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1. INTRODUCTION

1.1 Project Background

The Government of India has taken up development of Economic Corridors, Inter Corridors, Feeder Corridors and National Corridors (GQ and NS-EW Corridors) to improve the efficiency of Freight Movements in India under Bharatmala Pariyojana. The National Highways Authority of India (NHAI) has appointed M/s. Feedback Infra Pvt. Ltd. for providing the required Consultancy services for preparation of Detailed Project Report for 5 such corridors under LOT 6//Package 1, in Tamil Nadu State. Originally 5 corridors, as listed below, were included in the project, which were subsequently modified as below

Classification	Corridor Name	Road	State	Stretch Name (Start – End)	Original length (Km)	Revised Length (Km)	Changes Suggested
Economic Corridor	Chennai - Madurai	NH - 132	TN	Tindivanam - Trichy	205	253	The original 6 lane widening of existing road proposal changed to Chennai – Tiruvannmalai – Harur Salem Greenfield Highway.
Economic Corridor	Chennai - Madurai	NH - 32	TN	Maduravoyal - Tambaram	19	0	Road not to be considered now
Economic Corridor	Chennai - Madurai	NH - 38	TN	Tovarankurchi - Madurai	64	27	The road to be changed to Tovarankurichi – Natham (27 km) for development of 4 lane facility
Economic Corridor	Mumbai - Kanyakumari	NH - 66	TN	Padmanavan - Kanyakumari	31	0	Road not to be considered now
Inter Corridor	Coimbatore – Trichy - Tanjavore	NH - 83	TN	Tanjavur - Trichy	56	56	No change
Additional							The Salem Bypass (22 km) to be included
Additional							Three Spurs on Chennai Salem Highway (51 km) to be added

The scope of the project is to establish the technical, economic and financial viability of the project and prepare Detailed Project Reports for proposed 6 / 8 lane access controlled Chennai Salem greenfield highway of 277.3 km long including Salem Bypass and 51 km long three Spurs (Kanchipuram to Changelpattu Spur of 30.000 km (SH 132b), Chetpet Spur of 4.7

(SH 4) km and Tiruvannmalai Spur of 16 km (NH 38)), development of Tovarankurichi to Natham road to 4 lane facility and Tanjavur to Trichy road (56 km) to 6 lane facility in a sound technical and most economical manner, taking into consideration the environment and social aspects of the area, quality audit and safety audit requirement in design and to carry out through financial analysis for implementation. The Consultants have already submitted the Inception Report and Alignment Report as part of the assignment. This report pertains to Feasibility Study of the **Green Field Chennai-Salem highway** (From Chennai Outer Ring Road to end of Salem Bypass) along with 3 Spurs as mentioned above.

1.2 Scope of Consultancy Services

The main objective of the consultancy services is to establish the technical, economic and financial viability of the project and prepare Detailed Project Report for Greenfield Green field highway including rehabilitation and upgrading of the existing road, if any.

The Scope of work shall thus cover the following major tasks.

i. Review of all available reports and published information about the project road and the project influence area.

ii. Environmental and social impact assessment, including social related to cultural related properties, natural habitats, involuntary resettlement etc.

ii Public consultation, including consultation with communities located along the road, NGOs working in the area, other stake holders and relevant Government Departments at all the different stages of assignment (such as inception stage, feasibility stage, preliminary design stage and once final designs are concretized).

iii. Detailed Reconnaissance.

iv. Identification of possible alternative alignments for Green field highway along with improvements in the existing alignment, if any bypassing congested locations with alternatives, evaluation of different alternatives comparison on techno-economic and other considerations and recommendations regarding most appropriate option.

v. Traffic studies including traffic surveys and Axle load survey and demand forecasting for next thirty years.

vi. Inventory and condition surveys for the spurs (existing road), existing road portions other than the proposed green field highway.

vii. Inventory and condition surveys for bridges, cross-drainage structures, other Structures, river Bank training/Protection works and drainage provisions.

viii. Detailed topographic surveys using LIDAR equipped with minimum engineering grade system or any other better technology having output accuracy not less than
(a) Specified in IRC SP 19
(b) Total Station
(c) GPS/ DGPS
The use of conventional high precision instruments i.e. Total Station or equivalent can be used at locations such as major bypasses, water bodies etc. where it may not be possible to survey using LIDAR.

ix. Pavement investigations.

x. Sub-grade characteristics and strength: investigation of required sub-grade and sub-soil characteristics and strength for road and embankment design and sub soil investigation.

xi. Identification of sources of construction materials.

xii. Detailed design of road, its x-sections, horizontal and vertical alignment and design of embankment of height more than 6m and also in poor soil conditions and where density consideration require, even lesser height embankment. Detailed design of structures preparation of GAD and construction drawings and cross-drainage structures and underpasses etc.

xiii. Identification of the type and the design of intersections.

xiv. Identification and design of grade separated interchanges

xv. Design of complete drainage system and disposal point for storm water.

xvi. Value analysis / value engineering and project costing.

xvii. Economic and financial analysis.

xviii. Contract packaging and implementation schedule.

xix. Strip plan indicating the scheme for schedule for LA: reports documents and drawings arrangement of estimates for cutting/ transplanting of trees and shifting of utilities from the concerned department.

xx. To find out financial viability of project for implementation and suggest the preferred mode on which the project is to be taken up.

xxi. Preparation of detailed project report, cost estimate, approved for construction Drawings, rate analysis, detailed bill of quantities, bid documents for execution of civil works through budgeting resources.

xxii. Design of toll plaza and identification of their numbers and location and office cum residential complex including working drawings.

xxiii. Design of weighing stations, parking areas and road side amenities.

xxiv. Any other user oriented facility en-route toll facility.

xxv. Tie-in of on-going/sanctioned works of MORT&H/ NHAI/ other agencies.

xxvi. Preparation of social plans for the project affected people as per policy of the lending agencies / Govt. of India R&R Policy.

1.3 Schedule of Deliverables:

As per Terms of Reference of Contract Agreement the following documents have to be prepared and submitted to the NHAI.

1.	Stage I	- Draft Inception Report including QAP document
		- Inception Report including QAP document
		- Draft Alignment Report
		- Final Alignment Report
2.	Stage II	- Draft Feasibility Study Report including option study report
		- Final Feasibility Study Report incorporating compliance of comments of Client
3.	Stage III	- Draft LA and Clearances I Report
		- Final LA and Clearances I Report incorporating compliance of comments of Client

4.	Stage IV	-	Draft DPR
		-	Final DPR incorporating compliance of comments of Client
5.	Stage V	-	Draft Technical Schedules
		-	Final technical schedule
6.	Stage VI	-	LA and Clearances II Report

1.4 Structure of the report (Draft Feasibility Report):

This report (Draft Feasibility Report) has been chaptalized as below.

Chapter 1 : Introduction
Chapter 2 : Site of the project
Chapter 3 : Socio-Economic Profile of the area
Chapter 4 : Traffic studies and Forecast
Chapter 5 : Finalization of Alignment for the Expressway
Chapter 6 : Specifications and Standards
Chapter 7 : Preliminary Design of the Project
Chapter 8 : Project Facilities
Chapter 9 : Preliminary Project Cost
Chapter 10 : Environmental Screening and Preliminary Environmental Assessment
Chapter 11 : Initial Social Assessment
Chapter 12 : Conclusions

2. SITE OF THE PROJECT

2.1. General

The present connection between Chennai to Salem is provided by three routes; **Route I** : National Highways NH-48 and NE2 passing through Chennai, Kanchipuram, Vellore, Krishnagiri, Dharmapuri and Salem districts of Tamil Nadu state with the length of 352.70 Km consisting 4/6 lane configuration, **Route II :** National Highway NH-48 and State Highway SH-18 (New NH-179A) travelling along same districts as route I has a length of 331.89 Km consisting 2/4 lane configuration and **Route III :** National Highway NH-32, NH-132, NH-38, NH-79 and NE2 traversing along Chennai, Villupuram and Salem districts of Tamil Nadu state with the length of 334.28 Km with 2/4 lane configuration. Since these routes are not access-controlled, speed of the travel is affected by considerable cross movement of traffic through the side roads and access of vehicles from the abutting settlements leading to slower than design speed of the through traffic. Besides, the sections through mountainous terrain along existing route II on SH-18 (New NH-179A) section have lower radius curves at some places which restrict smooth movement of traffic at design speed.

The idea of constructing a high- speed facility like a fully access-controlled green field highway has originated from the primary necessity to eliminate the bottlenecks and limitations that exist in the present corridors to reduce the travel time between Chennai – Salem. It has been felt that substantial reduction of travel time between these two districts would not only fetch direct benefits to the users due to less vehicle operating cost, passenger time saving and other intangible benefits as well. The connectivity provided through interchanges with residential, commercial and industrial hub would also fetch direct and indirect benefits. The project is expected to generate development around the abutting towns connected through proposed spurs from the green field highway. Number of openings and employment opportunities to the local people and for the local and National contractors as well, which would satisfy the Federal Govt agenda of employment opportunities. There would be short and long term tangible and intangible benefits by this project.

All the above factors warrant the construction of an access controlled green field highway ensuring safety and high speed movement of men and materials from production units to consumers in shortest possible time.

The present project alignment has been sub divided into parts of two recently declared National Highways (NH 179A and 179B). The first part of the project alignment, (179A) starts from Salem bypass end (Project chainage 0+000), and ends at the off-take point of NH 179A to Baniyambadi (Project Chainage 57+300 km). The second part of the project alignment, (179B) starts from the Chennai bypass at Vandalur (Project chainage 0+000), and ends at the off-take point of NH 179A to Baniyambadi (Project Chainage 220+000 km).

Comparative statement of proposed green field highway with the existing routes between Chennai to Salem

Sl. No	Description	Existing Route I	Existing Route II	Existing Route III	Proposed Alignment
1	**Length, km**	352.70	331.89	334.28	277.300
2	**Start point**	Alignment starts at Maduravoyal Cloverleaf junction in Chennai	Alignment starts at Maduravoyal Cloverleaf junction in Chennai	Alignment starts at Maduravoyal Cloverleaf junction in Chennai	Alignment starts near Chennai ring road in Vandalur due to constraints for the green field highway in the Chennai city. It is about 24.89 Km from proposed start location to Maduravoyal Cloverleaf junction
3	**End point**	Alignment ends at NH-544 Trumpet interchange junction	Alignment ends at NH-544 Trumpet interchange junction	Alignment ends at NH-544 Trumpet interchange junction	After bypassing Salem district alignment ends connecting NH-544
4	**Districts**	Chennai, Thiruvallur, Kanchipuram, Vellore, Krishnagiri, Dharmapuri, Salem	Chennai, Thiruvallur, Kanchipuram, Vellore, Krishnagiri, Dharmapuri, Salem	Chennai, kanchipuram, Villupuram, Salem	Chennai, Kanchipuram, Thiruvannmalai,Krishnagiri, Dharmapuri, Salem
5	**Connecting Highways**	NH-48 & NE2	NH-48 & SH-18 (New NH-179A)	NH-32, NH-132, NH-38,NH-79 & NE2	-
6	**Design Speed, Kmph**	60-80	60-80	60-80	120
7	**Lane Configuration**	4/6 Lane	4 Lane (2 Lane SH-18)	2/4 Lane	6 lane / 8 Lane Access Controlled
8	**Right of Way, m**	30 - 45	30 – 45 (10 – 15 SH-18)	30 - 45	70m / 90m
9	**Approx Travel**	5.43	6.54	5.24	3.00

Sl. No	Description	Existing Route I	Existing Route II	Existing Route III	Proposed Alignment
	Time, Hours minutes				
10	**No of NH crossings**	6	5	6	5
11	**No of SH crossings**	21	21	20	10
12	**Access Control**	No access /Partial access control	No access /Partial access Control	No access /Partial access Control	Complete access control with only 9 possible location for Entry and exit.
13	**Merits**	1. Since roads are already present, there is no structure affecting and land acquisition, unlike the proposed greenfield highway. 2. All the existing routes are either no access/partial access controlled, the connectivity is much higher to the villages/town along its path. 3. Although the average travel time for these routes from Chennai to Salem is 5 hours 45 minutes, with the improvements to the existing it can be reduced. 4. There is no forest land acquisition, which is a very difficult & lingering process required for proposed greenfield highway. 5. Proposed highway with closed toll policy system is difficult to access for a common man.			1. Better connectivity to major towns through spurs at Kanchipuram-Changalpattu, Chepet & Tiruvannamalai utlising existing SH-58, SH-4 & NH-234 respectively. 2. Shorter travel time and distance compared to existing routes. 3. Completely access controlled for high a speed corridor. 4. Green field highway intends to connect industrial area and special economic zones present along Chennai and Salem districts. 5. The new access controlled green field highway will pave the way for economic development of the region.

Sl. No	Description	Existing Route I	Existing Route II	Existing Route III	Proposed Alignment
14	**Demerits**	1. All the existing roads are having 2/4 lane configuration except a small stretch from Walajapet to Krishnagiri with 6 lane configuration along existing route I, leading to congestion in traffic movement and higher vehicle operation cost. 2. Widening of existing roads not only causes large structures being affected but also leads to many socio-economic issues. 3. Even with the widening, travel time will be more due to reduction in speed due to congestion and mixing of local traffic. 4. Rehabilitation & resettlement cost (R&R) will be very high.			1. With the complete access control the green field highway, connectivity to the smaller villages and town are not possible. 2. Greenfield alignment leads to higher land acquisition, Also the structure proposals like double trumpet interchange, cloverleaf & at grade interchanges requires additional area to be acquired. 3. The alignment requires tunnel at 3 location spanning a Length of 2.5km. 4. Forest land needs to be acquired which is about 10.680km.

2.2. Districts linked by the project

The expressway route will link following districts as shown in **Table 2-1:**

Table 2-1

S. No.	District	Population (2011 Census)
1	Kanchipuram	40.0 Lakhs
2	Thiruvannmalai	24.8 Lakhs
3	Krishnagiri	18.8 Lakhs
4	Dharampuri	15.1 Lakhs
5	Salem	34.8 Lakhs

2.3. Villages Falling Along the Expressway Alignment

On preliminary assessment, it is found that a total of 854 villages fall along the Expressway alignment. The tentative numbers of villages according to the districts falling within are given below as **Table 2-2**.

Table 2-2

S. No.	Name of the Districts	No. of Villages
1	Kanchipuram	42
2	Thiruvannmalai	74
3	Krishnagiri	1
4	Dharampuri	24
5	Salem	18
	Total	**159**

2.3.1 Villages Falling Along the Green Field Highway Alignment

The green field highway alignment from Vandalur pass through 159 villagesthe lands of 193 villages. The details of district, Taluks and villages are shown below as **Table 2-3.**

Table 2-3: Villages Falling Along the Green Field Highway Alignment

S.NO.	DISTRICT	TALUK	VILLAGES
1	KANCHIPURAM	SRIPERUMBUDUR	VARADHARAJAPURAM
2			VALAYAKARANAI
3			ADHANUR
4			KARASANGAL
5			THUNDALKALANI
6			KORUKANTHANGAL
7			ORATHUR
8			SENTHAMANGALAM
9			KAVANUR

S.NO.	DISTRICT	TALUK	VILLAGES
10			NATTARASANPATTU
11			ARAMBAKKAM
12			ERIVAKKAM
13			KANCHIVAKKAM
14			UMAYALPARAMANCHERI
15			VADAKKUPATTU
16			KOLATHANCHERI
17			ECHOOR
18			KOLATHANCHERI
19			POONDI
20		CHENGALPATTU	MANNIVAKKAM
21			AMMANUMBAKKAM
22			APPUR
23			GURUVANMEDU
24			REDDIKUPPAM
25		UTHIRAMERUR	SEETTANCHERRY
26			ARUMBULIYUR COLONY
27			KARUMBAKKAM
28			ARUMBULIYUR
29			SEETHAPURAM
30			SEETHANANJERI
31			PINAYUR
32			ANAMBAKKAM
33			CHITALAPAKKAM
34			PUTHALI
35			ADAVAPAKKAM
36			OZHUGARAI
37			AZHISOOR
38			SILAMBAKKAM
39			VENGARAM
40			KARUVEPPAMPOON
41			HANUMANTHANDALAM
42			ELANAGAR
43	THIRUVANNMALAI	CHEYYAR	SIRUNALLUR
44			KILNEERKUNDRAM
45			ATHI
46			VADA ALAPIRANDAN
47			ANAPATHUR
48			ERUMAIVETTI
49			THENTHANDALAM
50			PERUMBALAI
51			VILARIPPATTU
52			CHITTAMOOR

S.NO.	DISTRICT	TALUK	VILLAGES
53			THENMAVANTHAL
54			SENGADU
55			KOVILUR
56		VANDABASI	VILANALLUR
57			NAMBEDU
58			ARIYAPADI
59			INJIMEDU
60			SANDIRAMBADI
61			ALLIYANDAL
62			MAHADEVIMANGALAM
63			NAMATHODU
64			TAVANI
65			KONAMANGALAM
66			ANADIMANGALAM
67		POLUR	KOTHANDAVADY
68			MARUTHUVAMBADY
69			KOLAKKARAVADY
70			THATCHAMBADI
71			ATHURAI
72			CHITTATHURAI
73			PERANAMBAKKAM
74			SEMIYAMANGALAM
75			RANDAM
76			KAMBUT
77			PELASUR
78		THIRUVANNMALAI	PALLIKONDAPATTU
79			NELLIMEDU
80			C. ANDAPATTU
81			ANDAPATTU
82			NARTHAMPOONDI
83			MUTHARASAMPUNDI
84			SIRU KILAMBADI
85		CHENGAM	PERIYA KILAMBADI
86			NAYAMBADI
87			ARIDHARIMANGALAM
88			NAMMIANDAL KOOT
89			ORAVANDAVADI
90			ALATHUR
91			KORATTAMPATTU
92			PUDUPATTU
93			PANAIOLAPADI
94			NANDIMANGALAM
95			UNNAMALAIPALAYAM

S.NO.	DISTRICT	TALUK	VILLAGES
96			PERIYERI
97			PUDURCHENGAM
98			MUNNURMANGALAM
99			ANWARABATH
100			SE.NACHIPATTU
101			MANMALAI
102			CHENGAM
103			PERUMBATTAM
104			PERUMBAKKAM
105			PAKKIRIPALAYAM
106			MELPULIDIYUR
107			ANDANUR
108			VEDANKUPPAM
109			MELVANAKKAMBADI
110			PERUMANADU
111			MELPALLIPATTU
112			ANANDAVADI R.F
113			KARIMALAPADI
114			MELRAVANDAVADI
115			NARADAPATTU
116			KATTAMADUVU
117	KRISHNAGIRI	UTHANGARAI	ATHIPADI
118	DHARMAPURI	HARUR	ETTIPATTI
119			TAMBAL
120			VEDAKADAMADUVU
121			ALAMBADI
122			ANDIYUR
123			THEERTHAMALAI
124			MAMBADI
125			VEPPAMPATTY
126			PALAYAM
127			GUDALUR
128			ITTAIAMPATTY
129			THEDAMPATTI
130			KAMMALAMPATTY
131			HARUR
132		PAPPIREDDIPATTI	NAMBIPPATTI
133			CHINNANKUPPAM
134			PARAYAPATTI
135			ERUMIYAMPATTI
136			PUDUPATTI
137			ERULAPATTI
138			KAVANDAMPATTY
139			THADAMPATTI

S.NO.	DISTRICT	TALUK	VILLAGES
140			PALLIPATTI
141			PAPPIREDDIPATTI
142	SALEM	YERACAUD	KUTTUR R.F.
143			MANJAVADI R.F.
144		VAZHAPADI	KULLAMPATTY
145			MINNAMPALLI
146		SALEM	VELAMPATTI R.F.
147			ACHANKUTTAPATTI
148			MOOKANUR
149			KUPPANUR
150			VELLAIYANPATTI
151			SUKKAMPATTI
152			VALASAIYUR
153			PARAPATTI
154			NILAVARAPATTI
155			NALIKALPATTI
156			SITTANERI
157			VEERAPANDI
158			AKKARAPALAYAM
159			GAJJALNAICKENPATTI

2.4 Requirement of Crossing Structures

2.4.1 Along the Expressway

The expressway will be crossing the existing NH, SH, MDR, ODR, canals, rivers, railway tracks etc, where major structures such as bridges, interchanges, grade separators, ROB's underpasses etc. will be required. An assessment of the requirement of major structures is provided in the following **Table 2-4:**

Table 2-4: Crossing Structures

S.No	Structure Type	Location	
		Nearest Place	District
1	Trumpet Interchange	Varadharajapuram	Kanchipuram
2	MJB	Neelamangalam	Kanchipuram
3	VUP G-II	Neelamangalam	Kanchipuram
4	VUP	Orathur	Kanchipuram
5	VUP	Vadamelpakkam	Kanchipuram
6	VUP	Kanchivakkam	Kanchipuram
7	MJB	Kanchivakkam	Kanchipuram
8	Flyover	Umayalparamancheri	Kanchipuram
9	MJB	Umayalparamancheri	Kanchipuram
10	VUP	Guruvanmedu	Kanchipuram
11	VUP G-II	Guruvanmedu	Kanchipuram

S.No	Structure Type	Location	
		Nearest Place	District
12	ROB Cum MJB Cum Flyover Cum Interchange	Palur	Kanchipuram
13	VUP	Seetancherry	Kanchipuram
14	VUP	Sethapuram	Kanchipuram
15	VUP	Anambakkam	Kanchipuram
16	VUP	Sirumailur	Kanchipuram
17	MJB	Sirumailur	Kanchipuram
18	VUP G-II	Vayalakkavoor	Kanchipuram
19	MJB	Irumaram	Kanchipuram
20	Flyover	Adavapakkam	Kanchipuram
21	VUP G-II	Vengaram	Kanchipuram
22	VUP G-II	Elanagar	Kanchipuram
23	VUP	Manampathi	Kanchipuram
24	MJB Cum Flyover	Nedungal	Tiruvannamalai
25	VUP G-II	Vada Alapirandan	Tiruvannamalai
26	VUP G-II	Erumaivetti	Tiruvannamalai
27	Interchange	Thenthanadalam	Tiruvannamalai
28	MJB	Perumbalai	Tiruvannamalai
29	MJB	Chittamoor	Tiruvannamalai
30	VUP G-II	Thenmavanthal	Tiruvannamalai
31	VUP	Vilanallur	Tiruvannamalai
32	MJB	Kottagaram	Tiruvannamalai
33	VUP G-II	Kottagaram	Tiruvannamalai
34	VUP	Nambedu	Tiruvannamalai
35	MJB	Pudur	Tiruvannamalai
36	VUP	Ariyapadi	Tiruvannamalai
37	MNB Cum VUP	Alliyandal	Tiruvannamalai
38	VUP G-II	Tavani	Tiruvannamalai
39	VOP @ 90+940	Visamangalam	Tiruvannamalai
40	Double Trumpet Intechange	Ulagampattu	Tiruvannamalai
41	VUP G-II	Appedu	Tiruvannamalai
42	VUP G-II	Kollakaravady	Tiruvannamalai
43	VOP @ 103+480	Thatchambadi	Tiruvannamalai
44	VUP	Athurai	Tiruvannamalai
45	VUP G-II	Peranambakkam	Tiruvannamalai
46	VUP	Analiya kambattu	Tiruvannamalai
47	MJB	Pathiyavadi	Tiruvannamalai
48	Flyover	Palliput	Tiruvannamalai
49	Trumpet Interchange	Palliput	Tiruvannamalai
50	VUP	Andapattu	Tiruvannamalai
51	VUP	Periya Kilambadi	Tiruvannamalai
52	VUP	Namminadal Koot	Tiruvannamalai

S.No	Structure Type	Location	
		Nearest Place	District
53	MJB	Namminadal Koot	Tiruvannamalai
54	MJB	Pudupattu	Tiruvannamalai
55	VUP G-II	Pudupattu	Tiruvannamalai
56	MNB Cum VUP	Alliandal	Tiruvannamalai
57	MJB	Melapunjai	Tiruvannamalai
58	VUP G-II	Narasinghanallur	Tiruvannamalai
59	VUP	Melmudiyanur	Tiruvannamalai
60	MJB	Nachipattu	Tiruvannamalai
61	Interchange	Manmalai	Tiruvannamalai
62	MJB	Perumbattam	Tiruvannamalai
63	MJB	Melpulidiyur	Tiruvannamalai
64	MJB	Melpulidiyur	Tiruvannamalai
65	VUP G-II	Andanur	Tiruvannamalai
66	MJB	Melvanakkambadi	Tiruvannamalai
67	VUP G-II	Andipatti	Tiruvannamalai
68	VUP G-II	Andipatti	Tiruvannamalai
69	VUP G-II	Naradapattu	Tiruvannamalai
70	VUP G-II	Athipadi	Krishnagiri
71	VUP G-II	Neepathurai	Tiruvannamalai
72	MJB	Neepathurai	Tiruvannamalai
73	VUP G-II	Neepathurai	Tiruvannamalai
74	VUP G-II	Andiyur	Dharmapuri
75	Flyover	Andiyur	Dharmapuri
76	VUP G-II	Theerthamalai	Dharmapuri
77	VUP	Palayam	Dharmapuri
78	VUP G-II	Pudinattam	Dharmapuri
79	VUP	Ittaiampatty	Dharmapuri
80	MJB	Thedampatti	Dharmapuri
81	VUP	Harur	Dharmapuri
82	MJB	Kalladipatty	Dharmapuri
83	MJB	Nachanampatti	Dharmapuri
84	MJB	Nambipatti	Dharmapuri
85	VUP G-II	Pethathampatti	Dharmapuri
86	VUP G-II	Puludiyur	Dharmapuri
87	VUP G-II	Pappambadi	Dharmapuri
88	MNB Cum VUP	Mookkareddipatti	Dharmapuri
89	Interchange	Pallipatti	Dharmapuri
90	Flyover	Pattukonampatty	Dharmapuri
91	Flyover	Krishnapuram	Dharmapuri
92	VUP G-II	Manjavadi	Dharmapuri
93	Flyover	Kombur	Dharmapuri
94	Flyover	Mookanur	Salem

S.No	Structure Type	Location	
		Nearest Place	District
95	VUP G-II	Vellaiyanpatti	Salem
96	Flyover	Kullampatty	Salem
97	VUP	Minnampalli	Salem
98	Cloverleaf Interchange	Ramalingapuram	Salem
99	VUP G-II	Masiyanakampatti	Salem
100	VUP G-II	Masiyanakampatti	Salem
101	VUP G-II	Masiyanakampatti	Salem
102	VUP G-II	Masiyanakampatti	Salem
103	Double Trumpet Intechange	Gajallanickenpatti	Salem
104	MJB	Nalikalpatti	Salem
105	Trumpet Interchange	Ariyanur	Salem

3. SOCIO-ECONOMIC PROFILE

3.1 INTRODUCTION

To understand completely how the growth of traffic and demand for transport infrastructure is dependent on the region's available resources, human and natural, the social and economic distribution, the gross output, the growth potential, a study of socioeconomic profile is essential. For a region a close inter-relation exists between the socio economic activity and transport infrastructure. The region's development is completely governed by these two components and how they complement each other.

This chapter endeavours to provide socio-economic profile at two levels i) Region or State level and ii) Project Influence Area. Socio-economic and demographic data of the project area – population & density, employment, poverty levels, industry, agriculture, literacy, health, transport, tourism potential and related aspects. Socio- economic profile has been prepared to provide a quantitative framework against which qualitative socio and economic impacts of any of the development initiative can be assessed and evaluated.

3.2 BACKGROUND

The socio economic profile helps in making project implementation decisions. A survey of historical economic and demographic activity can help to explain current social status distribution among the society, the living standards, the quality of life, the general awareness, maturity levels, in turn the reflection on the growth of traffic etc.

An understanding of the past and current industrialization, for example, could help to explain the presence and contemporary value of the dams that obstruct fish passage, the types of contaminants that are likely to be present behind those dams, and the economic and political pressures that may promote or inhibit their removal or modification, which decide the investing potential in the region.

The socio-economic profile is discussed in terms of a few selected indicators, which are broadly categorized in to the following and hence together are termed as Socio Economic Indicators.

Socio and Demographic Indicators

Social indicators are set of indicators that measure progress towards the policy objectives designed for promoting employment, combating poverty, improving living and working conditions, combating exclusion, developing human resources, etc.

Demographic Indicators are a scientific measure of human population dynamics. It encompasses the study of the size, structure and distribution of populations, and how populations change over time due to births, deaths, migration and ageing.

A list of socio and demographic indicators considered for this report is as under:

- Population
- Male/Female Ratio
- Health
- Household
- Literacy
- Poverty
- Employment

Economic Indicators

An economic indicator is simply any economic statistic, which indicates how well the economy is doing and how well the economy is going to do in the future. To understand economic indicators, we must understand the ways in which economic indicators differ. Alternatively statistics, which indicates current economic growth rates and trends such as retail sales and employment. Economic indicators allow analysis of economic performance and predictions of future performance.

- Gross Domestic Product (GDP)
- Net State Domestic Product (NSDP)
- Per Capita Income
- Agriculture & Irrigation
- Industry
- Transportation

3.3 PROJECT BACKGROUND

The Government of India has decided to develop Economic Corridors, Inter Corridors, Feeder Corridors and National Corridors (GQ and NS-EW Corridors) to improve the efficiency of Freight Movements in India under Bharatmala Pariyojana.

The National Highways Authority of India (NHAI) has appointed M/s. Feedback Infra Pvt. Ltd. for providing the required Consultancy services for preparation of Detailed Project Report for 5 such corridors under LOT 6//Package 1, in Tamilnadu State.

Originally 5 corridors, as listed below, were included in the project, which were subsequently modified as below

Classification	Corridor Name	Road	State	Stretch Name (Start – End)	Original length (Km)	Revised Length (Km)	Changes Suggested
Economic Corridor	Chennai - Madurai	NH - 132	TN	Tindivanam - Trichy	205	253	The original 6 lane widening of existing road proposal changed to Chennai – Tiruvannmalai – Harur Salem Greenfield Highway.
Economic Corridor	Chennai - Madurai	NH - 32	TN	Maduravoyal - Tambaram	19	0	Road not to be considered now
Economic Corridor	Chennai - Madurai	NH - 38	TN	Tovarankurchi - Madurai	64	27	The road to be changed to Tovarankurichi – Natham (27 km) for development of 4 lane facility
Economic Corridor	Mumbai - Kanyakumari	NH - 66	TN	Padmanavan - Kanyakumari	31	0	Road not to be considered now
Inter Corridor	Coimbatore – Trichy - Tanjavore	NH - 83	TN	Tanjavur - Trichy	56	56	No change

Classification	Corridor Name	Road	State	Stretch Name (Start – End)	Original length (Km)	Revised Length (Km)	Changes Suggested
Additional							The Salem Bypass (22 km) to be included
Additional							Three Spurs on Chennai Salem Highway (51 km) to be added

3.4 PROJECT LOCATION

Existing roads starting at Chennai traverses through Kanchipuram, Vellore, Krishnagiri, Dharmapuri, Villupuram and ends at Salem district of Tamil Nadu state. District wise details along existing routes are given in **Table 3-1.**

Table 3-1: District wise details along the Existing Routes

Existing Route	Districts	Connecting Highways	Length, km
I	Chennai	NH-48 and NE2	352.70
	Kanchipuram		
	Vellore		
	Krishnagiri		
	Dharmapuri		
	Salem		
II	Chennai	NH-48 and SH-18 (New NH-179A)	331.89
	Kanchipuram		
	Vellore		
	Krishnagiri		
	Dharmapuri		
	Salem		
III	Chennai	NH-32, NH-132, NH-38, NH-79 and NE2	334.28
	Villupuram		
	Salem		

Proposed alignment starts near the Chennai outer ring road junction on SH-48, traverses through Kanchipuram, Tiruvannamalai, Krishnsgiri, Dharmapuri and Salem districts in the state of Tamil Nadu, which run parallel, intersect and overlap; National Highway (NH-38, NH-77, NH-79, NH-NE2 and NH-544), State Highway (SH-48, SH-57, SH-58, SH-118A, SH-116, SH-5, SH-4, SH-115, SH-6A and SH-18) and Major District Roads (MDR-789, MDR-709, MDR-43, MDR-503, MDR-800 and MDR-1044). The proposed alignment passing through Greenfield is divided into 7 packages. Packagewise details along with proposed right of way are provided in the **Table 3-2.**

Kanchipuram – Chengalpattu Spur Starts near murugan Colony in Kanchipuram traverses through Thimmaiyanpettai, Walajabad, Palur, Athur, and ends at NH-45 near Vaibhav Lakshmi Nagar, Chengalpattu. The Proposed Alignment Passes through SH-58. It connects SH-120 and NH-45.

Chetpet Spur Road Starts near Chetpet Lake traverses through Gangasoodamani, ulagampattu and connects our Proposed Chennai – Salem alignment.

Thiruvannamalai Spur Starts near Deepam Nagar and traverses through Pudhumallavadi, Vada Pulidiyur, Naidumangalam and connects our Proposed Chennai – Salem alignment. The Proposed Alignment Passes through NH-234/SH-9.

Table 3-2: Package wise details with proposed Right of way

Package	Design Chainage		Length	Location	PROW, m	Remarks
	From	To				
I	0+000	25+600	25.600	Vandalur to Palur	70	179B
II	25+600	67+700	42.100	Palur to Erumaivetti	90	
III	67+700	122+660	54.960	Erumaivetti to Thenpallipattu	90	
IV	122+660	157+570	34.910	Thenpallipattu to Manmalai	90	
V	157+570	207+200	49.630	Manmali to Harur	90	
VI	207+200	220+000	12.800	Harur to Ayodhiyapatinam	90	
	57+300	21+800	35.500			179A
VII	21+800	0+000	21.800	Ayodhiyapattinam to Ariyanur	70	

Proposed Right of way – Spur Roads

S.No	Design Chainage		Length	PROW, m	Remarks
	From	To			
I	0+000	29+635	29.635	60	Kanchipuram – Chengalpattu
2	0+000	4+900	4.900	60	Chetpet
3	0+000	16+200	16.200	60	Thiruvannamalai

Project road aims to connect (Chennai and Salem) two major districts in the state with the shortest possible path and also intends to connect many Industrial areas and SEZ along the project road and the connectivity are contemplated through spurs and interchanges. Taluk wise details along different districts are given in Location map of project road is given in **Figure 3-1.** This green field highway alignment is proposed to be Integrated/connected with other highways planned/ executed in Tamil Nadu state in the future.

Table 3-3: Taluk wise details along different districts of proposed alignment

Sl. No	Name of District	Name of Taluk	Approx. Length in Km
1	Kanchipuram	Walajabad	59.100
2		Sriperumbudur	
3		Chengalpattu	
4		Kanchipuram	

Sl. No	Name of District	Name of Taluk	Approx. Length in Km
5		Uthiramerur	
6	Tiruvannamalai	Cheyyaru	123.900
7		Vandavasi	
8		Polur	
9		Arani	
10		Tiruvannamalai	
11			
12		Chetpet	
13	Tiruvannamalai	Kalasapakkam	
14		Chengam	
15	Krishnagiri	Uttangarai	2.000
16	Dharmapuri	Harur	56.000
17		Papireddipatty	
18	Salem	Yercadu	36.300
19		Valappadi	
20		Salem south	
21		Salem	
Total Length, Km			**277.300**

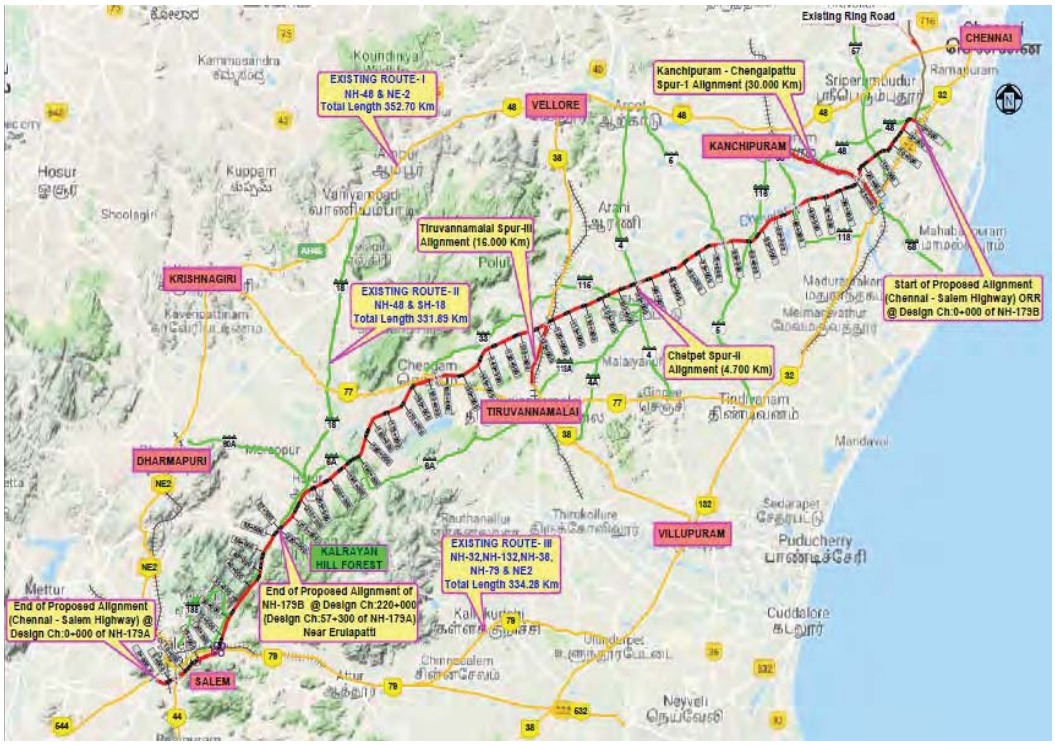


Figure 3-1: Location Map of Project Road

Methodology

The socio economic characteristics of the PIA as indicated above have been examined through a preliminary socio economic survey. The base data required was collected from numerous agencies and referring the various literature available from the Directorate of Economics and Statistics and official government websites. All statistics used to study the past economic performance of the PIA are based on secondary official sources of information. As the social surveys are being conducted the profile is limited to state level and of immediate PIA is submitted with the Final Feasibility Report.

3.5 SOCIAL AND DEMOGRAPHIC PROFILE OF TAMILNADU

General History

Tamil Nadu (literally The Land of Tamils or Tamil Country) is one of the 29 states of India. Chennai (formerly known as Madras), capital city of the state is the largest city. Tamil Nadu is a land most known for its monumental ancient Hindu temples and classical form of dance Bharata Natyam. Tamil Nadu lies in the southernmost part of the Indian Peninsula and is bordered by the union territory of Puducherry and the states of Kerala, Karnataka, and Andhra Pradesh. It is bounded by the Eastern Ghats on the north by the Nilgiri, the Anamalai Hills and Kerala on the west, by the Bay of Bengal in the east, by the Gulf of Mannar and the Palk Strait on the southeast, and by the Indian Ocean on the south.

Tamil Nadu is the eleventh largest state in India by area and the seventh most populous state in India. It is the second largest state economy in India as of 2012. The state ranked 6th among states in India according to the Human Development Index as of 2011. The state has the highest number (10.56 per cent) of business enterprises and stands second in total employment (9.97 per cent) in India, compared to the population share of about 6 per cent. In the 2013 Raghuram Rajan panel report, Tamil Nadu was ranked as the third most developed state in India based on a "Multidimensional Development Index".

The region has been the home of the Tamil people since at least 1500 BC. Its official language is Tamil, which holds a status of being a classical language. Tamil has been in use in inscriptions and literature for over 2500 years. Mythical traditions dictate that Lord Shiva himself taught sage Agastya this language. Sage Agastya is considered to be the father of Tamil literature and compiled the first Tamil grammar called Agathiyam, but the scripts of Agathiyam no longer exist. It is believed that he lived in the 6^{th} or 7^{th} century BC and specialized in language, alchemy, medicine and spirituality (yogam and gnanam). There are 96 books in the name of Agathiyar. Tamil Nadu is home to many natural resources, classical arts, classical music, classical literature, Hindu temples of Dravidian architecture, hill stations, beach resorts, multi-religious pilgrimage sites, and eight UNESCO World Heritage Sites.

Tamil Nadu has performed reasonably well in terms of literacy growth during previous decades. The state's literacy rate increased from 62.66% in 1991 to 73.47% in 2001 which is above the national average.

India has a human development index calculated as 0.619, while the corresponding figure for Tamil Nadu is 0.736, placing it among the top states in the country. The life expectancy at birth for males is 65.2 years and for females it is 67.6 years.

3.6 ECONOMIC PROFILE

Net State Domestic Product (NSDP)

Tamil Nadu's gross state domestic product for 2007 is estimated at 275,000 in current prices. The state experienced a GSDP growth rate of 12.1% for this period. Possessing the third largest economy (2007-2008) among states in India, Tamil Nadu is also the most industrialised state in India. The per capita income for the period 2007 - 2008 for the state was Rs. 43,000 ranking second among the South Indian states. It ranks third in foreign direct investment approvals (cumulative 1991-2002) of Rs.225,826 million ($5,000 million), next only to Maharashtra (Rs.366,024 million ($8,100 million)) and Delhi (Rs.303,038 million ($6,700 million)) and the State's FDI investment constitutes 9.12% of the total FDI in the country.

According to the 2001 Census, Tamil Nadu has the highest level of urbanisation (43.86%) in India, accounting for 6% of India's total population and 9.6% of the urban population and is the most urbanized state in India. Service sector contributes 45% of the economic activity in the state, followed by manufacturing at 34% and agriculture at 21%. Government is the major investor in the state with 51% of total investments, followed by private Indian investors at 29.9% and foreign private investors at 14.9%.

Annual Plan outlays have increased by a record 75% from Rs.52,000 million ($1,100 million) in 2001-2 to Rs.91,000 million ($2,000 million) in 2005-6. Based on URP - Consumption for the period 2004 - 2005, percentage of the state's population Below Poverty Line was 27.5%.

Tamil Nadu lies in the southernmost part of the Indian Peninsula and is bordered by the union territory of Puducherry and the South Indian states of Kerala, Karnataka, and Andhra Pradesh. It is bounded by the Eastern Ghats on the north, by the Nilgiri, the Anamalai Hills, and Kerala on the west, by the Bay of Bengal in the east, by the Gulf of Mannar and the Palk Strait on the southeast, and by the Indian Ocean on the south. It also shares a maritime border with the nation of Sri Lanka.

Tamil Nadu covers an area of 130,058 sq.km and is the eleventh largest state in India. The bordering states are Kerala to the west, Karnataka to the north west and Andhra Pradesh to the north. To the east is the Bay of Bengal and the state encircles the union territory of Puducherry. The southernmost tip of the Indian Peninsula is Kanyakumari which is the meeting point of the Arabian Sea, the Bay of Bengal, and the Indian Ocean.

The western, southern and the north western parts are hilly and rich in vegetation. The Western Ghats and the Eastern Ghats meet at the Nilgiri hills. The Western Ghats traverse the entire western border with Kerala, effectively blocking much of the rain bearing clouds of the south west monsoon from entering the state. The eastern parts are fertile coastal plains and the northern parts are a mix of hills and plains. The central and the south central regions are arid plains and receive less rainfall than the other regions. Tamil Nadu has a coastline of about 1,076 km which is the country's second longest coastline.

Tamil Nadu is the seventh most populous state in India. 48.4 per cent of the state's population live in urban areas, the highest among large states in India. At the 2011 India census, Tamil Nadu had a population of 72,147,030.

Tamil Nadu is mostly dependent on monsoon rains, and thereby is prone to droughts when the monsoons fail. The climate of the state ranges from dry sub-humid to semi-arid. The state has two distinct periods of rainfall: south west monsoon from June to September, with strong southwest winds; North east monsoon from October to December, with dominant north east winds;

The annual rainfall of the state is about 945 mm of which 48 per cent is through the north east

monsoon, and 32 per cent through the south west monsoon. Since the state is entirely dependent on rains for recharging its water resources, monsoon failures lead to acute water scarcity and severe drought.

Socio-Economic Characteristics

Tamil Nadu is one of the 28 states of India. Its capital is Chennai, the largest city. Tamil Nadu is a land most known for its monumental ancient Hindu temples and classical form of dance Bharata Natyam Population: 72.14 million (2011) Area: 130,058 km² Founded: 1773.

Table 3-4: Socio-Economic Characteristics

Gross State Domestic Product in ₹Crores at Constant			
Year	**GSDP**	**Growth Rate**	**Share in India**
2000–01	142,065	5.87%	7.62%
2001–02	139,842	-1.56%	7.09%
Gross State Domestic Product in ₹Crores at Constant			
Year	**GSDP**	**Growth Rate**	**Share in India**
2002–03	142,295	1.75%	6.95%
2003–04	150,815	5.99%	6.79%
2004–05	219,003	11.45%	7.37%
2005–06	249,567	13.96%	7.67%
2006–07	287,530	15.21%	8.07%
2007–08	305,157	6.13%	7.83%
2008–09	320,085	4.89%	7.70%
2009–10	350,258	9.43%	7.77%
2010–11	391,372	11.74%	8.01%

2011–12	428,109	9.39%	8.20%

According to the 2011 Census, Tamil Nadu is the most urbanised state in India (49 per cent), accounting for 9.6 per cent of the urban population while only comprising 6 per cent of India's total population and is the most urbanised state in India.CITEREFThe_Hindu18_May_2008 Services contributes to 45 per cent of the economic activity in the state, followed by manufacturing at 34 per cent and agriculture at 21 per cent. Government is the major investor in the state with 51 per cent of total investments, followed by private Indian investors at 29.9 per cent and foreign private investors at 14.9 per cent. Tamil Nadu has a network of about 113 industrial parks and estates offering developed plots with supporting infrastructure.

According to the publications of the Tamil Nadu government the Gross State Domestic Product at Constant Prices (Base year 2004–2005) for the year 2011–2012 is ₹428,109 crores, an increase of 9.39 per cent over the previous year. The per capita income at current price is ₹72,993.

Table 3-5: Districts of Tamil Nadu

	District	Headquarters	Area	Population (2011)	Population density
1	Ariyalur	Ariyalur	1,944 km³	752,481	387 /km²
2	Chennai	Chennai	174 km²	4,681,087	26,903 /km²
3	Coimbatore	Coimbatore	4,642 km²	3,172,578	648 /km²
4	Cuddalore	Cuddalore	3,705 km²	2,600,880	702 /km²
5	Dharmapuri	Dharmapuri	4,527 km²	1,502,900	332 /km²
6	Dindigul	Dindigul	6,054 km²	2,161,367	357 /km²
7	Erode	Erode	5,692 km²	2,259,608	397 /km²
8	Kanchipuram	Kanchipuram	4,305 km²	2,690,897	666 /km²
9	Kanyakumari	Nagercoil	1,685 km²	1,863,174	1,106 /km²
10	Karur	Karur	2,902 km²	1,076,588	371 /km²
11	Krishnagiri	Krishnagiri	5,091 km²	1,883,731	370 /km²
12	Madurai	Madurai	3,695 km²	2,441,038	663 /km²
13	Nagapattinam	Nagapattinam	2,416 km²	1,614,069	668 /km²
14	Namakkal	Namakkal	3,402 km²	1,721,179	506 /km²
15	Nilgiris	Udagamandalam	2,552 km²	735,071	288 /km²
16	Perambalur	Perambalur	1,748 km²	564,511	323 /km²
17	Pudukkottai	Pudukkottai	4,652 km²	1,618,725	348 /km²
18	Ramanathapuram	Ramanathapuram	4,180 km²	1,337,560	320 /km²
19	Salem	Salem	5,249 km²	3,480,008	663 /km²
20	Sivaganga	Sivaganga	4,140 km²	1,341,250	324 /km²
21	Thanjavur	Thanjavur	3,477 km²	2,302,781	661 /km²
22	Theni	Theni	2,872 km²	1,143,684	397 /km²
23	Thoothukudi	Thoothukudi	4,599 km²	1,738,376	378 /km²
24	Tiruchirappalli	Tiruchirappalli	4,508 km²	2,713,858	602 /km²

	District	Headquarters	Area	Population (2011)	Population density
25	Tirunelveli	Tirunelveli	6,709 km²	3,072,880	458 /km²
26	Tirupur	Tirupur	5,192 km²	2,471,222	476 /km²
27	Tiruvallur	Tiruvallur	3,552 km²	3,725,697	1,049 /km²
28	Tiruvannamalai	Tiruvannamalai	6,188 km²	4,121,965	667 /km²
29	Tiruvarur	Tiruvarur	2,379 km²	1,268,094	533 /km²
30	Vellore	Vellore	6,081 km²	4,028,106	671 /km²
31	Viluppuram	Viluppuram	7,185 km²	3,463,284	482 /km²
32	Virudhunagar	Virudhunagar	4,280 km²	1,943,309	454 /km²

Source: Provisional Population Totals, Paper -2 (volume -1) of 2011, Census of India

3.7 THE PROJECT DISTRICTS

The project section of Chennai – Salem Project stretch passes through Five districts such as Kanchipuram, tiruvannamalai, Krishnagiri, Dharmapuri and Salem districts. The details about the districts are as below:

Kanchipuram District

Kanchipuram district is a district in the northeast of the state of Tamil Nadu in India. In Early Days Chengalpattu was called as the District. In Later Kanchipuram is considered as a District. It is bounded in the west by Vellore District and Thiruvannamalai District, in the north by Tiruvallur District and Chennai District, in the south by Viluppuram District and in the east by the Bay of Bengal. It lies between 11° 00' to 12° 00' latitudes and 77° 28' to 78° 50' longitudes. The district has a total geographical area of 4,432 km2(1,711 sq mi) and coastline of 57 km (35 mi). The town of Kanchipuram is the district headquarters. The Chennai International Airportis located in Tirusulam in Kanchipuram district now under Greater Chennai Corporation Limit. In 2011, Kancheepuramdistrict had a population of 3,998,252.

Agriculture is the main occupation of the people with 47% of the population engaged in it. Paddy is the major crop cultivated in this district. Groundnuts, Sugarcane, Cereals & Millets and Pulses are the other major crops cultivated. 76.50 Metric Tonnes lands are cultivated in Fuel wood and

8.039 Tonnes in Cashew. Palar River along with Tanks and wells are the main sources of irrigation in this district.

Kancheepuram is also known as 'Silk City' and 'Temple City', since one of the main professions of the people living in and around is weaving silk sarees. The silk weavers of Kanchi settled more than 400 years ago and have given it an enviable reputation as the producer of the best silk sarees in the country.

More than 70 percent of the 163 notified areas (megalithic sites) in the state of Tamil Nadu are in Kancheepuram district, including those at, Erumaiyur, Nandampakkam, Sirukalathur, Sikarayapuram, Ayyancheri, Kilambakkam and Nanmangalam.

Kanchipuram is also one of the most industrialized districts in the country, kanchipuram district has many automobile manufacturers such as Hyundai, Nissan, Ford, BMW, Daimler,

Yamaha etc. thanks to its proximity to the state capital Chennai. Areas surrounding Sriperumbudur have turned out to become one of the largest manufacturing hubs of India. The district is home to the manufacturing units of Hyundai, Ford, Mitsubishi, Nokia, Samsung, Dell, Saint Gobain, etc. The district is also at the center of the Information Technology boom in India. Many multinational IT companies like Tata Consultancy Services (TCS), Infosys, Wipro Technologies, Cognizant Technology Solutions, etc. have set up their offices in Kanchipuram district. TCS and Infosys have built huge offices with capacities of 22,000 and 25,000 employees, respectively.

Tiruvannamalai district

Tiruvannamalai District (also known as Thiruvannaamalai) is one of the districts in the state of Tamil Nadu, in South India. It was formed in the year 1989 from non-existing North Arcot District as Tiruvannamalai Sambuvarayar and Vellore Ambedkar. Tiruvannamalai town is the district headquarters. The district is divided into 12 Taluks - Aarani, Chengam, Tiruvannamalai, Polur, Thandarampattu,Vandavasi, kalasapakkam, chetpet , Cheyyar and vembakk am . Arani is famous for silk sarees. As of 2011, the district had a population of 4,164,875 with a sex-ratio of 994 females for every 1,000 males.

According to 2011 census, Tiruvannamalai District had a population of 2,464,875 with a sex-ratio of 994 females for every 1,000 males, much above the national average of 929. A total of 272,569 were under the age of six, constituting 141,205 males and 131,364 females. Scheduled Castes and Scheduled Tribes accounted for 22.94% and 3.69% of the population respectively. The average literacy of the district was 66%, compared to the national average of 72.99%. The district had a total of 588,836 households. There were a total of 1,238,177 workers, comprising 265,183 cultivators, 351,310 main agricultural labourers, 37,020 in house hold industries, 316,559 other workers, 268,105 marginal workers, 27,458 marginal cultivators, 173,753 marginal agricultural labourers, 9,700 marginal workers in household industries and 57,194 other marginal workers.

Tiruvannamalai District has an area of 6,191 km2. It is bounded on the north by Vellore District, on the east by Kanchipuram District, on the south by Villupuram District, and on the west by Dharmapuri and Krishnagiri districts.

In the District Arani and Thiruvannamalai regions are highest revenue generations regions respectievely.In 2006 the Ministry of Panchayati Raj named Tiruvannamalai one of the country's 250 most backward districts (out of a total of 640). It is one of the six districts in Tamil Nadu currently receiving funds from the Backward Regions Grant Fund Programme (BRGF).

Tiruvannamalai District is known for its two major businesses, agriculture and silk saree weaving. Rice cultivation and processing is one of the biggest businesses in this district. 112013 hectares of paddy cultivation is irrigated by 1965 lakes and 18 reservoirs and small dams. It has 18 regulated markets through which the farmers sell their agri products directly to the government. Through these regulated markets, 271411 metric tonnes of paddy harvested in 2007. There are lots of rice mills to process paddy found throughout the district. The modern rice mill near Cheyyar is the biggest government owned mill and Arani has around 278 rice mills. Kalambur is also has around 20 Rice mills and known for variety of rice called Kalambur Ponni rice.

The district has a large populace of weavers who are specialize in making Silk sarees. Hand looms are often engaged for weaving, although recently some have turned to mechanized methods of using Power looms. Arani taluk contributes high percent of Silk weaving. Arani is the most important revenue earning town in the district. Though the town is not popular off the state, a bulk of India's Silk apparels is produced by the people of Arani.

The district started to industrialize following the establishment of the industrial complex near Cheyyar by the State Industries Promotion Corporation of Tamil Nadu (SIPCOT). This is evidenced by the recent announcements of a 250-acre (1.0 km2) hi-tech Special Economic Zone for automative components, a 300-acre (1.2 km2) electronics hardware park and the commitment from the Taiwanese Shoe Company to set up its unit. In November 2009 the Tamil Nadu cabinet approved the Mahindara & Mahindra's Rs 1800 core automobile project in 450 acres. This unit will produce tractors, SUVs and commercial vehicles and auto parts. Aluminum die cast unit by Ashley Alteams, a joint venture by Ashok Leyland and Finland-based Alteams Oy started its production in January 2010. This High pressure die cast will manufacture automobile and telecommunication components with initial capacity of 7000 ton per year. One of the largest sugar mills in the country - Cheyyar co-operative sugars - is situated near Cheyyar.

Since Tiruvannamalai District has its capital at Tiruvannamalai City, there are many factories around Tiruvannamalai. Scent factories are large in number due to the high production of flowers around Tiruvannamalai. They are listed as follows: 1. Hindusthan house hold factories, 2. Sarala birla factory of aroma oil, 3. Parthiban cottages aroma oil factory. The Tamil Nadu government is planning for a SIPCOT at naidumangalam and kilpennathur both near Tiruvannamalai. Arani has the factories related to Rice and Silk with in the town and in the Taluk area. As well, there are few other mills near Arani, such as Lakshmi Saraswathi Cotton mills Arni Pvt Ltd and some Engineering Industries.

Krishnagiri District

Krishnagiri district is a district in the western part of the state of Tamil Nadu, in India. This district is carved out from Dharmapuri District by 2004. The municipal town of Krishnagiri is the district headquarters. In Tamil NaduKrishnagiri district was formed as the 30th district of Tamil Nadu on February 9, 2004. Krishnagiri District was formed by carving out five taluks and ten blocks of the erstwhile Dharmapuri district. The first collector of Krishnagiri was Mangat Ram Sharma

A district collector heads the district administration. Krishnagiri district is divided into two divisions and five taluks for the purpose of revenue administration. Revenue Divisional Officer heads the divisions and Tahsildar is the head of taluk level administration. Development administration in this district is coordinated by the panchayats (also called as blocks) for the rural areas. There are about ten panchayat unions, seven town panchayats, 352 village Panchayats and 874 revenue villages in this district. Krishnagiri district comprises two revenue divisions Krishnagiri and Hosur. There are seven taluks: Krishnagiri, Hosur, Pochampalli, Uthangarai, Shoolagiri, Bargur and Denkanikottai. There are 12 panchayat unions: Kelamangalam, Thalli, Anchetti, Krishnagiri, Shoolagiri, Vepanapalli, Hosur, Kaveripattinam, Pochampalli, Mathur and Uthangarai.

According to the 2011 census, Krishnagiri district had a population of 1,879,809 with a sex-ratio of 963 females for every 1,000 males, much above the national average of 929. A total of 217,323 were under the age of six, constituting 112,832 males and 104,491 females. Scheduled Castes and Scheduled Tribes accounted for 14.22% and 1.19% of the population

respectively. The average literacy of the district was 63.2%, compared to the national average of 72.99%.The district had a total of 448,053 households. There were a total of 877,779 workers, comprising 218,600 cultivators, 197,369 main agricultural labourers, 15,237 in house hold industries, 310,795 other workers, 135,778 marginal workers, 17,438 marginal cultivators, 65,959 marginal agricultural labourers, 6,681 marginal workers in household industries and 45,700 other marginal workers.

The State industrial Promotion Corporation of Tamil Nadu, (SIPCOT) has developed one of the largest industrial complexes in the country in Hosur in over an area of 1370 acres and to develop Large/Medium/Small industries with SIDCO offering comprehensive services for more than 500 industries.

The industries in Hosur are the source of raising the standard of living of people in Krishnagiri district. It is producing goods varying from Pin to Aeroplance. The credit goes to the good climate, incentives and inspiration provided by the State government and Central government. It is at an altitude of 10000m from mean sea level. It is very near to Bangalore, the capital of Karnataka. Industries of various kinds such as electrical, electronic, automobile, chemical, iron & steel are flourishing because of the favorable conditions and infrastructure availability. Information technology has a great scup for investment because of the proximity of Bangalore.

Several industrialist of repute have started their units in Hosur. Hosur has been able to attract some of the most prestigious industrial houses in the country including the Tatas, The Birlas, the Hindujas, TVS group companies, Murugappa group of companies, Lakshmi group and also a number of MNC's. Hosur Industrial area is consists of about 700 industries comprising of Large, Medium, Small and tiny industries. The location of these industries are SIPCOT phase I & II, SIDCO industrial estates, SIDCO electronic industrial estate and the outside industries are scattered in private lands within 20 Kms radius of Hosur towards Krishnagiri, Royakottai & Thalli Roads and few major industries in Harita, Bagalur, Belagondapalli, Thorapalli and other areas.

The units located at Hosur manufacture sophisticated products ranging from Trucks, Automobiles and Automobiles parts, Motor Cycles, Mopeds, Diesel Engines, Power shift Transmission, Castings, Forgings, Cigarettes, Watches & Jewellery, Abrasives, Hosiery knilling needles. Machineries, Aircrafts and Pharmaceuticals, Biotech textiles, Chemicals, Electronic, electrical and general engineering.

Dharmapuri district

Dharmapuri is a district in Western part of Tamil Nadu in South India. It is the first district created in Tamil Nadu after the independence of India by splitting from then Salem district on 10 October, 1965.

The other major towns in the district are Harur, Palacode, Karimangalam, Pennagaram and Pappireddipatti. Dharmapuri District is one of the major producers of mango in the state, fine quality of Granite is found in the district. It is also one of the main Sericulture belts in the state. Around 30 percent of the district area is under forest cover. Cauvery river enters into tamilnadu through this district.

The district is located between latitudes N 11 47' and 12 33' and longitudes E 77 02' and 78 40'. Occupies an area of 4497.77 km² (i.e. 3.46% of Tamil Nadu) and has a population of

2,856,300 (as of 2001). It is bounded on the north by Krishnagiri District, on the east by Tiruvannamalai District and Viluppuram District districts, on the south by Salem District, and on the west by Karnataka's Chamarajanagar District. The Whole district is surrounded by hills and forests. The terrain of dharmapuri is of rolling plains type. Dharmapuri is located on the geographically important area in south India.

The whole district is predominantly covered with forests. Spider valley located near Hogenakkal is home to many wild animals. The district falls in the migratory path of elephants. Man and elephant conflicts are most common in these parts. Many tribal communities depend on these forests. Vathalmalai, a mountain hamlet on top of Shervarayan hill chain has suitable conditions to cultivate coffee and jack fruit. Wild boars and spotted deers are commonly seen in Morappur and Harur forest region. Gaurs sometimes stroll near villages near Bommidi region. Thoppur ghat section has one of the scenic highways surrounded by mountains and forests. This district lies in a geography where both Western and Eastern ghats make their presence.

Dharmapuri and Krishnagiri districts account for more than 60 -70% total mango production in Tamil Nadu. It is a major producer of Ragi and saamai crops in the state. Exotic crops like dates are also being cultivated by some farmers in the areas around Ariyakulam.

Dharmapuri district shows vigorous increasing performance in literacy and education. Where by the year 2011 it secured last position in Tamil Nadu by scoring 62%, whereas by the year 2016 it showed 92% literacy by securing 12th rank in Tamil Nadu out of 32. It also shows vigorous increase in educational hubs by having colleges and school in various fields of education.

Salem district

Salem District is a district of Tamil Nadu state in southern India.Salem was the biggest district before separating Dharmapuri in Tamilnadu. The district was now separated into Dharmapuri, Krishnagiri and Namakkal as individual district .Salem district is the best location to live in India.Salem is the district headquarters and other major towns in the district include Attur,Mettur Sankagiri and Edappadi. Salem two thousand years ago is evident from the discovery of silver coins of the Greek Emperor Tiberices Claudices Nero (37-68 A.D.) in Koneripatti of Salem in 1987. It was ruled by Mazhavar kings Adhiyamaan and Valvil Ori of sangam age. It comes under Mazhanadu a vast region dated 2nd century BC. Salem was the largest district of Tamilnadu, it was bifurcated into Salem – Dharmapuri districts in 1965 and Namakkal district in 1997.

According to 2011 census, Salem district had a population of 3,482,056 with a sex-ratio of 954 females for every 1,000 males, much above the national average of 929. A total of 344,960 were under the age of six, constituting 180,002 males and 164,958 females. Scheduled Castes and Scheduled Tribes accounted for 16.67% and 3.43% of the population respectively. The average literacy of the district was 65.64%, compared to the national average of 72.99%. The district had a total of 915,967 households. There were a total of 1,694,160 workers, comprising 247,011 cultivators, 396,158 main agricultural labourers, 132,700 in house hold industries, 785,161 other workers, 133,130 marginal workers, 9,993 marginal cultivators, 58,052 marginal agricultural labourers, 8,803 marginal workers in household industries and 56,282 other marginal workers.

The Salem handloom industry is one of the most ancient cottage industries and producing quality sari, dothi and angavasthram out of silk yarn and cotton yarn. In the recent past, home furnishing items are also woven, mainly for export purposes. More than 75,000 handlooms are working and the total value of cloth produced per annum is estimated at Rs. 5,000 crores. With more than 125 spinning mills, with modern weaving units and garment units Salem established itself as one of the major textile center in Tamil Nadu .The history of handloom and spinning mills dates back to pre- independence period in Salem. But till 1960s there were fewer than 5 spinning mills. Private handloom weaving started thriving in the region along with the large scale cooperative sector handloom weaving and marketing units. Small scale hand dying units were started around the region to support the industry. Around 1980s the textile industry grew significantly. Many major spinning mills and waste spinning units came up into existence. Many Handloom societies and dying houses were established. New and increased numbers of Power Loom units were mushroomed in the places like Gugai, Ammapet, Attayampatti, Vennandur, Magudanchavadi, Rasipuram, Komarapalayam Pallipalayam, Jalakandapuram and Ellampillai.

The Salem region also houses the Tamil Nadu largest number of Sago industries which are engaged in the production Sago Foods and Starch.In Salem District alone, 34000 hectares of land is under tapioca cultivation which is the raw material for the sago industries and there are 650 units engaged in tapioca processing. In and around Salem the yield of tapioca is about 25-30 T/ha, highest in the World. National average is 19 T/ha and World average production stands at 10 T/ha. Hence it is called land of sago. In 1981, Salem Starch and Sago Manufacturers Service Industrial Co-operative Society Ltd (popularly called as SAGOSERVE) were established to promote the growth of sago industries. Nearly 80% of the national demand for Sago and Starch is being met by the Sagoserv.

Salem Steel Plant, a special steel unit of Steel Authority of India Ltd have their plant located in Salem which produces Cold rolled stainless steel and Hot rolled stainless steel/carbon steel. The plant can produce austenitic, ferritic, martensitic and low-nickel stainless steel in the form of coils and sheets with an installed capacity of 70,000 tonnes/year in Cold Rolling Mill and 1,86,000 tonnes/year in Hot Rolling Mill. In addition, the plant has country's first top-of-the-line stainless steel blanking facility with a capacity of 3,600 tonnes/year of coin blanks and utility blanks/circles. Expansion and modernisation of Salem Steel Plant is ongoing. The plan envisages installation of Steel Melting and Continuous Casting facilities to produce 1,80,000 tonnes of slabs along with expansion of Cold Rolling Mill complex, enhancing the capacity of Cold Rolled Stainless Steel Products from 65,000 TPA to 1,46,000 TPA and an additional Roll Grinding Machine for Hot Rolling Mill for increasing production to 3,64,000 TPA. The total project area is 1130 acres and cost of the project is 1780 crores.

