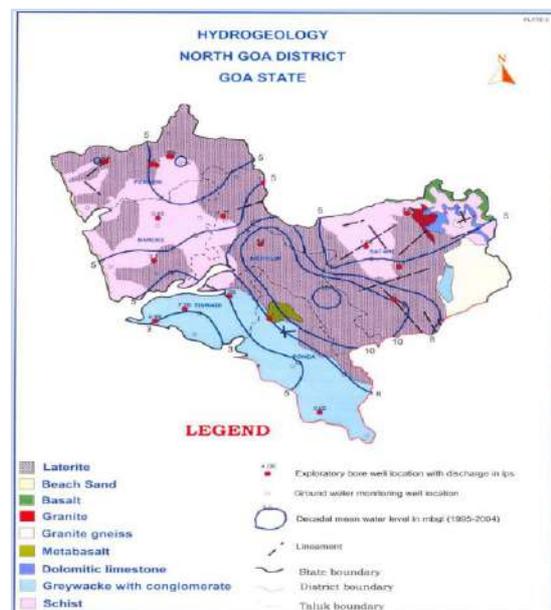
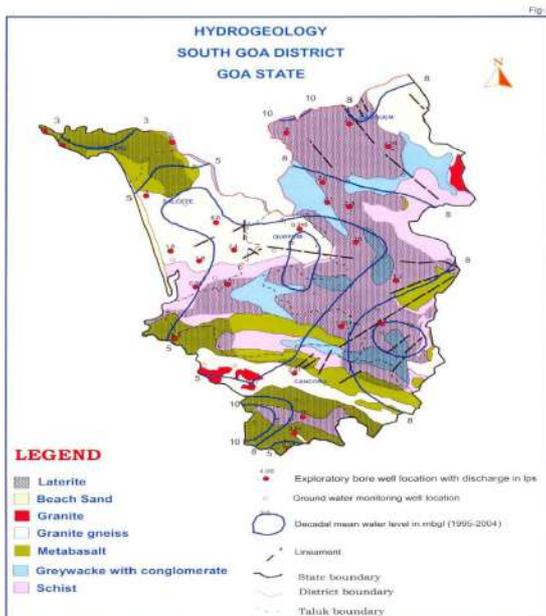


Laterite stones and rubbles, River sand, Murrum etc., which are in great demand as construction material. This industry is labour intensive and provides work to large number of people.

5.1.4 Hydro-geology

The Depth to water level ranged from 1.49 to 14.90 m bgl during pre-monsoon period. Water level in the range of 10 to 20 m bgl is seen as small pockets in Salcete, Quepem, Canacona & Sanguem taluks. The Depth to water level ranged from 0.74 to 14.50 m bgl. Water level depicted in the range of <2 – 2 m bgl occur in small pockets of Sanguem & Quepem taluks, 2 – 5 m bgl occur in major portions of Marmugao, Salcete, Quepem, Sanguem & Canacona taluks, 5 – 10 m bgl occur in Marmugao, Salcete, Sanguem & Canacona taluks. Water level in the range of 10 – 20 m bgl occurs as a small pocket in Canacona taluk. There is good scope of ground water exploitation in all the 5 taluks of South Goa district. All the 5 taluks are 100% SAFE for ground water exploitation.

However, there are pockets of declining water level in Quepem taluk of South Goa district. On the basis of long term water level trend (1995 – 2005) considered for computation of ground water resource, pre – monsoon trend of 11% of the observation wells in Sanguem, 14% in Canacona and 16% in Quepem taluks have recorded declining trend. Hence, ground water development may be regulated in such pockets. Declining long-term post – monsoon trend has been observed in 40% of observation wells falling in Quepem taluk of South Goa.





Source: Ground water information booklet, Goa State, CGWB

Figure -5.2: Hydro-geology maps of South Goa & North Goa

5.1.5 River basins, Flood and Cyclones

Goa region is drained by nine independent rivers flowing generally from East (Western Ghats) to West (the Arabian Sea). An exception is the Sal river in south Goa which follows a north-east to south-west course due to the west coast fault. Terekhol, Mandovi, Zuari, Chapora, Sal, Talpona, Saleri, Canacona and Galgibagh are the major rivers of Goa. These main nine rivers and their 42 tributaries play a significant role in the lives of the people of the State. Of the nine rivers, the Mandovi and Zuari alone together drain 2553 sq km, which is about 70% of the total geographical area.

5.1.6 Industries

In the state of Goa Iron ore and Pharmaceutical Formulations are the major items of export. During the financial year 2011-2012 the MPT handled 29.37 million tonnes of iron ore including iron ore pellets, 7.21 million tonnes of coal/coke and 1.39 million tonnes of petroleum products and other liquid cargo. In Pharmaceutical Formulations sector the export was Rs.200 crores in the year 2002-03 and has grown to Rs. 5,000 crores with the total employment of 8,800 people and with the total turnover of Rs.10,000 crores. Though Goa Pharma Cluster is small & compact, it is very progressive cluster. With half a percent of the total units in the country, about 12% of the medicines are made in Goa. 90% of the units are WHO-GMP compliant. It is growing at a healthy rate of 18-20%. Almost all prominent Indian Companies and MNCs are having their production facilities in Goa and the cluster is self sustaining

5.1.7 Transportation

The study districts are having a good transport system in the State of Goa. These are connected to all the major cities across the country through various major and local highways, railways, waterways and air. There is a couple of major highways. State Highways and MDRs, Panchayat roads etc. Common modes of road transport within the cities /towns are city buses, cars and auto-rickshaws etc.

5.1.8 Infrastructure

The study region has well-developed and extensive infrastructural facilities in place. The power supply position is good and almost all the villages in study districts are electrified. The district head quarters such as Panjim and Margao have facilities like housing, hospital, drinking water facility, school and technical education, universities, medical college, etc. Emergency medical care and firefighting facilities are also



available at all Tehsils headquarters along the proposed project corridor.

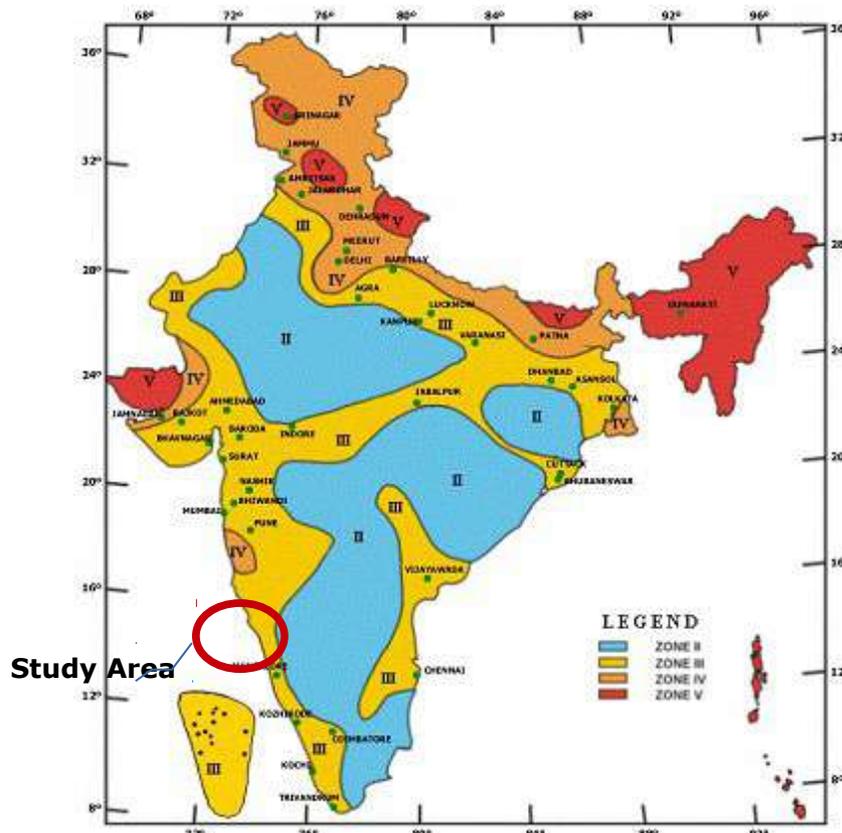
5.1.9 Seismic Details of the Area

Goa falls in seismic zone IV that indicates that Goa has high probability for occurrence of earthquakes. Goa forms part of the moderate seismic zone in the country, namely, Zone IV of seismic zoning map of India. Though Goa has not directly witnessed any earthquake it was affected by tremors from devastating earthquakes from neighboring state.

Although Goa has not witnessed earthquakes directly, the tremors of the devastating earthquakes with magnitude 5.0 or more that hit "Koyana" and "Latur" in Maharashtra in the year 1967 and 1993 respectively, affected the routine life of the people in Goa as many of the residential as well as public structures, infrastructures were damaged severely, although no casualties were taken place.

Earthquake Disaster Vulnerability of North Goa

Although the vulnerability is low, towns are more at risk than rural areas due to higher density of population. Another concern is the large numbers of building both private and public have been constructed without proper earthquake resistance features. Goa being a tourist location has a number of heritage sites (No. of listed heritage buildings is 431 as per Town and Country Planning Department Notification) that need to be made earthquake resistant.





Source: NIDM, Goa

Figure 5.3: Seismic zone map of India

5.1.10 Archeological Sites/Places of Tourist Interest

No archeological sites were present within the Right of Way (ROW) of project highway.

5.1.11 Sources of Irrigation and Cropping Pattern

Agriculture is one of the important economic activities in the district. Rice is the staple food and paddy is the principal agricultural crop. Gross cropped area under paddy in 2005 – 06 was 22572 ha, accounting for nearly 35.32% of the Gross Cropped Area (63914 ha). Other crops grown are cereals, millets, pulses & oil seeds, which constitute an area of 2147 ha (3.36%), sugarcane 870 ha (1.36%), coconut 14157 ha (22.15%), arecanut 220 ha (0.34%) and cashewnut 14912 ha (23.33%). Irrigation potential created as on March 2000 by the Salauli Irrigation Project was 4614 ha in Sanguem, Quepem and Salcete taluks of Goa district.

5.2 Meteorology of the Region

In order to analyze the past meteorological data near to the proposed project site, data from Indian Meteorological Department (IMD), Goa Station is considered. The selected stations are located within the project site and the data collected for a period of 30 years

(1964-990).

5.3 Climatic Conditions

The climate of the region is characterized as tropical. The climate, wind and wave pattern are governed by the annually changing monsoons and transition periods between them dividing the year into four seasons as given in Table -5.1.

Table – 5.1 Seasons of the region

Season	Months	Characteristics
Summer	March–May	Hottest part of the year, occurrence of dust storms
South-West monsoon	June-Sept	Characterized by predominantly SW winds. Generally strong and persistent winds prevail.
North-East monsoon	Oct-Nov	Characterized by predominantly NE winds. Fair weather with the variable winds.
Winter	Dec-Feb	Cool season of the year



Temperature

The cold weather commences towards the end of December when the temperature begins to fall down in Goa is observed as the coldest month, with the mean daily maximum temperature at 32.6oC and the mean daily minimum at 19.8oC. The period from April to June is the hottest month with the mean daily maximum temperature at 33.3oC and a mean daily minimum at 24.7oC. With the advance of south-west & north-east monsoon by about mid of June there is an appreciable drop in temperatures. By about 3rd week of November when the monsoon withdraws, the day temperature begins to increase slightly but the night temperatures decrease steadily. After November both day and night temperatures decrease rapidly.

Rainfall

The rainfall in Goa in general increases from the south-west towards the north east. About 94.6 % of annual rainfall is received during the south-west monsoon season. July being the peak rainy month with 899.8 mm, the variation in the Annual rainfall from year is almost compatible with the base levels. The Annual rainfall of the Kakinada station is observed as 2880.8 mm.

Relative Humidity

Due to proximity to the sea, the territory is generally humid, with a further rise in humidity during the monsoon weather. Even during the summer months the relative humidity is generally above 60 percent.

Wind Speed And Direction

Winds in morning are easterly to north-easterly during October to April backing to the west or north-east in May while in the afternoon they tend towards west or north-west, due to the sea breeze effect. During the monsoon months the winds are generally westerly throughout the day.

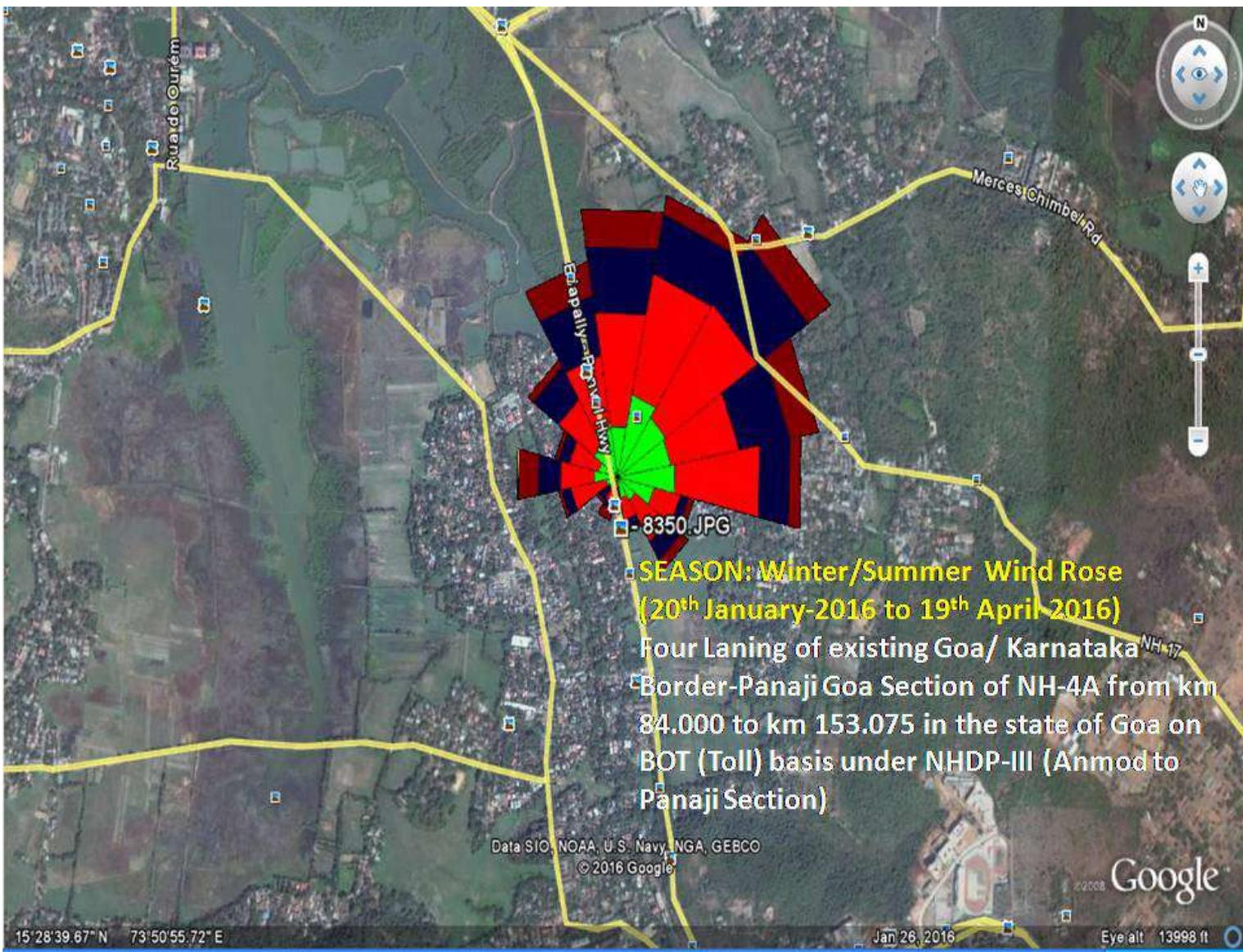
5.3.1 On site Meteorological Conditions

As a part of the EIA study, an automatic weather station at Panjim (NH 4A and NH 17 Junction) has been installed and monitored for the months of 20th January 2016 to 19th April 2016. The micro-meteorological parameters observed are Temperature, Relative Humidity, Wind speed, Wind direction and Rainfall. The summary of meteorological conditions observed is presented in Table -5.2.



Table-5.2: Summary of the Micro meteorological data

Month	Temperature (°C)		Relative Humidity (%)		Rainfall in mm		Wind Speed km/h	
	Max	Min	Max	Min	Max	Min	Max	Min
January-2016	36.7	18.1	88.1	39.9	0	0	18.0	<1.0
February-2016	34.9	16.9	88.4	45.2	0	0	18.0	<1.0
March-2016	35.6	19.7	85.6	41.0	0	0	20.0	<1.0
April-2016	37.3	22.9	80.4	38.4	0	0	16.0	<1.0



Source: Generated by Aarvee Associates, Hyd

Figure 5.4: Wind Rose Diagram for the Study Period (Jan-2016 to April-2016) at Panjim



The predominant wind direction during this Study period is observed to be blowing from NNW to SSE, N to S, NW to SE, WNW to SES, SW to NE and W to E. An average Wind speed during this period is 2.71 m/s. Calm winds during this period 8.11 %.

5.4 Air Environment

In assessing the environmental impact, collection and interpretation of baseline data is of prime importance. The primary data for the study period were collected 24 hourly twice in a week for three months as per national guidelines. The criteria followed for selecting the AAQM stations is recommended by IS: 5182 and CPCB.

They are:

- The sampling station had free exposure so that it did not collect air from stagnant pockets.
- It was not obstructed by large structures including hills.
- The sampling point was not directly influenced by any local source of emission.
- It was located at a minimum height of 1.5 m from the ground level.

Monitoring and analytical procedure:

Ambient air quality was monitored for the presence of contaminants existing in the air. In order to evaluate and quantify the air pollution problem, measurements were carried out for various air pollutants mentioned above. This data was used not only to evaluate the air quality in the study region but also as the basis to develop programs aiming at preventing the spread of pollutants leading to a risk to human health and general environment. Fine Dust Samplers (FDS) were used for ambient air sampling of selected parameters. The method for the selected parameters are based on the methods recommended by IS: 5182.

Selection of monitoring parameters:

The parameters selected for analyzing ambient air quality status were Sulphur dioxide (SO₂), Nitrogen dioxide (NO₂), Respirable Particulate Matter (PM₁₀), Fine Particulate Matter (PM_{2.5}), Carbon Monoxide (CO) and Hydro carbon (HC).

5.4.1 AAQ Assessment

After a preliminary reconnaissance of the study region and taking into account the meteorological (predominant wind directions, wind speed) & topographic conditions, traffic volume, major settlements and details on existing industrial activities in the study region, three (03) stations are identified for carrying out Ambient Air Quality Monitoring (AAQM) in the study area spread over an existing length of 69.075 **kms.**



The study was carried out during summer season viz., 20th January 2016 to 19th April 2016. The AAQ monitored locations are given in Table -5.3. and corresponding pictures are shown in Figure -5.5. The Environmental Baseline Monitoring locations are shown in the Figure -5.6.

Table -5.3: Ambient air quality monitoring locations

Station Number	Station
AAQ-1	Molem
AAQ-2	Tisk Usgao
AAQ-3	Ella





Figure -5.5: AAQ Monitoring Station installed at Ella, Molem and Tisk Usgao

Data analysis

The observed concentrations of various pollutants at all the sampling stations were processed for different statistical parameters like arithmetic mean, minimum concentration, and maximum concentration and percentile values (75th & 98th). The existing baseline levels obtained during the study period at three monitored locations are presented in Table -5.4.

All of the Ambient Air Quality Monitoring (AAQM) stations where AAQM was carried out falls under Residential category/ Industrial/ Rural. The recorded concentrations are compared with the National Ambient Air Quality Standards as notified on 16.11.2009 by MoEF.

Table -5.4: Ambient air quality during study period

Location/Category	Min.	Max.	Mean	75 Percentile	98 Percentile	CPCB Standard
PM₁₀ (µg/m³)						
Molem	56.8	70.6	62.5	63.7	69.6	100



Location/Category	Min.	Max.	Mean	75 Percentile	98 Percentile	CPCB Standard
Tisk Usgao	58.9	73.4	66.2	69.0	73.1	100
Ella	58.7	71.3	64.3	66.2	70.8	100
PM_{2.5} (µg/m³)						
Molem	22.7	30.8	27.1	28.9	30.8	60
Tisk Usgao	24.6	34.8	30.1	31.9	34.8	60
Ella	28.1	35.6	31.5	33.1	35.5	60
SO₂ (µg/m³)						
Molem	9.8	14.3	12.4	13.4	14.1	80
Tisk Usgao	11.2	14.8	13.0	13.9	14.7	80
Ella	10.1	14.7	12.8	13.4	14.7	80
NO₂ (µg/m³)						
Molem	21.3	36.2	27.8	30.2	35.9	80
Tisk Usgao	28.0	33.5	30.9	31.9	33.3	80
Ella	24.3	31	27.7	29.2	30.7	80
CO (mg/m³)						
Molem	1.0	1.6	1.3	1.5	1.6	4
Tisk Usgao	1.1	1.9	1.4	1.6	1.9	4
Ella	1.0	1.6	1.2	1.3	1.6	4
HC (µg/m³)						
Molem	<0.01	<0.01	<0.01	<0.01	<0.01	---
Tisk Usgao	<0.01	<0.01	<0.01	<0.01	<0.01	---
Ella	<0.01	<0.01	<0.01	<0.01	<0.01	---

As can be seen from the above Table:

- The mean Respirable Particulate Matter (PM₁₀) values observed in the range between 62.5 – 66.2 µg/m³ as against the CPCB standard of 100 µg/m³ for residential / industrial category. The maximum and 98th percentile values found to be well within the stipulated standards for all the locations.
- The mean Fine Particulate Matter (PM_{2.5}) values were found in the range between 27.1 – 31.5 µg/m³ as against the CPCB standard of 60 µg/m³ for residential/industrial category. The maximum and 98th percentile values found to be well within the stipulated standards for all the locations.
- The mean Sulfur dioxide values were found in the range between 12.4 – 13.0



$\mu\text{g}/\text{m}^3$ against the CPCB standard of $80 \mu\text{g}/\text{m}^3$ for residential / industrial category. The maximum and 98th percentile values found to be well within the stipulated standards for all the locations.

- The mean Dioxides of Nitrogen (NO_2) values were observed in the range between $27.7 - 30.9 \mu\text{g}/\text{m}^3$ against the CPCB standard of $80 \mu\text{g}/\text{m}^3$ for residential / industrial category. The maximum and 98th percentile values found to be well within the stipulated standards for all the locations.
- The mean carbon monoxide (CO) levels observed in the range between $1.2 - 1.4 \text{mg}/\text{m}^3$ as against the CPCB standard of $4\text{mg}/\text{m}^3$ for residential / industrial category. The maximum and 98th percentile values found to be well within the stipulated standards for all the locations.
- The Hydro carbon levels observed in the range between $<0.01 \mu\text{g}/\text{m}^3 - <0.01 \mu\text{g}/\text{m}^3$.

In general, the ambient air quality in the study area is satisfactory. It is envisaged that due to proposed four laning project traffic may further come down and ease the vehicles movement and traffic congestion, which may leads to reduce the pollution levels. The PM10, PM 2.5, SO2 & NO2 concentrations are shown in the figure 5.7 & 5.8.

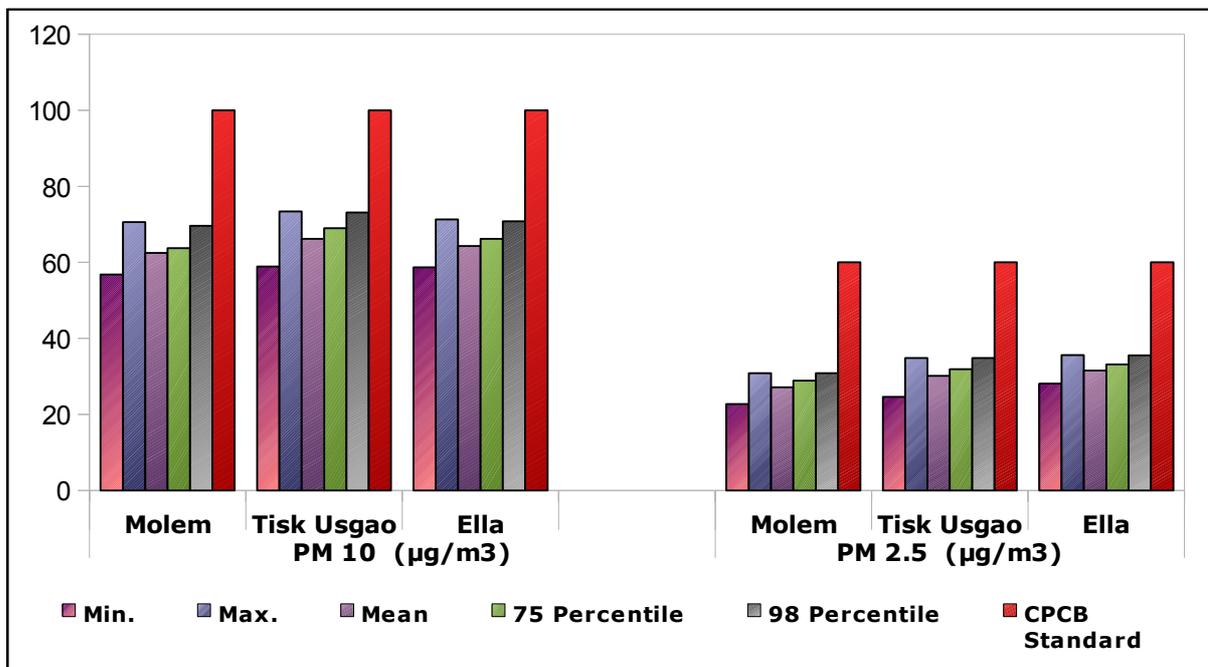


Figure -5.7: Graph Showing the PM10 and PM 2.5 Concentrations in the Study Area

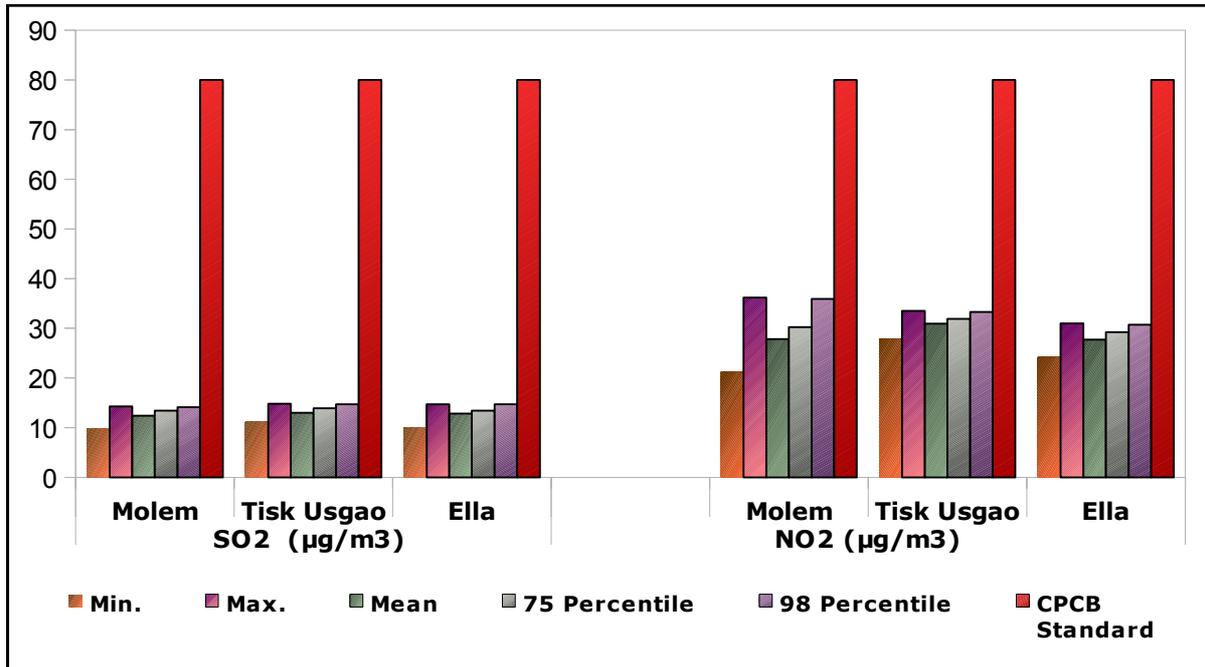


Figure -5.8: Graph Showing the NO_x and SO₂ Concentrations in the Study Area

5.5 Water Environment

Selected physico-chemical parameters along with bacteriological indicators of pollution have been used for describing the baseline status of water environment. Generation of baseline data for water quality covers sources of ground and surface water. Assessment of water quality in the study area includes:

- Surface water quality (IS - 2296)
- Ground water quality (IS - 10500)

5.5.1 Surface water quality

During the study period five (05) samples were collected for assessing the water quality. The sampling locations are designated as SW1 to SW5 described in Table -5.5. These were identified considering proximity to the project site, their activities and depending upon its utility by the people in the region. Table -5.6 presents surface water quality obtained at different locations.