Southern Iron & Steel Company Ltd (joint venture with JSW Steel) the first integrated steel plant of India at a cost of 2,235 Crores, located near Salem for the production of TMT corrosion resistant bars/alloy steels. The Salem plant is the largest special steel plant in India aims to develop the Kanjamalai, Kavuthimalai and Vediappanmalai iron ore mines in Tamil Nadu on receipt of requisite approvals to improve raw material security. This will facilitate expansion of production capacity to 2 MTPA. It will also allow the unit to diversify into the production of value- added products such as annealed, drawn and peeled steel. The plant is continuously working to develop special grades for critical automotive applications.

The Madras Aluminium Company Ltd (MALCO) is part of Vedanta Resources Plc, a London Stock Exchange listed FTSE 100 diversified metals and mining major. MALCO has a state-of-the-art, coal- based Captive Power Plant at the same location which was commissioned in

the year 1999. In the year 2004 MALCO augmented its smelter capacity from earlier 25,000TPA to 40,000TPA. It generates 100 MW power from 4 units of 25MW each through power plant located at Mettur, Tamil Nadu. Around 90% of the entire power generated is exported; the rest is used internally. Efficient plant operations enabled MALCO to achieve a higher plant load factor since existence.

The region around Salem is rich in mineral ores. Salem has one of the largest magnesite, and bauxite and also irons ore deposits in India. It has many magnesite factories operated by private and public sectors such as Burn Standard & Co, Dalmia Magnesites and Tata Refractories, SAIL refractories. The Leigh Bazaar market in Salem is the biggest regional market for agro products. Narasus coffee one of the famous coffee in Tamil Nadu, Nandhi Dall Mills the oldest flour mill company, BSP refineries (Usha Refined Sunflower Oil) are other few companies have their presence in Salem.

Being one of the fastest growing tier II cities, the Tamil Nadu government and ELCOT are planning to establish an IT park in Salem covering about 160 acres (0.65 km2). SAIL is planning a Steel SEZ inside the Salem Steel plant covering about 250 acres (1.0 km2) there is an exclusive Electrical and Electronics Industrial Estate in the Suramangalam area of Salem city. Coimbatore-Erode-Salem stretch was well known for Industries and Textile processings and it is announced as Coimbatore- Salem Industrial Corridor and further development works are carried by SIPCOT Linking.

4. TRAFFIC STUDIES & FORECASTS

4.1 Traffic surveys and analysis

4.1.1 Introduction

This section presents the traffic studies and analyses carried out for addressing various objectives and issues pertaining to upgrading for 8 laning of Chennai-Salem highway (green field alignment) in the state of Tamil Nadu. The results of this analysis will form inputs for forecasting future traffic, planning and designing the pavement, developing capacity augmentation proposals, designing the toll plaza and design of intersections along the project road.

Since it is a green field highway a thorough knowledge of the travel characteristics of the traffic on the existing alternate routes is essential for future diverted traffic estimation on the project road. Hence, detailed traffic surveys have been carried out to assess the baseline traffic characteristics on various alternative routes from Chennai to Salem.

4.1.2 Project details

The Project corridor (Chennai - Salem highway) starts at Vandalur from Chennai outer ring road in Tamilnadu state, traverses through Walajabad, Chetpet, Tiruvanaamalai, Harur and connects Salem town on NH 79 at Ayodhyapatnam, then by passes Salem town through green field and culminates at NH 544. This part of the alignment is a completely green field alignment and passes through towns like Oragadam, Walajabad, Chetpet, Tiruvannmalai and Harur. On the way it crosses SH 48, SH 58, SH 118A, SH 116, SH 5, SH 4, SH 115, NH 38, NH 77, SH 6A, SH 18 and end on NH 79 at Ayodhyapatnam. The Samen bypass starts from Ayodhyapatnam and crosses NH 44 bypassing Salem town on the south and culminates at Aryanur on NH 544 (Salem Coimbatore NH). The project road is divided into seven packages and the details are given below.

Package	Section		Length, km	Locations
	From km	To km		
I	0+000	25+600	25.600	Vandalur to Palur
II	25+600	67+700	42.100	Palur to Erumaivetti
III	67+700	122+660	54.960	Erumaivetti to Thenpallipattu
IV	122+660	157+570	34.910	Thenpallipattu to Manmalai
V	157+570	207+200	49.630	Manmali to Harur
VI	207+200	220+000	12.800	Harur to Ayodhiyapatinam
	57+300	21+800	35.500	
VII	21+800	0+000	21.800	Ayodhiyapatinam to Ariyanur

Project road aims to connect Airports of all two major cities and also intends to connect many Industrial areas and SEZ along the project road and the connectivity are contemplated through spurs and interchanges.

4.1.3 Competing alternate routes

As the study corridor is green field, the various existing alternative routes were identified. **Table 4-1** briefs about the various existing alternative routes near project corridor and shown in **Figure 4-1.**

Alternate route 1 starts from Chennai passes through Vellore, Vaniyambadi, Krishnagiri and ends at Salem. Alternate route 2 starts from Chennai passes through Tindivanam, Ulundurpet and ends at Salem. There is high potential for this through traffic on both roads from Chennai to Salem to get diverted to the project corridor as both distance and travel time will be relatively less. Alternate route 3 starts from Chennai passes through Vellore, Vaniyambadi and ends at Krishnagiri. Traffic from Krishnagiri, Hosur, and Bangalore has potential to get diverted to Krishnagiri-Chengam-Chennai section on the project corridor. Alternate route 4 starts from Vellore passes through Krishnagiri and ends at Salem. Traffic coming from Andhra Pradesh and beyond to Vellore has potential to get diverted to Vellore-Polur-Salem section on the project corridor. Alternate route 5 starts from Chennai passes through Tindivanam and ends at Tiruvannamalai. Traffic from this road has potential to get diverted to Chennai-Tiruvannamalai section on the project corridor. Alternate route 6 starts from Chennai passes through Vellore and ends at Tiruvannamalai. Traffic from this road has potential to get diverted to Chennai-Tiruvannamalai section on the project corridor.

Table 4-1: Alternative Corridors

Alternatives	Corridor	Distance (km)
Alternative 1	Chennai - Krishnagiri - Salem	345
Alternative 2	Chennai - Ulundurpet- Salem	313
Alternative 3	Chennai-Vellore - Krishnagiri	238
Alternative 4	Vellore-Krishnagiri-Salem	235
Alternative 5	Chennai - Tindivanam - Tiruvannamalai	155
Alternative 6	Chennai - Vellore - Tiruvannamalai	195

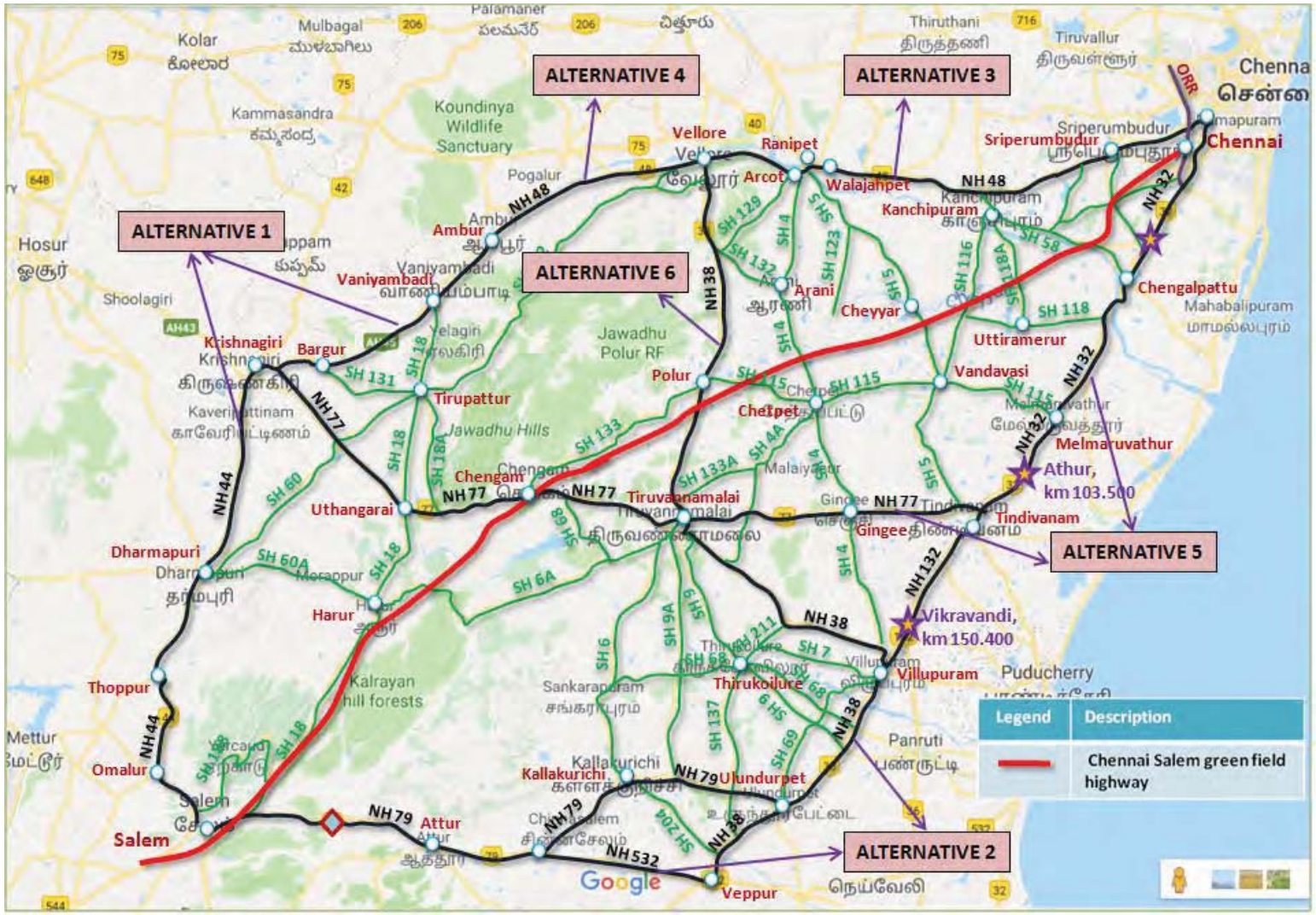


Figure 4-1: Alternate routes from Chennai to Salem

4.1.4 Survey Methodology

4.1.4.1 Primary surveys and considerations

To capture traffic flow characteristics, travel pattern, speed characteristics, users' preference regarding toll imposition on traffic passing through the existing routes from Chennai to Salem and other characteristics related to miscellaneous requirements on the project road, following primary traffic surveys were conducted.

- *Classified traffic volume count (CTVC) using ATCC method*
- *Origin – destination survey (OD)*
- *Axle load survey*
- *Speed and delay study*

Traffic survey stations for carrying out CTVC, OD and axle load surveys were selected after a site reconnaissance considering the following parameters.

- The station should represent homogeneous traffic section
- The station should be free from urban and local traffic influence
- The station should be located in a reasonably level terrain with good visibility

The summary of primary surveys conducted on the project corridor is illustrated in **Figure 4-2** below.

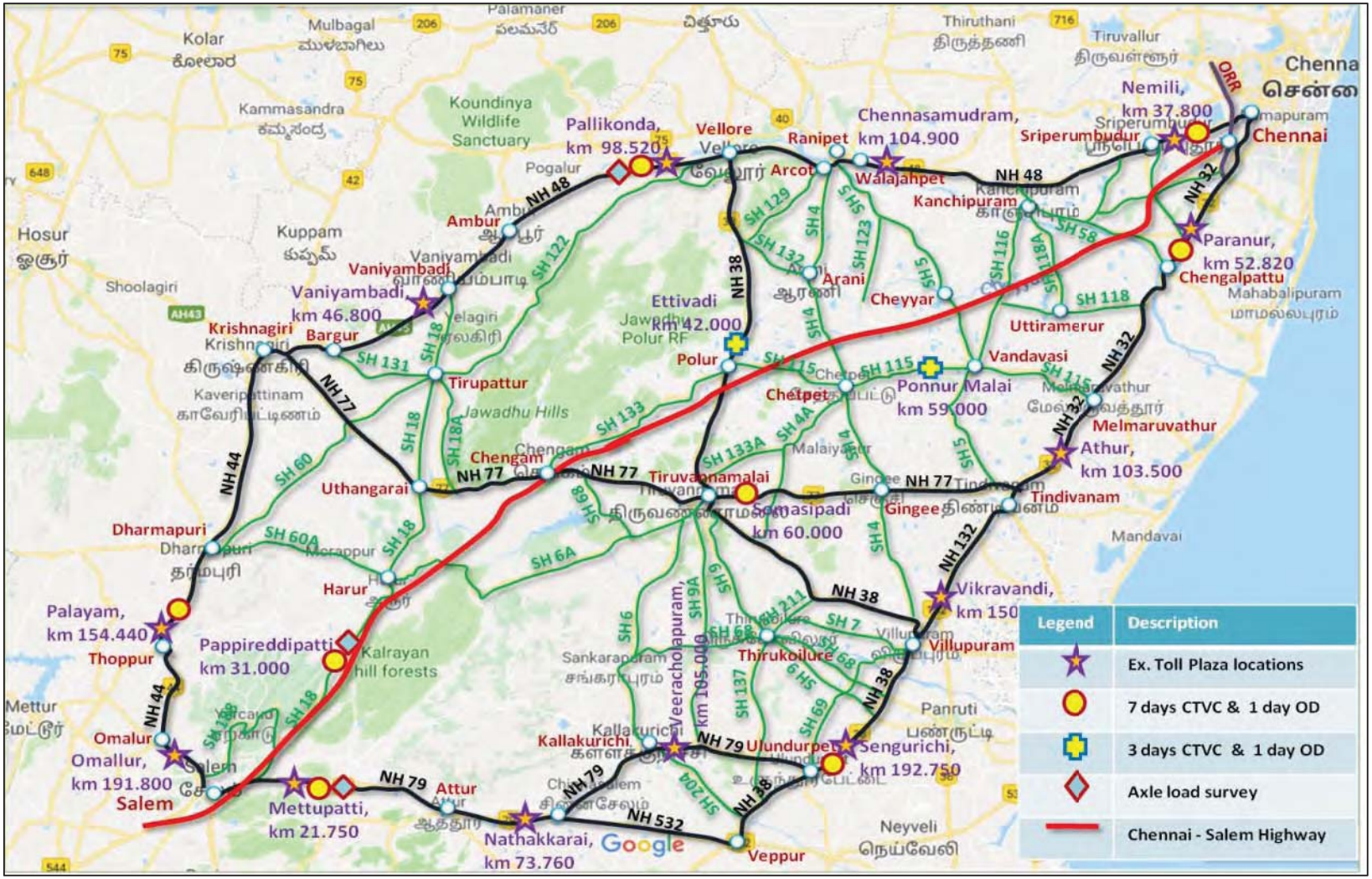


Figure 4-2: Traffic surveys location map

4.1.4.2 Classified traffic volume count

The CTVC surveys were conducted at ten locations on existing roads from Chennai to Salem. For seven locations CTVC were conducted continuously for 7 consecutive days and for 24 hours, through Automatic Traffic Counter and Classifier (ATCC) method. For the remaining three locations CTVC were conducted continuously for 3 consecutive days and for 24 hours. The counts location is representing mid block count station for each homogeneous section of existing roads. The surveys were as per guidelines illustrated in IRC: SP: 19 – 2001, 'Manual for Survey, Investigation and Preparation of Road Projects'. For carrying out the counts, the vehicles were grouped under the following categories (**Table 4-2**).

Automatic Traffic Counter and Classifier (ATCC) is capable of counting vehicles according to their class with help of different non intrusive technologies such as infrared sensors, Pneumatic tubes etc. Pneumatic Tube Technology used for the present traffic study of Automatic Traffic Counter and Classifier.

Table 4-2: Vehicle classification system

Motorised traffic	
2 wheelers: Scooters, bikes, motor cycles and mopeds etc	
3 wheelers including auto rickshaw	
Passenger Car	Car, jeep, taxi & van
Bus	Mini bus
	Govt. bus
	Private bus
Truck	Light commercial vehicles (LCV)
	2 Axle truck
	3 Axle truck
	4 to 6 Axle Truck
	Truck with more than 6 Axle
Other Vehicles	Agriculture Tractor, Tractor & Trailer
Slow moving vehicles	
Bicycle	
Cycle rickshaw	
Animal drawn	
Hand cart	

The count data was recorded for 60 minute intervals for each vehicle group for each direction of travel separately. This traffic data is used for working out traffic characteristics analysis and forecast, capacity augmentation and toll analysis. The schedule of survey is given in **Table 4-3**.

Table 4-3: Schedule of traffic volume count survey

Location	Survey Locations	Existing km	Date
CTVC 1	Paranur (near Chengalpet)	km 52.820 (old NH-45)	28-02-2018 to 06-03-2018
CTVC 2	Sengurichi (near Ulundurpet)	km 192.750 (old NH-45)	27-02-2018 to 05-03-2018
CTVC 3	Mettupatti (near Valappadi)	km 21.750 (old NH-68)	01-03-2018 to 07-03-2018
CTVC 5	Pallikonda (near Vellore)	km 98.520 (old NH-4)	03-03-2018 to 09-03-2018
CTVC 6	Palayam (near Dharmapuri)	km 154.440 (old NH-7)	01-03-2018 to 07-03-2018
CTVC 7	Somasipadi (near Tiruvannamalai)	km 95.600 (old NH-66)	26-02-2018 to 04-03-2018

Location	Survey Locations	Existing km	Date
CTVC 8	Near Pappireddipatti Jn. (near Harur)	km 31.000 (SH-18)	27-02-2018 to 05-02-2018
CTVC 9	Ponnur Malai (near Vandavasi)	km 59.000 (SH-115)	28-02-2018 to 02-03-2018
CTVC 10	Ettivadi (near Polur)	km 42.000 (old NH-234)	27-02-2018 to 01-03-2018

4.1.4.3 Origin-Destination survey

The origin-destination survey was carried out with the primary objective of studying the travel pattern of goods and passenger traffic along the existing roads from Chennai to Salem. The results have also been useful for identifying the influence area of the project road, estimating the growth rates of traffic and planning tolling strategies and locating toll plaza on the most viable section of the project road. The tonnage analysis will form valuable inputs for new pavement design as well as design of overlay on existing pavement.

The survey was conducted at ten locations for a day (24 hours) as stated in **Table 4-4**. Roadside interview method was adopted for the survey, in accordance with guidelines given by IRC: SP 19 – 2001. The road users were interviewed by trained enumerators to obtain the required data under the guidance of traffic engineer and supervisor.

For this purpose, cars (private and taxi cars) and buses were considered as passenger vehicles. Similarly, LMVs, LCVs, 2-axle trucks, 3- axle trucks, 4 to 6-axle trucks and more than 6-axle trucks were considered as goods vehicles. The information collected contained trip origin and trip destination. In addition, type of commodity and tonnage for goods vehicles and purpose and occupancy for passenger vehicles were also collected. Further, trip length, trip frequency are also elicited during O-D surveys.

Table 4-4: Schedule of origin – destination survey

Location	Survey locations	Existing km	Date
OD 1	Paranur (near Chengalpet)	km 52.820 (old NH-45)	06-03-2018
OD 2	Sengurichi (near Ulundurpet)	km 192.750 (old NH-45)	05-03-2018
OD 3	Mettupatti (near Valappadi)	km 21.750 (old NH-68)	07-03-2018
OD 4	Nemili (near Sriperumbudur)	km 37.800 (old NH-4)	05-03-2018
OD 5	Pallikonda (near Vellore)	km 98.520 (old NH-4)	05-03-2018
OD 6	Palayam (near Dharmapuri)	km 154.440 (old NH-7)	07-03-2018
OD 7	Somasipadi (near Tiruvannamalai)	km 95.600 (old NH-66)	02-03-2018
OD 8	Near Pappireddipatti Jn. (near Harur)	km 31.000 (SH-18)	06-03-2018
OD 9	Ponnur Malai (near Vandavasi)	km 59.000 (SH-115)	01-03-2018
OD 10	Ettivadi (near Polur)	km 42.000 (old NH-234)	01-03-2018

4.1.4.4 Axle load survey

Axle Load survey has been carried out in order to estimate vehicle damage factor (VDF) for using in design of overlay on existing pavement and new pavement design for additional lanes.

The survey was carried out at two locations as shown in **Table 4-5**, using portable weigh pads. Axle loads of LCVs, and two, three and multi axle trucks are recorded on random sampling basis. The vehicles were stopped with the help of police and the drivers were directed to stop their vehicles in such a way that wheel of each axle can be weighed using

the weighing pad. The readings were recorded by trained enumerators for each axle separately. In addition, information about origin, destination and type of goods transported by commercial vehicles are recorded.

Table 4-5: Schedule of axle load survey

Location	Survey location/ section	Existing km	Date
AL 1	Mettupatti (near Valappadi)	km 21.750 (old NH-68)	07-03-2018
AL 2	Pallikonda (near Vellore)	km 98.520 (old NH-4)	05-03-2018
AL 3	Near Pappireddipatti Jn. (near Harur)	km 31.000 (SH-18)	06-03-2018

4.1.4.5 Speed and delay survey

The speed and delay survey was conducted using moving car observer method. It was conducted for all the existing roads from Chennai to Salem. The existing roads were divided into suitable sections based on the traffic characteristics of the corridor. The test vehicle was run at the perceptible average speed of the traffic stream along the road. The observers inside the test vehicles recorded travel time and stopping delay timings along with the causes of delays. The test vehicle was made to travel on both directions of travel covering different peak and off peak traffic flow conditions.

4.1.5 Data Analysis

4.1.5.1 Traffic volume count

The classified traffic volume count survey data for four locations was analysed in order to obtain the following traffic characteristics:

- *Average hourly variation of traffic volume*
- *Daily variation of traffic volume*
- *Average Composition of traffic*
- *Directional distribution of traffic*
- *Average Daily Traffic (ADT) volume*

Daily and hourly variation of classified traffic flow is recorded by conducting traffic count at strategically selected traffic count stations. Recorded traffic data has been converted into Passenger Car Unit using PCU factors as shown in **Table 4-6**. These equivalency factors are extracted from IRC: 64 – 1990, 'Guidelines for Capacity of Roads in Rural Areas'.

Table 4-6: Passenger car equivalency factors

Sl. No	Vehicle Type	PCU Factors
1.	Two Wheeler	0.50
2.	Auto–rickshaw	1.00
3.	Car / Jeep / Van	1.00
4.	Mini Bus	1.50
5.	Standard Bus	3.00
6.	Light Commercial Vehicle (LCV), Agricultural Tractor	1.50
7.	Two Axle Truck	3.00
8.	Three Axle Truck	3.00
9.	Truck Trailer	4.50

Sl. No	Vehicle Type	PCU Factors
10.	Agriculture Tractor-trailer	4.50
11.	Animal Drawn	8.00
12.	Cycle	0.50
13.	Hand Cart	3.00
14.	Cycle Rickshaw	2.00

4.1.5.2 Average daily traffic (ADT)

Traffic volume count data for 7 days at seven count locations, 3 days at three locations was averaged to determine Average Daily Traffic (ADT). Traffic volume count summary sheets for count locations along with ADT tables are presented in **Annexure 4.1** to this report. The count location ADT by vehicle type is presented in **Table 4-7**.

Table 4-7: Average Daily Traffic at count locations

Mode of Vehicle	Paranur TP (old NH-45)	Sengurichi TP (old NH-45)	Mettupatti TP (old NH-68)	Nemili TP (old NH-4)	Pallikonda TP (old NH-4)	Palayam TP (old NH-7)	Somasipadi (old NH-66)	Pappireddipatti Jn (SH-18)	Ponnurmalai (SH-115)	Ettivadi (old NH-234)
Car / Jeep / Van	22687	10721	7299	14691	10195	10265	2975	1330	730	2436
Local/Shared Car	85	4	10	12	5	5	3	2	2	0
Mini Bus	2086	369	176	1245	197	175	105	66	44	81
School Bus	112	29	75	85	68	30	230	55	30	92
Govt. bus	3655	1440	881	1679	1199	808	574	233	160	487
Pvt. bus	2036	1628	771	1448	598	893	196	127	39	206
LMV	2363	1166	1373	2204	1106	1999	508	370	226	622
LCV (4 Wheels)	196	74	73	349	130	178	16	23	6	30
LCV (6 Wheels)	2367	1553	1061	3008	2020	2864	119	180	53	270
2 Axle	1473	946	972	1784	803	1308	178	456	64	284
3 Axle	2387	1092	611	1882	869	1614	160	702	107	537
MAV (4 - 6 Axles)	1999	1470	681	2056	1640	4346	71	820	73	623
MAV (7++ Axles)	0	0	0	0	1	0	0	0	0	0
2 Wheeler	23878	5213	8807	14505	11819	5450	9974	1835	2299	5338
3 wheeler/Auto	851	106	213	397	1095	507	366	7	42	106
Tractor	2	8	8	2	5	4	7	12	1	4
Tractor with trailer	7	17	13	4	15	19	21	13	1	20
Cycle	13	6	19	12	118	116	105	33	38	42
Cycle rickshaw	3	0	3	2	2	1	1	0	0	0
Animal drawn	0	0	0	0	0	1	0	0	0	2
Toll exempted Vehicles	47	22	18	34	28	28	6	2	0	2
Tollable Vehicles	**41446**	**20492**	**13983**	**30443**	**18831**	**24485**	**5135**	**4364**	**1534**	**5668**
Tollable PCU	**70094**	**36906**	**23642**	**53697**	**32822**	**50611**	**8180**	**10515**	**2641**	**11252**
Non-tollable vehicles	**24801**	**5372**	**9081**	**14956**	**13082**	**6126**	**10480**	**1902**	**2381**	**5514**
Non-tollable PCU	**12903**	**2835**	**4728**	**7728**	**7181**	**3427**	**5522**	**1021**	**1217**	**2908**
Motorised Vehicles	**66231**	**25858**	**23042**	**45385**	**31793**	**30493**	**15509**	**6233**	**3877**	**11138**

Mode of Vehicle	Paranur TP (old NH-45)	Sengurichi TP (old NH-45)	Mettupatti TP (old NH-68)	Nemili TP (old NH-4)	Pallikonda TP (old NH-4)	Palayam TP (old NH-7)	Somasipadi (old NH-66)	Pappireddipatti Jn (SH-18)	Ponnurmalai (SH-115)	Ettivadi (old NH-234)
Non-Motorised Vehicles	**16**	**6**	**22**	**14**	**120**	**118**	**106**	**33**	**38**	**44**
Total Vehicles	**66247**	**25864**	**23064**	**45399**	**31913**	**30611**	**15615**	**6266**	**3915**	**11182**
Total PCU	**82995**	**39739**	**28369**	**61424**	**40003**	**54038**	**13701**	**11535**	**3858**	**14158**

Traffic volume exhibits considerable variations in both passenger and freight traffic. Goods vehicular movements follow the same trend throughout the day whereas passenger vehicles' flow falls in night time.

4.1.5.2.1 Annual average daily traffic (AADT)

AADT is the base year (FY-18) traffic. This is a product of ADT and seasonal variation factor. Seasonal variation factor can be derived using various methods. Vehicle data from toll booths check posts etc. or sale details of petrol and diesel fuels along the corridor are the commonly used sets of data. In the present case both toll plaza data and fuel sales data were used, which is collected from various fuel outlets along the project stretch. Location wise SCF was calculated based on toll plaza and fuel sales data. For Nemili, Somasipadi, Pappireddipatti, Ponnurmalai and Ettivadi fuel sales data were considered for SCF calculations**.** For remaining locations data collected from respective toll plazas were used for SCF calculations. **Table 4-8** and **Table 4-9** shows the seasonal factors calculated based on fuel sales data and toll plaza data.

Table 4-8: Seasonal factors based on Fuel sales data

Locations/TP	MS	HSD
km 37.800 (old NH-4), Nemili TP	1.020	1.001
km 95.600 (old NH-66), Somasipadi (near Tiruvannamalai)	0.989	0.979
km 31.000 (SH-18), Pappireddipatti Jn. (Harur road)	0.943	0.949
km 59.000 (SH-115), Ponnur Malai (near Vandavasi)	1.014	0.995
km 42.000 (old NH-234), Ettivadi (near Polur)	0.938	1.011

Table 4-9: Seasonal factors based on Toll plaza data

Locations/TP	Car	LCV	Bus	Truck	3A	MAV
km 52.820 (old NH-45), Paranur TP	0.979	0.694	0.645	0.645	0.848	0.848
km 192.750 (old NH-45), Sengurichi TP	1.120	0.920	0.980	0.980	0.888	0.888
km 21.750 (old NH-68), Mettupatti TP	0.983	0.888	1.036	0.920	0.927	0.927
km 98.520 (old NH-4), Pallikonda	1.041	0.919	1.006	0.893	0.885	0.885
km 154.440 (old NH-7), Palayam	1.072	0.958	1.079	0.927	0.928	0.928

The traffic volume survey along the project road has been carried out in month of March 2018 and seasonal factor for this has been considered for converting ADT to AADT. Vehicle class wise AADT at count locations along the project road is shown in **Table 4-10**. The AADT values of base year (FY-18) has been used for the traffic volume projection up to year 2053 and projected traffic volume for 30 years has been used in design of pavement and for projecting the tollable traffic. Summary of ADT & AADT are shown in **Table 4-11**.

Table 4-10: Annual Average Daily Traffic at count locations

Mode of Vehicle	Paranur TP (old NH-45)	Sengurichi TP (old NH-45)	Mettupatti TP (old NH-68)	Nemili TP (old NH-4)	Pallikonda TP (old NH-4)	Palayam TP (old NH-7)	Somasipadi (old NH-66)	Pappireddipatti Jn (SH-18)	Ponnurmalai (SH-115)	Ettivadi (old NH-234)
Car / Jeep / Van	22211	12008	7175	14845	10613	11004	2927	1258	733	2374
Local/Shared Car	83	4	10	12	5	5	3	2	2	0
Mini Bus	1448	339	156	1246	181	168	103	63	44	82
School Bus	72	28	78	85	68	32	225	52	30	93
Govt. bus	2357	1411	913	1681	1206	872	562	221	159	492
Pvt. bus	1727	1446	715	1449	529	829	192	121	39	208
LMV	2313	1306	1350	2206	1151	2143	497	351	225	629
LCV (4 Wheels)	136	68	65	349	119	171	16	22	6	30
LCV (6 Wheels)	1643	1429	942	3011	1856	2744	117	171	53	273
2 Axle	950	927	894	1786	717	1213	174	433	64	287
3 Axle	2024	970	566	1884	769	1498	157	666	106	543
MAV (4 - 6 Axles)	1695	1305	631	2058	1451	4033	70	778	73	630
MAV (7++ Axles)	0	0	0	0	1	0	0	0	0	0
2 Wheeler	23878	5213	8807	14795	11819	5450	9864	1730	2331	5007
3 wheeler/Auto	851	106	213	404	1095	507	361	7	43	102
Tractor	2	8	8	2	5	4	7	12	1	4
Tractor with trailer	7	17	13	4	15	19	21	13	1	20
Cycle	13	6	19	12	118	116	105	33	38	42
Cycle rickshaw	3	0	3	2	2	1	1	0	0	0
Animal drawn	0	0	0	0	0	1	0	0	0	2
Toll exempted Vehicles	47	22	18	34	28	28	6	2	0	2
Tollable Vehicles	**36659**	**21241**	**13495**	**30612**	**18666**	**24712**	**5043**	**4138**	**1534**	**5641**
Tollable PCU	**58465**	**36291**	**22617**	**53888**	**31404**	**49257**	**8026**	**9975**	**2637**	**11285**
Non-tollable vehicles	**24801**	**5372**	**9081**	**15253**	**13082**	**6126**	**10365**	**1797**	**2414**	**5179**
Non-tollable PCU	**12902**	**2834**	**4727**	**7880**	**7181**	**3427**	**5461**	**968**	**1234**	**2738**
Motorised Vehicles	**61444**	**26607**	**22554**	**45851**	**31628**	**30720**	**15302**	**5902**	**3910**	**10776**

Mode of Vehicle	Paranur TP (old NH-45)	Sengurichi TP (old NH-45)	Mettupatti TP (old NH-68)	Nemili TP (old NH-4)	Pallikonda TP (old NH-4)	Palayam TP (old NH-7)	Somasipadi (old NH-66)	Pappireddipatti Jn (SH-18)	Ponnurmalai (SH-115)	Ettivadi (old NH-234)
Non-Motorised Vehicles	16	6	22	14	120	118	106	33	38	44
Total Vehicles	61460	26613	22576	45865	31748	30838	15408	5935	3948	10820
Total PCU	71367	39125	27344	61768	38585	52684	13487	10943	3871	14022

Table 4-11: Summary of ADT and AADT at count locations

Sl. No.	Location	ADT		AADT	
		Nos.	PCUs	Nos.	PCUs
1	Paranur TP (old NH-45)	66247	82995	61460	71367
2	Sengurichi TP (old NH-45)	25864	39739	26613	39125
3	Mettupatti TP (old NH-68)	23064	28369	22576	27344
4	Nemili TP (old NH-4)	45399	61424	45865	61768
5	Pallikonda TP (old NH-4)	31913	40003	31748	38585
6	Palayam TP (old NH-7)	30611	54038	30838	52684
7	Somasipadi (near Tiruvanamalai) (old NH-66)	15615	13701	15408	13487
8	Pappireddipatti Jn. (Harur road) (SH-18)	6266	11535	5935	10943
9	Ponnur Malai (near Vandavasi) (SH-115)	3915	3858	3948	3871
10	Ettivadi (near Polur) (NH-234)	11182	14158	10820	14022

4.1.5.2.2 Composition of traffic

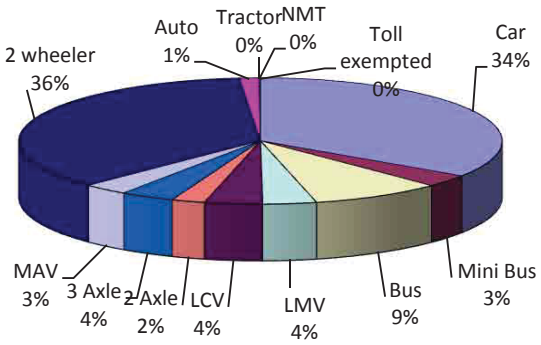
The average composition of tollable traffic at count locations is presented in **Figure 4-3** and **Table 4-12** shows the average composition of total traffic at CTVC count locations. It is observed that two wheelers are having highest share of composition i.e., from 17.8% to 63.9% and next by cars i.e., from 18.6% to 41.5%. In terms of freight traffic LMVs & LCVs share are more in all location. MAVs share is more in toll plaza locations followed by 3-Axle trucks and 2-Axle trucks.

Table 4-12: Average total traffic composition at count locations

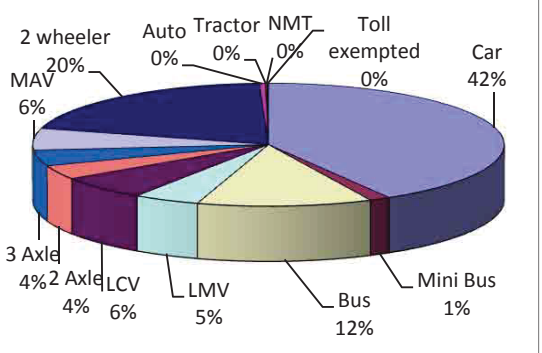
Mode of Vehicle	Paranur TP (old NH-45)		Sengurichi TP (old NH-45)		Mettupatti TP (old NH-68)		Nemili TP (old NH-4)		Pallikonda TP (old NH-4)		Palayam TP (old NH-7)		Somasipadi (old NH-66)		Pappireddipatti Jn (SH-18)		Ponnurmalai (SH-115)		Ettivadi (old NH-234)	
	No's	%	No's	%	No's	%	No's	%	No's	%	No's	%	No's	%	No's	%	No's	%	No's	%
Car/Jeep/Van	22687	34.2	10721	41.5	7299	31.6	14691	32.4	10195	31.9	10265	33.5	2975	19.1	1330	21.2	730	18.6	2436	21.8
Local/Shared Car	85	0.1	4	0.0	10	0.0	12	0.0	5	0.0	5	0.0	3	0.0	2	0.0	2	0.1	0	0.0
Mini Bus	2086	3.1	369	1.4	176	0.8	1245	2.7	197	0.6	175	0.6	105	0.7	66	1.1	44	1.1	81	0.7
School Bus	112	0.2	29	0.1	75	0.3	85	0.2	68	0.2	30	0.1	230	1.5	55	0.9	30	0.8	92	0.8
Govt. bus	3655	5.5	1440	5.6	881	3.8	1679	3.7	1199	3.8	808	2.6	574	3.7	233	3.7	160	4.1	487	4.4
Pvt. bus	2036	3.1	1628	6.3	771	3.3	1448	3.2	598	1.9	893	2.9	196	1.3	127	2.0	39	1.0	206	1.8
LMV	2363	3.6	1166	4.5	1373	6.0	2204	4.9	1106	3.5	1999	6.5	508	3.3	370	5.9	226	5.8	622	5.6
LCV (4 Wheels)	196	0.3	74	0.3	73	0.3	349	0.8	130	0.4	178	0.6	16	0.1	23	0.4	6	0.2	30	0.3
LCV (6 Wheels)	2367	3.6	1553	6.0	1061	4.6	3008	6.6	2020	6.3	2864	9.4	119	0.8	180	2.9	53	1.4	270	2.4
2 Axle	1473	2.2	946	3.7	972	4.2	1784	3.9	803	2.5	1308	4.3	178	1.1	456	7.3	64	1.6	284	2.5
3 Axle	2387	3.6	1092	4.2	611	2.6	1882	4.1	869	2.7	1614	5.3	160	1.0	702	11.2	107	2.7	537	4.8
MAV (4 - 6 Axles)	1999	3.0	1470	5.7	681	3.0	2056	4.5	1640	5.1	4346	14.2	71	0.5	820	13.1	73	1.9	623	5.6
MAV (7++ Axles)	0	0.0	0	0.0	0	0.0	0	0.0	1	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
2 Wheeler	23878	36.0	5213	20.2	8807	38.2	14505	32.0	11819	37.0	5450	17.8	9974	63.9	1835	29.3	2299	58.7	5338	47.7
3 Wheeler/Auto	797	1.2	89	0.3	142	0.6	343	0.8	964	3.0	425	1.4	322	2.1	3	0.0	36	0.9	71	0.6
Auto(G)	54	0.1	17	0.1	71	0.3	54	0.1	131	0.4	82	0.3	44	0.3	4	0.1	6	0.2	35	0.3

Mode of Vehicle	Paranur TP (old NH-45)		Sengurichi TP (old NH-45)		Mettupatti TP (old NH-68)		Nemili TP (old NH-4)		Pallikonda TP (old NH-4)		Palayam TP (old NH-7)		Somasipadi (old NH-66)		Pappireddipatti Jn (SH-18)		Ponnurmalai (SH-115)		Ettivadi (old NH-234)	
	No's	%	No's	%	No's	%	No's	%	No's	%	No's	%	No's	%	No's	%	No's	%	No's	%
Tractor	2	0.0	8	0.0	8	0.0	2	0.0	5	0.0	4	0.0	7	0.0	12	0.2	1	0.0	4	0.0
Tractor+Trailer	7	0.0	17	0.1	13	0.1	4	0.0	15	0.0	19	0.1	21	0.1	13	0.2	1	0.0	20	0.2
Cycle	13	0.0	6	0.0	19	0.1	12	0.0	118	0.4	116	0.4	105	0.7	33	0.5	38	1.0	42	0.4
Cycle Rickshaw	3	0.0	0	0.0	3	0.0	2	0.0	2	0.0	1	0.0	1	0.0	0	0.0	0	0.0	0	0.0
Animal Drawn	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	0.0	0	0.0	0	0.0	0	0.0	2	0.0
toll Ex Veh	47	0.1	22	0.1	18	0.1	34	0.1	28	0.1	28	0.1	6	0.0	2	0.0	0	0.0	2	0.0
Tollable Vehicles	**41446**	**62.6**	**20492**	**79.2**	**13983**	**60.6**	**30443**	**67.1**	**18831**	**59.0**	**24485**	**80.0**	**5135**	**32.9**	**4364**	**69.6**	**1534**	**39.2**	**5668**	**50.7**
Non-Tollable Vehicles	**24801**	**37.4**	**5372**	**20.8**	**9081**	**39.4**	**14956**	**32.9**	**13082**	**41.0**	**6126**	**20.0**	**10480**	**67.1**	**1902**	**30.4**	**2381**	**60.8**	**5514**	**49.3**
Passenger Vehicles	**55381**	**83.6**	**19514**	**75.4**	**18175**	**78.8**	**34039**	**75.0**	**25073**	**78.6**	**18079**	**59.1**	**14385**	**92.1**	**3653**	**58.3**	**3340**	**85.3**	**8713**	**77.9**
Freight Vehicles	**10850**	**16.4**	**6344**	**24.5**	**4867**	**21.1**	**11346**	**25.0**	**6720**	**21.1**	**12414**	**40.6**	**1124**	**7.2**	**2580**	**41.2**	**537**	**13.7**	**2425**	**21.7**
Slow Moving	**16**	**0.0**	**6**	**0.0**	**22**	**0.1**	**14**	**0.0**	**120**	**0.4**	**118**	**0.4**	**106**	**0.7**	**33**	**0.5**	**38**	**1.0**	**44**	**0.4**
Motorised	**66231**	**100.0**	**25858**	**100.0**	**23042**	**99.9**	**45385**	**100.0**	**31793**	**99.6**	**30493**	**99.6**	**15509**	**99.3**	**6233**	**99.5**	**3877**	**99.0**	**11138**	**99.6**
Non motorised	**16**	**0.0**	**6**	**0.0**	**22**	**0.1**	**14**	**0.0**	**120**	**0.4**	**118**	**0.4**	**106**	**0.7**	**33**	**0.5**	**38**	**1.0**	**44**	**0.4**
Total (Vehicles)	***66247***	***100.0***	***25864***	***100.0***	***23064***	***100.0***	***45399***	***100.0***	***31913***	***100.0***	***30611***	***100.0***	***15615***	***100.0***	***6266***	***100.0***	***3915***	***100.0***	***11182***	***100.0***

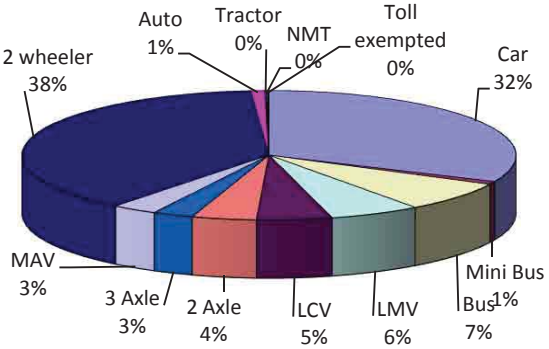
Vehicle Composition at Paranur TP (old NH-45)



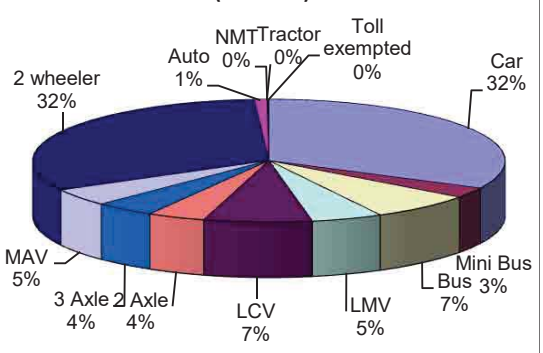
Vehicle Composition at Sengurichi TP (old NH-45)



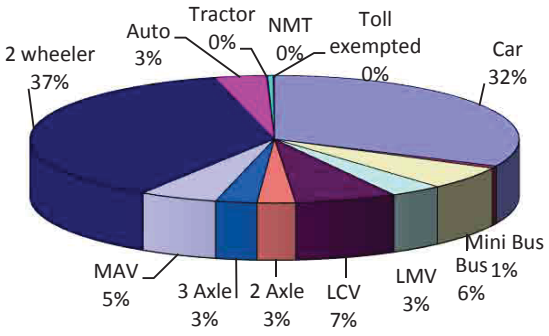
Vehicle Composition at Mettupatti TP (old NH-68)



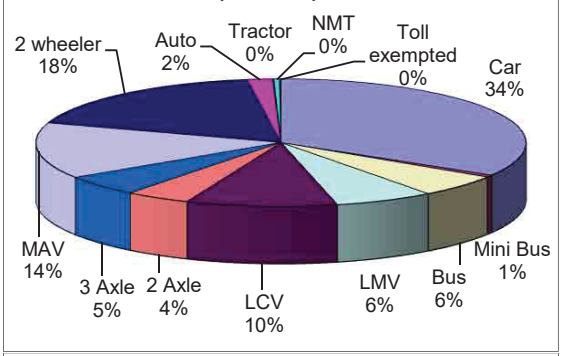
Vehicle Composition at Nemili TP (old NH-4)



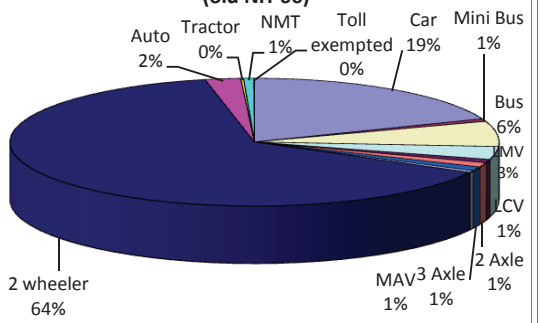
Vehicle Composition at Pallikonda TP (old NH-4)



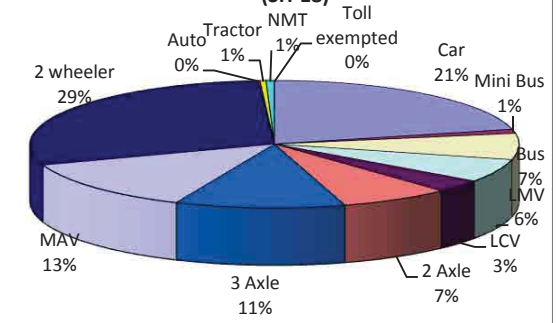
Vehicle Composition at Palayam TP (old NH-7)



Vehicle Composition at Somasipadi (old NH-66)



Vehicle Composition at Pappireddipatti Jn (SH-18)



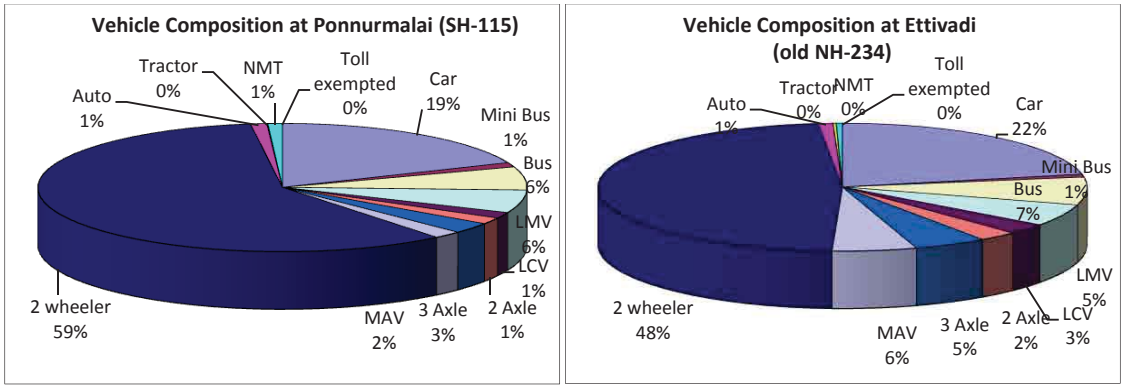


Figure 4-3: Vehicle Composition

4.1.5.2.3 Hourly variation of traffic

Average hourly variation of traffic at count locations is shown in **Figure 4-4.** It is observed that traffic flow in day and night has considerable variation in volume. At all count locations the morning peak observed between 10.00AM to 12.00PM and evening peak hour between 4.00PM to 6.00PM.

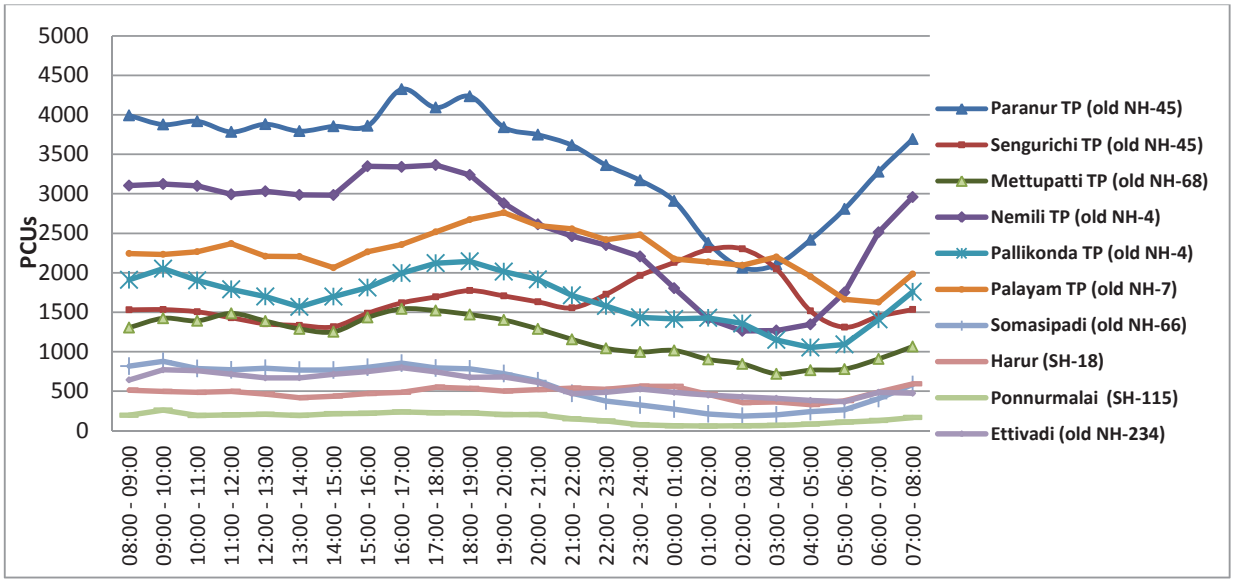


Figure 4-4: Hourly traffic variation at count locations

4.1.5.2.4 Daily variation of traffic volume

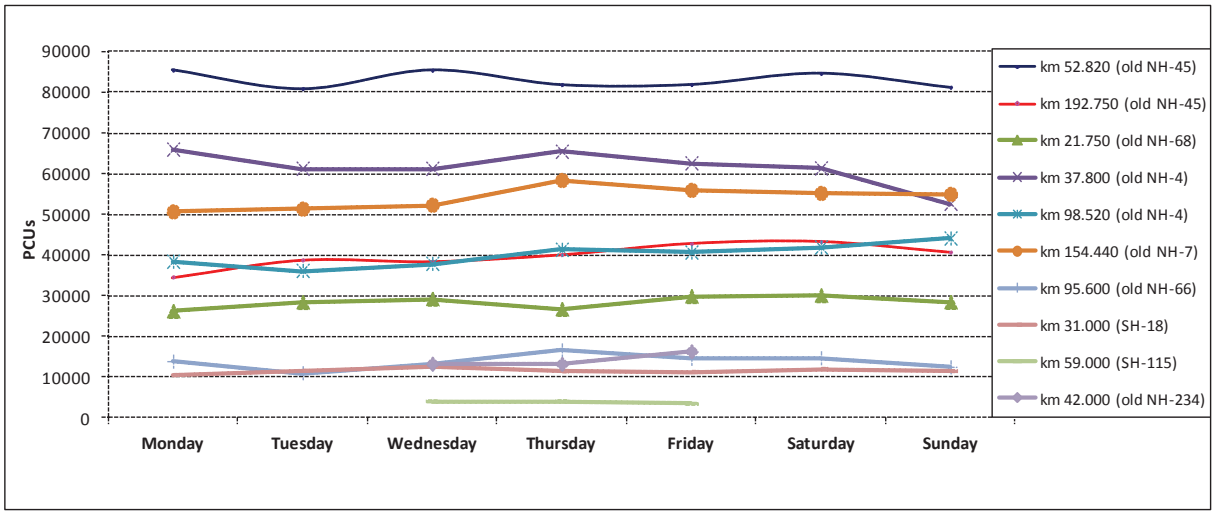


Figure 4-5: Daily variation of traffic at count locations

Daily variation of traffic for count locations is shown in **Figure 4-5.** Daily variation of traffic in terms of day factors at count locations is presented in **Table 4-5**.

Table 4-13: Day factors and maximum variations

Location	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Paranur TP (old NH-45)	2.9	-2.6	2.8	-1.4	-1.4	1.9	-2.2
Sengurichi TP (old NH-45)	-13.1	-2.6	-3.4	0.7	7.5	8.7	2.3
Mettupatti TP (old NH-68)	-7.7	0.0	2.9	-6.0	5.1	5.9	0.1
Nemili TP (old NH-4)	7.3	-0.4	-0.4	6.4	1.8	-0.2	-14.4
Pallikonda TP (old NH-4)	-4.1	-9.8	-5.4	3.2	1.5	4.6	10.1
Palayam TP (old NH-7)	-6.4	-5.1	-3.3	7.9	3.4	2.0	1.6
Somasipadi (old NH-66)	0.7	-20.1	-4.5	20.9	5.7	6.8	-9.5
Pappireddipatti Jn. (SH-18)	-8.9	0.0	8.6	-1.1	-2.3	4.1	-0.5
Ponnur Malai (SH-115)			5.1	6.1	-11.3		
Ettivadi (NH-234)			-7.0	-7.3	14.4		

Daily traffic for 7 days at count locations in histogram form is presented in **Figure 4-6** and the variation of daily total PCU is presented in **Table 4-14** along with maximum and minimum variations from average volume in percentages.

Table 4-14: Daily Variation of Traffic Volume (PCUs)

Location	Mon	Tue	Wed	Thu	Fri	Sat	Sun	ADT	Maximum variation	
									+ Ve (%)	- Ve (%)
Paranur TP (old NH-45)	85390	80812	85356	81804	81835	84566	81172	**82995**	**2.9**	**-2.6**
Sengurichi TP (old NH-45)	34547	38723	38383	40017	42720	43207	40650	**39739**	**8.7**	**-13.1**
Mettupatti TP (old NH-68)	26173	28367	29183	26664	29820	30034	28387	**28369**	**5.9**	**-7.7**

Location	Mon	Tue	Wed	Thu	Fri	Sat	Sun	ADT	Maximum variation	
									+ Ve (%)	- Ve (%)
Nemili TP (old NH-4)	65905	61195	61173	65368	62521	61274	52594	**61424**	**7.3**	**-14.4**
Pallikonda TP (old NH-4)	38347	36086	37827	41277	40601	41847	44059	**40003**	**10.1**	**-9.8**
Palayam TP (old NH-7)	50596	51269	52229	58312	55881	55125	54891	**54038**	**7.9**	**-6.4**
Somasipadi (old NH-66)	13796	10951	13087	16559	14483	14635	12399	**13701**	**20.9**	**-20.1**
Pappireddipatti Jn. (SH-18)	10508	11530	12528	11404	11274	12008	11479	**11535**	**8.6**	**-8.9**
Ponnur Malai (SH-115)	-	-	4054	4092	3423	-	-	**3858**	**6.1**	**-11.3**
Ettivadi (NH-234)	-	-	13164	13118	16199	-	-	**14158**	**14.4**	**-7.3**

Day factor is the variation of each day's traffic to the average daily traffic. Day wise variations are observed at count locations. It is observed that, weekends along with Monday pictures maximum passenger traffic at all locations.

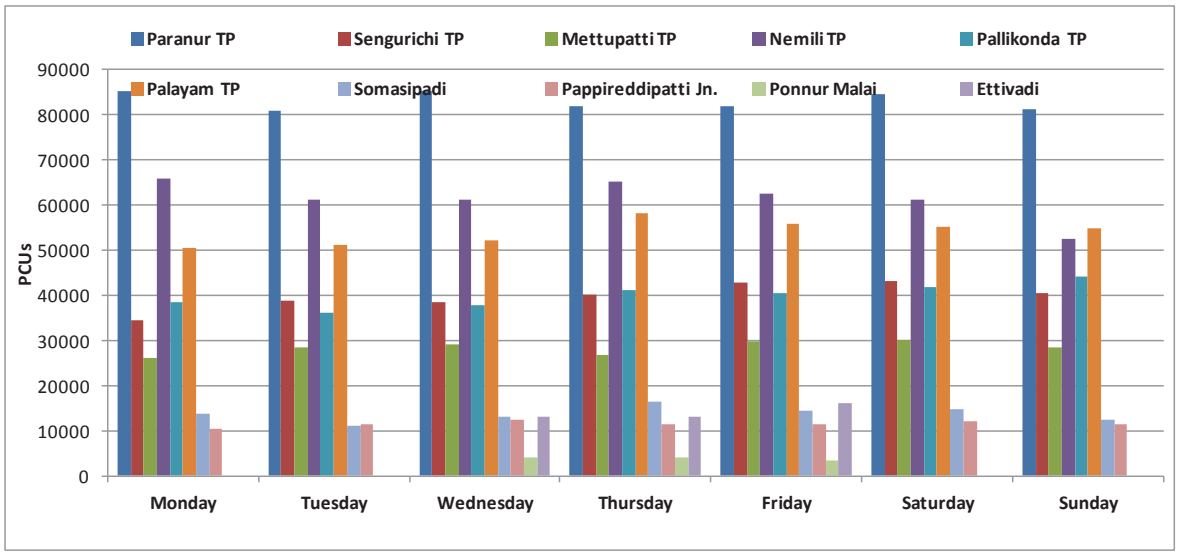


Figure 4-6: Daily variation of traffic at count locations across week

4.1.5.2.5 Directional distribution of traffic

Directional split at count locations is shown in **Table 4-15**. This is a useful input for capacity analysis and pavement design. As seen, the directional split for up and down traffic is almost equal along the project corridor.

Table 4-15: Directional split

Location	Chennai-Salem	Salem-Chennai
Paranur TP (old NH-45)	50.66%	49.34%
Sengurichi TP (old NH-45)	50.45%	49.55%
Mettupatti TP (old NH-68)	50.01%	49.99%
Nemili TP (old NH-4)	48.75%	51.25%
Pallikonda TP (old NH-4)	50.46%	49.54%

Location	Chennai-Salem	Salem-Chennai
Palayam TP (old NH-7)	50.67%	49.33%
Somasipadi (old NH-66)	49.38%	50.62%
Pappireddipatti Jn. (SH-18)	52.51%	47.49%
Ponnur Malai (SH-115)	53.26%	46.74%
Ettivadi (NH-234)	52.40%	47.60%

4.1.5.3 Origin – Destination Survey

The O–D survey has been carried out on random sample basis and sample size in terms of percentage of daily traffic obtained for each class of vehicle is shown in **Table 4-16** below.

Table 4-16: Sample Size for O – D Survey

S. No	Vehicle type	Paranur TP (old NH-45)	Sengurichi TP (old NH-45)	Mettupatti TP (old NH-68)	Nemili TP (old NH-4)	Pallikonda TP (old NH-4)
1	Car / Jeep / Van	28.20%	31.86%	36.39%	22.58%	28.89%
2	Bus	17.22%	28.24%	39.52%	16.20%	19.28%
3	LMV	19.65%	20.97%	42.86%	17.03%	17.20%
4	LCV	20.55%	24.53%	23.62%	17.14%	24.24%
5	2 Axle Truck	44.00%	51.95%	69.77%	47.59%	54.91%
6	3 Axle Truck	23.96%	45.53%	46.57%	27.08%	43.26%
7	Multi Axle Truck	23.80%	82.96%	64.42%	23.97%	44.22%
S. No	**Vehicle type**	**Palayam TP (old NH-7)**	**Somasipadi (old NH-66)**	**Pappireddipatti Jn (SH-18)**	**Ponnurmalai (SH-115)**	**Ettivadi (old NH-234)**
1	Car / Jeep / Van	30.92%	27.70%	41.22%	35.60%	19.95%
2	Bus	26.46%	19.71%	54.47%	34.01%	16.98%
3	LMV	22.92%	28.06%	14.59%	23.70%	14.66%
4	LCV	27.46%	34.90%	30.05%	67.39%	28.66%
5	2 Axle Truck	51.71%	24.46%	39.69%	45.16%	42.96%
6	3 Axle Truck	28.52%	29.10%	44.59%	16.10%	38.98%
7	Multi Axle Truck	38.41%	25.69%	25.24%	28.26%	38.94%

The collected data were entered into the computer and checked manually. Incorrect entries were corrected by cross-checking it with original field data sheets. The data was also checked for inconsistencies. The checking included:

- Trips from zones to zones which cannot possibly ply through the survey location
- Vehicle type with their corresponding lead / load / occupancy for any inconsistencies

The checked and corrected data were used for final analysis.

4.1.5.3.1 Zoning system

For analysis of data collected from the field, it is required to code them for developing origin and destination matrices of trips. The project road passes through in the state of Tamil Nadu. The project stretch comes under Kanchipuram, Tiruvanamalai, Dharmapuri and Salem districts of Tamil nadu

These zones were considered as immediate influence area (IIA) and rest of the zones are considered

as external zones. Neighbouring districts considered as IIA region and remaining districts of Tamil Nadu, Karnataka, Kerala, Andhra Pradesh and Telangana and rest of India were grouped to form external influencing zones. These considerations helped in arriving at 45 zones for the project. The zones are listed in **Table 4-17**.

Table 4-17: Adopted zoning system for the study

Zone No	Description	State/District
1	Tiruvallur district	Tiruvallur
2	Chennai North (Ennore, Red hills, Aladu, Madhavaram, Vichoor, Ediyanchavadi)	Tiruvallur/Chennai
3	Chennai South (Chennai, Port, Poonamalle, Avadi, Tambaram, Adyar, Velacherry)	Chennai/Kanchipuram
4	Chengalpattu, Maraimalai nagar, Mahabalipuram, Kalpakkam	Kanchipuram
5	Sriperambudur, Kanchipuram, Sunguvarchattram, Walajabad	Kanchipuram
6	Arakkonnam, Tiruttani, Pallipattu	Tiruvallur, Vellore
7	Walajapet, Arcot, Ranipet, Pudupadi, Sholinghur, Ponnai, Ammoor	Vellore
8	Vellore, Katpadi, Brahmapuram, Kannamangalam, Pennathur	Vellore
9	Gudiyattam, Pudupettai, Melpatti, Ambur, Agaram, Vinayambadi	Vellore
10	Tirupattur, Jolarpet, Uthangarai, Motupatti, Mathur	Vellore/Krishnagiri
11	Hosur, Krishnagiri, Bargur, Denkanalkota	Krishnagiri
12	Tirvettipuram, Cheyyar, Kalavai, Kilpudipakkam, Brahmadesam	Tiruvannamalai/Vellore
13	Vandavasi, Uttiramerur, Maduranattakam, Padalam, Melmaruvattur	Tiruvannamalai/Kanchipuram
14	Arani, Velpadi, Gengapuram, Semmambadi	Tiruvannamalai
15	Chetpet, Sattambadi, Avalurpettai	Tiruvannamalai/Villupuram
16	Polur, Ettivadi, Tirusur, Kunnathur, Kalasapakkam, Pettai, Palankovil	Tiruvannamalai
17	Tiruvannamalai	Tiruvannamalai
18	Chengam, Valayampattu, Kottakulam, Kariyamangalam	Tiruvannamalai
19	Gingee, Tindivanam, Vairapuram, Marakkanam	Villupuram
20	Villupuram, Tirukovillur, Kallakurichi, Rest of Villupuram	Villupuram
21	Harur, Morappur	Dharmapuri
22	Dharmapuri	Dharmapuri
23	Markarampatti, Pallippatti, Samiyapuram, Lakshmipuram, Valvandi	Dharmapuri
24	Yercaud, Kulampatti, Vazhappadi, Ayodhyapattnam, Belur	Salem
25	Salem	Salem
26	Attur, Gangavalli, Malliyakarai, Sondarapalli	Salem
27	Omalur, Mettur, Kadiyampatti	Salem

Zone No	Description	State/District
28	Cuddalore, Nagapattanam, Perambalur, Thiruvarur, Thanjavur	Tamil Nadu
29	Tiruchchurapalli	Tamil Nadu
30	Nammakal, Karur districts	Tamil Nadu
31	Erode, Coimbatore, Nilgiris	Tamil Nadu
32	Pudukottai, Sivaganga, Ramanathapuram districts	Tamil Nadu
33	Dindigul, Madurai, Theni districts	Tamil Nadu
34	Virudunagar, Tuticorin, Tirunelveli, Kanniyakumari districts	Tamil Nadu
35	Pondicherry	Pondicherry
36	Mysore, Chamaraj nagar districts	Karnataka
37	Rest of Karnataka	Karnataka
38	Kasaragod, Kannur, Wayanad, Kozhikode districts	Kerala
39	Rest of Kerala	Kerala
40	Ananthapur, Kadapa, Kurnool districts	Andhra Pradesh
41	Nellore, Chittor, Prakasam, Guntur, Krishna (Vijayawada), Vishakhapatnam, Rest of AP	Andhra Pradesh
42	Telangana, Maharashtra states	Rest of India
43	Odisha, West Bengal, Chhattisgarh, Bihar, Jharkhand, North East States	Rest of India
44	Gujarat, Rajasthan, Madhya Pradesh, Haryana, Delhi, Himachal Pradesh	Rest of India
45	Rest of India	Rest of India

4.1.5.3.2 Expansion factors and development of O – D matrices

The origin – destination details were collected from the trip makers during the survey on sample basis. Sampling varied with the changes in traffic flow across the day. Care has been taken to eliminate any element of bias in sampling. Since data was collected on sample basis, expansion factors are required to replicate the pattern as reflected in the sample to the total number of vehicular trips made during the day. These expansion factors are calculated separately for each class of vehicle. For example, if x_c is number of cars interviewed and X_c is the total number of cars counted during the day, then X_c/x_c would be the expansion factor for cars.

O – D matrices are developed to assess the traffic movement pattern. These matrices actually speak about distribution of trips for each zone as intra zonal and inter zonal movements. The vehicle wise O – D matrices are developed by multiplying the sample O – D matrix obtained from survey data with expansion factors. Accordingly 8 matrices, for different modes were developed for each survey location. O – D matrices for different vehicle type all ten locations are presented in **Annexure 4.2a to 4.2j** to this report.

4.1.5.3.3 Lead Distribution

The lead distribution of vehicles as revealed from O – D survey is given in **Table 4-18**. LMV is included in this, as its trips also impart important characteristics about distances.

Table 4-18: Lead distribution of vehicles

Vehicle type	Trip Length Range (km)									
	< 20	**21 -50**	**51-100**	**101-200**	**201-350**	**351-500**	**501-750**	**751-1000**	**>1000**	**Total**
Paranur TP (old NH-45)										
Car	0.00	2.23	8.75	41.42	27.18	19.43	0.33	0.57	0.09	100.00

Bus	0.00	1.58	16.29	35.75	28.05	17.19	0.68	0.00	0.45	100.00
LMV	0.00	3.14	33.63	43.50	12.56	5.38	1.79	0.00	0.00	100.00
LCV	0.00	2.27	45.31	26.21	11.97	11.33	2.59	0.32	0.00	100.00
2-Axle	0.00	2.00	28.67	54.67	7.73	4.53	1.60	0.67	0.13	100.00
3-Axle	0.00	1.03	22.79	32.06	35.00	6.76	1.18	1.03	0.15	100.00
MAV	0.00	1.34	17.78	54.30	13.96	7.65	2.68	1.72	0.57	100.00
Sengurichi TP (old NH-45)										
Car	0.00	2.99	2.06	26.54	52.76	12.45	2.56	0.28	0.36	100.00
Bus	0.00	1.47	0.49	20.47	60.91	13.85	2.45	0.12	0.25	100.00
LMV	0.00	6.98	2.91	26.16	46.51	12.79	3.49	0.00	1.16	100.00
LCV	0.00	4.10	2.24	19.78	55.22	10.45	5.22	0.75	2.24	100.00
2-Axle	0.00	3.71	2.29	16.00	46.86	20.86	8.29	0.29	1.71	100.00
3-Axle	0.00	2.70	1.80	17.72	49.25	17.42	8.71	1.80	0.60	100.00
MAV	0.00	2.46	0.65	17.36	47.93	19.30	9.46	1.68	1.17	100.00
Mettupatti TP (old NH-68)										
Car	1.30	0.75	21.64	26.75	29.06	9.52	7.13	3.77	0.08	100.00
Bus	2.34	0.29	13.62	31.92	38.36	5.71	5.71	2.05	0.00	100.00
LMV	1.15	1.64	23.61	32.46	27.05	7.21	4.10	1.48	1.31	100.00
LCV	0.60	1.79	17.91	23.28	28.96	19.40	5.97	2.09	0.00	100.00
2-Axle	1.09	1.09	18.39	22.62	31.34	12.67	8.45	3.00	1.36	100.00
3-Axle	0.62	0.93	15.17	26.63	28.79	12.07	9.29	5.26	1.24	100.00
MAV	0.23	0.92	8.05	14.25	29.20	17.93	14.25	11.72	3.45	100.00
Nemili TP (old NH-4)										
Car	0.03	27.20	3.48	40.60	16.33	1.93	2.07	8.14	0.23	100.00
Bus	0.00	29.04	3.31	48.53	13.24	1.47	0.37	4.04	0.00	100.00
LMV	0.00	41.41	3.13	33.59	12.50	4.69	2.34	2.34	0.00	100.00
LCV	0.00	30.37	4.44	32.96	15.19	4.07	1.11	11.48	0.37	100.00
2-Axle	0.00	29.13	2.80	36.01	10.81	3.82	2.54	13.49	1.40	100.00
3-Axle	0.00	22.50	2.46	30.58	17.40	3.34	4.04	18.28	1.41	100.00
MAV	0.00	23.84	0.69	34.03	12.73	6.02	3.01	16.44	3.24	100.00
Pallikonda TP (old NH-4)										
Car	0.00	0.14	9.41	21.15	15.86	4.11	25.41	23.60	0.32	100.00
Bus	0.00	0.26	10.16	10.68	12.76	1.30	37.50	27.08	0.26	100.00
LMV	0.00	0.00	25.12	16.26	14.29	4.93	23.65	12.81	2.96	100.00
LCV	0.00	0.00	8.10	16.84	21.96	5.12	23.67	22.39	1.92	100.00
2-Axle	0.00	0.00	3.36	14.35	14.80	3.59	37.44	24.66	1.79	100.00
3-Axle	0.00	0.66	3.62	13.16	17.43	3.29	37.17	22.70	1.97	100.00
MAV	0.00	0.00	4.57	11.34	15.12	5.20	32.60	29.61	1.57	100.00
Palayam TP (old NH-7)										
Car	0.00	5.23	17.87	20.13	15.21	6.22	25.16	8.12	2.06	100.00
Bus	0.00	6.70	28.71	16.99	7.18	1.67	30.86	7.66	0.24	100.00
LMV	0.00	8.65	21.31	21.10	15.82	5.49	12.24	5.06	10.34	100.00

LCV	0.00	3.22	11.45	14.67	18.40	8.11	19.56	13.00	11.58	100.00
2-Axle	0.00	2.41	7.42	17.95	16.35	6.12	18.46	13.24	18.05	100.00
3-Axle	0.00	2.19	5.06	12.14	11.80	6.24	22.77	10.62	29.17	100.00
MAV	0.00	2.43	5.69	13.23	12.01	3.83	19.62	10.29	32.91	100.00
Somasipadi (old NH-66)										
Car	0.00	0.61	27.20	55.78	3.80	0.00	11.09	1.22	0.30	100.00
Bus	0.00	0.98	33.33	58.82	0.98	0.00	3.92	0.00	1.96	100.00
LMV	0.00	1.92	54.81	29.81	6.73	0.00	5.77	0.00	0.96	100.00
LCV	0.00	2.33	27.91	46.51	16.28	2.33	4.65	0.00	0.00	100.00
2-Axle	0.00	6.98	25.58	39.53	4.65	0.00	6.98	9.30	6.98	100.00
3-Axle	0.00	1.96	15.69	50.98	15.69	1.96	1.96	9.80	1.96	100.00
MAV	0.00	0.00	18.52	37.04	3.70	0.00	29.63	7.41	3.70	100.00
Near Pappireddipatti Jn (SH-18)										
Car	0.00	0.00	41.71	21.49	12.57	10.93	7.10	1.82	4.37	100.00
Bus	0.83	0.00	43.39	16.12	20.66	8.68	6.20	2.07	2.07	100.00
LMV	0.00	0.00	20.37	16.67	24.07	14.81	12.96	1.85	9.26	100.00
LCV	0.00	0.00	31.15	16.39	27.87	6.56	13.11	1.64	3.28	100.00
2-Axle	0.00	0.56	17.32	14.53	27.37	16.76	13.97	2.79	6.70	100.00
3-Axle	0.00	0.00	15.02	10.22	24.60	17.57	16.93	7.99	7.67	100.00
MAV	0.00	0.00	10.14	6.76	22.71	16.91	23.67	7.73	12.08	100.00
Ponnurmalai (SH-115)										
Car	0.00	1.73	34.95	55.36	2.08	4.84	1.04	0.00	0.00	100.00
Bus	0.00	1.10	26.37	68.13	0.00	3.30	1.10	0.00	0.00	100.00
LMV	0.00	6.00	42.00	28.00	10.00	14.00	0.00	0.00	0.00	100.00
LCV	0.00	3.23	38.71	38.71	9.68	6.45	3.23	0.00	0.00	100.00
2-Axle	0.00	0.00	35.71	39.29	17.86	3.57	3.57	0.00	0.00	100.00
3-Axle	0.00	5.26	36.84	42.11	5.26	5.26	5.26	0.00	0.00	100.00
MAV	0.00	0.00	30.77	53.85	15.38	0.00	0.00	0.00	0.00	100.00
Ettivadi (old NH-234)										
Car	0.00	17.07	51.07	12.65	4.42	0.61	12.96	0.30	0.91	100.00
Bus	0.00	24.87	55.33	4.57	6.09	0.00	7.61	1.52	0.00	100.00
LMV	0.00	16.87	39.76	10.84	16.87	3.61	9.64	2.41	0.00	100.00
LCV	0.00	7.78	37.78	10.00	12.22	8.89	11.11	4.44	7.78	100.00
2-Axle	0.00	6.03	36.21	12.07	15.52	11.21	11.21	3.45	4.31	100.00
3-Axle	0.00	7.07	26.77	17.17	15.15	7.07	16.16	4.04	6.57	100.00
MAV	0.00	2.65	23.01	16.81	15.04	8.41	20.35	6.19	7.52	100.00

All locations combined cars and buses are having an average trip length of 264 km and 261 km respectively, whereas freight vehicles LMVs, LCVs, 2 axle, 3 axle and Multi axle vehicles are having average trip length of 266 km, 310 km, 361 km, 395 km and 448 km respectively.

The major attraction and generation centers are Chennai, Salem, Vellore, Kanchipuram, Villupuram, Tiruvanamalai, Dharmapuri etc. The distribution of trip lengths should be looked against this context.

4.1.5.3.4 Trip purpose

The trip purposes of passengers as revealed in shown in **Table 4-19** and in **Figure 4-7.**

Table 4-19: Trip purpose of passenger vehicles

Location	Work	Business	Education	Shopping	Religious / Tourism	Social	Others
Paranur TP (old NH-45)	45.47	28.24	7.50	1.82	0.57	0.91	15.49
Sengurichi TP (old NH-45)	43.91	31.07	4.30	6.39	8.73	0.98	4.62
Mettupatti TP (old NH-68)	28.57	34.67	7.42	8.82	3.22	2.47	14.84
Nemili TP (old NH-4)	49.50	19.66	7.35	3.32	1.36	3.52	15.29
Pallikonda TP (old NH-4)	35.23	36.99	9.45	8.84	3.99	2.88	2.62
Palayam TP (old NH-7)	34.43	38.38	4.70	3.48	6.72	2.41	9.88
Somasipadi (old NH-66)	38.79	15.27	1.10	1.51	25.45	7.15	10.73
Pappireddipatti Jn. (SH-18)	46.99	34.97	8.01	8.56	0.55	0.73	0.18
Ponnur Malai (SH-115)	31.74	25.60	7.51	3.75	17.06	2.73	11.60
Ettivadi (NH-234)	23.48	39.86	8.99	13.48	9.28	2.61	2.32

It was observed that the maximum number of trips contributed to work trips and business trips at all the count locations by passenger vehicles.

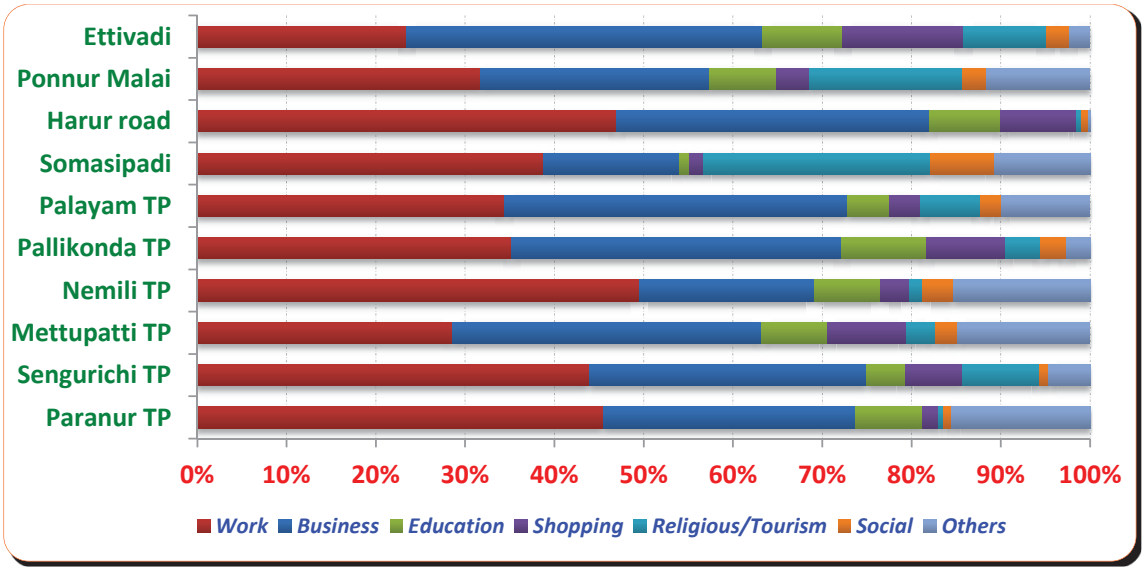


Figure 4-7: Trip purpose (%)

4.1.5.3.5 Commodity groups and analysis

The different commodities recorded during the O – D survey have been classified in to 17 categories as presented in **Table 4-20**. Due consideration has been given to include all possible commodities and to categorize them into homogeneous groups.

Table 4-20: Classification of commodities

Code	Commodity type
1	Food grains and other agricultural products (Rice, wheat, pulses, maize, chilly, coconut, sugarcane, sugar, cotton, milk, tea, eggs, etc.)
2	Fruits and vegetables
3	Petroleum, oil, Gas and lubricants product

Code	Commodity type
4	Minerals, chemicals, fertilizer, Charcoal, Coal, acid
5	Iron
6	Steel
7	Finished and manufactured products (Product of machinery, rubber, tyres, electric & electronics, glass, plastic, pipes, paint etc.)
8	Automobiles and machinery parts
9	Parcel service, Box and Containers
10	Sand
11	Cement
12	Building materials (Bricks, Stones, Soil, Tiles, Marbles, Granites, Wood, etc)
13	Miscellaneous goods (Livestock, Animal feed/food, Fish, Water, Salt, Waste, Book, Paper, etc)
14	Empty vehicles

The commodity movement pattern along the corridor is analysed and presented in **Table 4-21**. The percentage of each commodity is shown mode wise for all survey locations. **Figure 4-8** shows the bar chart of each commodity.

Table 4-21: Distribution of goods carried by commercial vehicles

Vehicle type	Commodities in %														Total
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	
Paranur TP															
LMV	5.83	9.87	5.38	0.90	1.35	0.45	3.59	1.35	15.25	4.93	1.79	13.45	11.21	24.66	100
LCV	6.11	4.50	6.75	1.29	2.25	1.93	3.22	0.96	12.54	5.79	5.47	12.86	7.72	28.62	100
2A Truck	7.32	3.33	9.59	0.27	3.20	1.60	2.13	1.86	17.98	9.59	6.52	17.31	4.66	14.65	100
3A Truck	7.34	3.08	8.08	0.73	3.82	2.06	1.91	1.17	12.48	11.89	6.31	20.56	6.02	14.54	100
MAV	7.24	1.33	16.00	0.76	3.05	2.86	3.62	3.81	14.10	8.76	7.24	15.24	4.38	11.62	100
Sengurichi TP															
LMV	9.68	6.91	4.61	0.46	0.46	1.38	4.61	0.92	14.29	0.46	2.76	2.76	5.53	45.16	100
LCV	10.56	5.63	8.45	0.35	0.00	0.70	4.23	1.06	13.73	0.70	4.23	3.87	25.70	20.77	100
2A Truck	13.44	6.98	9.56	2.07	0.26	2.58	6.98	1.55	17.05	0.26	5.43	5.43	9.04	19.38	100
3A Truck	14.16	3.18	11.85	1.45	0.58	2.31	4.62	1.45	18.79	0.29	8.67	6.07	5.49	21.10	100
MAV	9.10	3.20	15.38	0.49	1.35	2.34	4.18	2.46	7.87	2.46	7.50	3.20	5.41	35.06	100
Mettupatti TP															
LMV	9.66	7.89	2.58	2.74	0.81	1.77	7.25	0.32	13.53	0.64	3.22	5.96	8.37	35.27	100
LCV	12.72	4.44	1.78	2.37	1.18	3.55	10.36	0.59	17.46	1.48	3.85	4.73	8.58	26.92	100

Vehicle type	Commodities in %														Total
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	
2A Truck	11.31	3.10	3.90	2.42	0.81	1.88	4.04	0.81	12.11	2.15	8.34	6.46	9.02	33.65	100
3A Truck	18.40	2.15	7.06	4.60	2.15	1.53	4.91	1.84	7.67	2.45	5.52	5.21	8.90	27.61	100
MAV	8.82	1.36	7.92	4.30	1.58	3.85	6.79	5.20	10.18	1.13	12.90	4.30	8.82	22.85	100
Nemili TP															
LMV	6.06	6.06	8.33	1.52	3.79	0.76	7.58	0.76	11.36	0.76	1.52	12.12	11.36	28.03	100
LCV	8.99	7.55	10.79	0.72	7.91	0.36	5.76	5.04	6.12	2.88	0.36	13.67	7.19	22.66	100
2A Truck	7.59	7.59	7.21	0.13	1.64	0.63	7.84	5.44	13.40	3.41	0.38	11.38	6.32	27.05	100
3A Truck	8.32	3.64	10.92	0.00	3.12	1.39	7.63	4.16	11.44	11.61	0.17	11.96	4.16	21.49	100
MAV	4.11	6.39	9.59	0.00	3.42	0.91	7.99	5.94	13.70	8.68	0.23	12.33	5.25	21.46	100
Pallikonda TP															
LMV	12.25	11.76	2.94	1.96	0.00	0.49	8.33	4.41	10.29	2.45	1.96	2.94	8.33	31.86	100
LCV	9.34	9.13	7.01	2.97	0.64	1.27	8.28	7.64	10.40	0.42	3.61	4.67	9.77	24.84	100
2A Truck	12.08	5.37	13.42	0.67	0.45	1.79	10.29	7.38	7.16	0.00	4.70	2.68	10.29	23.71	100
3A Truck	12.79	5.57	9.51	1.97	1.31	1.31	9.18	10.16	4.92	0.66	4.26	6.23	8.20	23.93	100
MAV	7.87	6.14	7.56	1.73	0.79	0.79	8.50	17.32	14.65	0.31	4.09	5.83	10.08	14.33	100
Palayam TP															
LMV	10.06	11.53	2.52	1.47	1.89	0.63	5.87	0.84	15.72	0.42	0.63	3.14	5.24	40.04	100
LCV	9.14	19.82	5.02	1.80	0.51	2.06	6.44	2.19	12.23	0.26	1.93	3.22	8.62	26.77	100
2A Truck	12.12	14.53	5.71	2.40	1.70	2.51	7.11	2.20	12.22	0.20	1.50	4.91	10.52	22.34	100
3A Truck	12.79	7.58	4.71	2.86	1.01	2.02	8.59	2.86	18.18	0.51	2.86	4.71	10.77	20.54	100
MAV	12.78	8.37	6.13	3.13	1.85	2.30	8.37	3.71	11.57	0.26	5.37	4.15	11.57	20.45	100
Somasipadi															
LMV	10.30	6.67	2.42	0.61	0.00	0.00	3.64	0.61	11.52	3.64	1.82	10.91	11.52	36.36	100
LCV	17.31	11.54	1.92	0.00	0.00	0.00	0.00	0.00	13.46	3.85	0.00	23.08	5.77	23.08	100
2A Truck	8.77	7.02	3.51	0.00	1.75	0.00	0.00	7.02	14.04	5.26	0.00	17.54	10.53	24.56	100
3A Truck	12.73	0.00	16.36	0.00	0.00	0.00	0.00	1.82	23.64	1.82	0.00	12.73	7.27	23.64	100
MAV	14.29	0.00	17.86	3.57	0.00	0.00	0.00	0.00	32.14	3.57	3.57	7.14	0.00	17.86	100

Vehicle type	Commodities in %														Total
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	
Harur road															
LMV	22.22	5.56	3.70	3.70	0.00	0.00	3.70	0.00	16.67	0.00	0.00	3.70	5.56	35.19	100
LCV	9.84	9.84	1.64	1.64	0.00	0.00	13.11	0.00	11.48	0.00	8.20	0.00	4.92	39.34	100
2A Truck	16.02	8.29	5.52	3.31	1.10	0.00	6.08	2.21	14.36	0.00	8.29	4.42	5.52	24.86	100
3A Truck	18.53	2.56	2.88	1.92	1.28	0.00	10.86	0.96	13.42	0.64	8.95	3.83	12.14	22.04	100
MAV	14.98	5.31	2.90	3.86	0.48	0.97	5.80	0.97	12.56	0.48	16.43	1.93	11.59	21.74	100
Ponnur Malai															
LMV	38.00	0.00	2.00	0.00	4.00	0.00	2.00	0.00	8.00	2.00	6.00	12.00	6.00	20.00	100
LCV	25.81	0.00	3.23	0.00	6.45	0.00	0.00	0.00	6.45	0.00	3.23	0.00	6.45	48.39	100
2A Truck	21.43	3.57	0.00	0.00	3.57	0.00	3.57	0.00	0.00	10.71	3.57	7.14	7.14	39.29	100
3A Truck	26.32	0.00	0.00	0.00	0.00	0.00	10.53	0.00	10.53	5.26	0.00	5.26	5.26	36.84	100
MAV	15.38	0.00	7.69	0.00	23.08	0.00	0.00	0.00	7.69	0.00	0.00	7.69	0.00	38.46	100
Ettivadi															
LMV	15.56	2.22	1.11	3.33	1.11	1.11	2.22	0.00	6.67	1.11	12.22	10.00	6.67	36.67	100
LCV	17.71	3.13	3.13	4.17	0.00	2.08	2.08	1.04	9.38	0.00	15.63	1.04	16.67	23.96	100
2A Truck	20.17	3.36	2.52	0.00	2.52	1.68	7.56	2.52	6.72	3.36	13.45	5.04	8.40	22.69	100
3A Truck	15.66	2.02	6.06	8.59	1.52	2.53	6.57	0.00	11.11	1.01	13.64	1.52	6.06	23.74	100
MAV	14.98	4.85	3.08	6.17	3.52	2.20	8.37	0.88	9.25	0.00	11.89	4.41	7.05	23.35	100

All locations combined the distribution spectrum shows that the Food grains, fruits, vegetables and other agro products have maximum share of 13.2%, followed by Parcel service and Containers which have a share of 12%,Building materials and cement have a share of 7.5% and 5.5% respectively.

POL and gas have a share of 6.4%, Finished and manufactured products have a share of 5.7% and 8.2% is the share of miscellaneous goods. Parcel service and Containers have a share of 8.2%.

Empty vehicles have a higher presence on the project road with majorly either pickup or drop kind of trips reflecting a share of 25.9% contribution of trips on all the survey locations.

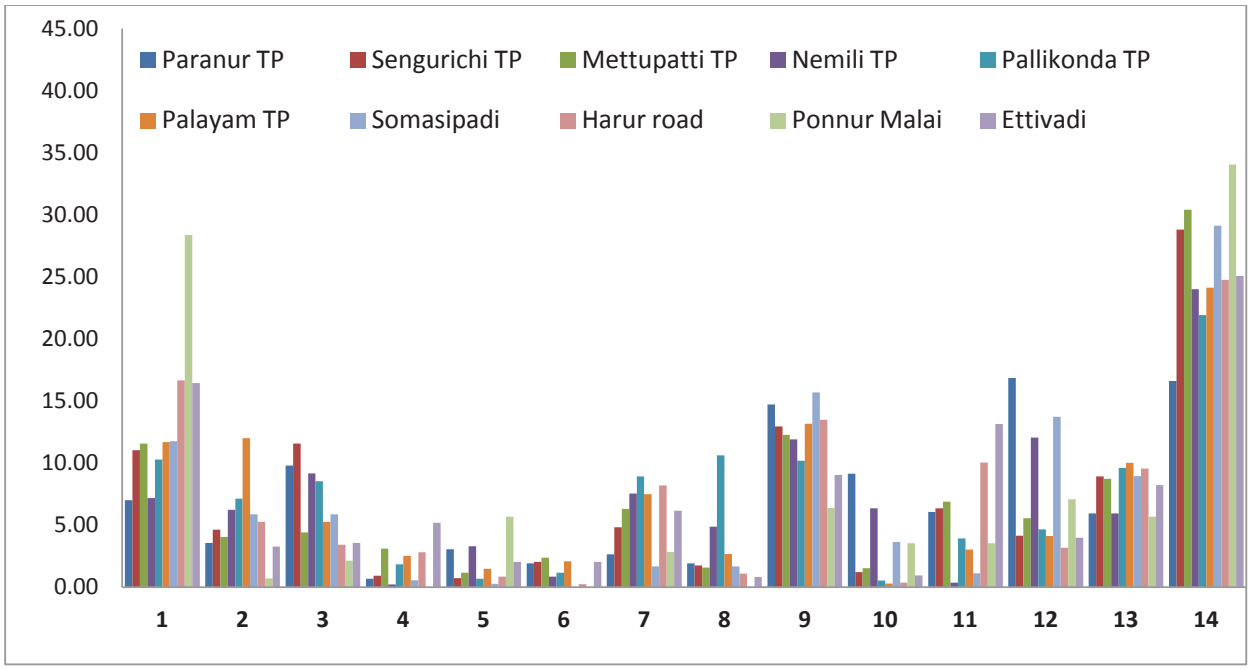


Figure 4-8: Percentage distribution of commodities

4.1.5.4 Axle load survey

Axle load survey has been carried out in order to estimate vehicle damage factor (VDF) for its use in design of overlay on existing pavement and new pavement for additional lanes.

4.1.5.4.1 Calculation of VDF

The vehicle damage factor is a multiplier for converting the number of commercial vehicles of different axle loads to the number of standard axle load repetitions. Design of new pavement for additional lane or strengthening of existing pavement is based upon the cumulative number of 8.17 tonne equivalent standard axles (ESA) that will pass over the pavement during its design period. The classes of traffic which lead to significant axle loads (or damage) to the pavement and accordingly considered for design are: LCVs, Buses, two axle, three axle and multi axle trucks. Cumulative standard axle (CSA) is calculated in accordance with the guidelines provided in IRC: 37 – 2012 and IRC: SP 73 - 2007. The overloaded vehicles have serious adverse impact on the performance of pavement. It has been ascertained that the damaging effect of axles on flexible pavement is approximately proportional to the fourth power of the ratio of axle load to standard axle load.

Equivalency factors as recommended by IRC have been used to convert the axle load spectrum into an equivalent number of standard axles. Equivalency factors as recommended by IRC have been used to convert the axle load spectrum into an equivalent number of standard axles. The equivalency factors are derived for each axle load category from the fourth power rule. The product of frequency of axles for each axle load category and corresponding equivalency factors gives the ESA for corresponding axle load category. The VDF is calculated by dividing the sum of ESA for all class of vehicles by the total number of vehicles weighed. The calculated VDF of LCVs, Buses, 2 axles, 3 axles and multi axle trucks are shown in **Table 4-22** below.

Table 4-22: Observed VDF

Mode	Chennai-Salem	Salem-Chennai
Mettupatti TP (old NH-68)		
LCV	0.72	0.79
2-axle	2.62	1.47
3-axle	5.75	4.38
MAV	8.76	7.95
Bus	0.72	1.16
Pallikonda TP (old NH-4)		
LCV	0.75	0.80
2-axle	1.64	1.87
3-axle	3.93	4.42
MAV	5.50	6.26
Bus	0.83	1.15
Papireddipatti Jn. (Hosur road) on SH-18		
LCV	0.65	0.59
2-axle	3.78	2.58
3-axle	6.81	5.19
MAV	9.42	9.50
Bus	0.75	1.10

4.1.5.4.2 Computation of Design Traffic

The design traffic is considered in terms of the Cumulative Standard Axles (CSA) to be carried during the design life of 15 years on the road. The computation involves initial volume of commercial vehicles per day, lateral distribution of traffic, growth rate, design life in years and vehicle damage factor (number of standard axle per commercial vehicle) to convert commercial vehicles to standard axles.

The following equation has been used to calculate the cumulative number of standard axles in accordance with IRC: 81 – 1997 and IRC: 37 – 2012.

$$N_s = \frac{365 \times A\left[(1+r)^x - 1\right]}{r} \times F$$

Where

N_s = The cumulative number of standard axles to be catered for in the design life.

A = Initial traffic, in the year of completion of construction, in terms of the number of commercial vehicles per day duly modified to account for lane distribution.

r = Annual growth rate of commercial vehicles, %

x = Design life in years

F = Vehicle Damage Factor (number of standard axles per commercial vehicle)

The Million Standard Axles (MSA) from base year to horizon year for commercial traffic has been estimated using VDF values derived from axle load survey for bus, LCV, 2 axle, 3 axle and multi axle trucks. The VDF values for both directions are used for calculations, in project stretch.

The summary of VDF calculation and cumulative MSA for the base and horizon years according to projected traffic for all homogeneous sections are discussed in Pavement Design Chapter.

4.1.5.5 Speed and delay survey

A speed and delay survey using the moving car method was carried out during peak and off peak hours for existing roads is summarised and presented in **Table 4-23** and **Table 4-24.** This survey provides data for assessing running speed, journey speeds and congestion levels. Journey speed is the effective speed of a vehicle between two points. It is determined by the distance between two points divided by the total time taken by the vehicle to complete the journey, including all delays incurred en-route. Running speed is the average speed maintained by a vehicle over given course while the vehicle is in motion. The length of course divided by running time determines it. Speed and delay surveys were done on two major existing routes one from Chennai to Vellore to Krishnagiri to Salem and other from Chennai to Tindivanam to Ulundurpet to Salem.

Table 4-23: Observed running time and speed along the Salem-Ulundurpet-Chennai road

Homogeneous road sections	Distance	Avg. journey time	Avg. journey speed	Avg. running time	Avg. running speed
	km	min	km/hr	min	km/hr
Salem (NH-44) Jn. To Ulundurpet (NH-38) Jn.					
Salem (NH-44) Jn. to Mettupatti TP	21.700	22.1	58.96	21.7	59.95
Mettupatti TP to Nathakkarai TP	52.000	45.3	68.95	45.1	69.26
Nathakkarai TP to Veeracholapuram TP	31.300	25.3	74.28	25.0	75.12
Veeracholapuram TP to Ulundurpet (NH-38) Jn.	31.650	24.3	78.31	24.3	78.31
Chennai (Vandalur-NH-45) Jn to Ulundurpet (NH-79) Jn					
Vandalur(CORR)Jn to Paranur TP	21.200	29.0	43.81	28.8	44.19
Paranur TP to Athur TP	50.300	48.0	62.92	47.8	63.18
Athur TP to Vikravandi TP	47.500	43.3	65.77	43.2	66.02
Vikravandi TP to Sengurichi TP	46.000	42.0	65.71	41.7	66.24
Sengurichi TP to Ulundurpet(NH-79)Jn	7.000	5.0	83.44	5.0	83.44

Average journey speed on Salem to Ulundurpet section is 70 kmph. Average running speed on Chennai to Ulundurpet section is 64 kmph. Journey speed is lesser near Chennai and Salem sections which reflect the congestion levels nearby both cities.

Table 4-24: Observed running time and speed along the Salem-Krishnagiri-Chennai road

Homogeneous road sections	Distance	Avg. journey time	Avg. journey speed	Avg. running time	Avg. running speed
	km	min	km/hr	min	km/hr
Krishnagiri (NH-48) Jn. To Salem (Seelanaickenpatti – NH-44) Jn.					
Krishnagiri (NH-48) Jn. to Palayam TP	61.300	51.6	71.28	50.9	72.33
Palayam TP to Omalur TP	37.700	33.3	68.00	32.6	69.42
Omalur TP to Seelanaickenpatti (NH-44) Jn.	16.000	23.3	41.26	22.3	43.05
Krishnagiri (NH-44) Jn. To Walajahpet (SH-61) Jn					
Krishnagiri (NH-44) Jn. to Vaniyambadi TP	46.800	38.0	73.96	37.8	74.32
Vaniyambadi TP to Vaniyambadi (SH-18) Jn.	3.300	3.1	64.22	2.9	68.67
Vaniyambadi (SH-18) Jn. to Pallikonda TP	48.300	49.1	59.08	48.3	60.00
Pallikonda TP to Vellore(NH-38)Jn	21.000	22.0	57.27	21.3	59.29

Homogeneous road sections	Distance	Avg. journey time	Avg. journey speed	Avg. running time	Avg. running speed
	km	min	km/hr	min	km/hr
Krishnagiri (NH-48) Jn. To Salem (Seelanaickenpatti – NH-44) Jn.					
Vellore(NH-38)Jn to Arcot(SH-4)Jn	23.000	21.0	65.71	20.1	68.71
Arcot(SH-4)Jn to Walajahpet(SH-61)Jn	6.200	10.0	37.20	9.4	39.50
Homogeneous road sections	**Distance**	**Avg. journey time**	**Avg. journey speed**	**Avg. running time**	**Avg. running speed**
	km	**min**	**km/hr**	**min**	**km/hr**
Walajahpet (SH-61) Jn to Poonamallee (CORR) Jn					
Walajahpet(SH-61)Jn to Chennasamudram TP	7.100	12.0	35.50	11.8	36.05
Chennasamudram TP to Nemili TP	72.600	77.1	56.53	76.9	56.68
Nemili TP to Poonamallee(CORR) Jn	18.000	25.0	43.20	24.3	44.54

Average journey speed on Salem to Krishnagiri section is 60 kmph. Average journey speed on Krishnagiri to Walajahpet section is 60 kmph. This is because of congestion near Arcot and Salem sections. Average journey speed drops significantly to 45 kmph in Walajahpet to Poonamallee section. The low journey speeds can be attributed due to built-up settlements along the road and congestion levels on the road.

4.2 Traffic forecasts and Demand estimates

4.2.1 Traffic Forecasting

Investment priorities are governed by the traffic demand, assessed benefits and cost of the project. Demand plays the important role, governing which type of facility / infrastructure needs to be created. This in turn determines likely benefits and costs to develop the same. A highway project of this nature calls for significant investment. Prediction of traffic demand becomes an important task and has to be carried out very accurately. Accurate estimation of traffic has direct bearing on the viability of the project. Recognizing this, efforts are made to carefully assess all the parameters that help in predicting the traffic demand in future, which necessitates realistic estimation of traffic growth rates. Traffic growth on a road facility is generally estimated on the basis of historical trends. In the present case, traffic growth rates have been estimated using elasticity method as per IRC: 108 – 2015. Demand changes are usually because of shifts in the pattern of economic activities in the surrounding regions. Hence, future traffic estimation necessitates a preview, however imprecise the probable pattern of future growth of the economy.

4.2.1.1 Past vehicle registration details

It is revealed from OD survey that the project stretch is influenced by traffic from the state of Tamil Nadu alone. For establishing growth rates, data of Tamil Nadu state and rest of India is considered.

The vehicle registration data for the state of Tamil Nadu and commercial vehicles in India are collected and presented in **Table 4-25** below.

Table 4-25: Past vehicle registration data

Year	Two wheeler	Car / Jeep	Bus	Commercial vehicles
Tamil Nadu				
2004-05	6106057	730414	32539	263068

Year	Two wheeler	Car / Jeep	Bus	Commercial vehicles
2005-06	6750328	802793	34473	323275
2006-07	7503426	884370	34813	337792
2007-08	8260019	990439	37490	402800
2008-09	9036783	1099368	40019	456316
2009-10	9969598	1230045	42365	475964
2010-11	11207338	1399799	43435	506480
2011-12	12659928	1574944	44529	547990
2012-13	14150373	1744738	48370	568566
2013-14	15595140	1923607	49077	620168
2014-15	16991527	2084864	49665	648404
2015-16	18400635	2252888	49765	664322
2016-17	19987302	2439734	49800	670530
CAGR	***10.39***	***10.57***	***3.61***	***8.11***
India				
Year	**CVs ('000)**	*Source :*		
2004-05	3877622	• *Road Transport Year Book by MORTH Publication, Govt. of India*		
2005-06	4274984	• *State Transport department, Govt. of Tamil Nadu*		
2006-07	5118880			
2007-08	5600938			
2008-09	6040924			
2009-10	6431926			
2010-11	7064495			
2011-12	7658391			
2012-13	8306834			
2013-14	8697541			
2014-15	9344464			
CAGR	***9.19***			

4.2.1.2 Past growth of the economy

Growth of traffic on the project road is influenced by existing development and future growth prospects of the influencing regions. The time series data of state income NSDP at constant (2004-05) prices, state population, per-capita income of PIA state and GDP as published by Central Statistical Organization have been collected and studied to assess the past performance of the influencing state economies. **Table 4-26** depicts these economic indicators.

Table 4-26: Economic indices of influence state and India at constant prices (2004 - 05)

Year	NSDP (millions)	% growth	PCI (Rs.)	% growth
Tamil Nadu				
2004-05	1936450	-	30062	-
2005-06	2215879	*14.4%*	34126	*13.5%*
2006-07	2562858	*15.7%*	39166	*14.8%*
2007-08	2723398	*6.3%*	41314	*5.5%*
2008-09	2867436	*5.3%*	43193	*4.5%*
2009-10	3167599	*10.5%*	47394	*9.7%*
2010-11	3599605	*13.6%*	53507	*12.9%*
2011-12	3865081	*7.4%*	57093	*6.7%*

Year	NSDP (millions)	% growth	PCI (Rs.)	% growth
2012-13	3974709	*2.8%*	58360	*2.2%*
2013-14	4271822	*7.5%*	62361	*6.9%*
2014-15	4589866	*7.4%*	66635	*6.9%*
2015-16	4785515	*4.3%*	68472	*2.8%*
2016-17	5153296	*7.7%*	73056	*6.7%*
CAGR	***8.50 %***		***7.68 %***	
GDP of India (Cr.)				
2004-05	2971464	-		
2005-06	3253073	*9.5*		
2006-07	3564364	*9.6*		
2007-08	3896636	*9.3*		
2008-09	4158676	*6.7*		
2009-10	4516071	*8.6*	*Source:*	
2010-11	4918533	*8.9*	*Census department, Govt. of India*	
2011-12	5247530	*6.7*		
2012-13	5482111	*4.5*		
2013-14	5741791	*4.7*		
2014-15	6070669	*5.7*		
CAGR	***7.41***			
Census Details				
	2001	**2011**	**CAGR**	
Tamil Nadu	62405679	72138958	1.46	

4.2.1.3 Transport demand elasticity

As discussed earlier, the elasticity approach has been used for determining growth rates of future traffic. Since time series traffic data on project road is not available, traffic growth rates and elasticity values are established by using registered vehicles as the dependent variable.

Description of Regression Analysis

The Regression Analysis tool performs linear regression analysis by using the "least squares" method to fit a line through a set of observations. It analyzes how a single dependent variable is affected by the values of one or more independent variables. In the present case, registered vehicles by type are the dependent variables whereas the economic parameters are independent variables. Once the relation is established by regression, the measures explained below are used to accept or reject the same.

T-statistic

The t-statistic is a measure of how strongly a particular independent variable explains variations in the dependent variable. The larger the t-statistic, the better is the independent variable's explanatory power. Next to each t-stat is a P-value. The P-value is used to interpret the t-stat. In short, the P-value is the probability that the independent variable in question has nothing to do with the dependent variable. Generally, we look for a P-value of less than 0.05, which means there is only 5% chance that the independent variable is unrelated to the dependent variable. If the P-value is higher than 0.10, a strong argument can be made for eliminating this particular independent variable from a model because it isn't statistically significant.

R Square

R Square is another measure of the explanatory power of the model. In theory, R square compares the amount of error explained by the model as compared to the amount of error explained by averages. The higher the R-Square, the better it is.

Regression analysis was carried out on the database to arrive at the transport demand elasticity and growth rates using each category of vehicle with various combinations of economic parameters and population of the respective states. The resultant elasticity values, growth rates, R^2 values and t-statistic are presented in **Table** 4-27. The highlighted parameters are selected for traffic forecast in each case, based on best fit. For commercial vehicles, growth trend of Tamil Nadu state and India are analyzed.

Table 4-27: Observed transport demand elasticity values and traffic growth

Vehicle Type	Indicator	Elasticity	GR (%)	R-square	t-stat
Two Wheeler	PCI	1.393	10.281	0.980	23.063
	NSDP	1.272	10.360	0.983	25.420
Car	PCI	1.438	10.613	0.983	25.200
	NSDP	1.312	10.692	0.986	27.737
Bus	PCI	0.541	3.994	0.960	16.170
	NSDP	0.493	4.016	0.959	15.959
Trucks	NSDP	0.877	7.149	0.965	17.490
LCV/LMV	NSDP	1.153	9.393	0.960	16.200
India					
CVs	GDP	1.199	8.683	0,9938	37.882
Trucks	GDP	0.688	4.980	0.9843	23.791
LCVs/LMVs	GDP	1.779	12.875	0.9766	19.365

Projected transport demand elasticity

In order to arrive at realistic future elasticity for the project road, various factors relating to vehicle technology changes, in addition to character of traffic and travel pattern on the project road, have been considered.

High elasticity of cars being witnessed now is because of large demand facilitated by financing schemes and loans. Factors like growth of household incomes (particularly in urban areas), reduction in the prices of entry-level cars, growth of the used car market, changes in life-style, growing personal incomes, desire to own a vehicle, facilitated by availability of loans/financing schemes on easy terms etc., have all contributed to the rapid growth in ownership of cars. However, such trend would slow down and elasticity can be expected to decline.

Over the years, there has been a change in passenger movement with more and more people shifting towards personalized modes. Moreover, buses are usually plying on fixed pre-decided routes and thus elasticity values for buses have been considered accordingly.

With the changing freight vehicle mix in favor of LCVs for short distance traffic and 3-axle/MAVs for long-distance traffic, higher elasticity values for these have been considered as compared to 2-axle trucks. Considering the ongoing technical advancements in automobile industry, some of the standard two axle trucks would gradually be replaced by three axle truck and MAVs, leading to reduction in number of trucks. This shift has already been observed in various parts of the country.

Transport demand elasticity by vehicle type, over a period of time tends to decline and approach unity or even less. As the economy and its various sectors grow, every region tends to become self-sufficient. Moreover, much of the past growth has been associated with the country's transition from a largely rural subsistence economy to cash-based urban economy, dominated by regional and national linkages. As the transition proceeds, its impact on transport pattern can be expected to become less dominant. Therefore, the demand for different type of vehicles falls over time, despite greater economic development. In other words the values of elasticity tend to decrease with economic development in future years due to changes in the structure of economy, with higher contribution from service sector and higher value of industrial outputs. The same is also clear from the relationships of the economy and transport demand elasticity over time, both nationally and internationally. The elasticity values have therefore been moderated for the future years as given in **Table 4-28.**

Table 4-28: Projected transport demand elasticity values

Period	Car	Bus	LCV	2A	3A	MAV
2019-22	1.10	0.51	1.07	0.27	0.43	1.07
2023-27	1.08	0.50	1.04	0.16	0.27	1.07
2028-32	1.06	0.49	1.02	0.05	0.16	1.05
2033-37	1.04	0.48	1.00	0.02	0.05	1.00
2038-42	1.02	0.47	0.99	0.00	0.00	1.03
> 2043	1.01	0.47	0.98	0.00	0.00	1.02

4.2.1.4 Perspective growth: state and national economies

Against the discussed background, any agenda for future growth of the state economies has to take into account past trends, future prospects, and the emerging challenges. The growth prospects for the state have been developed taking into consideration the past performance of the state economies and the economic growth envisaged for the future. The pace with which the regional economies grow with the envisaged growth of the state is a major contributing factor in growth of traffic.

The **Table 4-29** depicts the projection of GDP for horizon years. The future GDP suggested is considered for factoring NSDP and the projections. The regions which out-performed the GDP in the past will continue to do so, though the gap will become smaller, while others will follow the trends which are marked by their present trend as well as likely changes in longer term.

As mentioned earlier, the government of India introduced a new series for GDP growth recently which has changed the datum from FY05 to FY12 and the methodology of calculating the GDP also has been changed along with. This made the historic values in the new series and projection of the old series difficult to calculate, and hence there is no data available for linking both. Thus the elasticities of different modes are moderated considering the growth of both series in the overlapping period.

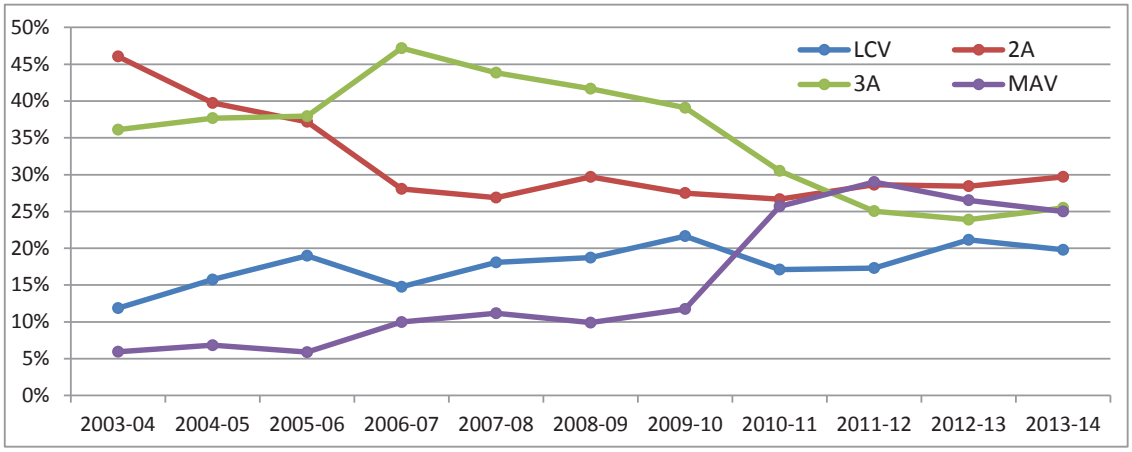
Table 4-29: Projected growth rates of indicators in percentage

Period	NSDP	
	TN	All India
2019-22	9.00	8.00
2023-27	8.40	7.54
2028-32	7.80	6.96
2033-37	6.60	5.89
2038-42	5.00	4.46

Period	NSDP	
	TN	All India
> 2043	5.00	4.46

4.2.1.5 Projected traffic rates

The production and sales data of commercial vehicles has been collected for 10 years from Society of Indian Automobile Manufactures (SIAM) and analysed.



Source: From various volumes published by SIAM

It is found that production / sale of multi axle trucks have increased whereas the same has decreased for 2-axle trucks in the recent past. The exhibit shows the ratio of sale of multi-axle trucks / 2-axle trucks. Based on the present composition of goods vehicles, overall growth of goods vehicles and average load carried by each vehicle type, tonnage has been calculated for 5 year blocks for present and future composition of traffic. The difference in the present and future tonnage gives the additional traffic due to change in modal share which has been converted into vehicles. On this basis growth rate of 2-axle trucks and multi-axle trucks have been moderated keeping the overall growth rates of trucks constant.

Normally, the growth potential of passenger traffic in a region depends on its population and economic growth rates. Therefore, both these parameters have been incorporated in forecasting of passenger traffic. Further, taking into account the fact that the different modes of passenger traffic grow at different rate, the elasticity (as discussed earlier) with respect to population and income growth rates is graded differently by different modes.

Growth potential of goods traffic is different from passenger traffic. This is more directly related to zone's economic activity and production levels than its population and income growth, although the latter may strongly correlate with the former, especially the income growth.

In view of the above discussions, it is felt that the future growth rates should neither be under nor over targeted. The complexities involved and sensitive dimensions of economy are many, so it is important that its larger issues are to be addressed by constructing different scenarios. Thus an effort has been made to develop three different scenarios of varying growth rates of economic indicators as under:

- ***Optimistic Scenario***
- ***Most likely Scenario***
- ***Pessimistic Scenario***

Considering all the above discussed points, the growth rates were conceived using methods

discussed earlier and have been modified accordingly. The basic growth factors are considered to be realistic rates. In the calculation, the growth rate of economic indicators was treated with ±0.5 sensitivity to arrive pessimistic and optimistic values. The final recommended growth rates are given in **Table 4-30**.

Table 4-30: Estimated and recommended traffic growth rates

Mode	2019-22	2023-27	2028-32	2033-37	2038-42	2043-47
Most likely						
Car	9.8	8.9	8.1	6.7	5.1	5.0
Bus	4.5	4.1	3.8	3.1	2.3	2.3
LCV	9.5	8.6	7.8	6.5	4.9	4.8
2 Axle Truck	2.4	1.3	0.3	0.1	0.0	0.0
3 Axle Truck	3.8	2.2	1.2	0.3	0.0	0.0
MAVs	9.4	8.9	8.1	6.5	5.1	5.0
Two wheeler	12.0	11.0	10.0	8.3	6.2	6.2
Optimistic						
Car	10.0	9.5	9.1	8.7	8.2	7.7
Bus	4.6	4.4	4.2	4.0	3.8	3.6
LCV	10.1	9.2	8.3	7.0	5.4	5.3
2 Axle Truck	2.8	1.7	0.7	0.5	0.0	0.0
3 Axle Truck	4.3	2.6	1.6	0.7	0.4	0.0
MAVs	9.9	9.3	8.5	6.9	5.4	5.4
Two wheeler	12.3	11.8	11.2	10.7	10.1	9.5
Pessimistic						
Car	9.5	9.1	8.7	8.3	7.8	7.4
Bus	4.4	4.2	4.0	3.9	3.6	3.4
LCV	9.0	8.1	7.3	6.0	4.4	4.3
2 Axle Truck	2.0	0.9	-0.1	-0.3	0.0	0.0
3 Axle Truck	3.4	1.8	0.8	-0.1	-0.4	0.0
MAVs	9.0	8.5	7.7	6.1	4.7	4.6
Two wheeler	11.8	11.2	10.7	10.3	9.7	9.1

4.2.1.5.1 Traffic forecast for non–motorised traffic

The slow moving vehicles essentially cater to short haul traffic, meeting localised demand for transportation of individual passenger and goods to market centres and urban centres. Non–motorised traffic, especially pedal cycles, cycle rickshaws and animal drawn vehicles will be gradually replaced by motorised vehicles. Therefore, it is assumed that volume of animal drawn vehicles and pedal cycles are expected to decline by a negative growth of 2% per annum because of economic improvement. The growth rates of tractors have been however considered as 2% per annum.

4.2.2 Travel Demand Estimates

4.2.2.1 Traffic demand estimation for proposed project road

This section presents the assessment of traffic on the proposed Chennai – Salem Greenfield alignment. The results of this analysis will form inputs for forecasting toll traffic and revenue, deciding tolling strategy, planning and designing the pavement, developing capacity augmentation proposals and designing the toll plaza.

The corridor traffic would consist of three components:

- **Diverted Traffic**: This is traffic based on trips that are already being made between various origin and destination pairs and likely to be diverted to the proposed project corridor.
- **Development Traffic**: This is the traffic based on new trips that would be generated due to the development of new nodes along the project highway.
- **Generated / Induced Traffic:** This is traffic that is based on trips that were not taken earlier due to lack of desired infrastructure.

Thus the total traffic on project corridor is sum of Diverted traffic, Developmental traffic and Generated traffic

4.2.2.2 Sections along project corridor

The assessment of traffic along the corridor is based on the nodes and interchanges proposed for developing along the road, as they are going to act as traffic generation and attraction centroids. The nodes and interchanges are at same location. The locations of nodes and interchanges are defining the homogenous sections in the present case. The **Table 4-31** below lists the homogenous sections for the project corridor.

Table 4-31: Homogenous sections based on nodes and interchanges

Section	Chainage (km)		Section		Length, km
	From	To	From	To	
1	0.000	24.580	Start Point(Chennai)	SH 58 interchange (Kanchipuram)	24.580
2	24.580	67.395	SH 58 interchange (Kanchipuram)	SH 5 interchange (Vandavasi)	42.815
3	67.395	94.505	SH 5 interchange (Vandavasi)	SH 4 interchange (Chetpet)	27.110
4	94.505	121.760	SH 4 interchange (Chetpet)	NH234interchange (Tiruvannamalai)	27.255
5	121.760	157.880	NH234 interchange (Tiruvannamalai)	NH 66 interchange (Chengam)	36.120
6	157.880	220.625	NH 66 interchange (Chengam)	SH18 interchange (Harur)	62.745
7	220.625	243.920	SH18 interchange (Harur)	NH 68 interchange (Salem)	23.295
8	243.920	270.360	NH 68 interchange (Salem)	NH 44 interchange (Namakkal road)	26.440
9	270.360	277.320	NH 44 interchange (Namakkal road)	NH 544 inerchange (Coimbatore road)	6.960

*Chainages are tentative

4.2.2.3 Diverted traffic

The diversion traffic analysis is performed to assess the percentage of traffic that would be diverting to the project corridor from potential competing corridors. All the potential competing corridors were identified through reconnaissance surveys and assessment on various influencing factors has been done to identify the traffic likely to be diverted to project corridor at the time of operations.

4.2.2.3.1 Procedure for diversion analysis

Cost ratio diversion curves have been used for estimating the diverted traffic to the green field alignment. In this approach, traffic likely to be diverted to project road from alternate route is estimated using diversion curves suggested by *IRC: 108 – 2015, Guidelines for Traffic Forecast on Highways*, which computes the ratio of perceived costs on the competitive/alternative facilities.
The estimation of percentage diversion for all the alternatives has been done through following steps:

i. Firstly to estimate the divertible traffic various data has been collected through primary and secondary surveys. In primary surveys, Origin–Destination survey and speed and delay survey was organized to analyze the percentage all through traffic for desired OD pairs and average speed on competing corridors. In secondary data collection, range of data collected on vehicle operating cost, value of time, toll rates, average toll rates per km for NH and SH, etc.

ii. Secondly, generalized cost has been estimated based on values of time, vehicle operating cost, toll rates, roughness of road, travel time, corridor length.

iii. Thirdly, In order to assess the potential amount of percentage traffic diversion to the project corridor, a generalized cost analysis comparing the competing routes was conducted, through which the equations with respect to mode has been calculated. This analysis is based on the guidance provided by the Road User Cost Study 2000 for India, and the diversion curve equations derived under the Technical Assistance Programme funded by ADB for Ministry of Transport and the same are provided in IRC: 108-105.
These equations are as given below:

Vehicle	Cost Ratio (CR) Interval	Equations
Car	<= 0.634	%Div = 98.750 - (CR/0.634) * 8.125
	0.634 <= CR <= 1.465	%Div = 90.625 - ((CR-0.634)/0.831) * 84.375
	1.465 <= CR <= 2.0	%Div = 6.25 - ((CR-1.465)/0.535) * 5.25
Truck & Bus	<= 0.750	%Div = 100 - ((CR/0.75) * 5)
	0.750 <= CR <= 1.250	%Div = 95 - ((CR-0.75)/0.5) * 90
	1.250 <= CR <= 2.0	%Div = ((2-CR)/0.75) * 5

Where,
CR = (Total Cost of Alternate Route) / (Total Cost of Project Route)

Total Cost (Rs.) = Vehicle Operating Cost (Rs.)+Toll Charges (Rs.)+Value of time (Rs.)

iv. The percentage diversion is estimated based on the diversion of total traffic on to the alternate route and the remaining percentage is diverted on to the project road.

4.2.2.3.2 Generalized cost

The generalized cost (GC) function used for diversion analysis relates the various time and cost element into one value. For detail calculation of generalized costs for various alternative routes the following elements are considered.

a. Length of routes: For all the potential alternative routes the length of route is considered as the total distance between two points, along the alternate route and along the route involving the project corridor. The details of the routes are given below.

Stretch	Route	Type of Road	No. of lanes	Condition	Toll Plaza	Length
Alternate Route 1: Chennai - Krishnagiri - Salem						

Alternate Route	Chennai - Krishnagiri	NH48	4/6 lane	Good	4	230.0
	Krishnagiri - Salem	NH44	4/6 lane	Good	2	115.0
	Total					**345.0**
Project road	Chennai - Salem highway	Project road	4/6 lane	Good	1*	277.0
Alternate Route 2: Chennai - Ulundurpet- Salem						
Alternate Route	Chennai - Ulundurpet	NH32/132/38	4 lane	Good	4	176.0
	Ulundurpet - Salem	NH79(68)	4 lane	Good	3	137.0
	Total					**313.0**
Project road	Chennai - Salem highway	Project road	4/6 lane	Good	1*	277.0
Alternate Route 3: Chennai - Vellore - Krishnagiri						
Project Road	Krishnagiri - Chengam	NH77	2 lane	Fair		80.0
	Chennai - Chengam	Project road	4/6 lane	Good	1*	158.0
	Total					**238.0**
Alternate Road	Chennai - Krishnagiri	NH48	4/6 lane	Good	4	230.0
Alternate Route 4: Vellore - Krishnagiri - Salem						
Project road	Vellore - Polur (Project highway)	NH234	2 lane	Fair		62.0
	Polur (Project highway) - Salem	Project road	4/6 lane	Good	1*	155.0
	Total					**217.0**
Alternate Road	Vellore - Krishnagiri - Salem	NH48/NH44	4/6 lane	Good	4	235.0
Alternate Route 5: Chennai - Tindivanam - Tiruvannamalai						
Alternate Route	Chennai - Tindivanam	NH32	4/6 lane	Good	2	88.0
	Tindivanam - Tiruvannamalai	NH77	2 lane	Fair		67.0
	Total					**155.0**
Project road	Chennai-Salem highway	Project road	4/6 lane	Good	1*	137.0
Alternate Route 6: Chennai - Vellore – Tiruvannamalai						
Alternate Road	Chennai - Vellore	NH48	4/6 lane	Good	2	114.0
	Vellore - Tiruvannamalai	NH234	2 lane	Fair	-	81.0
	Total					**195.0**
Project road	Chennai - Salem highway	Project road	4/6 lane	Good	1*	137.0

*Toll amount for corresponding length

b. Vehicle operating cost: The VOC for various vehicle types are suggested in IRC: SP: 30 – 2009. Vehicle operating cost comprises of fixed and variable costs, like, fuel, tyres,

maintenance, lubricants etc. which vary with the distance travelled forming the variable cost component and insurance, taxes and depreciation forming the fixed component. The IRC: SP: 30 – 2009 suggests VOCs based on lane configuration, rise and fall and roughness. The revised VOCs for present year has considered for alternate routes mentioned above based on the lane configuration and pavement conditions.

c. Value of time: The values of time costs for different modes is adopted from IRC: SP: 30 – 2009. It has been revised for present year and adopted values given below.

Nature of Journey by Passenger	Value of Time (Rs per hour) (2009)		Value of Time (Rs per hour) (2018)	
	Primary Route	Secondary Route	Primary Route	Secondary Route
Cars	62.5	52.5	89.4	75.1
Ordinary Bus Passenger	39.5	14.5	56.5	20.7
Deluxe Bus Passenger	43.5	-	62.2	-

Types of Route	Commodity Holding Cost (Rs/day)	Commodity Holding Cost (Rs/hr) (2009)	Commodity Holding Cost (Rs/hr) (2018)
Primary Route	58.1	2.4	3.5
	178	7.4	10.6
	333	13.9	19.9
Secondary Route	53.8	2.2	3.2
	148.4	6.2	8.8

d. Travel Time: Travel time is derived from the length of alternative route and average speed. The average speed is adopted from the speed and delay survey results.

e. Toll: Toll estimation for each route is done using the prevailing toll policies and actual toll on various routes, wherever necessary. The toll on project highway is considered as suggested by NHAI toll notification.

The Generalized Cost for cost ratio calculation for vehicles has the following form;

GC = VOC*TL +VOT * TT +TR

Where,

VOC = Vehicle Operating Cost

VOT = Value of Travel Time

TT = Travel Time

TR = Toll Rates

TL = Trip Length

Table 4-32 gives the generalised cost for all the potential alternative routes along with proposed corridor

Table 4-32: **Generalised cost for Alternate routes and Project road**

Vehicle type	Alternate route 1	Alternate route 2	Alternate route 3	Alternate route 4	Alternate route 5	Alternate route 6	Proposed Corridor*
Car	2913.92	2623.07	1920.10	2021.19	1281.80	1579.26	2237.36
Bus	6840.50	6190.97	4469.77	4777.81	2994.60	3650.05	5363.13

Vehicle type	Alternate route 1	Alternate route 2	Alternate route 3	Alternate route 4	Alternate route 5	Alternate route 6	Proposed Corridor*
LCV	6678.32	6069.28	4402.46	4609.03	2929.72	3627.25	4864.72
2Axle	7677.27	6950.13	5028.40	5348.59	3283.57	4011.05	6005.97
3Axle	8364.05	7556.29	5367.92	5998.21	3318.47	4052.22	6127.28
MAV	13955.33	12649.25	9149.98	9693.89	5968.43	7335.22	10429.35

*for entire project road

4.2.2.3.3 Diversion analysis

Diversion model as described above is used for estimating diversions for the corridor following the opening of the same for operations. With respect to cost ratio the diversion curves is determined based on diversion equation for all the alternative routes. The percentage of divertible traffic is applied on the potential divertible traffic from the alternative routes or the network. The potential divertible traffic is elucidated from the OD data, which is the likely to use the project corridor. The project expressway is proposed to open for traffic in Year 2022-23 and the diverted traffic is assessed for present year (2017-18) and projected till horizon year. Generally mini buses and buses are route specific travelling and thus from the total diverted numbers only 25% of mini buses & 30% buses are considered as divertable. Also from LMVs, which are used for short haul use, from the estimated divertable numbers, only 30% is considered as divertable on to the highway. The alternate routes are shown in **Table 4-1** and depicted in **Figure 4-1**, earlier. The base year traffic estimated from potential divertable traffic from all the alternate routes is given below in **Table 4-33.**

Table 4-33: Estimated Diverted traffic (2017-18), section wise

Mode	Section-1	Section-2	Section-3	Section-4	Section-5	Section-6	Section-7	Section-8	Section-9
Car	7994	4726	4032	5042	4629	2645	3798	1460	1238
Mini Bus	92	33	33	37	31	18	31	11	9
Bus	644	386	328	438	363	251	370	89	77
LMV	492	347	238	289	292	253	320	144	109
LCV	2247	1247	814	968	1033	664	823	398	364
2A	710	536	515	572	709	875	638	577	335
3A	1194	989	752	834	955	882	1170	713	664
MAV	1585	1221	1099	1185	1477	1297	1533	1022	971
Total	**14958**	**9485**	**7811**	**9365**	**9489**	**6885**	**8683**	**4414**	**3767**
Total PCU	**26771**	**18221**	**15271**	**17703**	**19245**	**15782**	**18832**	**10954**	**9504**

4.2.2.4 Development traffic

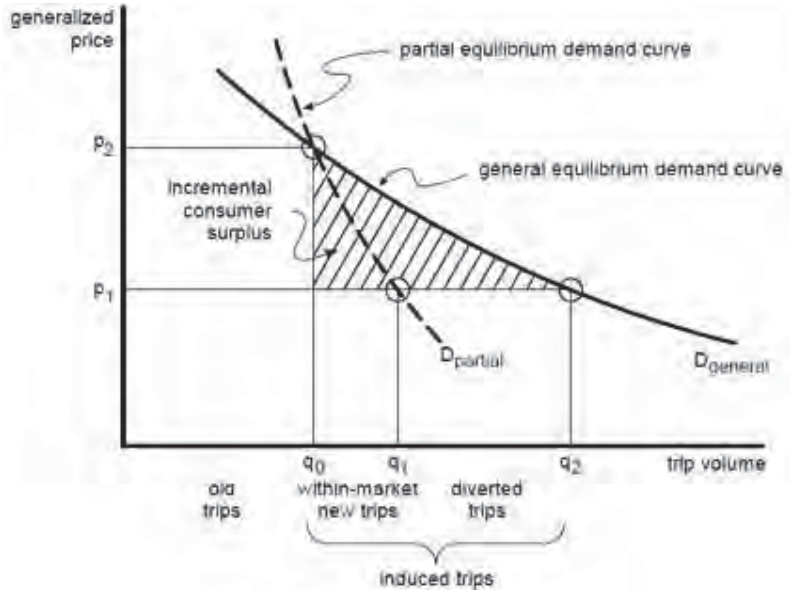
It is essential to predict the amount of traffic that will be generated by new land-use developments in order to anticipate impacts on the proposed Greenfield highway. Many factors affect the amount of traffic generated, including the type of land use i.e. residential or industrial, its size, and other factors. Major projects likely to be implemented in project influence area were included for the development traffic estimation of the proposed expressway.

As of now, there are no major development plans in between or along the project highway. The development plans at major cities Chennai and Salem are covered in the state NSDP growth and development of socio economic activities along the corridor.

Even, once the project corridor starts operational, the surrounding area land use activities starts develop with new industries and that will generate new traffic. Thus a certain percentage of traffic is estimated from the diverted traffic for next 10 years from the year 2022-23 and after 10th year the traffic assumed remains same till end of concession. For present case, section-1 being located near to the Chennai city, 5% and remaining sections 10% adopted for first 5 years and 2.5% and 5% for next years.