Figure -5.9: Surface Water Sample Collected at River Mandovi and Pond near Corlim (Syngenta)

Table-5.5: Surface water sampling locations

Location Code	Location
SW-1	Pond near Sangod
SW-2	Bridge site near Chowgule Bus Stop
SW-3	River Mandovi, near Boma
SW-4	Pond near Corlim (Syngenta)
SW-5	Pond near Corlim



Table -5.6: Surface water quality obtained at different locations

S.No	Parameter	Units	IS:2296 Class C Limits	SW-1	SW-2	SW-3	SW-4	SW-5
1	Temperature	°C	--	28.9	29.9	28.5	28.6	27.7
2	pH at 25 °C	-	6.5 – 8.5	6.94	7.21	7.59	7.14	7.51
3	Color	Hazen units	300	20	30	10	30	20
4	Odor			U.O	U.O	U.O	U.O	U.O
5	Conductivity at 25 °C	u.mhos/cm	2000	5986	12668	5902	228	5998
6	Turbidity	NTU	30 NTU (For Coastal standards)	6.7	11.3	3.6	2.6	4.2
7	Dissolved Oxygen	mg/L	4 min 5mg/l (For Coastal standards)	4.3	5.1	5.4	6.3	5.9
8	BOD (3 days at 27°C)	mg/L	3	32	4	8	3	7
9	COD	mg/L	--	105	14	32	12	24
10	TKN	mg/L	--	2.36	12.5	2.24	0.06	3.99
11	Total Suspended Solids	mg/L	--	23.3	46.2	12.2	6.2	24.5
12	Total Dissolved Solids	mg/L	1500	3864	8206	3796	144	3826
13	Total Hardness as CaCO ₃	mg/L	--	610	1450	590	50	600
14	Chloride as Cl ⁻	mg/L	600	380.1	3381.4	375.1	45.0	1800.7
15	Fluorides as F ⁻	mg/L	1.5	1.7	1.7	1.2	0.1	1.6



S.No	Parameter	Units	IS:2296 Class C Limits	SW-1	SW-2	SW-3	SW-4	SW-5
16	Sulphate as SO ₄ ²⁻	mg/L	400	2144.2	1303.6	2176.0	6.3	293.6
17	Alkalinity as CaCO ₃	mg/L	--	160	100	110	10	110
18	Nitrates as NO ₃	mg/L	50	39.6	71.2	27.7	1.8	28.9
19	Calcium as Ca	mg/L	--	64.0	64.0	56.0	8.0	40.0
20	Magnesium as Mg	mg/L	--	100.0	309.6	108.0	7.2	120.0
21	Sodium as Na	mg/L	--	1086.5	2235.6	1076.8	26.6	1094.8
22	Potassium as K	mg/L	--	7.0	8.2	6.2	1.1	66
23	Iron as Fe	mg/L	0.3	0.26	0.29	0.31	0.36	0.19
24	Zinc as Zn	mg/L	15	8.36	7.16	5.18	0.029	7.98
25	Phosphate as Po ₄	mg/L	--	0.29	0.41	0.21	<0.02	0.11
26	Surfactants (MBAS)	mg/L	--	0.079	0.031	0.082	0.098	0.086
27	Dissolved Iron	mg/L	--	0.15	0.22	0.13	0.06	0.12
28	Ammonia as NH ₄	mg/L	--	1.26	2.31	1.75	Nil	1.28
29	Copper as Cu	mg/L	1.5	0.33	0.56	0.31	0.005	0.41
30.	Manganese as Mn	mg/L	0.5	0.005	0.018	0.019	<0.001	0.006
31	Arsenic as As	mg/L	0.2	<0.001	<0.001	<0.001	<0.001	<0.001
32	Lead as Pb	mg/L	0.1	<0.001	<0.001	<0.001	<0.001	0.004
33	Mercury as Hg	mg/L	--	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
34	Boron as B	mg/L	--	0.69	0.93	0.058	0.011	0.71
35	Chromium as Cr	mg/L	0.05	0.035	0.08	0.026	<0.001	0.039
36	Phenols	mg/L	0.005	<0.001	<0.001	<0.001	<0.001	<0.001



S.No	Parameter	Units	IS:2296 Class C Limits	SW-1	SW-2	SW-3	SW-4	SW-5
37	Cadmium as Cd	mg/L	0.01	<0.001	<0.001	<0.001	<0.001	<0.001
38	Total Coli form	MPN/ 100 mL	Should not exceed 5000	1250	1400	2750	250	1140
39	Faecal Coli form	cfu/1mL	Absent	N.D	N.D	N.D	N.D	N.D

U.O – Un Objectionable, N.D – Not Detected



Data analysis

The surface water collected from various sources are analyzed for physico-chemical and bacteriological parameters. The results are compared with BIS- 2296 Class C Limit (Drinking water source after conventional treatment). The detail description of sample analyzed is given as below:

- Data on physical characteristics indicated variations in pH ranged between 6.94 – 7.59 as against IS standard of 6.5 – 8.5. Odour of water is un-objectionable. The Colour of water found to be well within desirable limit.
- Data on chemical characteristics:
 - The total hardness observed to be constant in all samples and is in the range of 50 to 1450 mg/l.
 - The total dissolved solids observed to be ranged between 144 mg/l to 8206 mg/l exceeding permissible limit of 1500 mg/l at all locations except at a pond near corlim due to intrusion of sea water.
 - The chlorides ranged between 45 – 3381.4 mg/l and are well within the permissible limits except at chowgule bus stop and pond near corlim due to intrusion of sea water.
 - The Nitrates ranged between 1.8– 71.2 mg/l and the Sulphates ranged between 6.3-2144.2 mg/l against permissible limits of 50mg/l and 400mg/l.
 - The Fluoride values found to be in the range of 0.1 to 1.7mg/l as against the permissible limits of 1.5 mg/l.
- Data on trace metals i.e., Fe, Zn, B, Cr & Cd concentrations found to be consistent in all the analysed samples and found to be very well within desirable limit.
- The Dissolved Oxygen in the sources is ranging between 4.3mg/l to 6.3 mg/l as against the minimum requirement limit 4mg/l, which implies sustainability of aquatic life in the tanks /lakes.
- Bio-chemical Oxidation Demand (BOD) is observed to be high and ranged between 3-32mg/l as against the specified limit of 3mg/l. This may be due to discharge of various effluents into the water bodies from Panjim city. The COD is found to be ranged between 12-105 mg/l.
- Bacteriological samples were analysed for all the surface water sampling



locations, the total coli form values are observed in the range of 250 to 2750 MPN/100ml, indicates the Total coliforms are present within the stipulated standard of 5000MPN/100 ml. The Fecal Coliforms are not detected.

The Concentrations of BOD & DO, COD & BOD, TDS and TSS & Turbidity in the study area are shown in the fig. 5.10, fig. 5.11, fig. 5.12 & fig. 5.13.

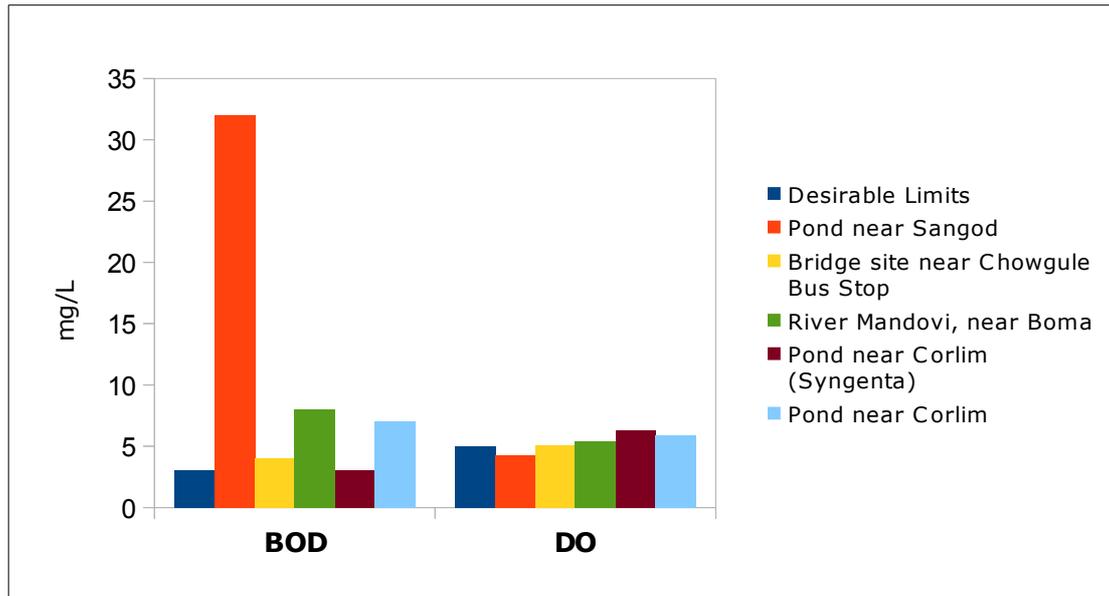


Figure -5.10: Graph Showing the BOD and DO Concentrations in the Study Area

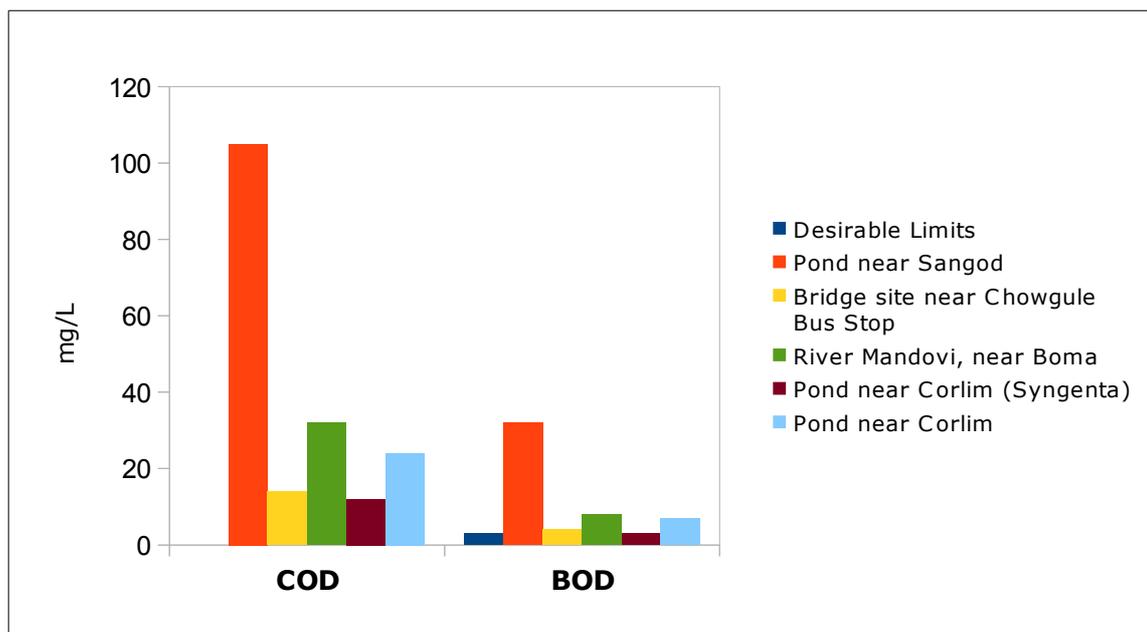


Figure -5.11: Graph Showing the COD and BOD Concentrations in the Study Area

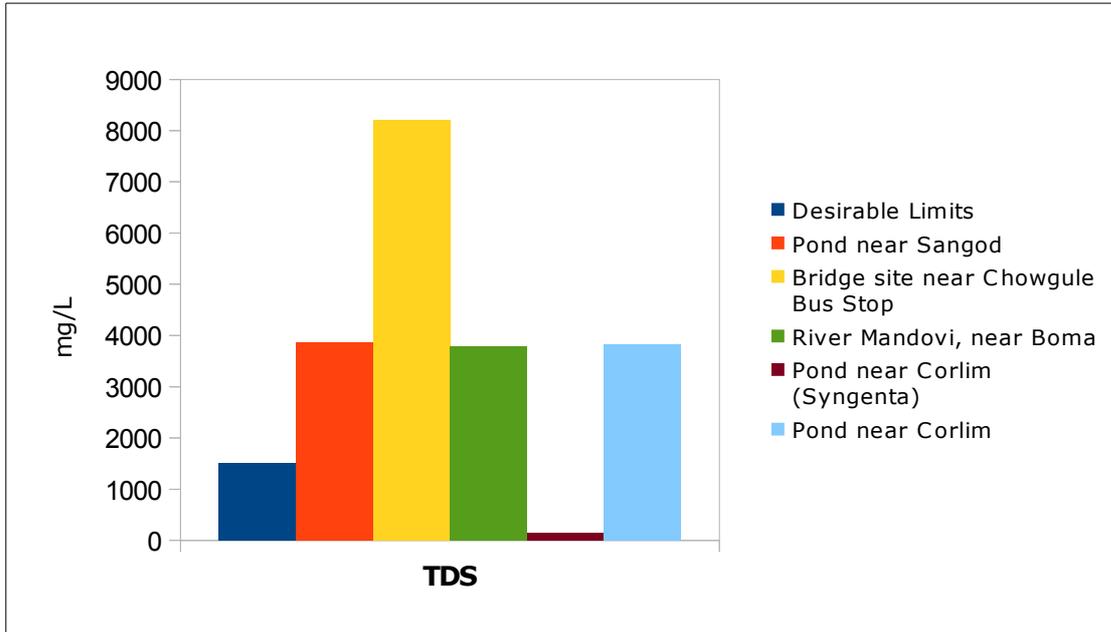


Figure -5.12: Graph Showing the TDS Concentration in the Study Area

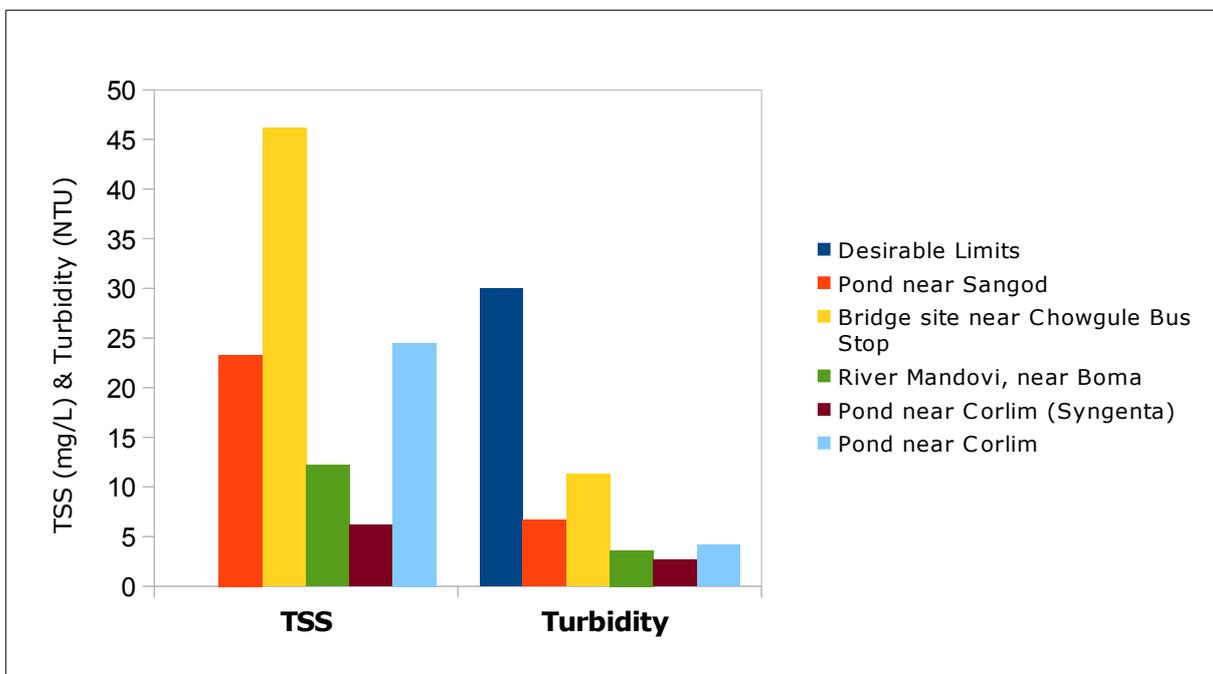


Figure -5.13: Graph Showing the TSS & Turbidity in the Study Area



5.5.2 Ground water quality

Ground Water is one of the main sources of water in the project corridor for domestic, commercial and other irrigation use hence the rate of extraction of ground water is at a moderate scale. For assessing the ground water quality in the study area, eight (08) samples were collected from the identified bore wells/dug wells and given in Table -5.7. Selection of samples considered as per the utilization of the people along the proposed road development project. Mostly ground water is used for domestic, drinking, gardening, floor washing and industrial purposes. The ground water quality analysis results are given in Table -5.8 and the locations are shown in Figure -5.14.



Figure -5.14: Ground Water Sample Collected at Molem and Farmagudi



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S. No.	Parameter	IS:10500		Units	GW-01	GW-02	GW-03	GW-04	GW-05	GW-06	GW-07	GW-08
		Desirable Limits	Permissible Limits in the Absence of Alternate Source									
11	Total Dissolve solids	500	2000	mg/L	200	1798	42	150	202	1048	102	166
12	Total Hardness as CaCO ₃	200	600	mg/L	20	480	20	40	50	320	50	90
13	Total Alkalinity	200	600	mg/L	20	40	20	30	20	50	30	60
14	Calcium as Ca	75	200	mg/L	4.0	48.0	4.0	4.0	8.0	80.0	8.0	28.0
15	Magnesium as Mg	30	100	mg/L	2.4	74.4	2.4	7.2	7.2	28.8	7.2	4.8
16	Chloride as Cl	250	1000	mg/L	25.0	610.2	5.0	50.0	47.3	460.2	25.0	20.0
17	Sulphate as SO ₄	200	400	mg/L	92.9	455.5	3.8	13.0	33.0	111.2	11.3	34.4
18	Fluorides as F ⁻	1.0	1.5	mg/L	0.2	1.7	<0.1	0.2	0.1	1.2	0.1	0.2
19	Nitrates as NO ₃	45	100	mg/L	3.7	11.3	0.6	1.9	2.5	11.6	2.5	3.7
20	Sodium as Na	--	--	mg/L	60.2	435.6	4.1	33.5	47.3	230.0	25.0	15.1
23	Potassium as K	--	--	mg/L	1.9	5.1	0.4	0.8	0.8	3.9	1.1	1.9



Data analysis:

The ground water collected from various sources are analysed for physico-chemical and bacteriological parameters. The results are compared with BIS: 10500 Drinking Water Standards. The detail description of sample analysed is given as below:

- Data on physical characteristics indicated variations in pH ranged between 5.46 – 6.95 as against IS standard of 6.5 – 8.5. The physical Taste of water is agreeable and Odour of water found to be un-objectionable.

Data on chemical characteristics:

- The Total Hardness observed to be varying in all samples and is in the range of 20 to 480mg/l as against the standard limits of 200 -600 mg/l.
- The Total Dissolved Solids observed to be high and ranged between 42 mg/l to 1798 mg/l as against the desirable limits 500 mg/l and well within the permissible limits 2000 mg/l.
- The chlorides ranged between 5 to 610.2 mg/l and are well within the desirable and permissible limits of 250 mg/l – 1000 mg/l.
- The Nitrates and Sulphates values observed to be ranging between 0.6 – 11.6 mg/l and 3.8 – 455.5 mg/l. Nitrates are well within the permissible limits of 100mg/l but sulphates are exceeding permissible limit of 400mg/l. This may be due to sea water influx into the groundwater.
- The Fluoride values found to be in the range of <0.1 – 1.7 mg/l. Fluoride content is found to be exceeding permissible limit of 1.5 mg/l at Darbandora location.
- Data on trace metal concentration found to be consistent in all the analyzed samples and very well within permissible limit.

The ground water quality in the study area is satisfactory as compared with BIS: 10500 standards except at Darbandora. The water can be used for domestic, commercial and agriculture purposes. It can also be used for drinking after treatment. The Concentrations of Total hardness & Total Alkalinity, Fluoride, Nitrates, Chloride & Sulphate and Manganese in the study area are shown in the figure nos 5.15, 5.16, 5.17, 5.18 & 5.19.

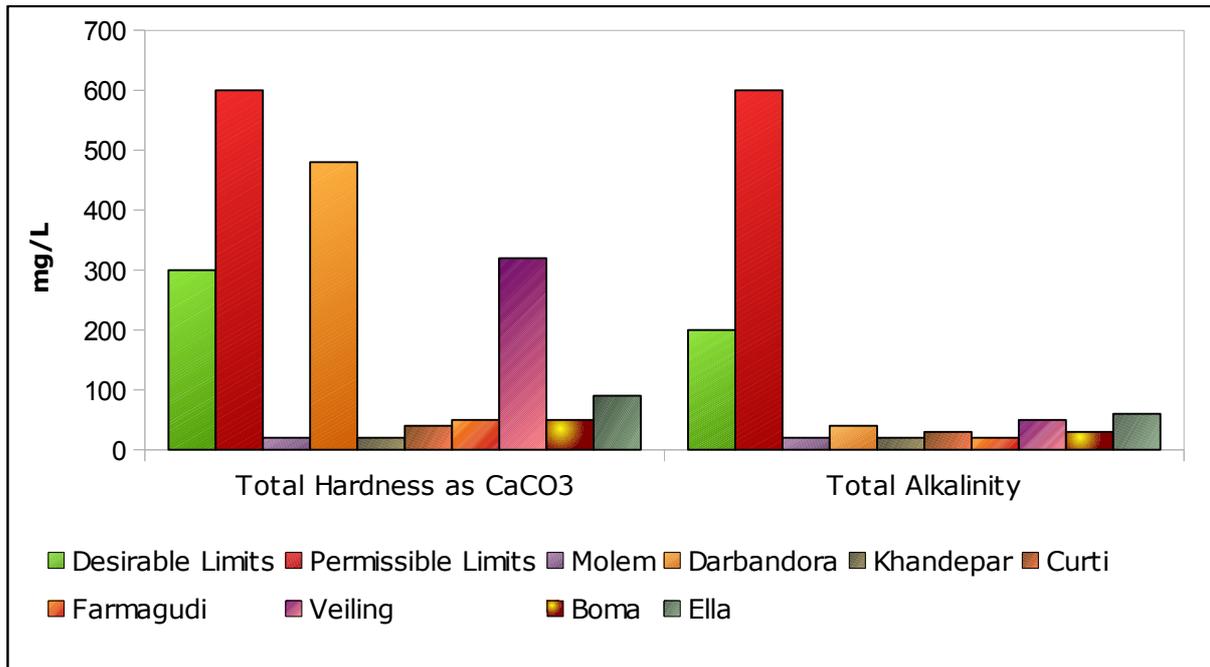


Figure -5.15: Graph Showing the Total Hardness and Total Alkalinity Concentrations in the Study Area

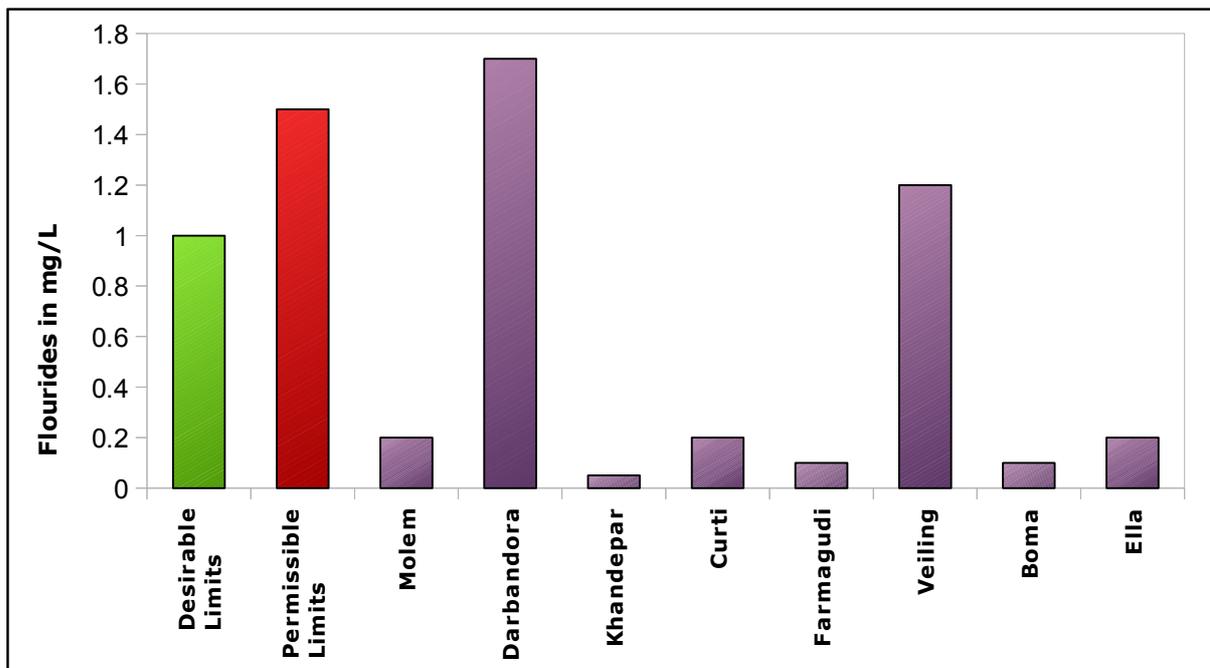


Figure -5.16: Graph Showing the Fluoride Concentration in the Study Area

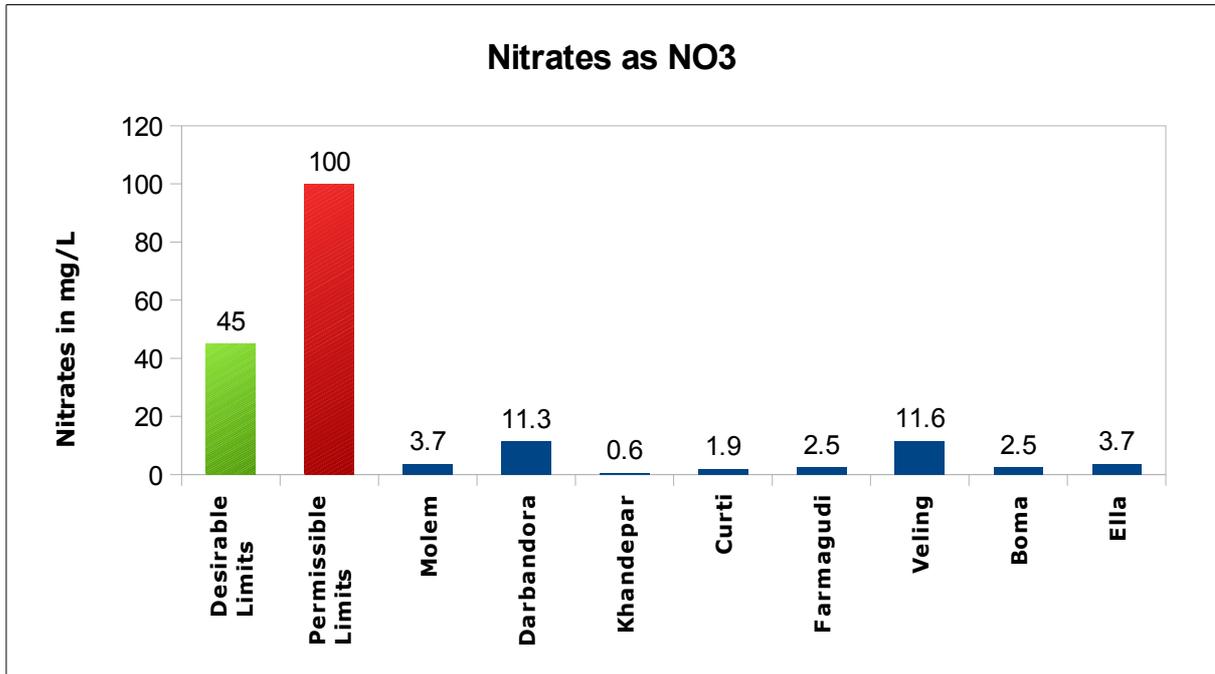


Figure -5.17: Graph Showing the Nitrate Concentration in the Study Area

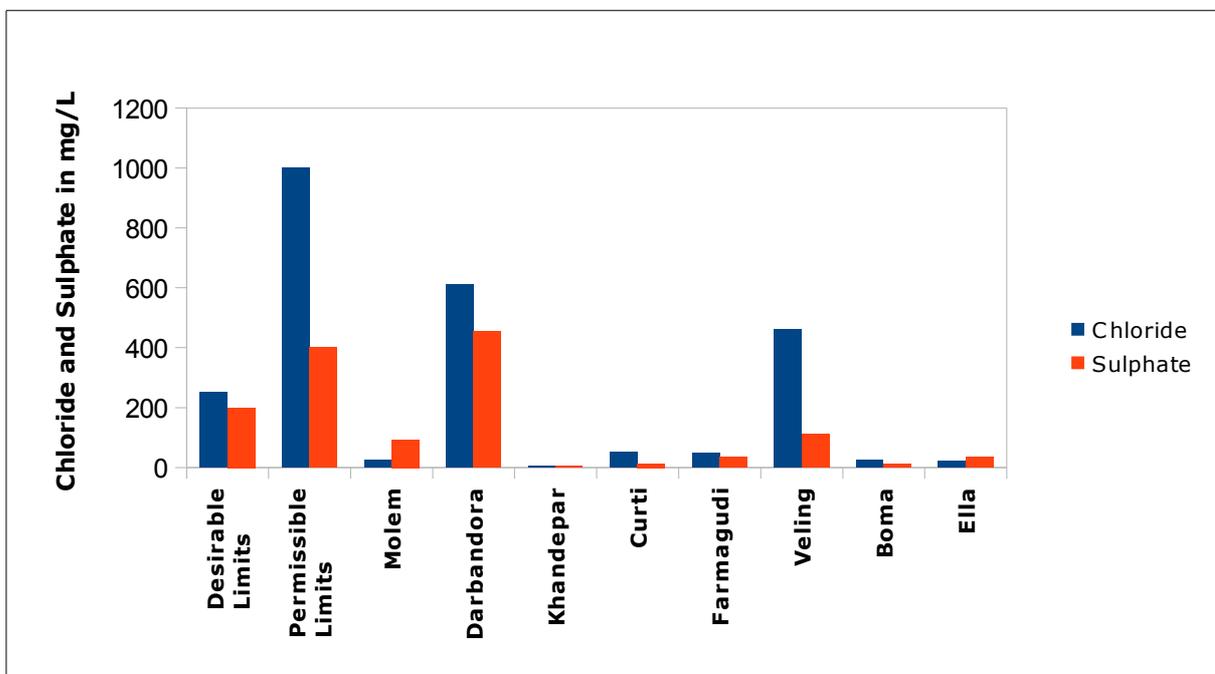


Figure -5.18: Graph Showing the Chloride & Sulphate Concentration in the Study Area