4.2.2.5 Generated/ induced Traffic

Additional trips on a roadway or area that takes place when capacity of roadway is increased, or due to improvement in travel conditions in other ways is known as generated traffic. Therefore in addition to the diverted and development traffic, trips that would generate on the corridor due to faster travel times and lowering of transport costs are calculated separately. This induced traffic would generate from improved economic activities covered by cheaper transport as well as the transport of commodities previously sold locally but could now be transported to distant markets to fetch better prices. The induced/ new generated traffic is usually estimated from demand curve of the nature shown in Figure below. The percentage induced/ new generated traffic is calculated using following equations (source: IRC: SP: 30 – 2009 and Toolkit for the Economic Evaluation of World Bank Transport Projects):



$$\frac{[\{Cost\ (VOC+VOT) without\ development\} - \{\text{Cost (VOC+VOT) with development}\}]}{\{\text{Cost (VOC+VOT) without development}\}} * 0.33$$

In above equation, cost ratio is multiplied by 0.33 as the equilibrium between traffic volume, traffic stream speed and cost is obtained at 0.33. For calculating the induced / generated traffic, diverted traffic and traffic through developments on the corridor is multiplied by percentage traffic generated

obtained by above equation. **Table 4-34** below shows the VOC and VOT for the existing and project road along with the induced ratio.

Table 4-34: Induced ratio for induced traffic

Vehicle Type	Existing corridor		Proposed corridor		Induced ratio
	VOC	VOT	VOC	VOT	
Car	1644.49	353.86	1533.51	309.63	2.6%
Bus	4010.55	313.46	3741.47	287.33	2.3%
LCV	4778.21	17.77	4211.88	15.99	3.9%
2Axle	4946.84	49.01	4618.20	53.44	2.1%
3Axle	4946.84	54.46	4618.20	53.44	2.2%
MAV	9296.78	61.26	7771.98	109.98	5.2%

The average of sectional traffic volume arrived from diverted and development traffic from section 2 to 7 is taken and induced ratio applied on traffic volume to estimate induced traffic. This traffic is assigned to all 9 sections.

4.2.2.6 Estimated Traffic on Proposed highway

The final traffic estimated on the proposed Greenfield highway is consists of diverted traffic, development traffic and induced traffic. The section wise total numbers and total pcu in the operational year of highway i.e, 2022-23 is given below in **Table 4-35** and the detailed mode wise estimated volume is presented in **Annexure 4.3** to this report.

Table 4-35: Section wise estimated traffic demand on project highway

Year	Section 1		Section 2		Section 3		Section 4		Section 5		Section 6		Section 7		Section 8		Section 9	
	Vehicles	PCU	Vehicles	PCU	Vehicles	PCU	Vehicles	PCU	Vehicles	PCU	Vehicles	PCU	Vehicles	PCU	Vehicles	PCU	Vehicles	PCU
2022-23	24084	41959	16019	29961	13254	25258	15843	29154	15961	31529	11437	25505	14503	30635	7442	18007	6470	15944
2023-24	26007	45055	17271	32119	14288	27081	17090	31271	17197	33794	12271	27235	15598	32786	7975	19233	6945	17068
2024-25	28094	48404	18630	34458	15414	29061	18443	33558	18542	36255	13177	29106	16786	35112	8554	20554	7458	18278
2025-26	30362	52036	20108	36992	16636	31203	19910	36028	19999	38910	14159	31128	18076	37632	9183	21988	8019	19597
2026-27	32829	55986	21714	39748	17964	33534	21507	38723	21587	41808	15227	33333	19478	40374	9867	23551	8626	21028
2027-28	34386	58351	22222	40479	18383	34152	22020	39450	22078	42566	15517	33819	19891	41049	10044	23893	8797	21388
2028-29	36927	62375	23835	43214	19715	36460	23625	42121	23670	45437	16579	35986	21292	43755	10717	25418	9400	22800
2029-30	39669	66707	25576	46161	21158	38956	25358	45006	25389	48532	17724	38312	22804	46673	11449	27070	10054	24325
2030-31	42627	71379	27454	49334	22710	41641	27230	48117	27242	51867	18960	40826	24433	49812	12236	28848	10756	25966
2031-32	45821	76418	29482	52764	24389	44542	29251	51473	29243	55465	20293	43536	26196	53211	13086	30769	11516	27740
2032-33	48583	80723	31189	55608	25800	46949	30953	54263	30926	58452	21408	45770	27670	56011	13792	32343	12147	29195
2033-34	51529	85313	33011	58643	27308	49517	32771	57239	32723	61637	22598	48153	29245	58998	14548	34025	12823	30750
2034-35	54670	90204	34952	61878	28915	52255	34707	60411	34637	65033	23867	50694	30922	62181	15353	35819	13542	32409
2035-	58018	95408	37023	65319	30627	55167	36773	63786	36679	68646	25219	53397	32710	65567	16211	37726	14308	3417

Year	Section 1		Section 2		Section 3		Section 4		Section 5		Section 6		Section 7		Section 8		Section 9	
	Vehicles	PCU	Vehicles	PCU	Vehicles	PCU	Vehicles	PCU	Vehicles	PCU	Vehicles	PCU	Vehicles	PCU	Vehicles	PCU	Vehicles	PCU
36																		2
2036-37	61585	100948	39227	68980	32451	58264	38972	67375	38853	72489	26658	56270	34614	69168	17123	39753	15124	36046
2037-38	64449	105423	41000	71945	33919	60777	40740	70284	40602	75608	27818	58608	36146	72093	17862	41409	15784	37579
2038-39	67453	110112	42858	75050	35457	63407	42594	73329	42436	78874	29033	61055	37753	75156	18634	43140	16475	39181
2039-40	70604	115029	44806	78304	37070	66163	44538	76519	44359	82297	30307	63618	39437	78365	19443	44951	17198	40858
2040-41	73915	120198	46855	81729	38766	69066	46582	79878	46382	85901	31647	66318	41208	81744	20295	46864	17960	42628
2041-42	77390	125622	49004	85321	40547	72110	48727	83400	48504	89682	33054	69150	43067	85288	21189	48869	18760	44484
2042-43	81004	131264	51241	89059	42399	75279	50958	87066	50713	93617	34517	72099	45001	88978	22120	50958	19592	46418
2043-44	84794	137179	53585	92977	44340	78599	53298	90908	53028	97742	36051	75190	47028	92846	23095	53146	20464	48443
2044-45	88773	143390	56047	97093	46379	82088	55754	94944	55459	102076	37662	78439	49158	96910	24120	55449	21380	50574
2045-46	92948	149906	58630	101411	48519	85748	58333	99178	58011	106623	39353	81846	51392	101173	25196	57863	22342	52809
2046-47	97331	156745	61343	105944	50765	89591	61040	103624	60690	111397	41128	85425	53738	105649	26326	60401	23353	55158
2047-48	101929	163916	64188	110697	53122	93619	63879	108284	63500	116404	42990	89178	56199	110343	27510	63060	24412	57620
2048-49	106754	171443	67174	115687	55596	97849	66859	113177	66451	121660	44945	93118	58783	115271	28754	65853	25524	60206
2049-	111818	17934	70308	12092	58192	10229	69987	11831	69547	12718	46997	97257	61494	12044	30060	68790	26692	6292

Year	Section 1		Section 2		Section 3		Section 4		Section 5		Section 6		Section 7		Section 8		Section 9	
	Vehicles	PCU	Vehicles	PCU	Vehicles	PCU	Vehicles	PCU	Vehicles	PCU	Vehicles	PCU	Vehicles	PCU	Vehicles	PCU	Vehicles	PCU
50		5		7		2		5		0				7				5
2050-51	117131	187628	73596	126418	60915	106947	73268	123699	72795	132965	49148	101593	64338	125871	31429	71864	27916	65771
2051-52	122709	196327	77049	132186	63776	111839	76714	129355	76206	139044	51409	106151	67325	131571	32868	75098	29204	68765
2052-53	128562	205454	80671	138239	66778	116972	80330	135290	79786	145422	53781	110934	70459	137551	34378	78492	30554	71908
2053-54	134704	215030	84473	144590	69928	122357	84125	141518	83543	152116	56270	115954	73748	143828	35963	82054	31972	75206
2054-55	141150	225080	88463	151258	73235	128012	88109	148055	87486	159144	58883	121224	77201	150417	37627	85795	33460	78670
2055-56	147914	235624	92650	158251	76704	133944	92288	154913	91624	166516	61624	126753	80823	157330	39372	89720	35021	82304
2056-57	155013	246689	97044	165592	80346	140169	96675	162111	95967	174255	64502	132557	84626	164586	41205	93841	36660	86120
2057-58	162462	258297	101656	173292	84167	146700	101279	169661	100525	182374	67521	138646	88616	172199	43128	98163	38380	90122
2058-59	170282	270486	106497	181382	88181	153563	106113	177593	105312	190904	70693	145045	92807	180198	45149	102710	40187	94332
2059-60	178488	283271	111577	189865	92391	160759	111185	185912	110333	199851	74020	151756	97203	188586	47268	107476	42083	98746

4.2.3 Toll Plaza

4.2.3.1 Location of toll plaza

Since it is an access controlled highway, toll plazas will be kept at all entry and exit points along the highway. Exact locations will be decided during FFR stage.

4.2.4 Capacity Analysis

4.2.3.2 Capacity augmentation proposals (lane requirement)

Capacity analysis for project road has been carried out in order to define the Level of Service (LoS) offered by road sections under the prevailing roadway and traffic conditions.

Capacity and level of service guidelines

Capacity and design service volumes for various lane configurations are specified in IRC: 64 – 1990, 'Capacity of Roads in Rural Areas', IRC-SP: 84-2014 'Manual of Specifications and Standards for Four-laning of Highways through Public Private Partnership' and IRC-SP:87-2013 'Manual of specifications and Standards for Six-laning of Highways through Public Private Partnership'.. The project stretch passes through plain terrain predominantly. The design service volume standards for LoS B and LoS C considered as per guidelines are given in **Table 4-36** below.

Table 4-36: Design service volume standards for LoS B & LoS C

Road	Plain Terrain	
	LOS B	LOS C
2 lane	10000*	14000
4 lane	40000	60000
6 lane[#]	80000	120000

As per MORTH notification (F.N. RW/NH-33044/37/2015/S&R(R);

[#] The capacity of 6 lane as given in "Assumptions for Financial feasibility Analysis of BOT (Toll) projects" (Circular ref: NHAI/11033/CGM(fin)/2011 dated: 29.04.2011).

4.2.3.2.1 Projected traffic levels

The capacity analysis was done for entire project road with respective homogeneous sections. The projected traffic volumes for the projected road are given in **Table 4-37.**

Table 4-37: Projected sectional traffic (AADT) in PCUs

Section	Section 1	Section 2	Section 3	Section 4	Section 5	Section 6	Section 7	Section 8	Section 9
2023	41959	29961	25258	29154	31529	25505	30635	18007	15944
2025	48404	34458	29061	33558	36255	29106	35112	20554	18278
2030	66707	46161	38956	45006	48532	38312	46673	27070	24325
2035	90204	61878	52255	60411	65033	50694	62181	35819	32409
2040	115029	78304	66163	76519	82297	63618	78365	44951	40858
2045	143390	97093	82088	94944	102076	78439	96910	55449	50574
2050	179345	120927	102292	118315	127180	97257	120447	68790	62925
2055	225080	151258	128012	148055	159144	121224	150417	85795	78670
2060	283271	189865	160759	185912	199851	151756	188586	107476	98746

Projected sectional AADT was compared with design service volume. The design service volume for project road is considered at the end of LOS B and LOS C and capacity augmentation is suggested for road section, which carry traffic volume more than design service volume.

Table 4-38 shows the year up to which LoS B and LoS C will serve and when the facility is falling to next LOS, for most likely scenario.

Table 4-38: Year upto which LoS B and LoS C will serve

Facility	Section 1		Section 2		Section 3		Section 4		Section 5		Section 6		Section 7		Section 8		Section 9	
	LOS B	LOS C	LOS B	LOS C	LOS B	LOS C	LOS B	LOS C	LOS B	LOS C	LOS B	LOSC	LOS B	LOS C	LOS B	LOS C	LOS B	LOS C
Realistic growth scenario																		
4 lane	2022	2028	2027	2034	2030	2037	2028	2034	2026	2033	2030	2038	2026	2034	2037	2046	2039	2048
6 lane	2032	2040	2040	2049	2044	2053	2041	2050	2039	2048	2045	2054	2040	2049	2053	2060	2055	2060
8 lane + PS	2060*																	

2060- Beyond the year 2060*

Section 1

To serve in LOS B the 6 lane facility should be ready by 2022 and to serve in LOS C 6 lane facility should be ready by 2028. To serve in LOS B the 8 lane facility should be ready by 2032 and to serve in LOS C 8 lane facility should be ready by 2040.

Section 2

To serve in LOS B the 6 lane facility should be ready by 2027 and to serve in LOS C 6 lane facility should be ready by 2034. To serve in LOS B the 8 lane facility should be ready by 2040 and to serve in LOS C 8 lane facility should be ready by 2049.

Section 3

To serve in LOS B the 6 lane facility should be ready by 2030 and to serve in LOS C 6 lane facility should be ready by 2037. To serve in LOS B the 8 lane facility should be ready by 2044 and to serve in LOS C 8 lane facility should be ready by 2053.

Section 4

To serve in LOS B the 6 lane facility should be ready by 2028 and to serve in LOS C 6 lane facility should be ready by 2034. To serve in LOS B the 8 lane facility should be ready by 2041 and to serve in LOS C 8 lane facility should be ready by 2050.

Section 5

To serve in LOS B the 6 lane facility should be ready by 2026 and to serve in LOS C 6 lane facility should be ready by 2033. To serve in LOS B the 8 lane facility should be ready by 2039 and to serve in LOS C 8 lane facility should be ready by 2048.

Section 6

To serve in LOS B the 6 lane facility should be ready by 2030 and to serve in LOS C 6 lane facility should be ready by 2038. To serve in LOS B the 8 lane facility should be ready by 2045 and to serve in LOS C 8 lane facility should be ready by 2054.

Section 7

To serve in LOS B the 6 lane facility should be ready by 2026 and to serve in LOS C 6 lane facility should be ready by 2034. To serve in LOS B the 8 lane facility should be ready by 2040 and to serve in LOS C 8 lane facility should be ready by 2049.

Section 8

To serve in LOS B the 6 lane facility should be ready by 2037 and to serve in LOS C 6 lane facility should be ready by 2046. To serve in LOS B the 8 lane facility should be ready by 2053 and to serve in LOS C 8 lane facility should be ready by 2060.

Section 9

To serve in LOS B the 6 lane facility should be ready by 2039 and to serve in LOS C 6 lane facility should be ready by 2048. To serve in LOS B the 8 lane facility should be ready by 2055 and to serve in LOS C 8 lane facility should be ready by 2060.

CONCLUSION

Section between Chennai and Kanchipuram/Chengalpet (Section 1) is having highest traffic volume and it requires 6 lane facility and it will serve upto 2032 in LOS B and upto 2040 in LOS C. 8-lane facility is required from 2032. In remaining sections (from section 2 to section 9), the six lane facility is required at the earliest in 2026 and 8-lane facility at the earliest by 2039 to serve in LOS B.

As per Indo-HCM (Indian Highway Capacity Manual), a suggested threshold limit for four lane to six

lane divided road to ensure enhanced safety in traffic operations is 22,500 PCUs and for six lane to eight lane is 34000 PCUs. Thus the average PCUs of all sections 25749 PCUs (sections 2 to 9) is reaching threshold limit by 2023 and demanding six lane requirement and eight lane by 2028 with an average PCUs of 34600.

5. FINALIZATION OF ALIGNMENT OF THE PROPOSED HIGHWAY

5.1 Background

The Government of India has taken up the Bharatmala project on top priority. The LOT six projects earlier conceived have been modified to Chennai Selam Green Field highway along with spurs and two more existing roads improvement, as stated in Chapter 1 and 2. This chapter contains description of Chennai Selam Green Field Highway alignment finalization only along with spurs.

5.2 Need for the Green field highway

The present connection between Chennai to Salem is provided by three routes; **Route I** : National Highways NH-48 and NE2 passing through Chennai, Kanchipuram, Vellore, Krishnagiri, Dharmapuri and Salem districts of Tamil Nadu state with the length of 352.70 Km consisting 4/6 lane configuration, **Route II :** National Highway NH-48 and State Highway SH-18 (New NH-179A) travelling along same districts as route I has a length of 331.89 Km consisting 2/4 lane configuration and **Route III :** National Highway NH-32, NH-132, NH-38, NH-79 and NE2 traversing along Chennai, Villupuram and Salem districts of Tamil Nadu state with the length of 334.28 Km with 2/4 lane configuration. Since these routes are not access-controlled, speed of the travel is affected by considerable cross movement of traffic through the side roads and access of vehicles from the abutting settlements leading to slower than design speed of the through traffic. Besides, the sections through mountainous terrain along existing route II on SH-18 (New NH-179A) section have lower radius curves at some places which restrict smooth movement of traffic at design speed.

The idea of constructing a high- speed facility like a fully access-controlled green field highway has originated from the primary necessity to eliminate the bottlenecks and limitations that exist in the present corridors to reduce the travel time between Chennai – Salem. It has been felt that substantial reduction of travel time between these two districts would not only fetch direct benefits to the users due to less vehicle operating cost, passenger time saving and other intangible benefits as well. The connectivity provided through interchanges with residential, commercial and industrial hub would also fetch direct and indirect benefits. The project is expected to generate development around the abutting towns connected through proposed spurs from the green field highway. Number of openings and employment opportunities to the local people and for the local and National contractors as well, which would satisfy the Federal Govt agenda of employment opportunities. There would be short and long term tangible and intangible benefits by this project.

All the above factors warrant the construction of an access controlled green field highway ensuring safety and high speed movement of men and materials from production units to consumers in shortest possible time.

5.3 Existing Traffic

Traffic along the existing routes from Chennai Salem, via krishnagiri, via Vaniyambadi or via Ulundrupet is substantially driven by commercial and industrial traffic. In addition to this, some religious and archaeological attractions are there along and around the project

corridor and expected to increase passenger traffic considerably.
A preliminary estimate shows, the traffic from Salem – Ulundrupet – Chennai route is around 8000 to 10000 PCU, Salem – Harur – Vellore route is 4000 to 5000 PCU and Salem – Krishnagiri – Chennai route is around 4000 PCU.

5.4 Project Location

Existing roads starting at Chennai traverses through Kanchipuram, Vellore, Krishnagiri, Dharmapuri, Villupuram and ends at Salem district of Tamil Nadu state. Proposed alignment starts near the Chennai outer ring road junction on SH-48, traverses through Kanchipuram, Tiruvannamalai, Krishnsgiri, Dharmapuri and Salem districts in the state of Tamil Nadu, which run parallel, intersect and overlap; National Highway (NH-38, NH-77, NH-79, NH-NE2 and NH-544), State Highway (SH-48, SH-57, SH-58, SH-118A, SH-116, SH-5, SH-4, SH-115, SH-6A and SH-18) and Major District Roads (MDR-789, MDR-709, MDR-43, MDR-503, MDR-800 and MDR-1044).

5.5 Methodology of finalization of alignment

The following steps were taken in finalizing the alignment of the Expressway

Step I: List out the Districts, Tehsils and Villages to be passed by the Expressway alignment.
Step II: Collection of Topographic Maps and Village Maps
Step III: Preliminary finalization of the alignment of the Green Field Highway from the Google earth and check it on SOI Topographic Maps
Step IV: Consider connectivity requirement after discussion with NHAI officials
Step V: Consider most direct route with least number of structures
Step VI: Avoid / modify alignment to bypass forest land / pond / archeological important areas
Step VII: Select type of interchanges
Step VIII: Verify selected alignment at site
Step IX: Prepare preliminary alignment plan

5.6 Packaging of the alignment selected

The proposed alignment passing through green-field is divided into 7 packages. Package-wise details along with proposed right of way are provided in the **Table 5-1.**

Table 5-1: Package-wise details with proposed right of way

Package	Design Chainage		Length	Location	PROW, m
	From	To			
I	0+000	25+600	25.600	Vandalur to Palur	70
II	25+600	67+700	42.100	Palur to Erumaivetti	90
III	67+700	122+660	54.960	Erumaivetti to Thenpallipattu	90
IV	122+660	157+570	34.910	Thenpallipattu to Manmalai	90
V	157+570	207+200	49.630	Manmali to Harur	90
VI	207+200	220+000	12.800	Harur to Ayodhiyapatinam	90
	57+300	21+800	35.500		

Package	Design Chainage		Length	Location	PROW, m
	From	To			
VII	21+800	0+000	21.800	Ayodhiyapattinam to Ariyanur	70

Project road aims to connect (Chennai and Salem) two major districts in the state with the shortest possible path and also intends to connect many Industrial areas and SEZ along the project road and the connectivity are contemplated through spurs and interchanges. Taluk wise details along different districts are given in Location map of project road is given in **Figure 5-1.** This green field highway alignment is proposed to be Integrated / connected with other highways planned/ executed in Tamil Nadu state in the future.

Table 5-2: Taluk wise details along different districts of proposed alignment

Sl. No	Name of District	Name of Taluk	Approx. Length in Km
1	Kanchipuram	Tambaram	59.11
2		Sriperumbudur	
3		Chengalpattu	
4		Uthiramerur	
5	Tiruvannamalai	Cheyyaru	119.58
6		Vandavasi	
7		Polur	
8		Arani	
9		Tiruvannamalai	
10		Chengam	
11	Krishnagiri	Uttangarai	3.67
12	Dharmapuri	Harur	59.27
13		Papireddipatty	
14	Salem	Yercadu	35.67
15		Valappadi	
16		Salem	
Total Length, Km			**277.300**

Figure 5-2: Location Map of Project Road

5.7 DETAILS OF THE ALIGNMENT OF CHENNAI SALEM GREEN FIELD HIGHWAY INCLUDING SPURS

Every 10 th kilometer wise details of the alignment are given below. The existing Chennai Salem starts from Maduravel. But the present Green field highway starts from the Outer Ring Road at Vandalur.

Km 0 to 10: Km 0 to 5, the alignment starts from Vandalur from the Outer ring road through a proposed interchange. Due to heavy settlements the green field highway can not follow the green field alignment from the start. It follows 2 km of the State Highway 48 (Vandalur – Orgadam – Walajabad). The green field alignment starts from Km 2 and turns left towards Karasangal. In this 3 km green field stretch the alignment passes through the in between land of the two major tanks and on the agricultural areas. It passes through Varadarajapuram village and settlemets like Padapai and Adhanur. At Km 2+000 a flyover is proposed to fly the Green field highway and at grade connection to the Existing State Highway 48. 3 HIPs have been proposed at Km 1+000 (L/S), 2+000 (L/S) and 4+800 (R/S). Three minor bridges have been proposed at Km 1+280, 1+385 and 1+905 on local streams.

Km 5 to 10, the alignment in this 5 km passes through open areas including agricultural land, barren land and in between villages. On the way it passes through villages Korukanthangal and Orathur villages. The alignment bypasses major tank at km 8+600 on the right side. Two minor bridges have been proposed at km 5+060 and km 6+570 on local streams. Two VUPs have been proposed at Km 6+460 and Km 8+430. 2 HIPs have been proposed at Km 6+400 (R/S) and 9+900 (L/S).

Km 10 to 20 : Km 10 to 15, the alignment in this 5 km is proposed in such a way that it passes through two major tanks at km 11+500 near village Nattarasangpattu and then bypassing major tank and major village Kanchivakkam. At other places it passes through agricultural and barren lands. It

passes through villages Vadamelpakkam, Kanchivakkam and Appur villages. Three minor bridges have been proposed at km 11+510, Km 12+600 and 13+620 on local streams. A major bridge of 100m length has been proposed on the tank at Km 14+230. Two VUPs have been proposed at Km 11+340 and Km 13+470. 2 HIPs have been proposed at Km 11+600 (R/S) and 13+800 (L/S). The alignment passes through forest land at Km 13+100 to 13+600.

Km 15 to 20, the alignment in this 5 km is proposed as a straight one without any horizontal intersection points bypassing two tanks at Umayalparamancheri, then two big tanks at Eaichur village and passing through agricultural lands. The abutting villages are Umayaparamancheri, valayakaranai, Eaichur and Guruvanmedu. The poposed alignment crosses existing 4 Lane SH 57 (Sriperumbudur – Orgadam – Appur Road) where a Flyover / Overpass is proposed. A VUP on local road is proposed at Km 19+190. A major bridge of 525 m length has been proposed on the tank at Km 15+980 over Tank at Umayalparamancheri.

Km 20 to 30: Km 20 to 25 the alignment in this 5 km passes through plain agricultural land and low lying land. It crosses major river Palar. Two minor bridges have been proposed, one over Nala and another over pond at Km 20+250 and 20+740. One VUP has been proposed at Km 20+940. A major structure (Interchange+ROB+Flyover) has been proposed at Km 24+580 to cross Palar river, railway line and providing both side spurs on SH 58 to kanchipuram and Chengalpattu. Two HIPs have been proposed at Km 21+185 (L/S) and 23+449 (R/S). The villages pass by in this streach are Guruvanmedu, Kolathancheri, Reddypalayam and Palar.

Km 25 to 30, the alignment in this 5 km passes through plain agricultural land and low lying land. Five minor bridges have been proposed, three over Nala and two over ponds at Km 26+040, 26+170, 26+650, 26+960 and 28+615. Two VUPs have been proposed at Km 26+270 and 28+090. The alignment generally bypasses tanks at Pinayur. Two HIPs have been proposed at Km 25+916 (R/S) and at 28+910 (L/S). The villages pass by in this streach are Seethancherry, Arumbuliyan, Pazaverri and Seethapuram.

Km 30 to 40: Km 30 to 40 the alignment in this 10 km passes through plain agricultural land and low lying land bypassing ponds and settlements. There are series of ponds at km 32 to 34 which have been avoided. Seven minor bridges have been proposed, six over Nala and one over pond at Km 30+080, 31+870, 32+875, 33+000, 35+665, 38+430, 38+620. Three VUPs have been proposed at Km 30+810, 34+515 and 38+195. Three HIPs have been proposed at Km 31+391 (L/S), 34+158 (R/S) and 39+982 (L/S). The villages pass by in this streach are Anambakkam, Pullampakkam, Sirumaliur, Neyadupakkam, Vayalakkavoor and Elayamarvelur.

Km 40 to 50: This portion of the alignment in this 10 km passes through plain agricultural land and low lying land bypassing ponds and settlements. The alignment bypasses some ponds and seven minor bridges, six over Nala and one over pond at Km 40+870, 42+090, 42+930, 43+580, 45+600, 46+020, 48+630. One major bridge has been proposed at 42+440 over pond. Two VUPs have been proposed at Km 43+710 (SH 118A) and at 47+950. Three HIPs have been proposed at Km 44+902 (R/S), 47+302 (R/S) and 49+510 (R/S). The villages pass by in this streach are Puthali, Adavapakkam, Karuveppampoondi, Ozhugarai and Azhisoor.

Km 50 to 60: This portion of the alignment in this 10 km passes through plain agricultural land and low lying land bypassing ponds and settlements. An important archeological monument (Pegalithic cists and cairns) are found at Perunagar village, kanchipuram. The alignment has been diverted by providing 3000m radius curve to avoid the monument by a distance of over 500m and taken near manampathi village in between km 51 to 63. The alignment bypasses some ponds and six minor

bridges, four over Nala, one over pond and another over pond inlet at Km 50+120, 51+990, 53+240, 56+430, 58+500 and 59+340. One VUP has been been proposed at Km 57+005. Two HIPs have been proposed at Km 51+645 (L/S) and 59+131 (R/S). The villages pass by in this streach are Anumanthandalam, Elanagar, Perunagar and Manampathi.

Km 60 to 70: This portion of the alignment in this 10 km passes through plain agricultural land, low lying land, barren lands bypassing ponds, settlements and factories. The alignment bypasses some ponds. Six minor bridges have been proposed, five over Nala and one over pond inlet at Km 63+130, 63+760, 64+610, 65+060, 66+165 and 67+070. One Major Bridge and Flyover combined has been proposed at 60+110 over SH 116. One VUP has been been proposed at Km 67+395 (SH 5). One major bridge has been proposed at 68+720 over pond. Two HIPs have been proposed at Km 64+100 (L/S) and 67+242 (R/S). The villages pass by in this streach are Athi, Nedungal, Anapathur, Erumiavetti, Vinayagapuram, Perumbalai, Thenthandalam and Chittamoor.

Km 70 to 80: This portion of the alignment in this 10 km passes through plain agricultural land, low lying land, barren lands bypassing ponds and settlements. The alignment bypasses some ponds. Seven minor bridges have been proposed, four over Nala, two over ponds and one over pond inlet at Km 71+040, 72+260, 72+510, 73+475, 74+680, 78+270 and 78+880. Two Major Bridges have been proposed at 70+720 and 77+250. Three VUPs have been been proposed at Km 72+050, 75+290 and 79+400. Two HIPs have been proposed at Km 71+693 (L/S) and 78+332 (L/S). The villages pass by in this streach are Sengadu, Kovilur, Villanalur, Chinna Sengadu, Kottagaram and Nambedu.

Km 80 to 90: This portion of the alignment in this 10 km passes through plain agricultural land, low lying land, barren lands bypassing series of big and small ponds and settlements. Five minor bridges have been proposed, two over Nala, two over ponds and one over pond inlet at Km 82+890, 86+240, 87+650, 88+420 and 89+495. One Major Bridge has been proposed at 82+070 on pond. One VUP has been been proposed at Km 83+420. Three HIPs have been proposed at Km 82+006 (R/S), 84+773 (L/S) and 87+299 (R/S). The villages pass by in this streach are Aryapadi, Peranamallur, Pulur, Septangulam, Injimedu, Sandirambadi, Alliyandal, Mahadevimangalam, Taveni and Namathodu. The alignment passes through forest land in km 80+100 to 80+400.

Km 90 to 100: This portion of the alignment in this 10 km passes through plain agricultural land, low lying land, barren lands bypassing series of big and small ponds and settlements. Nine minor bridges have been proposed, eight over Nala and one over pond inlet at Km 90+510, 91+780, 95+050, 97+720, 98+320, 98+580, 98+995, 99+250 and 99+380. Two VUPs have been been proposed at Km 90+940 and 98+830. One cloverleaf interchange on crossing with SH alongwith Chetpet spur has been proposed at Km 94+505. Four HIPs have been proposed at Km 91+458 (R/S), 94+479 (L/S), 97+321 (R/S) and 99+727 (L/S). The villages pass by in this streach are Anadimangalam, Imapuram, Ulagampattu, Semmambadi, Appedu, Maruthuvambadi and Kolakkaravadi.

Km 100 to 110: This portion of the alignment in this 10 km passes through plain agricultural land and in some parts barren lands. Six minor bridges have been proposed, four over Nala and two at pond edge at Km 101+840, 106+240, 106+450, 106+740, 107+870 and 108+660. One Overpass over SH 115 (Chetpet to Ranipet Road) has been proposed at 103+480 so that the SH overpasses the green field highway. One VUP has been proposed at Km 105+610. The portion is a fairly straight alignment with only one HIP proposed at Km 109+166 (R/S). The villages pass by in this streach are Devikapuram, Thatchambodi, Chithathurai, Peranambakkam. The alignment passes through forest land in km 106+400 to 107+700.

Km 110 to 120: This portion of the alignment in this 10 km passes through plain agricultural land, in some parts barren lands, bypassing tanks, lakes and waterbodies. Five minor bridges have been proposed, Two over Nala and three on pond and at pond edges at Km 113+285, 116+230, 117+000, 118+200 and 118+370. Two VUPs have been proposed at Km 110+455 and 115+750. The portion is a fairly straight alignment with only one HIP proposed at Km 112+636 (L/S). The villages pass by in this streach are Semiyamangalam, Randam, Pelasur, Analiya, Kambattu and Pathiyavadi.

Km 120 to 130: This portion of the alignment in this 10 km passes through plain agricultural land, in some parts barren lands, bypassing series of ponds on both sides and waterbodies. Four minor bridges have been proposed, Two over Nala and two on pond and at pond inlet and edges at Km 122+250, 122+740, 123+580 and 126+720. A major bridge and ROB has been proposed at Km 120+545 to cross Vellore – Tiruvannmalai Railway line and a tank besides the railway line trough a combined structure. One Double Trumpet interchange has been proposed at Km 121+760 to provide access to Polur and Thiruvannmalai through ramps and loops on NH 38. One VUP has been proposed at Km 125+500. The portion is a fairly straight alignment with only one HIP proposed at Km 125+743 (R/S). The villages pass by in this streach are Salayanoor, Thenpallypattu, Mettupalayam, Nellimedu, C. Andapattu, Narthampoondi, Mutharasampoondi, Siru Kilambadi and Thenagaram.

Km 130 to 140: This portion of the alignment in this 10 km passes through plain agricultural land, in some parts barren lands, bypassing series of ponds on both sides and waterbodies. Six minor bridges have been proposed, all over Nala at Km 132+720, 133+680, 138+940, 139+200, 139+560 and 139+940. A major bridge has been proposed at Km 138+690 on local stream. Two VUPs has been proposed at Km 131+450 and 136+180. The portion is a fairly straight alignment with only one HIP proposed at Km 130+599 (L/S). The villages pass by in this streach are Kodi Kuppam, Nayambadi, N. Mottur, C. Namiyandal, Namyandal Koot, Alathur, Karattampattu and Kanji.

Km 140 to 150: This portion of the alignment in this 10 km passes through plain agricultural land, rolling terrain, in some parts barren lands, bypassing some ponds on both sides and waterbodies. Five minor bridges have been proposed, four over Nala and one over pond at Km 142+680, 143+380, 146+700, 147+110, and 147+340. Two major bridges have been proposed at Km 140+930 and 145+990 on local stream. The portion is a curvy one with s curves with large radius to avoid forest land on both sides of the green field highway. Two HIPs have been proposed at Km 141+126 (L/S) and 145+229 (R/S). The villages pass by in this streach are Kodi Kuppam, Nayambadi, N. Mottur, C. Namiyandal, Namyandal Koot, Alathur, Karattampattu and Kanji.

Km 150 to 160: This portion of the alignment in this 10 km passes through plain agricultural land, rolling terrain, in some parts barren lands, bypassing some villages and habitations on both sides. Four minor bridges have been proposed, three over Nala and one over pond at Km 152+020, 154+180, 158+850 and 158+960. Two major bridges have been proposed at Km 157+260 and 159+395 on local stream and ponds. One VUP has been proposed at 150+760 on local roads. Cloverleaf Interchange is proposed on the crossing with NH 77 to give connection to Chengam bound traffic. The portion is a curvy one with s curves with large radius to avoid forest land on both sides of the green field highway. Two HIPs have been proposed at Km 150+564 (R/S) and 155+100 (L/S). The villages pass by in this streach are Melmudiyanur, Ammapalayan, Muthanur, Kottakulam, Manmalai and Perumbatam.

Km 160 to 170: This portion of the alignment in this 10 km passes through rolling terrain within hills. The alignment has been curved to avoid forest land. One HIP has been proposed at Km 164+930 (L/S). Four minor bridges have been proposed, three over Nala and one over pond at Km 160+425, 162+050, 169+000 and 169+330. Three major bridges have been proposed at Km 162+520, 163+750

and 167+670 on local stream and ponds. One VUP has been proposed at 165+060 on a local road. The villages pass by in this streach are Chengam, Pakkirapalayam, Melpulidiyur, Andanur, Melpallipattu and melvanakkambadi.

Km 170 to 180: This portion of the alignment in this 10 km passes through hilly terrain bypassing the eserve forest on both sides. Two HIPs have been proposed at Km 170+989 (R/S) and 179+432 (L/S). Six minor bridges have been proposed all on nalla at Km 170+750, 171+780, 172+485, 174+030, 175+760 and 179+120. Two VUPs have been proposed at 170+360 and 175+550 on local roads. The villages pass by in this streach are Naradapattu, Karimalapadi and Athipadi.

Km 180 to 190: This portion of the alignment in this 10 km passes through hilly terrain, a part of which (180+860 to 182+700) falls on the reserve forest. The alignment has been curved to avoid forest land (Anandamalai Reserve Forest). Two HIPs have been proposed at Km 184+142 (L/S) and 189+583 (R/S). Eight minor bridges have been proposed, five on local streams and three on ponds at Km 180+940, 181+260, 184+190, 184+460, 186+140, 187+360, 188+640 and 188+970. One Major bridge has been proposed on local stream at 183+560. Two VUPs have been proposed at 183+180 and 183+930 on local roads. The village pass by in this streach is Neepathurai.

Km 190 to 200: This portion of the alignment in this 10 km passes through plain agricultural and some barren lands in between hilly areas (Vadakadamaduvu and Mondukuli). Only one HIP has been proposed at Km 192+269 (L/S). An overpass has been proposed at km 192+200 on State Highway from Thiruvannmalai to Harur (SH 6A). Eight minor bridges have been proposed all on nallas at Km 192+900, 193+750, 194+040, 196+160, 196+480, 197+600 and 197+920. Two VUPs have been proposed at 190+680 and 196+260. The villages pass by in this streach are Andiyur, Teerthamalai, Poyapatty, Virappanyakkampatty.

Km 200 to 210: This portion of the alignment in this 10 km passes through agricultural lands in between scattered houses throughout. Three HIPs have been proposed at Km 200+790 (R/S), 203+500 (L/S) and 208+075 (L/S). Three major bridges on local streams at Km 202+140, 206+840 and 207+760. Four minor bridges have been proposed all on nallas at Km 203+780, 204+700, 207+080 and at 209+760. Only one VUP has been proposed at Km 201+380 on lpocal roads. The villages / major settlements pass by in this streach are Ittiyampatty, Koochanoor, Vengiampatti and Harur.

Km 210 to 220: This portion of the alignment in this 10 km passes through agricultural lands in between scattered houses throughout. Only one HIP has been proposed at Km 215+255 (R/S). One major bridge has been proposed on local streams at Km 210+100. Seven minor bridges have been proposed all on nallas at Km 211+850, 214+400, 216+360, 217+120, 217+520, 218+620 and 219+230. Three VUPs have been proposed at Km 201+550, 213+060 and 219+530 all on local roads. The villages / major settlements pass by in this streach are Erumiyamapatty, Pudupatty and Mukkareddypatty.

Km 57+300 to 47+300: This portion of the alignment in this 10 km passes through agricultural lands in between scattered houses, savoiding some tank and wet lands. Four HIPs have been proposed at Km 55+527 (L/S), 53+050 (R/S), 52+660(L/S) and 48+968 (L/S). One single trumpet interchange has been proposed to connect the green field highway (Newly formed NH 179B) with Ayadhyapatnam to Baniyambhatti road (SH 18, renamed to NH 179A) at Km 55+750. Nine minor bridges have been proposed all on nallas at Km 57+260, 56+920, 56+190, 53+520, 53+000, 52+440, 50+730, 50+450 and 47+970. Only one VUP has been proposed at Km 48+900 on a local road. The villages / major settlements pass by in this streach are Pappireddypatty, Pattukonampatty and Varadha Kavundanoor.

Km 47+300 to 37+300: This portion of the alignment in this 10 km passes through in between land of Manjavari reserve forest (Km 41+600 to 38+100). Three HIPs have been proposed at Km 43+600 (R/S), 39+141 (L/S) and 38+208 (R/S). Five minor bridges have been proposed all on nallas at Km 46+160, 43+930, 43+780, 41+300 and 38+740. Only one VUP has been proposed at Km 43+280 on a local road. The villages / major settlements pass by in this streach are Kallattupatti, Manjavadi, Chinnamanjanavadi and Komvur.

Km 37+300 to 27+300: This portion of the alignment in this 10 km passes through in between forest land, agricultural land and open areas and in between scattered houses. Four HIPs have been proposed at Km 36+177 (L/S), 35+200 (R/S), 32+902 (L/S) and 28+665 (L/S). Six minor bridges have been proposed all on nallas at Km 37+140, 36+960, 36+400, 31+400, 30+220 and 29+300. One flyover at Km 31+800 has been proposed at the connection point with SH 18 (Newly formed NH 179A). The villages / major settlements pass by in this streach are Kuppanoor, Paruthikadu, Vellaiyanpatty, and Sukkampatty.

Km 27+300 to 17+300: This portion of the alignment in this 10 km passes through semi urban areas with agricultural land and scattered houses throughout. The alignment passes through forest land in km 17+500 to 16+100, 15+800 to 15+000, 14+100 to 13+100 and 12+900 to 12+600. Two HIPs have been proposed, one at 20+709 at the crossing point of the green field highway with the NH 79 and at 17+530 (R/S). An interchange has been proposed at the crossing points at Km 21+590. At 22+140 a ROB has been proposed. Two minor bridges have been proposed all on nallas at Km 26+500 and 25+220. The villages / major settlements pass by in this streach are Ayodhyapatnam, Ramalingapuram and Chinnakavundapuram.

Km 17+300 to 7+300: This portion of the alignment in this 10 km bypasses Salem city through semi urban areas, hilly area, agricultural land and scattered houses. The alignment bypasses forest land (Jerugumalai Reserve Forest) and passes through hills where tunnel will be needed at three locations (14+100 to 13+300, 12+900 to 12+200 and 11+000 to 10+400). Six HIPs have been proposed at 14+329 (R/S), 13+800 (L/S), 13+400 (R/S), 13+000 (L/S), 11+300 (R/S) and 7+555 (L/S). Three minor bridges have been proposed all on nallas at Km 17+200, 14+960 and 9+940. The villages / major settlements pass by in this streach are Saravana Nagar and Rajaram Colony.

Km 7+300 to 0+000: This portion of the alignment in this 7.3 km bypasses Salem city through semi urban areas and scattered houses. Two interchanges have been proposed at Km 6+940 (with NH 44 where a double trumpet interchange will be proposed) and at end of the preject road at 0+000 (At the meeting point with NH 544, where a cloverleaf interchange will be proposed). Three HIPs have been proposed at 5+900 (L/S), 3+800 (R/S) and 0+800 (R/S). At 4+630 a ROB has been proposed. At 5+620 a major bridge has been proposed on pond. Two minor bridges have been proposed at Km 3+960 and 0+660 on nalla crossings.

The alignment plan superimposed on toposheet and google earth images are provided along with this report.

6. DESIGN STANDARD AND SPECIFICATION

6.1 General

The geometric design of the Project Expressway shall conform to the standards set out in the Manual for expressway (IRC: SP: 99-2013).

6.2 Design Speed

The design speeds given in below table shall be adopted for various terrain classifications.

Design Speed

Nature of Terrain	Cross Slope of Ground	Design Speed
Plain	Less than 10%	120
Rolling	Between 10 and 25 %	100

Where an intervening stretch is classified as hilly/mountainous stretch and it may not be expedient from economic and environmental consideration to adopt even standards applicable to rolling terrain, a lower design speed of 80 kmph consistent with the topography and driver expectancy may be adopted and in such stretches speed limit signs shall be posted.

6.3 Right of Way

The Right–of–Way (ROW) for the project expressway shall be as per site condition and requirements. The recommended minimum Right of Way in Plain/Rolling terrain for expressways is given below

Right of Way in Plain/Rolling Terrain

Section	Right of Way Width (ROW)
Rural Section	90m – 120m
Rural sections passing through semi urban areas	120m

No service roads shall be provided within the ROW of the Expressway.

6.4 Lane Width of Carriageway

The standard lane width of the Project Expressway shall be 3.75 m. expressways shall have a minimum of two lanes for each direction of travel.

6.5 Median

The median shall bedepressed or flush. The recommended width of median is given below

Width of Median

Type of Median	Recommended median width	
	Minimum (m)	Desirable (m)
Depressed	12.0	15.0
Flushed	4.5	4.5
Flush (To accommodate structure\pier on median)	8.0	8.0

- The depressed median shall have suitably designed drainage system so that water does not stagnate in the median.
- An edge strip of 0.75m width of depressed median adjacent to carriageway in either direction shall be paved with same specifications as of the adjacent carriageway.
- As for as possible, the median shall be of uniform width in a particular section of the Project Expressway. However, where changes are unavoidable, a transition of 1 in 50 shall be provided.
- Median barriers shall be provided as specified in Section-10 of IRC SP: 99-2013 Manual. In case of flush type medians, suitable antiglare measures such as metal/plastic screens shall be provided to reduce headlight glare from opposite traffic. The total height of screen including the height of barrier shall be of 1.5 m.

6.6 Shoulders

The shoulders on the outerside (left side of carriageway shall be 3 m) wide paved plus 2 m wide earthen. The shoulder composition shall be as below:

- The composition and specification of the paved shoulder shall be as that of the main carriageway.
- The earthen shoulder shall be provided with 200 mm thick layer of non-erodible/granular material for protection against erosion.

6.7 Crossfall

The crossfall on straightsections of expressway carriageway shall be as given in below table. Each carriageway shall have unidirectional crossfall.

Crossfall on Different Surfaces

Cross-sectional Element	Annual Rainfall	
	1000 mm or more	Less than 1000 mm
Carriageway, Paved Shoulders, Edge Strip, Flush median	2.5 Percent	2.0 Percent

The crossfall for earthen/granular shoulders on straight portions shall be atleast 1.0 percent steeper than the values given in above table. On super elevated sections, the earthen portion of the shoulder on the outer side of the curve would be provided with reverse crossfall so that the earth does not drain on the carriageway and the storm water drain out with minimum travel path.

6.8 Acceleration/Deceleration Lane

Acceleration/Deceleration lane shall be provided as per Cl. 3.3.8, Section 3, IRC SP: 99-2013.

Each entry and exit ramp shall have acceleration/decelerartion lane for the Project Expressway. The length of the acceleration/decelerartion lanes shall be decided on the basis of speed differentials of the Project Expressway traffic and the speed permitted on the ramps.

Minimum Acceleration Lengths for Entry
(Grades of 2 Percent or Less)

Expressway Design Sped V (Km/h)	Acceleration Length L (m)				
	V' Speed on Entry Curve at A (Km/h)				
	40	50	60	70	80 or more
80	145	115	65	-	-
100	285	255	205	110	40
120	490	460	410	325	245

Minimum Deceleration Lengths for Exit
(Grades of 2 Percent or Less)

Expressway Design Sped V (Km/h)	Deceleration Length L (m)				
	V' Speed on Exit Curve at A (Km/h)				
	40	50	60	70	80 or more
80	100	90	80	55	-
100	145	135	120	100	85
120	175	170	155	140	120

V-Design speed of Expressway, V'-Design speed of entry/exit ramp

6.9 Design of Horizontal/Vertical Alignment

The general principles and design criteria laid down in MORTH Guidelines for Expressways shall be followed accordance with the manual, relevant IRC guidelines and International guidelines as required.

The following code of standards & technical specifications were reviewed for the definition of the Geometrics:

Publication	Issued by	Date of issue
IRC:73-1980 – Geometric Design Standards for Rural (Non Urban) Highway	Indian Road Congress (IRC)	October 1980
IRC:38-1988 – Guidelines for Design of Horizontal Curves	Indian Road Congress (IRC)	September 1988
IRC:SP:23-1993- Vertical Curves for Highway	Indian Road Congress (IRC)	December 1993
IRC: 92-1988- Guidelines for Design of Interchanges in Urban Areas	Indian Road Congress (IRC)	1988

6.9.1 Horizontal Alignment

Alignment shall be fluent and blend with the topography. The horizontal curves shall be designed to have a practical radius and shall consist of circular portion flanked by spiral transitions at both ends.

Super Elevation

Super elevation shall be limited to 7 percent, if radius of curve is less than the desirable minimum radius. It shall be limited to 5 percent if radius is more than or equal to the desirable minimum. Super elevation shall not be less than the minimum specified crossfall.

Radii of horizontal Curves

The desirable minimum radii of horizontal curves are given below

Minimum Radii of horizontal Curves

Design Speed (Km/h)	120	100	80
Absolute Minimum Radius (m)	670	440	260
Desirable Minimum Radius (m)	1000	700	400

Transition Curves

Properly designed transition curves shall be provided at both ends of the circular curve. The recommended minimum length of transition curves is given below

Minimum Length of Transition Curves

Design Speed (Km/h)	Minimum Length of Transition curve (m)
120	100
100	85
80	70

Sight Distance

The safe stopping sight distance and desirable minimum sight distance for divided carriageway for various design speeds are given in below table. The desirable values of sight distance shall be adopted unless there are site constraints. A minimum of safe stopping sight distance shall be available throughout.

Safe sight Distance

Design Speed (Km/h)	Safe Stopping Sight Distance (m)	Desirable Minimum Sight Distance (m) (Intermediate Sight distance)
120	250	500
100	180	360
80	120	240

At critical locations or decision points where changes in cross-sections occur such as toll plazas and interchanges, the sight distance shall not be less than the decision sight distance given below. The criteria for measuring the decision sight distance are same as for the stopping sight distance.

Decision of Sight Distance

Design Speed (Km/h)	Decision Sight Distance (m)
120	360
100	315
80	230

6.9.2 Vertical Alignment

The vertical alignment should provide for a smooth longitudinal profile. Grade changes shall not be too frequent as to cause kinks and visual discontinuities in the profile.

The vertical alignment of the carriageway will generally be compatible with the guidelines given in the IRC: SP: 99-2013.

At locations of grade break of 0.5%, vertical curves will be provided.

The length of vertical curve will be not less than 0.6V (V in kmph).

At locations of sight deficiency, at least Stopping Sight Distance (SSD) will be provided.

Gradients

The ruling and limiting gradients are given below

Gradients

Terrain	Ruling Gradient	Limiting Gradient
Plain	2.5 Percent	3 Percent
Rolling	3 Percent	4 Percent

In cut- sections, minimum gradient for drainage considerations is 0.5 percent (1 in 200) if the side drains are lined; and 1.0 percent (1 in 100) if this are unlined.

Vertical Curves

A vertical curve provides a transition between two sloped roadways, allowing a vehicle to negotiate the elevation rate change at a gradual rate rather than a sharp cut. The design of the curve is dependent on the intended design speed for the roadway, as well as other factors including drainage, slope, acceptable rate of change, and friction. These curves are parabolic and are assigned stationing based on a horizontal axis. Vertical curves will be designed to provide for visibility at least corresponding to the safe stopping sight distance. More liberal values will be adopted wherever this is economically feasible. The minimum grade change requiring vertical curve and minimum length of vertical curve will be as follows in given below

Minimum Length of Vertical curve

Design speed (Km/h)	Minimum Grade change Requiring Vertical curve	Minimum Length of Vertical Curve (m)
120	0.5 Percent	100
100	0.5 Percent	85
80	0.6 Percent	70

6.9.3 Coordination of Horizontal and Vertical alignment

The overall appearance of an expressway can be enhanced considerably by judicious combination of the horizontal and vertical alignments. Plan and profile of the road shall not be designed independently but in unison, so as to produce an appropriate three dimensional effect. Proper co-ordination in this respect will ensure safety, avoid visual discontinuities and contribute to overall aesthetics.

Vertical curvature superimposed upon horizontal curvature gives a pleasing effect. As such the vertical and horizontal curves shall coincide as far as possible and their length shall be somewhat longer than the vertical curve. Short vertical curve superimposed on long horizontal curves shall be avoided at or near the apex of pronounced summit/sag vertical curves from safety considerations.

The designer shall check profile design in long continuous plots to help avoid a roller-coaster profile.

6.9.4 Lateral and Vertical Clearance at Underpasses

Lateral clearance at underpasses shall not be less than the values given below

Lateral Clearance

Type of Underpass	Minimum Lateral Clearance
VUP	12m (7m Carriageway+2x2.5m Shoulder)
VUP (Grade-II)*	12m (7.5m Carriageway+2x2.5m Shoulder)

Vertical clearance at underpasses shall not be less than the values given below

Vertical Clearance

Type of Underpass	Minimum Vertical Clearance
Vehicle underpass	5.5m
VUP(Grade-II)*	4.0m

* As per NHAI circular No. 11014/11/2016-HR-1 dated 12.06.2017 "Policy Matter-10.1.16/2016 (Decision Taken on File No. NHAI/SRD&Q/CGM(T)/2017)

6.9.5 Lateral and Vertical Clearance at Overpasses

Lateral Clearance

Full roadway width for 8-lane carriageway or wider shall be carried through the overpass Structure. The abutments and piers shall be provided with suitable protection against collision of vehicles.

Vertical Clearance

A minimum 5.5 m vertical clearance shall be provided from all points of the carriageway of the Project Expressway.

6.9.6 Access Control

Project Expressway shall be designed for fast motorized traffic with full control of access. Access to the Expressway shall be provided with grade separators at location of intersections. Parking/standing, loading/unloading of goods and passengers and pedestrians/animals shall not be permitted on the Expressway in accordance with MORTH Guidelines for Expressway Manual.

6.9.7 Interchange

Interchange shall be provided at crossing or nearest points of other Expressways, National Highways, State Highways and important arterial roads.

At crossing or nearest points of major roads to important ports, airports, material transport facilities, commercial and industrial areas, and places of tourist interest.

There are two broad categories of Interchanges, based on traffic exchange:

i) **Service Interchanges :** This refers to an interchange of the Expressway with a road less in in importance than Expressway.

For this category, it is considered that Expressway shall be a toll road, and the other intersecting road shall be a "non-tolled" road or a road with open system of tolling with the toll plaza on the other road minimum 2 km away. This requires the consideration of tolling system which considers a barrier system as well as toll booths on the interchange ramps. This requires provision of appropriate deceleration and acceleration lanes and operating speed limitations in the interchange areas.

ii) **System Interchanges:** This refers to an interchange between the Expressways

For this category, since the both intersecting roads are toll roads under the closed system, toll booths on ramps are not required. The system needs to cater for high speed operation. The toll collection arrangements need be considered on integrated basis between the two involved Expressway stretches. The modalities need to be suitably addressed.

Ramp Design Speed

Recommended design speeds for interchange ramps are given below

Recommended Design Speeds for Ramps

Configuration	Type of ramp	Range of Expressway Design Speeda (Km/h)	
		100-120	80-100
		Range of Ramp Design Speeds	
System Interchange	Semi-Direct	50-70	40-60
	Loop	70-90	60-80
	Direct	80-100	70-90
Servics Interchange	Semi-Direct	40-60	40-60
	Loop	60-80	60-70
	Direct	60-90	60-80

6.9.8 Connecting Roads

Connecting roads where required to maintain proper circulation of local traffic, continuity of travel and to facilitate crossing over to the other side of the Project Expressway through an under/overpass shall be constructed on the land acquired within the ROW of the Project Expressway. These shall be provided outside the fencing. The width of the connecting road shall be 7.0 m. The construction and maintenance of connecting roads shall be part of the Project Expressway.

6.10 Geometric Design

Using the existing road alignment, profile and the terrain model developed from the topographical survey as a base, a final design will be developed for the road lengths to be upgraded, including intersections and service roads.

In order to create a good digital terrain model the road designer will coordinate with the survey engineer to ensure high quality and an efficient process.

A team of design engineers will, by the help of the software MX Road, design the plan and profile of the road in accordance to the required standards and in accordance to instructions from the Highway Engineer. The plan and profiles will be presented in scale 1:2500 horizontal and 1:250 vertical. The plan / profiles will be taken to the field and verified at site at critical locations to ensure that an optimum design is reached and that all-important existing features have been entered on the drawings. Revisions from the sites will then be incorporated on the drawings.

Longitudinal section levels shall be taken along centre line at every 1m intervals. Cross sections will be prepared at an interval of about 1m along the alignment.

6.11 Grade Separated Structures

The type, location, length, number and the openings required and approach gradients for various grade separated structures shall be as per site requirement. The approach gradient to the grade separated structure shall not be steeper than 2.5 percent (1 in 40). The design shall be in accordance with MORTH Guidelines for Expressway Manual and Relevant IRC Guidelines.

6.11.1 Vehicular Underpass/Overpass

The vehicular under/overpass structures shall be provided at the intersection of the Project Expressway with all the National Highways, State Highways and Major District Roads. Under/over passes shall also be provided across other categories of roads which cannot be terminated and are required to be continued across the Project Expressway. For such intersections where parallel cross roads are located within 2 km distance additional crossings may be provided through a vehicular underpass/overpass. The vehicular underpasses/overpasses shall be so located that no vehicle is required to travel more than 2 km on connecting road for crossing over.

6.11.2 Vehicular Under pass (Grade-II)

The location of VUP (Grade-II) shall be as per site requirement.

6.11.3 ROBs/RUBs

ROB/RUB shall be provided as per MORTH Guidelines for Expressways manual and relevant IRC guidelines for Bridges and IRC:32

6.11.4 Tunnels

Provision of Tunnels shall be as per Section-7 of the Manual (IRC: SP: 99:2013 -Standards for Tunnels).

6.12 Median Openings

Median openings with detachable barrier shall be provided for traffic management for maintenance works and vehicles involved in accidents. Such barriers shall be located at ends of interchanges and rest areas. It is desirable to provide median openings with detachable barriers at about 5 km spacing. Maintenance and emergency crossovers generally should not be located on super elevated curves and closer than 450 m to the end of a speed change taper of a ramp or to any structure.

6.13 Fencing and Boundary Stones

Fencing shall be provided all along the Project Expressway at the ROW boundary. The fencing shall be of type and design given in Section-10 of MORTH guidelines for Expressway Manual. The ROW shall be demarcated by installing Road Boundary Stones at the edges.

6.14 Typical Cross Sections

Typical cross section will be adopted as per MORTH Guidelines for Expressways manual. The proposed TCS are attached as Appendix I.

6.15 Capacity of Expressway

Rural expressways shall be designed for Level of Service-B. For the purpose of design and future augmentation of the Project Expressway, the design service volume for level of service- B for plain/rolling terrain shall be 1300 PCU/hr/lane, as per MORTH Guidelines for Expressways.

6.16 Service Road

Service road shall be designed in accordance with Manual of Specifications and Standards for Four Laning of Highways through Public Private Partnership (IRC SP 84) or Manual of Specifications and Standards for Six Laning of Highways through Public Private Partnership (IRC SP 87) based on site requirements and design Proposal.

6.17 Embankment and Cut Sections

The design and construction of the road in embankment and in cutting shall be carried out in accordance with Section 300 of MORTH Specifications and the requirements, and standards and specifications given in Section 4 of MORTH Guidelines for Expressway Manual.

6.18 Pavement Design

The design of pavement shall take into account all relevant factors for assuring reliable performance, surface characteristics and shall satisfy the specified minimum performance requirements. The guidelines to be followed for the Pavement design are IRC 37, IRC 58, IRC SP 76, AASHP Pavement Design 1993and MORTH guidelines for Expressways manual.

6.18.1 Type of Pavement

The type and crust thickness of Pavement for Main Carriageway and paved shoulders/edge strips will be finalized considering the existing site condition, locally available materials and project viability.

6.18.2 Design of Flexible Pavement

The pavement shall be designed to ensure the specified performance for the projected traffic needs, climate and type of soils in the given area. A design procedure that is appropriate to produce a cost-effective structure meeting the performance requirements and long term durability shall be taken into account. Use of IRC 37 "Tentative Guidelines for the Design of Flexible Pavements" or any internationally accepted design procedure that is based on past performance and research will be used as basis for design. Design life of Flexible Pavement for expressways shall be minimum of 20 years.

6.18.3 Design of Plain Jointed Rigid Pavement

Plain Jointed rigid pavement shall be designed in accordance with the method prescribed in IRC - 58 - 2011 "Guidelines for the Design of Plain Jointed Rigid Pavements for Highways". Design life of Rigid Pavement for expressways shall be minimum of 30 years.

6.18.4 Design of Continuously Reinforced Concrete Pavement

Continuously Reinforced Concrete Pavements (CRCP) shall be designed in accordance with IRC 101 as well as any recognized international guidelines.

6.18.5 Design of Composite Pavements

Composite Pavements are the pavements comprising of flexible layer and rigid layer or cement treated sub-base and/or base. The Composite pavement shall be designed considering inputs like soil property, traffic, etc. and individual layer properties of the pavement. IRC guidelines for flexible pavement (IRC 37), rigid pavements (IRC 58 and IRC SP 76) and other relevant Indian and international standards shall be referred.

6.19 Materials

All materials to be used in works shall be in conformity with the requirements laid down for relevant item in MORTH Specifications. If any material, which is not covered in MORTH Specifications, is used, shall conform to IRC or relevant Indian or International Standards, provisions.

6.20 Drainage Design

The IRC SP 42 will generally be followed for design of highway drainage. The planning of highway and drainage is intricately linked with the terrain, alignment of the highway and the proposed cross drainage works. Improper planning and design of any of the above factors may lead to unsatisfactory performance of the system. Hence planning and designing of adequate drainage system is a primary requirement for maintaining a structural soundness and functional efficiency of a road. Pavement structure including sub-grade must be protected from any ingress of water; otherwise over a period of time it may weaken the sub-grade by saturating it and cause distress in the pavement structure. Hence disposal of water from the pavement and sub-grade is a basic consideration in road design. Over and above quick drainage takes away the water from pavement surface and reduces chances of skidding of vehicles. In order to guard the pavement from the poorly drained conditions, planning, designing, construction and maintenance of longitudinal drains on either side of the roads is very much essential. The surface water from the pavement and shoulders will be made to flow in to the drains by providing suitable cross slopes / Camber. In addition, the proposed drains may have to cater for the runoff from the adjoining lands.

Design procedure:

- After the finalisation of the road alignment including vertical and horizontal alignment, the centreline of the longitudinal drain is fixed keeping a safe distance from the foot of embankment.
- The corridor along the Highway will be divided into suitable zones / sections depending on

the terrain / topography in such a way that between the two ridges / crown points there will be natural valley and vice versa.

- The extent of catchment area between the ridge and valley will be worked out from the surveyed maps or Topo maps.
- The Discharge will be worked based on the catchment area using rational / empherical / Dicken's / Unit Hydrograph formulae. Suitable design factor will be applied as per standard code of practice to arrive at the design discharges.
- The section of the drain will be designed as trapezoidal and lined. Manning's formula will be used for velocity calculations. The bed gradient adopted will achieve velocity on the scouring side to avoid any stagnation of water in the drain.
- The longitudinal drains will drain in to natural streams / channels / rivers etc by providing suitable outfall structures.
- The flood level in the drains will be so fixed that it will be always below the sub-grade of the road for efficient disposal of water even from sub base.

6.21 Traffic Control Devices, Road Safety Devices and Road Side Furniture

Traffic Control Devices, Road Safety Devices and Road Side Furniture shall comprise of road signs, road markings, object markers, hazard markers, studs, delineators, attenuators, safety barriers, boundary fences, boundary stones, kilometre stones, etc. Relevant IRC Guidelines (IRC 2, IRC 8, IRC 35, IRC 67,etc), MORTH Guidelines for Expressways manual and Section 800 of MORTH Specifications shall be followed.

6.22 Traffic Management Systems

Advance Traffic Management Systems (ATMS) shall be provided as per Clause-816 of MORTH Specifications for road and bridge works. ATMS shall have the following sub-systems and shall be provided as per site conditions and design Proposals.

- Emergency Call Boxes
- Mobile Communication System
- Variable Message Signs System
- Meteorological Data System
- Automatic Traffic Counter and Vehicle Classification
- Video Surveillance System
- Video Incident Detection System (VIDS)

6.23 Toll Plazas

Toll plazas shall be provided as per MORTH Guidelines for Expressways manual.

Toll plaza shall be designed for peak hour traffic projected for minimum 25 years. The total number of toll booths and lanes shall be designed to ensure the service time of not more than 10 seconds per vehicle at peak flow. The width of each ETC toll lane shall be 3.5m, for manual/smart card lanes shall be 3.2 meters and for the lane for over dimensional vehicles, it shall be 4.5 m. between each toll lane, traffic islands will be provided so as to accommodate toll booth. These islands shall be of minimum 25 m length and 1.8 m width. Protective barriers of reinforced concrete shall be placed at the front of each island to prevent out of control approaching vehicles crashing into the toll booth. They would be painted with reflective chevron markings. The area of toll plaza covering the flared portion shall be provided with concrete pavement. The toll plaza(s) shall be provided for collection of toll/fee as per the Proposal. The fee collection system shall be electronic toll collection (ETC) system. The design of the Toll Plaza(s) shall be aesthetically pleasing. The fee collection staff should be efficient, courteous and adequately trained before deployment.

6.24 Project Facilities

Project facilities like service areas, Rest areas, Truck lay byes, etc. shall be provided in accordance to the MORTH Guidelines for Expressways manual.

6.25 Design criteria for Structures

6.25.1 Definition of Structures

Interchanges: Interchange is a system of interconnecting raods (ramps and loops) in conjuction with one or more grade separations that provide for the uninterrupted movement of traffic between two or more roads.

Culverts: Cross drainage structures having length ≤ 6 m shall be classified as culverts.

Major and minor bridges: Bridges having length upto 60m shall be classified as minor bridges and bridges having length greater than 60m shall be classified as major bridges.

ROBs: Structure provided over the railway lines to carry the Project Highway.

RUBs: Structure provided below the railway lines to carry the Project Highway.

Vehicular Underpass(VUP): Grade separated structure which is provided for crossing of vehicles under the Project Highway

Vehicular Overpass(VOP): Grade separated structure which is provided for crossing of vehicles over the Project Highway

Viaducts: Structures carrying the project road over land and spanning across the valleys are termed as viaducts.

6.25.2 Design Standards-Structures

T The design shall cover all aspects of preliminary design pertaining to various parts of bridges / grade separators / ROBs, foundations, protective works etc. The design shall generally be based on relevant IRC codes of practice, MoRTH circulars. However, where the IRC codes are not applicable or silent, appropriate BIS or other international Codes of Practice, such as, British / American / Australian Codes based on sound engineering practice shall be used.

This section below outlines the standards to be adopted for the design of the structures t which include Flyovers and Interchanges, Culverts, Major Bridges, & CUPs.

The IRC codes/Standards/Act, MoRTH Publications, IS & BIS codes shall be followed in the project. Design of all proposed structures shall be done in accordance with the provisions of the following IRC Codes:

List of IRC Codes

IRC: 5 - 2015	-	Section I- General Features of Design (Eighth Revision)
IRC: 6 - 2017	-	Section II- Loads and Stresses
IRC: 22 - 2015	-	Section IV-Composite construction for Road Bridges (Second Revision)
IRC: 24 - 2010	-	Section V-Steel Road Bridges (Second Revision)
IRC: 78 - 2014	-	Section VII- Foundations and Substructure (Second Revision)
IRC:83(Part-II) - 2015	-	Section IX- Bearings, Part II: Elastomeric Bearings
IRC: 83(Part-III) - 2002	-	Section IX-Bearings, Part III: POT, POT- CUM-PTFE, Pin and Metallic Guide Bearings
IRC: 87 - 2011	-	Guidelines for the Design and Erection of False work for Road Bridges
IRC: 89 - 1997	-	Guidelines for Design and Construction of River Training and Control Works for Road Bridges (First Revision)
IRC:112 - 2014	-	Code of Practice for Concrete Road Bridges
IRC: SP13 - 2004	-	Guidelines for Design of Small Bridges and Culverts
IRC: SP:40 - 1993	-	Techniques for strengthening & rehabilitation of bridges.
IRC: SP:64 - 2005	-	Guidelines for the Analysis and Design of Cast-in-Place Voided Slab Superstructure
IRC: SP:66 - 2005	-	Guidelines for Design of Continuous Bridges
IRC: SP:69 - 2005	-	Guidelines & Specifications for Expansion Joints
IRC: SP:70 – 2005	-	Guidelines for the Use of High Performance Concrete in Bridges.
IS:14593-1995		Design and Construction of Bored cast in situ Piles founded on Rocks.
IS:13620-1993		Fusion bonded epoxy coated reinforcement.
IS: 2062-2011		Hot rolled medium and high tensile structural steel specifications.
IS:14268-1995		Uncoated stress relieved low relaxation seven Ply strand for pre stressed concrete specifications.
IS-2911-2010		For Pile foundations
		MoRTH Specifications for Road and Bridges Works, 2001 (Fourth Revision) MoRTH Circular No. RW/NH-34059/1/96-S&R dated30.11.2000 regarding expansion joints. IS 13620 regarding coating of reinforcement bars
		Ministry of Road Transport and Highways Circular no.RW/NH/34041/44/91-S&R dated 21.3.2000 regarding coating of reinforcement bars in marine environment.

6.25.3 Special Design Requirements

The complete structure shall be designed to be safe against collapse and to maintain at all times an acceptable serviceability level. These shall be also designed to be durable to withstand the deteriorating effects of climate and environment.

All new bridges shall have independent superstructures for each direction of travel. Choice of single or independent structure for culverts shall be decided based site condition. Width of median in structural portion will be maintained same as that in the approaches.

In cases where median is kept open to sky, suitable provision will be made for retaining the earth likely to spill from median portion of immediate embankment.

All new bridges will be provided for carriageway width as per MORTH Guidelines for Expressway Manual.

Bridge superstructure may be reinforced concrete, pre-stressed concrete or steel-concrete composite construction. Similarly, the substructure and foundations may also be concrete, steel or steel-concrete composite construction.

Bearing of new bridges shall be easily accessible for inspection and maintenance.

Reinforced Earth/R.C.C Retaining wall type shall be provided for high fill/embankment with aesthetically pleasing appearance. Design life of reinforcing elements for earth retaining structures shall be 100 years minimum. Structure with viaduct shall be provided for ensuring unhindered local cross movement of pedestrians and local vehicular traffic.

6.25.4 Design Basis

The design would be carried out using the limit state design philosophy satisfying the requirements of IRC-112 2014. The structure would be designed to meet both the ultimate and serviceability requirements of the code.

Ultimate limit state: This cover static equilibrium and failure of structural element or structure as a whole when acted upon by ultimate design load.

Serviceability limit state: This deals with the condition of structure subjected to serviceability design loads. These conditions include level of internal stress, fatigue failure, deflection, cracking and discomfort by vibrations.

Load Combination shall be adopted as per table B.1 to B.4 of Annex-B of IRC: 6-2017 as given below:-

- Table B.1 for Verification of Equilibrium.
- Table B.2 for Verification of Structural Strength
- Table B.3 for Verification of Serviceability
- Table B.4 for Base Pressure and Design of Foundation

At present the combination of loads shown in Table B.4 shall be used for structural design of foundation only. For checking the base pressure under foundation, load combination given in IRC: 78-2014 shall be used. Table B.4 shall be used for checking of base pressure under foundation only when relevant material safety factor and resistance factor are introduced in IRC: 78-2014.

S. No.	Design Figure	Standard
1	**Service life(Years)** Foundations 100 Piers 100 Deck 100 Bearings 40 Expansion Joints 20 Parapets(Metals) 100 Parapets(Concrete) 20	
	Exposure Condition: As the general environment condition is Moderate	
2	Minimum clear cover to reinforcement is given below. According to Exposure condition clear cover is provided for structural components as per IRC: 112-2014.	

S. No.	Design Figure		Standard
	i	Superstructures	40mm
	ii	Crash Barrier	50mm
	iii	Substructures	50mm
	iv	Pre-stressing cable duct	75/90mm
	v	Pre-cast elements	45mm
	vi	Foundations	75mm
	vii	Earth Face of Abutment, return wall, retaining wall, box side wall	75mm
	viii	Non Earth Face	50mm
3	**Grade of Steel**		
	i	HYSD bars	Fe500D (Section 1600 of Specifications: High yield strength deformed bars Fe500 conforming to IS: 1786)
	ii	Structural Steel	Fe490(IS 2062)
4	**Grade of Concrete**		
	i	Pre stressed Concrete Girder and Box Girder	M45
	ii	RCC Deck slab over PSC Girder	M45
	iii	RCC Box type structure-MNB	M35
	iv	Pier and Pier Cap	M35
	v	Bearing Pedestal	M40
	vi	RCC Abutment, Abutment cap, Return Wall, Dirt wall.	M35
	vii	Open foundation, Pile and Pile cap	M35
	viii	Crash Barrier	M40
	ix	Approach slab	M30
	x	Box Culverts	M30
	xi	Leveling course	M10/M15
	xii	Head Wall	M20
5	**Dead load-(unit wt.)**		
	i	Pre-stressed Concrete	2.5 T/m^3
	ii	Reinforced Concrete (RCC)	2.5 T/m^3
	iii	Plain Cement Concrete (PCC)	2.5 T/m^3
	iv	Steel	7.854 T/m^3
	v	Wearing Coat	2.2 T/m^3
6	**Live Load**		
	i	Footpath	400 Kg/m^2 (Rural area)
			500 Kg/m^2(Urban area)
	ii	c/w 5.3m to 9.6m	One lane of class 70R or Two lane of Class A
	iii	c/w 9.6m to 13.1 m	One lane of class 70R for every two lanes with one lane of class A on the remaining lane or 3 lanes of class A

S. No.	Design Figure		Standard
7	**Impact factor**		
	Concrete Bridges		
	i	for Class A	4.5/(6+L)
	ii	for Class 70 RT and 70RW	**Upto-9m** For Tracked-25% for span up to 5m and linear reducing to 10% for span up to 9m. For Wheeled-25% for span up to 9m **More than 9 m-** For Tracked-10% for span between 9m to 40m.As per curve for span more than 40m. For wheeled-25% for span up to 12m and as per curve for span more than 12m
	Steel Bridges		
	i	for Class A	9/(13.5+L)
	ii	for Class 70 RT & Class 70 R W	**Up to -9m** For Tracked-25% for span up to 5m and linear reducing to 10% for span up to 9m. For wheeled-25% for span up to 9m **More than 9m-** For Tracked-10% for all spans. For wheeled-25% for span up to 23m and as per curve for span more than 23m.
8	**Wind Load**		
	i	As per basic wind speed and Type of the structure (IRC:6-2017,clause 209).	
9	**Horizontal Forces due to water current**		
	i	Case-I	Parallel to pier
	ii	Case-II	At inclination of (20±θ) to the pier
10	**Longitudinal forces**		
	i	Case-I	In case of single lane and two lane 20% of first train load plus 10% of load of succeeding train or part thereof
	ii	Case-II	In case of bridges with more than two lane braking force for two lane plus 5 % of the loads on the lanes in excess of two

S. No.	Design Figure		Standard
11	**Buoyancy**		
	i	100 % buoyancy for stability check	
	ii	15 % buoyancy for design	
12	**Temperature (as per IRC:6-2017 clause 215)**		
	For bridge having difference between max and min air shade temperature-		
	>20 degree C	Mean of Maximum and Minimum air shade temperature +,- 10˚C whichever is critical	
	<20 degree C	Mean of Maximum and Minimum air shade temperature +,- 5˚C whichever is critical	
	The nonlinear temperature gradient for design of superstructure shall be considered as per clause 215.3 of IRC: 6-2017.		
13	**Seismic force (as per IRC:6-2017, clause 219)**		
	i	Zone-III	Bridges in Seismic Zone- III need not to be designed for seismic forces if span in less than 15.0m and total length of bridge is less than 60.0m. For all other cases seismic forces shall be considered as per Clause 219 of IRC 6-2017
14	**Expansion Joints**		
	i	Filler type	For span up to 10m(Section 2600 of the specification)
	ii	Strip Seal Type	For Span >10m and movement up to ±80(Section 2600 of specification)
	iii	Modular Type	movement more than ±80(Section 2600 of specification)
15	**Bearing**		
	i	Tar paper	Solid slab up to 10m
	ii	Elastomeric	As per design requirements
	iii	Pot cum PTFE	As per design requirements
	iv	Pin and Guided Bearing	As per design requirements
16	**Wearing Coat**		50 mm thick
17	**Pre stressing (**IS: 14268, section 1800 of Specifications: Uncoated stress relieved low relaxation steel) Type of Strand-Stress relieved multiply strands of low relaxation Ultimate Stress in Cable - 1861 MPa Maximum pre stress jacking force-0.783(90% of 0.1% of proof load) 1) The maximum force applied to a tendon at active end during		

S. No.	Design Figure	Standard
	tensioning, shall not exceed 90% of 0.1% proof stress 2) The analysis of pre stressed section would be as per the stress strain properties given in clause 6.3.5 of IRC-112. 3) Maximum pre stressing force applied to structure immediately after transfer shall not be greater than 75% of characteristic tensile strength of pre stressing steel or 0.85 of 0.1% of proof load whichever less is. 4)For serviceability limit state the section would be checked for 10% higher and 10% lower values of pre stressing force as per IRC -112	
18	**Sheathing**	HDPE
19	**Shrinkage** Total shrinkage is drying shrinkage and auto-generous shrinkage	
20	**Creep** Creep to be calculated as per IRC112	
21	**Coefficient of thermal Expansion-**$12x10^{-6}$/degree C	
22	**Modulus of Elasticity-**Modulus of Elasticity to be calculated as per short term and long term creep and shrinkage	
23	**Minimum Bar Diameter**	10 mm (refer Table 15.1,IRC112)
	Diameter if any reinforcing bar including transverse ties, stirrups etc. shall not be less than 10 mm. Diameter of any longitudinal reinforcement bars in columns/ vertical member shall not be less than 12 mm. However diameter of the reinforcing bars shall not exceed 25 mm in slabs and 32 mm in other member.	
20	**Margin in Material (FOS)**	
	All critical sections shall be checked for stresses under various load combinations. A suitable margin (preferably 5%) shall be there between maximum stress and allowable stress in concrete as well as reinforcement in the final design.	

6.25.5 Design Load and Stresses

design loads shall be as per IRC: 6-2017, appropriate for the proposed carriageway width, type and properties of stream, location, altitude, etc.

Dead Load (DL)

The dead load i.e. the self-weight of the superstructure, substructure and foundations, backfill will be considered as per the Cl. 203 of IRC: 6 -2017 and are summarized as below:

Wet concrete including reinforcement - 2.6 t/m^3 (IRC: 87 – 2011)
Concrete (Cement Reinforced) - 2.5 t/m^3
Concrete (Cement Prestressed) - 2.5 t/m^3
Concrete (Asphalt) - 2.2 t/m^3
Earth (Compacted) - 2.0 t/m^3
Concrete (Cement - plain with plum) - 2.5 t/m^3

Superimposed Dead Load (SIDL)

SIDL comprises of the following items

Crash barrier without Hand Rail – 0.8 t/m
Crash barrier with Hand Rail – 1.0 t/m
Wearing Course – 0.246 t/m^2

Railing – 0.6 t/m
Footpath Load

Crash barrier is adopted as per IRC: 5-2015.

Live Load Combinations

Live load combinations mentioned in IRC: 6-2017 Table-6 shall be followed as per relevant carriageway width.

In general for Bridges and Flyovers following combinations shall be used for typical 4 lane

i) Class A 4-Lane Loading
ii) 1 Lane of 70R + 2 Lane of Class A Loading
iii) 2 Lane of 70R

Minimum clear distance between the two vehicles shall be 1.2m.

The loads which are not mentioned in this clause shall be as per IRC: 6-2017.

Where ever footpath is provided in the bridge Footpath live load is taken and bridge is also designed for without footpath case.

Reduction in the longitudinal effect on bridges having more than two traffic lanes due to the low probability that all lanes will be subjected to the characteristic loads simultaneously shall be in accordance with the Table shown below:

Number of lanes	Reduction in longitudinal effect
For two lanes	No reduction
For three lanes	10% reduction
For four lanes	20% reduction
For five or more lanes	20% reduction

Notes:

1) However, it should be ensured that the reduced longitudinal effects are not less severe than the longitudinal effect, resulting from simultaneous loads on two adjacent lanes. Longitudinal effects mentioned above are bending moment, shear force and torsion in longitudinal direction.

2) The above Table is applicable for individually supported superstructure of multi-laned carriageway. In the case of separate sub-structure and foundations, the number of lanes supported by each of them is to be considered while working out the reduction percentage. In the case of combined sub-structure and foundations, the total number of lanes for both

Special vehicle loading

Structure need to be checked for special vehicle also. The total load of special vehicle is the load is considered to act at 300mm from center of carriageway. No other load is considered to moving on structure when special vehicle is moving.

Congestion Factor

For bridges, flyovers/grade separators close to areas such as ports, heavy industries and mines and any other areas where frequent congestion of heavy vehicles may occur, additional check for congestion of vehicular live load on the carriageway shall be considered. In the absence of any stipulated value, the congestion factor, as mentioned in Table 7 of IRC 6-2017 shall be considered. This factor shall be used as a multiplying factor on the global effect of vehicular live load only.

Under this condition, horizontal force due to braking/acceleration, centrifugal action and temperature gradient effect need not be included, but the effect of live load impact shall be included.

Longitudinal forces

In all road bridges, provision shall be made for longitudinal forces arising from anyone or more of the following causes:

a) Tractive effort caused through acceleration of the driving wheels;
b) Braking effect resulting from the application of the brakes to braked wheels.
c) Frictional resistance offered to the movement of free bearings due to change of temperature or any other cause. The braking effect on a simply supported span or a continuous unit of spans or on any other type of bridge unit shall be assumed to have the following value:

a) In the case of a single lane or a two lane bridge: twenty percent of the first train load plus ten percent of the load of the succeeding trains or part thereof, the train loads in one lane only being considered. Where the entire first train is not on the full span, the braking force shall be taken as equal to twenty percent of the loads actually on the span or continuous unit of spans.

b) In the case of bridges having more than two-lanes: as in (a) above for the first two lanes plus five per cent of the loads on the lanes in excess of two.

Construction Live Load

Construction load wherever applicable may be considered as 0.36 t/m^2 of the form area to be considered as per IRC 87-2011.This load include load due to mobile construction plant or equipment and temporary loads.

A minimum dynamic amplification of 50% of the loads during normal lifting operations to be assumed. When Pre cast segmental construction is done consequence to stability to the structure to be determine due to sudden loss of segment. Dynamic amplification of 100% to be considered.

Differential Settlement

If the riding quality permits, clause 706.3.2.1 of IRC: 78-2014 specify that the calculated differential settlement between the foundations of simply supported span shall not exceed L / 400 of the distance between the foundations, where L is distance between two foundations. In case of structure sensitive to differential settlement such as continuous structures the value of differential settlement shall be taken as 10mm.

Temperature Gradient

Effective bridge temperature shall be estimated from the isotherms of shade air temperature given in fig 15 and fig 16 of IRC: 6-2017. Difference in temperature between the top surface and other levels through the depth of the structure, where ever applicable shall be taken in accordance with clause :215.3 of IRC:6-2017.

Centrifugal Forces

Centrifugal forces are considered for spans in curved portion as per IRC 6-2017 Centrifugal forces shall be determined from following formula:

$C= WV^2/127R$
Where,
C =Centrifugal force acting normal to the traffic. W = Live load (tons/m)
V= Design speed of vehicles (Km/ hour)
R = Radius of curvature (m)
It is considered to be acting at 1.2m above deck level**.**

Earth Pressure

1. All earth retaining structures like Abutment and Other Earth Retaining Structures designed to retain earth fills shall be proportioned to withstand pressure calculated in accordance with any rational theory. Coulomb's theory, subject to the modification that the center of pressure exerted by the backfill, when considered dry, is located at an elevation of 0.42 of the height of the wall above the base instead of 0.33 of that height.

2. For RCC Box Structure-Active Earth pressure / Earth pressure at rest will be considered to be acting on the vertical walls of the RCC Box. The Co-efficient of such Earth pressure will be taken as 0.5.

3. Surcharge Pressure-All Earth retaining wall are designed for a live load surcharge pressure equivalent to 1.2 m earth fill as per IRC 6-2017.

Wind forces

1. The superstructure shall be designed for wind induced horizontal forces (acting in the transverse and longitudinal direction) and vertical loads acting simultaneously. The assumed wind direction shall be perpendicular to longitudinal axis for a straight structure or to an axis chosen to maximize the wind induced effects for a structure curved in plan.

2. The substructure shall be designed for wind induced loads transmitted to it from the Super structure and wind loads acting directly on the substructure. Loads for wind directions both normal and skewed to the longitudinal center line of the superstructure shall be considered.

3. The longitudinal force on bridge superstructure (in N) shall be taken as 25% and 50% of the transverse wind load as calculated as per Clause 209 for beam/box/ plate girder bridges and truss girder bridges respectively.

Water Current Forces

Any part of a road bridge which may be submerged in running water shall be designed to sustain safely the horizontal pressure due to the force of the current.

On piers parallel to the direction of the water current, the intensity of pressure shall be calculated from the following equation:

P = 52K\/
Where,
P = intensity of pressure due to water current, in kg/m^
V = the velocity of the current at the point where the pressure intensity is being calculated, in metre per second, and
K = a constant having the following values for different shapes of piers illustrated in Fig.11

i) Square ended piers (and for the superstructure)	1.50
ii) Circular piers or piers with semi-circular ends	0.66
iii) Piers with triangular cut and ease waters, the angle included between the faces being 30° or less	0.50
iv) Piers with triangular cut and ease waters, the angle included between the faces being more than 30° but less than 60°	0.50 to 0.70
v) -do- 60 to 90°	0.70 to 0.90
vi) Piers with cut and ease waters of equilateral arcs of circles	0.45
vii) Piers with arcs of the cut and ease waters intersecting at 90°	0.50

Buoyancy

1. In the design of abutments, especially those of submersible bridges, the effects of buoyancy shall also be considered assuming that the fill behind the abutments has been removed by scour.

2. To allow for full buoyancy, a reduction shall be made in the gross weight of the member affected by reducing its density by the density of the displaced water.

   The density of water may be taken as 1 .0 t/m^2.
   For artesian condition, HFL or actual water head, whichever is higher, shall be considered for calculating the uplift.

3. In the design of submerged masonry or concrete structures, the buoyancy effect through pore pressure may be limited to 15% of full buoyancy. 213.4 In case of submersible bridges, the full buoyancy effect on the superstructure shall be taken into consideration.

Seismic Forces

The project corridor falls under seismic zone-III which is Moderate seismic zone. Seismic design is carried out as per zone and as per codal provisions along with provision of ductile detailing and seismic arrestor Block.
All bridges supported on piers, pier bents and arches, directly or through bearings, and not exempted below in the category (a) and (b), are to be designed for horizontal and Vertical forces as given in the following clauses.

The following types of bridges need not be checked for seismic effects:

a) Culverts and minor bridges up to 10 m span in all seismic zones.

b) Bridges in seismic zones II and III satisfying both limits of total length not exceeding 60 m and spans not exceeding 15 m

6.25.6 Culverts

As per Manual the culverts with vertical clearance 2m can be used by cattle and pedestrians during dry season.

6.26 Hydrology and Flood Control

The following Indian Standards have been considered:

- Design flood events based on the 100-year flood level, except in case that only agricultural areas are at stake, it will be reduced to the 25-year event;
- Calculations for the 100-year flood level based on the 100-year flood discharge, calculated using the log-Pearson III equation;
- The minimum width to be left between the river bank and the embankment will be based on Lacey's wetted perimeter.The riverbank will be the farthest envelope visible on SOI maps or Satellie imagry.
- Design if drainage of areas outside the Expressway embankment will require an agreement on a combination of rainfall intensity and its duration.The design discharge will be worked out by synthetic unit hydrograph method. The HFL will be taken based on local inquiry.

The relevant publications and Indian Standards are given below:

Designation	Issued by	Date of issue
River behaviour Management and Training (vol I & II)	Central Board of Irrigation & Power	1994
IS 12094 : 2000- Guidelines for planning and design of river embankments	B.I.S	2000
IS 12169 : 1997- Criteria for design of small embankment dam up to 15 m height	B.I.S	1997
Embankment Manual, Investigation, Design, Construction and Maintenance	Central Board of Irrigation & Power	
IS 11532 : 1985- Guidelines for construction of river embankments	B.I.S	1985
SP13 : Guidelines for the design of	IRC	2004

small bridges and culverts		
SP42 : Guidelines on road drainage	IRC	2014

Regarding Slope Protection Measure and River Training & Flood Protection Works, Schedule D of Concession Agreement stipulates that:

Side Slopes

IRC: 36-2010 recommends the following side slopes for highway embankments, purely from the safety point of view.

- 1V: 4H up to 1.5m heights
- 1V: 3H from 1.5m to 3m heights

The foregoing slopes require an appreciable width of land. It is therefore felt that the side slopes of 1V:2H and 1V:1.5H is enough for embankments with Turfed and Stone pitched respectively.

Slope Protection Measure

Side Slope of embankments affected by flood shall be protected with pitching on over granular filter. The Pitching shall be extended upto 0.5m above the HFL. All other locations side slopes shall be protecting by seeding & mulching as per specification clause 308 of specification of road & bridge works (MoRT&H) in consultation with the NHAI/ Independent Engineer.

River Training & Flood Protection Works

The proposed protective measures are to be designed in accordance with the requirement of IRC: 89-1998.

It is proposed to provide stone pitching of suitable thickness all around the abutments and in the front portion of abutment with suitable thickness, which will be extended up to 1.5m above HFL.

In order to prevent Expressway embankment erosion during high flood, bank protection works shall be provided as required.

For River Training works, if required, for protection of Embankment, detailed hydrological investigation will be carried out and necessary protection works if required will be provided, based on study report.

Flood protection measures shall be provided as follows:

a) Installation of Sluice gates for culverts/pedestrian boxes, cattle crossings or other structures getting affected by flood
b) Construction of Leeves (Bunds), up to HFL, along both the banks of streams/rivers joining to contain back flow during Flood.
c) Raising the invert of the vehicular and pedestrian underpasses above design HFL or providing an auxiliary bund downstream.

7. PRELIMINARY DESIGNS

7.1 TYPICAL CROSS SECTIONS

Based on traffic considerations, geometric standards and existing site condition, the following parameters for cross sections have been proposed for different sections of the project road.

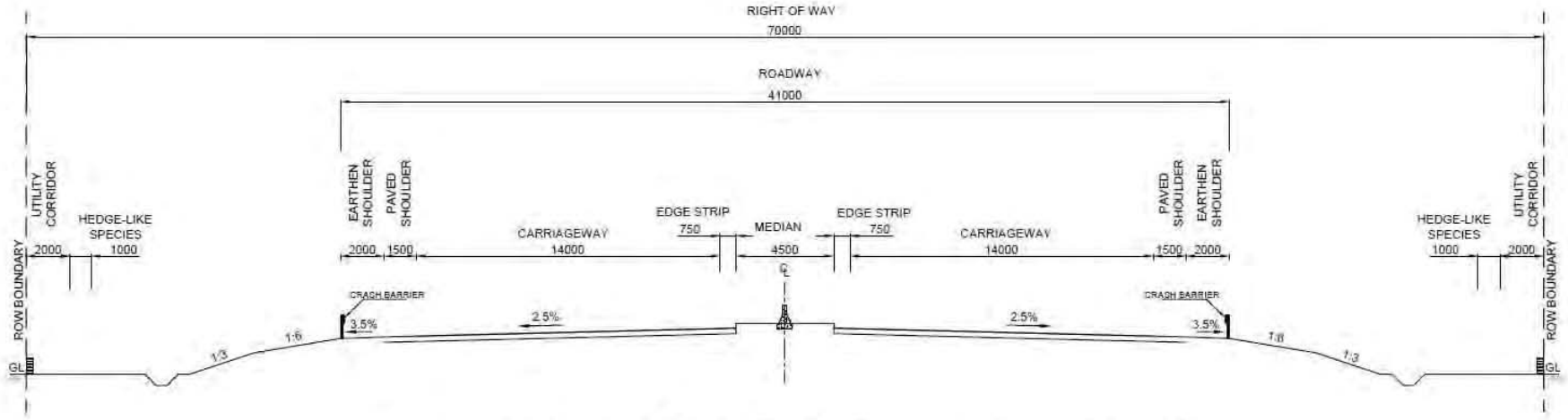
Table 7-1: Details of Proposed Cross Section

Element	Width (m)	Total Width (m)
Type 1 - Dual 4-lane (8 - Lane Divided) Carriageway in Plain or Rolling Terrain with Flush median Cross Section		
Main Carriageway	2 X 14.00	28
Median including shyness	1 X 6.00	6
Paved shoulder	2 X 1.50	3
Earthen Shoulders	2 X 2.00	4
Hedge Like Species	2 X 1.00	2
Utility Corridor	2 X 2.00	4
Space left for future expansion and others	2 X 11.50	23
Total		**70**
Type 2 - Dual 4-lane (8 - Lane Divided) Carriageway in Plain or Rolling Terrain with Flush median Cross Section		
Main Carriageway	2 X 14.00	28
Median including shyness	1 X 6.00	6
Paved shoulder	2 X 1.50	3
Lined Drain	2 X 2.00	4
Shy-Off between Lined Drain and Service Road	2 X 0.50	1
Service Road	2 X 9.00	18
Earthen Shoulders	2 X 1.50	3
Utility Corridor	2 X 2.00	4
Space left for future expansion and others	2 X 1.50	3
Total		**70**
Type 3 - Dual 4-lane (8 - Lane Divided) Flyover/VUP/LVUP Approach with Slip Roads		
Main Carriageway	2 X 21.250	42.5
Median	1 X 4.50	4.5
Divider between Slip Road and Main Carriageway	2 X 0.50	1
Slip Road	2 X 7.50	15
Drain	2 X 1.50	3
Utility Corridor	2 X 2.00	4
Total		**70**
Type 3A - Dual 4-lane (8 - Lane Divided) Flyover/VUP/LVUP Approach		

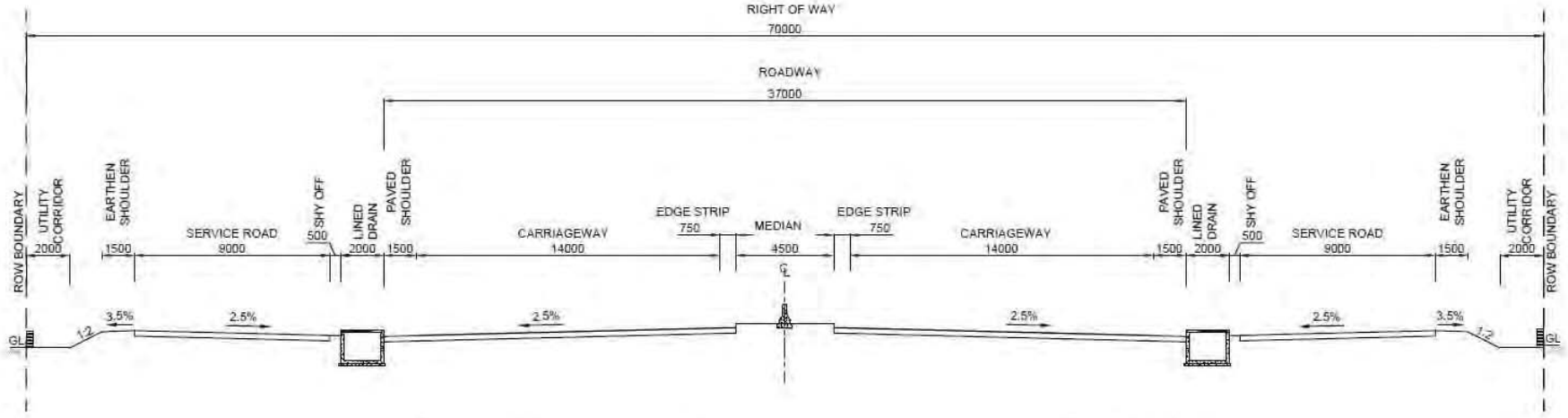
Element	Width (m)	Total Width (m)
Main Carriageway	2 X 21.250	42.5
Median	1 X 4.50	4.5
Varies	2 X 11.50	23
Total		**70**
Type 4 - Dual 4-lane (8 - Lane Divided) Carriageway in Plain or Rolling Terrain without Service Road		
Main Carriageway	2 X 14.00	28
Median including shyness	1 X 6.00	6
Paved shoulder	2 X 1.50	3
Earthen Shoulders	2 X 2.00	4
Utility Corridor	2 X 2.00	4
Hedge Like Species	2 X 1.00	2
Varies	2 X 9.50	19
Space left for future Widening	2 X 12.00	24
Total		**90**
Type 5 - Dual 4-lane (8 - Lane Divided) Carriageway in Plain or Rolling Terrain with Service Road		
Main Carriageway	2 X 14.00	28
Median including shyness	1 X 6.00	6
Paved shoulder	2 X 1.50	3
Earthen Shoulders	2 X 2.00	4
Service Road	2 X 9.00	18
Earthen Shoulders between Service Road	2 X 2.00	4
Varies	2 X 1.50	3
Utility Corridor	2 X 2.00	4
Total		**70**
Type 3 - Dual 4-lane (8 - Lane Divided) Flyover/VUP/LVUP Approach with Slip Roads		
Main Carriageway	2 X 21.250	42.5
Median	1 X 4.50	4.5
Separator between Slip Road and Main Carriageway	2 X 4.00	8
Slip Road	2 X 9.00	18
Earthen Shoulder	2 X 1.00	2
Earthen Drain & Varies	2 X 5.50	11
Utility Corridor	2 X 2.00	4
Total		**90**
Type 6A - Dual 4-lane (8 - Lane Divided) Flyover/VUP/LVUP Approach		
Main Carriageway	2 X 21.250	42.5
Median	1 X 4.50	4.5

Element	Width (m)	Total Width (m)
Varies	2 X 11.50	43
Total		**90**
Type -7 - 4-lane Divided Carriageway with Paved Shoulders for Realignment/Bypass in Rural Area		
Main Carriageway	2 X 7.00	14
Median including shyness	1 X 5.00	5
Paved shoulder	2 X 1.50	3
Earthen Shoulders	2 X 2.00	4
Space for Services	2 X 2.00	4
Space left for Future Widening and Earthen Drain	2 X 15.00	30
Total		**60**
Type -7A - 4-lane Divided Carriageway with Paved Shoulders for Concentric Widening in Rural Area		
Main Carriageway	2 X 7.00	14
Median including shyness	1 X 5.00	5
Paved shoulder	2 X 1.50	3
Earthen Shoulders	2 X 2.00	4
Space for Services	2 X 2.00	4
Space left for Future Widening and Earthen Drain	2 X 15.00	30
Total		**60**
Type -7B - 4-lane Divided Carriageway with Paved Shoulders for Eccentric Widening in Rural Area		
Main Carriageway	2 X 7.00	14
Median including shyness	1 X 5.00	5
Paved shoulder	2 X 1.50	3
Earthen Shoulders	2 X 2.00	4
Space for Services	2 X 2.00	4
Space left for Future Widening and Earthen Drain	2 X 15.00	30
Total		**60**
Type -8 - 4-lane Divided Carriageway with Lined Drain for Concentric Widening in Built - Up Area		
Main Carriageway	2 X 7.00	14
Median including shyness	1 X 2.50	2.5
Paved shoulder	2 X 2.00	4
Earthen Shoulders	2 X 2.00	4
Earthen Shoulders on service road	2 X 1.50	3
Drain/Future Widening	2 X 5.25	10.5
Service Road	2 X 7.50	15
Drain	2 X 1.50	3

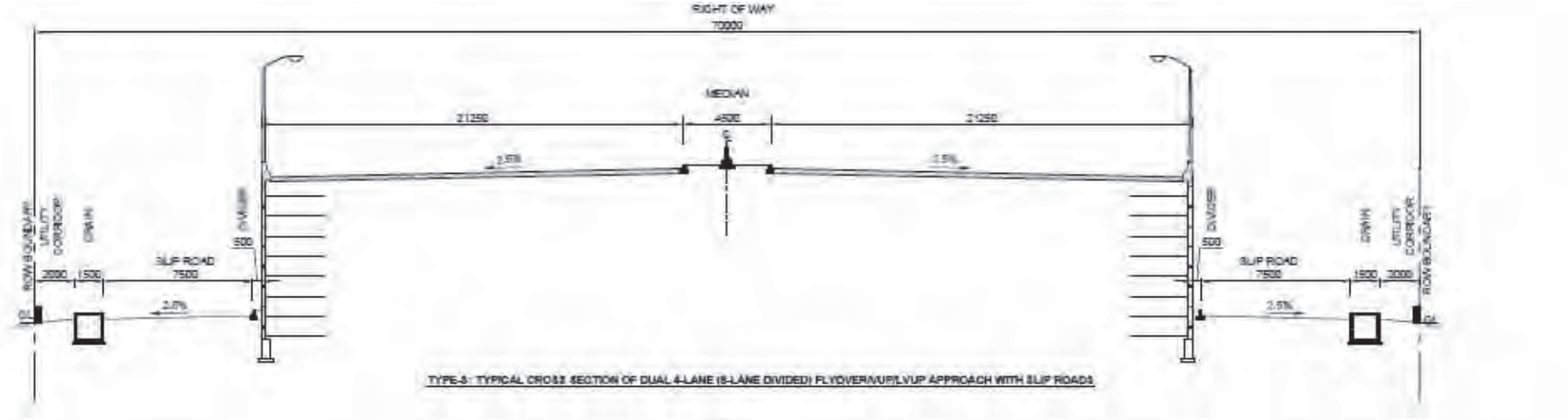
Element	Width (m)	Total Width (m)
Space for Services	2 X 2.00	4
Total		**60**
Type -8A - 4-lane Divided Carriageway with Lined Drain for Eccentric Widening in Built - Up Area		
Main Carriageway	2 X 7.00	14
Median including shyness	1 X 2.50	2.5
Paved shoulder	2 X 2.00	4
Earthen Shoulders	2 X 2.00	4
Earthen Shoulders on service road	2 X 1.50	3
Drain/Future Widening	2 X 5.25	10.5
Service Road	2 X 7.50	15
Drain	2 X 1.50	3
Space for Services	2 X 2.00	4
Total		**60**
Type -9 - 6-lane Carriageway in Plain or Rolling Terrain without Service Road		
Main Carriageway	2 X 10.50	21
Median including Edge Strip	1 X 6.00	6
Paved Shoulder	2 X 1.50	3
Earthen Shoulder	2 X 2.00	4
Space for Future Widening	2 X 16.00	32
Hedge Like Species	2 X 1.00	2
Varies	2 X 9.00	18
Utility corridor	2 X2.00	4
Total		**90**
Type -9A - 6-lane Divided Carriageway in Plain or Rolling Terrain withService Road on Both Side		
Main Carriageway	2 X 10.50	21
Median including Edge Strip	1 X 6.00	6
Paved Shoulder	2 X 1.50	3
Earthen Shoulder	2 X 2.00	4
Space for Future Widening	2 X 4.50	9
Earthen Shoulder between Service Road	2 X 2.00	4
Service Road	2 X 9.00	18
Earthen Drain & Varies	2 X 10.50	21
Utility corridor	2 X2.00	4
Total		**90**



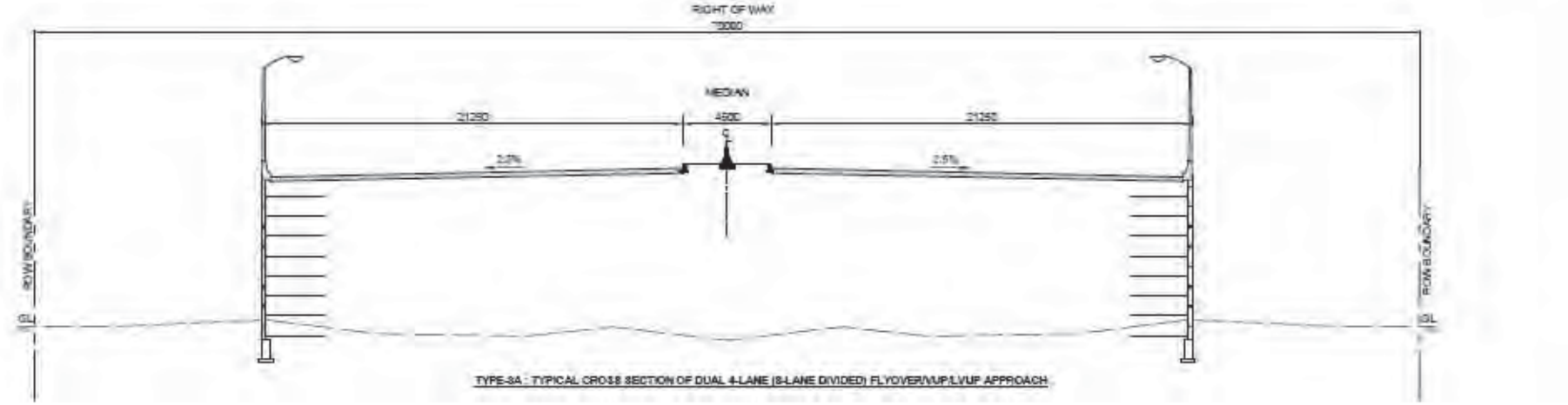
TYPE-1 : TYPICAL CROSS SECTION OF DUAL 4-LANE (8-LANE DIVIDED) CARRIAGEWAY IN PLAIN OR ROLLING TERRAIN WITH FLUSH MEDIAN



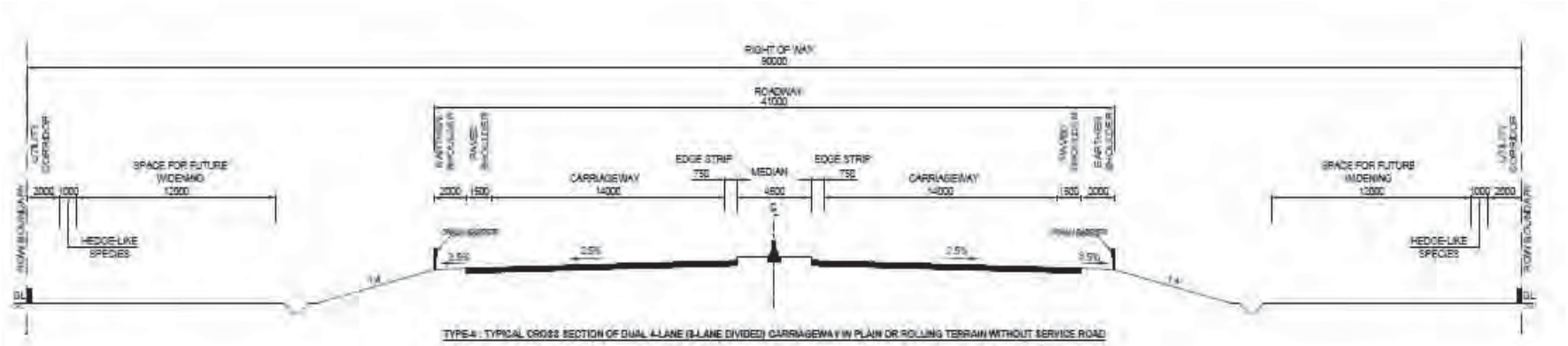
TYPE-2 : TYPICAL CROSS SECTION OF DUAL 4-LANE (8-LANE DIVIDED) CARRIAGEWAY IN PLAIN OR ROLLING TERRAIN WITH FLUSH MEDIAN



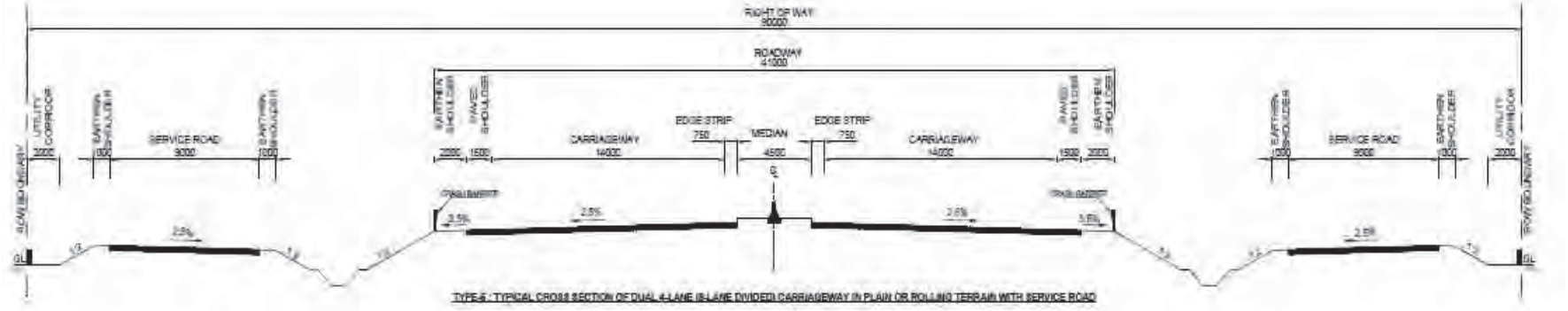
TYPE-3 : TYPICAL CROSS SECTION OF DUAL 4-LANE (8-LANE DIVIDED) FLYOVER/VUP/LVUP APPROACH WITH SLIP ROADS



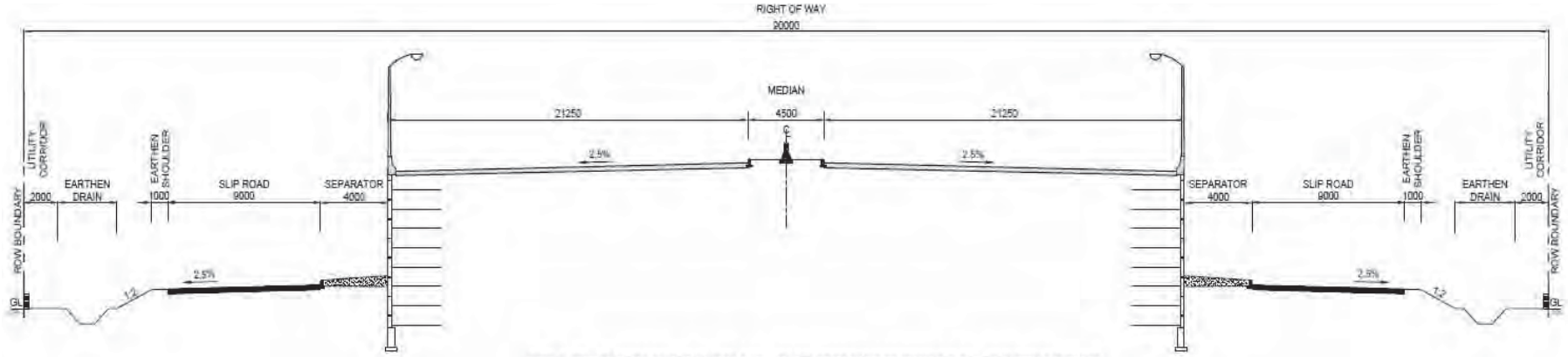
TYPE-3A : TYPICAL CROSS SECTION OF DUAL 4-LANE (8-LANE DIVIDED) FLYOVER/VUP/LVUP APPROACH



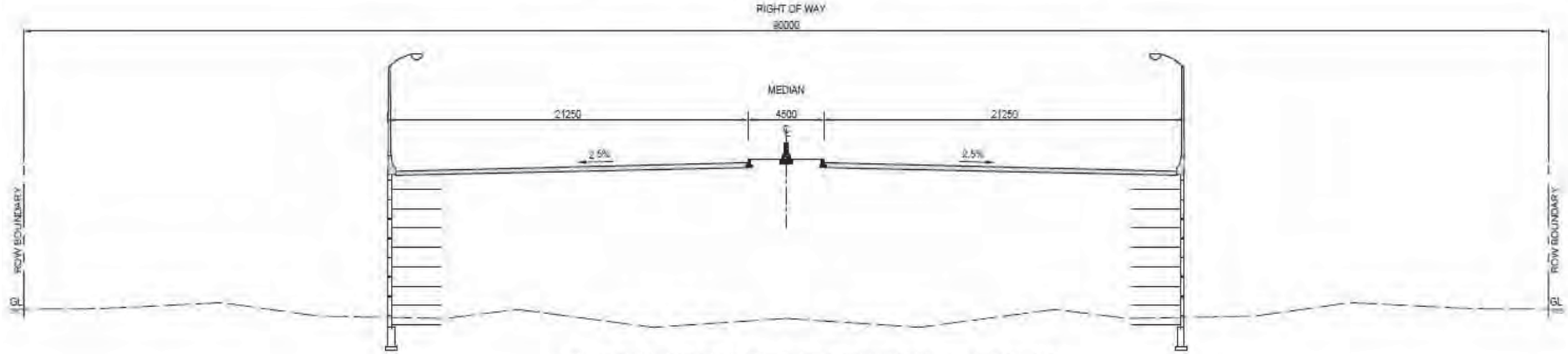
TYPE-4 : TYPICAL CROSS SECTION OF DUAL 4-LANE (2-LANE DIVIDED) CARRIAGEWAY IN PLAIN OR ROLLING TERRAIN WITHOUT SERVICE ROAD



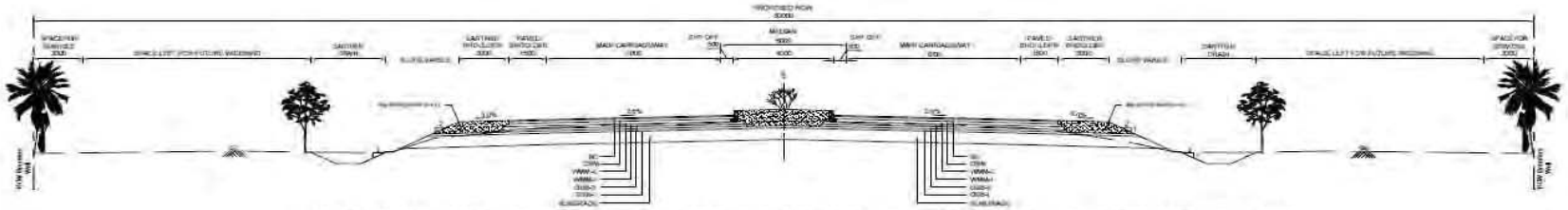
TYPE-5 : TYPICAL CROSS SECTION OF DUAL 4-LANE (2-LANE DIVIDED) CARRIAGEWAY IN PLAIN OR ROLLING TERRAIN WITH SERVICE ROAD



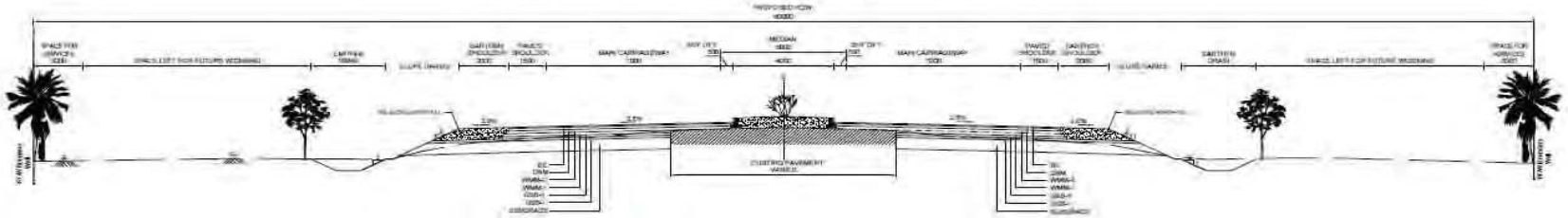
TYPE-6 : TYPICAL CROSS SECTION OF DUAL 4-LANE (8-LANE DIVIDED) FLYOVER/VUP/LVUP APPROACH WITH SLIP ROADS



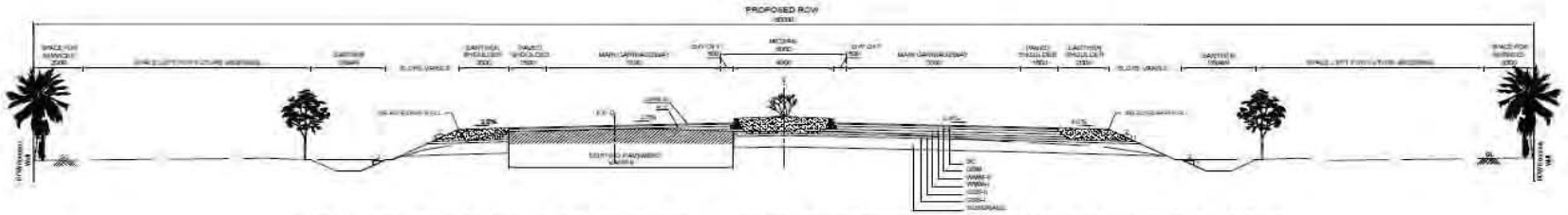
TYPE-6A : TYPICAL CROSS SECTION OF DUAL 4-LANE (8-LANE DIVIDED) FLYOVER/VUP/LVUP APPROACH



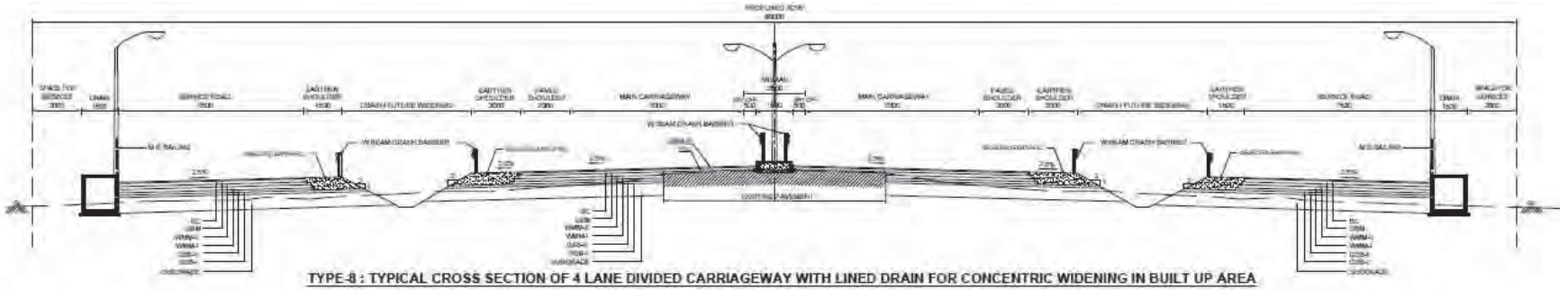
TYPE-7 : TYPICAL CROSS SECTION OF 4 LANE DIVIDED CARRIAGEWAY WITH PAVED SHOULDER FOR REALIGNMENT / BYPASS IN RURAL AREA



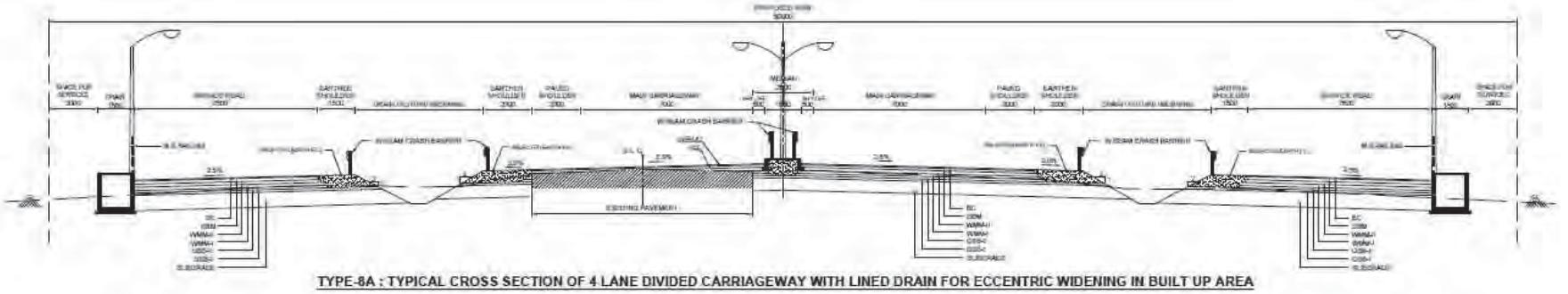
TYPE-7A : TYPICAL CROSS SECTION OF 4 LANE DIVIDED CARRIAGEWAY WITH PAVED SHOULDER FOR CONCENTRIC WIDENING RURAL AREA



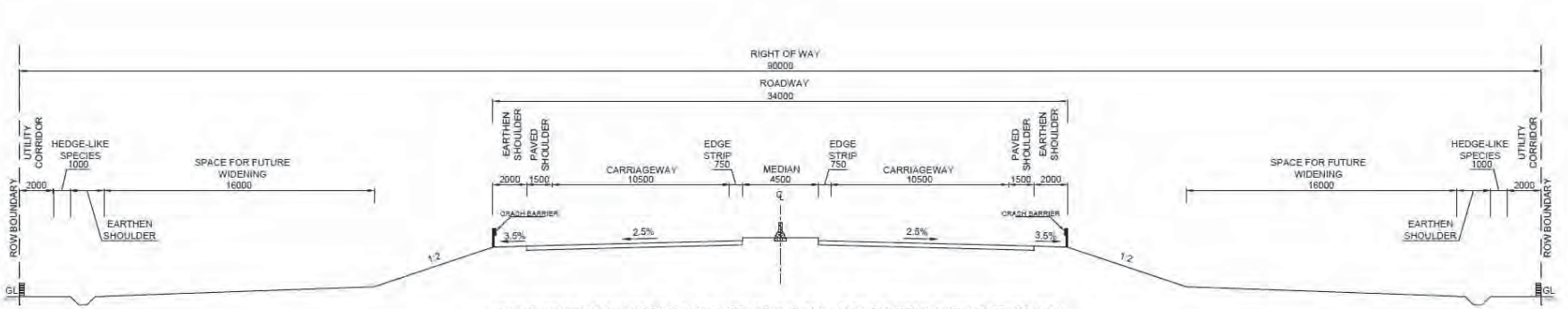
TYPE-7B : TYPICAL CROSS SECTION OF 4 LANE DIVIDED CARRIAGEWAY WITH PAVED SHOULDER FOR ECCENTRIC WIDENING IN RURAL AREA



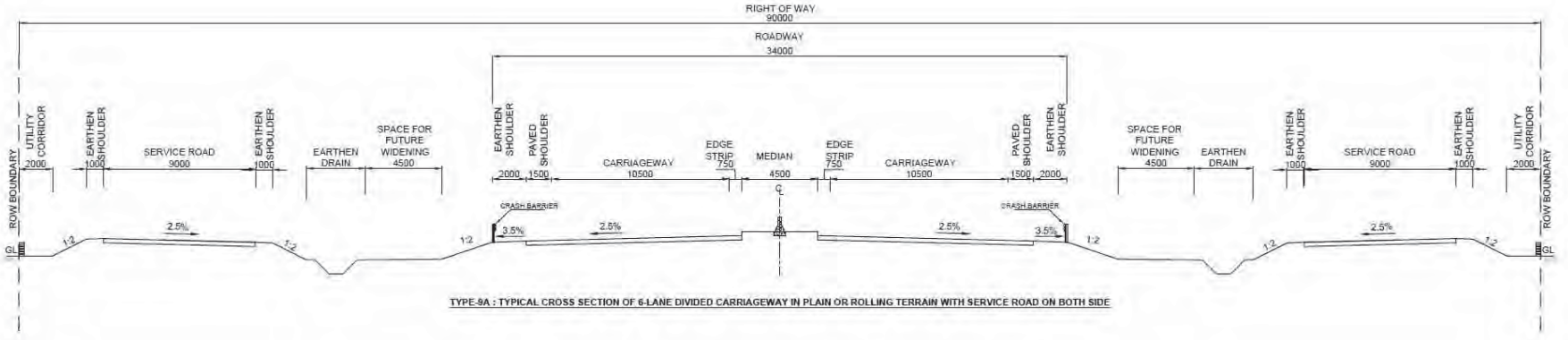
TYPE-8 : TYPICAL CROSS SECTION OF 4 LANE DIVIDED CARRIAGEWAY WITH LINED DRAIN FOR CONCENTRIC WIDENING IN BUILT UP AREA



TYPE-8A : TYPICAL CROSS SECTION OF 4 LANE DIVIDED CARRIAGEWAY WITH LINED DRAIN FOR ECCENTRIC WIDENING IN BUILT UP AREA



TYPE-9 : TYPICAL CROSS SECTION OF 6-LANE CARRIAGEWAY IN PLAIN OR ROLLING TERRAIN WITHOUT SERVICE ROAD



TYPE-9A : TYPICAL CROSS SECTION OF 6-LANE DIVIDED CARRIAGEWAY IN PLAIN OR ROLLING TERRAIN WITH SERVICE ROAD ON BOTH SIDE

7.2 SCHEME OF WIDENING

The existing project stretch under study has multidimensional facets in terms of geometry, pavement condition, existing utilities, religious structures, etc. and considering all these aspects the section-wise policy is adopted for widening based on the initial investigations. The adopted type of widening scheme is summarised in **Table 7-2.**

Table 7-2: Widening Scheme for Chennai – Salem Main Alignment

S.No	Design Chainage		Length (m)	Type of TCS	Remarks
	From	To			
1	0+000	1+700	1700	2	
2	1+700	2+700	1000	3	
3	2+700	6+110	3410	1	
4	6+110	6+200	90	3A	
5	6+200	6+810	610	3	
6	6+810	7+990	1180	2	
7	7+990	8+890	900	3	
8	8+890	10+000	1110	2	
9	10+000	10+890	890	1	
10	10+890	11+000	110	3A	
11	11+000	11+600	600	3	
12	11+600	11+790	190	3A	
13	11+790	13+020	1230	1	
14	13+020	13+920	900	3A	
15	13+920	14+960	1040	1	
16	14+960	15+000	40	3A	
17	15+000	15+960	960	3	
18	15+960	18+720	2760	2	NH-179B
19	18+720	19+620	900	3	
20	19+620	20+590	970	2	
21	20+590	21+290	700	3	
22	21+290	23+460	2170	2	
23	23+460	25+200	1740	3	
24	25+200	25+600	400	1	
25	25+600	25+820	220	4	
26	25+820	26+000	180	6A	
27	26+000	26+400	400	6	
28	26+400	26+720	320	6A	
29	26+720	27+640	920	4	
30	27+640	28+540	900	6A	
31	28+540	30+360	1820	4	
32	30+360	31+260	900	6A	
33	31+260	34+065	2805	4	
34	34+065	34+965	900	6A	
35	34+965	37+845	2880	4	

S.No	Design Chainage		Length (m)	Type of TCS	Remarks
	From	To			
36	37+845	38+545	700	6A	NH-179B
37	38+545	43+210	4665	4	
38	43+210	44+210	1000	6A	
39	44+210	47+000	2790	4	
40	47+000	47+600	600	5	
41	47+600	48+000	400	6	
42	48+000	48+300	300	6A	
43	48+300	53+190	4890	4	
44	53+190	53+890	700	6A	
45	53+890	56+300	2410	4	
46	56+300	56+555	255	5	
47	56+555	57+100	545	6	
48	57+100	57+455	355	6A	
49	57+455	59+610	2155	4	
50	59+610	60+610	1000	6A	
51	60+610	62+270	1660	4	
52	62+270	62+970	700	6A	
53	62+970	65+570	2600	4	
54	65+570	66+270	700	6A	
55	66+270	66+895	625	4	
56	66+895	67+895	1000	6	
57	67+895	71+700	3805	4	
58	71+700	72+400	700	6A	
59	72+400	74+840	2440	4	
60	74+840	75+740	900	6A	
61	75+740	77+830	2090	4	
62	77+830	78+530	700	6A	
63	78+530	78+950	420	4	
64	78+950	79+850	900	6A	
65	79+850	82+970	3120	4	
66	82+970	83+200	230	6A	
67	83+200	83+500	300	6	
68	83+500	83+870	370	6A	
69	83+870	84+500	630	4	
70	84+500	85+790	1290	5	
71	85+790	86+400	610	6	
72	86+400	86+690	290	6A	
73	86+690	87+400	710	4	
74	87+400	88+100	700	5	
75	88+100	88+600	500	6	
76	88+600	88+800	200	6A	
77	88+800	93+100	4300	4	

S.No	Design Chainage		Length (m)	Type of TCS	Remarks
	From	To			
78	93+100	94+005	905	5	NH-179B
79	94+005	95+005	1000	6	
80	95+005	95+480	475	4	
81	95+480	96+180	700	6A	
82	96+180	98+480	2300	4	
83	98+480	99+180	700	6A	
84	99+180	105+160	5980	4	
85	105+160	106+060	900	6A	
86	106+060	110+105	4045	4	
87	110+105	110+805	700	6A	
88	110+805	115+300	4495	4	
89	115+300	116+200	900	6A	
90	116+200	121+260	5060	4	
91	121+260	121+600	340	6A	
92	121+600	122+260	660	6	
93	122+260	123+170	910	6	
94	123+170	125+050	1880	4	
95	125+050	125+300	250	6A	
96	125+300	125+950	650	6	
97	125+950	128+000	2050	5	
98	128+000	131+000	3000	4	
99	131+000	131+900	900	6A	
100	131+900	134+300	2400	4	
101	134+300	135+000	700	5	
102	135+000	137+000	2000	4	
103	137+000	137+730	730	5	
104	137+730	138+300	570	6	
105	138+300	138+630	330	6A	
106	138+630	141+200	2570	4	
107	141+200	141+400	200	5	
108	141+400	141+800	400	6	
109	141+800	142+100	300	6A	
110	142+100	142+930	830	4	
111	142+930	143+830	900	6A	
112	143+830	146+710	2880	4	
113	146+710	147+410	700	6A	
114	147+410	150+100	2690	4	
115	150+100	150+310	210	5	
116	150+310	150+900	590	6	
117	150+900	151+210	310	6A	
118	151+210	156+000	4790	4	
119	156+000	157+380	1380	5	

S.No	Design Chainage		Length (m)	Type of TCS	Remarks
	From	To			
120	157+380	158+380	1000	6	NH-179B
121	158+380	161+400	3020	4	
122	161+400	162+000	600	5	
123	162+000	164+710	2710	4	
124	164+710	165+410	700	6A	
125	165+410	170+010	4600	4	
126	170+010	170+710	700	6A	
127	170+710	171+320	610	4	
128	171+320	172+020	700	6A	
129	172+020	175+200	3180	4	
130	175+200	175+900	700	6A	
131	175+900	178+170	2270	4	
132	178+170	178+870	700	6A	
133	178+870	182+830	3960	4	
134	182+830	183+530	700	6A	
135	183+530	183+900	370	6A	
136	183+900	184+280	380	6	
137	184+280	185+200	920	5	
138	185+200	186+300	1100	4	
139	186+300	186+700	400	5	
140	186+700	190+330	3630	4	
141	190+330	191+030	700	6A	
142	191+030	191+700	670	4	
143	191+700	192+700	1000	6A	
144	192+700	192+910	210	4	
145	192+910	193+610	700	6A	
146	193+610	195+810	2200	4	
147	195+810	196+710	900	6A	
148	196+710	199+765	3055	4	
149	199+765	200+465	700	6A	
150	200+465	200+930	465	4	
151	200+930	201+200	270	6A	
152	201+200	201+830	630	6	
153	201+830	202+500	670	5	
154	202+500	204+970	2470	4	
155	204+970	205+870	900	6A	
156	205+870	211+200	5330	4	
157	211+200	211+500	300	6A	
158	211+500	211+700	200	6	
159	211+700	211+900	200	6A	
160	211+900	212+710	810	4	
161	212+710	212+900	190	6A	

S.No	Design Chainage		Length (m)	Type of TCS	Remarks
	From	To			
162	212+900	213+410	510	6	
163	213+410	216+750	3340	5	
164	216+750	217+450	700	6	NH-179B
165	217+450	219+080	1630	5	
166	219+080	220+000	920	6	
167	57+300	56+175	1125	6	
168	56+175	53+300	2875	5	
169	53+300	50+400	2900	4	
170	50+400	49+740	660	5	
171	49+740	48+740	1000	6	
172	48+740	46+900	1840	5	
173	46+900	45+900	1000	6	
174	45+900	43+630	2270	5	
175	43+630	42+930	700	6	
176	42+930	41+000	1930	5	
177	41+000	40+000	1000	6	
178	40+000	32+300	7700	5	
179	32+300	31+600	700	6	
180	31+600	31+300	300	6A	
181	31+300	29+630	1670	4	
182	29+630	28+930	700	6A	
183	28+930	24+900	4030	4	
184	24+900	24+170	730	5	
185	24+170	23+170	1000	6	NH-179A
186	23+170	22+250	920	6	
187	22+250	22+090	160	5	
188	22+090	21+800	290	6	
189	21+800	21+090	710	3	
190	21+090	18+830	2260	2	
191	18+830	18+200	630	3	
192	18+200	18+130	70	3A	
193	18+130	15+950	2180	1	
194	15+950	15+250	700	3A	
195	15+250	13+580	1670	1	
196	13+580	12+880	700	3A	
197	12+880	12+200	680	1	
198	12+200	11+500	700	3A	
199	11+500	9+600	1900	1	
200	9+600	7+440	2160	2	
201	7+440	6+440	1000	3	
202	6+440	0+500	5940	2	
203	0+500	0+000	500	3	

Table 7-3: Widening Scheme for Kanchipuram Spur

Sl. No	Design Chainage		Design Length (m)	Type of C/S	Type of Widening
	From	To			
1	0+000	0+200	200	8A	Ecentric Right
2	0+200	0+500	300	8A	Ecentric Left
3	0+500	0+700	200	8A	Ecentric Right
4	0+700	0+900	200	8A	Ecentric Left
5	0+900	2+100	1200	8A	Ecentric Right
6	2+100	2+700	600	8A	Ecentric Left
7	2+700	2+900	200	8A	Ecentric Right
8	2+900	3+200	300	8A	Ecentric Left
9	3+200	3+360	160	8A	Ecentric Right
10	3+360	3+560	200	8A	Ecentric Left
11	3+560	3+700	140	8A	Ecentric Right
12	3+700	3+920	220	8A	Ecentric Left
13	3+920	4+100	180	8A	Ecentric Right
14	4+100	5+000	900	8	Concentric
15	5+000	5+200	200	8A	Ecentric Right
16	5+200	5+300	100	8A	Ecentric Left
17	5+300	5+400	100	8A	Ecentric Right
18	5+400	5+700	300	8A	Ecentric Left
19	5+700	7+100	1400	8	Concentric
20	7+100	7+600	500	8A	Curve Improvement
21	7+600	7+900	300	8	Concentric
22	7+900	8+080	180	8A	Ecentric Left
23	8+080	8+700	620	8A	Ecentric Right
24	8+700	11+100	2400	8	Concentric
25	11+100	11+420	320	8A	Ecentric Left
26	11+420	11+900	480	8A	Ecentric Right
27	11+900	12+150	250	8A	Realignment
28	12+150	15+900	3750	8	Concentric
29	15+900	18+700	2800	7B	Ecentric Right
30	18+700	22+900	4200	8A	Ecentric Right
31	22+900	23+300	400	8A	Ecentric Left
32	23+300	24+100	800	8	Concentric
33	24+100	25+500	1400	8A	Ecentric Right
34	25+500	29+635	4135	8	Concentric

Table 7-4: Widening Scheme for Chetpet Spur

Sl. No	Design Chainage		Design Length (m)	Type of C/S	Type of Widening
	From	To			
1	0+000	3+300	3300	7B	Eccentric Lift
2	3+300	4+900	1600	7B	Eccentric Right

Table 7-5: Widening Scheme for Tiruvanamalai Spur

Sl. No	Design Chainage		Design Length (m)	Type of C/S	Type of Widening
	From	To			
1	0+000	0+900	900	7	Realignment
2	0+900	1+300	400	7B	Eccentric Left
3	1+300	2+200	900	7B	Eccentric Right
4	2+200	3+600	1400	8	Concentric
5	3+600	4+100	500	8A	Eccentric Left
6	4+100	4+700	600	7B	Eccentric Left
7	4+700	6+300	1600	8	Concentic
8	6+300	6+700	400	7A	Concentic
9	6+700	7+400	700	7B	Ecentric left
10	7+400	7+900	500	7B	Ecentric Right
11	7+900	8+600	700	7B	Ecentric left
12	8+600	9+200	600	7B	Ecentric Right
13	9+200	9+700	500	8	Concentic
14	9+700	10+300	600	7B	Ecentric Right
15	10+300	10+900	600	8A	Ecentric Right
16	10+900	11+600	700	8	Concentric
17	11+600	13+600	2000	7B	Ecentric Right
18	13+600	13+900	300	8A	Ecentric left
19	13+900	14+400	500	8A	Ecentric Right
20	14+400	15+200	800	8A	Ecentric left
21	15+200	16+200	1000	8	Concentic

7.3 Curve Details

Table 7-6: Curve Details

S.No	Design Chainage	Radius	Design Speed	Remarks
1	1+064	700	120	NH-179B
2	2+174	700	120	
3	3+046	3000	120	
4	4+734	3000	120	
5	6+453	3000	120	
6	9+969	3000	120	
7	11+514	700	120	
8	14+026	3000	120	
9	21+115	1000	120	
10	23+449	700	120	
11	25+916	2000	120	
12	28+911	5000	120	
13	31+391	3000	120	
14	34+159	3000	120	

S.No	Design Chainage	Radius	Design Speed	Remarks
15	39+983	3000	120	
16	44+902	3000	120	
17	47+302	3000	120	
18	49+511	5000	120	
19	51+646	3000	120	
20	59+131	2000	120	
21	64+416	3000	120	
22	67+242	3000	120	
23	71+693	3000	120	
24	78+333	3000	120	
25	82+006	2000	120	
26	84+773	2000	120	
27	87+299	5000	120	
28	91+458	3000	120	
29	94+479	3000	120	
30	97+321	2000	120	
31	99+727	3000	120	
32	103+043	10000	120	
33	106+361	10000	120	
34	109+162	3000	120	NH-179B
35	112+637	3000	120	
36	120+768	3000	120	
37	125+743	3000	120	
38	130+599	3000	120	
39	133+894	10000	120	
40	138+179	10000	120	
41	141+127	3000	120	
42	145+229	3000	120	
43	150+564	3000	120	
44	155+100	3000	120	
45	164+931	3000	120	
46	170+990	3000	120	
47	179+478	2000	120	
48	184+142	3000	120	
49	189+583	2200	120	
50	192+270	3000	120	
51	200+790	3000	120	
52	208+097	3000	120	
53	214+980	3000	120	
54	53+036	3000	120	NH-179A
55	50+646	3000	120	
56	48+955	4000	120	
57	43+586	3000	120	

S.No	Design Chainage	Radius	Design Speed	Remarks
58	39+136	1000	120	
59	38+194	3000	120	
60	36+164	2000	120	
61	35+186	3000	120	
62	32+888	5000	120	
63	30+770	5000	120	
64	28+651	3000	120	
65	23+941	3000	120	
66	20+696	2000	120	NH-179A
67	17+516	3000	120	
68	14+316	5000	120	
69	12+939	1000	120	
70	11+439	2000	120	
71	7+541	2000	120	
72	5+746	2000	120	
73	3+479	2000	120	
74	0+609	1500	120	

7.4 INTERSECTION PROPOSALS

The geometric design of intersections has been carried out taking in to account the site conditions, turning movement characteristics, level of services, overall economy and operational safety. There are 117 Intersections proposed, out of which 81 are proposed as grade separated intersections and 36 as at-grade intersections with service roads.