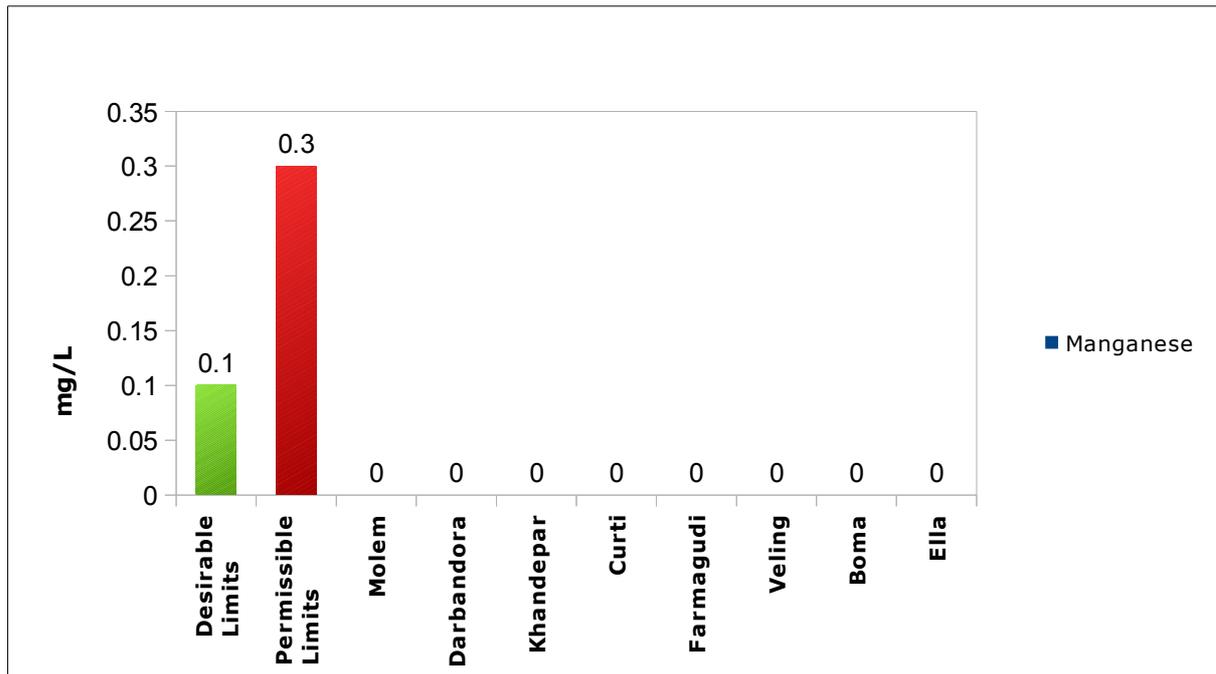


Figure -5.19: Graph Showing the Manganese Concentration in the Study Area

5.6 Noise Environment

In view of the proposed road widening project, field monitoring was carried out at eight (08) locations. The locations were selected based on the land use pattern, traffic intersections and diversions along the existing alignment. Precision integrated sound level meter having statistical unit with digital display was used for ambient noise level monitoring in the present study. Noise monitoring was carried out for 24 hours at each location. Noise monitoring locations and noise levels recorded i.e., Leq day, Leq night, are presented in Table 5.9 and Noise quality monitoring status of the study area is presented in Table 5.10.

Table -5.9: Ambient Noise Quality Locations:

Location Code	Location Name
N1	Molem
N2	Darbandora
N3	Tisk Usgao
N4	Curti
N5	Near Ponda Caves
N6	Mangeshim



Location Code	Location Name
N7	Banastari Corlim bridge
N8	Road junction near Ella

Table -5.10: Noise Quality Monitoring Status in the Study Area

Station No.	Location	Category	Leq day dB(A)	Leq Night dB(A)
N1	Molem	Commercial	62.2	50.6
N2	Darbandora	Residential	59.8	49.7
N3	Tisk Usgao	Industrial	70.1	57.3
N4	Curti	Residential	63.9	54.1
N5	Near Ponda Caves	Commercial	60.4	48.1
N6	Mangeshim	Residential	63.9	53.3
N7	Banastari Corlim bridge	Residential	65.8	53.6
N8	Road junction near Ella	Residential	59.5	48.0

Data analysis

As is seen from Table -5.9, noise monitoring was carried out at eight locations, all the locations fall under various categories such as Residential, Commercial and Industrial.

Eight noise monitoring locations are identified covering major junctions, residential areas and commercial activities i.e., Molem, Curti, Ponda, Corlim bridge, Ella Junction and Tisk Usgao etc. The day and night noise levels of Commercial category are observed to be in the range of 60.4 to 62.2 dB (A) & 48.1 to 50.6 dB(A) as against the CPCB Standard of 65.0 & 55.0 dB(A). Similarly, The day and night noise levels of Residential category are observed to be in the range of 59.5 to 65.8 dB (A) & 48.0 to 54.1 dB(A) as against the CPCB Standard of 55.0 & 45.0 dB(A). Whereas The day and night noise levels of Industrial category are observed to be 70.1 dB (A) & 57.3 dB(A) as against the CPCB Standard of 75.0 & 70.0 dB(A). The noise levels are found to be well within the limits in Commercial and Industrial categories but they have exceeded the limits in Residential category. The Noise quality levels of the study are shown in the fig. 5.20, fig. 5.21 & fig. 5.22.

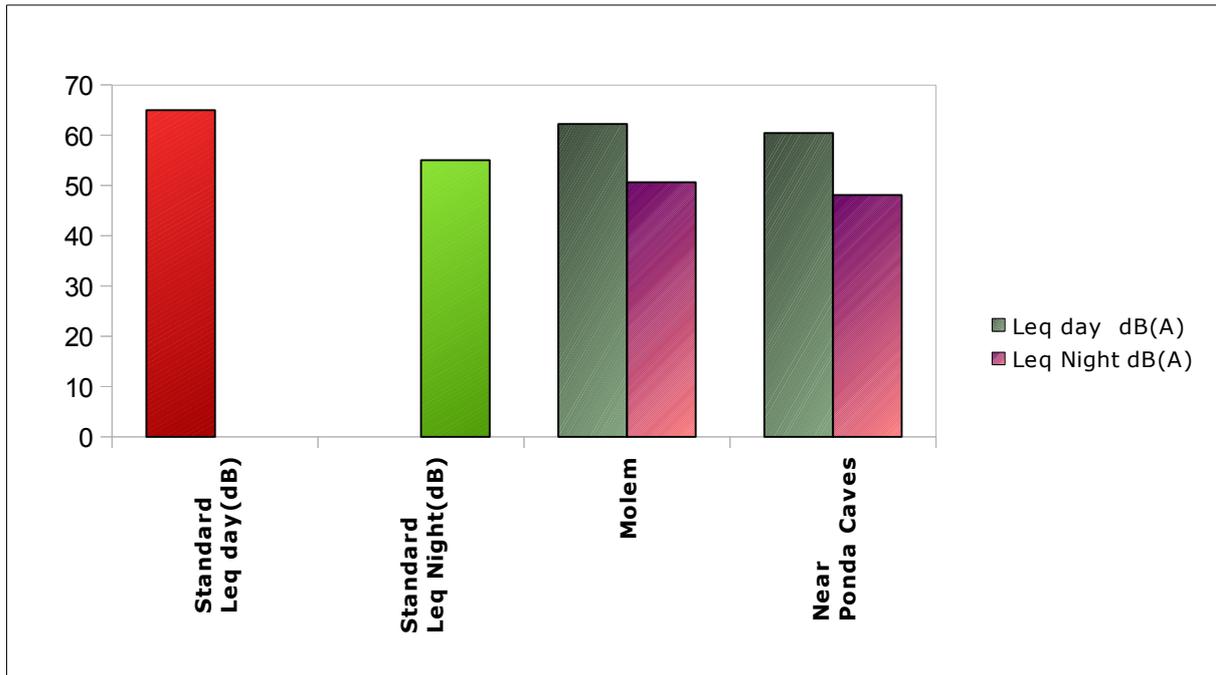


Figure -5.20: Noise Quality levels in Commercial Category

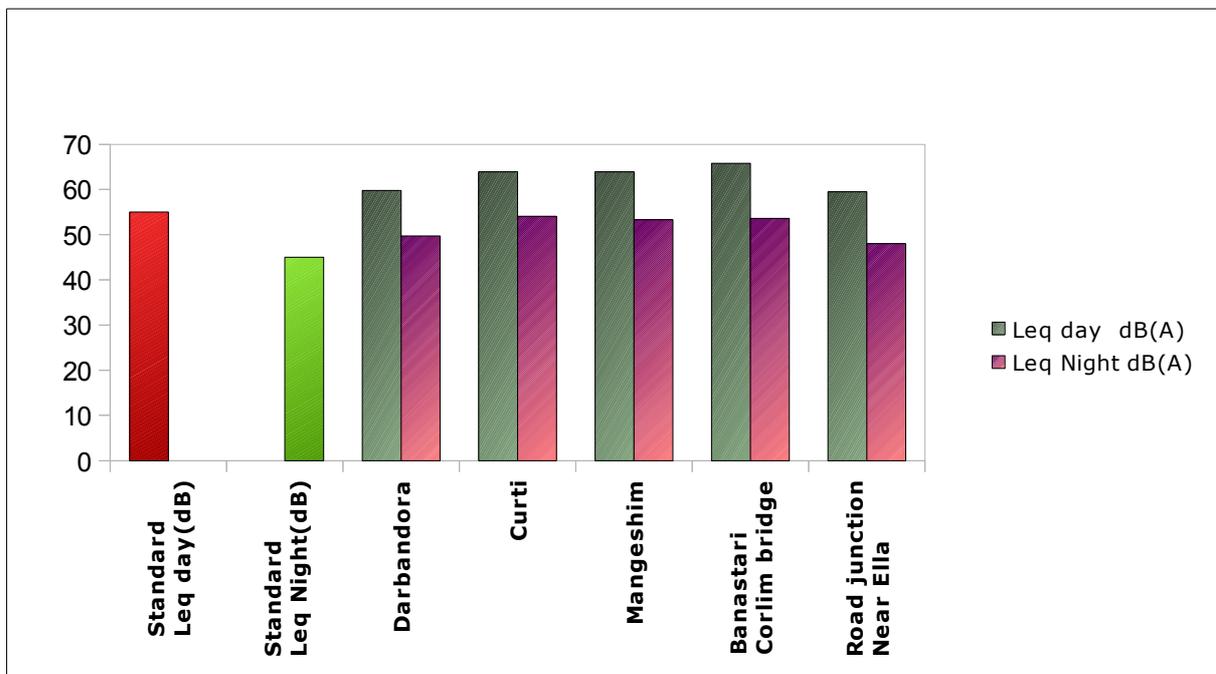


Figure -5.21: Noise Quality levels in Residential Category

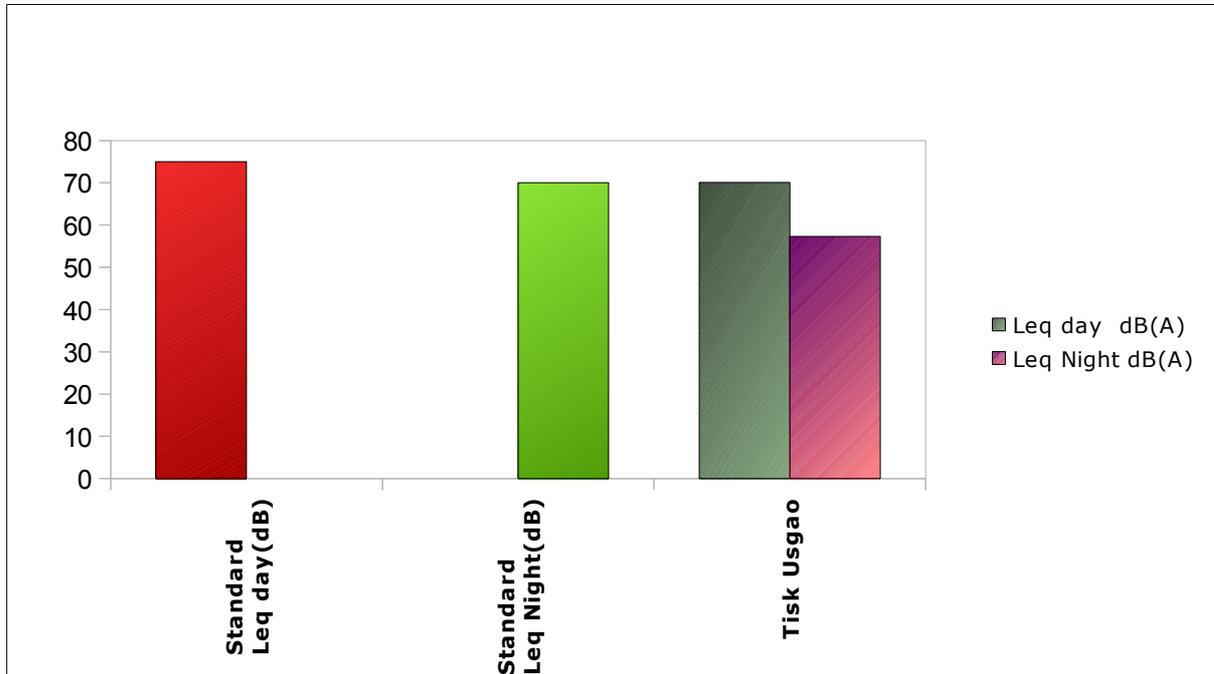


Figure -5.22: Noise Quality levels in Industrial Category

National Noise Standards

The Central Pollution Control Board has specified ambient noise levels for different land use for day and night times. Importance was given to the timing of exposure and areas designated as sensitive. The National ambient noise level standards are given below. National ambient noise level standards are given in the table no.5.11.

Table-5.11: National ambient noise level standards

Area Code	Category	Limits in Decibels (dB(A))	
		Day Time	Night Time
A	Industrial	75	70
B	Commercial	65	55
C	Residential	55	45
D	Silence Zones	50	40

Note:



- Day Time is recorded in between 6 a.m. and 9 p.m.
- Night time is recorded in between 9 p.m. to 6 a.m.
- Silence zone is defined as areas upto 100 meters around such premises as hospitals, educational institutions and courts. The silence zones are to be declared by the Competent Authority.
- Use of vehicular horns, loudspeakers and bursting of crackers shall be banned in these zones.
- Mixed categories of areas should be declared as one of the four above mentioned categories by the Competent Authority and the corresponding standards shall apply.

Source: EPA Notification [G.S.R. 1063 (E) dt. 26.12.1989 published in the Gazette No. 643 dt. 26.12.1989].

5.7 Land Environment

5.7.1 Geology

Geologically the state constitutes the northwesterly extension of the granitoid-greenstone terrain of Karnataka, comprising rocks of Precambrian age viz., gneisses, migmatites, granitoids, granites, schists, meta-volcanics (both acid and basic), meta-greywackes, banded ferruginous quartzites associated with manganiferous phyllites / argillites, limestones, dolomites and thin bands of quartzite intruded by granite and maficultramafic complex. Deccan Trap is exposed on the NE border of Goa. Peninsular Gneisses are well exposed in Anmod Ghat section along the Panaji-Ponda- Londa highway. Qupem in central Goa and Chauri in the south, when Ranebennur Subgroup of Shimoga belt further extend north and northwesterly into Goa in response to the variation in their litho-spectrum and in accordance to the stratigraphic guidelines, they are assigned with the local name called 'Goa Group' which is further divided into four formations. The rocks of Peninsular Gneissic Complex and Goa Group are intruded by maficultramafic complexes.

5.7.2 Soil

For land environment three (3) samples were selected from different villages in the study area to understand the Physico-chemical properties of the soil. The activities around the sampling sites were also taken into consideration to understand the sources of pollution if any and all other factors governing the Physico-chemical properties of the soil. Meticulous attention was paid to collect adequate amount of composite soil samples at three depths for analysis. The samples were collected in dependable, waterproof containers marking the samples accurately, distinctly and brought to the laboratory for analysis. The soil sampling locations and results of the analysis are presented in Table -5.12 & 5.13 respectively.



Table-5.12: Soil Quality Location

Location Code	Soil Sampling Location
S-01	Molem
S-02	Tisk Usgao
S-03	Ella (from ICAR Research complex)

Table No -5.13: Soil Quality Analysis

S. No	Parameter	Units	S-01	S-02	S-03
1	Texture	--	Silty Clay	Clay	Silty Clay
	Sand (%)	%	16	20	22
	Silt (%)	%	45	32	48
	Clay (%)	%	39	48	30
2	pH at 25 °C	-	5.62	5.78	6.05
3	Conductivity at 25 °C	µs/cm	68	75	84
4	Moisture retention capacity	mm/cm	12.3	10.6	9.6
5	Infiltration rate	cm/hr	15.2	19.3	18.5
6	Bulk Density	g/cc	1.26	1.32	1.31
7	Porosity	%	72	65	70
8	Organic matter	%	3.26	4.12	4.6
9	Nitrogen	mg/kg	388	372	406
10	Potassium	mg/kg	176	146	212
11	Phosphorous	mg/kg	102	93	116
12	Lead as Pb	mg/kg	<0.01	<0.01	<0.01
13	Iron as Fe	mg/kg	12.3	8.68	6.6
14	Organic Carbon	%	1.89	2.38	2.66

Data analysis

As it can be seen from the Table -5.13, the soil along the study area is classified as clay & silty clay in nature. Characterized by pH, the values are in the range of 5.62 – 6.05. If the soil's Electrical Conductivity (EC) falls below 1000 micro Siemens, the soil can be classified as normal. In analyzed samples EC found to be in the range between 75 – 84 µS/cm. The Organic matter ranged from 3.26% to 4.6%. The available Nitrogen in the soil is 372 – 406 mg/Kg, found to be average/sufficient requirement for the plantation. The available Phosphorous in the soil is 93 – 116 mg/Kg, found to be



average requirement for the plantation and agricultural purposes. The available Potassium in the soil is 146 – 212 mg/Kg, found to be medium requirement for the plantation and agricultural purposes. Trace metal concentrations found to be low.

5.8 Biological Environment

Goa is having rich tropical biodiversity. The state is covered with Bamboo canes, Chillar barks, Bhirand, Coconut trees as main forest products. Fruit trees like jack fruits, mangoes, pineapples and black berries are present in the state. Being close to the Arabian Sea the Goan climate is warm and humid throughout the year. Goa is home to rich tropical biodiversity. Goa is also a home for several faunal species. Goa's state animal is the Gaur, the state bird is the Ruby Throated Yellow Bulbul, which is a variation of Black-crested Bulbul, and the state tree is the Asan. Other animals like foxes, wild boars and migratory birds are found in the jungles of Goa. Crabs, lobsters, shrimps, jellyfish, oysters and catfish form important part of the water-life of the state. Goa also has a high snake population, which keeps the rodent population in control.

5.8.1 Land use

The existing project of 4 laning of Anmod to Panaji on NH-4A is passing through hilly, highly rolling and plain terrain. The project stretch passes through hilly terrain and majority of adjoining land is Forest. Some of the stretch where industrial places and junction locations are built up. The important crops grown along the project stretch are Cashew, Rice and Areca. The land utilization pattern of the study districts are given in Table – 5.14. The Goa land use map is given in Figure -5.23

Table – 5.14: Land Utilization Pattern of the Goa (Area in Hectare)

Sl.No	Land Use	Area in Ha	Percentage
1	Reporting area for land utilization	361	-
2	Forests	125	34.63
3	Not available for cultivation	37	10.25
4	Permanet pastures and other grazing lands	1	0.28
5	Land under misc. tree crops & groves	1	0.28
6	Culturable wasteland	53	14.68
7	Fallow lands other than current fallows	0	0.00
8	Current fallows	7	1.94
9	Net are sown	137	37.94



Consultancy Services for Four Laning of existing Goa/Karnataka Border-Panaji Goa Section of NH-4A from Km 84.000 to Km 153.075 in the state of Goa on BOT (Toll) basis under NHDP-III (Anmod to Panaji Section)

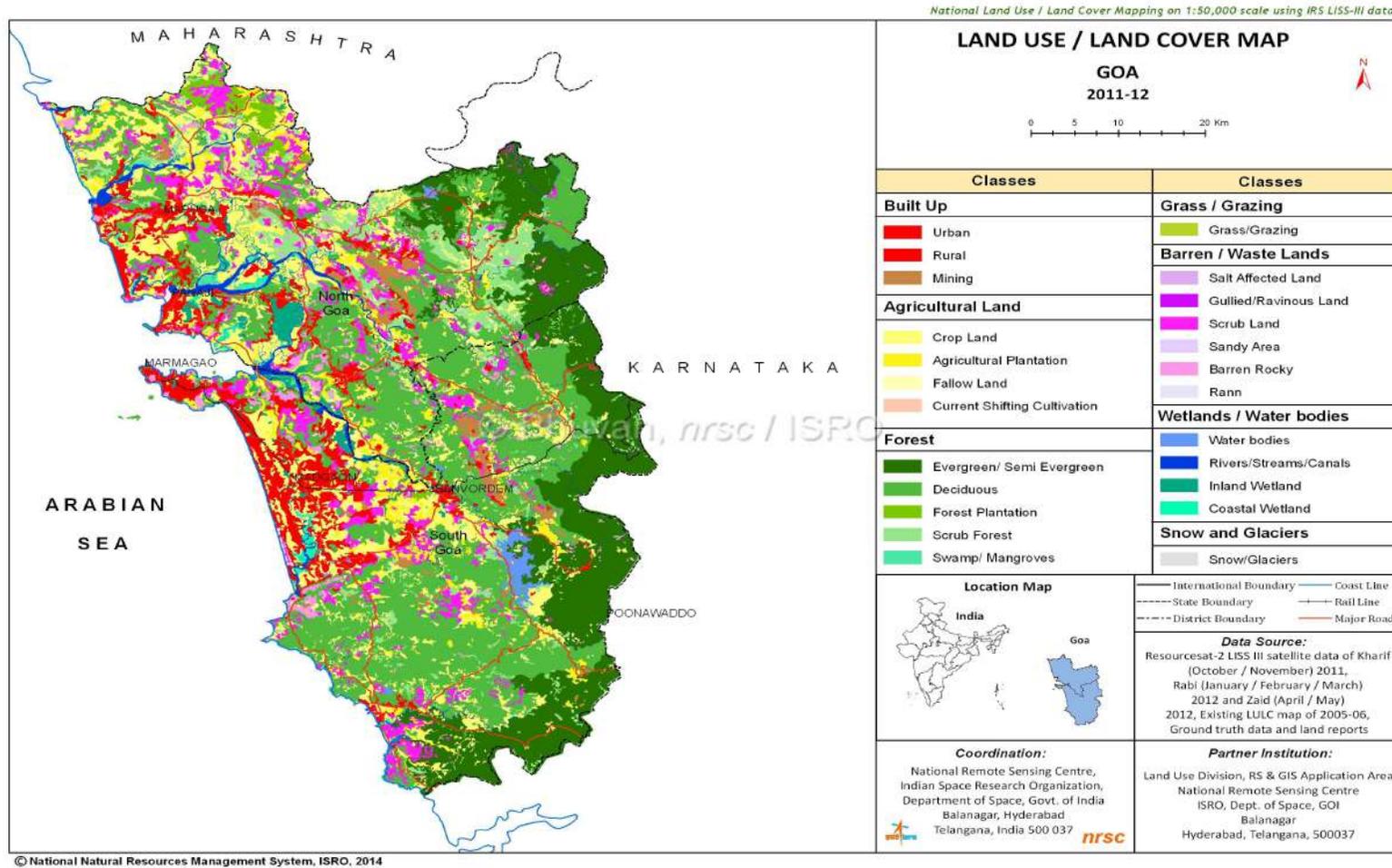
Environmental Impact Assessment & Environmental Management Plan

370

100

Total Geographical area

Source: Land Use Statistics, Ministry of Agriculture, GoI, 2006.



Source: NRSC, ISRO, GoI

Figure 5.23 : Map showing the Land use pattern of Goa



5.8.1 Forests, Biosphere and Sanctuary

Forests in the Study Area:

A major section of the project road from km 84.000 to km 96.000 passes through part of Western Ghats, which has been considered as one of the richest reservoirs of the bio-diversity and termed as 'Biodiversity hotspot'. (Hot spots are areas that are extremely rich in species, have high endemism, and are under constant threat). Floristically Western Ghats bio-region is one of the richest harbouring with almost 3500 species of flowering plants (27 percent of the flowering plants in India). The ten dominant natural orders of plants are Gramineae, Leguminosae, Acanthaceae, Orchidaceae, Compositae, Euphorbiaceae, Rubiaceae, Asclepiadaceae, Geraniaceae and Labiatae. The genera found in the region with more than 15 species each are *Crotalaria*, *Impatiens*, *Diospyros*, *Ipomoea*, *Eugenia*, *Strobilanthus*, *Ficus*, *Desmodium*, *Habenaria*, *Grewia* and *Osbeckia*. There are 58 endemic genera mostly confined to Western Ghats of which 47 are monotypic. Gramineae (Poaceae) has the highest number of endemic genera and the genus *Nilgirianthus* has the maximum number (20) of endemic species. Tree genera endemic to the Western Ghats are *Blepharisternma*, *Erinocarpus*, *Meteromyrtus*, *Ostonephelium*, *Poeciloneuron* and *Pseudoglochidion*. Other endemic genera are *Adenoon*, *Griffithella*, *Willisia*, *Meineckia*, *Baeolepis*, *Nanothamnus*, *Wagarea*, *Campbellia* and *Calacanthus*. In addition, there are 6 genera and 17 species belonging to *Bambusae* of which 6 are confined to Western Ghats. Of 25 species of *Dalbergia* found in India, 22 species and 1 variety are from the Western Ghats. There are also 84 species and two variants of endemic orchids belonging to 30 genera (these genera are endemic). Of the known orchids of Indian peninsula, 37 percent are endemic to the Western Ghats region and of those 15 species are endangered.

Diversity and endemism are also seen in fauna of Western Ghats. There are 48 genera of mammals, 275 genera of birds (with 28 endemic forms), 60 genera of reptiles with 7 *Hoplodactyles*, *Salea*, *Pseudoplecturus*, *Pleucturus*, *Melanophidium*, *Platylecturus* and *Xylophis* have been recorded. The order *Salientia* is the best represented amphibian group in India. The genus *Rana* within this order with 35 species reported from India is mainly found in the peninsula, with 14 species endemic to the Western Ghats. Family *Rhacophoridae* with two genera and nine species occurring in the Western Ghats, out of the 10 species known from India, family *Bufo* has three genera. The genus *Nectophryne* has endemic *N. tuberculosa* in the Western Ghats. In the genus *Bufo*, out of fifteen species, seven are endemic to the Western Ghats.