7.4.1 Grade Separated Intersections

Grade separated structures are proposed for intersections with National highways, State highways and Major District Roads with traffic exceeding the capacity of at-grade intersections as per Manual of Specifications and Standards. The location of grade separated intersections is given in **Table 7-7**.

Table 7-7: List of Grade Separated Intersections

S. No	Existing Chainage	Design Chainage	Type of Structure	Leads To		Remarks
				LHS	RHS	
1		2+200	Trumpet Interchange	-	Perungalathur	SH-48
2		6+460	VUP G-II	Neelamangalam	-	
3		8+440	VUP	Kavanur	Padapai	
4		11+340	VUP	Kuthanur	Arambakkam	
5		13+470	VUP	Appur	Arambakkam	
6		15+460	Flyover	Appur	Oragadam	SH-57
7		19+170	VUP	Vadakkupattu	Eaichur	
8		20+940	VUP G-II	Vadakkupattu	Kolathancheri	
9		24+060	ROB Cum MJB Cum Flyover Cum Interchange	Chengalpattu	kanchipuram	SH-58

S. No	Existing Chainage	Design Chainage	Type of Structure	Leads To		Remarks
				LHS	RHS	
10	Greenfield	26+270	VUP	Sathananchery	Settancherry	
11		28+090	VUP	Karumbakkam	Pazhveri	
12		30+810	VUP	Edamachi	Tirumukkudal	
13		34+515	VUP	Alanjeri	Tirumukkudal	MDR-789
14		38+195	VUP G-II	Vayalakkavoor	Elayanarvelur	
15		43+710	Flyover	Uttiramerur	kanchipuram	SH-118A
16		47+950	VUP G-II	Azhisoor	-	
17		53+540	VUP G-II	Elanagar	Perunagar	
18		57+005	VUP	Uttiramerur	Sethupattu	
19		60+110	MJB Cum Flyover	Vandavasi	kanchipuram	SH-116
20		62+620	VUP G-II	Nedungal	Athi	
21		65+920	VUP G-II	Vinayagapuram	Erumaivetti	
22		67+395	Interchange	Vandavasi	Arcot	SH-5
23		72+050	VUP G-II	Thenmavanthal	Thachanthangal	
24		75+290	VUP	Cheyyar	Thavasi	MDR-709
25		78+180	VUP G-II	Melnemili	Karivelpattu	
26		79+400	VUP	Vandavasi	Arni	MDR-43
27		83+420	VUP	Kozhiplyur	Peranamallur	
28		86+240	MNB Cum VUP	Mahadevimangalam	Alliyandal	
29		88+450	VUP G-II	Visamangalam R.F	Alliyandal	
30		90+940	VOP @ 90+940	Anadimangalam	Namathodu	
31		94+505	Double Trumpet Intechange	Chetpet	Arani	SH-4
32		95+830	VUP G-II	Kothandavady	Appedu	
33		98+830	VUP G-II	Kolakkaravady	Murukkananthal	
34		103+480	VOP @ 103+480	Chetpet	Polur	SH-115
35		105+610	VUP	Avalurpettai	Devikapuram	
36		110+455	VUP G-II	Peranambakkam	Semiyamangalam	
37		115+750	VUP	Padagam	Pelasur	
38		121+760	Flyover	Tiruvanamalai	Polur	NH-38
39		122+670	Trumpet Interchange	Tiruvanamalai	-	
40		125+500	VUP	Narthampoondi	Kanji	
41		131+450	VUP	-	Kilpotharai	
42		138+180	VUP	Tiruvanamalai	Kanji	MDR-503
43		141+750	VUP G-II	Alathur	Nandimangalam	
44		143+380	MNB Cum VUP	Vasudevanapattu	Padiagragaram	
45		147+060	VUP G-II	Narasinghanallur	Padiagraharm	
46		150+760	VUP	Melmudiyanur	Muthanur	MDR-800

S. No	Existing Chainage	Design Chainage	Type of Structure	Leads To		Remarks
				LHS	RHS	
47	Greenfield	157+880	Interchange	Kottakulam	Chengam	NH-77
48		165+060	VUP G-II	Vedanakuppam	Andanur	
49		170+360	VUP G-II	Andipatti	Cross rd	
50		171+670	VUP G-II	Melravandavadi	Melpallipattu	
51		175+550	VUP G-II	Melravandavadi	Naradapattu	
52		178+520	VUP G-II	Cross rd	Athipadi	
53		183+180	VUP G-II	Neepathurai	Nadupatti	
54		183+930	VUP G-II	Neepathurai	Nadupatti	
55		190+680	VUP G-II	Andiyur	Vadakattamadu	
56		192+200	Flyover	Tiruvanamalai	Harur	SH-6A
57		193+260	VUP G-II	Cross rd	Theerthamalai	
58		196+260	VUP	Harur	Theerthamalai	
59		200+115	VUP G-II	Ittaiampatty	Sanipoondi	
60		201+380	VUP	Theerthamalai	Harur	
61		205+420	VUP	Sitheri	Harur	
62		211+550	VUP G-II	Kudumiyampatty	Cross rd	
63		213+060	VUP G-II	Vachati	Puludiyur	
64		217+100	VUP G-II	Pappambadi	Pudupatti	
65		219+530	MNB Cum VUP	Cross rd	Mookkareddipatti	
66		56+675	Interchange	A.Pallipatti	Pallipati	
67		49+240	Flyover	A.Pallipatti	-	SH-18
68		46+400	Flyover	Pattukonampatty	Krishnapuram	
69		43+280	VUP G-II	Manjavadi	Lakshmapuram	
70		40+500	Flyover	Kombur	Kallipettai	
71		31+800	Flyover			
72		29+280	VUP G-II	Velliyanpatti	Paruthikadu	
73		23+670	Flyover	Nirmulikuttai	Ayodhiyapattinum	MDR-1044
74		22+700	VUP	Minnampalli	Ayodhiyapattinum	
75		21+590	Cloverleaf Interchange	Attur	Masinayakkampatti	NH-79
76		18+480	VUP G-II	To Village	Kuppanur	SH-18
77		15+600	VUP G-II	To Village	Ram Nagar	
78		13+230	VUP G-II	Saniyasugnada	Ponnamapet	
79		11+850	VUP G-II	Cross rd	Suppottamaram	
80		6+940	Double Trumpet Intechange	Nammakal	Salem	NH-44
81		0+000	Trumpet Interchange	Coimbatore	Salem	NH-544

7.4.2 At Grade Intersections

At grade intersection shall be provided with the intersecting roads at the following locations as given below, the cross roads shall be regarded and strengthen to have a crust as same of main carriageway for a length shown in the Ministry's type designs for intersections along-with provision of adequate cross drainage structure on the cross roads. At grade Intersection Improvement proposals are given for in **Table 7-8**.

Table 7-8: List of At Grade Intersections with Service Roads

Sl.No	Ex KM	Design Chainage	Type of Intersection	Leads to	
				LHS	RHS
1	NH-179B	0+010	Y	To Mannivakkam Street	-
2		0+100	T	To Mannivakkam Street	
3		0+580	+	To Mannivakkam Street	Sri Krishna Nagar
4		26+070	X	Meyyur	Penayur
5		47+120	X	Kannikulam	Vengaram
6		56+390	X	Manampathi	Perunagar
7		66+310	X	Erumaivetti	Vinayagapuram
8		83+300	X	Pudur	Ariyapadi
9		84+800	X	Injimedu	Sandirambadi
10		85+720	X	Injimedu	Alliyandal
11		93+150	X	Anadimangalam	Kinnanur
12		127+780	X	Kanji	Narthampoondi
13		134+400	X	Agaram Sibbadi	Kanji
14		135+000	Y	Kanji	
15		137+160	X	Agaram Sibbadi	Kanji
16		141+400	X	Alathur	Nandimangalam
17		150+200	Y	Narasinghanallur	
18		156+200	Y		Muthanur
19		156+780	X	Cross rd	Se.Nachipattu
20		157+580	X	Cross rd	Se.Nachipattu
21		161+500	Y		Chengam
22		161+900	Y		Pakkiripalayam
23		184+920	X	Neepathurai	Vadakattamadu
24		202+230	X	Harur	Theerthamalai
25		213+840	X	Vachati	Kokkarapatti
26		215+180	X	Pudhu Kokkarapatti	Erumiyampatti
27		216+350	X	Cross rd	Erumiyampatti
28	NH-179A	56+380	X	A.Pallipatti	Pallipati
29		42+080	+	Chinnamanjavadi	Cross rd
30		40+800	+	Kombur	Cross rd
31		24+150	X	Cross rd	Kullampatty
32		17+350	X	Cross rd	Masinayakkampatti
33		8+380	X	Cross rd	Saravana Nagar

Sl.No	Ex KM	Design Chainage	Type of Intersection	Leads to	
				LHS	RHS
34	NH-179A	3+420	X	Parapatti	Agarahara Poolavarai
35		2+600	X	Ervadi	Agarahara Poolavarai
36		1+460	X	Akkarapalayam	Agarahara Poolavarai

7.5 Material Investigation

7.5.1 Characterization of Sub-grade

The following tests were conducted on each of the sub-grade samples collected from trial pits:

- Grain size distribution (Wet)
- Atterberg's Limits (Liquid limit and plastic limit)
- Modified Proctor Density at three compaction levels
- Four days soaked CBR at three energy levels

The methods of testing adopted for materials investigations are given in **Table 7-9.**

Table 7-9: Method of Testing

Type of Tests	Unit	Test Method
Grain Size Analysis (Wet Sieve)	% by wt.	IS: 2720 (Part 4)
Atterberg's Limits (LL, PL, PI)	% by wt.	IS: 2720 (Part 5)
Laboratory Moisture Density Characteristic (Modified AASHTO compaction)	Gm/cc and % by wt.	AASHTO T-180-97
Laboratory CBR (4 day soaked compacted at three energy level)	%	AASHTO T-193-99

The Summary of laboratory test results for sub-grade of existing roads (Spur & Harur to Salem) is given in **Annexure 7.1.**

7.5.2 SUBGRADE INVESTIGATIONS

7.5.2.1 Methodology (Test Pits)

Investigations have been carried out by digging test pits at every 500 m interval to obtain subgrade soil properties to establish the strengthening/ reconstruction requirements to cater for design traffic during service life. Test pits were excavated at the pavement-shoulder interface, extending through the pavement layers and down to the level of the subgrade.

7.5.2.2 Large Pits (1.0 m X 1.0 m)

The sequence of operations for large pits was as follows:

Manual excavation of 1.0 m x 1.0 m pit down to subgrade level. After reaching the subgrade level, type of material examined. Subgrade soil samples were collected and field moisture content was determined at site by using moisture meter method as per is 2720: part 2.

One sample of 30 kg subgrade soil was collected from the top 100 mm of sub-grade for the following laboratory tests:

- Field Moisture Content : As Per IS: 2720

- Grain Size Analysis : As Per IS: 2720
- Atterberg Limits : As Per IS: 2720
- Moisture-Density Test (Heavy Compaction) : As Per IS: 2720
- CBR (4 days soaked) : As per IS: 2720

Field moisture content is determined at site by using moisture meter method as per IS 2720: part 2.

7.5.3 Material for Embankment and Subgrade

Potential sources of earth for the construction of embankment and sub grade (for carriageway) were identified on either side . Based on the local information the borrow areas are primarily owned by contractors, local people and private/government organizations. The details of all the borrow areas investigated with their respective locations, corresponding chainage; locations including the distance from the project road to quarry are tabulated in **Table 7-10.**

Table 7-10: Details of Soil/ Moorum Borrow Areas

Sl. No	Chainage	Side	Lead (km)	Remarks
1	26+300	LHS	4.00	BA-1
2	49+000	LHS	6.90	BA-2
3	61+000	LHS	5.00	BA-3
4	72+000	RHS	1.00	BA-4
5	75+300	RHS	2.00	BA-5
6	75+300	LHS	8.00	BA-6
7	103+100	RHS	0.20	BA-7
8	83+400	LHS	3.00	BA-8
9	94+500	RHS	-	BA-9
10	115+700	LHS	5.00	BA-10
11	141+200	RHS	2.10	BA-11
12	151+000	LHS	10.00	BA-12
13	175+500	LHS	16.00	BA-13
14	182+000	RHS	26.00	BA-14
15	185+000	LHS	29.00	BA-15
16	194+000	RHS	-	BA-16
17	223+300	LHS	15.00	BA-17
18	228+800	RHS	-	BA-18
19	270+300	LHS	2.00	BA-19

The following test has been conducted to check the suitability of the fine-grained materials:

- Grain size analysis
- Atterberg limits
- Maximum laboratory dry unit weight (Heavy Compaction)
- Optimum moisture content
- CBR (4 days soaked) at three energy levels.

7.5.4 Stone Aggregates

Stone quarries have been primarily identified as stone aggregate source for construction of various components of road, namely, Asphaltic Concrete (AC), Dense Bituminous Macadam (DBM), Wet Mix Macadam (WMM) as well as for the cement concrete works. The sources identified including their location and details, distance from quarry to Project stretch are tabulated in **Table 7-11.**

Table 7-11: Stone Aggregate Quarries

Sl. No	Chainage	Side	Lead (km)	Contact Details
1	28+000	RHS	5.00	RS Enterprices
2	49+000	LHS	14.00	Bhagyalaxmi Crusher
3	56+000	LHS	4.00	GaneshPulamathi Crusher
4	78+000	LHS	14.00	Avaniyapuram Blue Metal Quarry
5	78+000	RHS	16.00	TRL Stone Crusher
6	82+000	RHS	1.00	KNS Quarry
7	-	LHS	0.50	Shri Balaji Blue Metal Service
8	173+000	RHS	1.50	Sri Shanmuga Stone Crusher
9	201+000	LHS	6.00	City Blue Metals

Representative samples from the above stone quarries were collected for testing in the laboratory. The following tests have been conducted on the samples collected.

- Los Angeles Abrasion Test : As per IS: 2386 (Part-4)
- Aggregate Impact value : As per IS: 2386 (Part-6)
- Combined flakiness and elongation indices : As per IS: 2386 (Part-7)
- Soundness : As per IS: 2386 (Part-5)
- Water absorption : As per IS: 2386 (Part-3)

- MoRT&H requirement of stone aggregates for their use in base / surfacing courses of pavement are as follows:

- Los Angeles Abrasion Value < 40%
- Aggregate Impact Value < 30%
- Flakiness and Elongation indices (combined) < 30%
- Water absorption < 2%

Summary of Laboratory Test Results of Stone Aggregates were given in **Annexure 7.1.**

Sources of natural sand have been primarily identified for construction works. The nearest existing sand source was identified and the location details are given in **Table 7-12.**

Table 7-12: Details of Sand Quarries

Sl.No	Location/ Chainage	Side	Lead (Km)	Remarks
1	Kanchipuram - Chengalpattu Route Kanchipuram to 16+000 Near Vill Palayasivaram (Palar River)	LHS	0.1	Palar River

Sl.No	Location/ Chainage	Side	Lead (Km)	Remarks
2	Vill. Neeyadipakam Cheyyar River (Cheyyar-Palar River Bank)	RHS	0.0	Cheyyar river
3	Cheyyar river (polur - Vandavasi Road, Polur to 3.0 Km	LHS	3.0	Cheyyar river
4	Salem to Bhavani 60.0 Km. (Bhavani Vill. Kaveri River)	LHS	60.0	Kaveri River

7.6 Pavement Design

7.6.1 GENERAL

The project envisages Greenfield alignment with eight lanes with paved shoulder for the carriageway for augmenting the capacity of the project road and significantly extending its service life. Wide paved shoulders are suggested at certain stretches to further enhance the capacity of project.

The general procedure for design of the flexible pavement green field highway has been followed as per the guidelines of IRC: 37-2012 – "Guidelines for the design of flexible pavements" and IRC: 81-1997- "Guidelines for Strengthening of flexible road pavements using Benkelman Beam Deflection Technique" respectively. The rigid pavements are designed as per the guidelines of IRC: 58-2015 – "Guidelines for the design of rigid pavements for highways" .The design of the Project Expressway conforms to the standards set out in the Manual for expressway IRC: SP: 99-2013.

Based on the evaluation of the functional and structural properties of the pavement, subgrade strength, axle loads and design traffic, the pavement design can be divided into two parts:

1. Design of the new pavement
2. Design of the overlay for spur Roads

New pavement design is based on the design traffic (msa) and the subgrade strength; however the overlay design will vary for each homogenous sections based on its structural and functional adequacy.

7.7 DESIGN CONSIDERATION FOR FLEXIBLE PAVEMENT

7.7.1 Design Life

Pavement design life is the period for which the initial design of pavement crust layers shall be carried out. Design life should not be referred as terminal stage of crust beyond which crust becomes unusable. A design life of 20 years for flexible pavement is to be considered as per IRC SP 99 :2013. Similarly, design life is 30 years for the rigid pavement as per IRC 58:2015

However, for stage construction, the design life of sub-base/ base courses is considered to equal to 20 years post construction. For binder/ wearing course the same is considered as 12 years post construction as per IRC SP 99: 2013.

7.7.2 VDF

Vehicle damage factor (VDF) for different categories of vehicle has been established by carrying fresh axle load survey at Mettupatti (near Valappadi) Ex. km 21.750 (old NH-68),

Pallikonda (near Vellore) Ex.km 98.520 (old NH-4) and Near Pappireddipatti Jn. (near Harur) Ex.km 31.000 (SH-18) respectively.

The vehicle damage factor is a multiplier for converting the number of commercial vehicles of different axle loads to the number of standard axle load repetitions. Cumulative standard axle (CSA) is calculated in accordance with the guidelines provided in IRC: 37 – 2012 and IRC: 81 - 1997. It has been ascertained that the damaging effect of axles on flexible pavement is approximately proportional to the fourth power of the axle load. The VDF values are taken from the traffic report submitted by the consultant, hence detailed calculations are shown in the traffic report.

The VDF is calculated by average of the individual vehicles VDF values calculated using fourth power formula suggested by IRC 37-2012. The calculated VDF values at the survey location for Bus, LCV, 2 axle, 3 axle and multi axle trucks are shown in **Table 7-13.**

Table 7-13: VDF Calculated

Mode	km 97.100		km 129.970		km 97.100		Recommended VDF	Adopted VDF
	C-S*	S-C*	C-S*	S-C*	C-S*	S-C*		
LCV	0.72	0.79	0.75	0.8	0.65	0.59	0.80	0.80
2-axle	2.62	1.47	1.64	1.87	3.78	2.58	1.16	1.16
3-axle	5.75	4.38	3.93	4.42	6.81	5.19	3.78	3.78
MAV	8.76	7.95	5.5	6.26	9.42	9.5	6.81	4.50
Bus	0.72	1.16	0.83	1.15	0.75	1.1	9.50	6.00
C-S* :Chennai-Salem ;S-C* :Salem-Chennai								

* Though axle load survey was performed for 3A and MAVs at survey location, as their respective counts were lesser and the sampling was not representing, the results were found to be skewed. So, the average VDF proposed by IRC 37– 2012 is recommended.

7.7.3 Traffic Growth Rates

To estimate the realistic traffic growth rates methodology recommended in IRC 108: 1996 is adopted. The econometric models developed by elasticity method relate traffic growth to changes in the socio-economic parameters like population, NSDP, per capita income and GDP. The best fit equation (log-log regression) of each mode of vehicles with different combinations of socio-economic parameters considered in estimating growth rates. As per guidelines given in IRC SP 84:2014 the growth rate of commercial vehicles shall not be less than 5% .The estimated and recommended final growth rates are presented in **Table 7-14** below.

Table 7-14: Traffic growth rates

Period range	Estimated Growth Rates					Recommended Growth Rates				
	LCV	Bus	2A	3A	MAV	LCV	Bus	2A	3A	MAV
2019-22	9.52	4.52	2.40	3.84	9.45	9.52	5.00	5.00	5.00	9.45
2023-27	8.65	4.14	1.29	2.21	8.90	8.65	5.00	5.00	5.00	8.90
2028-32	7.83	3.76	0.35	1.24	8.09	7.83	5.00	5.00	5.00	8.09
2033-37	6.49	3.12	0.12	0.31	6.53	6.49	5.00	5.00	5.00	6.53
2038-42	4.87	2.34	0.00	0.00	5.06	5.00	5.00	5.00	5.00	5.06
2043-47	4.83	2.32	0.00	0.00	5.02	5.00	5.00	5.00	5.00	5.02
>2047	4.83	2.32	0.00	0.00	5.02	5.00	5.00	5.00	5.00	5.02

7.7.4 Design Loading

Design traffic loading in million standard axles (MSA) estimated for the concession period using the base traffic figures with assessed growth rates and VDFs are furnished in **Annexure 7.2** direction wise.

Computation of Design Traffic

The design traffic is considered in terms of the Cumulative Standard Axles (CSA) to be carried during the design life of the road. MSA for new pavement design is worked out considering that the construction of the project road would be completed by the year 2022 and traffic will start using the facility from 2022 onwards. The computation involves initial volume of commercial vehicles per day, lateral distribution of traffic, growth rate, design life in years and vehicle damage factor (number of standard axle per commercial vehicle) to convert commercial vehicles to standard axles.

The following equation has been used to calculate the cumulative number of standard axles in accordance with IRC: 81 – 1997 and IRC: 37 – 2012.

$$N_s = \frac{365 \times A\left[(1+r)^x - 1\right]}{r} \times F$$

Where,

N_s = The cumulative number of standard axles to be catered for in the design.

A = Initial traffic, in the year of completion of construction, in terms of the number of commercial vehicles per day duly modified to account for lane distribution.

r = Annual growth rate of commercial vehicles, %

x = Design life in years

F = Vehicle Damage Factor (number of standard axles per commercial vehicle)

7.7.5 Homogeneous Sections for Pavement Design

The project stretch is divided into nine homogeneous sections based on traffic, soil investigation and pavement condition for new pavement design. The homogeneous sections are given in **Table** 7-15**.**

Table 7-15: Homogenous Sections

Sl. No.	Section from		Section to		Length (km)
	Place	Chainage	Place	Chainage	
1	Start Point (Chennai)	0+000	SH 58 (Kanchipuram)	24+580	24.580
2	SH 58 (Kanchipuram)	24+580	SH 5 (Vandavasi)	67+390	42.815
3	SH 5 (Vandavasi)	67+390	SH 4 (Chetpet)	94+500	27.110
4	SH 4 (Chetpet)	94+500	NH 234 (Tiruvannamalai)	121+760	27.255
5	NH 234 (Tiruvannamalai)	121+760	NH 66 (Chengam)	157+880	36.120
6	NH 66 (Chengam)	157+880	SH 18 (Harur)	220+620	62.745
7	SH 18 (Harur)	56+670	NH 68 (Salem)	33+380	23.295

Sl. No.	Section from		Section to		Length (km)
	Place	Chainage	Place	Chainage	
8	NH 68 (Salem)	33+380	NH 44 (Namakkal road)	6+940	26.440
9	NH 44 (Namakkal road)	6+940	NH 544 (Coimbatore road)	0+000	6.960

7.7.6 Flexible Pavement Design

New Construction for the main carriageway is to be carried out for Greenfield alignment eight lanes with paved shoulder of the carriageway for augmenting the capacity of the project road .The pavement for new construction is designed based on IRC: 37 Guidelines for the Design of Flexible Pavement.

Crust Designs

The conventional method of flexible pavement as given in IRC:37-2012 has been adopted for this purpose. This method is based on results of experimentation or experience and strength parameters of soil subgrade. Empirical design charts are given in IRC: 37 -Guidelines for the Design of Flexible Pavement, using empirical strength parameter of CBR
The guidelines present fatigue and rutting model corresponding to 80% and 90% reliability. Traffic greater than 30 msa should be designed for 90% reliability. Different grades of bitumen can be used depending upon the requirement. For traffic greater than 30msa, VG 40 has been recommended for both DBM and BC. DBM has air voids 3% after rolling (Bitumen content being 0.5-0.6% higher than optimum). For lower traffic VG 30 may be used. Effective CBR concept is also introduced to account for difference in CBR of embankment and sub grade.

Strength Parameter: Resilient Modulus

Resilient modulus is the measure of its elastic behavior determined from recoverable deformation in the laboratory tests. The modulus is an important parameter for design and the performance of a pavement.
MR sub-grade = 10 X CBR, if Sub-grade CBR is <=5
MR sub-grade = 17.6 X (CBR)^0.64, if Sub-grade CBR is >5
MRgsb= 0.2 X h^(0.45) X MR sub-grade,
Where,
h is thickness of sub-base layer in mm.
M_R value of sub-base is dependent on M_R value of sub-grade since weaker sub-grade does not permit higher modulus of the upper layer because of deformation under loads.

Tensile strain, Єt, at the bottom of the bituminous layer and the vertical sub-grade strain, Єv, on the top of the sub-grade are conventionally considered as critical parameters for pavement design to limit cracking and rutting in the bituminous layers and non-bituminous layers respectively.

Fatigue in Bottom Layer of Bituminous Pavement and Fatigue Life
The number of load repetitions in terms of standard axles that cause fatigue denotes the fatigue life of the pavement. According to the guidelines, cracking in 20 per cent area has been considered for traffic up to 30 msa and 10 per cent for traffic beyond that.
The relationships governing the above criteria are expressed as:

Nf = 2.21 * 10-04 x [1/εt]3.89 * [1/MR]0.854, (80 per cent reliability)

Nf = 0.711 * 10-04 x [1/εt]3.89 * [1/MR]0.854, (90 per cent reliability)

Where,

Nf = fatigue life in number of standard axles,

εt = Maximum Tensile strain at the bottom of the bituminous layer, and

MR = resilient modulus of the bituminous layer.

Rutting in Pavement

Excessive rutting greatly reduces the serviceability of the pavement and therefore, it has to be limited to a certain reasonable value. According to the guidelines, the limiting rutting is recommended as 20 mm in 20 per cent of the length for design traffic up to 30 msa and 10 per cent of the length for the design traffic beyond.

The relationships governing the above criteria are expressed as:

N = 4.1656 x 10-08 [1/εv] 4.5337

N = 1.41x 10-8x [1/εv] 4.5337

Where,

N = Number of cumulative standard axles, and

εv = Vertical strain in the subgrade

Pavement design for new carriageway is done based on IRC: 37-2012, considering construction period of two years and design life of 15 years for bituminous layer, base and sub base course. For the service roads, the design MSA is taken as 10 MSA As per IRC SP:84-2014. The proposed pavement design thickness is listed in **Table 7-16 and Table7-17.**

Table 7-16: Proposed Pavement Design

Pavement composition (mm) as per IRC 37-2012									
Description	**HS I**	**HS II**	**HS III**	**HS IV**	**HS V**	**HS VI**	**HS VII**	**HS VIII**	**HS IX**
Direction	**Both**								
Proposed Lane Configuration	**8 Lane**								
Design life Base and Sub Base (in years)	20								
Design life BT Layers (in years)	20								
Lane Distribution factor	0.45								
Directional Distribution	0.50								
Initial Design period of BT Layers (in years)**	12**								
MSA for BT Layers	148.7	114.8	106.3	116.2	141.2	128.6	148.0	98.6	89.3
MSA for Base and Sub Base	332.9	255.5	237.3	259.3	315.6	286.5	330.3	220.0	199.8
Adopted Effective CBR Value (%)	10								
Grade of Bitumen	VG 40 , Va = 3 % & Vb = 13 %								
Bituminous Concrete , mm	50	50	50	50	50	50	50	40	40
Dense Bituminous Macadam , mm	120	110	105	110	120	115	120	110	110
Granular Base (WMM) , mm	250	250	250	250	250	250	250	250	250
Granular Sub Base , mm	200	200	200	200	200	200	200	200	200
Total Thickness, mm	**620**	**610**	**605**	**610**	**620**	**615**	**620**	**600**	**600**
Material Specifications									
Gradation of BC	Grading 2 - As per Table 500-17 of MORTH specifications (Fifth Revision)								
Gradation of DBM	Grading 1 for Thickness between 75 - 100 mm and Grading 2 for Thickness between 50 - 75 mm - As per Table 500-10 of MORTH specifications (Fifth Revision)								
Gradation of WMM	Gradation as per Table 400-13 of MORTH specifications (Fifth Revision)								
Gradation of GSB	Grading I/II - As per Table 400-1 of MORTH specifications (Fifth Revision)								

Pavement composition (mm) as per IRC 37-2012									
Description	**HS I**	**HS II**	**HS III**	**HS IV**	**HS V**	**HS VI**	**HS VII**	**HS VIII**	**HS IX**
** Actual design life is taken as 20 years for flexible pavement (Considered 12 years as initial design period and pavement strengthening for the balance period)									

Table7-17: Proposed Pavement Design for service roads & Spur Roads

Section	CBR (%)	MSA	BC (mm)	DBM (mm)	WMM (mm)	GSB (mm)
I to IX & Spur Roads	8	10	40	50	250	200

7.7.7 Rigid Pavement Design

Rigid Pavement is required to be constructed at toll plaza location. At these locations, braking tendency remains to be high and therefore, impact loading is significant in the design. The pavement has been designed based on IRC: 58-2015 Design of Rigid Pavement and for design life of 30 years. **Axle load spectrum** - The load spectrums obtained from Axle Load survey considered for the design purpose is shown in Error! Reference source not found. **to Table 7-29.**

Figure 1: Rigid Pavement Design Flow Chart (IRC: 58-2015)

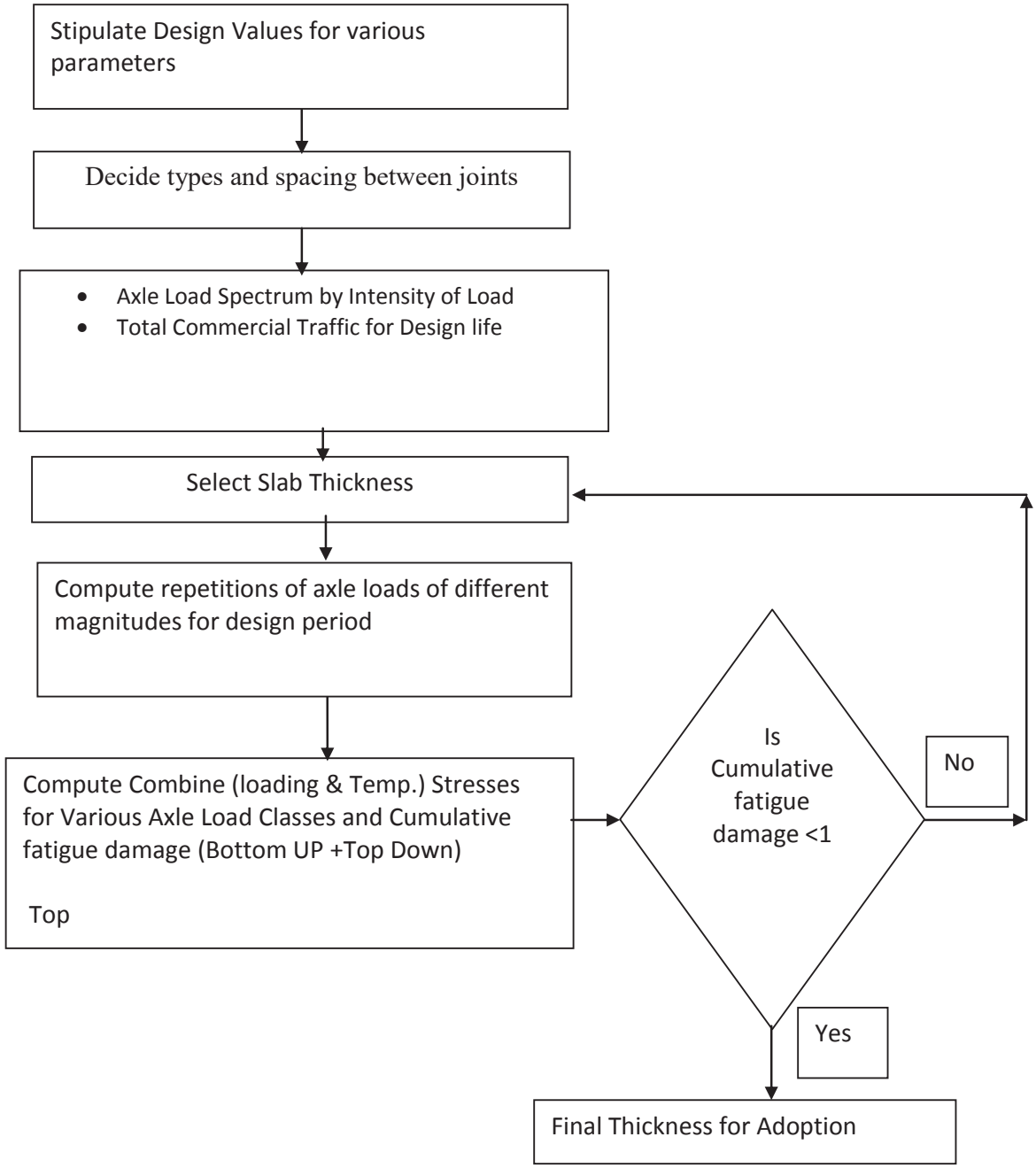


Table 7-18: Axle load spectrum at location 1 Mettupatti Ex.km.21.750 (old NH-68) (Chennai -Salem)

Load Group		Mid-point of load	Nos	Frequency	Load Group		Mid-point of load	Nos	Frequency	Load Group		Mid-point of load	Nos	Frequency
185	195	190	0	0.00	380	400	390	0	0.00	530	560	545	0	0.00
175	185	180	0	0.00	360	380	370	0	0.00	500	530	515	0	0.00
165	175	170	0	0.00	340	360	350	0	0.00	470	500	485	0	0.00
155	165	160	0	0.00	320	340	330	1	1.05	440	470	455	0	0.00
145	155	150	1	0.50	300	320	310	0	0.00	410	440	425	0	0.00
135	145	140	3	1.50	280	300	290	1	1.05	380	410	395	0	0.00
125	135	130	3	1.50	260	280	270	6	6.32	350	380	365	1	12.50
115	125	120	9	4.50	240	260	250	15	15.79	320	350	335	2	25.00
105	115	110	21	10.50	220	240	230	15	15.79	290	320	305	1	12.50
95	105	100	17	8.50	200	220	210	23	24.21	260	290	275	1	12.50
85	95	90	22	11.00	180	200	190	11	11.58	230	260	245	0	0.00
<	85	80	124	62.00	<	180	170	23	24.21	<	230	215	3	37.50
		Total	**200**	**100.00**			**Total**	**95**	**100.00**			**Total**	**8**	**100.00**

Table 7-19: Result of Axle load spectrum location 1 Mettupatti Ex.km.21.750 (old NH-68) (Chennai -Salem)

Total No of axles	555
Average No of axles per commercial vehicle, B	2.202
Proportion of Front single (steering) Axles, K1	0.454
Proportion of Rear single Axles,K2	0.360
Proportion of tandem Axles, K3	0.171
Proportion of Tridem Axles, K4 = (1-K1-K2-K3)	0.014

Table 7-20: Axle load spectrum at location 1 Mettupatti Ex.km.21.750 (old NH-68) (Salem - Chennai)

Load Group		Mid-point of load	Nos	Frequency	Load Group		Mid-point of load	Nos	Frequency	Load Group		Mid-point of load	Nos	Frequency
185	195	190	0	0.00	380	400	390	0	0.00	530	560	545	0	0.00
175	185	180	0	0.00	360	380	370	0	0.00	500	530	515	0	0.00
165	175	170	0	0.00	340	360	350	0	0.00	470	500	485	0	0.00
155	165	160	0	0.00	320	340	330	0	0.00	440	470	455	1	50.00
145	155	150	0	0.00	300	320	310	1	1.03	410	440	425	0	0.00
135	145	140	0	0.00	280	300	290	2	2.06	380	410	395	0	0.00
125	135	130	1	0.51	260	280	270	3	3.09	350	380	365	0	0.00
115	125	120	3	1.52	240	260	250	10	10.31	320	350	335	0	0.00
105	115	110	6	3.03	220	240	230	10	10.31	290	320	305	0	0.00
95	105	100	16	8.08	200	220	210	25	25.77	260	290	275	0	0.00
85	95	90	18	9.09	180	200	190	14	14.43	230	260	245	0	0.00
<	85	80	154	77.78	<	180	170	32	32.99	<	230	215	1	50.00
		Total	**198**	**100.00**			**Total**	**97**	**100.00**			**Total**	**2**	**100.00**

Table 7-21: Result of Axle load spectrum at location 1 Mettupatti Ex.km.21.750 (old NH-68) (Salem - Chennai)

Total No of axles	542
Average No of axles per commercial vehicle, B	2.212
Proportion of Front single (steering) Axles, K1	0.452
Proportion of Rear single Axles,K2	0.365
Proportion of tandem Axles, K3	0.179
Proportion of Tridem Axles, K4 = (1-K1-K2-K3)	0.004

Table 7-22: Axle load spectrum at location 2 Pallikonda Ex.km.km 98.520 (old NH-4) (Chennai -Salem)

Load Group		Mid-point of load	Nos	Frequency	Load Group		Mid-point of load	Nos	Frequency	Load Group		Mid-point of load	Nos	Frequency
185	195	190	0	0.00	380	400	390	0	0.00	530	560	545	0	0
175	185	180	0	0.00	360	380	370	0	0.00	500	530	515	0	0
165	175	170	0	0.00	340	360	350	0	0.00	470	500	485	0	0
155	165	160	0	0.00	320	340	330	0	0.00	440	470	455	0	0
145	155	150	0	0.00	300	320	310	0	0.00	410	440	425	0	0
135	145	140	0	0.00	280	300	290	0	0.00	380	410	395	0	0
125	135	130	0	0.00	260	280	270	1	11.11	350	380	365	0	0
115	125	120	1	7.69	240	260	250	0	0.00	320	350	335	0	0
105	115	110	0	0.00	220	240	230	1	11.11	290	320	305	0	0
95	105	100	1	7.69	200	220	210	1	11.11	260	290	275	0	0
85	95	90	0	0.00	180	200	190	0	0.00	230	260	245	0	0
<	85	80	11	84.62	<	180	170	6	66.67	<	230	215	0	0
		Total	**13**	**100.00**			**Total**	**9**	**100.00**			**Total**	**0**	**0**

Table 7-23: Result of Axle load spectrum at location 2 Pallikonda Ex.km.km 98.520 (old NH-4)(Chennai -Salem)

Total No of axles	41
Average No of axles per commercial vehicle, B	2.158
Proportion of Front single (steering) Axles, K1	0.463
Proportion of Rear single Axles,K2	0.317
Proportion of tandem Axles, K3	0.220
Proportion of Tridem Axles, K4 = (1-K1-K2-K3)	0.000

Table 7-24: Axle load spectrum at location 2 Pallikonda Ex.km.km 98.520 (old NH-4) (Salem - Chennai)

Load Group		Mid-point of load	Nos	Frequency	Load Group		Mid-point of load	Nos	Frequency	Load Group		Mid-point of load	Nos	Frequency
185	195	190	0	0.00	380	400	390	0	0.00	530	560	545	0	0.00
175	185	180	0	0.00	360	380	370	0	0.00	500	530	515	0	0.00
165	175	170	0	0.00	340	360	350	0	0.00	470	500	485	0	0.00
155	165	160	0	0.00	320	340	330	0	0.00	440	470	455	0	0.00
145	155	150	0	0.00	300	320	310	0	0.00	410	440	425	0	0.00
135	145	140	1	0.81	280	300	290	1	1.41	380	410	395	1	14.29
125	135	130	1	0.81	260	280	270	1	1.41	350	380	365	3	42.86
115	125	120	4	3.23	240	260	250	4	5.63	320	350	335	2	28.57
105	115	110	5	4.03	220	240	230	9	12.68	290	320	305	0	0.00
95	105	100	12	9.68	200	220	210	19	26.76	260	290	275	0	0.00
85	95	90	11	8.87	180	200	190	10	14.08	230	260	245	0	0.00
<	85	80	90	72.58	<	180	170	27	38.03	<	230	215	1	14.29
		Total	**124**	**100.00**			**Total**	**71**	**100.00**			**Total**	**7**	**100.00**

Table 7-25: Result of Axle load spectrum at location 2 Pallikonda Ex.km.km 98.520 (old NH-4) (Salem - Chennai)

Total No of axles	356
Average No of axles per commercial vehicle, B	2.312
Proportion of Front single (steering) Axles, K1	0.433
Proportion of Rear single Axles,K2	0.348
Proportion of tandem Axles, K3	0.199
Proportion of Tridem Axles, K4 = (1-K1-K2-K3)	0.020

Table 7-26: Axle load spectrum at location 3 Near Pappireddipatti Jn. Ex.km km 31.000 (SH-18) (Chennai -Salem)

Load Group		Mid-point of load	Nos	Frequency	Load Group		Mid-point of load	Nos	Frequency	Load Group		Mid-point of load	Nos	Frequency
185	195	190	0	0.00	380	400	390	0	0.00	530	560	545	0	0.00
175	185	180	0	0.00	360	380	370	0	0.00	500	530	515	0	0.00
165	175	170	0	0.00	340	360	350	0	0.00	470	500	485	0	0.00
155	165	160	1	0.84	320	340	330	2	1.59	440	470	455	1	50.00
145	155	150	2	1.68	300	320	310	2	1.59	410	440	425	0	0.00
135	145	140	1	0.84	280	300	290	4	3.17	380	410	395	0	0.00
125	135	130	2	1.68	260	280	270	12	9.52	350	380	365	0	0.00
115	125	120	3	2.52	240	260	250	26	20.63	320	350	335	0	0.00
105	115	110	12	10.08	220	240	230	19	15.08	290	320	305	1	50.00
95	105	100	6	5.04	200	220	210	22	17.46	260	290	275	0	0.00
85	95	90	11	9.24	180	200	190	7	5.56	230	260	245	0	0.00
<	85	80	81	68.07	<	180	170	32	25.40	<	230	215	0	0.00
		Total	**119**	**100.00**			**Total**	**126**	**100.00**			**Total**	**2**	**100.00**

Table 7-27: Result of Axle load spectrum at location 3 Near Pappireddipatti Jn. Ex.km km 31.000 (SH-18) (Chennai -Salem)

Total No of axles	436
Average No of axles per commercial vehicle, B	2.307
Proportion of Front single (steering) Axles, K1	0.433
Proportion of Rear single Axles,K2	0.273
Proportion of tandem Axles, K3	0.289
Proportion of Tridem Axles, K4 = (1-K1-K2-K3)	0.005

Table 7-28: Axle load spectrum at location 3 Near Pappireddipatti Jn. Ex.km km 31.000 (SH-18) (Salem - Chennai)

Load Group		Mid-point of load	Nos	Frequency	Load Group		Mid-point of load	Nos	Frequency	Load Group		Mid-point of load	Nos	Frequency
185	195	190	0	0.00	380	400	390	0	0.00	530	560	545	0	0.00
175	185	180	0	0.00	360	380	370	0	0.00	500	530	515	0	0.00
165	175	170	0	0.00	340	360	350	0	0.00	470	500	485	0	0.00
155	165	160	0	0.00	320	340	330	2	1.06	440	470	455	3	75.00
145	155	150	3	1.66	300	320	310	4	2.13	410	440	425	0	0.00
135	145	140	2	1.10	280	300	290	8	4.26	380	410	395	0	0.00
125	135	130	3	1.66	260	280	270	27	14.36	350	380	365	0	0.00
115	125	120	4	2.21	240	260	250	12	6.38	320	350	335	0	0.00
105	115	110	7	3.87	220	240	230	17	9.04	290	320	305	0	0.00
95	105	100	9	4.97	200	220	210	29	15.43	260	290	275	0	0.00
85	95	90	14	7.73	180	200	190	16	8.51	230	260	245	0	0.00
<	85	80	139	76.80	<	180	170	73	38.83	<	230	215	1	25.00
		Total	**181**	**100.00**			**Total**	**188**	**100.00**			**Total**	**4**	**100.00**

Table 7-29: Result of Axle load spectrum at location 3 Near Pappireddipatti Jn. Ex.km km 31.000 (SH-18) (Salem - Chennai)

Total No of axles	654
Average No of axles per commercial vehicle, B	2.327
Proportion of Front single (steering) Axles, K1	0.430
Proportion of Rear single Axles,K2	0.277
Proportion of tandem Axles, K3	0.287
Proportion of Tridem Axles, K4 = (1-K1-K2-K3)	0.006

Design Life and Traffic Parameters:
Design period of 30 years have been considered. The cumulative number of commercial vehicles over 30 years design life is estimated and 25% of this traffic is considered as design traffic.

Temperature Differential:
According to Table-1 of IRC: 58-2015, the temperature differential is a function of geographical location of the project road and the temperature differential to be adopted for the project area (North Tamil Nadu) is 20.3°C.

Modulus of Subgrade reaction:
Dry Lean Concrete (DLC) sub base is generally recommended for a modern concrete pavement, particularly those with high intensity of traffic.

Table 7-30: Modulus of Sub-grade Reaction

Sub-grade CBR (%)	10
Modulus Of Sub-grade Reaction Of Sub-grade, Mpa/m	55
Effective Modulus Of Sub-grade Reaction Of Foundation, Mpa/m	300

Concrete Strength
The 28 days flexural strength for the pavement quality concrete (PQC) has been taken as 4.7 Mpa for the purpose of design.
Modulus of Elasticity, Poisson's Ratio & Coefficient of Thermal Expansion
The following input parameters have been used in designing the rigid pavements:
- Modulus of Elasticity of Concrete : $3X10^5$
- Poisson's Ratio: 0.15
- Coefficient of thermal Expansion of Concrete $10X10^{-6}$
- Tyre Pressure 8.15 Kg/Cm^2
- Subgrade CBR 10%

Design of slab thickness
The flexural stress due to the combined action of traffic loads and temperature differential between the top and bottom fibers of the concrete slab is considered for design of pavement thickness. Positive temperature during day time will create bottom-up cracking and negative temperature during night will create top-down cracking in concrete slab. Hence analysis has been done for these two cases.

For bottom-up cracking case, the combination of load and positive non-linear temperature differential has been considered where as for top-down cracking analysis, the combination of load and negative linear temperature differential has been taken. For a trial slab thickness and other design parameters, the pavement will be checked for cumulative bottom-up and top-down fatigue damage.

Cumulative fatigue damage (CFD) for bottom-up cracking is significant only during 10 AM to 4 PM because of higher stresses, hence the day traffic during the six hour (10 AM to 4 PM) is considered for bottom-up cracking analysis. Whereas CFD for top-down cracking is significant only during 0 AM to 6 AM, hence the six hour night time traffic (0 AM to 6 AM) is considered for top-down cracking analysis.

Design of Sub-Grade and Sub-Base

As per clause 5.7.3.6 of IRC 58-2015, 500 mm sub-grade of effective design CBR of 15% and 150 mm Granular Sub-base of minimum 30% CBR shall be provided. This sub-base layer shall act as drainage layer as well.

Dry Lean Concrete

As per clause 5.4.2 (ii) of manual, Dry lean concrete of 150 mm thickness shall be provided as base for better load distribution, and better support for concrete Paver. Minimum strength requirement of DLC shall be as per MoRTH Clause 601.3.4 "the average compressive strength of each consecutive group of 5 cubes made in accordance with Clause 903.5.1.1 shall not be less than 10 MPa at 7 days. In addition, the minimum compressive strength of any individual cube shall not be less than 7.5 MPa at 7 days."

Pavement Quality Concrete (PQC)

M-45 grade concrete has been considered for the Pavement Quality Concrete. The minimum characteristic flexural strength of concrete is to be achieved at site during construction is 4.7 MPa by carrying out mix design for the fly ash mixed PQC.

As per IRC: 58-2015, detailed designs of rigid pavement for Main carriageway & toll lanes are given in **Annexure 7.3**.

Based on the above parameters the rigid pavement design is proposed as given in **Table 7-31**

Table 7-31: Proposed Rigid Pavement Design

Toll Plaza Location	Direction	Rigid Pavement Composition (mm)						
		PQC	DLC	GSB	Sub-grade with material having effective CBR of 10%	Plain Dowel Bar Details	Deformed Tie Bar Details	Remarks
For Main Carriageway								
I to V	C-S	260	150	150	500	32 mm Dia at 300 mm c/c, 450 mm long	12 mm Dia at 700 mm c/c, 650 mm long	
	S-C	260	150	150	500	32 mm Dia at 300 mm c/c, 450 mm long	12 mm Dia at 700 mm c/c, 650 mm long	
VI	C-S	280	150	150	500	32 mm Dia at 300 mm c/c, 450 mm long	12 mm Dia at 700 mm c/c, 650 mm long	
	S-C	270	150	150	500	32 mm Dia at 300 mm c/c, 450 mm long	12 mm Dia at 700 mm c/c, 650 mm long	
VII	C-S	280	150	150	500	32 mm Dia at 300 mm c/c, 450 mm long	12 mm Dia at 700 mm c/c, 650 mm long	
	S-C	280	150	150	500	32 mm Dia at 300 mm c/c, 450 mm long	12 mm Dia at 700 mm c/c, 650 mm long	
VIII & IX	C-S	250	150	150	500	32 mm Dia at 300 mm c/c, 450 mm long	12 mm Dia at 700 mm c/c, 650 mm long	
	S-C	250	150	150	500	32 mm Dia at 300 mm c/c, 450 mm long	12 mm Dia at 700 mm c/c, 650 mm long	

7.8 PROPOSALS FOR STRUCTURES

Along the project stretch 23 Major bridges, 1 MJB Cum ROB, 156 Minor bridges, 2 MNB Cum VUP, 2 MNB Cum VUP Grade-II, 1 ROB Cum MJB Cum Flyover Cum Interchange, 2 ROB's, 3 Interchange, 3 Trumpet Interchange, 2 Double Trumpet Interchange, 1 Cloverleaf Interchange, 9 Flyovers, 1 MJB Cum Flyover, 22 VUP's, 2 VOP's, 33 VUP Grade-II and 3 tunnels are proposed. Summary of structures are given in below Table.

Table 7-32 Summary of Structures

Sl. No.	Type of structure	New Construction	Reconstruction	Widening with minor repairs	Retain + New Constructio n	Reconstructi on + New Constructio n	SR-New Constrution + MCW-New Constructio n	SR-New Constrution + MCW-Reconstructio n	Total
1	Major bridge	23	-	-	-	-	-	-	23
2	Major bridge Cum Flyover	1	-	-	-	-	-	-	1
3	Major bridge cum ROB	1	-	-	-	-	-	-	1
4	ROB Cum MJB Cum Flyover Cum Interchange	1	-	-	-	-	-	-	1
5	Minor bridge	116	1			-	38	1	156
6	Flyover	9	-	-	-	-	-	-	9
7	VUP	22	-	-	-	-	-	-	22
8	VOP	2	-	-	-	-	-	-	2

Sl. No.	Type of structure	New Construction	Reconstruction	Widening with minor repairs	Retain + New Constructio n	Reconstructi on + New Constructio n	SR-New Constrution + MCW-New Constructio n	SR-New Constrution + MCW-Reconstructio n	Total
9	VUP-Grade-II	33	-	-	-	-	-	-	33
10	MNB Cum VUP	2	-	-	-	-	-	-	2
11	MNB Cum VUP Grade-II	2							2
12	Interchange	3	-	-	-	-	-	-	3
13	Trumpet Interchange	3							3
14	Double Trumpet Interchange	2							2
15	Cloverleaf Interchange	1							1
16	ROB	2	-	-	-	-	-	-	2
17	Tunnels	3	-	-	-	-	-	-	3

Spur Road:

In Tiruvannamalai Spur road, 3 Minor bridges and 26 Box culverts are proposed. In Chetpet Spur road, 1 Minor bridges and 26 Box culverts are proposed. Summary of structures are given in below Table.

Sl. No.	Type of structure	New Construction	Reconstruction	Widening with minor repairs	Retain + New Constructio n	Reconstructi on + New Constructio n	SR-New Constrution + MCW-New Constructio n	SR-New Constrution + MCW-Reconstructio n	Total
Tiruvannamalai Spur road									
1	Minor bridge	1	-	1	-	1	-	-	3
2	Box Culverts	-	19	7	-	-	-	-	26
Chetpet Spur road									
1	Minor bridge	-	-	-	-	1	-	-	1
2	Box Culverts	-	6	5	-	-	-	-	11
Kanchipuram Spur road									
1	Major bridge	-	-	-	1	-	-	-	1
2	Minor bridge	-	-	-	-	4	-	-	4
3	Box Culverts	-	17	-	-	-	-	-	17

7.8.1 MAJOR BRIDGES

23 new major bridges, 1 Major bridge cum Flyover, 1 Major bridge cum ROB, 1 ROB Cum MJB Cum Flyover Cum Interchange are proposed along the project stretch. The details of the Major Bridges are given in below Table.

Major bridge - New construction

Table 7-33 Details of Major bridge proposed for New Construction

Sl. No.	Proposed Chainage	Span Arrangement	Total Length (m)	Type of Structure			Proposed Width (m)	Remarks
		No.of Spans x Span Length(m)		Super Structure	Sub Structure	Foundation		
1	5+700	3x30.00	90.00	PSC I-Girder + Deck Slab	RCC Abutment & Piers	Open	21.25 + M + 21.25	-
2	14+230	3x30.00	90.00	PSC I-Girder + Deck Slab	RCC Abutment & Piers	Pile	21.25 + M + 21.25	Inlet/Outlet of Kanchivakkam Pond on RHS
3	15+980	15x35.00	525.00	PSC I-Girder + Deck Slab	RCC Abutment & Piers	Pile	21.25 + M + 21.25	Crossing Pond
4	35+230	10x30.00	300.00	PSC I-Girder + Deck Slab	RCC Abutment & Piers	Pile	21.25 + M + 21.25	Pond near Sirumailur
5	42+440	3x30.00	90.00	PSC I-Girder + Deck Slab	RCC Abutment & Piers	Open	21.25 + M + 21.25	-
6	68+720	4x30.00	120.00	PSC I-Girder + Deck Slab	RCC Abutment & Piers	Pile	21.25 + M + 21.25	-

Sl. No.	Proposed Chainage	Span Arrangement	Total Length (m)	Type of Structure			Proposed Width (m)	Remarks
		No.of Spans x Span Length(m)		Super Structure	Sub Structure	Foundation		
7	70+720	7x30.00	210.00	PSC I-Girder + Deck Slab	RCC Abutment & Piers	Pile	21.25 + M + 21.25	-
8	77+250	6x30.00	180.00	PSC I-Girder + Deck Slab	RCC Abutment & Piers	Open	21.25 + M + 21.25	-
9	82+070	6x30.00	180.00	PSC I-Girder + Deck Slab	RCC Abutment & Piers	Open	21.25 + M + 21.25	-
10	117+000	10x30.00	300.00	PSC I-Girder + Deck Slab	RCC Abutment & Piers	Open	21.25 + M + 21.25	-
11	138+480	3x30.00	90.00	PSC I-Girder + Deck Slab	RCC Abutment & Piers	Open	21.25 + M + 21.25	Crossing Cheyyar River
12	140+930	4x30.00	120.00	PSC I-Girder + Deck Slab	RCC Abutment & Piers	Open	21.25 + M + 21.25	-
13	157+260	4x30.00	120.00	PSC I-Girder + Deck Slab	RCC Abutment & Piers	Open	21.25 + M + 21.25	Crossing Cheyyar River
14	159+395	11x35.00	385.00	PSC I-Girder + Deck Slab	RCC Abutment & Piers	Pile	21.25 + M + 21.25	-
15	162+520	11x40.00	440.00	PSC I-Girder + Deck Slab	RCC Abutment & Piers	Pile	21.25 + M + 21.25	-

Sl. No.	Proposed Chainage	Span Arrangement	Total Length (m)	Type of Structure			Proposed Width (m)	Remarks
		No.of Spans x Span Length(m)		Super Structure	Sub Structure	Foundation		
16	163+750	7x40.00	280.00	PSC I-Girder + Deck Slab	RCC Abutment & Piers	Pile	21.25 + M + 21.25	-
17	167+670	14x40.00	560.00	PSC I-Girder + Deck Slab	RCC Abutment & Piers	Pile	21.25 + M + 21.25	-
18	183+560	6x40.00	240.00	PSC I-Girder + Deck Slab	RCC Abutment & Piers	Pile	21.25+M+21.25	Crossing Ponnaiyar River
19	202+140	6x40.00	240.00	PSC I-Girder + Deck Slab	RCC Abutment & Piers	Pile	21.25+M+21.25	-
20	206+840	6x40.00	240.00	PSC I-Girder + Deck Slab	RCC Abutment & Piers	Pile	21.25+M+21.25	-
21	207+690	4x30.00	120.00	PSC I-Girder+Deck Slab	RCC Abutment & Piers	Open	21.25+M+21.25	Crossing Vaniyar River
22	210+100	4x25.00	100.00	PSC-I-Girder+Deck Slab	RCC Abutment & Piers	Open	21.25+M+21.25	Crossing Vaniyar River
23	5+620	7x30.00	210.00	PSC I-Girder + Deck Slab	RCC Abutment & Piers	Pile	21.25+M+21.25	Crossing Pond

Note:
*S.No-1-22 belongs to NH-179B-Chennai-Harur Stretch & S.No-23 belongs to NH-179A-Salem-Harur Stretch.

7.8.2 Major bridge Cum Flyover - New construction

The details of the Major Bridge Cum Flyover are given in below Table.

Table 7-34: Details of Major bridge Cum Flyover proposed for New Construction

Sl. No.	Proposed Chainage	Span Arrangement	Total Length (m)	Type of Structure			Proposed Width (m)	Remarks
		No.of Spans x Span Length(m)		Super Structure	Sub Structure	Foundation		
1	60+110	2x30.00 (Pond) + 1x30.00 (Road) + 3x30.00 (Pond)	180.00	PSC I-Girder + Deck Slab	RCC Abutment & Piers	Pile	21.25 + M + 21.25	Crossing SH-116; LHS-Vandavasi, RHS-Kanchipuram

7.8.3 Major bridge Cum ROB - New construction

The details of the Major Bridge Cum ROB are given in below Table.

Table 7-35: Details of Major bridge Cum ROB proposed for New Construction

Sl. No.	Proposed Chainage	Span Arrangement	Total Length (m)	Type of Structure			Proposed Width (m)	Remarks
		No.of Spans x Span Length(m)		Super Structure	Sub Structure	Foundation		
1	120+545	7x30.00 + 1x45.40 + 1x20.00	275.40	Bow string Girder & PSC I-Girder & RCC I-Girder + Deck Slab	RCC Abutment & Piers	Pile & Open	21.25 + M + 21.25	Crossing Railway Line& Pond; LHS-Thurinjapuram Railway Station; RHS-Kalambur Railway Station

7.8.4 ROB Cum MJB Cum Flyover Cum Interchange - New construction

The details of the ROB Cum MJB Cum Flyover Cum Interchange are given in below Table.

Table 7-36: Details of ROB Cum Flyover Cum Interchange Cum MJB proposed for New Construction

Sl. No.	Proposed Chainage	Span Arrangement	Total Length (m)	Type of Structure			Proposed Width (m)	Remarks
		No.of Spans x Span Length(m)		Super Structure	Sub Structure	Foundation		
1	24+580	3x20.00+1x37.20(Railway Span)+2x25.00+1x25.00(SH-58 Crossing)+6x35.00+28x35.00(River Spans), Loop-1x20.00+1x37.20(Railway Span)+6x35.00(Pond)	1629.40	RCC-I-Girder & PSC-I-Girder & Steel Composite Girder(Railway Span) + Deck Slab	RCC Abutment & Piers	Pile	21.25 + M + 21.25	Crossing Palar River and SH-58 and Railway track;LHS-Villiyambakkam Railway Station;RHS-Palur railway Station

Note:

*S.No-1 belongs to NH-179B-Chennai-Harur Stretch.

Spur Road:

7.8.5 Major bridge – Existing Retained+New construction

In Tiruvannamalai and Chetpet Spur road, there is no major bridge proposed. In Kanchipuram Spur road, 1 existing Major bridge is retained with new 2 Lane Bridge and parallel new 3 lane major bridge is proposed.

Table 7-37: Details of Major bridge proposed for Existing retained + New construction

Sl. No.	Existing Km Stone	Proposed Chainage	Existing Details						Proposed Details					
			Structure no.	Span Arrangement	Type of Structure			Existing Width (m)	Proposal	Span Arrangement	Type of Structure			Proposed Width (m)
				No.of Spans x Span Length (m)	Super Structure	Sub Structure	Foundation			No.of Spans x Span Length (m)	Super Structure	Sub Structure	Foundation	
Kanchipuram Spur road														
1	30.120	29+680	-	5x14.50	RCC-I-Girder+Deck Slab	RCC Wall type Abutment and RCC Hammer head Circular type piers	Pile	11.60	LHS-MCW--New Construction ; RHS MCW-Existing Retained;+2 lane bridge New Construction	5x15.00	RCC I-Girder + Deck Slab	RCC Abutment & Pier	Pile	16.00+M+Existing+M+12.50

7.8.6 Minor Bridges

156 Minor bridges are proposed along the project stretch of which 116 minor bridges are proposed for new construction, 1 minor bridge is proposed for reconstruction, 38 minor bridges are proposed for new construction with service road on both sides, 1 existing minor bridge is proposed for reconstruction on one side main carriageway and parallel new bridge on other side main carriageway and new service road bridges are proposed.

Minor bridge- New construction

Table 7-38: Details of Minor Bridges proposed for New Construction

Sl. No.	Proposed Chainage	Span Arrangement	Type of Structure			Proposed Width (m)	Remarks
		No.of Spans x Span Length(m)	Super Structure	Sub Structure	Foundation		
1	5.060	1x20.00	RCC I-Girder + Deck Slab	RCC Abutment	Open	21.25 + M + 21.25	-
2	12.960	1x10.00	RCC Solid Slab	RCC Abutment	Open	21.25 + M + 21.25	Nala training to be done on RHS of length 400m
3	13.620	1x10.00	RCC Solid Slab	RCC Abutment	Open	21.25 + M + 21.25	In grade separator approach; Nala Training to be done on RHS of length 250m
4	26.650	2x30.00	PSC I-Girder + Deck Slab	RCC Abutment & Pier	Pile	21.25 + M + 21.25	Crossing pond
5	26.980	2x30.00	PSC I-Girder + Deck Slab	RCC Abutment & Pier	Pile	21.25 + M + 21.25	-
6	28.615	1x10.00	RCC Solid Slab	RCC Abutment	Open	21.25 + M + 21.25	-
7	30.080	2x20.00	RCC I-Girder + Deck Slab	RCC Abutment & Pier	Open	21.25 + M + 21.25	-

Sl. No.	Proposed Chainage	Span Arrangement	Type of Structure			Proposed Width (m)	Remarks
		No.of Spans x Span Length(m)	Super Structure	Sub Structure	Foundation		
8	31.870	1x8.00	RCC Box			21.25 + M + 21.25	-
9	32.875	1x8.00	RCC Box			21.25 + M + 21.25	Nala training to be done on RHS
10	33.000	1x8.00	RCC Box			21.25 + M + 21.25	Nala training to be done on LHS
11	33.670	1x10.00	RCC Solid Slab	RCC Abutment	Open	21.25 + M + 21.25	Nala training to be done
12	35.665	1x8.00	RCC Box			21.25 + M + 21.25	-
13	38.430	1x8.00	RCC Box			21.25 + M + 21.25	In grade separator approach
14	38.620	2x20.00	RCC I-Girder + Deck Slab	RCC Abutment & Pier	Open	21.25 + M + 21.25	-
15	40.870	2x20.00	RCC I-Girder + Deck Slab	RCC Abutment & Pier	Open	21.25 + M + 21.25	-
16	42.090	1x8.00	RCC Box			21.25 + M + 21.25	Nala Training to be done on bothsides
17	42.930	2x30.00	PSC I-Girder + Deck Slab	RCC Abutment & Pier	Open	21.25 + M + 21.25	-
18	43.580	1x15.00	RCC I-Girder + Deck Slab	RCC Abutment	Open	21.25 + M + 21.25	In grade separator approach; Nala Training to be done
19	45.600	1x8.00	RCC Box			21.25 + M + 21.25	-
20	46.020	1x8.00	RCC Box			21.25 + M + 21.25	Nala Training to be done on

Sl. No.	Proposed Chainage	Span Arrangement	Type of Structure			Proposed Width (m)	Remarks
		No.of Spans x Span Length(m)	Super Structure	Sub Structure	Foundation		
							RHS of length 150m
21	48.630	2x25.00	PSC I-Girder + Deck Slab	RCC Abutment & Pier	Open	21.25 + M + 21.25	-
22	50.120	1x15.00	RCC I-Girder + Deck Slab	RCC Abutment	Open	21.25 + M + 21.25	Nala Training to be done
23	51.990	2x20.00	RCC I-Girder + Deck Slab	RCC Abutment & Pier	Open	21.25 + M + 21.25	-
24	53.240	2x30.00	PSC I-Girder + Deck Slab	RCC Abutment & Pier	Open	21.25 + M + 21.25	-
25	58.500	1x8.00	RCC Box			21.25 + M + 21.25	-
26	59.340	1x15.00	RCC I-Girder + Deck Slab	RCC Abutment	Open	21.25 + M + 21.25	-
27	63.130	1x10.00	RCC Solid Slab	RCC Abutment	Open	21.25 + M + 21.25	-
28	63.760	1x8.00	RCC Box			21.25 + M + 21.25	-
29	64.610	1x10.00	RCC Solid Slab	RCC Abutment	Open	21.25 + M + 21.25	Nala training to be done
30	65.060	1x10.00	RCC Solid Slab	RCC Abutment	Open	21.25 + M + 21.25	Nala training to be done
31	66.165	1x10.00	RCC Solid Slab	RCC Abutment	Open	21.25 + M + 21.25	Nala training to be done

Sl. No.	Proposed Chainage	Span Arrangement	Type of Structure			Proposed Width (m)	Remarks
		No.of Spans x Span Length(m)	Super Structure	Sub Structure	Foundation		
32	71.040	1x8.00	RCC Box			21.25 + M + 21.25	-
33	72.260	1x10.00	RCC Solid Slab	RCC Abutment	Open	21.25 + M + 21.25	In grade separator approach
34	72.510	1x10.00	RCC Solid Slab	RCC Abutment	Open	21.25 + M + 21.25	-
35	73.475	2x30.00	PSC I-Girder + Deck Slab	RCC Abutment & Pier	Open	21.25 + M + 21.25	-
36	74.680	1x15.00	RCC I-Girder + Deck Slab	RCC Abutment	Open	21.25 + M + 21.25	-
37	78.270	1x20.00	RCC I-Girder + Deck Slab	RCC Abutment	Open	21.25 + M + 21.25	-
38	78.880	1x20.00	RCC I-Girder + Deck Slab	RCC Abutment	Open	21.25 + M + 21.25	-
39	82.890	1x10.00	RCC Solid Slab	RCC Abutment	Open	21.25 + M + 21.25	Nala Training to be done on RHS
40	89.495	1x8.00	RCC Box			21.25 + M + 21.25	-
41	90.510	1x8.00	RCC Box			21.25 + M + 21.25	-
42	91.780	1x10.00	RCC Solid Slab	RCC Abutment	Open	21.25 + M + 21.25	-
43	95.050	1x15.00	RCC I-Girder + Deck Slab	RCC Abutment	Open	21.25 + M + 21.25	-
44	97.720	1x20.00	RCC I-Girder + Deck Slab	RCC Abutment	Open	21.25 + M + 21.25	-
45	98.320	1x10.00	RCC Solid Slab	RCC Abutment	Open	21.25 + M + 21.25	-

Sl. No.	Proposed Chainage	Span Arrangement	Type of Structure			Proposed Width (m)	Remarks
		No.of Spans x Span Length(m)	Super Structure	Sub Structure	Foundation		
46	98.580	1x20.00	RCC I-Girder + Deck Slab	RCC Abutment	Open	21.25 + M + 21.25	-
47	98.995	1x10.00	RCC Solid Slab	RCC Abutment	Open	21.25 + M + 21.25	In grade separator approach
48	99.250	1x10.00	RCC Solid Slab	RCC Abutment	Open	21.25 + M + 21.25	-
49	99.380	1x10.00	RCC Solid Slab	RCC Abutment	Open	21.25 + M + 21.25	Nala training to be done on bothsides
50	99.905	1x10.00	RCC Solid Slab	RCC Abutment	Open	21.25 + M + 21.25	-
51	101.840	1x10.00	RCC Solid Slab	RCC Abutment	Open	21.25 + M + 21.25	-
52	106.240	1x20.00	RCC I-Girder + Deck Slab	RCC Abutment	Open	21.25 + M + 21.25	-
53	106.450	1x10.00	RCC Solid Slab	RCC Abutment	Open	21.25 + M + 21.25	-
54	106.740	1x15.00	RCC I-Girder + Deck Slab	RCC Abutment	Open	21.25 + M + 21.25	Nala training to be done for length of 200m on bothsides
55	107.870	1x20.00	RCC I-Girder + Deck Slab	RCC Abutment	Open	21.25 + M + 21.25	-
56	108.660	1x10.00	RCC Solid Slab	RCC Abutment	Open	21.25 + M + 21.25	-
57	113.285	1x8.00	RCC Box			21.25 + M + 21.25	-
58	116.230	1x10.00	RCC Solid Slab	RCC Abutment	Open	21.25 + M + 21.25	Nala training to be done for length of 100m on RHS
59	118.200	1x10.00	RCC Solid Slab	RCC Abutment	Open	21.25 + M + 21.25	-
60	118.370	1x10.00	RCC Solid Slab	RCC	Open	21.25 + M + 21.25	-

Sl. No.	Proposed Chainage	Span Arrangement	Type of Structure			Proposed Width (m)	Remarks
		No.of Spans x Span Length(m)	Super Structure	Sub Structure	Foundation		
				Abutment			
61	123.580	1x20.00	RCC I-Girder + Deck Slab	RCC Abutment	Open	21.25 + M + 21.25	-
62	132.720	1x15.00	RCC I-Girder + Deck Slab	RCC Abutment	Open	21.25 + M + 21.25	Nala training is to be done on LHS of length 180.0m
63	133.680	1x8.00	RCC Box			21.25 + M + 21.25	-
64	138.940	1x10.00	RCC Solid Slab	RCC Abutment	Open	21.25 + M + 21.25	-
65	139.200	1x10.00	RCC Solid Slab	RCC Abutment	Open	21.25 + M + 21.25	-
66	139.940	1x10.00	RCC Solid Slab	RCC Abutment	Open	21.25 + M + 21.25	-
67	142.680	1x15.00	RCC I-Girder + Deck Slab	RCC Abutment	Open	21.25 + M + 21.25	Nala training is to be done on LHS of length 300.0m
68	145.990	2x30.00	PSC I-Girder + Deck Slab	RCC Abutment & Pier	Open	21.25 + M + 21.25	Crossing Cheyyar River
69	146.700	1x8.00	RCC Box			21.25 + M + 21.25	Nala training is to be done on LHS of length 150.0m
70	147.110	1x10.00	RCC Solid Slab	RCC Abutment	Open	21.25 + M + 21.25	Nala training is to be done on LHS of length 150.0m
71	147.340	2x30.00	PSC I-Girder + Deck Slab	RCC Abutment & Pier	Open	21.25 + M + 21.25	Crossing Cheyyar River
72	152.020	2x20.00	RCC I-Girder + Deck Slab	RCC Abutment &	Open	21.25 + M + 21.25	-

Sl. No.	Proposed Chainage	Span Arrangement	Type of Structure			Proposed Width (m)	Remarks
		No.of Spans x Span Length(m)	Super Structure	Sub Structure	Foundation		
				Pier			
73	154.180	2x20.00	RCC I-Girder + Deck Slab	RCC Abutment & Pier	Open	21.25 + M + 21.25	-
74	158.960	1x10.00	RCC Solid Slab	RCC Abutment	Open	21.25 + M + 21.25	-
75	158.850	1x10.00	RCC Solid Slab	RCC Abutment	Open	21.25 + M + 21.25	-
76	160.425	2x30.00	PSC I-Girder + Deck Slab	RCC Abutment & Pier	Open	21.25 + M + 21.25	-
77	162.050	1x30.00	PSC I-Girder + Deck Slab	RCC Abutment	Open	21.25 + M + 21.25	Nala training to be done on bothsides
78	169.000	1x10.00	RCC Solid Slab	RCC Abutment	Open	21.25 + M + 21.25	Nala training to be done on LHS for length 280.0m_Cross road MNB to be reconstructed
79	169.330	1x8.00	RCC Box			21.25 + M + 21.25	-
80	170.750	1x10.00	RCC Solid Slab	RCC Abutment	Open	21.25 + M + 21.25	Nala training to be done on LHS for length 60.0m
81	171.780	1x10.00	RCC Solid Slab	RCC Abutment	Open	21.25 + M + 21.25	Nala training to be done on bothsides
82	172.485	1x15.00	RCC I-Girder + Deck Slab	RCC Abutment	Open	21.25 + M + 21.25	-
83	174.030	1x10.00	RCC Solid Slab	RCC Abutment	Open	21.25 + M + 21.25	-

Sl. No.	Proposed Chainage	Span Arrangement	Type of Structure			Proposed Width (m)	Remarks
		No.of Spans x Span Length(m)	Super Structure	Sub Structure	Foundation		
84	175.760	1x8.00	RCC Box			21.25 + M + 21.25	In grade separator approach
85	179.120	1x25.00	PSC I-Girder + Deck Slab	RCC Abutment	Open	21.25 + M + 21.25	Nala training to be done on RHS for length 200.0m & 100.0m at Dch.179.550
86	180.940	1x25.00	PSC I-Girder+Deck Slab	RCC Abutment	Open	21.25 + M+ 21.25	-
87	181.260	1x25.00	PSC I-Girder+Deck Slab	RCC Abutment	Open	21.25 + M+ 21.25	-
88	181.260	1x8.00	RCC Box			21.25 + M+ 21.25	-
89	186.140	1x8.00	RCC Box			21.25 + M+ 21.25	-
90	187.360	1x8.00	RCC Box			21.25 + M+ 21.25	-
91	188.640	1x20.00	RCC I-Girder+Deck Slab	RCC Abutment	Open	21.25 + M+ 21.25	-
92	188.970	2x30.00	PSC I-Girder+Deck Slab	RCC Abutment & Pier	Open	21.25 + M+ 21.25	-
93	192.900	1x10.00	RCC Solid Slab	RCC Abutment	Open	21.25 + M+ 21.25	-
94	193.750	1x8.00	RCC Box			21.25 + M+ 21.25	Nala training to be done on RHS of length 100m
95	194.040	1x8.00	RCC Box			21.25 + M+ 21.25	-
96	194.880	1x8.00	RCC Box			21.25 + M+ 21.25	-

Sl. No.	Proposed Chainage	Span Arrangement	Type of Structure			Proposed Width (m)	Remarks
		No.of Spans x Span Length(m)	Super Structure	Sub Structure	Foundation		
97	196.160	1x8.00	RCC Box			21.25 + M + 21.25	In approach of Grade separator_Nala training is required and cross road bridge need to be reconstructed
98	196.480	1x8.00	RCC Box			21.25 + M + 21.25	-
99	197.600	1x30.00	PSC-I-Girder+Deck Slab	RCC Abutment	Open	21.25 + M+ 21.25	Nala_Nala training to be done on RHS of length 200m
100	197.920	1x10.00	RCC Solid Slab	RCC Abutment	Open	21.25 + M+ 21.25	-
101	203.780	1x8.00	RCC Box	-	-	21.25 + M+ 21.25	Nala training to be done of length 100m
102	204.700	2x30.00	PSC I-Girder+Deck Slab	RCC Abutment & Pier	Open	21.25 + M+ 21.25	Nala taining to be done of length 180m
103	207.080	1x10.00	RCC Solid Slab	RCC Abutment	Open	21.25 + M+ 21.25	-
104	209.760	2x20.00	RCC I-Girder+Deck Slab	RCC Abutment & Pier	Open	21.25 + M+ 21.25	Crossing Vaniyar River
105	211.850	1x25.00	PSC I-Girder+Deck Slab	RCC Abutment	Open	21.25 + M + 21.25	-
106	53.000	1x8.00	RCC Box			21.25+M+21.25	-
107	52.440	1x30.00	PSC I-Girder + Deck Slab	RCC Abutment	Open	21.25+M+21.25	-
108	50.730	1x30.00	PSC I-Girder + Deck Slab	RCC Abutment	Open	21.25+M+21.25	-

Sl. No.	Proposed Chainage	Span Arrangement	Type of Structure			Proposed Width (m)	Remarks
		No.of Spans x Span Length(m)	Super Structure	Sub Structure	Foundation		
109	50.450	1x30.00	PSC I-Girder + Deck Slab	RCC Abutment	Open	21.25+M+21.25	-
110	31.380	1x11.00	RCC Solid Slab	RCC Abutment	Open	21.25+M+21.25	-
111	30.220	1x11.00	RCC Solid Slab	RCC Abutment	Open	21.25 + M+ 21.25	-
112	26.500	1x10.00	RCC Solid Slab	RCC Abutment	Open	21.25 + M+ 21.25	-
113	25.220	1x12.00	RCC Solid Slab	RCC Abutment	Open	21.25 + M+ 21.25	Nala training to be done
114	17.200	1x10.00	RCC Solid Slab	RCC Abutment	Open	21.25 + M+ 21.25	Nala training to be done
115	14.960	1x10.00	RCC Solid Slab	RCC Abutment	Open	21.25 + M+ 21.25	Nala training to be done
116	9.940	1x15.00	RCC I Girder+Deck Slab	RCC Abutment	Open	21.25 + M+ 21.25	-

Note:

*S.No-1-105 belongs to NH-179B-Chennai-Harur Stretch & S.No-106-116 belongs to NH-179A-Salem-Harur Stretch.

Minor Bridge – Reconstruction

Table 7-39: Details of Minor Bridges proposed for Reconstruction

Sl. No.	Existing Km Stone	Proposed Chainage	Existing Details						Proposed Details					
			Structure no.	Span Arrangement	Type of Structure			Existing Width (m)	Proposal	Span Arrangement	Type of Structure			Proposed Width (m)
				No.of Spans x Span Length (m)	Super Structure	Sub Structure	Foundation			No.of Spans x Span Length (m)	Super Structure	Sub Structure	Foundation	
1	*	139+560	-	2x20.00	-	-	-	7.00	Reconstruction	2x20.00	RCC Girder + Deck Slab	RCC Abutment & Pier	Open	21.25 + M + 21.25

*Minor Bridge on Crossroad is reconstructed.

Minor Bridge – SR-New Construction + MCW-New Construction

Table 7-40: Details of Minor Bridges proposed for SR-New Construction + MCW-New Construction

Sl. No.	Proposed Chainage	Span Arrangement	Type of Structure			Proposed Width (m)	Remarks
		No.of Spans x Span Length(m)	Super Structure	Sub Structure	Foundation		
1	1.280	1x20.00	RCC I-Girder + Deck Slab	RCC Abutment	Open	11.00 + M + 21.25 + M + 21.25 + M + 11.00	-
2	1.385	1x20.00	RCC I-Girder + Deck Slab	RCC Abutment	Open	11.00 + M + 21.25 + M + 21.25 + M + 11.00	-
3	6.570	2x20.00	RCC I-Girder + Deck Slab	RCC Abutment & Pier	Open	11.00 + M + 21.25 + M + 21.25 + M + 11.00	In grade separator approach
4	9.950	1x10.00	RCC Solid Slab	RCC Abutment	Open	11.00 + M + 21.25 + M + 21.25 + M + 11.00	-
5	11.170	1x8.00	RCC Box			11.00 + M + 21.25 + M + 21.25 + M + 11.00	In grade separator approach
6	11.495	1x15.00	RCC I-Girder + Deck Slab	RCC Abutment	Open	11.00 + M + 21.25 + M + 21.25 + M + 11.00	In grade separator approach
7	20.250	2x30.00	PSC I-Girder + Deck Slab	RCC Abutment & Pier	Open	11.00 + M + 21.25 + M + 21.25 + M + 11.00	-
8	20.740	2x25.00	PSC I-Girder + Deck Slab	RCC Abutment & Pier	Open	11.00 + M + 21.25 + M + 21.25 + M + 11.00	In grade separator approach
9	26.040	1x10.00	RCC Solid Slab	RCC Abutment	Open	11.00 + M + 21.25 + M + 21.25 + M + 11.00	In grade separator approach
10	26.170	1x10.00	RCC Solid Slab	RCC Abutment	Open	11.00 + M + 21.25 + M + 21.25 + M + 11.00	In grade separator approach

Sl. No.	Proposed Chainage	Span Arrangement	Type of Structure			Proposed Width (m)	Remarks
		No.of Spans x Span Length(m)	Super Structure	Sub Structure	Foundation		
11	56.430	2x30.00	PSC I-Girder + Deck Slab	RCC Abutment & Pier	Open	11.00 + M + 21.25 + M + 21.25 + M + 11.00	-
12	67.070	2x20.00	RCC I-Girder + Deck Slab	RCC Abutment & Pier	Open	11.00 + M + 21.25 + M + 21.25 + M + 11.00	In grade separator approach
13	87.650	1x30.00	PSC I-Girder + Deck Slab	RCC Abutment	Open	11.00 + M + 21.25 + M + 21.25 + M + 11.00	-
14	88.420	2x20.00	RCC I-Girder + Deck Slab	RCC Abutment & Pier	Open	11.00 + M + 21.25 + M + 21.25 + M + 11.00	-
15	88.420	2x20.00	RCC I-Girder + Deck Slab	RCC Abutment & Pier	Open	11.00+M+21.25 + M + 21.25+M+11.00	
16	122.250	2x20.00	RCC I-Girder + Deck Slab	RCC Abutment & Pier	Open	11.00 + M + 21.25 + M + 21.25 + M + 11.00	-
17	122.740	1x20.00	RCC I-Girder + Deck Slab	RCC Abutment	Open	11.00 + M + 21.25 + M + 21.25 + M + 11.00	Nala training is to be done on RHS of length 160.0m
18	126.720	1x8.00	RCC Box			11.00 + M + 21.25 + M + 21.25 + M + 11.00	-
19	184.190	1x30.00	PSC I-Girder+Deck Slab	RCC Abutment	Open	11.00 + M + 21.250 + M + 21.25 + M + 11.00	-
20	184.460	2x25.00	PSC I-Girder + Deck Slab	RCC Abutment & Pier	Open	11.00 + M + 21.25 + M + 21.25 + M + 11.00	-
21	216.360	1x15.00	RCC I-	RCC	Open	11.00 + M + 21.25 + M	Nala training to be done

Sl. No.	Proposed Chainage	Span Arrangement	Type of Structure			Proposed Width (m)	Remarks
		No.of Spans x Span Length(m)	Super Structure	Sub Structure	Foundation		
			Girder+Deck Slab	Abutment		+ 21.25 + M + 11.00	
22	217.200	1x8.00	RCC Box			11.00 + M + 21.25 + M + 21.25 + M + 11.00	Nala training to be done
23	217.520	1x20.00	RCC I-Girder+Deck Slab	RCC Abutment	Open	11.00 + M + 21.25 + M + 21.25 + M + 11.00	-
24	218.620	1x10.00	RCC Solid Slab	RCC Abutment	Open	11.00 + M + 21.25 + M + 21.25 + M + 11.00	-
25	219.230	1x8.00	RCC Box			11.00 + M + 21.25 + M + 21.25 + M + 11.00	-
26	57.260	1x8.00	RCC Box			11.00 + M + 21.25 + M + 21.25 + M + 11.00	-
27	56.920	1x8.00	RCC Box			11.00 + M + 21.25 + M + 21.25 + M + 11.00	-
28	56.190	1x8.00	RCC Box			11.00 + M + 21.250 + M + 21.25 + M + 11.00	In Grade Seperator approach;Nala traine to be done for a length of 200.00m
29	50.110	1x9.00	RCC Box			11.00 + M + 21.25 + M + 21.25 + M + 11.00	-
30	46.160	1x12.00	RCC Solid Slab	RCC Abutment	Open	11.00 + M + 21.250 + M + 21.25 + M + 11.00	-
31	43.930	1x10.00	RCC Solid Slab	RCC Abutment	Open	11.00 + M + 21.25 + M + 21.25 + M + 11.00	-
32	43.780	1x8.00	RCC Box			11.00 + M + 21.25 + M + 21.25 + M + 11.00	-
33	41.300	1x8.00	RCC Box			11.00 + M + 21.25 + M + 21.25 + M + 11.00	-

Sl. No.	Proposed Chainage	Span Arrangement	Type of Structure			Proposed Width (m)	Remarks
		No.of Spans x Span Length(m)	Super Structure	Sub Structure	Foundation		
34	40.540	1x8.00	RCC Box			11.00 + M + 21.25 + M + 21.25 + M + 11.00	Nala training to be done
35	21.800	1x30.00	PSC I-Girder + Deck Slab	RCC Abutment	Open	11.00 + M + 21.25 + M + 21.25 + M + 11.00	-
36	6.500	1x12.00	RCC Solid Slab	RCC Abutment	Open	11.00 + M + 21.250 + M + 21.25 + M + 11.00	-
37	3.960	1x12.00	RCC Solid Slab	RCC Abutment	Open	11.00 + M + 21.25 + M + 21.25 + M + 11.00	Pond on LHS
38	0.660	2x30.00	PSC I-Girder + Deck Slab	RCC Abutment & Pier	Pile	11.00 + M + 21.25 + M + 21.25 + M + 11.00	Crossing River

Note:

*S.No-1-25 belongs to NH-179B-Chennai-Harur Stretch & S.No-26-38 belongs to NH-179A-Salem-Harur Stretch.

Minor Bridge - SR-New Construction +MCW-Reconstruction + SR & MCW-New Construction

Table 7-41: Details of Minor Bridges proposed for SR-New Construction +MCW-Reconstruction + New Construction

Sl. No.	Existing Km Stone	Proposed Chainage	Existing Details						Proposed Details					
			Structure no.	Span Arrangement	Type of Structure			Existing Width (m)	Proposal	Span Arrangement	Type of Structure			Proposed Width (m)
				No.of Spans x Span Length (m)	Super Structure	Sub Structure	Foundation			No.of Spans x Span Length (m)	Super Structure	Sub Structure	Foundation	
1	-	1+905	-	1x15.00	RCC I-Girder + Deck Slab	RCC Abutment	Open	12.00+M +12.00	LHS-SR-New Construction + MCW-Reconstruction; RHS-MCW-New construction + SR-New Construction	1x15.00	RCC I-Girder + Deck Slab	RCC Abutment	Open	11.00 + M + 21.25 + M + 21.25 + M + 11.00

Note:

*S.No-1 belongs to NH-179B-Chennai-Harur Stretch.

Spur Road:

In Tiruvannamalai Spur road, 3 minor bridges are proposed of which 1 minor bridge is proposed for new construction, 1 minor bridge is reconstructed and parallel new bridge is proposed on other side and 1 minor bridge is proposed for widening with minor repairs. In Chetpet spur road, 1 minor bridge is reconstructed and parallel new bridge is proposed on other side. In Kanchipuram Spur road, 4 minor bridges are reconstructed and parallel new bridge is proposed on other side.

Minor bridge- New construction

Table 7-42: Details of Minor Bridges proposed for New Construction

Sl. No.	Proposed Chainage	Span Arrangement	Type of Structure			Proposed Width (m)	Remarks
		No.of Spans x Span Length(m)	Super Structure	Sub Structure	Foundation		
Tiruvannamalai Spur road							
1	0+500	2x20.00	RCC I-Girder + Deck Slab	RCC Abutment and Pier	Open	12.50+M+12.50	-

Minor bridge – Reconstruction+New construction

In Tiruvannamalai and Chetpet Spur road, there is no major bridge proposed. In Kanchipuram Spur road, 1 existing Major bridge is retained with new 2 lane bridge and parallel new 3 lane major bridge is proposed.

Table 7-43: Details of Minor bridge proposed for Reconstruction + New construction

Sl. No.	Existing Km Stone	Proposed Chainage	Existing Details						Proposed Details					
			Structure no.	Span Arrangement	Type of Structure			Existing Width (m)	Proposal	Span Arrangement	Type of Structure			Proposed Width (m)
				No.of Spans x Span Length (m)	Super Structure	Sub Structure	Foundation			No.of Spans x Span Length (m)	Super Structure	Sub Structure	Foundation	
Tiruvannamalai Spur road														
1	132.410	10+000	-	1x6.80	RCC Solid Slab	PCC Abutment	Open	12.00	LHS MCW-Reconstruction; RHS MCW-New Construction	1x7.00	RCC Box	-	-	12.50+M+12.50
Chetpet Spur road														
1	50.210	4+090		LHS-2x3.70 C/C RHS-2x3.40 Clear	LHS-RCC Solid Slab RHS-RCC Box	LHS-BBM Abutment and Piers	Open	13.50	LHS-MCW-Reconstruction; RHS-MCW-New Construction	2x4.00	RCC Box	-	-	12.50+M+12.50
Kanchipuram Spur road														

Sl. No.	Existing Km Stone	Proposed Chainage	Existing Details						Proposed Details					
			Structure no.	Span Arrangement	Type of Structure			Existing Width (m)	Proposal	Span Arrangement	Type of Structure			Proposed Width (m)
				No.of Spans x Span Length (m)	Super Structure	Sub Structure	Foundation			No.of Spans x Span Length (m)	Super Structure	Sub Structure	Foundation	
1	57.700	1+380	58/1	2x3.70	RCC Solid Slab	PCC Abutment and Piers	Open	15.00	LHS-MCW-Reconstruction; RHS-MCW-New Construction	2x4.00	RCC Box	-	-	12.50+M+12.50
2	43.230	16+510	-	4x2.10	Hume Pipe	-	-	19.00	LHS-MCW-Reconstruction; RHS-MCW-New Construction	1x12.00	RCC Solid Slab	RCC Abutment	Open	12.50+M+12.50
3	43.070	16+650	-	2x2.10	Hume Pipe			18.30	LHS-MCW-Reconstruction; RHS-MCW-New Construction	1x8.00	RCC Box	-	-	12.50+M+12.50
4	40.100	19+650	-	5x1.00	Hume Pipe	-	-	20.60	LHS-MCW-Reconstruction; RHS-MCW-New Construction	1x10.00	RCC Solid Slab	RCC Abutment	Open	12.50+M+12.50

Minor bridge – Widening with minor repairs

In Tiruvannamalai and Chetpet Spur road, there is no major bridge proposed. In Kanchipuram Spur road, 1 existing Major bridge is retained with new 2 Lane Bridge and parallel new 3 lane major bridge is proposed.

Table 7-44: Details of Minor bridge proposed for Widening with minor repairs

Sl. No.	Existing Km Stone	Proposed Chainage	Existing Details						Proposed Details					
			Structure no.	Span Arrangement	Type of Structure			Existing Width (m)	Proposal	Span Arrangement	Type of Structure			Proposed Width (m)
				No.of Spans x Span Length (m)	Super Structure	Sub Structure	Foundation			No.of Spans x Span Length (m)	Super Structure	Sub Structure	Foundation	
Tiruvannamalai Spur road														
1	136.100	13+625	-	3x5.00	RCC Box	-	-	12.30	MCW-Widening with minor repairs	3x5.00	RCC Box	-	-	12.50+M+12.50

7.8.7 ROB – New Construction

2 new ROB is proposed along the project stretch and the details are given in below table.

Table 7-45: Details of ROB's proposed for New Construction

Sl. No.	Proposed Chainage	Span Arrangement	Total Length (m)	Type of Structure			Proposed Width (m)	Remarks
		No.of Spans x Span Length(m)		Super Structure	Sub Structure	Foundation		
1	22+140	1x20.00 + 1x37.200 + 1x20.00	76.00	Steel Composite Girder & RCC T-Girder + Deck Slab	RCC Abutment & Piers	Pile & Open	21.25+M+21.25	Crossing Railway Line; LHS-Valappadi Gate Railway Station; RHS-Ayodhyapattanam Railway Station
2	4+630	1x20.00 + 1x45.40 + 1x20.00	76.00	Bow String Girder & RCC T-Girder + Deck Slab	RCC Abutment & Piers	Pile & Open	21.25+M+21.25	Crossing Railway Line; LHS-Rasipuram Railway Station; RHS-Salem Railway Station

Note:

*S.No-1& 2 belongs to NH-179A-Salem-Harur Stretch.

7.8.8 Tunnels– New Construction

3 new Tunnels are proposed along the project stretch and the details are given in below table.

Table 7-46: Details of Tunnels proposed for New Construction

Sl. No.	Proposed Chainage	Span Arrangement	Total Length (m)	Type of Structure			Proposed Width (m)	Remarks
		No.of Spans x Span Length(m)		Super Structure	Sub Structure	Foundation		
1	13+700	1x1000.00	1000.00	Tunnel	-	-	21.45+M+21.45	-
2	12+425	1x750.00	750.00	Tunnel	-	-	21.45+M+21.45	-
3	10+735	1x750.00	750.00	Tunnel	-	-	21.45+M+21.45	-

Note:

*S.No-1-3 belongs to NH-179A-Salem-Harur Stretch.

7.8.9 Culverts

Along the project stretch,there are 524 Box culverts are proposed of which 10 Slab Culverts are proposed for widening with Box,12 Culverts are proposed for reconstruction and 502 culverts are proposed for new construction. Summary of improvement proposal of Culverts are given in below table.

Table 7-47: Summary of culverts

Sl. No.	Type of structure	Widening with minor repairs	Reconstruction	New Construction	Total
1	Box culvert	10	12	502	524

Spur road:

In Tiruvannamalai Spur road, there are 26 Box culverts proposed of which 7 Culverts are proposed for Widening with minor repairs and 19 Culverts are proposed for reconstruction. In Chetpet Spur road, there are 11 Box culverts proposed of which 5 Culverts are proposed for Widening with minor repairs and 6 Culverts are proposed for reconstruction. In Kanchipuram Spur road, there are 17 Box culverts proposed of which 17 Culverts are proposed for reconstruction.

Sl. No.	Type of structure	Widening with minor repairs	Reconstruction	New Construction	Total
Tiruvannamalai Spur road					
1	Box culvert	7	19	-	26
Tiruvannamalai Spur road					
1	Box culvert	5	6	-	11
Tiruvannamalai Spur road					
1	Box culvert	-	17	-	17

7.8.10 Grade Separator

There are 79 grade separators are proposed along the project stretch of which 9 Flyovers, 22 VUP's,2 VOP's, 33 VUP Grade-II, 3 MNB Cum VUP,1 MNB Cum VUP Grade-II,3 Interchanges,3 Trumpet Interchange,2 Double Trumpet Interchange and 1 Cloverleaf Interchange is proposed and the details are given in below table.

Table 7-48: Details of Grade Separators proposed for New Construction

Sl. No.	Proposed Chainage	Proposed Type of Structure	Proposed Details						Remarks
			Span Arrangement	Total Length	Structure Details			Proposed Deck Width	
			No. of Spans x Span Length		Super structure	Sub structure	Foundation		
	(km)	-	(m)	(m)	-	-	-	(m)	-
1	2.200	Trumpet Interchange	2x30.00	60.00	PSC I-Girder + Deck Slab	RCC Abutment & Pier	Pile	21.25 + M + 21.25	Start of Bypass; RHS-SH-48
2	6.460	VUP G-II	1x12.00	12.00	RCC Box	-	-	21.25 + M + 21.25	Crossing Village Road_LHS-Guduvanchey, RHS-Padapai
3	8.440	VUP	1x15.00	15.00	RCC Box	-	-	21.25 + M + 21.25	Village Road/MDR_Ortahur built-Up; LHS-Kattankulathur, RHS-Padapai
4	11.340	VUP	1x15.00	15.00	RCC Box	-	-	21.25 + M + 21.25	Crossing Village Road/MDR;LHS-Ortahur;RHS-Arambakkam; Conecting to NH-45 & SH-57
5	13.470	VUP	1x15.00	15.00	RCC Box	-	-	21.25 + M + 21.25	Crossing Village Road/MDR;LHS-Appur, RHS-Arambakkam;

Sl. No.	Proposed Chainage	Proposed Type of Structure	Proposed Details						Remarks
			Span Arrangement	Total Length	Structure Details			Proposed Deck Width	
			No. of Spans x Span Length		Super structure	Sub structure	Found ation		
	(km)	-	(m)	(m)	-	-	-	(m)	-
									Conecting to SH-57
6	15.460	Flyover	2x30.00	60.00	PSC I-Girder + Deck Slab	RCC Abutment & Pier	Pile	21.25 + M + 21.25	Crossing SH-57;LHS-Singaperumalkoil, RHS-Thiruvallur
7	19.170	VUP	1x15.00	15.00	RCC Box	-	-	21.25 + M + 21.25	Crossing Village Road/MDR; LHS-Reddipalayam, RHS-Eaichur; Connecting to SH-57
8	20.940	VUP G-II	1x12.00	12.00	RCC Box	-	-	21.25 + M + 21.25	Crossing village road;LHS-Reddipalayam;RHS-Kolathancheri
9	26.270	VUP	1x15.00	15.00	RCC Box	-	-	21.25 + M + 21.25	Crossing Village Road/MDR; LHS-Meyyur, RHS-Penayur Road;In Seetanacherry built-Up
10	28.090	VUP	1x15.00	15.00	RCC Box	-	-	21.25 + M + 21.25	Crossing Village Road/MDR; LHS-Arumbuliyur, RHS-Pazhaveri
11	30.810	VUP	1x15.00	15.00	RCC Box	-	-	21.25 + M + 21.25	Crossing Village Road/MDR; LHS-Salavakkam, RHS-Tirumukudal; Connecting to SH-58
12	34.515	VUP	1x15.00	15.00	RCC Box	-	-	21.25 + M + 21.25	Crossing MDR-789;LHS-Anambakkam, RHS-Tirumukkudal

Sl. No.	Proposed Chainage	Proposed Type of Structure	Proposed Details						Remarks
			Span Arrangement	Total Length	Structure Details			Proposed Deck Width	
			No. of Spans x Span Length		Super structure	Sub structure	Foundation		
	(km)	-	(m)	(m)	-	-	-	(m)	-
13	38.195	VUP G-II	1x12.00	12.00	RCC Box	-	-	21.25 + M + 21.25	Crossing Village Road; LHS-Vayalakkavoor, RHS-Elayanarvelur
14	43.710	Flyover	1x25.00	25.00	PSC I-Girder + Deck Slab	RCC Abutment	Pile	21.25 + M + 21.25	Crossing SH-118A;LHS-Kannikulam;RHS-Magaral
15	47.950	VUP G-II	1x12.00	12.00	RCC Box	-	-	21.25 + M + 21.25	Crossing Village Road; LHS-Azhisoor, RHS-Cheyyar-Palar River bank road(South)
16	53.540	VUP G-II	1x12.00	12.00	RCC Box	-	-	21.25 + M + 21.25	Crossing Village road;LHS-Hanumanthandalam;RHS-Perunagar
17	57.005	VUP	1x15.00	15.00	RCC Box	-	-	21.25 + M + 21.25	Crossing Village Road/MDR; LHS-Uthiramerur, RHS-Kanchipuram to Vandavasi Road
18	62.620	VUP G-II	1x12.00	12.00	RCC Box	-	-	21.25 + M + 21.25	Crossing Village road;
19	65.920	VUP G-II	1x12.00	12.00	RCC Box	-	-	21.25 + M + 21.25	Crossing Village road;LHS-Erumaivetti
20	67.395	Interchange	1x25.00	25.00	PSC I-Girder + Deck Slab	RCC Abutment	Pile	21.25 + M + 21.25	Crossing SH-5;LHS-Purisai;RHS-Vinayagapuram; At-grade

Sl. No.	Proposed Chainage	Proposed Type of Structure	Proposed Details						Remarks
			Span Arrangement	Total Length	Structure Details			Proposed Deck Width	
			No. of Spans x Span Length		Super structure	Sub structure	Foundation		
	(km)	-	(m)	(m)	-	-	-	(m)	-
									interchange
21	72.050	VUP G-II	1x12.00	12.00	RCC Box	-	-	21.25 + M + 21.25	Crossing Village Road; LHS-Thenmavanthal, RHS-Vilarippattu
22	75.290	VUP	1x15.00	15.00	RCC Box	-	-	21.25 + M + 21.25	Crossing MDR/SH; LHS- Cheyyar, RHS-Thavasi
23	78.180	VUP G-II	1x12.00	12.00	RCC Box	-	-	21.25 + M + 21.25	Crossing Village road;RHS-Karivelpattu
24	79.400	VUP	1x15.00	15.00	RCC Box	-	-	21.25 + M + 21.25	Crossing MDR/SH; LHS-Vandavasi, RHS-Arani
25	83.420	VUP	1x15.00	15.00	RCC Box	-	-	21.25 + M + 21.25	Crossing Village Road/MDR; LHS-Kozhliplyur, RHS-Peranamallur; Connecting to SH-115
26	86.240	MNB Cum VUP G-II	MCW-1x25.00; SR-1x12.00	25.00	PSC I-Girder & RCC Solid Slab+ Deck Slab	RCC Abutment & Pier	Open	11.00 + M + 21.25 + M + 21.25 + M + 11.00	Crossing Village Road;LHS-Mahadevimangalam;RHS-Alliyandal
27	88.450	VUP G-II	1x12.00	12.00	RCC Box	-	-	21.25 + M + 21.25	Crossing Village road;RHS-Panaiolapadi

Sl. No.	Proposed Chainage	Proposed Type of Structure	Proposed Details						Remarks
			Span Arrangement	Total Length	Structure Details			Proposed Deck Width	
			No. of Spans x Span Length		Super structure	Sub structure	Foundation		
	(km)	-	(m)	(m)	-	-	-	(m)	-
28	90.940	VOP	2x45.00	90.00	PSC Box Girder+Deck Slab	RCC Abutment and Pier	Pile	1x16.00	Crossing Village Road; LHS-Anadimangalam, RHS-Namathodu
29	94.505	Double Trumpet Intechange	1x1x30.00 (SH-Crossing) & 1x30.00 Entry loop & 1x30.00 (Exit loop)	90.00	PSC I-Girder + Deck Slab	RCC Abutment	Pile	21.25 + M + 21.25 (SH-Crossing) & 21.25+M+21.25 +M+9.00 & 16.00+M+9.00	Crossing SH-4; LHS-Chetpet;RHS-Vinnamangalam
30	95.830	VUP G-II	1x12.00	12.00	RCC Box	-	-	21.25 + M + 21.25	Crossing Village Road; LHS-Maruthuvambadyi; RHS-Joins to SH-4
31	98.830	VUP G-II	1x12.00	12.00	RCC Box	-	-	21.25 + M + 21.25	Village Road/MDR; LHS-Nambedu; RHS-Murukkananthal
32	103.480	VOP	2x45.00	90.00	PSC Box Girder+Deck Slab	RCC Abutment and Pier	Pile	1x16.00	Crossing SH-115_LHS-Chetpet; RHS-Devikapuram
33	105.610	VUP	1x15.00	15.00	RCC Box	-	-	21.25 + M + 21.25	Crossing MDR_LHS-Avalurpettai Link Road; RHS-Devikapuram

Sl. No.	Proposed Chainage	Proposed Type of Structure	Proposed Details						Remarks
			Span Arrangement	Total Length	Structure Details			Proposed Deck Width	
			No. of Spans x Span Length		Super structure	Sub structure	Foundation		
	(km)	-	(m)	(m)	-	-	-	(m)	-
34	110.455	VUP G-II	1x12.00	12.00	RCC Box	-	-	21.25 + M + 21.25	Village Road/MDR; LHS-Chittathurai; RHS-Semiyamangalam
35	115.750	VUP	1x15.00	15.00	RCC Box	-	-	21.25 + M + 21.25	Crossing MDR; LHS-Padagem; RHS-Kommananthal connectin gto SH-115
36	121.760	Flyover	1x15.00 + 1x30.00 + 1x15.00	60.00	PSC I-Girder & RCC I-Girder + Deck Slab	RCC Abutment & Piers	Pile	21.25 + M + 21.25	Crossing NH-234; LHS-Tiruvannamalai; RHS-Vellore
37	122.670	Trumpet Interchange	2x30.00	60.00	PSC I-Girder + Deck Slab	RCC Abutment & Pier	Pile	21.25 + M + 21.25	At the start of Tiruvannamalai Spur road
38	125.500	VUP	1x15.00	15.00	RCC Box	-	-	21.25 + M + 21.25	Crossing SH/MDR; LHS-AgaramSibbandhi; RHS-Kanji
39	131.450	VUP	1x15.00	15.00	RCC Box	-	-	21.25 + M + 21.25	Crossing SH/MDR; LHS-AgaramSibbandhi; RHS-Kanji
40	138.180	VUP	1x15.00	15.00	RCC Box	-	-	21.25 + M + 21.25	Crossing SH/MDR; LHS-Tiruvannamalai; RHS-Kanji
41	141.750	VUP G-II	1x12.00	12.00	RCC Box	-	-	21.25 + M + 21.25	Crossing Village Road/MDR;RHS-Panaiolapadi

Sl. No.	Proposed Chainage	Proposed Type of Structure	Proposed Details						Remarks
			Span Arrangement	Total Length	Structure Details			Proposed Deck Width	
			No. of Spans x Span Length		Super structure	Sub structure	Foundation		
	(km)	-	(m)	(m)	-	-	-	(m)	-
42	143.380	MNB Cum VUP	MCW-1x15.00 (Nala) + 1x15.00 (Road)	30.00	RCC I-Girder + Deck Slab	RCC Abutment & Pier	Open	21.25 + M + 21.25	Crossing Nala & Village Road/MDR; LHS-Alliandal, RHS-Nandimangalam; Nala training is to be done on LHS of length 140.0m & Cross road existing bridge reconstruction to be done
43	147.060	VUP G-II	1x12.00	12.00	RCC Box	-	-	21.25 + M + 21.25	Crossing Village Road/MDR;RHS-Padiagraharam
44	150.760	VUP	1x15.00	15.00	RCC Box	-	-	21.25 + M + 21.25	Crossing Village ROAD/mdr; LHS-Melmudiyanur, RHS-Muthanur
45	157.880	Interchange	1x15.00 + 1x30.00 + 1x15.00	60.00	PSC I-Girder & RCC I-Girder + Deck Slab	RCC Abutment & Piers	Pile	21.25 + M + 21.25	Crossing NH-66; LHS-Tiruvannamalai, RHS-Chengam; At - grade interchange
46	165.060	VUP G-II	1x12.00	12.00	RCC Box	-	-	21.25 + M + 21.25	Crossing Village Road; LHS-Vedankuppam, RHS-Andanur
47	170.360	VUP G-II	1x12.00	12.00	RCC Box	-	-	21.25 + M + 21.25	Crossing Village Road; LHS-Andipatti, RHS-Melpallipattu
48	171.670	VUP G-II	1x12.00	12.00	RCC Box	-	-	21.25 + M + 21.25	Crossing Village Road;

Sl. No.	Proposed Chainage	Proposed Type of Structure	Proposed Details						Remarks
			Span Arrangement	Total Length	Structure Details			Proposed Deck Width	
			No. of Spans x Span Length		Super structure	Sub structure	Foundation		
	(km)	-	(m)	(m)	-	-	-	(m)	-
49	175.550	VUP G-II	1x12.00	12.00	RCC Box	-	-	21.25 + M + 21.25	Crossing Village Road; LHS-Melravandavadi, RHS-Naradapattu
50	178.520	VUP G-II	1x12.00	12.00	RCC Box	-	-	21.25 + M + 21.25	Crossing Village Road;RHS-Athipadi
51	183.180	VUP G-II	1x12.00	12.00	RCC Box	-	-	21.25+M+21.25	Village Road/MDR; LHS-Neepathurai; RHS-Kuppanatham_Connects to NH-66
52	183.930	VUP G-II	1x12.00	12.00	RCC Box	-	-	21.25+M+21.25	Village Road/MDR; LHS-Neepathurai; RHS-Pavakkal_Connects to NH-66
53	190.680	VUP G-II	1x12.00	12.00	RCC Box	-	-	21.25 + M+ 21.25	Crossing Village Road; LHS-Forest Road; RHS-Andiyur
54	192.200	Flyover	1x37.00	37.00	PSC I-Girder + Deck Slab	RCC Abutment	Open	21.25+M+21.25	Crossing SH-6A_LHS-Thiruvannamalai-Harur Road; RHS-Theerthamalai
55	193.260	VUP G-II	1x12.00	12.00	RCC Box	-	-	21.25+M+21.25	Village Road_LHS-Theerthagireeswarar Temple; RHS-Theerhamalai connecting to

Sl. No.	Proposed Chainage	Proposed Type of Structure	Proposed Details						Remarks
			Span Arrangement	Total Length	Structure Details			Proposed Deck Width	
			No. of Spans x Span Length		Super structure	Sub structure	Foundation		
	(km)	-	(m)	(m)	-	-	-	(m)	-
									SH-6A
56	196.260	VUP	1x22.00	22.00	RCC I Girder+Deck Slab	RCC Abutment	Open	21.25+M+21.25	Crossing SH/MDR; LHS-Harur; RHS-Theerthamalai
57	200.115	VUP G-II	1x12.00	12.00	RCC Box	-	-	21.25 + M + 21.25	Crossing Village Road;LHS-Ittaimpatty
58	201.380	VUP	1x26.00	26.00	PSC I-Girder+Deck Slab	RCC Abutment	Open	21.25+M+21.25	Crossing SH/MDR; LHS-Theerthamalai; RHS-Harur
59	205.420	VUP	1x17.00	17.00	RCC I Girder+Deck Slab	RCC Abutment	Open	21.25+M+21.25	Crossing SH/MDR; LHS-Sitheri; RHS-Harur
60	211.550	VUP G-II	1x12.00	12.00	RCC Box	-	-	21.25+M+21.25	Crossing Village Road; LHS-Achalvadi; RHS-Gobinathampatti
61	213.060	VUP G-II	1x12.00	12.00	RCC Box	-	-	21.25+M+21.25	Crossing Village Road; LHS-Pethathampatti; RHS-Gobinathampatti connecting to SH-18
62	217.100	VUP G-II	1x12.00	12.00	RCC Box	-	-	21.25 + M + 21.25	Crossing Village Road;
63	219.530	MNB Cum VUP	MCW-2x15.00 SR-1x15.00	30.00	RCC I-Girder+Deck Slab	RCC Abutment	Open	11.00 + M + 21.25 + M+	Crossing Nala & Village Road; LHS-Village Road; RHS-

Sl. No.	Proposed Chainage	Proposed Type of Structure	Proposed Details						Remarks
			Span Arrangement	Total Length	Structure Details			Proposed Deck Width	
			No. of Spans x Span Length		Super structure	Sub structure	Foundation		
	(km)	-	(m)	(m)	-	-	-	(m)	-
						& Piers		21.25 + M + 11.00	Mookkareddipatti; Nala training to be done of length 180.00m
64	56.675	Interchange	1x25.00	25.00	PSC I-Girder + Deck Slab	RCC Abutment	Open	21.25+M+21.25	End of Byapss; RHS-Pallipatti
65	49.240	Flyover	1x25.00	25.00	PSC I-Girder + Deck Slab	RCC Abutment	Open	21.25+M+21.25	Crossing SH-18; LHS-Vaniyambadi
66	46.400	Flyover	1x25.00	25.00	PSC I-Girder + Deck Slab	RCC Abutment	Open	21.25+M+21.25	Start of Bypass; RHS-SH-18
67	43.280	VUP G-II	1x12.00	12.00	RCC Box	-	-	21.25 + M+ 21.25	Crossing Village Raod; LHS-Manjavadi Reserve Forest; RHS - Laskhmapuram
68	40.500	Flyover	1x25.00	25.00	PSC I-Girder + Deck Slab	RCC Abutment	Open	21.25+M+21.25	End of Bypass; RHS-SH-18
69	31.800	Flyover	1x25.00	25.00	PSC I -Girder + Deck Slab	RCC Abutment	Open	21.25+M+21.25	Start of Bypass; RHS-Achanguttapattipudur, SH-18
70	29.280	MNB Cum VUP G-II	1x25.00	25.00	PSC-I-Girder+Deck Slab	RCC Abutmnent	Open	21.25 + M + 21.25	Crossing Village Road;RHS-Paruthikaduu
71	23.670	Flyover	1x25.00	25.00	PSC I-Girder + Deck Slab	RCC Abutment	Open	21.25+M+21.25	Crossing SH/MDR;RHS-Ayothiyapattinam

Sl. No.	Proposed Chainage	Proposed Type of Structure	Proposed Details						Remarks
			Span Arrangement	Total Length	Structure Details			Proposed Deck Width	
			No. of Spans x Span Length		Super structure	Sub structure	Foundation		
	(km)	-	(m)	(m)	-	-	-	(m)	-
72	22.700	VUP	1x15.00	15.00	RCC Box	-	-	21.25 + M + 21.25	Crossing MDR; LHS-Minnampalli
73	21.590	Cloverleaf Interchange	1x15.00+2x30.00+1x15.00	90.00	PSC I-Girder +RCC I Girder + Deck Slab	RCC Abutment & Pier	Pile	21.25+M+21.25	Crossing NH-68; LHS-Kallakurchi; RHS-Salem
74	18.480	VUP G-II	1x12.00	12.00	RCC Box	-	-	21.25 + M + 21.25	Crossing Village Road;
75	15.600	VUP G-II	1x12.00	12.00	RCC Box	-	-	21.25 + M + 21.25	Crossing Village Road
76	13.230	VUP G-II	1x12.00	12.00	RCC Box	-	-	21.25 + M + 21.25	Crossing Village Road;RHS-Sanyasigundu
77	11.850	VUP G-II	1x12.00	12.00	RCC Box	-	-	21.25 + M + 21.25	Crossing Village Road;RHS-Paruthikaduu
78	6.940	Double Trumpet Intechange	1x1x30.00 (SH-Crossing) & 1x30.00 Entry loop & 1x30.00 (Exit loop)	90.00	PSC I-Girder + Deck Slab	RCC Abutment	Pile	21.25 + M + 21.25 (SH-Crossing) & 21.25+M+21.25 +M+9.00 & 16.00+M+9.00	Crossing NH-7; LHS-Namakkal; RHS-Salem

Sl. No.	Proposed Chainage	Proposed Type of Structure	Proposed Details						Remarks
			Span Arrangement	Total Length	Structure Details			Proposed Deck Width	
			No. of Spans x Span Length		Super structure	Sub structure	Foundation		
	(km)	-	(m)	(m)	-	-	-	(m)	-
79	0.000	Trumpet Interchange	1x15.00+2x30.00+1x15.00	90.00	PSC I-Girder + RCC I Girder + Deck Slab	RCC Abutment & Pier	Pile	21.25+M+21.25	Crossing NH-47; LHS-Coimbatore; RHS-Salem

Note:

*S.No-1-63 belongs to NH-179B-Chennai-Harur Stretch & S.No-64-79 belongs to NH-179A-Salem-Harur Stretch.

8. Project Facilities

8.1 General

Project facilities shall be planned and provided as wayside amenities for users of the Expressways to enable them to stop, take rest and refresh themselves so as to ease their fatigue. These Areas also cover facilities for providing fuel for vehicle and emergency requirements without having to exit from the expressway. Thus, Provision of service area and their operation and maintenance are to be an integral part of the project Expressway for comfortable and safe driving.

8.2 Service Area

Service area shall be provided for facilities of Expressway Users. The service areas may be planned at approximately 50 km interval. Subjective opinion of the drivers regarding necessity of Parking Lot is gathered. It consists of deceleration and acceleration lane of length 85.0m with central parking area of 250.0 m length and 7.0 m wide, with 1.0m wide raised kerb island separating carriageway & Lay bye. Sufficient working area and space for roadside establishments such as repair shops, vulcanising shops, service centre, spare parts shops, and telephone booth and light refreshments with first aid facilities is provided. The Tentative locations of the truck lay byes are presented in **Table 8-1**.

Table 8-1: Proposed Service Area locations

Sl. No.	Design Chainage	Side	Location
1	25+800	LHS	Seettacherry
2	27+600	RHS	Seethapuram
3	74+200	LHS	Kovilur
4	75+000	RHS	Kovilur
5	121+200	LHS	Thenpallipattu
6	122+900	RHS	Nellimedu
7	174+400	LHS	Naradapattu
8	175+400	RHS	Naradapattu
9	54+200	LHS	Alamelupuram
10	53+600	RHS	Alamelupuram

The Service areas will have the following provisions:

Restaurant / Cafeteria

Dormitory with toilet facilities

Shopping Kiosks / ATM facility

Fuel station with air and water

Tourist / Information centre

Emergency First Aid

Repair / Maintenance facility

Parking provisions for trucks and cars

Police outpost

8.3 Laybyes

In addition to the regular service areas, Only toilet facilities are also to be provided. Their Locations may be approximately half way between the service areas. These toilet facilities may be on short laybyes off the expressway shoulders but with proper deceleration and acceleration lanes. The laybyes tentatively proposed; details are given in

Table 8-2.

Table 8-2: Proposed Laybyes locations

Sl.no	Ds.Chainage	Side	Location
1	48+900	LHS	Vengaram
2	49+500	RHS	Vengaram
3	99+600	LHS	Kolakkaravady
4	100+600	RHS	Kolakkaravady
5	148+400	LHS	Thorapadi
6	149+500	RHS	Thorapadi
7	200+000	LHS	Sanipoondi
8	199+100	RHS	Sanipoondi
9	26+800	LHS	Kattur
10	25+800	RHS	Kattur

8.4 Toll Plazas

The locations of the toll plazas are given below in **Table 8-3**.

Table 8-3: Toll Plaza locations

S.No	Design Chainage	Location	Remarks
1	7+500	Near Neelamangalam	
2	55+800	Near manampathi	
3	94+505	Chetpet Spur	At Double Trumpet Interchange
4	122+670	Tiruvannamalai Spur	At Trumpet Interchange
5	152+000	Near Chengam	
6	56+675	Near Harur	At Trumpet Interchange
7	34+200	Near Velampatti R.F	
8	8+800	Near Dasanaikenpatty (Near Jerugumalai R.F)	

8.5 Road Markings

Road markings perform the important function of guiding and controlling traffic on a highway. The markings serve as psychological barriers and signify the delineation of traffic paths and their lateral clearance from traffic hazards for safe movement of traffic. Road markings are therefore essential to ensure smooth and orderly flow of traffic and to promote road safety. The Code of Practice for Road Markings, IRC: 35 – 2015 has been used in the study as the design basis.

The road markings were carefully planned on carriageways, intersections, toll plazas and bridge locations.

8.6 Road Signs

Cautionary, mandatory and informatory signs have been provided depending on the situation and function they perform in accordance with the IRC: 67 – 2012 guidelines for road signs.

8.7 Kilometre Stones

The details of kilometre stones are in accordance with IRC: 8 – 1980 and MOSRT&H circular guidelines. Both regular and zero/fifth kilometre stones are to be provided on both sides of the road i.e., independently for each direction of travel. The stones shall be fixed at right angles to the centre line of the carriageway.

8.8 200 m Stones and Boundary Stones

The details of 200 m (hectometre) stones and boundary stones conform to IRC: 26 – 1967 and IRC: 25 – 1967, respectively. 200 m stones are located on both the sides of the road as the kilometre stones. The inscription on the stones shall be the numerals 2, 4, 6 and 8 marked in an ascending order in the direction of increasing chainage, away from the starting station. Boundary stones shall be located on either side of the road opposite every 200 m stone and kilometre stone. In addition these shall be fixed at all angular points of the boundary. Where the boundary is on a curve or the land is of significant value and likely to be encroached upon, the boundary stones shall be installed at closer intervals, as required.

8.9 Delineators and Object Markers

Roadway delineators are intended to mark the edges of the roadway so as to guide drivers on the alignment ahead. Object markers are used to indicate hazards and obstructions within vehicle flow path, for example, channelising islands close to the intersections.

Delineators and object markers are provided as per the details given in the drawings and are provided in accordance with the provisions of IRC: 79 – 1989. Delineators are provided for all curves of radius less than 600 m. They are not provided at locations where Chevron signboards are provided.

8.10 Guard Post

Guard posts are proposed on embankments of height more than 1.0 m, bridge approaches and horizontal curves of radius greater than 170 m. The spacing of guard post shall be 2.0m c/c in these areas. Typical Guard post consists of precast (M20) post of size 200mm x 200mm and a height of 600 mm above ground level. They are encased in M15 cement concrete for a depth of 450 mm below ground level. Guard posts are painted with alternate black and white reflective paint of 150 mm wide bands.

8.11 Crash Barrier

Steel Single W-beam metal crash barrier shall be installed mainly at major hazard locations. It will also generally be installed on sections of the road (a) where the embankment height is more than 3 m (b) bridge approaches and (c) on the outside of curves. These guardrails shall be installed along the edge of the outside shoulder with an offset of 2.5 m from the edge of the pavement of carriageway. The crash barrier location given in Table 8-6, Table 8-7 and Table 8-8 are based on typical cross section.