Bhagwan Mahaveer Sanctuary and National Park:

This protected area located in the Western Ghats of South India, in Sanguem taluk, Goa along the eastern border with Karnataka with an area of 240 sq.km. Initially, it was notified as a Sanctuary (Molem Wildlife Sanctuary) in 1967. Subsequently an area of 107 sq.km. of the said Sanctuary was notified as the Molem National Park in 1978. Later, the name was changed to Bhagwan Mahaveer Wildlife Sanctuary and National Park. It is located between 15°15'30' to 15°29'30' N and 74°10'15' to 74°20'15' E.

The area is situated near the town of Molem, 57 kilometres east of Panaji, the state capital of Goa. National Highway 4A divides it into two parts and the Mormugao - Londa railway line passes through the area.

The sanctuary is classified as West Coast tropical evergreen forests, West Coast semi-evergreen forests and moist deciduous forest. The sanctuary's setting in the foothills of the Western Ghats is wonderful and the countryside is one of the most peaceful across in Goa. The sanctuary is rich in wildlife and paradise for bird watchers.

The predominant wild mammals in the sanctuary are tiger, leopard black panther, flying squirrel, barking deer, spotted deer common langur, gaur, wild dog, sambar, porcupine and mouse deer etc., The Popular birds are greater Indian hornbill, large green barbet, grey jungle fowl, Indian black woodpecker, grey-headed myna, Malabar grey hornbill and the Goa state bird Yellow-throated bulbul etc.,

5.8.2 Flora and Fauna in the Study Area

i) Methodology

A list of all macroscopic plants is prepared based on extensive field survey covering the entire project site or core area. Quantitative data on frequency, density, dominance as percent cover etc are noted based on quadrats of 10 x 10 m in case of trees, 2 x 5 m in case of shrubs and 1 x 1 m in case of herbs. Cover is usually estimated by a modified line intercept method where the area occupied by each species is estimated as percentage of total length of a line transect either intercepted or over lain or under laid along with the transect.

Data from field study is recorded in the following Tables:



List of plant species found in the Project area			
Name of plant species	Local name or common name (if any)	Family	
Frequency, density and dominance of different species of plants (separate Table for each quadrat and transect will be maintained)			
Name of plant species	Frequency (recorded as + or - only)	Density as number per quadrat	% cover based on line transects

Relative frequency (R.F), relative density (R.D), relative dominance (R.dom) and Importance value indices (IVI) of different species					
Name of plant species	Frequency		Density		IVI
	%	R.F	%	R.D	

Based on the IVI values, Shannon -Wiener Indices of Diversity was calculated.

Shannon - Wiener Indices of Diversity was calculated as the sum of p^i value of each species multiplied by \ln of p^i using the following equation:

$$H' = - \sum_{i=1}^S p_i \ln p_i$$

Where, p^i is calculated by dividing the IVI of a species by the total IVI of all species in the sampled community.

ii) Vegetation Sampling Instructions followed:

Subject to accessibility, desirability and feasibility, restricted random sampling techniques are used where the number of quadrates in each type of vegetation shall be proportionate to the area under its cover. Non destructive sampling techniques are used. Stratified sampling is used where trees, shrubs and herbs are sampled separately. However, suitable modifications have been made depending on the situation and circumstances. These sampling techniques are suitable if the majority of the sampling area is under natural communities.



iii) Field Study on Flora

The structure and type of vegetation depends on climatic conditions and physiography of an area. Climate of the study area is much suited for the variety of vegetation because of annual averages more than 1000 mm. A floral enlistment of trees, shrub & herbs with their scientific names, common names and the family to which they belong are presented in a tabular format. The floral species and their status with reference to IUCN Red data book has been placed in the Table -5.15. The contents of this subsection are based primarily on reconnaissance survey carried out by the team of AARVEE associates & available information collected from secondary data. A total 12 random line transects were laid to study the flora along the study area with a length of 5 Km each covering entire project stretch. As per the vegetation analysis to determine the species density, abundance and dominance, the plant species *Tectona grandis* known to be dominating over other species with a Shannon wiener index of 2.6.

Table -5.15: List of Floral Species Along With Family Names

S. No.	Local name	Botanical name	Family	Category as per IUCN
1	Khair	<i>Acacia catachu</i>	Mimosaceae	Not Assessed
2	Hewar	<i>Acacia leucocepholea</i>	Fabaceae	Not Assessed
3	Shembi	<i>Acacia pennata</i>	Mimosaceae	Not Assessed
4	Sapota	<i>Achras zapota</i>	Sapotaceae	Not Assessed
5	Asan	<i>Terminalia elliptica</i>	Combretaceae	Not assessed
6	Saguvan	<i>Tectona grandis</i>	Lamiaceae	Not assessed
7	Sal	<i>Shorea robusta</i>	Dipterocarpaceae	Threatened Species
8	Caju	<i>Anacardium occidentale</i>	Anacardiaceae	Not assessed
9	Ambo	<i>Mangifera indica</i>	Anacardiaceae	Data Deficient
10	Asoka	<i>Saraca indica</i>	Fabaceae	Not assessed
11	Bayo	<i>Cassia fistula</i>	Fabaceae	Not assessed
12	Apto	<i>Bahuhinia racemosa</i>	Fabaceae	Not assessed
13	Tamas	<i>Borassus flabellifer</i>	Palmae	Not assessed
14	Awala	<i>Phyllanthus emblica</i>	Phyllanthaceae	Not assessed
15	Boram	<i>Zizuphus mauriliana</i>	Rhamnaceae	Not assessed
16	Char	<i>Buchanania lanzan</i>	Anacardiaceae	Not assessed
17	Ambado	<i>Spondia mangifera</i>	Anacardiaceae	Not assessed
18	Bavaldi	<i>Vitex altissima</i>	Lamiaceae	Not assessed
19	Goting	<i>Terminalia bellerica</i>	Combretaceae	Not assessed
20	Bhedas	<i>Syzygium caryophyllatum</i>	Myrtaceae	Not assessed
21	Gulmohar	<i>Delonix regia</i>	Fabaceae	Least Concern
22	Bhirand	<i>Garcinia indica</i>	Clusiaceae	Vulnerable
23	Chandado	<i>Macaranga peltata</i>	Euphorbiaceae	Not assessed
24	Goinda	<i>Diospyros motana</i>	Ebenaceae	Not assessed



S. No.	Local name	Botanical name	Family	Category as per IUCN
25	Karanji	Pongamia pinnata	Fabaceae	Least Concern
26	Karo	Strychnos nux-vomica	Loganiaceae	Not assessed
27	Datura	Datura stramonium	Solanaceae	Not assessed
28	Jamun	Syzygium cumini	Myrtaceae	Not assessed
29	Kamdali	Rhizophora mucronata	Rhizophoraceae	Not assessed
30	Kusum	Schleichera Oleosa	Sapindaceae	Not assessed
31	Kakad	Garunga pinnata	Burseraceae	Not assessed
32	Kala Siras	Albizzia odoratissima	Fabaceae	Not assessed
33	Vad	Ficus bengalensis	Moraceae	Not assessed
34	Hirda	Terminalia chebula	Combretaceae	Not assessed
35	Palas	Butea monosperma	Fabaceae	Not assessed
36	Taman	Lagerstoemia speciosa	Lythraceae	Not assessed
37	Zamba	Xylia xylocarpa	Fabaceae	Not assessed
38	Pipal	Ficus religiosa	Moraceae	Not assessed
39	Sissum	Dalbergia latifolia	Fabaceae	Vulnerable
40	Siras	Albizzia lebbek	Fabaceae	Not assessed
41	Sitaphal	Annona squamosa	Annonaceae	Not assessed
42	Limb	Azadirachta indica	Meliaceae	Not assessed
43	Gul Mohwa	Bassia latifolia	Sapotaceae	Not assessed
44	Chillar	Caesalpinia sepiaria	Caesalpinaceae	Not assessed
45	Papaya	Carica papaya	Caricaceae	Not assessed
46	Casuarina	Casuarina equisetifolia	Casuarinaceae	Not assessed
47	Coconut	Cocos nucifera	Palmae	Not assessed
48	White silk cotton tree	Ceiba pentandra	Bombaceae	Not assessed
49	Downy	Datura metel	Solanaceae	Not assessed
50	Eucalyptus	Eucalyptus territiconis	Myrtaceae	Not assessed
51	Ashvath	Ficus religiosa	Moraceae	Not assessed
52	Kurule	Garuga pinnata	Burseraceae	Not assessed
53	Haldu	Haldinia cordifolia	Rubiaceae	Not assessed
54	Papra	Holoptelea integrifolia	Ulmaceae	Not assessed
55	Kurat	Ixora arborea	Rubiaceae	Not assessed
56	Shirali	Microcos paniculatus	Tiliaceae	Not assessed
57	Vilayathi	Pithecelobium dulce	Mimosaceae	Not assessed

iv) Survey of Fauna of the study area:

Since the animals with the exception of a few sedentary species and a few residents move from place to place either for feeding or breeding or for shelter etc, it may not be possible to prepare separate lists of fauna for core and buffer zones. The mere absence of a species at the time of sampling does not rule out its presence. In order to overcome such problems, a list based on both primary survey and secondary data is



prepared. The primary survey takes in to account both direct evidence and indirect evidence including the circumstantial evidence. All relevant scientific documents such as the scientific publications, documents and reports are a good source of information provided they are site, area and location specific. Recent reports were taken into considering the species, and in the absence of data and information, reports of eye witness accounts and information from local non governmental organizations are considered. Due attention is paid to rare or endangered or endemic or threatened (REET) species. In order to find out whether a species comes under any of the REET categories, references are made to IUCN Red Data, Indian Wildlife (Protection) Act 1972 and its amendments thereof, Botanical survey of India (BSI) and Zoological Survey of India (ZSI).

v) Faunal Diversity and impact of the project:

The field survey and local consultation with the local villagers a faunal enlisting of birds & mammals with their scientific names and common names is presented. The list of faunal species, the family they belong to and the status of the faunal species with reference to the IUCN red data book and with reference to the Wildlife act 1972 schedules were placed in Table -5.16. The table depicts the animals and birds found in the study area and its adjoining area. However, the faunal species are not having any endangered or extinct species and will not have any adverse impact due to the construction activity in the core Project area. Even after construction phase, the faunal species will not get affected and rather they may increase in number because of the road structures as the project will not obstruct their movement rather can create new habitats for them.

Table -5.16: List of Faunal Species Along With Family Names And Status As Per Iucn And Wildlife Act Schedules in Goa

S. No.	Local name	Scientific name	Family	Status as per Wild life act Schedule	Category as per IUCN
1	Vandor	Presbytis entellus	Cercopithecidae	II	Not assessed
2	Indian robin	Saxicoloides fulcata	Muscicapidae	-	Least concerned
3	Katanoor	Viverricula indica	Viverridae	-	Least Concern
4	Colo	Canisaureus	Canidae	-	Not assessed
5	Mongus	Herpestes edwardsi	Herpestidae	-	Least Concern
6	Bibtto Vag	Panthera pardus	Felidae	I	Vulnerable
7	Khadi Khar	Funambulus palmarum	Sciuridae	-	Least Concern
8	Ran Dukar	Sus scrofa	Suidae	III	Least Concern
9	Baul Manzor	Felis chaus	Felidae	II	Least Concern
10	Vagul	Rousettus leshenaulti	Pteropodidae	-	Not assessed



S. No.	Local name	Scientific name	Family	Status as per Wild life act Schedule	Category as per IUCN
11	Bhalu	Melursus ursinus	Ursidae	II	Vulnerable
12	Shenkaro	Ratufa indica	Sciuridae	II	Least Concern
13	Bhenkaro	Muntiacus muntjak	Cervidae	III	Not assessed
14	Sambhar	Cervus unicolor	Cervidae	III	Vulnerable
15	Koli Undir	Bandicot Indica	Muridae	-	Not assessed
16	Vagati	Felis bengalensis	Felidae	-	Not assessed
17	Pak Mazor	Petaurista petaurista	Sciuridae	-	Least Concern

Measures to compensate removed plants during construction

There are 20,000 nos. of trees needs to be planted along the project corridor. The type of plants to be removed are Asan, Rosewood, Bamboo, Khair, Mango, Neem, Cashew, Casuearina, Betel nuts, Coconut and Eucalyptus. The short-term impact due to felling of trees will be compensated in long term through the proposed plantation programme. The local plant varieties will be identified and the same will be planted along the aqueduct and surrounding areas.

Mitigation Measures:

- Avenue Plantation programme shall be promptly adopted to restore and further enrich the loss of vegetation.
- Avenue Plantation with an appropriate mix of indigenous and specially suited species shall be carried out along the corridor. The number of plants proposed to be planted is 20,000 nos.
- Local plant varieties especially, soil bounding species will be planted near to the constructed aqueduct and also in the surroundings in order to hold the soil tightly.

5.8.4 Study of Aquatic flora and Fauna:

The Phytoplankton, Zooplankton, Macrobenthos, Nekton, Macrofauna, Mangroves and Angiosperms are present in the aquatic flora in the study area. Predominant Mangroves identified in the study area are Rhizophora mucronata, Rhizophora apiculata, Avicennia officinalis, Avicennia marina, Avicennia alba, Sonneratia alba, Sonneratia caseolaris, Ceriops tagal, Aegiceras corniculatum, Derris heterophylla etc. Figure 5.24 is showing the Mangroves near River Mandovi Estuary.



Figure 5.24: Mangroves near River Mandovi Estuary

Aquatic fauna

Crocodylus palustris, Lepidochelyes olivacea, Calotes rouxii, Hoplobatrachus tigerinus, Rana malabarica, Melanochelys trijuga are present in the aquatic fauna in the study area.

5.9 Socio-economic Status (According to 2011 Census)

Population Size	1458545
Population size (Males)	739140
Population size (Females)	719405
Population size (Rural)	551731
Population size (Urban)	906814
Population size (Rural Males)	275436
Population size (Rural Females)	276295
Population size (Urban Males)	463704
Population size (Urban Females)	443110
Population density (Total, Person per sq km)	394
Sex Ratio (Females per 1000 males)	973



Sex Ratio (Rural)	1003
Sex Ratio (Urban)	956

There are two districts falling under the study area namely North Goa and South Goa. The district wise demographic details are given below:

North Goa District:

In 2011, North Goa had population of 817,761 which is roughly equal to the nation of Comoros or the US state of South Dakota. This gives it a ranking of 480th in India (out of a total of 640). The district has a population density of 471 inhabitants per square kilometer (1,220/sq mi). Its population growth rate over the decade 2001-2011 was 7.8%. North Goa has a sex ratio of 959 females for every 1000 males, and a literacy rate of 88.85%.

Konkani is the mother tongue of a majority of the people living in North Goa district. Marathi is spoken by a substantial number of people. English and Hindi are understood by a majority of the population. Portuguese is also spoken and understood by a small number of people.

South Goa District:

In 2011, South Goa had population of 639,962 which is roughly equal to the nation of Montenegro or the US state of Vermont. This gives it a ranking of 515th in India (out of a total of 640). The district has a population density of 326 inhabitants per square kilometer (840/sq mi). Its population growth rate over the decade 2001-2011 was 8.63%. South Goa has a sex ratio of 980 females for every 1000 males, and a literacy rate of 85.53%.

Konkani is the mother tongue of a majority of the people living in South Goa district. Marathi is spoken by a substantial number of people. English and Hindi are understood by a majority of the population. Portuguese is also spoken and understood by a small number of people.

5.9.1 Social Impact Assessment in the Project

i) Land Requirement:

The proposed road improvement including widening involves expropriation of land from the current owners/users. It is assessed that land acquisition would be required only in 35 km. Land acquisition in Wild Life Sanctuary is for 31.01 ha and forests area is for 33.17 ha. With regard to widening, upgradation and improvement of existing alignment. The total extent of land to be acquired including non-forest, forests and



Mahaveer WLS area is estimated to be 136.67ha.

A land acquisition plan is separately prepared for this proposed project. The plan includes land acquisition maps of the affected villages showing proposed right of way and land schedule for the affected survey numbers. The land plan schedules include details like ownership status and the survey numbers with required area. Requirement of Land in Revenue Villages is given in the table no. 5.17.

Table 5.17: Requirement of Land in Revenue Villages

S. No.	Village/ Town	Total Required Land (Sq. mt.)	Total Required Land (Ha.)
South Goa District			
1	Mollem (Option-2)	200	0.020
2	Sangod	7700	0.770
3	Dharbandora	47800	4.78
4	Piliem	46700	4.67
5	Usgao	56100	5.61
6	Candepar	15600	1.56
7	Kurti	20000	2.00
North Goa District			
8	Bandora	98900	9.89
9	Priol	92000	9.20
10	Velinga	3100	0.310
11	Cuncolim	27100	2.71
12	Cundaim	48500	4.85
13	Boma	79400	7.94
14	Adcolna	54500	5.45
15	Corlim	54100	5.41
16	Ella	52600	5.26
Total		704300	70.43

Source: Land Plan Schedule, Aarvee Associates, Hyderabad, 2015-16

ii) Magnitude of Impact on Structure:

Census of all the structures lying within proposed RoW is undertaken to assess the project impact on the population for displacement, resettlement and rehabilitation. As per our preliminary survey it was estimated that about 377 structures consisting of private [residential, commercial, mixed structure(res+com)], government, religious, community and others might be affected by the proposed road. The project affected person may be titleholder or non titleholder e.g., encroacher, squatter, tenant, kiosk owner etc. About 108 structures belonging to non titleholders were found within existing RoW. Of the 269 Titleholders' properties, 63 structures owned by religious and



government would be affected. Of the total likely to be impacted structures, commercial structures constitute a major chunk.

The impact on structures owned by schedule tribe households/community can be ascertained after the completion of census survey exercises. The survey activities are underway and as per firsthand information and discussion with various stakeholders it is reached into conclusion that people belonging to ST community may hardly get affected. Ownership status of the Structure is given in the Table no. 5.18.

Table 5.18: Ownership status of the Structure

Private	Titleholder		Non-Titleholder	Total
	Religious	Government		
206	24	39	108	377

Source: Preliminary Survey Data, Aarvee Associates, 2015-16



CHAPTER -06

ANTICIPATED ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

6.0 ANTICIPATED ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

The Highway development projects exhibit a symbiotic relationship between the environment and development with both positive and negative and reversible and irreversible impacts. The present chapter gives the analysis of the environmental impacts in the proposed project corridor and suggested suitable mitigative measures.

Matrix method will be adopted as methodology for assessment of cumulative impacts on the project. Based on the scoping of the areas and the work being proposed the following key issues were assessed for this project.

- Preservation of aesthetic and landscape of the area to the possible extent
- Effective restoration of borrow area and quarries
- Noise and air quality
- Tree removal and tree plantation
- Sanitation and waste disposal
- Road safety
- Protection of flora and fauna

Road development projects can have impacts or cause impacts in four specific situations as follows:

- Impacts of Location
- Impacts of Project Design
- Impacts during Construction, and
- Impacts when the Road become Operational.

6.1 Impacts of Location

The road stretch has no specific impacts from the location. During this phase, those impacts, which are likely to take place due to the layout of the project, have been assessed.

These impacts are:

- Project Affected People (PAPs)



- Change of Land use
- Loss of trees/forest
- Utility/Drainage Problems
- Impact on Historical and Cultural Monuments
- Impact on Local Transport Facilities

Apart from the clearances, the project road is lack of side drains, inadequate stone pitching near high embankments, up gradation of structures, paved shoulders and protection with the crash barriers near high embankments to be upgraded as per the norms of the Ministry of Road Transport and Highways (MoRTH). Proper care is being taken in the design of the existing corridor to 4/6-laning configuration of the MoRTH standards.

6.2 Impacts Due to Project Design

The engineering design of the road is being prepared incorporating all environmental safeguards. The basic design criteria have been covered in Project Description. The side drains, stone pitching near high embankments, up gradation of structures and protection with the crash barriers near high embankments are being taken care in the design of the project to ensure the 4/6-lane with paved shoulders as per the MoRTH norms.

6.3 Impacts During Construction

Since the construction is dependent on the quality and properties of the available material, the choice of material, particularly the management of borrow pits, assumes importance during construction.

6.3.1 Borrow Areas / Stone Quarries / Sand Quarries

The proposed project corridor requires raw materials from 10 borrow areas, 2 metal quarries and 2 sand quarries. Borrow Areas of Large quantity of earth/ gravel material is required for widening of formation and embankment, necessitating earth / gravel from borrow pits.

Mitigation Measures:

- To avoid any embankment slippage, the borrow areas will not be dug continuously, and the size and shape of borrow pits will be decided by the Site Engineer. Redevelopment of the borrow areas to mitigate the impacts will be the responsibility of the Contractor. The Contractor shall evolve site-specific redevelopment plans for each borrow area location, which shall be implemented after the approval of the Supervision Consultant.



Precautionary measures as the covering of vehicles will be taken to avoid spillage during transport of borrow materials. To ensure that the spills, which might result from the transport of borrow and quarry materials do not impact the settlements, it will be ensured that the excavation and carrying of earth will be done during day-time only. The unpaved surfaces used for the haulage of borrow materials will be maintained properly. Borrowing of earth shall be carried out at locations recommended as follows:

- **Non-Cultivable Lands:** Borrowing of earth will be carried out upto a depth of 2.0m from the existing ground level. Borrowing of earth shall not be done continuously. Ridges of not less than 8m width shall be left at intervals not exceeding 300m. Small drains shall be cut through the ridges, if necessary, to facilitate drainage. Borrow pits shall have slopes not steeper than "1 vertical" in "4 horizontal".
- **Productive Lands:** Borrowing of earth shall be avoided on productive lands. However, in the event of borrowing from productive lands, under circumstances as described above, topsoil shall be preserved in stockpiles. The conservation of topsoil shall be carried out as per the standard procedures. At productive land locations, the depth of borrow pits shall not exceed 45cm and it may be dug out to a depth of not more than 30cm after stripping the 15cm topsoil aside.
- **Elevated Lands:** At locations where private owners desire their fields to be levelled, the borrowing shall be done to a depth of not more than 2m or up to the level of surrounding fields. Borrow pits along Roadside: Borrow pits shall be located 5m away from the toe of the embankment. Depth of the pit should be such that the bottom of the pit shall not fall within an imaginary line of slope 1 vertical to 4 horizontal projected from the edge of the final section of the bank. Borrow pits should not be dug continuously. Ridges of not less than 8m width should be left at intervals not exceeding 300m. Small drains should be cut through the ridges to facilitate drainage.
- **Borrow pits on the riverside:** The borrow pit should be located not less than 15m from the toe of the bank, distance depending on the magnitude and duration of flood to be withstood.
- **Community / Private Ponds:** Borrowing can be carried out at locations, where the private owners (or in some cases, the community) desire to develop lands (mostly low-lying areas) for pisciculture purposes and for use



as fish ponds.

- **Borrow Areas near Settlements:** Borrow pit location shall be located at least 0.8 km from villages and settlements. If unavoidable, they should not be dug for more than 30cm and should be drained.
- Quarries and borrow pits will be back filled with rejected construction wastes and will be given a vegetative cover. If this is not possible, then slopes will be smoothed and depression will be filled in such a way that it looks more or less like the original ground surface.
- During works execution, the Contractor shall ensure preservation of trees during piling of materials; spreading of stripping material to facilitate water percolation and allow natural vegetation growth; re establishment of previous natural drainage flows; improvement of site appearance; digging of ditches to collect runoff; and maintenance of roadways where a pit or quarry is declared useable water source for livestock or people nearby. Once the works are completed, and at own expense of the Contractor, he shall restore the environment around the work site to its original splits.
- To create a safe environment under the terms of The Mines and Quarries Act the faces have to be reduced to a naturally stable slope or be adequately fenced to prevent access to the top and bottom of the faces. Such a fence must be of a height as prescribed under The Mines Act with a barbed wire top strand designed to exclude the public from the quarry area. Depending on the location of the site presence of a permanent lake is considered to be as at is factory alternative to a fence.
- Appropriate plant species for the planting programme have to be selected in consultation with ecological consultant and local forest department. Depending on the limitations on the availability of appropriate plant material, harsh growing conditions (lack of irrigation and hot summer) and ongoing quarry rehabilitation operations there may be substantial loss of plantation and the planting programme may have to be continued for over 3–5 years. As plantings are progressively established they should be monitored before undertaking the next stage to ensure maximum plant survival rates.

6.3.2 Utilization of Fly Ash

Appreciating the overall concern for environmental and management issues pertaining to fly ash, which otherwise is a very useful by-product of thermal power plants, the Technology Information, Forecasting & Assessment Council (TIFAC), Department of



Science & Technology (DST), and Ministry of Environment and Forests (MoEF), Government of India identified "Safe Disposal and Gainful Utilisation of Fly Ash" identified the Highways as one of the thrust area.

There are four Thermal Power Stations identified which fall within 500 Km from the project corridor and their details are given in the below Table -6.1.

Table -6.1: List of Thermal power plants which fall with in 500 km of project stretch

S.No	Name of the power plant	Capacity (MW)	Location	District	State	Distance from Molem(Km)
1	Raichur Thermal Power Station	1720	Raichur	Raichur	Karnataka	423
2	Udupi Thermal Power Plant	122	Nandikoor	Udupi	Karnataka	348
3	JSW Vijayanagar Power Station	860	Vijayanagar	Bellary	Karnataka	323
4	Bellary Thermal Power Station	500	Kudatini	Bellary	Karnataka	320

The total Fly ash requirement during construction for utilizing in embankments etc., is 4,00,000 cum. The same may be met from the nearby or aforesaid thermal power stations. Hence, Utilization of Fly Ash provision is to be made as per the IRC SP:58 – 2001 and Fly ash Notification 2007 and the subsequent amendments in 25th March, 2015. The same shall also be put under the BoQs. Utilization of Fly ash in the highways shows the positive impact on the environment. Utilization of fly ash will not only minimize the disposal problem but will also help convert waste into useful material. Construction of road embankments using fly ash, involves encapsulation of fly ash in earthen core or with RCC facing panels. Since there is no seepage of rain water into the fly ash core, leaching of heavy metals is also prevented. When fly ash is used in concrete, it chemically reacts with cement and reduces any leaching effect. Even when it is used in stabilization work, a similar chemical reaction takes place which binds fly ash particles. Hence, chances of pollution due to use of fly ash in road works are negligible.

6.3.3 Borrow Pit Restoration

Arrangements for opening and using material from borrow pits shall contain enforceable provisions for the extraction and restoration of the borrow area, and their surroundings, in an environmentally sound manner to the satisfaction of the Site Engineer. Areas shall be graded to ensure drainage and visual uniformity, and arrangements shall be made to collect and preserve top soil for use in the excavated



borrow pit sides and bottom to make it green area alternatively, these borrow areas would be sited as far as possible on high grounds or hillocks. Topsoil shall be replaced and the area will be re-vegetated to the satisfaction of the Engineer. The topsoil can also be used for side slope, median covering for the growth of shrubs and grass. Additional borrow pits will not be opened without restoration of those areas no longer in use.

6.3.4 Solid Waste / Surplus Earth

During the construction phase, the quantity of muck generated is approximately 13,00,000 cum and same shall be used for filling up the low-lying areas and some part will be useful for construction of service roads, etc. The top soil shall be kept separately and shall be used for plantation/ landscape development purpose in the project, and also utilized for soil conditioning by the local farmers. An amount of Rs. 9.7 Crore provision is already made in the BoQs for disposal of the same in the project.

6.3.5 Soil Quality

The problems of soil erosion exist in the stretch due to varying topography, erratic rainfall and swift velocities of water in the drains during monsoon.

Top Soil Loss: The loss of fertile topsoil / humus may occur because of the extension of carriageway along the proposed corridor, hence care and precaution need to be taken to preserve the layer and reuse the soil as it contains the humus.

Soil Erosion: It may occur due to the uneven topography and intensity of rainfall. A major problem of erosion may occur due to the removal of age-old trees along the roadside within ROW. The removal will result in the instability of soil binding and soil structure, as uprooting will make the soil loose. Erosion may occur due to the swift velocities of drains in monsoon.

Mitigation measures include periodic maintenance of drains to check scouring of soil and limiting construction activities of culverts and bridges to dry seasons. Measures should be taken to prevent contamination of soil by bituminous material and other chemicals utilized during construction. No agricultural land would be used for borrow areas. The excavated top soil will be properly stored for reuse. In addition to the engineering design the corridor will be planted with trees to support and the strengthen the soil binding capacity.

6.3.6 Impact on water resources and water quality

To prevent accumulation of water by the road side, adequate cross drainage (CD)



structures in the form of culverts with adequate discharge and dream along the road capacity will be constructed. During reconstruction of old cross drainage structures and construction of new ones, diversion is required to aid uninterrupted movement of traffic. Material will not be put in the drainage to avoid blockage and prevent the erosion. This will help in protecting the aquatic ecology. There are 2 major bridges (1-existing and 1-proposed), 14 minor bridges (7-existing and 7-proposed), 350 culverts (175-existing and 175-proposed) are operated for adequate discharge of cross drainage in the project. For the said cross drainage structures, every care has been taken to the safe flow of water towards the downstream.

No permanent impact is anticipated on water quality due to the project. The construction of the project needs partial filling of the tanks roadside which remain dry during non-monsoon. The some of the ponds, wells, and other water bodies fully and partially affected will be accounted as given in Table -6.2.

Table -6.2: List of Affected Tube wells, Ponds, Lakes

Type	Fully Affected	Partly Affected	Total
Tube well /Dug wells	0	0	0
Pond	0	0	0
Lakes	0	0	0

The details of water bodies/ lakes abutting within 500m radius from the project road are given in Table -6.3.

Table -6.3: Details of the Water Bodies/ Lakes Abutting the Project Road

Sl.No	Name of the Water Body/Package	Chainage	Flow Direction	Description
1	Lake	103.500	-	This lake lies on LHS of Project Stretch
2	Stream	115.000	East to West	This stream lies on LHS of Project Stretch
3	Pond	127.400	-	This pond lies on RHS of Project Stretch
4	Stream	134.500	East to West	This stream lies on LHS of Project Stretch
5	Pond	137.100	-	This pond lies on LHS of Project Stretch
6	Pond	137.500	-	This pond lies on LHS of Project Stretch
7	Cambarjua Canal	137.900	East to West	This canal passes under the



Sl.No	Name of the Water Body/Package	Chainage	Flow Direction	Description
				bridge of Project Stretch
8	Pond	138.400	-	This pond lies on LHS of Project Stretch
9	Syngenta Lake	139.590	-	This lake lies on RHS of Project Stretch
10	Carambolim Lake	141.000	-	This lake lies on LHS of Project Stretch

Construction activities may temporarily deteriorate surface water quality in terms of increased turbidity and as well as oil and grease.

The mitigation measures include proper disposal of water and other liquid wastes arising from construction. Stream courses and drains will be kept free from dumping of solid wastes and earth material.

6.3.7 Impact on Air Quality

Road construction will involve earth excavation, backfilling and concreting. Impacts on air during the construction phase could be due to earth excavation, backfilling and transportation of construction materials, D.G sets which may lead to rise in air pollution. However, the impact on ambient air quality will not be significant, since the dust and gases generated is confined to the proposed area and as it will be taken care of by adopting suitable control measures as described in EMP. However, this impact is localized.

Impacts on air during the construction phase could be due to transportation of construction equipment, construction material and road construction activities. Operation of hot mix plants and Asphalt Plants will result in the emission of fumes and obnoxious gases to the environment. Loading/ unloading of construction materials and their transportation, particularly through the unpaved or un-metalled sections of the road may lead to a rise in the ambient SPM and RPM levels. Material handling, spillage may occur during the transportation of construction materials.

Mitigation Measures:

- Hot mix plants shall be located away from the inhabited areas, residential settlements and water bodies.
- Trucks and tippers carrying earth for filling, sand, gravel or stone will be duly



covered with Tarpaulin sheets to avoid spilling.

- Dust level at the construction sites shall be controlled by sprinkling water on haulage roads thrice in a day.
- Construction material, machinery and equipment will be maintained in a good working condition and shall be handled with due precaution and only by trained professionals.

6.3.8 Impact on Noise

The impact of noise levels from the project on the neighboring communities would be anticipated with the increase in vehicles and vary with vehicles speed. The increased noise level is attenuated by vegetative noise barriers. (rows of trees planted). The major sources for noise pollution during construction will be movement of vehicles transporting the construction material to the construction yard and the noise generating activities at the yard itself. The construction equipment with high noise levels, loading and transportation of material near the borrow areas will affect the construction personnel and other humans in the area.

Mitigation Measures:

- The required mitigation measures include location of construction equipment at least 250m away from inhabited areas. In addition construction workers will have to be provided with protection devices like earplugs.
- Other ancillary measures include maintenance of equipment in good condition, proper design of engine enclosures. Project activities shall be coincide with periods when people would be least affected. Construction activities shall be strictly prohibited between 10 p.m. and 6 a.m. in residential areas.

6.3.9 Impact on Biological Environment

The forests of Goa are typical of the Western Ghats (Southern Maharashtra and Karnataka). There is diversity in the forests due to the variation in altitude, aspect, soil characters, slope etc. As per Champion and Seth (1968) Classification of Forest types of India, the forests of Goa fall in the following types:-

- (i) Estuarine vegetation consisting of mangrove species along narrow muddy banks of rivers [4 B/TS1 and 4B/TS2]
- (ii) Strand vegetation along the coastal belts
- (iii) Plateau vegetation confined especially to the low altitude
 - a. Open scrub jungle (5.E7)
 - b. Moist mixed deciduous forests [3B/C2]



- c. Secondary moist mixed deciduous forests [3B/C2/2SI]
- d. Sub-tropical Hill forests [8A/C2]
- (iv) Semi-evergreen and evergreen forest.
 - a. Semi-evergreen forests [2A/C2]
 - b. Lateritic Semi-evergreen forests [2 E4]
 - c. Evergreen forests [1A/C4]

i) Flora

The widening & strengthening of the existing 2-lane road to 4-lane road might require felling of recently planted trees of about 10,000 nos. from the roadside plantation areas. The predominant tree species going to be felled include Asan, Rosewood, Bamboo, Khair, Mango, Neem, Cashew, Casuarina, Betel nuts, Coconut and Eucalyptus. etc. These are all ubiquitous species. The short-term impact due to felling of trees will be compensated in long term through the proposed avenue plantation programme. There are 20,000 nos. of trees proposed to be replanted in the project in the ratio of 1:2 against the trees cut.

It is estimated that there are about 50 Kms (excluding major and minor bridges), Median plantation is proposed with provisions of 333 nos. of plants per kilometer in Wild life sanctuary and provisions of 666 nos. of plants per kilometer in the rest of the stretch. Hence, the estimated median plantation is around 27,445 nos. The median plant proposed in the project are i.e., Bougainvillea, Nerium Oleander, Thevitia Nerifolia, Tabernaemontana Coronaria etc.

Mitigation Measures:

- È An avenue plantation programme shall be promptly adopted to restore and further enrich the loss of vegetation. Plantation with an appropriate mix of indigenous and especially suited species shall be carried out along the corridor. The number of avenue plants proposed to be planted is 20,000 throughout the project stretch including parking areas, toll gates, bus bays and truck laybys.
- È Along the extreme edge of road boundary, fall growing and desert trees such as Bor, Khair, Banyan, Peepal, Neem, Ain, Amla, Char, Thedu, Mahua, Anjan, Bel, etc shall be planted at a distance of 3 m from the outer ROW of the project stretch.
- È In the median, the Flowering plants & shrubs with a height of about 2m shall be proposed to be planted. The plantation in the median will serve, as a barrier against glaring headlights of the vehicular traffic plying in the opposite direction. Further, this will improve the aesthetics of the road. The suggested



plantation in the median is Bougainvillea, Thevita peruviana (Be still tree), Nerium Oleander (Ganneru dwarf) etc.

Mitigation Measures for Bhagwan Mahaveer Wildlife Sanctuary during Construction Phase:

- ➔ Awareness programmes shall be conducted in the command area as well as construction labours in the form of seminars/workshops/exhibitions. An amount of Rs.20.0 lakhs is made in the EMP for this purpose.
- ➔ Define the construction boundary near Sanctuary peripheral area, and shall be provided with hoarding/notice boards/sign boards for the restriction of movement of construction labours/local public.
- ➔ Construction camps shall be put 10 Kms away from the Bhagwan Mahaveer Wildlife Sanctuary boundaries.
- ➔ Mitigation of man versus animal conflict is going to be the important issue that will threaten wildlife in Sanctuary area
- ➔ The construction activity across the reserve forests shall be taken up during day time only.
- ➔ Project Authorities shall make periodic visits to meet Forest authorities to obtain their approval/suggestions during construction and operation of the project.
- ➔ Necessary noise mitigation measures as mentioned above shall be strictly implemented.
- ➔ Vehicles under PUC checkup only be used during construction activities to minimize air emissions.

II) Fauna

Terrestrial Fauna:

During the construction, no impact on the wildlife is anticipated.

Aquatic Fauna:

There are 9 nos. of rivers / lakes / ponds identified in the project stretch of 500m radius, most of them are remain dry during non-monsoon months.

Increasing sediment load to the recipient water bodies i.e. ponds and rivers will restrict the penetration of solar energy in the water body. This will affect photosynthesis of the aquatic flora, which in turn will have adverse impacts on the aquatic fauna. Since most of the water bodies remain dry during the non-monsoon months, this impact will be negligible. But, the implementation of the following measures will help to avoid soil erosion and further minimize the impacts of the aquatic fauna.



Mitigation Measures:

- ➔ Filling up of ponds wherever required shall be done during the non-monsoon months.
- ➔ Construction of bridges and culverts shall be accomplished during the non-monsoon periods.
- ➔ Filling up of ponds will be resorted only after exhausting all other options.
- ➔ The direct discharge of oil and chemical spills to the water bodies shall be avoided.

6.3.10 Impacts on Human Use Values

i) Land Use

Widening & strengthening of the existing highway to 4/6-laning with National highway norms may lead to a change in the land use pattern of areas adjacent to the road. The existing land adjacent to the road at present is mostly of barren, agricultural use and forest area and grazing use which needs to be acquired for widening of the road.

The project corridor is a mix of hilly, highly rolling and plain terrain and thus, no disfiguration of land is envisaged due to construction activities except for the opening up of borrow pits. The borrow pit locations have already been identified and will be restricted to those areas only.

Mitigation Measures:

-  Construction activities shall be limited to the corridor only.
-  Care shall be taken to ensure that the construction workers camp does not disturb the surrounding land use.
-  Existing access/ entrances to the highway shall be duly maintained.
-  The realignment alternatives that are best from Engineering, Environmental and Social aspects are selected for this project.

ii) Flood Characteristics

The project stretch comprises forty two (31) cross drainage existing structures and eight (11) more are proposed to meet the demand. There are two (2) major bridges are existing and two (2) more major bridges are proposed. There are eight (8) minor bridges are existing and one (1) more bridge is proposed. The project stretch are designed for above HFL hence, the flooding in the area can be avoided. The flood characteristics of the project area are given project description. In the proposed



improvement scheme, embankments will be constructed for forming bypasses, construction of ROBs and vehicular underpasses. These may lead to flooding of the project area in the event of unprecedented rains.

Mitigation Measures:

All the structures shall have adequate waterway. The design discharge shall be evaluated for flood of 100 years in case 4 /6 laning is considered in the design of the project.

- Raising of the embankment height above the submergence depth, with provision of balancing culverts.
- Widening and strengthening of the existing cross-drainage structures particularly at the specified locations of submergence.
- Providing drain on both sides of the widened road and extending the drains to a proper outfall.
- Proper supervision during construction to avoid blocking of micro-drainage across the road.
- Maintaining existing drainage outlets.
- Replace inadequate or distressed drainage structures.
- Adequate number of cross drainage structures will be provided along the bypasses.

6.3.11 Impacts on Quality of Life

i. Socio-economics, Land Acquisitions and Re-settlements

Impacts and mitigation measures associated with social environment in the project influence area (PIA), land acquisition and resettlement of project-affected persons (PAP) have been dealt in report.

ii. Accident, Health and Safety

Construction activities will cause hindrance to the existing traffic flow. Thus, short-term impact in terms of accident is anticipated during construction phase of the widening project. Adequate safety measures to be considered during construction phase of the project.

Mitigation Measures:

- Reduce speed through construction zones.



- Construction of bridges/ culverts shall be carried out prior to construction of new corridor at the first stage.
- Proper cautionary signs shall be displayed at construction sites.
- Diversion roads will be provided wherever needed.

iii. Aesthetics and Landscape

The proposed widening of the existing lane to 4/6-lane road will require very partial removal of roadside plantation, which will deteriorate the corridors aesthetic values temporarily. But the proposed plantation all along in long run will improve the aesthetics and landscaping of the corridor. Dis-figuration of the landscape is also anticipated due to opening of borrow pits.

Mitigation Measures

- Mixed plantation shall be carried out at roadside and flowering shrubs shall be planted in the median
- Borrow pits shall be resurfaced with conserved topsoil (borrow pit opening shall be as per IRC 10-1961).
- Plan for controlled development shall be evolved by land planning agencies.
- There shall be proper vigilance to avoid squatter development all along the corridor.

6.3.12 Impacts from Construction Workers Camp

Local labourers shall be employed for the construction activities to the maximum possible number to minimise the production of domestic waste generation. As for this project is concerned, the number of persons to be employed during the peak and average construction period would be around 1000 nos. and 500 nos. respectively. The period of construction is tentatively worked out for 36 months.

Mitigation Measures:

Labourers residing in the camps shall be provided with safe drinking water, adequate sanitation facilities, kerosene/gas and all other amenities as per the prevailing Labour laws. Domestic waste generated will be treated as per IS-2470 norms.

Sanitation and Waste Disposal

Sewage and domestic solid waste generated at the construction workers camp will be properly disposed of to prevent health and hygiene related problems. Adequate sanitary facilities such as pit latrines/water seal latrines will be established based on



the soil conditions in construction camp. Periodical health checkup of construction workers will be undertaken.

6.3.13 Rain Water Harvesting (RWH) Pits

There are 200 nos. of RWH Pits are proposed either side of the road at an interval of 500m. The Rain water harvesting pits are having diameter of 1.5 m with a depth of 3.8 m are proposed in the project. The project stretch was considered about 50 Km excluding settlements, bridge portions, etc. The budget provision for the RWH structures are provided at the rate of Rs. 15000/pit and the total amount is estimated to be Rs. 0.30 Crores.

6.4 Impacts During Operation Phase

6.4.1 Impact on Land use

Road development may lead to establishment of petty shops and other commercial pursuits by the local people. Local statutory bodies will strictly enforce land use. In addition, the project proponent should prevent development of squatters settlements and encroachments on the vacant portions of the RoW of the road.

6.4.2 Impact on Air Quality

During operation phase significant positive impact on the ambient air quality is envisaged due to ease of the traffic and reduction in travel distance. The fuel consumptions and maintenance cost will also come down due to the project. The fuel consumptions are also estimated for the base year (2018), interim year (2033) and ultimate year (2046). The details are given in Table -6.4.

Table -6.4: Fuel Consumptions Without and With Project Scenarios

Year	PCUs	Without Project Scenario		With Project Scenario		Overall Savings	
		Fuel Consumption (KL/Year)	Cost per year (Crores)	Fuel Consumption (KL/Year)	Cost per year (Crores)	Fuel (KL/Year)	Cost per year (Crores)
2018	10507255	56288.5	329.6	41613.5	243.7	14675.0	85.9
2033	31538555	174957.4	1024.5	128353.0	751.6	46604.4	272.9
2046	69466252.5	391316.6	2291.4	285865.3	1673.9	105451.3	617.5

Source: Assessed by M/s. Aarvee Associates, Hyderabad

Overall fuel savings for the base year (2018), interim year (2033) and ultimate year (2046) is estimated to be 14675.0 KL/Year, 46604.4 KL/Year and 105451.3 KL/Year.



Accordingly, the cost saving is estimated to be 85.9 Crores, 272.9 Crores and 617.5 Crores for base, interim and ultimate years respectively. Fuel savings are directly representing the amount of reduction in pollution loads.

In addition to the above, an attempt has been made for the assessment of the reduction of the criteria air pollutants such as CO₂, CO, NO_x, SO₂, PM and HC in the proposed project. The considerable reduction in greenhouse gas (CO₂) for the base year (2018), interim year (2033) and ultimate year (2046) is estimated to be 74665003.0 tonnes/year, 888805660.0 tonnes/year and 4928527511.0 tonnes/year respectively and equivalent amount of Carbon credits will also be anticipated in the project. The other criteria pollutants CO, NO_x, PM and HC for the base year (2018), interim year (2033) and ultimate year (2046) are also estimated to be reduced due to this project. The emissions to be reduced in the proposed metro-rail project are given in Table -6.5.

Table -6.5: Details of the emissions reduced in the project

Year	Average PCUs	Emissions Reduced (Approx.) (Tonnes/Year)				
		CO	NO _x	PM	CO ₂	HC
2018	10507255	1680947	119384	7587	74665003	110182
2033	31538555	20702901	1071487	60485	888805660	1324170
2046	69466252.5	115805082	5428343	293634	4928527511	7365646

Source: Assessed by M/s. Aarvee Associates, Hyderabad

6.4.2.1 Other Direct Benefits:

As per the EIRR Report, the direct benefits of road improvement considered in the study includes vehicle operating cost (VOC) savings for vehicular traffic using the project road, travel time savings for passengers and goods (carried) in transit and accident cost savings. The benefit streams have been computed annually over the 200 year benefit period for all homogeneous sections

i) Vehicle Operating Cost (VOC) Savings:

The unit Vehicle Operating Cost (VOC) by vehicle type and VOC savings section-wise has been computed by the HDM model. The VOC computation takes into account capacity augmentation, pavement characteristics, roughness progression vis-à-vis intervening surface treatment and strengthening policies, traffic characteristics, geometric conditions and vehicle characteristics. The EIRR report assessed the routine and periodic maintenance in the project as given in Table -6.6.



Table -6.6: Routine and Periodic Maintenance

Sl.No	Description	Amount (Rs. Lakhs/Km)
1	Routine maintenance cost for 2 lane with out Paved shoulder (every year)	1.92
2	Routine maintenance cost for 2 lane with Paved shoulder (every year)	2.14
3	Periodic maintenance cost for 2 lane with out Paved shoulder (every 7 th year)	23.52
4	Periodic maintenance cost for 2 lane with Paved shoulder (every 7 th year)	33.60

ii) Time Savings:

The HDM Model has generated average speeds in km/hr by vehicle type, in the existing (without project) and the improved (with project) road conditions. The time savings for passengers and goods (in transit) vehicles have been derived separately. For computing time saving for passengers of cars and buses, a weighted average occupancy was used viz. Car – 4 persons and Bus – 30 persons. The average payloads considered for goods vehicles are: LCV – 6 tonnes, Truck-16.2 tonnes and MAV – 24 tonnes.

The value of time (VOT) for passengers and goods considered in this analysis is based on earlier studies carried out in recent years. For the average car passenger, VOT has been taken as Rs. 52 per hour, and for the average bus passenger it was Rs. 40 per hour. The value placed on time is rather on the conservative side. For goods in transit, time value has been worked out using the inventory cost method, with a 15% interest rate considered as the opportunity cost of capital. The VOT for goods (Cargo) vehicle worked out to Rs. 2.96 per hour for LCV, Rs. 9.10 per hour for 2-axle trucks and Rs. 17.0 per hour for multi-axle vehicles.

iii) Pollution Aspects:

The present baseline levels of other criteria pollutants such as CO, PM10, PM2.5, NOx & SO₂ are below the stipulated standards. At these locations, already realignments are provided to overcome these issue. It is envisaged that due to construction/widening of existing road to 4 lane configuration with adequate no. of realignments may further reduce the pollutant levels by ease the traffic at junctions. however, mitigation's suggested to further improve the corridors air quality are:

- Phasing out of old technology vehicles, regular emission checks, use of fuel-efficient engines, use of catalytic converter and land use control are the measures that are to be implemented by central and state governments to



reduce pollution levels.

- Enforcing the existing emission norms.
- Avenue Plantation on either side of the road with selected plant species capable of absorbing pollutants.
- Provision of road, improvements at intersections and separate truck parking facilities to ensure smooth and uninterrupted traffic flow.

All these facilities shall result in minimizing, stopping and idling of vehicles and thus improving air quality

6.4.3 Impact on Noise Quality

The major source of noise pollution in the project region is due to vehicular movements on the highway and noise in the junctions. The noise impact due to the transportation activity depends on the ultimate traffic volume and the type of the vehicles in operation. The typical base noise levels generated in the corridor are presented in the Chapter -5. To predict the cumulative noise impacts due to the traffic movement, Federal Highways Administration (FHWA) model was used. In this model, traffic characteristics used in predicting future noise levels could make a substantial difference in the results. "Worst hourly traffic noise impact" occurs at a time when truck volumes and vehicle speeds are the greatest have been considered. FHWA model calculates day (L_d) and night (L_n) noise equivalent for each category of vehicle and also the total day night (L_{dn}) due to all kinds of vehicles.

The noise levels are predicted at various locations for different years (i.e., 2015, 2020, 2025, 2030, 2035 and 2040) 'without project scenario' and 'with project scenario'. The predicted noise levels are given in Table -6.7.

'Without project scenario'

From Table -6.7, it is clearly indicated that the predicted noise levels based on model are almost compatible to base noise levels and observed to be slightly higher in some cases for Leq Day and higher in most of the cases for Leq Night, when compared with base noise levels (observed at study area).

In commercial category, the predicted noise levels are mostly matching with the CPCB limits (Leq Day: 65 & Leq Night: 55 dB(A)) and they are start exceeding their base noise levels in the year 2045. The day & night noise levels are 62.9 & 59.1 dB(A) for the year 2040.

In residential category, the predicted noise levels are crossing the CPCB limits (Leq



Day: 55 & Leq Night: 45 dB(A)) from 2015 itself. The day & night noise levels are ranging from 65.3 to 65.3 dB(A) & 62.6 to 62.9 dB(A) respectively in all the locations for the year 2040.

'With project scenario'

From Table -6.7, it is clearly indicated that the predicted noise levels for the horizon years 2015, 2020, 2025, 2030,2035 and 2040 are well within the stipulated CPCB standards for commercial category (Commercial day and night limits of 65 & 55 dB(A)) but crossing the CPCB standards for residential category (Residential day and night limits of 55 & 45 dB(A)) from 2020 in Mardol and from 2035 in Old Goa. In order to reduce the noise levels, a thick vegetation of two rows of plantation is proposed in the project.



Table -6.7: Predicted noise concentrations along the project area

Location/ Chainage	Noise Levels in dB(A)											
	Base Noise Levels Leq day/ Night	Without project (Predicted)						With Project Scenario (Predicted)				
		2015	2020	2025	2030	2035	2040	2020	2025	2030	2035	2040
Km. 96.600	62.2/ 50.6	57.4/ 53.6	58.5/ 54.7	59.6/ 55.8	60.7/ 56.9	61.8/ 58.0	62.9/ 59.1	52.9/49.1	54.0/50.2	55.1/51.3	56.2/52.4	57.3/53.5
Km. 133.000	63.9/ 53.3	59.5/ 57.3	60.7/ 58.5	61.8/ 59.6	63.0/ 60.7	64.1/ 61.8	65.3/ 62.9	55.1/52.8	56.2/53.9	57.3/55.1	58.5/56.2	59.6/57.3
Km. 140.000	59.5/ 48.0	59.2/ 56.7	60.4/ 57.9	61.6/ 59.1	62.9/ 60.3	64.1/ 61.4	65.3/ 62.6	52.1/49.6	53.3/50.8	54.6/52.0	55.8/53.1	57.0/54.3

Note: The base noise levels are extracted from the field study and the predicted noise levels are assessed from the Vehicle population in different stretches of the project.



Noise from construction equipment

Apart from these the utilization of construction machinery/ equipment (hot-mixer, bulldozer, loader concrete mixer, etc) and regular movement of these causes disturbance to the traffic and increases the noise levels and emits a noise ranging from 80 -95 dB. Apart from the vehicles carrying the raw materials will also create the noise than the desired levels. The magnitude of impact shall depend upon the type of machinery being used and the standards of noise emissions for the different equipment used are presented in Table -6.8.

Table -6.8: Equipment Noise Levels (dB(A))

Clearing		Structure Construction	
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 and 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 and Compacting		Landscaping and Clean-Up	
Grader	80-93	Bulldozer	80
Roller	73-75	Backhoe	72-93
		Truck	83-94
PAVING		Front end loader	72-84
Paver	86-88	Dump truck	83-94
Truck	83-94	Paver	86-88
Tamper	74-77	Dump truck	83-94
Source: U.S. Environmental Protection Agency. Noise From Construction Equipment and Operations. Building Equipment and Home Appliances. NJID. 300.1. December 31. 1971			

The noise emission level generated from a source shall increase in distance as per the following empirical formula:

$$SPL2 = spl1 - 20 \text{ Log}_{10} (r2/r1)$$



Where, SPL1 and SPL2 are the sound pressure levels at distance r_1 and r_2 respectively. Considering the emissions of different equipment and the stationary nature of the construction equipment as a point source generating 9 dB(A) at a reference distance of 2m, the computed distance required to meet the permissible limits during day time for different land use categories are given in Table -6.9.

Table -6.9: Required distance from Stationary source for meeting standards.

Category	Permissible limit (Day time)	Distance Required(M)
Silence zone	50dB(A)	200
Residential	55dB(A)	113
Commercial	65dB(A)	36
Industrial	75dB(A)	11

The mitigation measures can be taken by attenuating noise levels providing vegetation noise barrier (by absorbing technique) which can reduce 5 – 6 dB (A). Most of the villages are 50- 60 m away from the C/L of the road. But prediction has been done at 25 – 30 m from the centre line. Thus doubling of distance between sources to the receptor shall enable to reduce noise level by 5-6 dB (A). Thus the noise level at village shall be about 55 dB (A) which is the permissible limit and in the junctions the noise barriers shall be suggested.

6.5 Accident Hazards and Safety

In North Goa, from 2011 to 2015, a total of 675 accidents ranging from Fatal, Grievous to Slight and Minor took place in Panaji; similarly, a total of 141 accidents happened in Old Goa; a total of 278 (highest among all the places in North Goa) accidents happened in Agacaim; a total of 257 accidents occurred in Valpoi; totals of 201, 39, 262, 82, 22 at Mapusa, Anjuna, Provorum, Pernem, Bicholim respectively.

In South Goa, from 2011 to 2015, accidents ranging from Fatal, Grievous to Slight and Minor took place in different junctions. A total of 662 accidents, the highest in Goa, happened in Ponda. Totals of 173, 272, 45, 16, 43, 372 and 47 at Kollem, Margao, Curtorim, Quepem, Curcholem, Verna and Marmugao respectively.

Major accident prone spots are located in Ponda, Verna, Agacaim, Margao, Provorum and Valpoi. Near KTC Bus Stand of Panaji and Litan Junction of Verna are the most accident prone spots.

Accident hazards would be greatly reduced because of construction of 4/6-laning of



proposed realignments will ensure smooth and fast flow of traffic. In the event of spillage of hazardous chemicals a spillage containment mechanism will be developed along with the participation of police and the fire department. In addition to this an emergency response mechanism should be evolved to tackle accidents and spillage of substances.

6.6 Aesthetics

There are zero nos. of bus bays existed and 20 locations (Both sides) are proposed. There is 1 no. of Toll plazas proposed. Junctions development with landscape, median plantation in 4/6-lane road and avenue plantation along the project will improve the aesthetics of the project. The public amenities and parking place for long distance travelers have been provided for in the project design.

6.7 Evaluation of Impacts

The environmental impact of a project depends both on the project activities and on the background environmental setting. The environmental impact assessment process involves four basic steps:

- Identification
- Evaluation
- Interpretation
- Communication

For the present project, the matrix method is used for assessment of impacts. In the present case the impact, a scale of -4 to +4 is taken. This method is selected because it identifies the impact of each project activity on each of the environmental attributes. Evaluation and interpretation of impacts is mostly subjective and convey a holistic view of the environmental impact of the project.

Matrix Method

The matrix used for EIA consists of project activities on the x-axis and the environmental attributes likely to be affected by these activities on the y-axis. Each cell of the matrix represents a subjective evaluation of the impacts of a particular activity on a particular attribute in terms of magnitude and importance. A blank cell indicates no impact of the activity on the component. The magnitude (M) is represented by a number from 1 to 4,

Where,



- 1 = minimal 2 = appreciable
3 = significant 4 = severe

Positive sign (or no sign) indicates beneficial impact and negative sign indicates adverse impact. The importance (I) of the impact is given on a scale of 1 to 4 in each cell. This number indicates relative importance of the impact of the activity on the concerned attribute for this project. The magnitude and importance are multiplied to get a score of each cell. The score of individual cells in each row are added to determine the total impact of the project activities on each attribute. Similarly, the score in individual cells in each column are added to determine the total impact of each activity on all the environmental attributes likely to be affected. The grand total of all cells indicates the total project impact.

Since both 'M' and 'I' vary from 1 to 4, the total score in each cell can theoretically vary between -16 to +16. Therefore the total project impact can vary between (-16 x total number of cells in the matrix) and (16 x total number of cells in the matrix). To compare score from matrices containing different number of cells, the total project scores can be normalized to a scale of 100 as follows

Total project impact scale of 100 = ((Total project impact computed by matrix)/ (16 x total number of cells in the matrix)) X100

On this scale, the overall impact can be classified as follows:

Total project impact (Scale of 100)	Magnitude of impact
-100 to -75	Severely adverse
-75 to -50	Significantly adverse
-50 to -25	Appreciably adverse
-25 to 0	Minimally adverse
0 to 25	Minimally beneficial
25 to 50	Appreciably beneficial
50 to 75	Significantly beneficial
75 to 100	Extremely beneficial

6.7.1 Evaluation for Alternative Scenarios

EIA without EMP

This scenario was based upon the assumption that the proposed development would go ahead without any environmental management options being implemented. The



total project impact for the scenario, as can be seen in Table -6.10, was found to be - 80 on a scale of (+/-) 1344. The score on a scale of (+/-) 100 for this scenario was found to be -5.95, which is on the minimally adverse side. This shows that if the project goes ahead without an EMP, the adverse impact on the existing environment would be several times that of the impact without the project. Thus, the EMP described in Chapter -8 will have to be implemented to minimize the potential negative impact due to the proposed activity.

EIA with EMP

If the environmental management strategies discussed in Chapter -8 is fully implemented, the adverse impact of the project would be reduced, and there will be an overall improvement in physical, chemical, biological and socio-economic environment of the region. This is reflected in the total project impact score of +55 on scale of (+/-) 1536, as shown in the Table -6.11 below, for this scenario. The score on a scale of (+/-) 100 for this scenario was found to be +3.58, which is on the beneficial side. Therefore, the proposed activity will be beneficial for the environment of the area, provided the EMP is in place.

It is clear from the above, that the proposed road development project would have negative effect without implementing certain environmental management strategies. If EMP, as discussed in the Chapter-8, is strictly adopted and implemented, the adverse impacts will be reduced and the overall environmental quality of the area would improve.



Table 6.10: Impact Assessment for the Proposed Project (EIA WITHOUT EMP)

Environmental components likely to be affected	Project activities likely to affect environmental components								
		Site preparation/Resettlement and Rehabilitation	Construction/other activities	Transportation construction materials	Solid waste generation and its handling.	Traffic escalation	Waste water generation	Post construction and operational phase	Total impact component
Air quality	M	-2	-2	-1	-1	-1		-2	-16
	I	1	2	2	2	2		2	
Noise and Vibration	M	-2	-3	-1	-1	-2		-3	-21
	I	1	2	2	1	2		2	
Surface water quality	M	-1	-1	-1	-1		-1	-2	-11
	I	1	2	2	1		1	2	
Ground water quality	M		-1		-1		-1	-1	-5
	I		2		1		1	1	
Soil quality / erosion	M	-1	-2	-1	-1	-1	-1	-1	-10
	I	1	2	1	1	1	1	1	
Land use pattern	M	-2	-2	-1	-1			-2	-14
	I	2	2	1	1			2	
Flora and Fauna	M	-2	-2	-1	-1			-1	-12
	I	2	2	1	1			2	
Aesthetics	M	-1	-2	-1	-1			-1	-11



Environmental components likely to be affected	Project activities likely to affect environmental components								
		Site preparation/Resettlement and Rehabilitation	Construction/other activities	Transportation construction materials	Solid waste generation and its handling.	Traffic escalation	Waste water generation	Post construction and operational phase	Total impact component
	I	1	2	2	2			2	
Safety	M		-2	-2	-1	-2		-2	-17
	I		2	2	1	2		2	
Human health	M	-1	-1	-2	-1	-1	-1	-1	-11
	I	1	2	2	1	1	1	1	
Socio-economic status	M	1	2	1	1	1		3	19
	I	1	2	2	1	2		3	
Economy, trade and commerce	M	2	2	2	1	2		3	29
	I	2	3	2	2	2		3	
Total Action Impact		-11	-26	-13	-9	-6	-4	-11	-80

I = Importance, M = Magnitude; Impact scale: 1 = Minimal, 2 = Appreciable, 3 = Significant, 4 = Severe. Positive sign (or no sign) indicates beneficial impact, Negative sign indicates adverse impact, Blank indicates no impact



Table -6.11: Impact Assessment for the Proposed Project (EIA WITH EMP)

Environmental components likely to be affected	Project activities likely to affect environmental components									
		Site preparation/ Resettlement and Rehabilitation	Construction /other activities	Transportation construction materials	Solid waste generation and its handling	Traffic escalation	Waste water generation	Greenbelt development	Post construction/ Operational phase	Total impact component
Air quality	M	-1	-2	-2	-1	-1		1	-1	-6
	I	1	1	1	1	1		2	1	
Noise and Vibration	M	-1	-2	-2	-1	-1		2	-1	-4
	I	1	1	1	1	1		2	1	
Surface water quality	M	-1	-2	-1	-1	-1	-1		-1	-8
	I	1	1	1	1	1	1		1	
Ground water quality	M		-1		-1		-1		-1	-4
	I		1		1		1		1	
Soil quality / erosion	M	-1	-1	-1	-1	-1	-1	2		-3
	I	1	1	2	1	1	1	2		
Land use pattern	M	-2	-2	-1	-1			2	1	-6
	I	2	2	1	2			2	1	
Flora and Fauna	M	-2		-1	-1	-1		2	1	-2
	I	2		1	1	1		2	1	
Aesthetics	M	-1	-1	-1	-1			2	2	4



Environmental components likely to be affected	Project activities likely to affect environmental components									
		Site preparation/ Resettlement and Rehabilitation	Construction /other activities	Transportation construction materials	Solid waste generation and its handling	Traffic escalation	Waste water generation	Greenbelt development	Post construction/ Operational phase	Total impact component
	I	1	1	1	1			2	2	
Safety	M		-1	-1		-1			-1	-4
	I		1	1		1			1	
Human health	M	-1	-1	-1	-1	-1	-1	2		-2
	I	1	1	1	1	1	1	2		
Socio-economic status	M	3	3	3	2	2		2	4	43
	I	2	2	3	1	2		2	3	
Economy, trade and commerce	M	3	3	3	2	2		2	4	47
	I	2	3	2	2	3		2	3	
Total Action Impact		-2	0	3	-4	3	-4	34	25	55

I = Importance, M = Magnitude; Impact scale: 1 = Minimal; 2 = Appreciable; 3 = Significant; 4 = Severe. Positive sign (or no sign) indicates beneficial impact, Negative sign indicates adverse impact, Blank indicates no impact



CHAPTER -07

RISK AND DISASTER MANAGEMENT PLAN

7.0 RISK AND DISASTER MANAGEMENT PLAN

India has been traditionally vulnerable to natural disasters on account of its unique geo-climatic conditions. Floods, droughts, cyclones, earthquakes and landslides have been a recurrent phenomenon. About 60% of the landmass is prone to earthquakes of various intensities; over 40 million hectares is prone to floods; about 8% of the total area is prone to cyclones and 68% of the area is susceptible to drought. In the decade 1990-2000, an average of about 4344 people lost their lives and about 30 million people were affected by disasters every year. The loss in terms of private, community and public assets has been astronomical.

At the global level, there has been considerable concern over natural disasters. Even as substantial scientific and material progress is made, the loss of lives and property due to disasters has not decreased. In fact, the human toll and economic losses have mounted. It was in this background that the United Nations General Assembly, in 1989, declared the decade 1990-2000 as the International Decade for Natural Disaster Reduction with the objective to reduce loss of lives and property and restrict socio-economic damage through concerted international action, especially in developing countries.

In the case of earthquakes in India, there is a need to adopt a multi-dimensional endeavor involving diverse scientific, engineering, financial and social processes; the need to adopt multi-disciplinary and multi-sectoral approach and incorporation of risk reduction in the developmental plans and strategies.

Risk assessment is the determination of quantitative or qualitative value of risk related to a concrete situation and a recognized threat (also called hazard). *Quantitative risk assessment* requires calculations of two components of risk (R):, the magnitude of the potential loss (L), and the probability (p) that the loss will occur. Acceptable risk is a risk that is understood and tolerated usually because the cost or difficulty of implementing an effective countermeasure for the associated vulnerability exceeds the expectation of loss

The proposed project is also vulnerable to the various risks and the disasters in the project stretch as well as in the region. A project study has been made and assessed



the project specific Risks and Disaster Management Plan in the report.

The report contains the findings of the study to identify risks, identification of most likely risks, health and Environmental hazards/Impacts along the Right of Way (RoW) & possible natural and manmade disasters happening in the project area and suggesting suitable remedial measures in all stages of the project i.e. Design phase, Construction phase, and Operation phase and preparation of Disaster Management Plan.

The objectives of the study are:

- Identify the hazards
- Decide areas of hazards in the project and how it shows impact.
- Evaluation of risks and decide on precautions
- Record of findings and its implementation
- Assessment of hazards likely likely happening due to result from the proposed project and suggesting suitable mitigation measures.
- Preparation of Disaster Management Plan in order to support in the event of road accidents (major road mishaps, gas tanker explosions, fire hazards etc.) and natural calamities (floods, cyclones, earth quakes etc.).

7.1 Natural Disaster Encountered in the Region

As far as Goa is concerned, two types of disasters are being experienced by the State i.e. 1) Natural Disaster like Earthquake, Floods / Heavy rains, Cyclones, Landslides, Tsunami and 2) Man-made Disaster like Oil spill in the Sea / Land, Gas leakage, Explosives, Mine collapse, etc. South Goa District is comparatively safer District in terms of human and property loss in disasters. The disasters caused in South Goa are mainly floods, landslides, accidents, fire to markets, property and crops, gas leak and cyclonic winds and tree fallings. As the problems are identifiable the solutions are easily traceable. Out of six disasters five can be avoided, loss accrued in one i.e. cyclone can be mitigated. The brief history of floods/ cyclones/ Drought / Earthquakes in the region are given in Table -7.1.



Table 7.1: History of Floods/Cyclones/Landslides/Earthquakes in the region

Natural Disasters	Past History	Vulnerable Area
Floods	2000 Bicholim 2005 Mala, Panaji and Bicholim 2007 Bicholim	North Goa
Cyclones	2009 Cyclone Phyan	Full of North Goa
Landslides	2007 (Monsoon)	Mapusa-Panaji NH-17
Earthquakes	1967 Koyna earthquake 1993 Latur earthquake	No casualties were taken place

7.1.1 Floods:

A number of large and small river systems drain the district and the gradient and topography of the region combined with heavy monsoons and high tide conditions caused flooding and water logging in quite a few places. The occurrence of cyclones / floods, however, is restricted to the monsoons only. The impact of cyclonic winds is felt towards the onset of the monsoons in April end and May and again towards the flag and around September/October.

It is a natural principle that water seeks its own level and water always flows down from higher latitude. But due to ignorance and lack of planning by the stakeholders the issue of rising in water level catches fire. It is observed that in towns the settlements are developed irrespective of the natural watercourse and consideration of low-lying areas. As such with the first monsoon rains the water is unable to flow downwards and gets accumulated then increases in level, thereby entering in the residences and shops thereby causing floods. In villages the natural course of stream, nallah etc. is blocked due to slit, trees, and other debris thereby causing rise in flowing water and inundating the low lying area wherein the localities gets cut off from rest of the World. Apart from the property loss what is of more concern is the probability of spreading of epidemics and other water borne diseases. The cause and effect of the floods though are devastating, can be controlled to reduce the loss, if not eliminate this disaster.

The North Goa district had not experienced any major floods in past few years, except in 2000 at Bicholim; 2005 at Mala, Panaji and Bicholim and in **2007 also in Bicholim**



due to verflowing of rivulet, causing no major casualties but causing heavy damages to the properties. As far as North Goa District is concerned, there are 3 main rivers viz. Terekhol, Chapora and Mandovi, besides one minor river Baga. The river Mandovi has 10 tributaries viz. Madei, Surla, Kotrachi, Ragda, Khandepar, Kudnem, Valvanta, Bicholim, Assonora and Sinker. Bicholim and Sattari Talukas are mainly affected due to floods due to River Valvonti, whereas the other Talukas of Tiswadi, Bardez, Pernem and Ponda are flooded either due to low lying areas or due to temporary rise in water level of nearby rivulets.

7.1.2 Cyclone

Tropical cyclones are considered to be the worst among all the natural hazards when viewed in terms of their severity, frequency of occurrence and areas of destruction. It is noted that severe cyclones cause colossal damage not only to non-engineered buildings such as thatched roofs, tiled houses, etc., but also inflict heavy damage to semi-engineered buildings such as school, work shop buildings, factory buildings, etc. and also to well-engineered structures including communication towers and wind mill towers etc. An important aspect of cyclone risk reduction is to ensure availability of adequate numbers of shelters, community centers/school buildings, places of worship etc. This can be utilized for moving the vulnerable people to safety.

Additionally, both the areas along coastline and interior regions can be affected by gusty winds which can cause damage to property, damage to crops, collapse of trees and in turn threatening lives of people including fishermen, livestock, ships and barges, boats, ships, fishing trawlers at ports. If cyclonic winds are accompanied by heavy rainfall then there is possibility of flooding in low lying areas, in Goa

7.1.3 Earthquakes in the Region

Goa falls in seismic zone IV that indicates that Goa has high probability for occurrence of earthquakes. Goa forms part of the moderate seismic zone in the country, namely, Zone IV of seismic zoning map of India. Though Goa has not directly witnessed any earthquake it was affected by tremors from devastating earthquakes from neighboring state.

Although Goa has not witnessed earthquakes directly, the tremors of the devastating earthquakes with magnitude 5.0 or more that hit "Koyana" and "Latur" in Maharashtra in the year 1967 and 1993 respectively, affected the routine life of the people in Goa as many of the residential as well as public structures, infrastructures were damaged severely, although no casualties were taken place.



Earthquake Disaster Vulnerability of North Goa

Although the vulnerability is low, towns are more at risk than rural areas due to higher density of population. Another concern is the large numbers of building both private and public have been constructed without proper earthquake resistance features. Goa being a tourist location has a number of heritage sites (No. of listed heritage buildings is 431 as per Town and Country Planning Department Notification) that need to be made earthquake resistant

7.1.4 Soil Erosion

Coastal erosion, or coastal instability, threatens property and businesses and puts people living near cliffs and shorelines at risk. The great concentration of national resources in coastal zones makes it imperative that coastal change is well understood.

Along the coastline of Goa, sea /coastal erosion has been observed on the beaches Siolim, DonaPaula, Anjuna beach. Additionally, according to a study by the National Institute of Oceanography, the beach along the Candolim-Sinquerim coast has been affected by erosion due to the grounded super tanker M.V. River Princess.

7.1.5 Landslides

Landslides are another common disaster experienced. Usually the landslides occur at the sites that are disturbed by human activities. Though the landslides are reported in forests lands it has less concerned than the one in settlement area thereby putting the human life at stake. Geologists have opined that the reckless hill cutting in the most unscientific manner results in landslides. When proper gradient is not maintained the inter-locking of the boulders and the hold of the soil loosens resulting into sliding of the boulders, erosion of soil and uprooting of the trees. And the structures that are within the purview are destroyed. The worst affected is the life and property, but what also gets disturbed is the pure drinking water, power supply, telecommunication, and if the landslide occurs during the monsoon then there is a fear of spread of epidemics.

Incidences of Landslides in Goa (no year)

Sr. No.	Taluka	Location	Severity of Landslide
1	Tiswadi	Aradi, St. Cruz.	Low
2	Bardez	Nerul	Low
3		Malim, Betim	Low
4		Gaunswada, Mapusa	Low
5		Alto Betim, Mapusa-Panaji NH-17, Near Mandovi Bridge	High
6	Pernem	Vaidongor	Low



The landslides specified at 1 to 4 and 6 above were of low nature as far as the severity is concerned. In this case, some boulders had slide down towards the residential structures / school buildings thereby causing severe damages to the structures. However, the landslide that took place on Mapusa–Panaji NH-17 during the monsoon, 2007 was of high severity as the vehicular traffic on this road was obstructed almost for a month.

7.2 Risk Assessment & Mitigation Measures

Risk assessment is a process that seeks to estimate the likelihood of occurrence of adverse effects as a result of poor design, congested roads, in adequate vehicular underpasses, pedestrian underpasses, road furniture, RoBs, sharp curves, major road mishaps, gas tanker explosions, fire hazards, floods, cyclones, earth quakes etc. in the proposed widening and strengthening of Highway project. Fatality rate on Indian highways is very high mainly due to road accidents associated with the above said issues. The other adverse impacts due to gas tanker explosions, fire hazards, floods, cyclones, earth quakes etc. are nominal.

Every care has been taken during the design stage itself for elimination of the risk or hazard (avoidance of accidents) is given prime importance and Ministry of Road Transport & Highways (MoRTH) has also introduced many safety provisions in the design of highways are:

- Identification of risk prone areas,
- Underpasses & other grade separators at congested junctions,
- Service roads in towns & villages for segregating local and through traffic.
- Other design and safety issues of the project
- Traffic control devices / Road safety devices / Road side furniture

7.2.1 Major Risk Prone Areas

The major risk prone areas identified in the project with respect to the poor design, congested road, junction development, major settlements causing various accidents in the project stretch between Anmod to Panaji corridor is given in table no.7.2

Table -7.2 : Major settlements along the project stretch

S. No.	Name of Township	Location (Km)		Length (m)
		From	To	
1	Mollem	96.300	96.900	0.6



S. No.	Name of Township	Location (Km)		Length (m)
		From	To	
2	Ponda	125.000	125.400	0.4
3	Farmagudi	126.400	127.100	0.7
4	Mardol	130.300	131.000	0.7
5	Cundaim	134.100	135.000	0.9
6	Boma	135.000	136.400	1.4
7	Muslimwada	136.400	137.100	0.7
8	Corlim	139.200	141.300	2.1
9	Ella	141.300	141.900	0.6

7.2.2 Underpasses and other grade separators at congested junctions

The existing situation of the highway is short of the underpasses (vehicle underpasses, pedestrian/ animal underpasses), road over bridges in the various stretches of the project and the same are not meeting the criteria of IRC:SP:87-2010. Hence, these issues are considered as a road hazard for the users. The same was studied with respect to the requirements and guidelines of the project as given below:

- The road stretch carrying an average daily traffic of more than 5000 Passenger car units shall needs to provide an underpass or overpass depending upon the nature of terrain, vertical profile of road, availability of Right of Way. See that the approach road gradient shall not be steeper than 1 in 40.
- The cattle and pedestrian underpass shall not be provided within a distance of 2 Km from the vehicular underpass.
- The 1 no. of pedestrian underpass/ overpass shall be provided within a distance of 200m from school or hospital or factory / industrial area.
- The RoB shall design as per the norms of the Railways and get approval of all the designs & drawings from the railway authorities.
- In order to overcome the shortage of underpasses in the project, there are 11 number of vehicular/ pedestrian /animal underpasses are proposed in the project. The details of the underpasses proposed in the project are given in Table -7.3.



Table -7.3: Details of the underpasses proposed in the project

Sl No.	Existing Chainage (Km)	Design Chainage (Km)	Span / Opening (m)	Underpass	Remarks
1	96.612	96.610	1 x 20.0 x 5.5	VUP	MDR-33
2	102.950	102.830	1 x 10.5 x 4.5	LVUP	Local
3	112.630	112.427	1 x 20.0 x 5.5	VUP	Sugar Factory
4	114.380	114.160	1 x 20.0 x 5.5	VUP	SH-3
5	126.375	125.380	1 x 20.0 x 5.5	VUP	Link road to NH-17B
6	131.800	130.630	1 x 12.0 x 5.5	VUP	Mardol-Priol
7	133.410	132.164	1 x 20.0 x 5.5	VUP	Mangesh Temple Road
8	135.616	134.370	1 x 20.0 x 5.5	VUP	Local
9	138.950	137.750	1 x 20.0 x 5.5	VUP	MDR-29
10	142.650	141.200	1 x 10.5 x 4.5	LVUP	Urban, near ROB
11	144.080	142.600	1 x 40.0 x 5.5	VUP	MDR-1, Railway Station Road

7.2.3 Construction of Vehicular Underpasses

As per four laning manual IRC: SP87 under pass structures shall be provided at the intersection of the project highway with all the National Highways/State Highways and also be provided across other category of roads carrying an average daily traffic of 5000 PCUs. There are 11 Vehicular underpasses proposed along the project corridor.

7.2.4 Service roads in towns and villages for segregating local and through traffic.

The main purpose of the service roads in highways are access the local traffic and cross traffic through service roads which shall be provided on both sides of the main highway and interconnected through underpasses, overpasses or grade separators and minimise the risk of accidents on the highway. As the project is taken up for 4-lane with paved shoulders, built up sections have been proposed with service roads. During the study such locations are identified and provided the service roads in the project and given in Table -7.4.

Table -7.4: Details of the Service roads proposed in the project

S.No	Existing Chainage (km)		Design Chainage (km)			Slip/Service Road
	From	To	From	To	Length	
1	96.170	96.970	96.300	97.080	0.780	Slip Road



S.No	Existing Chainage (km)		Design Chainage (km)			Slip/Service Road
	From	To	From	To	Length	
2	102.700	103.300	102.550	103.100	0.550	Slip Road
3	108.600	110.700	108.400	110.600	2.200	Slip & Service Road
4	112.250	113.300	112.050	113.080	1.030	Slip Road
5	114.000	114.950	113.750	114.750	1.000	Slip Road
6	116.000	118.000	115.350	117.350	2.000	Service Road
7	125.000	125.600	125.000	125.600	0.600	Slip Road
8	125.600	126.220	125.600	126.220	0.620	Slip Road
9	126.220	127.700	126.220	127.700	1.480	Service Road
10	129.980	130.690	130.250	130.960	0.710	Slip Road
11	130.690	133.000	130.960	131.710	0.750	Service Road
12	133.000	133.890	131.710	132.600	0.890	Slip Road
13	135.000	136.500	133.865	135.390	1.525	Slip & Service Road
14	136.700	138.300	135.390	137.100	1.710	Service Road
15	138.700	139.400	137.100	137.725	0.625	Slip Road
16	140.300	140.700	139.600	141.070	1.470	Service Road
17	140.700	141.400	141.070	141.900	0.830	Service Road

7.2.5 Construction of Pedestrian Underpasses

It is proposed to prevent direct access from cross roads to the project road, through a judicious combination of service roads and pedestrian underpasses with 4.0 m vertical clearance and 10 m horizontal clearance. The extra cost on account of such underpasses will be more than justified by way of decrease in the number of accidents that would have otherwise occurred in the event of direct access. There are 0 Pedestrian underpasses proposed along the project corridor.

7.3 Other Design Considerations for Mitigation of Risks

7.3.1 Construction of Bypasses

No bypasses have been proposed for the Project.

7.3.2 Median Openings:

Median openings of not less than 20 m are provided in the project for emergency and for repair / maintenance with a detachable guard barrier at a spacing of 5 Km.

7.3.3 High Embankment:

Embankment with height 6m or above shall be designed in accordance with IRC:75 taking into account of slope stability, bearing capacity, consolidation, settlement and safety considerations of the structure and adequate safety delineators proposed in the



project as per the IRC:SP-55

7.3.4 Sight Distances

To avoid unwarranted accident, it is necessary to provide adequate sight distance to permit the drivers enough time and distance to control their vehicles. The safe stopping sight distance, intermediate sight distance and overtaking sight distance are shown below in Table -7.5.

Table-7.5: Sight Distance Standards

V (Km/h)	Safe stopping distance (m)	Intermediate sight distance (m)	Overtaking sight distance (m)
20	20	40	-
25	25	50	-
30	30	60	-
40	45	90	165
50	60	120	235
60	80	160	300
65	90	180	340
80	120	240	470
100	180	360	640

The Intermediate sight distance of 360 m is followed for the present project.

7.3.5 Horizontal Alignment

IRC:38 – 1988 is being followed for design of Horizontal alignment.

7.3.6 Vertical Alignment

IRC: SP:23 – 1983 is being followed for design of vertical alignment.

7.3.7 Gradients

The gradients is being maintained in the design are as per guidelines of the manual.

7.3.8 Combination of Horizontal and Vertical Curves

Where the curves cannot separate entirely, the vertical curves are contained wholly within, or kept wholly outside the horizontal curve. The length of horizontal and vertical curves is kept same and the chainages of their centres made to coincide in the design process. Sharp horizontal curvature is well avoided at or near neither top of crest of vertical curve nor the same is introduced at or near the low point of a sag vertical curve. Horizontal alignment and profile are made as flat as possible at intersections, where sight distance is very important.



7.3.9 Drainage Design, Slope protection & New Culverts

Trapezoidal shaped open drain will be proposed near embankment toes. On hill side of mountainous sections. "V" shaped drains lined with PCC will be provided. At high embankments (height exceeding 3m) a system of kerbing at edge of paved shoulders and chuting at 25m intervals is proposed to safely dispose off surface water to avoid erosion. For intra-pavement drainage, it is proposed to extend the sub-base layer upto edge of embankment slopes. In the super elevation sections, a drain in the median will be constructed and the openings are provided at regular intervals to collect water. This water will be discharged by providing suitable outfall.

Slope protection in the form of turfing will be proposed on all the embankment slopes. Pitching will be proposed at the toe where the height of embankment is more than 3m. Chutes will be proposed to drain off water in case of high embankments.

Planning for New Culverts

- Weak and distressed culverts to be dismantled. Totally new culverts to be constructed with carriageway and median matching with highway plan and profile drawing.
- Culverts in service road locations to be extended up to the road side longitudinal drain.
- The design invert levels of the existing culvert after widening would be compared with that of the prevailing invert level on the ground. If the design invert level falls below the existing invert level then the existing culvert would be proposed to be replaced with another.

7.3.10 Traffic Control Devices / Road Safety Devices / Road Furniture

Traffic control devices / road safety devices / road side furniture shall comprise of road signs, road markings, object markers, hazard markers, studs, delineators safety barricades etc proposed in the project.

Road Signs (Danger boards/ Speed limits/ other hazardous indicators)

All signs shall be placed on the left hand side of the road. Where extra emphasis is warranted, they may be duplicated on the right hand side as well. On non-kerbed, the extreme edge of the sign shall be 1.5m-2.0m from the edge of the carriageway. On kerbed portion, it shall not be less than 60cm from the edge of the kerb. Arrangement for proper surveillance by PWD Goa authority personnel after the expiry of the maintenance period by the construction agency.



Road Marking

Provisions have been made for centre and edge road marking with thermo-plastic paint as per MOST specification in preference to ordinary paint as a way of better caution to the driving motorist. This would help reduce road accidents. Border/Edge lines shall also be marked on both sides of the carriageway along with the Centre line. Road studs shall also be provided with pavement marking.

Road Delineators

Provision of road delineators has been made in the design that shall comprise roadway indicators, hazard makers and objects makers. The design shall conform to the recommendation made in IRC-79. Reflective Chevron signs at bends shall also be provided for.

Reflective Pavement Markers (Road Studs)

Necessary reflective pavement markers such as road studs, solar studs are proposed in the project to improve the visibility in night time and wet weather conditions. These are the prismatic retro-reflective type two way markers conforming to ASTM D 4280.

Conducting of awareness programmes

PWD Goa will conduct the awareness programmes to the nearby community, transportation associations, NGOs and other interested parties about road safety.

Vigilance by highway patrolling unit

The highway patrolling unit under the control of local police will conduct route checks and maintain the safety surveillance.

7.4 Disaster Management Plan

Disaster Management Plan (DMP) should be prepared on the basis of risk analysis considering worst case disaster scenario with respect to specific cases, major road mishaps, gas tanker explosions, fire hazards, floods, cyclones, earth quakes etc. An emergency response system should be developed in co-operation with local fire, police and Medical service. Frequent exercise should be carried out to test the preparedness of the system by mock drills.

The disaster management plan is given in Fig no.7.2. The role and responsibility of the concerned officers are well defined and the details are as follows.



7.4.1 Emergency plan in the event of emergency

On receiving the information of emergency due to road mishaps, Executive Engineer, PWD Goa and Traffic wing will co-ordinate for rescuing the persons, arrangement of ambulance & first aid, Hospital/Dispensary, information passed on to Police/Fire brigade/Security, engagement of Rescue team with equipment (crane, mobile van and other tools).

7.4.2 Emergency plan in the event of emergency (major in nature)

On receiving the information of emergency (due to major in nature like major road accidents, gas tanker explosions, earth quakes, floods etc) Executive Engineer, PWD Goa and Traffic wing will co-ordinate for rescuing the persons, arrangement of ambulance & first aid, Hospital/Dispensary, information passed on to Police/Fire brigade/Security, engagement of Rescue team with equipment (crane and other tools).

After receiving the intimation from Executive Engineer/Safety /Traffic wing, Director, Project Implementation Unit (PIU) will form a Committee to deal with the emergency with the following:

- Medical facilities
- Set of Control room
- Preparation of action plan
- Welfare activities and
- Repairing and Rehabilitation works.

For the said arrangements, Executive Engineer in co-ordination with project implementing unit will guide and monitor the work in rendering effective services to the affected people with the help of Supervisory Consultant & Contractor. The action taken and final report will be sent to top Management.

Disaster Management Plan (DMP) should be prepared on the basis of risk analysis considering worst case disaster scenario with respect to specific cases, major road mishaps, gas tanker explosions, fire hazards, floods, cyclones, earth quakes etc. An emergency response system should be developed in co-ordination with local fire, police and Medical service. Frequent exercise should be carried out to test the preparedness of the system by mock drills.



The disaster management plan is given in Figure -7.2. The role and responsibility of the concerned officers are well defined and the details are as follows.

7.4.3 Emergency plan in the event of road mishaps

On receiving the information of emergency due to road mishaps, Executive Engineer, PWD Goa and Traffic wing will co-ordinate for rescuing the persons, arrangement of ambulance & first aid, Hospital/Dispensary, information passed on to Police/Fire brigade/Security, engagement of Rescue team with equipment (crane, mobile van and other tools).

7.4.4 Emergency plan in the event of emergency (major in nature due to major road accidents, gas tanker explosions etc.)

On receiving the information of emergency (due to major in nature like major road accidents, gas tanker explosions etc., Executive Engineer, PWD Goa and Traffic wing will co-ordinate for rescuing the persons, arrangement of ambulance & first aid, Hospital/Dispensary, information passed on to Police/Fire brigade/Security, engagement of Rescue team with equipment (crane and other tools).

After receiving the intimation from Executive Engineer (PWD, Goa)/Safety /Traffic wing, Director, Project Implementation Unit (PIU) will form a Committee to deal with the emergency with the following:

- Medical facilities
- Set of Control room
- Preparation of action plan
- Welfare activities and
- Repairing and Rehabilitation works.

For the said arrangements, Executive Engineer (PWD, Goa) in co-ordination with project implementing unit will guide and monitor the work in rendering effective services to the affected people with the help of Supervisory Consultant & Contractor. The action taken and final report will be sent to top Management.

7.4.5 Emergency plan in the event of emergency (major in nature due to Natural disasters.)

On receiving the information of emergency (major in nature due to natural disasters like earth quakes, floods etc) Executive Engineer, PWD Goa and Traffic wing will co-ordinate the following;



- a) for rescuing the persons,
- b) arrangement of ambulance & first aid,
- c) Hospital/Dispensary,
- d) information passed on to Police/Fire brigade/Security,
- e) engagement of Rescue team with equipment (crane and other tools) in co-ordination with District administration.

DMP team will be formed under District Administration control with the following officials / representatives:

- District Collector or District Magistrate and or his nominated officer
- Executive Engineer, PWD Goa
- Superintendent of Police (S.P) and or his nominee
- District Medical and Health officer
- Representative from Fire department
- Representative from R&B department
- Divisional Engineer, Electricity department
- Executive engineer, Public health engineering department
- Representatives from NGOs etc.

7.4.6 Role and Responsibility of Important Agencies

District Administration: District administration will take active roll and they will co-ordinate with all the state government agencies for successful implementation of DMP. All the relief operations and rehabilitations will be supervised by them.

Fire Services: The Fire services department during disaster has to evacuate the people who are trapped in highway, top on the trees etc. People can be shifted to safer places (rehabilitation centres). In some cases they also take up supply of drinking water to relief camps.

Police Department: The law and order situation of the project site will be maintained by the Police Department and they will also help Fire services whenever required. The monetary relief released for disbursement to the victims will be escorted by them. The communications (VHF sets) will be established by them.



Medical & Health department: The medical and health department has to play vital role during the disaster. During emergency, the department shall ensure that all ambulances and other vehicles are available at site along with medical teams. Mobile medical teams shall move to spot to render medical aid to the victims. Preventive measures to be taken against Gastro-enteritis, Diarrhoea and fever cases. Medical and health department also distribute the medicines to the victims with proper treatment.

Role of Press & electronic media: The role of Press & Electronic media is particularly important as it helps to communicate the latest information to the public as they have close accessibility with the administration department. Flash news, news items, headlines etc helps the public to move into safer places. The T.V & newspapers are also educates the people about the possible hazards, steps to mitigate the distress etc.

Role of NGOs: NGOs plays a vital role for successful implementation of relief works. Many NGO organizations are also helps to collect the donations and disburse them directly to the victims.

7.5 Implementation of DMP

In the event of disaster, Executive Engineer, PWD Goa and Traffic wing will co-ordinate for rescuing the persons, arrangement of ambulance & first aid, Hospital/Dispensary, information passed on to Police/Fire brigade/Security, engagement of Rescue team with equipment (crane and other tools) in co-ordination with District administration. The following rescue operations are to be made on emergency basis:

Implementation of DMP in the event of emergency (major in nature due to major road accidents, gas tanker explosions, hazardous material spillage etc.)

1. In case of disaster event, alarm the people and other persons using the Outer Ring Road and other connected roads.
2. The ambulance, fire tender and 'hazardous material removal vehicle' need to be informed to be ready.
3. Only concerned persons will be present in the affected area and all other personnel and guests need to be moved to the nearest assembly points.
4. Source of leakage to be traced and isolated from all the other areas.
5. Electrical department need to be informed to shut the power supply (in case of



fuel or other fire hazard substance leakage).

6. In case of a fire the instructions listed against fire hazards needs to be followed.
7. If the fire is small engage in extinguishing the fire using nearest fire extinguisher. In case of big fire, fire tender shall be mobilized along with quick response team and take all the necessary steps to stop the fire.

7.6 Emergency plan in the event of emergency (major in nature due to Natural disasters.)

- Siren blowing & communication arrangements: In case of disaster event, the siren will be blown to alarm the drivers, local people and other persons using the highway. The news about the alarming situation will be telecasted and published in newspaper along with Radio advertisement. (Agencies responsible: PWD Goa; District Administration; Electronic Media)
- Evacuation of victims and food arrangements: The arrangements shall be made to evacuate the victims with the help of Fire brigade and local Police to rehabilitation places. Necessary arrangement shall be made for accommodation and provisions. In case of problem to evacuate through road, Air Lifting shall be done by using helicopters. Air dropping of food packets, medicines and other needful items shall be done in case of non-approach through roadways. (Agencies responsible: PWD Goa, District Administration, Fire brigade, police dept.)
- Monitoring Relief operations: It was the practice that senior officers from State level were sent by the government to over-see and monitor the arrangements and effective implementation of the relief operations. The necessary staff, services and goods shall be deployed for successful implementation of relief operations. Adequate arrangements are also to be made in advance for supply of drinking water. (Agencies responsible: State Government, District Administration, Municipalities, PWD Goa, police dept.) Welfare activities: The Social welfare/ Tribal Welfare Departments have to reserve in advance stocks of essential commodities in their hostels functioning in the vulnerable areas. During the disaster, they are responsible for preparation of food and water packets and to load them in to the Helicopters for air dropping. (Agencies responsible: The Social welfare/ Tribal Welfare Departments, PWD Goa, District Administration)



- Medical and health services: Medical aid to be provided to the victims by the Mobile medical teams immediately. Post disaster relief measures including surveillance of Gastro-enteritis, Diarrhoea, Dysentery and other water borne diseases and spraying of disinfectant to prevent epidemics. Proper sanitation arrangement should be provided in the flood areas. (Agencies responsible: DM&HO, District Administration, Municipalities, PWD Goa)
- Post Disaster Management: During post disaster the district administration shall convene a meeting of all NGOs and role of NGO's is quite crucial also in terms of smooth running of relief camps.
- One of the major tasks after disaster will be restoration of normal life and repair of the damaged structures. After governments approval the Restoration and Rehabilitation works will be executed by the concerned departments. The final Disaster Management report will be submitted to the PWD Goa's top management and State Government. (Agencies responsible: District Administration, PWD Goa, Roads & Building department, Municipalities)

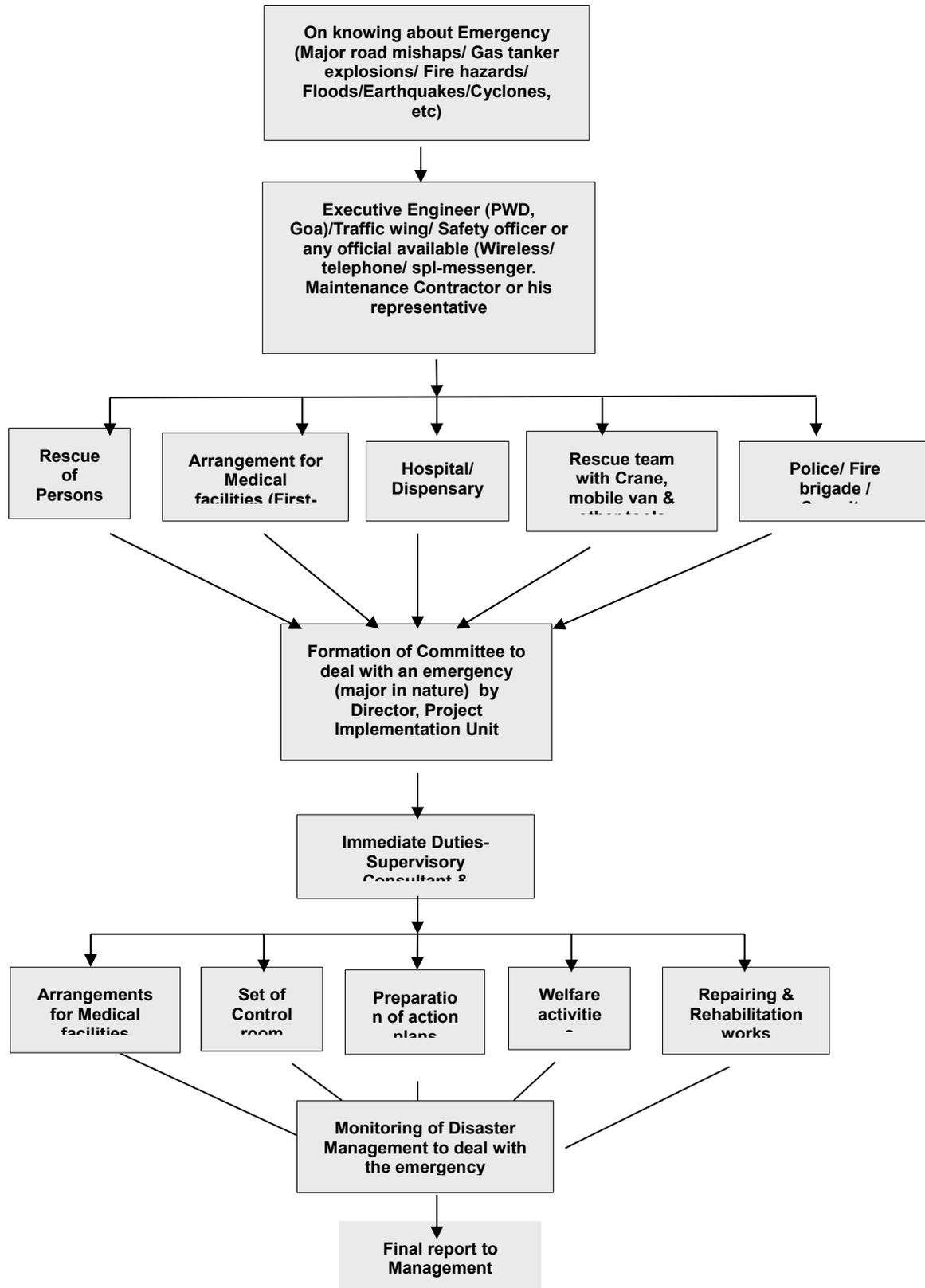


Figure -7.1 : Disaster Management Plan for the proposed 4 laning project for Anmod to Panaji section



CHAPTER -08

ENVIRONMENT MANAGEMENT PLAN

8.0 ENVIRONMENT MANAGEMENT PLAN

The Environmental Management Plan (EMP) state the procedure in which the project proponent would carry out the implementation of the mitigation measures and ensure compliance with environmental regulations that are binding on the project. This plan also specifies the organizational requirements and institutional strengthening necessary for sound environmental management of the project. The major components of the EMP are:

1. EMP Implementing Agency
2. Monitoring of the EMP implementation
3. Training on Environmental management
4. Budget for EMP implementation.

8.1 EMP Implementing Agency

The project proponent will establish an Environmental Management Cell (EMC) to supervise and implement the mitigation measures as documented in the EMP. This EMC must also be adequately empowered to discharge the responsibilities as outlined in the EMP. To ensure smooth implementation of EMP the project proponent will have to collaborate with various government agencies like Revenue Department, State Pollution Control Board, State Forest Department, Police Department and other allied departments.

The details of EMP implementation and implementation responsibilities are given in Table -8.1. This table comprehensively lists out the tasks to be performed and completed by the Contracting Company and also lists out the agencies that are involved and responsible for ensuring the timely completion of the tasks outlined under EMP. The contractors responsibilities in matters related to protection of environment shall be the part of the tender document. Table -8.1 gives the provisions that are built in the bid document to protect and safeguard the environment by the Contractor.



Table -8.1: Implementation Schedule with Responsible Supervising Organization/ Authority

S. No	Project related Issues	Action to be taken	Frequency	Implementation Agency / Authority	Supervision Agency
DESIGN PHASE					
1.	Alignment	Right of Way (RoW) available for entire reach is varying 8m to 35m and the proposed ROW is 60m. Land acquisition is required throughout the project.	Monthly	DPR Consultant / Public Works Department, Goa (PWD, Goa)	PWD, Goa
2.	Interference on People	Passageways (including 5 flyovers / 1 RoBs & 11 underpasses) are designed/widened for road development work to meet the needs of the local residents and vehicles.	Monthly	DPR Consultant / Project Proponent (PWD, Goa)	PWD, Goa
3.	Soil Erosion	In slopes and suitable places along the roadside, bush grass will be planted, and retaining wall, water intercepting ditches, and masonry rubbles will be built to prevent soil erosion. Temporary and permanent drainage systems are designed to minimize the soil erosion and the impact on irrigation canals. There are 3 nos. Lakes, 0 nos. borewell/dugwell, 4 nos. ponds, 1 nos. canal and 2 nos. streams are abutting /affecting in the project.	Monthly	Consultant / Project Proponent (PWD, Goa)	PWD, Goa
4.	Cultural Relics	No cultural relics present in the project core area.	Quarterly	PWD, Goa / Archaeological dept.	PWD, Goa
5.	Flood	Adequate care has been taken for the purpose of free flow of flood discharge in the design stage itself. There are 1 major bridge, 7 minor bridges, upgradation of Box culverts (38) and Pipe Culverts (137) (slab / box / pipe culverts) are proposed in the project to allow the free flow of the natural flood water in the area.	Quarterly	Feasibility Study Consultant/ Project Proponent	PWD, Goa
6.	Preparation of feasible land acquisition plan	<ul style="list-style-type: none"> Initiate and complete the process for land acquisition of 90 hectares as per Land Acquisition Act, 2013. R&R plan for 377 structures/ PAFs to be prepared as per Land acquisition Act, 2013 (Private – 206, Religious – 24, Govt. - 39, Non-title holders – 108) Prepare and administer land use control measures. 		PWD, Goa, revenue department in consultation with the affected people	PWD, Goa



S. No	Project related Issues	Action to be taken	Frequency	Implementation Agency / Authority	Supervision Agency
CONSTRUCTION PHASE					
1	Avenue tree cutting and plantation	<ul style="list-style-type: none"> Prepare an action plan for about 10,000 nos. of trees to be felled in the project stretch and minimum of 20,000 nos. trees need to be planted as per the Forest Conservation Act, 1980 and subsequent amendments thereof. Intimate forest department before cutting trees. Prepare action plan for avenue and median plantation. Avenue Plantation: There are two rows of avenue plants proposed along the Project corridor as per IRC-SP-21: 2011. There are 10,000 nos. of trees are affected due to the proposed project. Hence 20,000 nos. of trees are proposed to be planted, out of which 18035 nos. of trees are planted along the sides of road and 1965 nos. of trees are to be planted in parking areas, toll gates, bus bays, truck lay byes. The plants proposed are i.e., Cinamomum camphora, Dalbergia latifolia, Palms, Saraca indica, Sweitenia mahogoni, Tabubea rosea etc. Median Plantation: Since the project is widening to four/six laning project median will be utilized. Median plantation is proposed along the four lane stretch of length 50 Kms (excluding major and minor bridges). Median plantation is proposed with provisions of 333 nos. of plants per kilometer in Wild life sanctuary and provisions of 666 nos. of plants per kilometer in the rest of the stretch. Hence, the estimated median plantation is around 27,445 nos. The median plant proposed in the project are i.e., Bougainvillea, Nerium Oleander, Thevitia Nerifolia, Tabernaemontana Coronaria etc. Budget allocation for avenue and median plantation is Rs.2.96crores. 	Monthly	Concessionaire	PWD, Goa in consultation with the Forest dept.



S. No	Project related Issues	Action to be taken	Frequency	Implementation Agency / Authority	Supervision Agency
2	Burrow pits and Quarry sites (stone / sand).	<ol style="list-style-type: none"> There are 10 nos. of borrow areas identified in the project and the same shall get NoC from the private / Government owners well before start of the work. Firm up contract with mining & Geology department for obtaining the identified stone quarries of 2 nos. And 2 sand quarries in the project stretch. Borrow areas shall be carried out upto depth of 2.0m in non-cultivable & elevated lands, 0.45 m in productive lands etc. with a slope of not steeper than 1 vertical to 4 horizontal. Borrow areas shall be away from the 15m of the 10 nos. of water bodies identified in the project. Resurfacing and landscaping of the borrow pits utilised in the project. 	Monthly	Contractor or Concessionaire/	Mining Department / PWD, Goa
3	Site for storage and construction camp.	The location of the Campsite shall be selected by the Contractor duly confirming the labour laws.		Contractor or Concessionaire/	PWD, Goa
4	Sewerage and solid waste disposal.	<ol style="list-style-type: none"> Proper sanitation facilities at the construction workers camp shall be provided as per the IS:2470-1985 Domestic refuse shall be collected separately for bio-degradable waste as well as the inert waste and the same shall be sent for the disposal as per the MSW (Management & Handling) Rules, 2000. It is envisaged that approximate 300 - 500 Kg of domestic solid waste (300 - 500 gm/person) per day will be generated from the workers camps which will be disposed of to the nearest solid waste disposal sites as discussed above. 	Monthly	Contractor or Concessionaire	Labour department / Health department /PWD, Goa



S. No	Project related Issues	Action to be taken	Frequency	Implementation Agency / Authority	Supervision Agency
5	Traffic management	<ul style="list-style-type: none"> The project road passes through major towns & panchayats are Mollem, Ponda, Farmagudi, Mardol, Boma, Cundain, Corlim and Ella Secure assistance from local police for traffic control during the construction. Safety measures shall also be undertaken by installing road signs and markings for safe and smooth movement of traffic. 	Monthly	Contractor or Concessionaire	PWD, Goa
6	Noise level	<ol style="list-style-type: none"> Stationary equipment shall be placed as far as possible from residential areas to minimise noise impacts on the near inhabitants. Construction activities will be strictly prohibited between 10.00 p.m. to 6.00 a.m. near habitation Provision of ear plugs to workers exposed to high noise levels in the project who work in batch mix plants, hot mix plants, quarries etc. 	Quarterly	Contractor or Concessionaire	Goa State Pollution Control Board / PWD, Goa
7	Air Quality	<ul style="list-style-type: none"> During construction, a good number of trucks will carry the construction material for which emission of air pollutants will increase. We should see that all the vehicles deployed for construction of the project will have to keep "Pollution Under Control" certificates. DG sets will also emit air pollutants in the area during construction period. The emission generated during construction will be temporary and localized in nature. Vehicles carrying construction material shall be covered to avoid spilling. Hot mixing plant shall be over 500m away from residential neighbourhood and 300m away from the road. Mixing equipment shall be seated and equipped with dust removal device. Water will be sprinkled in morning and evening hours at the construction yards and the unpaved sections of the road. 	Quarterly	Contractor or Concessionaire	Goa State Pollution Control Board / PWD, Goa



S. No	Project related Issues	Action to be taken	Frequency	Implementation Agency / Authority	Supervision Agency
8	Water Quality	<ol style="list-style-type: none"> 1. Prior permission of the concerned engineer and regulatory authorities shall be taken regarding the discharge or disposing of any material arising from the execution of the works. 2. During construction it will be ensured that contractor does not dispose off debris in water bodies. 3. Soil laden run off will not be diverted to water bodies. Provision of waste disposal site for waste from construction and storage yards shall be made. 4. Vehicle maintenance and refueling will be confined to areas under construction yard to trap discarded lubricant and fuel spills. 	Quarterly	Contractor or Concessionaire	Goa State Pollution Control Board /PWD, Goa
9	Water logging and stagnation of water in the Borrow pits	<ul style="list-style-type: none"> • The majority of the project stretch is plane & horizontal land which will be act as water logging areas during the rainy seasons and may cause the breeding of the vectors in the area. • Uncontrolled digging of approved Borrow pits in the areas will be avoided to prevent water accumulation which results in breeding of disease causing vectors in the area. 	Monthly	Contractor or Concessionaire	PWD, Goa
10	Occupation Health and Safety	<ol style="list-style-type: none"> 1. Labourers shall be equipped with proper safety gears like helmets, gloves and gum boots. 2. Periodic health checkup of construction workers. 		Contractor or Concessionaire	Labour department /PWD, Goa



S. No	Project related Issues	Action to be taken	Frequency	Implementation Agency / Authority	Supervision Agency
11	Basic amenities and sanitation facilities for labourers	<ul style="list-style-type: none"> Adequate sanitary facilities shall be provided to the workers to avoid health related problems. Sanitation waste from workers camp will not be diverted to water bodies. Periodic health checkup of labourers shall be done. Contractor to prepare, MORTH's approved detailed public health utilities plan for the workers camp and other working sites, which make adequate provision for safe disposal of all wastes and prevention of spillages, leakage of polluting materials etc. Contractor will be required to pay all costs associated with cleaning up any pollution caused by their activities and to pay full compensation to those affected. 	Monthly	Contractor or Concessionaire	Labour department / Health Department /PWD, Goa
12	Fuel for labourers	<ul style="list-style-type: none"> Adequate supply of fuel (LPG/Kerosene) shall be provided to the labourers to avoid felling of trees for cooking and other domestic chores. 	Monthly	Contractor or Concessionaire	Labour department / Health Department /PWD, Goa
13	Prevention of erosion and scouring	<ul style="list-style-type: none"> Stabilizing the embankment with appropriate technique immediately after placing. The high embankment slopes near to the major bridges are washed out or weaken and the same shall be strengthened. Treating high embankment slopes with rip rap, stone pitching or other technologies to prevent erosion. Construction of toe drain all along the road on both sides. Avoiding obstruction of existing drainage during filling. 	Monthly	Contractor or Concessionaire	Concerned local department /PWD, Goa



S. No	Project related Issues	Action to be taken	Frequency	Implementation Agency / Authority	Supervision Agency
14	Drainage system	<ol style="list-style-type: none"> 1. Adequate care has been taken for the purpose of free flow of flood discharge in the design stage itself. There are 1 major bridge, 7 minor bridges, 175 culverts (slab / box / pipe culverts) are proposed in the project to allow the free flow of the natural drainage water in the area. 2. Construction of toe drain along the road on both the sides. 3. Avoiding obstruction of existing drainage during filling. 	Monthly	Contractor or Concessionaire	Irrigation /PWD, Goa
15	Conservation of Eco-resources	<ol style="list-style-type: none"> 1. To preserve the forests, earth borrowing, piling, and building temporary camps are prohibited in forests lands. 2. Arable lands should not be used as earth borrowing whenever possible. If needed, the topsoil (30cm) should be kept and refilled after construction is over to minimize the impact on ecosystem and agriculture. 3. Construction vehicles should run at temporary accesses to avoid damaging arable lands and cattle-raising lands. 	Monthly	Contractor or Concessionaire	Forests or WLS /PWD, Goa
16	Communications and Transportation	<ol style="list-style-type: none"> 1. Local materials should be used as much as possible so as to avoid long distance transportation that of earth and stone. 2. If there are traffic jammed during construction, measures should be taken to move the jam with the coordination of transportation and public security department. 3. Temporary access should be built at the interchange of the highway and other roads. 4. Passing time on National Highways will be limited, similar measures will also be applied to roads with traffic jams. 5. Materials may be delivery in advance in relatively leisurely season of traffic. 6. A transportation plan of materials will be formulated to avoid delivered of them at peak hours on existing roads. 	Quarterly	Contractor or Concessionaire	Transport Department /PWD, Goa



S. No	Project related Issues	Action to be taken	Frequency	Implementation Agency / Authority	Supervision Agency
17	Rain Water Harvesting	<ol style="list-style-type: none"> The project stretch was considered about an existing length of 50 Km excluding settlements, bridge portions etc. There are 200 nos. of RWH Pits are proposed either side of the road at an interval of 500m. The proposed RWHs are having dia. Of 1.5 m with a depth of 3.8 m. The budget provision for the RWH structures are provided at the rate of Rs. 15000/pit and the total amount is estimated to be Rs. 0.30 Crores. 	Monthly	Contractor or Concessionaire	GW Department /PWD, Goa
18	Utilization of Fly Ash	<ol style="list-style-type: none"> In the proposed project, There are fourteen Thermal Power Stations identified and which fall within 500 Km from the project corridor. Hence, Utilisation of Fly Ash in the project is estimated to be 4,00,000 cum provision made as per the IRC SP:58 – 2001 and Fly ash Notification 2007 and the subsequent amendments in 25th March, 2015 and the same shall also be put under the BoQs. 	Monthly	Contractor or Concessionaire	PWD, Goa/GSPCB
19	Surplus earth/ Muck disposal	<ol style="list-style-type: none"> During the construction phase, the quantity of muck generated is approximately 13,00,000 cum and same shall be used for filling up the low-lying areas and some part will be useful for construction of service roads, etc. The top soil shall be kept separately and shall be used for plantation/ landscape development purpose in the project, and also utilized for soil conditioning by the local farmers. An amount of Rs. 9.7 Crore provision is made in the EMP for disposal of the same in the project. 	Monthly	Contractor or Concessionaire	PWD, Goa
OPERATION PHASE					
1	Air Quality	<ol style="list-style-type: none"> Monitor periodically the AAQ at suggested locations. Developing road side vegetation for pollutant sinking. Enforcing different control measures to minimise pollution. Public will be educated about the regulations on air pollution and noise of vehicles. 	Quarterly	Contractor or Concessionaire	Goa State Pollution Control Board /PWD, Goa



S. No	Project related Issues	Action to be taken	Frequency	Implementation Agency / Authority	Supervision Agency
2	Road safety and traffic management	<ol style="list-style-type: none"> 1. Prepare and administer a monitoring system on road accidents. 2. Adequate number of road signs with clear visibility shall be installed. 3. In case of spill of hazardous materials, report to the relevant departments at once and deal with it in accordance with the emergency plan. 4. Drivers and Public will be educated about the Safety regulations. 	Quarterly	Contractor or Concessionaire	PWD, Goa/Traffic Police dept.
3	Noise level	<ol style="list-style-type: none"> 1. Provision of noise barriers (earthen berms/thick green belt development) has been proposed at sensitive areas and other noise prone areas. 2. Periodic monitoring of ambient noise levels at suggested locations 3. Erecting sign boards at sensitive and residential locations, prohibiting the use of air horns. Particularly near schools, temples and hospitals. 4. There are one/two rows of avenue plants proposed along the project corridor as per IRC-SP-21: 2011. The avenue plants proposed to be planted in the project are about 20,000 either side of the road to control noise levels. 	Quarterly	Contractor or Concessionaire	Goa State Pollution Control Board / PWD, Goa
4	Soil characteristics	<ol style="list-style-type: none"> 1. Periodic monitoring of soil quality at specified distance from the corridor for assessing soil contamination by vehicular emissions. The analysed samples shall be compared with the baseline values monitored at 3 locations along the Project corridor. 	Quarterly	Contractor or Concessionaire	Goa State Pollution Control Board / PWD, Goa



S. No	Project related Issues	Action to be taken	Frequency	Implementation Agency / Authority	Supervision Agency
5	Maintenance of road side plantations	<ol style="list-style-type: none"> 1. Avenue Plantation: There are two rows of avenue plants proposed along the project corridor as per IRC-SP-21: 2011. The avenue plants proposed to be planted in the project are about 20,000 either side of the road, parking areas, toll gates, bus bays and truck laybys. The plants proposed are i.e., Cinamomum camphora, Dalbergia latifolia, Palms, Saraca indica, Sweitenia mahogoni, Tabubea rosea etc. 2. Median Plantation: Since the project is widening of two lane to four laning project median will be utilised as it is. However, a provision of 50 Kms (excluding major and minor bridges) median plantation is made in the project to cover the bypasses, realignments etc. The median plantation is proposed in one/two rows and the numbers of species proposed are 27445 nos. The median plant proposed in the project are i.e., Bougainvillea, Nerium Oleander, Thevitia Nerifolia, Tabernaemontana Coronaria etc. 3. Employment of local people for the maintenance of plantation along the corridor 	Quarterly	Contractor or Concessionaire	Forests Department/ PWD, Goa
6	Maintenance of Drainage System	<ol style="list-style-type: none"> 1. The drainage system will be periodically cleared so as to ensure water flow. 	Quarterly	Contractor or Concessionaire	Irrigation /PWD, Goa



8.2 Monitoring of EMP Implementation

The EMP will primarily be implemented by the Project Proponent & Civil Contractor. However for an effective implementation of EMP, it is proposed to have two level monitoring. The first is internally by the top management of Contracting Agency and the second by the Public Works Department, Goa (PWD, Goa). The EMC constituted by the Contracting Company shall be the prime agency for monitoring all the activities during both the phases. PWD, Goa shall supervise all activities and accordingly advise the Contracting Company to improve on areas where any short comings are observed. The EMC shall provide all the monitoring results to PWD, Goa. PWD, Goa shall keep a record of all information and shall suggest suitable measures to be adopted by Contracting Company if any aspect is found to be deviating from the anticipated values/ standards. Monitoring shall be carried out during construction and operation phases.

This review by PWD, Goa and top management of Construction Company will make the EMC to implement the EMP more effectively. The parameters to be monitored with the frequency are given in Table -8.2.

Table -8.2: Environmental Monitoring during Construction and Operation phase

Parameters	Location	Duration	Frequency	
			Construction Phase	Operation Phase
Air Quality: PM10, PM2.5, Nox, SO ₂ , and CO	Three locations where baseline monitoring was carried out	24 hours continuous sampling	Once in a season or thrice in a year (other than monsoon season)	Twice in a year (other than monsoon season)
Noise Level: L _{eq} (day) and L _{eq} (night)	Eight locations where baseline monitoring was carried out.	24 hours continuously	Thrice in a year	Twice in a year
Soil Quality: Physico- chemical, Lead, oil and grease	Three samples where baseline monitoring was carried out.	Grab sampling	Once in a year (non – monsoon)	Once in a year (non – monsoon)
Water Quality: For different	Twelve (12) samples (4 Surface and 8	Grab sampling	Thrice in a year during	Twice a year during pre-post monsoon season



Parameters	Location	Duration	Frequency	
			Construction Phase	Operation Phase
physical, chemical and biological parameter	Ground Water)		pre-post monsoon season and winter season	
Maintenance for road side plantation	All along the project road. There are 18,035 of avenue and 27,445 of median plants proposed in the project.	Throughout the year	Regularly throughout the year for three years	--
Monitoring of sanitary and environmental status of Burrow areas	All the Borrow pits (10 nos)	Grab Sampling for Water and Soil	Once in a season	--



8.3 Corporate Social Responsibility (CSR)

The World Bank Group, stating, "Corporate social responsibility is the commitment of businesses to contribute to sustainable economic development by working with employees, their families, the local community and society at large, to improve their lives in ways that are good for business and for development."

The core elements of the CSR are:

1. Care for all stakeholders
2. Ethical functioning
3. Respect for workers' rights and welfare
4. Respect for human rights
5. Protection of Environmental
6. Activities for Social and Inclusive

8.3.1 CSR in Companies Bill 2012

The Companies Bill, 2012 incorporates a provision of CSR under Clause 135 which states that every company having net worth Rs. 500 crore or more, or a turnover of Rs. 1000 crore or more or a net profit of rupees five (05) crore or more during any financial year, shall constitute a CSR Committee of the Board consisting of three or more Directors, including at least one Independent Director, to recommend activities for discharging corporate social responsibilities in such a manner that the company would spend at least 2 per cent of its average net profits of the previous three years on specified CSR activities.

According to Schedule-VII of Companies Bill, 2012 the following activities can be included by companies in their CSR Policies:-

- Eradicating extreme hunger and poverty;
- Promotion of education;
- Promoting gender equality and empowering women;
- Reducing child mortality and improving maternal health;
- Combating human immunodeficiency virus, acquired immune deficiency syndrome, malaria and other diseases;
- Ensuring environmental sustainability;
- Employment enhancing vocational skills;



- Social business projects;
- Contribution to the Prime Minister's National Relief Fund or any other fund set by the Central Government or the State Governments for socio-economic development and relief and funds for the welfare of the Scheduled Caste, the Scheduled Tribes, other backward classes, minorities and women; and
- Such other matters as may be prescribed.

8.3.2 Guidelines on CSR for Public Enterprises

The Department of Public Enterprises had issued Guidelines on Corporate Social Responsibility (CSR) for Central Public Sector Enterprises (CPSEs) in April, 2010 which have been issued formally to the Ministries/Departments for compliance in the CPSEs under their administrative control. Following are the some of the salient features of guidelines on CSR & Sustainability:

(i) Corporate Social Responsibility and Sustainability is a company's commitment to its stakeholders to conduct business in an economically, socially and environmentally sustainable manner that is transparent and ethical.

(ii) In the revised guidelines, CSR and Sustainability agenda is perceived to be equally applicable to external and internal stakeholders, including the employees of a company, and a company's corporate social responsibility is expected to cover even its routine business operations and activities. CPSEs are expected to formulate their policies with a balanced emphasis on all aspects of CSR and Sustainability – equally with regard to their internal operations, activities and processes, as well as in their response to externalities.

(iii) In the revised guidelines CSR and Sustainable Development have been clubbed together in one set of guidelines for CSR and Sustainability because of close linkage between the two concepts.

(iv) Public Sector enterprises are required to have a CSR and Sustainability policy approved by their respective Boards of Directors. The CSR and Sustainability activities undertaken by them under such a policy should also have the approval/ratification of their Boards. Within the ambit of these guidelines, it is the discretion of the Board of Directors of CPSEs to decide on the CSR and Sustainability activities to be undertaken.

(v) The financial component/budgetary spend on CSR and Sustainability will be based on the profitability of the company and shall be determined by the Profit After Tax (PAT) on the company in the previous year.



S.No.	PAT of CPSEs in the Previous Years	Range of Budgetary allocation for CSR & Sustainability Activities (as % of PAT in Previous Year)
1	Less than 100 Crores	3-5%
2	Rs. 100 Crores to Rs. 500 Crores	2-3%
3	Rs. 500 Crores and Above	1-2%

Loss making companies are not mandated to earmark specific funding for CSR and Sustainability activities. However, they must pursue CSR and Sustainability policies by integrating them with their business plans, strategies and processes, which do not involve any financial expenditure. They may also collaborate with the profit making CPSEs and assist them in ingenious ways without financial support in CSR and Sustainability activities

8.3.3 CSR Budgetary Allocations for this Project

The Public Works Department plays a major role in the economic, Commercial and tourist development of the State of Goa. Being a service Department, it is entrusted with all the developmental activities like Planning, Design, Construction, Operation and Maintenance of all types of construction works in this State of Goa. PWD, Goa has undertaken the development of the proposed project road stretch of NH-4A starts from Anmod and ends at Panaji respectively. The cost of the project is Rs. 2130 Crores. CSR in Companies Bill, 2012 stating that the budgetary provisions shall be made on PAT, which is not envisaged throughout the concessions period for this project. However, as per the Government of India initiative taken on CSR activities, the lumpsum amount provision of Rs. 2.0 Crores shall be made in the project initially and the same shall be reviewed and adjusted time to time by the CSR Board of Directors for this project.

8.4 Environmental Training

The Environmental Management Cell (EMC), in addition to implementing and monitoring different environmental attributes, shall also be actively involved in imparting training and raising environmental awareness level of Contractors and the construction staff so as to enable them to take the environmental aspects into consideration as and when required. In the long term, the EMC can impart additional and specialized training in the Environmental Management of the road system.



8.5 Budget for EMP Implementation

The design and construction of the project involves a number of items such as resettlement & rehabilitation, erosion prevention, rehabilitation of Borrow areas, safety signage, etc., which are included in the contract cost. Only those items that are not covered under the budget for construction are shown in the EMP implementation budget. The total budget for implementation of EMP works out to be Rs. 20.005 Crores as given in Table -8.3.

The main components are:

- Tree plantation / Transplantation
- Environmental monitoring during construction and operation phase
- Training during construction and operation phase



Table -8.3: Budget for Implementation of Environment Management Plan

S.No.	Item	Unit cost/ Lump sum cost (Rs.)	Total cost (Rs.)
I. Logistics cum Administrative costs			
1	Vehicle cost	1 location@ Rs 20,000 per month for 12 vehicle months	2,40,000.00
2	Office administration (including man power costs) and logistics etc for Environment Management Cell (EMC)	1 locations For 12 months @ Rs.1,00,000/ month	12,00,000.00
II. Construction costs			
3	Sanitation- sulabh – sowchalaya 16.5 sq.m area (Included in project cost)		10,00,000.00
4	Sprinkling of water thrice in a day all along the stretch & Erosion control Retaining walls, slope pitching and turfing. (Included in project cost) (365 days x 3 times x 2 year x 3 vehicles x Rs. 1000/trip)		65,70,000.00
5	Labour camps, health and other services (Included in project cost)		10,00,000.00
6	Solid waste management (Included in project cost)		10,00,000.00
7	Muck/Debris Disposal from site (Approx 13,00,000cum, estimated to be Rs. 9.7 Crores)	Already included in Project BoQs	
8	Allocation of Budget towards the Corporate Social Responsibility (CSR) activities		2,00,00,000.00
III. Tree plantation and compensatory afforestation			
9	Compensatory afforestation of 31.01 hectares of Bhagawan Mahaveer Wild life sanctuary & 32.95 hectares of Reserve & Private forest area and Maintenance for 5 years (63.96*20 L/Ha)		12,79,20,000.00
10	Avenue trees including 3 years maintenance - around 20,000 trees including tree guards (Rs. 1000/tree) (Included in project cost)		2,00,00,000.00



S.No.	Item	Unit cost/ Lump sum cost (Rs.)	Total cost (Rs.)
11	Shrub plantation in median and landscaping in 4/6- lane project for 50 Kms(Excluding major and minor bridges): 27,445 plants @ Rs.350/- including maintenance for one year. (Included in project cost)		96,05,750.00
IV. Monitoring costs : Construction Phase			
12	Air Quality Monitoring (3 Monitoring stations) once in a season during the construction period - (3Stations x 3 Seasons x 3 Years)	Rs.7,000 per station	1,89,000.00
13	Noise level Monitoring (8 Monitoring stations) once in a season during the construction period - (8 Stations x 3 Seasons x 3 Years)	Rs.1500 per station	1,08,000.00
14	Water Quality Monitoring (12 Monitoring stations) once in a season during the construction period - (12 Stations x 3 Seasons x 3 Years)	Rs.7000 per station	7,56,000.00
15	Soil Quality Monitoring (3 stations) once in a year during the construction period - (3 Stations x 3 Seasons x 3 Years)	Rs.6000 per sample	1,62,000.00
16	Awareness programmes (Lumpsum)	10,00,000	10,00,000.00
17	Borrow area monitoring (Once in a year) 10 borrow areas	Rs.25,000 per borrow area per 3 seasons	7,50,000.00
18	200 nos. Rain Water Harvesting Structures (RWH) Pits of dia. 1.5m with a depth of 3.8 m at an interval of 500m either side of the road.	Rs. 15000 per RWH pit	30,00,000.00
19	Protection and mitigative measures for Bhagawan Mahaveer wildlife during construction phase	Lumpsum	20,00,000.00
V. Monitoring costs: Operation Phase			
20	Air Quality Monitoring (3 Monitoring stations) twice in a year (other than monsoon season) -(3 Stations x 3Seasons x 1 Year)	Rs.7,000 per station	63,000.00
21	Noise level Monitoring (8 Monitoring stations) twice in a year (other than monsoon season) -(8 Stations x 3Seasons x 1 Year)	Rs.1500 per station	36,000.00
22	Water Quality Monitoring (12 Monitoring stations) twice in a year (other than monsoon	Rs.7000 per station	2,52,000.00



Consultancy Services for Four Laning of existing Goa/Karnataka Border-Panaji Goa Section of NH-4A from Km 84.000 to Km 153.075 in the state of Goa on BOT (Toll) basis under NHDP-III (Anmod to Panaji Section)

Environmental Impact Assessment & Environmental Management Plan

S.No.	Item	Unit cost/ Lump sum cost (Rs.)	Total cost (Rs.)
	season) -(12 Stations x 3Seasons x 1 Year)		
23	Soil Quality Monitoring (3 stations) once in a year (other than monsoon season) -(3 Stations x 3Seasons x 1 Year)	Rs.6000 per sample	54,000.00
24	Disaster Management Plan	L.S	50,00,000.00
Sub Total			20,06,08,750.00
Service Tax @ 15 %			3,00,91313.00
Grand Total			23,07,00,062.00
Say@ Rs. 23.07 Crores			



CHAPTER -09

CONCLUSIONS AND RECOMMENDATIONS

9.0 CONCLUSIONS AND RECOMMENDATIONS

The proposed upgradation of existing road into 4 lanes with MoRTH guidelines from Anmod-Panaji stretch can harmonize with the surrounding environment with the following direct and indirect benefits.

1. The increased road capacity and improved pavements can reduce the travel time & traffic jams. Resulting, conservation of fuel and reduction of pollution load. Based on the vehicle population for year 2033, the saving of the fuel consumption per year estimated to be 46604.4 KL, which may have a direct savings of Rs. 272.9 Crores per year.
2. Due to road widening the noise levels can be reduced to 4-5 dB(A) & air pollutants will also be reduced considerably. Ultimately, this shows positive impact on human health.
3. There will be improvements of the economic growth in the surrounding places due to establishment of more industries, institutions, MNCs and other organizations.

Environmental Improvement Measure Adopted in the project are:

1. During the construction phase of the project, air pollution will be increased due to various construction activities, movement of construction vehicles etc. and the same will be mitigated by sprinkling of water thrice in a day. An amount of Rs. 65,70,000.00 provision is made in the EMP implementation budget to take care of this issue.
2. Avenue Plantation: There are two rows of avenue plants proposed along the Project corridor as per IRC-SP-21: 2011. There are 10,000 nos. of trees are affected due to the proposed project. Hence 20,000 nos. of trees are proposed to be planted, out of which 18035 nos. of trees are planted along the sides of road and 1965 nos. of trees are to be planted in parking areas, toll gates, bus bays, truck lay byes. The plants proposed are i.e., Cinamomum camphora, Dalbergia latifolia, Palms, Saraca indica, Sweitenia mahogoni, Tabubea rosea etc.
3. Median Plantation: Since the project is widening of two lane to four laning



project median will be utilised as it is. However, a provision of 50 Kms (excluding major and minor bridges) median plantation is made in the project to cover the bypasses, realignments etc. It is estimated that there are about 50 Kms (excluding major and minor bridges), Median plantation is proposed with provisions of 333 nos. of plants per kilometer in Wild life sanctuary and provisions of 666 nos. of plants per kilometer in the rest of the stretch. Hence, the estimated median plantation is around 27,445 nos. The median plant proposed in the project are i.e., Bougainvillea, Nerium Oleander, Thevetia Nerifolia, Tabernaemontana Coronaria etc.

4. Budget allocation for avenue and median plantation is Rs. 2.96 crores Implementation.
5. There are 200 nos. of RWH Pits are proposed either side of the road at an interval of 500m. The proposed RWHs are having dia. of 1.5 m with a depth of 3.8 m. The budget provision for the RWH structures are already made in the EMP and amount is estimated to be Rs. 0.30 Crores.
6. In the proposed project, there are fourteen Thermal Power Stations identified and which fall within 500 Km from the project corridor. The total Fly ash requirement during construction for utilizing in embankments, etc. is 4,00,000 Cum. Hence, Utilization of Fly Ash in the project shall be made as per the IRC SP:58 – 2001 and Fly ash Notification 2007 and subsequent amendments in 25th March,2015 and the same is estimated to be 18.7 crores and given under the BoQs.
7. The total budget for implementation of EMP during construction & operation phases of the project is for Rs. 20.0015 Crores.

In view of the above benefits, the road widening project can be taken up for the sustainable development of the society.



CHAPTER -10

DISCLOSURE OF CONSULTANT ENGAGED

10.0 DISCLOSURE OF THE CONSULTANT ENGANGED

Aarvee Associates is a premier, ISO 9001:2008 certified multi-disciplinary engineering consulting company, established in 1989 and based at Hyderabad in India. We have a pan-India presence, with branch offices in New Delhi, Ahmedabad and Bhubaneshwar, and project offices in all the major states across the country. We also have a wholly-owned Australian subsidiary, Aarvee Associates Pvt Ltd, based at Brisbane, Queensland.

In addition to over 1,000 successful assignments in India, we have carried out projects in Australia, Bangladesh, Ethiopia, Gabon, Mozambique, Nigeria, South Africa, Sri Lanka, and Uganda. We have worked on projects funded by various international agencies including the World Bank, the Asian Development Bank (ADB), the Department for International Development (DFID), and Japan International Cooperation Agency (JICA).

M/s. Aarvee Associates Architects Engineers and Consultants Pvt., Ltd., Hyderabad is a Civil Engineering Consultancy accredited by QCI-NABET in their Vide letter no. NABET/EIA/SA091/254 Dated: 12th December 2013 for doing EIA and EMP Studies in "Highways, Railways, Transport terminals, and Mass Rapid Transport Systems Sector".



ANNEXURE-1:Details of Borrow Areas/ Metal and Sand Quarries

S. No	Existing Chainage (Km)	Borrow Area	Side	Distance (km)	Area (Acres)	App. Depth/ Height (m)	App. Qty(m ³)
Borrow Areas							
1	96.500	BA-1	LHS	2.9	15	1.5	91057.5
2	96.500	BA-2	LHS	1.1	10	1	40470
3	101.600	BA-3	LHS	1.6	10	2	80940
4	103.200	BA-4	LHS	0.2	15	2	121410
5	107.800	BA-5	LHS	0.2	10	2	80940
6	112.000	BA-6	LHS	0.6	10	2	80940
7	116.700	BA-7	LHS	0.2	12	1.5	72846
8	146.800	BA-8	LHS	0.6	30	5	6070650
9	138.900	BA-9	RHS	1	20	5	404700
10	120.500	BA-10	RHS	0.2	15	2	121410
Metal Quarries							
1	146.800	MQ-1	LHS	0.6	30	5	607050
2	118.900	MQ-2	LHS	20	50	5	1011750

Sand Quarries				
S. No	Existing Chainage (Km)	Side	Distance (km)	Zone
1	99.700	LHS	0.8	III
2	140.200	RHS	2	III



CHAPTER – 11

PROVISIONS FOR WILDLIFE CROSSING

About Animal Passages :

Wildlife/Animal passages are those structures that facilitates the movement of wildlife across the man made barriers. Wildlife crossing structures are an important tool in multiple ecosystems to allow safe passage for wildlife across roadways. Hence, it is very essential to construct/provide access to cross the road for an animal to enable the movement, to maintain the continuity of the ecosystem. As the vehicles move at the design speed several animals may meet with accidents and succumb serious injuries. The purpose of constructing animal passes is to ensure free movement of animals by avoiding accidents due to vehicular movement.

Animal passes have to be provided based on the type of terrain and the type of wildlife in the region. These passages have to be constructed and maintained in such a way that the animals feel that the passage is a natural corridor.

Wildlife/Animal passes can be majorly divided into underpasses and overpasses depending on the type of terrain. **Overpasses** are those which allows passage of animals above the road, Similarly **Underpasses** allows the passage of animals below the road. Construction/Provision of fencing/railing is also an important measure to avoid accidents to animals. Further, fencing directs the animals to effectively use the passages and also acts as a barricade to stop the animals entering the highway.

Animal Underpasses/Overpasses along proposed project stretch

The proposed road widening in the Bhagwan Mahaveer wildlife sanctuary by constructing viaduct parallel to the existing road hardly abstracts the animal movement. However, wherever the existing road is being used a 2 Lane/4 Lane road, locations were identified with the help of the forest officials where the animals frequently crosses the road.

Important locations were identified to construct four animal passes in the proposed stretch. Based on the terrain conditions 3 Underpasses and 1 Overpass are proposed for wildlife movement. Details of the Underpasses and Overpasses locations are given below :

Table 11.1 Proposed Animal passages in Wildlife Sanctuary & National Park

Locations	Design Chainage (Km)	Latitude	Longitude	Proposal	Provisional Specifications
1	84.400L	15°25'4.94"N	74°16'3.24"E	Underpass	12 m X 5 m
2	92.150R	15°23'45.38"N	74°14'16.09"E	Underpass	20 m X 5 m



Locations	Design Chainage (Km)	Latitude	Longitude	Proposal	Provisional Specifications
3	93.170R	15°23'14.34"N	74°14'10.94"E	Underpass	12 m X 5 m
4	93.850R	15°23'2.90"N	74°13'58.21"E	Overpass	12 m X 5 m

Sectional View of the Proposed Passages :

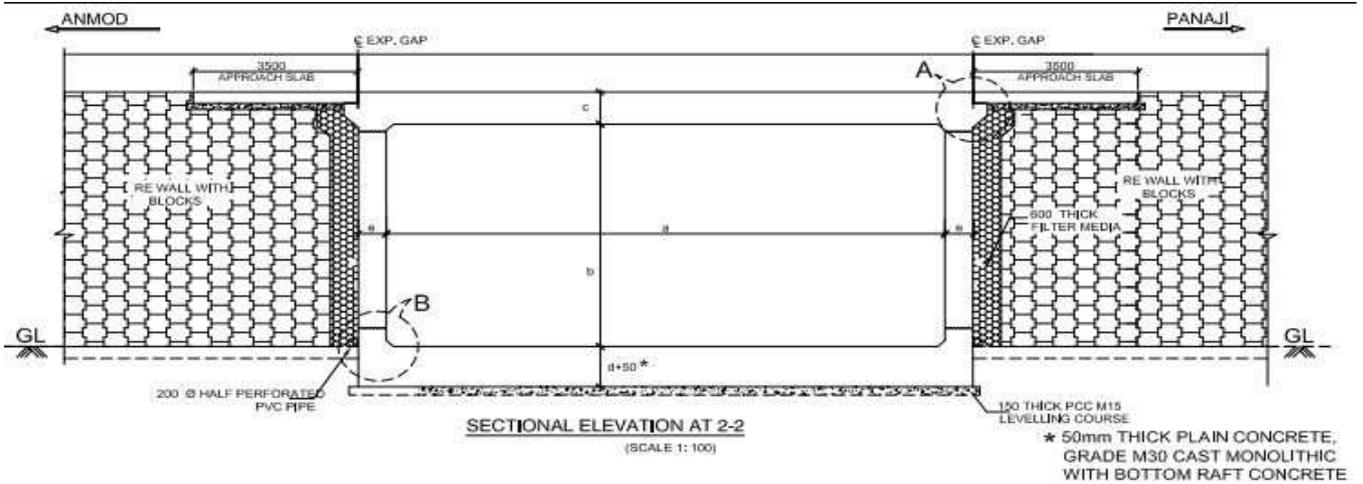


Fig. 11.1 Animal Underpass

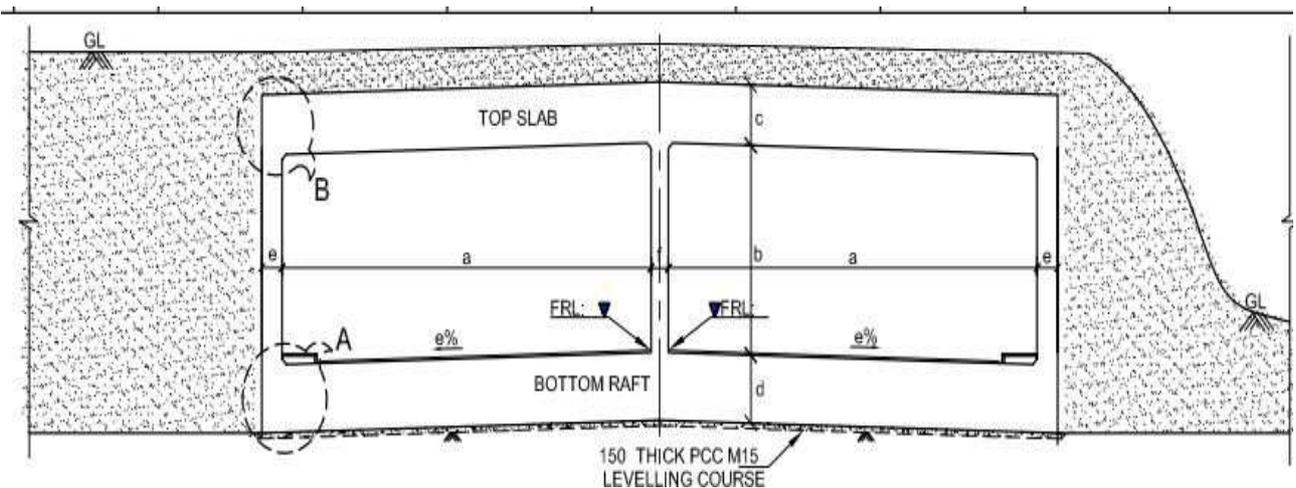


Fig. 11.2 Animal Overpass



Fig. 11.3 : Locations of the Animal Passages along the project corridor





Fig. 11.4 : Typical View of the Animal Underpass

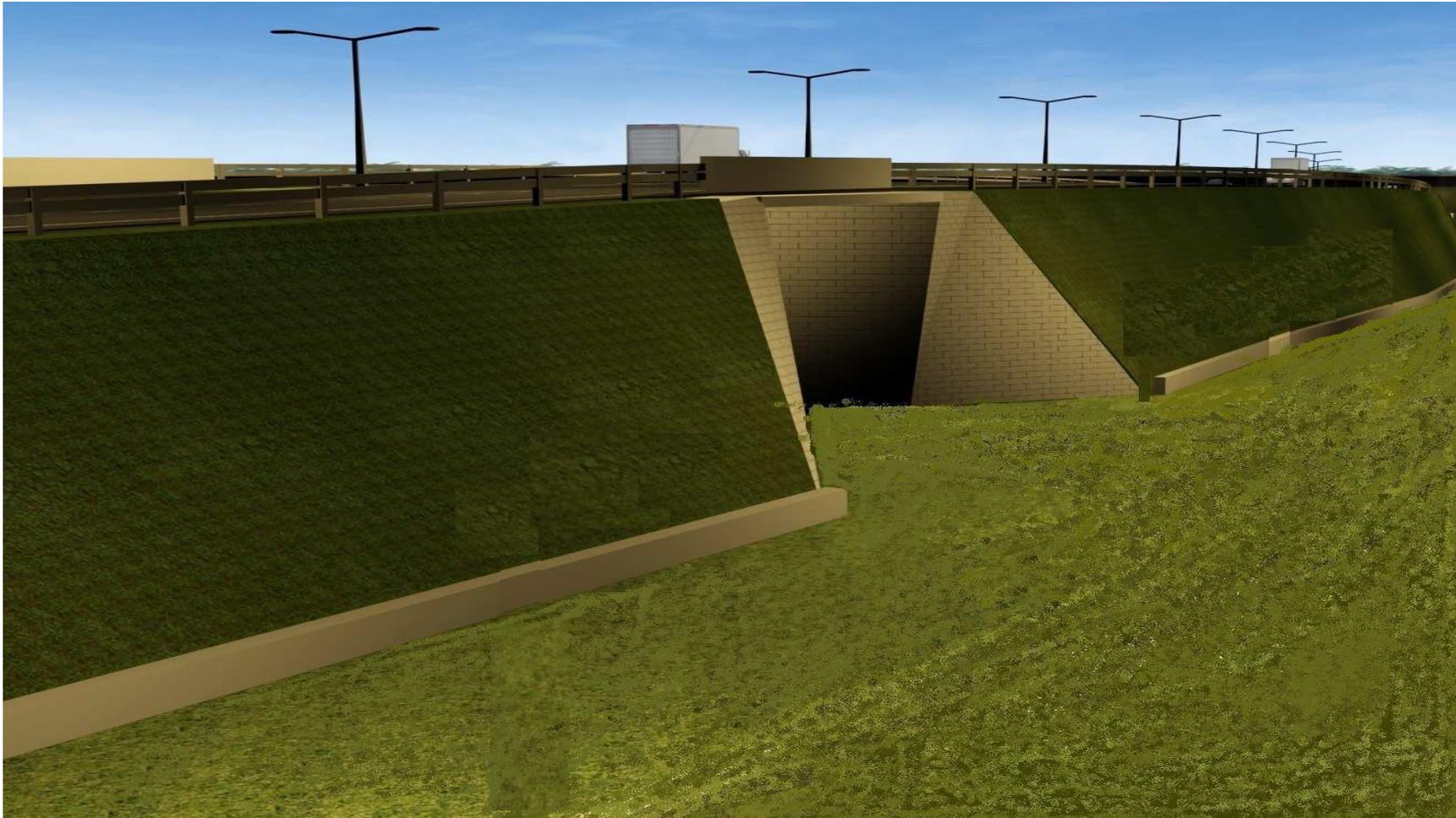




Fig. 11.5 : Typical View of the Animal Overpass