Table 8-4: MS railing proposed on Tiruvanamali Spur

Design Chainage		Design Length (m)	Type of C/S	MS Railing Length, m	Remarks
From	To				
2200	3600	1400	8	2800	Naidumangalam & Gandipuram Builtup
3600	4100	500	8A	1000	Vada Pulidiyur Builtup
4700	6300	1600	8	3200	Kondam & Maruthuvambadi Builtup
9200	9700	500	8	1000	Builtup
10300	10900	600	8A	1200	Builtup
10900	11600	700	8	1400	Builtup
13600	13900	300	8A	600	Builtup
13900	14400	500	8A	1000	Velakknandal Builtup
14400	15200	800	8A	1600	Builtup
15200	16200	1000	8	2000	Builtup
			Total	**15800**	

Table 8-5: MS railing proposed on Chengalpet Spur

Design Chainage		Design Length (m)	Type of C/S	MS Railing Length, m	Remarks
From	To				
0	200	200	8A	400	
200	500	300	8A	600	
500	700	200	8A	400	
700	900	200	8A	400	
900	2100	1200	8A	2400	
2100	2700	600	8A	1200	
2700	2900	200	8A	400	
2900	3200	300	8A	600	
3200	3360	160	8A	320	

Design Chainage		Design Length (m)	Type of C/S	MS Railing Length, m	Remarks
From	To				
3360	3560	200	8A	400	
3560	3700	140	8A	280	
3700	3920	220	8A	440	
3920	4100	180	8A	360	
4100	5000	900	8	1800	
5000	5200	200	8A	400	
5200	5300	100	8A	200	
5300	5400	100	8A	200	
5400	5700	300	8A	600	
5700	7100	1400	8	2800	
7100	7600	500	8A	1000	
7600	7900	300	8	600	
7900	8080	180	8A	360	
8080	8700	620	8A	1240	
8700	11100	2400	8	4800	
11100	11420	320	8A	640	
11420	11900	480	8A	960	
11900	12150	250	8A	500	
12150	15900	3750	8	7500	
18700	22900	4200	8A	8400	
22900	23300	400	8A	800	
23300	24100	800	8	1600	
24100	25500	1400	8A	2800	
25500	29635	4135	8	8270	
			Total	**53670**	

Table 8-6: Proposed location of Metal Beam Crash Barrier on Tiruvanamalai Spur

Design Chainage		Design Length (m)	Type of C/S	MS Railing Length, m	Remarks
From	To				
2200	3600	1400	8	5600	Naidumangalam & Gandipuram Builtup
3600	4100	500	8A	2000	Vada Pulidiyur Builtup

Design Chainage		Design Length (m)	Type of C/S	MS Railing Length, m	Remarks
From	To				
4700	6300	1600	8	6400	Kondam & Maruthuvambadi Builtup
9200	9700	500	8	2000	Builtup
10300	10900	600	8A	2400	Builtup
10900	11600	700	8	2800	Builtup
13600	13900	300	8A	1200	Builtup
13900	14400	500	8A	2000	Velakknandal Builtup
14400	15200	800	8A	3200	Builtup
15200	16200	1000	8	4000	Builtup
			Total	**31600**	

Table 8-7: Proposed location of Metal Beam Crash Barrier on Chengalpet Spur

Design Chainage		Design Length (m)	Type of C/S	MS Railing Length, m	Remarks
From	To				
200	500	300	8A	1200	
500	700	200	8A	800	
700	900	200	8A	800	
900	2100	1200	8A	4800	
2100	2700	600	8A	2400	
2700	2900	200	8A	800	
2900	3200	300	8A	1200	
3200	3360	160	8A	640	
3360	3560	200	8A	800	
3560	3700	140	8A	560	
3700	3920	220	8A	880	
3920	4100	180	8A	720	
4100	5000	900	8	3600	
5000	5200	200	8A	800	
5200	5300	100	8A	400	
5300	5400	100	8A	400	
5400	5700	300	8A	1200	
5700	7100	1400	8	5600	
7100	7600	500	8A	2000	
7600	7900	300	8	1200	
7900	8080	180	8A	720	

Design Chainage		Design Length (m)	Type of C/S	MS Railing Length, m	Remarks
From	To				
8080	8700	620	8A	2480	
8700	11100	2400	8	9600	
11100	11420	320	8A	1280	
11420	11900	480	8A	1920	
11900	12150	250	8A	1000	
12150	15900	3750	8	15000	
18700	22900	4200	8A	16800	
22900	23300	400	8A	1600	
23300	24100	800	8	3200	
24100	25500	1400	8A	5600	
25500	29635	4135	8	16540	
			Total	**106540**	

Table 8-8: Proposed location of Metal Beam Crash Barrier on Chennai Salem Alignment

Design Chainage		Design Length (m)	Type of C/S	MS Railing Length, m	Remarks
From	To				
2+700	6+110	3410	1	6820	
10+000	10+890	890	1	1780	
11+790	13+020	1230	1	2460	
13+920	14+960	1040	1	2080	
25+200	25+600	400	1	800	
25+600	25+820	220	4	440	
26+720	27+640	920	4	1840	
28+540	30+360	1820	4	3640	
31+260	34+065	2805	4	5610	
34+965	37+845	2880	4	5760	
38+545	43+210	4665	4	9330	
44+210	47+000	2790	4	5580	
47+000	47+600	600	5	1200	
48+300	53+190	4890	4	9780	
53+890	56+300	2410	4	4820	
56+300	56+555	255	5	510	
57+455	59+610	2155	4	4310	
60+610	62+270	1660	4	3320	
62+970	65+570	2600	4	5200	
66+270	66+895	625	4	1250	
67+895	71+700	3805	4	7610	

Design Chainage		Design Length (m)	Type of C/S	MS Railing Length, m	Remarks
From	To				
72+400	74+840	2440	4	4880	
75+740	77+830	2090	4	4180	
78+530	78+950	420	4	840	
79+850	82+970	3120	4	6240	
83+870	84+500	630	4	1260	
84+500	85+790	1290	5	2580	
86+690	87+400	710	4	1420	
87+400	88+100	700	5	1400	
88+800	93+100	4300	4	8600	
93+100	94+005	905	5	1810	
95+005	95+480	475	4	950	
96+180	98+480	2300	4	4600	
99+180	105+160	5980	4	11960	
106+060	110+105	4045	4	8090	
110+805	115+300	4495	4	8990	
116+200	121+260	5060	4	10120	
123+170	125+050	1880	4	3760	
125+950	128+000	2050	5	4100	
128+000	131+000	3000	4	6000	
131+900	134+300	2400	4	4800	
134+300	135+000	700	5	1400	
135+000	137+000	2000	4	4000	
137+000	137+730	730	5	1460	
138+630	141+200	2570	4	5140	
141+200	141+400	200	5	400	
142+100	142+930	830	4	1660	
143+830	146+710	2880	4	5760	
147+410	150+100	2690	4	5380	
150+100	150+310	210	5	420	
151+210	156+000	4790	4	9580	
156+000	157+380	1380	5	2760	
158+380	161+400	3020	4	6040	
161+400	162+000	600	5	1200	
162+000	164+710	2710	4	5420	
165+410	170+010	4600	4	9200	
170+710	171+320	610	4	1220	
172+020	175+200	3180	4	6360	
175+900	178+170	2270	4	4540	

Design Chainage		Design Length (m)	Type of C/S	MS Railing Length, m	Remarks
From	To				
178+870	182+830	3960	4	7920	
184+280	185+200	920	5	1840	
185+200	186+300	1100	4	2200	
186+300	186+700	400	5	800	
186+700	190+330	3630	4	7260	
191+030	191+700	670	4	1340	
192+700	192+910	210	4	420	
193+610	195+810	2200	4	4400	
196+710	199+765	3055	4	6110	
200+465	200+930	465	4	930	
201+830	202+500	670	5	1340	
202+500	204+970	2470	4	4940	
205+870	211+200	5330	4	10660	
211+900	212+710	810	4	1620	
213+410	216+750	3340	5	6680	
217+450	219+080	1630	5	3260	
56+175	53+300	2875	5	5750	
53+300	50+400	2900	4	5800	
50+400	49+740	660	5	1320	
48+740	46+900	1840	5	3680	
45+900	43+630	2270	5	4540	
42+930	41+000	1930	5	3860	
40+000	32+300	7700	5	15400	
31+300	29+630	1670	4	3340	
28+930	24+900	4030	4	8060	
24+900	24+170	730	5	1460	
22+250	22+090	160	5	320	
18+130	15+950	2180	1	4360	
15+250	13+580	1670	1	3340	
12+880	12+200	680	1	1360	
11+500	9+600	1900	1	3800	
			Total	**380770**	

9. COST ESTIMATE

9.1 INTRODUCTION AND ASSUMPTIONS

Cost estimation is important for the feasibility study as it provides vital input to the economic and financial evaluation of the project. The cost estimates have been prepared for the Project road considering the recommended alignment. The estimate has been prepared for the proposed Greenfield alignment considering Dual Four lane carriageway and Dual two lane carriageway for Spur alignments including strengthening / widening/reconstruction of existing structures, new bridges on the proposed realignments etc.

9.2 ADOPTION OF UNIT RATES

The Unit rates of all items of construction work have been analysed as per the guidelines given in Standard Data Book of MORT&H. The basic rates of materials are obtained from the latest edition of Tamilnadu Standard Schedule of Rates (SSR). Market rates are adopted for items for which the rates are not available in SSR. The location of material quarries like gravel, sand, crushed aggregate are obtained from the material investigations. The leads of different materials are obtained by drawing the lead chart. In respect of hourly hire and operating cost of various road construction machinery and equipment, rates given in MORT&H Standard Data Book and SSR are considered. For machinery and equipment not covered by these two, the prevailing market rates are considered. The labour rates are taken from Tamilnadu SOR. Unit rates so arrived have been compared with reference to the rates of similar items in the ongoing projects under NHAI and are found comparable.

9.3 BILL OF QUANTITIES FOR CIVIL WORKS

The bill of quantities for civil works has been prepared on the basis of preliminary design

9.4 COSTING FOR SAFETY DEVICES

Adequate numbers of road signage and pavement markings have been considered as a safety measures while making costing for road safety to give proper information to the road users to avoid accident on the project road

9.5 LAND ACQUISITION COST

Total land required for the improvement of the project corridor is **2791** hectares. The land acquisition cost along with R & R cost is mentioned further in the given table.

9.6 COST OF R & R

A tentative estimate of cost for Rehabilitation & Resettlement has been worked out to **Rs. 415.1385 Crores**, which covers all components of compensation, assistance and entitlements. The broad break up of R & R budget is given below **Table 9-1**;

Table 9-1: ESTIMATED BUDGET FOR R&R ACTIVITIES.

Sl. No	Particulars	Amount (Rs.)
A	**Compensation for Land Acquisition**	
1	**#**Compensation for Structure/Agriculture/barren land 2791 hectars (See table 8.19 & 8.20)	2582,00,00,000
2	Value of the 1141 structures x200000	22,82,00,000
3	Value of Wooden/Koisks @25000x104	26,00,000
	Total	**2605,08,00,000**
B	**R&R Entitlements**	
4	Subsistence Allowance Rs3000x12 months=36000 x1141structures	4,10,76,000
5	Subsistence Allowance Rs3000x12 months=36000 x104 Squatters	37,44,000
	Total	**4,48,20,000**
C	**Religious**	
9	Temples/Samadhis/Mazars 30x2,00,000	60,00,000
	Total	**60,00,000**
D	**Others Services**	
10	N.G.O Service Charges	25,00,000
11	Administrative Cost	30,00,000
12	M & E consultant Lump sum	40,00,000
13	HIV/AIDS awareness	20,00,000
	Total	**1,15,00,000**
	A+B+C+D	**2611,23,20,000**
14	Contingency 15%	391,68,48,000
15	**Grand Total**	**3002,91,68,000**

9.7 COST OF ENVIRONMENTAL MITIGATION PLAN

Environmental costs include the cost of cutting of trees (compensatory afforestation), rehabilitation of water source such as hand pumps, wells, bore wells and ponds, noise protection measures near sensitive locations, air, water and noise quality monitoring at different stages and the cost of environmental enhancement along the project road. Details are given in Chapter 10 of the report.

9.8 ANY OTHER ASSOCIATED COST

No other associated cost has been taken. Clause 11.9 reflects total project cost breakup of the project.

9.9 TOTAL COST ESTIMATES

There are four options based on the lane configuration have worked out as below

Dual Three Lane Carriageway

Option – 1: 6 Lane road & 8 Lane Structures with Flexible Pavement

Option – 2: 6 Lane road & 8 Lane Structures with Rigid Pavement

Dual Four Lane Carriageway

Option – 3: 8 Lane road & 8 Lane Structures with Flexible Pavement

Option – 4: 8 Lane road & 8 Lane Structures with Rigid Pavement

The summary of project cost has been worked out for each option is given below:

Option – 1: 6 Lane road & 8 Lane Structures with Flexible Pavement

ABSTRACT OF COST - CHENNAI-SALEM (6-LANE ROAD CUM 8-LANE STRUCTURE-FLEXIBLE PAVEMENT)

BILL NO.	BILL NAME	Total Amount in Rs	Total Amount in Crores	Total Amount in %
	CIVIL CONSTRUCTION COST			
1	Site Clearance and Dismantling	6,53,03,661	6.53	0.08%
2	Earth Work	11,98,51,68,491	1,198.52	15.14%
3	Granular Sub-Base and Base Courses	9,31,18,74,367	931.19	11.76%
4	Bituminious Works	-	-	
4A	Flexible Pavement	11,90,91,86,812	1,190.92	15.04%
5	CULVERTS	-	-	
5A	Box Culvert	77,36,43,656	77.36	0.98%
5B	Pipe Culvert	96,94,792	0.97	0.01%
6	BRIDGES	-	-	
6A	Repair & Rehabilitation of Structures	13,10,957	0.13	0.00%
6C	Minor Bridges	6,98,67,20,747	698.67	8.82%
6D	VUP	81,98,95,197	81.99	1.04%
6E	PUP/LVUP	72,75,89,997	72.76	0.92%
6G	ROB	4,03,80,27,285	403.80	5.10%
6H	Flyover and Overpass	1,46,82,55,064	146.83	1.85%
6I	RE Wall/Retaining Wall for Structures Approaches	7,42,84,32,000	742.84	9.38%
7	Drainage, Protective Works & Other Services	2,82,22,87,069	282.23	3.56%
8	Junctions	58,56,89,720	58.57	0.74%
9	Traffic Signs, Road Marking, and Other Appurtenances	2,75,20,85,456	275.21	3.48%
10	Miscellaneous	63,47,83,300	63.48	0.80%
11	Maintenance of Road during construction	-	-	
12	Toll Plaza Construction (Inc. Road works, Structure Lane, Toilet Blocks and toll Plaza Equipments, Sign Boards, lightings, Crane, Highway Patrol, ATMS and Highway Nest Mini)	4,68,44,33,128	468.44	5.92%
13	Tunnel	3,12,35,29,412	312.35	3.94%
I	**TOTAL CIVIL COST (YR: 2017-2018)**	**79,18,67,49,423**	**7,918.67**	
	(As per ministry circular dated 10th Aug 2016, for HAM project 15% of Civil Cost)	**11,87,80,12,413**	**1,187.80**	
	TOTAL PROJECT COST =	**91,06,47,61,836**	**9,106.48**	115.00%
	Civil Cost per Km (Length of Project Highway-328.035 Km)	**24.14**		
	Total Project Cost per Km	**27.76**		

Option – 2: 6 Lane road & 8 Lane Structures with Rigid Pavement

ABSTRACT OF COST - CHENNAI-SALEM (6-LANE ROAD CUM 8-LANE STRUCTURE-RIGID PAVEMENT)

BILL NO.	BILL NAME	Total Amount in Rs	Total Amount in Crores	Total Amount in %
	CIVIL CONSTRUCTION COST			
1	Site Clearance and Dismantling	6,53,03,661	6.53	0.08%
2	Earth Work	11,90,96,17,263	1,190.96	13.70%
3	Granular Sub-Base and Base Courses	4,76,87,36,524	476.87	5.48%
4	Bituminious Works	-	-	
4A	Flexible Pavement	2,34,89,03,219	234.89	2.70%
4B	Rigid Pavement	22,12,83,20,825	2,212.83	25.45%
5	CULVERTS	-	-	
5A	Box Culvert	77,36,43,656	77.36	0.89%
5B	Pipe Culvert	96,94,792	0.97	0.01%
6	BRIDGES	-	-	
6A	Repair & Rehabilitation of Structures	13,10,957	0.13	0.00%
6C	Minor Bridges	6,98,67,20,747	698.67	8.03%
6D	VUP	81,98,95,197	81.99	0.94%
6E	PUP/LVUP	72,75,89,997	72.76	0.84%
6G	ROB	4,03,80,27,285	403.80	4.64%
6H	Flyover and Overpass	1,46,82,55,064	146.83	1.69%
6I	RE Wall/Retaining Wall for Structures Approaches	7,42,84,32,000	742.84	8.54%
7	Drainage, Protective Works & Other Services	2,80,71,20,888	280.71	3.23%
8	Junctions	56,16,59,675	56.17	0.65%
9	Traffic Signs, Road Marking, and Other Appurtenances	2,74,24,43,252	274.24	3.15%
10	Miscellaneous	50,47,44,300	50.47	0.58%
11	Maintenance of Road during construction	-	-	
12	Toll Plaza Construction (Inc. Road works, Structure Lane, Toilet Blocks and toll Plaza Equipments, Sign Boards, lightings, Crane, Highway Patrol, ATMS and Highway Nest Mini)	4,68,44,33,128	468.44	5.39%
13	Tunnel	3,12,35,29,412	312.35	3.59%
I	**TOTAL CIVIL COST (YR: 2017-2018)**	**86,95,72,20,153**	**8,695.72**	
	(As per ministry circular dated 10th Aug 2016, for HAM project 15% of Civil Cost)	**13,04,35,83,023**	**1,304.36**	
	TOTAL PROJECT COST =	**1,00,00,08,03,176**	**10,000.08**	115.00%
	Civil Cost per Km (Length of Project Highway-328.035 Km)	**26.51**		
	Total Project Cost per Km	**30.48**		

Option – 3: 8 Lane road & 8 Lane Structures with Flexible Pavement

ABSTRACT OF COST - CHENNAI-SALEM (8-LANE ROAD CUM 8-LANE STRUCTURE-FLEXIBLE PAVEMENT)

BILL NO.	BILL NAME	Total Amount in Rs	Total Amount in Crores	Total Amount in %
	CIVIL CONSTRUCTION COST			
1	Site Clearance and Dismantling	5,21,00,693	5.21	0.05%
2	Earth Work	13,62,73,75,741	1,362.74	13.59%
3	Granular Sub-Base and Base Courses	10,99,87,86,207	1,099.88	10.97%
4	Bituminious Works	-	-	
4A	Flexible Pavement	14,63,98,49,331	1,463.98	14.60%
5	CULVERTS	-	-	
5A	Box Culvert	77,36,43,656	77.36	0.77%
5B	Pipe Culvert	96,94,792	0.97	0.01%
6	BRIDGES	-	-	
6A	Repair & Rehabilitation of Structures	13,10,957	0.13	0.00%
6C	Minor Bridges	6,98,67,20,747	698.67	6.97%
6D	VUP	81,98,95,197	81.99	0.82%
6E	PUP/LVUP	72,75,89,997	72.76	0.73%
6G	ROB	4,03,80,27,285	403.80	4.03%
6H	Flyover and Overpass	1,46,82,55,064	146.83	1.46%
6I	RE Wall/Retaining Wall for Structures Approaches	20,66,88,72,000	2,066.89	20.61%
7	Drainage, Protective Works & Other Services	2,81,74,99,294	281.75	2.81%
8	Junctions	53,00,96,506	53.01	0.53%
9	Traffic Signs, Road Marking, and Other Appurtenances	1,43,47,97,482	143.48	1.43%
10	Miscellaneous	88,21,02,200	88.21	0.88%
11	Maintenance of Road during construction	-	-	
12	Toll Plaza Construction (Inc. Road works, Structure Lane, Toilet Blocks and toll Plaza Equipments, Sign Boards, lightings, Crane, Highway Patrol, ATMS and Highway Nest Mini)	6,98,14,55,412	698.15	6.96%
13	Tunnel	3,75,00,00,000	375.00	3.74%
I	**TOTAL CIVIL COST (YR: 2017-2018)**	**1,00,26,69,10,873**	**10,026.69**	
	(As per ministry circular dated 10th Aug 2016, for HAM project 15% of Civil Cost)	**15,04,00,36,631**	**1,504.00**	
	TOTAL PROJECT COST =	**1,15,30,69,47,504**	**11,530.69**	115.00%
	Civil Cost per Km (Length of Project Highway-328.035 Km)	**30.57**		
	Total Project Cost per Km	**35.15**		

Option – 4: 8 Lane road & 8 Lane Structures with Rigid Pavement

ABSTRACT OF COST - CHENNAI-SALEM (8-LANE ROAD CUM 8-LANE STRUCTURE-RIGID PAVEMENT)

BILL NO.	BILL NAME	Total Amount in Rs	Total Amount in Crores	Total Amount in %
	CIVIL CONSTRUCTION COST			
1	Site Clearance and Dismantling	5,21,00,693	5.21	0.05%
2	Earth Work	13,56,89,18,869	1,356.89	12.42%
3	Granular Sub-Base and Base Courses	5,75,60,31,217	575.60	5.27%
4	Bituminious Works	-	-	
4A	Flexible Pavement	2,82,58,57,122	282.59	2.59%
5	CULVERTS	-	-	
5A	Box Culvert	77,36,43,656	77.36	0.71%
5B	Pipe Culvert	96,94,792	0.97	0.01%
6	BRIDGES	-	-	
6A	Repair & Rehabilitation of Structures	13,10,957	0.13	0.00%
6C	Minor Bridges	6,98,67,20,747	698.67	6.40%
6D	VUP	81,98,95,197	81.99	0.75%
6E	PUP/LVUP	72,75,89,997	72.76	0.67%
6G	ROB	4,03,80,27,285	403.80	3.70%
6H	Flyover and Overpass	1,46,82,55,064	146.83	1.34%
6I	RE Wall/Retaining Wall for Structures Approaches	20,66,88,72,000	2,066.89	18.92%
7	Drainage, Protective Works & Other Services	2,81,74,99,294	281.75	2.58%
8	Junctions	53,00,96,506	53.01	0.49%
9	Traffic Signs, Road Marking, and Other Appurtenances	1,43,47,97,482	143.48	1.31%
10	Miscellaneous	88,21,02,200	88.21	0.81%
11	Maintenance of Road during construction	-	-	
12	Toll Plaza Construction (Inc. Road works, Structure Lane, Toilet Blocks and toll Plaza Equipments, Sign Boards, lightings, Crane, Highway Patrol, ATMS and Highway Nest Mini)	6,98,14,55,412	698.15	6.39%
13	Tunnel	3,75,00,00,000	375.00	3.43%
I	**TOTAL CIVIL COST (YR: 2017-2018)**	**1,09,22,54,92,870**	**10,922.55**	
	(As per ministry circular dated 10th Aug 2016, for HAM project 15% of Civil Cost)	**16,38,38,23,931**	**1,638.38**	
	TOTAL PROJECT COST =	**1,25,60,93,16,801**	**12,560.93**	115.00%
	Civil Cost per Km (Length of Project Highway-328.035 Km)	**33.30**		
	Total Project Cost per Km	**38.29**		

9.10 COMPARISON OF COST WITH SIMILAR PROJECTS IN THE REGION

The consultant have studied the similar projects going on in the region and found the cost per km of the project corridor is almost same as that of worked out for this project.

10. ENVIRONMENTAL SCREENING AND PRELIMINARY ENVIRONMENTAL ASSESSMENT

10.1 INTRODUCTION

Road projects are meant for improving the quality of life of people and developing the country's economy. Along with all positive impacts of the road projects, there may also be some significant detrimental impact on nearby communities and environment. To account for adverse impacts, environmental impact assessment is utmost necessary. These concerns for environmental issue in road projects have also become a part of legal requirements and requirements for obtaining financial support. Environmental assessment is therefore, of prime importance in road projects.

Findings and outcome of the prelim environmental assessment are presented in this chapter. Further detailing will be taken up during subsequent stages of the project. This chapter is mainly based on secondary data and prelim field survey.

10.2 STUDY AREA

Study area for the prelim assessment is limited for 500m on either side of the proposed alignment. However, eco-sensitive zones have been identified upto the distance of 15km from the proposed alignment.

Proposed highway alignment starts from Chennai Outer Ring Road in Kancheepuram District and Ends at out skirt of Ayodhiyapatinam in Salem District after passing through the Truvannamalai, Krishnagiri and Dharmapuri districts.

10.3 SCOPE OF PRELIMINARY ENVIRONMENTAL ASSESSMENT

Preliminary EIA study has been carried out to identify critical issues and areas that would be studied in detailed during EIA study. Further details will be taken up during subsequent stages of the project preparation, if required.

In this stage, existing environmental set-up of the study corridor in particular were studied and is described in subsequent sections. The entire study was carried out within existing policy, legal and administrative framework considering the applicable environmental legislation, regulations and guidelines. The present covers the following:

- Project Screening in reference to Legal Framework
- Brief Baseline Environment Profile of the study area
- Probable Environment Impact Assessment
- Tentative Management Plan

10.4 METHODOLOGY

Environmental Impact Assessment is a detailed process, which starts from the conception of the project and continues till the operation phases. The steps for environmental impact assessment are varies at different phases. This report deals with preliminary environmental assessment for the feasibility assessment of the proposed improvement proposal.

Following activities were mainly undertaken during the prelim environment assessment.

- Study of Background information
- Study of Project Documents
- Study of Laws and regulations: Laws and regulations enacted by Government of India and Tamilnadu State relevant to road construction and environment were studied.
- Study of Guidelines, Standards etc.: Various documents and publications of the Ministry of Environment, Forest and Climate Chanage (MoEF&CC) and Indian Road Congress (IRC) were studied.

10.5 ONSITE STUDY

Some of the important environment components as studied during present scope of chapter or will be studied during Environment Impact Assessment Study are discussed in table below.

Table 10-1: Important Environment Components

S. No.	Environmental Attributes	Environmental Components
1	Topography	Terrain
2	Land use	Agriculture, settlements, forest, industrial areas etc.
3	Surface Water resources	Rivers, canals, ponds, etc.
4	Forests & Wild Life	Designated Protected Areas like Biosphere Reserves, National Parks and Wildlife Sanctuaries etc.) within 15 Km from the project road Presence of RF, PF other forests in proposed highway alignment Bio-diversity assessment of the area
5	Road side Plantations	Plantation in RoW, Green Tunnel, etc.
6	Settlements	Towns and villages along side of the proposed alignment Details of affected structures
7	Sensitive Receptors	Sensitive receptors such as educational and health facilities etc.
8	Drinking water sources	Wells, hand pumps, community water points / taps etc.
10	Religious Structures	Temples, shrines, mosque, church, gurudwara etc.
11	Cultural Properties	Protected / unprotected archaeological monuments
12	Common Property Resources	Community areas, cremation / burial grounds etc.
14	Environment Conditions	Ambient Air Quality Ambient Noise Level Ground and Surface Water Quality Soil Characteristics

10.6 LEGISLATIVE FRAMEWORK

The Government of India has formulated various policy guidelines; acts and regulations aimed at protection and enhancement of environmental resources. The summary of environment laws and their applicability analysis pertaining to proposed development project are discussed in Table below.

Table 10-2: Environment Laws and their Applicability

S. No.	Regulation / Guidelines	Relevance	Applicability (Yes / No)	Reason for Application	Implementing / Responsible Agency
1	The Environmental (Protection) Act. 1986, and the Environmental (Protection) Rules, 1987-2002 (various amendments)	Umbrella Act. Protection and improvement of the environment. Establishes the standards for emission of noise in the atmosphere.	Yes	All environmental notifications, rules and schedules are issued under the act	MoEF&CC, State Dept. of Environment & Forest, CPCB and SPCB
2	The EIA Notification, 14th September 2006 & subsequent amendments	Identifies All new National Highways, expansion of National highways projects greater than 100 Km involving additional ROW or land acquisition greater than 40m on existing alignments and 60m on re-alignments or by-passes and All new state highway projects & SH expansion projects in hilly terrain (above 1000 MSL) and or ecological sensitive areas (item 7 (f) of schedule) as one of the projects requiring prior clearance.	Yes	Project Highway is a new National Highway project. Hence, Environment Clearance is required from MoEF&CC.	MoEF&CC & SEIAA
		Opening of New Borrow Area	Yes	Prior Environmental Clearance to be taken by Contractor if there is any need for opening of new borrow area	
		Opening of new Quarry Area (including excavation of River bed)	Yes	Prior Environmental Clearance to be taken by Contractor if there is any need mining	
3	Notification for use of Fly ash, 3rd November 2009 and its amendment on 25th January 2016	"No agency, person or organization shall, within a radius of 300 Kilometers of a thermal power plant undertake construction or approve design for construction	Yes	Many Thermal Power Plant (Ennore TPS, North Chennai TPS, NTPC TPS, Neyveli TPS, Cuddalore TPS, Mettur TPS, Malco TPS, ETC.) are located	MoEF&CC, SPCB

S. No.	Regulation / Guidelines	Relevance	Applicability (Yes / No)	Reason for Application	Implementing / Responsible Agency
		of roads or flyover embankments with top soils; the guidelines or specifications issued by the Indian Road Congress (IRC) as contained in IRC specification No. SP: 58 of 2001 as amended from time to time regarding use of fly ash shall be followed and any deviation from this direction can only be agreed to on technical reasons if the same is approved by Chief Engineer (Design) or Engineer-in-Chief of the concerned agency or organization or on production of a certificate of "fly ash not available" from the Thermal Power Plant(s)		within 300km from the proposed highway alignment	
4	The Water (Prevention and Control of Pollution) Act, 1974	Central and State Pollution Control Board to establish / enforce water quality and effluent standards, monitor water quality, prosecute offenders, and issue licenses for construction / operation of certain facilities.	Yes	Consent required for not polluting ground and surface water during construction	State Pollution Control Board
5	The Air (Prevention and Control of Pollution) Act. 1981	Empowers RSPCB to set and monitor air quality standards and to prosecute offenders, excluding vehicular air and noise emission.	Yes	Consent required for establishing and operation of mixing plants and crushers	State Pollution Control Board
6	Noise Pollution (Regulation And Control) Act, 1990, 2010 and its subsequent amendments.	Standards for noise emission for various land uses	Yes	Construction machineries and vehicles to conform to the standards for construction	State Pollution Control Board
7	Forest	Conservation and	Yes	Proposed alignment	State Forest

S. No.	Regulation / Guidelines	Relevance	Applicability (Yes / No)	Reason for Application	Implementing / Responsible Agency
	(Conservation) Act, 1980 its subsequent amendments.	definition of forest areas. Diversion of forest land follows the process as laid by the Forest conservation Act.		passes through Reserved Forests at many locations.	Department, MoEF&CC
8	Coastal Regulatory Zone Notification, 2011 its subsequent amendments.	Protect and manage coastal areas	No	Based on Draft CZMP maps of Tamilnadu, project highway is not falling in the CRZ area.	MoEF&CC, State Department of Environment
9	Wildlife Protection Act, 1972 its subsequent amendments.	Protection of wildlife in sanctuaries and National Park	No	No Wildlife Sanctuary / National Park is located within 10km from project alignment	NBWL, SBWL & Chief Wild Life Warden
10	Ancient Monuments and Archaeological sites & Remains Act 1958 its subsequent amendments.	To protect and conserve cultural and historical remains found.	No	No archaeological Monuments within 300m from the proposed alignment.	Archaeological Survey of India, State Dept. of Archaeology
11	The Motor Vehicle Act. 1988 its subsequent amendments.	Empowers State Transport Authority to enforce standards for vehicular pollution. From August 1997 the "Pollution Under Control Certificate" is issued to reduce vehicular emissions	Yes	All vehicles used for construction will need to comply with the provisions of this act.	State Motor Vehicles Department
12	The Explosives Act (& Rules) 1884 (1983) its subsequent amendments.	Sets out the regulations as to regards the use of explosives and precautionary measures while blasting & quarrying	Yes	Use of blasting materials if required for new quarrying operation and storing of Diesel / Petrol in the camp site, to be obtained by the contractor / Concessionaire	Chief Controller of Explosives
13	Public Liability And Insurance Act,1991	Protection to the general public from accidents due to hazardous materials	Yes	Hazardous materials like Bitumen shall be used for road construction	State Pollution Control Board
14	Hazardous and Other Wastes	Protection to the general public against improper	Yes	Hazardous wastes shall be generated	State Pollution Control Board

S. No.	Regulation / Guidelines	Relevance	Applicability (Yes / No)	Reason for Application	Implementing / Responsible Agency
	(Management, & Transboundary Movement) Rules, 2016 and its subsequent amendments'	handling and disposal of hazardous wastes		due to activities like of maintenance and repair work on vehicles	
15	Construction and Demolition Waste Management Rules, 2016 and Solid Waste Management Rules 2016	Safe disposal of construction waste and municipal solid waste	Yes	Construction waste shall be generated due to the demolition of existing structures & construction activities and municipal waste shall be generated from the construction worker camp	State pollution Control Board
16	Chemical Accidents (Emergency Planning, Preparedness and Response) Rules, 1996	Protection against chemical accident while handling any hazardous chemicals resulting	Yes	Handling of hazardous (flammable, toxic and explosive) chemicals during road construction	District & Local Crisis Group headed by the DM and SDM
17	Mines & Minerals (Regulation & Development) Act, 1957 as amended in 1972	Permission of Mining of aggregates and sand from river bed & aggregates	Yes	Mining of sand, soil or aggregates shall require permission from mining dept.	State Department of Mining
18	The Building & Other Construction Workers (Regulation of Employment & Conditions of Service) BOCW Act, 1996	Employing Labour / workers	Yes	Employment of labours	District labour Commissioner

10.7 BASELINE ENVIRONMENT SCENARIO

10.7.1 Project Districts

Proposed highway alignment starts from Chennai Outer Ring Road in Kancheepuram District and Ends at out skirt of Ayodhiyapatinam in Salem District after passing through the Truvannamalai, Krishnagiri and Dharmapuri districts.

10.7.2 Climate and Meteorology

Proposed alignment is the part of Tropical Savanna Climate (Wet and Dry Climate) as per Köppen climate classification system. Most of the region's annual rainfall is experienced during the wet season and very little precipitation falls during the dry season.
Indian Meteorological Dept. is operating 6 nos. of observatories in near vicinity of proposed highway alignment. Details of IMD observatories along with their distance in respect to proposed alignment are given in table below.

Table 10-3: IMD observatories in vicinity of the proposed Highway Alignment

S. No.	Name of Observatory	Geographical Coordinate	Distance from alignment (km)
1	Chennai (Minambakkam) (A)	13° 00'N, 80° 11'E	15 km
2	Chennai (Nungambakkam)	13° 04'N, 80° 15'E	26 km
3	Dharmapuri	12° 08'N, 78° 02'E	35 km
4	Salem	11° 39'N, 78° 10'E	12 km
5	Tiruppattur	12° 29'N, 78° 34'E	33 km
6	Tiruttani	13° 11'N, 79° 37'E	38 km

Considering very close proximity of Chennai (Minambakkam) (A) and Chennai (Nungambakkam) data of Chennai (Minambakkam) (A) observatory has been considered due to proximity with proposed highway.

30 years (1981-2010) long-term climatological data was collected for assessment of prevailing meteorological scenario of the project region. The details of long term climatological conditions are given in Table below.

Table 10-4: Long-term (1981-2000) Climatological Conditions at IMD Observatories

Month	Temp Monthly (°C)		Humidity (%)		Average Wind Speed (kmph)	Dominant Direction	Avg. Rainfall (mm)
	Max	Min	Morning	Evening			
IMD Observatory- Chennai (Minambakkam) (A)							
January	31.6	18.6	83	64	5.2	N, NE	31.5
February	34.1	19.1	81	62	6.3	E, SE	4.6
March	37.0	21.2	76	63	7.7	SE, S	4.8
April	39.4	23.6	72	67	9.3	S, SE	14.2
May	42.2	24.2	64	62	10.0	S, SE	52.9
June	40.6	23.8	60	57	10.2	S, SE	63.5
July	38.7	23.0	66	60	8.9	W, SW	107.8
August	37.4	23.0	71	63	8.5	W, SW	137.2
September	36.9	22.6	75	69	7.1	SW, W	145.8
October	35.5	22.2	81	74	5.4	E, W	298.1
November	32.8	20.2	83	75	5.1	N, NE	373
December	30.9	18.9	83	69	5.3	NE, N	166
	42.6	18.0	74	65	7.4	S, SE	1399.3
IMD Observatory- Dharampuri							
January	32.3	13.9	78	50	5.7	NE, E	5.0
February	35.5	14.7	71	39	5.3	NE, E	3.8
March	38.1	16.7	65	32	4.9	NE, E	22.5
April	39.4	20.4	65	38	4.8	SW, NE	44.2

Month	Temp Monthly (°C)		Humidity (%)		Average Wind Speed (kmph)	Dominant Direction	Avg. Rainfall (mm)
	Max	Min	Morning	Evening			
May	39.6	21.2	64	46	5.8	SW, W	96.7
June	37.4	21.6	65	51	7.9	SW, W	70.0
July	36.7	21.5	67	54	7.6	SW, W	75.6
August	35.8	21.1	69	55	7.2	SW, W	105.5
September	35.1	20.6	73	60	5.1	SW, W	170.5
October	33.3	19.2	78	68	4.2	NE, SW	181.5
November	31.6	16.0	79	67	4.7	NE, E	93.8
December	30.6	14.2	80	60	5.5	NE, E	41.5
	40.1	12.9	71	52	5.7	SW, NE	910.4
IMD Observatory- Salem							
January	34.6	16.3	74	45	4.3	NE, E	4.4
February	37.2	16.9	71	36	4.7	NE, E	3.4
March	39.3	18.9	67	33	4.5	NE, E	17.3
April	40.1	21.6	68	40	4.3	NE, SW	55.5
May	40.1	21.5	71	49	4.1	SW, NE	109.7
June	38.0	22.0	75	55	4.6	SW, S	72.4
July	37.2	21.5	78	57	4.3	SW, S	108.0
August	36.3	21.2	79	58	3.8	SW, S	140.6
September	36.1	21.0	79	61	2.9	SW, S	176.5
October	34.9	20.1	81	69	2.2	NE, SW	185.5
November	33.7	17.6	79	66	2.6	NE	110.2
December	33.2	16.4	76	56	3.5	NE, E	35.0
	40.6	15.4	75	52	3.8	NE, SW	1018.5
IMD Observatory- Tiruppattur							
January	33.7	14.0	82	60	2.6	NE	2.4
February	36.7	14.8	77	53	2.9	NE, E	1.8
March	39.2	17.3	71	48	3.1	NE, E	13.8
April	40.7	20.3	70	53	3.0	NE, E	41.7
May	40.8	21.8	70	57	2.9	NE	77.5
June	38.9	22.2	71	59	3.3	W	64.6
July	37.7	21.5	73	61	3.5	W	93.2
August	36.5	21.2	76	65	3.3	W	132.3
September	36.0	20.9	78	67	2.9	W	185.3
October	34.5	19.7	83	74	2.5	NE	152.2
November	32.6	16.4	83	73	2.4	NE	78.7
December	32.0	14.4	84	68	2.3	NE	33.8
	41.3	13.2	77	62	2.9	NE	877.3
IMD Observatory- Tiruttani							
January	33.0	14.3	79	59	2.9	NE, E	16.0
February	35.4	14.8	78	52	3.1	E, NE	15.6
March	38.8	16.9	74	45	3.6	SE, E	9.7
April	41.9	20.4	68	45	4.5	SE, SW	33.1
May	44.5	21.9	59	44	5.5	SW, W	56.7
June	42.4	22.2	60	49	7.2	SW, W	70.4
July	39.8	21.2	65	56	6.0	SW, W	114.2
August	38.3	21.2	68	58	5.5	SW, W	113.2

Month	Temp Monthly (°C)		Humidity (%)		Average Wind Speed (kmph)	Dominant Direction	Avg. Rainfall (mm)
	Max	Min	Morning	Evening			
September	37.3	21.0	72	64	3.3	SW, NW	222.0
October	35.8	19.5	77	70	2.3	NE, SW	157.4
November	33.5	16.9	79	74	2.4	NE, N	229.9
December	32.1	15.5	80	70	2.9	NE, E	98.8
	44.6	13.6	72	57	4.1	SW, NE	1136.9

Review of above data presents that NE and SW are the predominant wind directions in the region. The average annual rainfall found in the range of 877.3mm at Tiruppattur Observatory to 1399.3mm at Chennai (Minambakkam) (A). Project region generally experiences hot and humid climatic conditions. The region receives the rain under the influence of both southeast and northeast monsoons.

10.7.3 Terrain and Land use

The proposed road alignment follows mostly plain, partly rolling and partly mountainous terrain and some forest area as well. Elevation varies from about 24m above MSL to 520m above MSL.

Proposed alignment mostly passes through the agricultural lands with patches of Forest and Hilly areas. Most of forest area as located along side the alignment is the part of Dharampuri and Tiruvannamalai District. Some settlement areas are also located in close vicinity of proposed alignment.

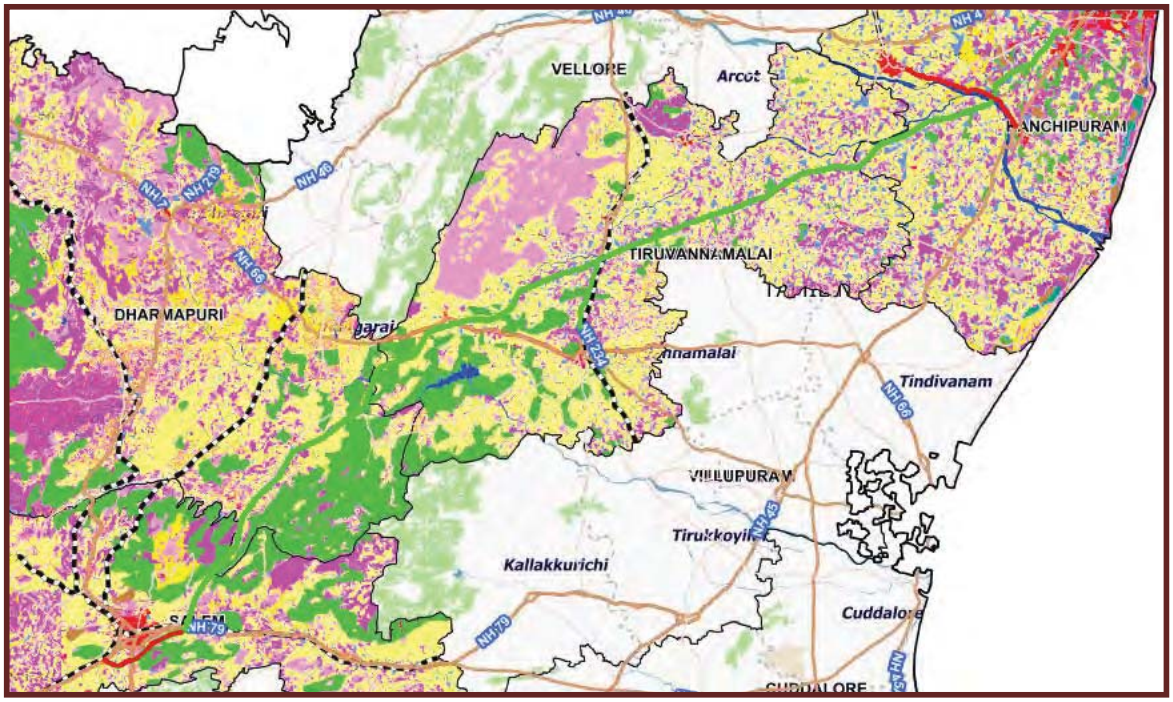


Table 10-5: Land use map of Project Region

10.7.4 Seismicity

Proposed alignment falls under Seismic Zone II and III. Zone - II is most stable and Zone - V is considered to be least stable. The project corridor thus is in a zone of stability. Proposed

highway will be located in Very High Damage Risk Zone (V_b = 50 m/s) as per Wind and Cyclone Hazard Classification of India.

10.7.5 Geology and Soil

Project region is underlain by Archaean Crystalline formations with recent alluvial deposits of limited areal and vertical extents along major rivers.

Soil type along the proposed road varies from brown clayey soil to Alluvial soils (near river bank) to red insitu and lateritic soils.

10.7.6 Ambient Air Quality

Monitoring of air quality shall establish the exact scenario and will also help to assess the potential impact of the project on them. To establish the baseline air quality scenario representative ambient air quality-monitoring stations shall be selected within the study corridor. Sampling and analysis of air samples shall be conducted by taking 24 hourly samples at each location as per guidelines of CPCB and the requirements of MoEF&CC.

Ambient monitoring stations shall be proposed during application for proposed Terms of Reference for Environment Clearance.

10.7.7 Noise

To understand the prevailing condition noise level along side of the proposed alignment shall be monitored by using suitable Noise Level Meter and shall be compared as per CPCB standard. Noise level is likely to increase due to movement of the vehicles in green field area. Day & night time Leq shall be computed from the hourly Leq values as per standards.

10.7.8 Water Environment

10.7.8.1 Hydrogeology

Project region is underlain by Archaean Crystalline formations with recent alluvial deposits of limited areal and vertical extents along major rivers. The important aquifer systems in the region are constituted by i) unconsolidated & semi-consolidated formations and (ii) weathered and fractured crystalline rocks.

10.7.9 Surface water / Ground Water Scenario

10.7.9.1 Surface Water

Proposed Greenfield alignment is crossing the rivers namely Palar River, Pennaiyar River, etc. Also there are many irrigation lakes/Tanks along the project corridor. The drainage pattern in general is sub-dendritic and radial. All the rivers are seasonal and carry substantial flows during monsoon period.

10.7.9.2 Ground Water

In study of the District Ground Water Brochures prepared for the project districts, observed that the ground water is suitable for drinking and domestic uses in respect of all the constituents except total hardness and Nitrate. Ground water in phreatic aquifers in general, is colourless, odourless and slightly alkaline in nature.

10.7.10 Biological Environment

10.7.10.1 Protected Areas

The details of Wildlife sanctuary and national parks within 15 km radius from the existing project road are given below.

Table 10-6: Eco-sensitive Areas within 15km from Project Road

S. No.	Category	Details	Distance (km) / Side
1	Wildlife Sanctuary	Karikili Bird Sanctuary	13.1 / LHS
2	Zoological Park	Arignar Zoological Park, Chennai	1.5 / Towards West from Start of Project road
3		Kurumbapatti Zoological Park	11.3 / RHS
4	Crocodile Farm	Sathanur Crocodile Farm	12.0 / LHS

No wildlife Sanctuary or National is located within 10km from the project road. Hence, clearance under wildlife protection act, 1972 shall not be applicable for the project.

10.7.10.2 Forest

Part of project stretch passes through the forest area. Chainage wise tentative details of affected forest stretches is given in Table below.

Table 10-7: Forest Area alongside the proposed Project Road

S. No.	Approx. Chainage		Approx. Length (Km)	District	Division Name	Forest Range	Reserved Forest Name
	From	To					
Main Alignment (Chennai-Salem Highway)							
1	13.000	13.560	460	Kancheepuram	Chengalpattu	Chengalpattu	Siruvanjur
2	81.000	81.340	340	Tiruvannamalai	Tiruvannamalai(n)	Arani	Nambedu
3	107.300	108.700	1340	Tiruvannamalai	Tiruvannamalai(n)	Polur	Alialamangalam
4	171.600	172.400	690	Tiruvannamalai	Tiruvannamalai(s)	Chengam	Anandavadi
5	175.650	176.400	710	Tiruvannamalai	Tiruvannamalai(s)	Chengam	Ravandavadi
6	180.900	182.700	1800	Tiruvannamalai	Tiruvannamalai(s)	Chengam	Ravandavadi
7	238.700	241.600	1780	Salem	Salem	Shervaroy north	Manjavadi ghat & Pallipatti extn
8	262.700	264.100	1360	Salem	Salem	Shervaroy South	Jarugumalai
9	264.450	265.300	780	Salem	Salem	Shervaroy South	Jarugumalai
10	266.200	267.100	855	Salem	Salem	Shervaroy South	Jarugumalai

S. No.	Approx. Chainage		Approx. Length (Km)	District	Division Name	Forest Range	Reserved Forest Name
	From	To					
11	267.300	267.500	145	Salem	Salem	Shervaroy South	Jarugumalai
Tiruvannamalai Spur							
1	6.250	8.250	2030	Tiruvannamalai	Tiruvannamalai(s)	Tiruvannamalai	Sorakolathur

Exact length of affected forest area shall be calculated after joint inspection with forest dept. during detailed designing.

10.7.10.3 Flora & Fauna

Following are the important flora and fauna in the project region.

Table 10-8: List of Flora in Study Region

S. No.	Species
Top Canopy	
1	Mimusops elengi
2	Diospyros ebenum
3	Strychnos nux vomia
4	Strychnos potatorum
5	Diospyros chloroxylon
6	Drypetes sepiarea
7	Syzygium cumini
8	Canthirum decoccum
9	Ziziphus glaberrima
10	Acacia leucophloea
11	Catunaregam spinosa
12	Buchanania lanzan
13	Sapinda emarginatus
14	Albizia amara
15	Albizia lebbek
16	Tamarindus indica
17	Azadirachta indica
18	Borassus flabellifer
Under-wood	
1	Carissa carandas
2	Flacourtia indica
3	Diospyros ferrea
4	Grewia sp.
5	Gymnosporia sp.
6	Ixora arborea
7	Tarenna ascatica
8	Memecylon umbellatum
9	Garcinia spicata
Thorn Forests	
1	Karunkali - Acacia chundra
2	Usil - Albizia amara
3	Neem - Azaridachita indica

S. No.	Species
4	Sarakonnai - Cassia fistula
5	Namai - Anogeissus latifolia
6	Karai - Randia dumentorum
7	Vagai - Albizia odaratissma
8	Kala - Carisa carandas
9	Etti - Strychnos nuxvomica
10	Virali - Dodonaea viscosa
11	Avaram - Cassia auriculata
12	Canthum dicoccum
13	Aristida setaca
14	Heteropogon contortus.

Table 10-9: List of Fauna in Study Region

S. No.	Species
1	Jackal - Canis aureus
2	Jungle cat - Felis chaus
3	Palm squirrels - Funambulus pennanti and F.palmarum
4	Hare - Lepus nigricollis nigricollis
5	Common mongoose - Harpestes edwardsi
6	Shrew - Suncus sp.
7	Pangolim - Manis crassicaudata.
8	Pariyakite - Milvus migrans govinda
9	Brahminy kite - Haliastuf Indus
10	Patridge - Francolinus pondicerianus
11	Koel - Eudynamys scolopacea.
12	Spotted owlet - Athene brahma
13	Common rat snake - Ptyas mucosus
14	Cobra - Naja naja
15	Green whip snake - Ahaetulla nasutus.

The data has been taken from secondary sources, however, detailed study of the flora and fauna along the project road shall be undertaken during the environmental Impact Assessment (EIA) study.

10.8 STAKEHOLDER CONSULTATION

As a part of the project preparation and to ensure that the community support is obtained and the project supports the felt needs of the people; stakeholder consultations shall be carried out as an integral component. Individual interviews, field level observations, community consultations & meetings shall be used to collect stakeholders input on the project. Meetings with community shall be conducted in both ways i.e. formal as well as informal.

Environment Issues that are of Concern to the Stakeholders to be discussed during consultation:

- Drainage system & drinking water facilities issues
- Provision of new bus shelters in lieu of demolished shelters
- Provision of public toilet facility
- Employment to local people during construction work
- Provision of footpath in settlement area
- Felling of trees
- Pollution due to vehicular emission and generation of dust & noise

10.9 POTENTIAL ENVIRONMENTAL IMPACTS

The environmental components are mainly impacted during the construction and operational stages of the project and have to be mitigated for and incorporated in the engineering design. Environmental mitigation measures represent the project's endeavour to reduce its environmental footprint to the minimum possible. These are conscious efforts from the project to reduce undesirable environmental impacts of the proposed activities and offset these to the degree practicable. Enhancement measures are project's efforts to gain acceptability in its area of influence. They reflect the pro-active approach of the project towards environmental management.

Typical project impacts and management plan suggested thereof are summarized in table below.

Table 10-10: Impact & Mitigation

Particulars	Stages	Potential Impacts	Mitigation Measures
Physiographic Environment			
Topography	Preconstruction & Construction	• Slight changes are expected due to proposed project • Impacts are marginal, but permanent.	• Proper planning to keep the land reformation up to bare minimum • If quarry is required then obtain Prior Environmental Clearance from SEIAA (if applicable) and Quarry Development Plan need to be enforced
Geology	Preconstruction & Construction	Impacts are moderate because of extraction of sand	• If new sand quarry is required then obtain Prior Environmental Clearance from SEIAA (if applicable) and Quarry Development Plan needed
Climate			
Temperature / Rainfall / Humidity	Preconstruction & Construction	• Tree felling will have an impact of micro-climate of the area • Heat island effect due to increase in paved roads • Low spatially restricted short-term impact	• Compensatory afforestation of the trees to be cut as per Forest Dept. guidelines • With the proposed avenue plantation scheme, the micro climate of the project corridor will be smoothening
Land			
Loss of Forest	Design, Preconstruction & Construction	Diversion of forest	• Compensatory afforestation • Payment of NPV
Induced Development	Preconstruction & Construction	Change in the land use pattern	• Civil authorities to plan and guide any induced development using the prevailing regulatory framework
Soil			
Soil Erosion	Preconstruction, Construction &	• In Road slopes and spoils	• Embankment protection through pitching & turfing

Particulars	Stages	Potential Impacts	Mitigation Measures
	Operation	• Erosion in excavated areas	• Regular water sprinkling in excavated areas
Contamination of Soil	Preconstruction, Construction & Operation	• Scarified bitumen wastes • Oil and diesel spills • Emulsion sprayer and laying of hot mix • Production of hot mix and rejected materials • Residential facilities for the labour and officers	• Hazardous and Other Wastes (Management & Transboundary Movement) Rules, 2016 • Oil Interceptor will be provided in storage areas for accidental spill of oil and diesel • Rejected material to be laid as directed by monitoring consultant. • Septic tank to be constructed for waste disposal.
Water			
Impact on Water Resource	Design, Preconstruction, Construction & Operation	• Physical Impact / Partial loss of Water Bodies • Depletion of ground water recharge • Contamination from fuel and lubricants & waste disposal in camp area • Contamination of surface water system due to run-off from road construction area	• Wise design; compensatory digging • Provision of Storage / harvesting structure of water, wherever feasible • Oil Interceptor, sedimentation chambers, oils and grease separators and Septic tank in construction camp to be provided. • Enforcement of Hazardous and Other Wastes (Management & Transboundary Movement) Rules, 2016 • Both side drain facility to suitably divert the run-off from roads
Air			
Dust generation	Preconstruction& Construction	Shifting of utilities, removal of trees & vegetation, transportation of material	• Regular Sprinkling of Water • Fine materials to be completely covered, during transport and stocking. • Hot mix plant to be installed in down wind direction with at least 500m distance from nearby settlement. • Regular monitoring of particulate matter in Ambient Air
Gaseous pollutants	Preconstruction, Construction & Operation	Operation of Hot mix plant and vehicle operation for material transportation	• Air pollution Norms will be enforced. • Only PUC certified vehicles and machineries shall be deployed • Labourers will be provided with mask. • Regular gaseous pollution monitoring in ambient air
Ambient air quality	Operation	Generation of Dust Air pollution from traffic	• Paving of shoulders • Compliance with statuary regulatory

Particulars	Stages	Potential Impacts	Mitigation Measures
			requirements
Noise			
Pre-Construction Activity	Pre-Construction	Man, material and machinery movements Establishment of labour camps, onsite offices, stock yards and construction plants	• No Horn Zone sign, Speed Barriers near sensitive receptors • Camps will be setup more than 500m away from settlements.
Construction Activity	Construction	Operation of high noise equipment like hot mix plant, diesel generators etc. Community residing near to the work zones.	• Camp will be setup more than 500m away from the settlements, in down wind direction. • Noise pollution regulation to be monitored and enforced. • Provision of Noise barriers etc.
Operation Stage	Operation	Indiscriminate blowing of horn near sensitive area	• Restriction on use of horns • No Horn Zone sign.
Ecology			
Flora	Preconstruction, Construction	Loss of vegetation cover Felling of trees	• Felling of only unavoidable trees • Compensatory Afforestation as per Forest Dept. guidelines • Plantation of trees along the project road, median and in areas realigned and maintaining the same for a fixed period
Fauna	Preconstruction, Construction & Operation	Loss of insect, avian and small mammalian species due to felling of trees Accidental run over	• Compensatory Afforestation • Speed breaker and limit in sensitive areas • Wise selection of alignment
Social			
Socio Environment	Design, Preconstruction & Construction	Loss of livelihood Loss of CPRs, Religious Structures	• Rehabilitation Action Plan • Relocation of CPRs, Religious Structures to suitable place
Public Health and Road Safety			
Health and safety	Preconstruction, Construction & Operation	• Psychological impacts on project affected people • Migration of worker may lead to sanitation problem creating congenial condition for disease vectors • Discomfort arising of air and noise pollution • Hazards of accident	• Continued consultation with PAPs and the competent authority for speedier settlements of appropriate compensation package and resettlement. • Ensuring sanitary measures at construction camp to prevent water borne disease and vector borne disease. • Provision for appropriate personal protective equipment like earplugs, gloves gumboot, and mask to the

Particulars	Stages	Potential Impacts	Mitigation Measures
			work force. • Safe traffic management at construction area. • Drive slow sign and speed barriers near community facilities like school, hospital, etc.

10.10 ENVIRONMENTAL BUDGET

Environmental Budget shall be worked out and furnished in detailed EIA Report.

11. INITIAL SOCIAL IMPACT ASSESSMENT

11.1 PROJECT BACKGROUND

The Government of India has taken up development of Economic Corridors, Inter Corridors, Feeder Corridors and National Corridors (GQ and NS-EW Corridors) to improve the efficiency of Freight Movements in India under Bharatmala Pariyojana. The National Highways Authority of India (NHAI) has appointed M/s. Feedback Infra Pvt. Ltd. for providing the required Consultancy services for preparation of Detailed Project Report for 5 such corridors under LOT 6/Package 1, in Tamil Nadu State. Originally 5 corridors, as listed below, were included in the project, which were subsequently modified as below:

Classification	Corridor Name	Road	State	Stretch Name (Start – End)	Original length (Km)	Revised Length (Km)	Changes Suggested
Economic Corridor	Chennai - Madurai	NH - 132	TN	Tindivanam - Trichy	205	253	The original 6 lane widening of existing road proposal changed to Chennai – Tiruvannmalai – Harur Salem Greenfield Highway.
Economic Corridor	Chennai - Madurai	NH - 32	TN	Maduravoyal - Tambaram	19	0	Road not to be considered now
Economic Corridor	Chennai - Madurai	NH - 38	TN	Tovarankurchi - Madurai	64	27	The road to be changed to Tovarankurichi – Natham (27 km) for development of 4 lane facility
Economic Corridor	Mumbai - Kanyakumari	NH - 66	TN	Padmanavan - Kanyakumari	31	0	Road not to be considered now
Inter Corridor	Coimbatore – Trichy - Tanjavore	NH - 83	TN	Tanjavur - Trichy	56	56	No change
Additional							The Salem Bypass (22 km) to be included
Additional							Three Spurs on Chennai Salem Highway (51 km) to be added

The scope of the project is to establish the technical, economic and financial viability of the project and prepare Detailed Project Reports for proposed 8 lane access controlled Chennai Salem greenfield highway of 277.300 km long along with Salem Bypass and three Spurs (Kanchipuram to Changelpattu Spur of 30.000 km, Chetpet Spur of 4.7 km and Tiruvannmalai Spur of 16 km), development of Tovarankurichi to Natham road to 4 lane facility and Tanjavur to Trichy road (56 km) to 6 lane facility in a sound technical and most economical manner, taking into consideration the environment and social aspects

of the area, quality audit and safety audit requirement in design and to carry out through financial analysis for implementation. This report provides details about **Greenfield Chennai-Salem highway**.

11.2 PROJECT LOCATION

Existing roads starting at Chennai traverses through Kanchipuram, Vellore, Krishnagiri, Dharmapuri, Villupuram and ends at Salem district of Tamil Nadu state. District wise details along existing routes are given in **Table 11-1.**

Table 11-1: District wise details along the Existing Routes

Existing Route	Districts	Connecting Highways	Length, km
I	Chennai	NH-48 and NE2	352.70
	Kanchipuram		
	Vellore		
	Krishnagiri		
	Dharmapuri		
	Salem		
II	Chennai	NH-48 and SH-18 (New NH-179A)	331.89
	Kanchipuram		
	Vellore		
	Krishnagiri		
	Dharmapuri		
	Salem		
III	Chennai	NH-32, NH-132, NH-38, NH-79 and NE2	334.28
	Villupuram		
	Salem		

Proposed alignment starts near the Chennai outer ring road junction on SH-48, traverses through Kanchipuram, Tiruvannamalai, Krishnsgiri, Dharmapuri and Salem districts in the state of Tamil Nadu, which run parallel, intersect and overlap; National Highway (NH-38, NH-77, NH-79, NH-NE2 and NH-544), State Highway (SH-48, SH-57, SH-58, SH-118A, SH-116, SH-5, SH-4, SH-115, SH-6A and SH-18) and Major District Roads (MDR-789, MDR-709, MDR-43, MDR-503, MDR-800 and MDR-1044). The proposed alignment passing through Greenfield is divided into 7 packages. Packagewise details along with proposed right of way are provided in the **Table 11-2.**

Table 11-2: Package wise details with proposed right of way

Package	Design Chainage		Length	Location	PROW, m	Remarks
	From	To				
I	0+000	25+600	25.600	Vandalur to Palur	70	179B
II	25+600	67+700	42.100	Palur to Erumaivetti	90	
III	67+700	122+660	54.960	Erumaivetti to Thenpallipattu	90	
IV	122+660	157+570	34.910	Thenpallipattu to Manmalai	90	
V	157+570	207+200	49.630	Manmali to Harur	90	
VI	207+200	220+000	12.800	Harur to Ayodhiyapatinam	90	
	57+300	21+800	35.500			

Package	Design Chainage		Length	Location	PROW, m	Remarks
	From	To				
VII	21+800	0+000	21.800	Ayodhiyapattinam to Ariyanur	70	179A

Project road aims to connect (Chennai and Salem) two major districts in the state with the shortest possible path and also intends to connect many Industrial areas and SEZ along the project road and the connectivity are contemplated through spurs and interchanges. Taluk wise details along different districts are given in Location map of project road is given in **Figure 11-1.** This green field highway alignment is proposed to be Integrated/connected with other highways planned/ executed in Tamil Nadu state in the future.

Table 11-3: Taluk wise details along different districts of proposed alignment

Sl. No	Name of District	Name of Taluk	Approx. Length in Km
1	Kanchipuram	Walajabad	59.100
2		Sriperumbudur	
3		Chengalpattu	
4		Kanchipuram	
5		Uthiramerur	
6	Tiruvannamalai	Cheyyaru	123.900
7		Vandavasi	
8		Polur	
9		Arani	
10		Tiruvannamalai	
11			
12		Chetpet	
13	Tiruvannamalai	Kalasapakkam	
14		Chengam	
15	Krishnagiri	Uttangarai	2.000
16	Dharmapuri	Harur	56.000
17		Papireddipatty	
18	Salem	Yercadu	36.300
19		Valappadi	
20		Salem south	
21		Salem	
Total Length, Km			**277.300**

Figure 11-1: Location Map of Project Road

11.3 THE STATE OF TAMILNADU

Tamil Nadu literally The Land of Tamils or Tamil Country) is one of the 28 states of India. Its capital is Chennai (formerly known as Madras), the largest city. Tamil Nadu is a land most known for its monumental ancient Hindu temples and classical form of dance Bharata Natyam Tamil Nadu lies in the southernmost part of the Indian Peninsula and is bordered by the union territory of Puducherry and the states of Kerala, Tamilnadu, and Andhra Pradesh. It is bounded by the Eastern Ghats on the north, by the Nilgiri, the Anamalai Hills, and Kerala on the west, by the Bay of Bengal in the east, by the Gulf of Mannar and the Palk Strait on the southeast, and by the Indian Ocean on the south.

Tamil Nadu lies in the southernmost part of the Indian Peninsula and is bordered by the union territory of Puducherry and the South Indian states of Kerala, Karnataka, and Andhra Pradesh. It is bounded by the Eastern Ghats on the north, by the Nilgiri, the Anamalai Hills, and Kerala on the west, by the Bay of Bengal in the east, by the Gulf of Mannar and the Palk Strait on the southeast, and by the Indian Ocean on the south. It also shares a maritime border with the nation of Sri Lanka.

Tamil Nadu covers an area of 130,058 sq.km and is the eleventh largest state in India. The bordering states are Kerala to the west, Karnataka to the north west and Andhra Pradesh to the north. To the east is the Bay of Bengal and the state encircles the union territory of Puducherry. The southernmost tip of the Indian Peninsula is Kanyakumari which is the meeting point of the Arabian Sea, the Bay of Bengal, and the Indian Ocean.

The western, southern and the north western parts are hilly and rich in vegetation. The Western Ghats and the Eastern Ghats meet at the Nilgiri hills. The Western Ghats

traverse the entire western border with Kerala, effectively blocking much of the rain bearing clouds of the south west monsoon from entering the state. The eastern parts are fertile coastal plains and the northern parts are a mix of hills and plains. The central and the south central regions are arid plains and receive less rainfall than the other regions. Tamil Nadu has a coastline of about 1,076 km which is the country's second longest coastline.
Tamil Nadu is the seventh most populous state in India. 48.4 per cent of the state's population live in urban areas, the highest among large states in India. At the 2011 India census, Tamil Nadu had a population of 72,147,030.

Tamil Nadu is mostly dependent on monsoon rains, and thereby is prone to droughts when the monsoons fail. The climate of the state ranges from dry sub-humid to semi-arid. The state has two distinct periods of rainfall: south west monsoon from June to September, with strong southwest winds; North east monsoon from October to December, with dominant north east winds;

The annual rainfall of the state is about 945 mm of which 48 per cent is through the north east monsoon, and 32 per cent through the south west monsoon. Since the state is entirely dependent on rains for recharging its water resources, monsoon failures lead to acute water scarcity and severe drought.

11.3.1The District

The project section of Chennai – Salem Project stretch passes through five districts such as Kanchipuram, Tiruvannamalai, Krishnagiri, Dharmapuri and Salem districts. The details about the districts are as below:

Kanchipuram district

Kanchipuram district is a district in the northeast of the state of Tamil Nadu in India. In Early Days Chengalpattu was called as the District. In Later Kanchipuram is considered as a District. It is bounded in the west by Vellore District and Thiruvannamalai District, in the north by Tiruvallur District and Chennai District, in the south by Viluppuram District and in the east by the Bay of Bengal. It lies between 11° 00' to 12° 00' latitudes and 77° 28' to 78° 50' longitudes. The district has a total geographical area of 4,432 km2(1,711 sq mi) and coastline of 57 km (35 mi). The town of Kanchipuram is the district headquarters. The Chennai International Airportis located in Tirusulam in Kanchipuram district now under Greater Chennai Corporation Limit. In 2011, Kancheepuramdistrict had a population of 3,998,252.

Agriculture is the main occupation of the people with 47% of the population engaged in it. Paddy is the major crop cultivated in this district. Groundnuts, Sugarcane, Cereals & Millets and Pulses are the other major crops cultivated. 76.50 Metric Tonnes lands are cultivated in Fuel wood and 8.039 Tonnes in Cashew. Palar river along with Tanks and wells are the main sources of irrigation in this district.

Kancheepuram is also known as 'Silk City' and 'Temple City', since one of the main professions of the people living in and around is weaving silk sarees. The silk weavers of Kanchi settled more than 400 years ago and have given it an enviable reputation as the producer of the best silk sarees in the country.

More than 70 percent of the 163 notified areas (megalithic sites) in the state of Tamil Nadu are in Kancheepuram district, including those at, Erumaiyur, Nandampakkam, Sirukalathur, Sikarayapuram, Ayyancheri, Kilambakkam and Nanmangalam.

Kanchipuram is also one of the most industrialized districts in the country; kanchipuram district has many automobile manufacturers such as Hyundai, Nissan, Ford, BMW, Daimler, Yamaha etc. thanks to its proximity to the state capital Chennai. Areas surrounding Sriperumbudur have turned out to become one of the largest manufacturing hubs of India. The district is home to the manufacturing units of Hyundai, Ford, Mitsubishi, Nokia, Samsung, Dell, Saint Gobain, etc. The district is also at the center of the Information Technology boom in India. Many multinational IT companies like Tata Consultancy Services (TCS), Infosys, Wipro Technologies, Cognizant Technology Solutions, etc. have set up their offices in Kanchipuram district. TCS and Infosys have built huge offices with capacities of 22,000 and 25,000 employees, respectively.

Tiruvannamalai district

Tiruvannamalai District (also known as Thiruvannaamalai) is one of the districts in the state of Tamil Nadu, in South India. It was formed in the year 1989 from non-existing North Arcot District as Tiruvannamalai Sambuvarayar and Vellore Ambedkar. Tiruvannamalai town is the district headquarters. The district is divided into 12 Taluks . Arani is famous for silk sarees. As of 2011, the district had a population of 4,164,875 with a sex-ratio of 994 females for every 1,000 males.

According to 2011 census, Tiruvannamalai District had a population of 2,464,875 with a sex-ratio of 994 females for every 1,000 males, much above the national average of 929. A total of 272,569 were under the age of six, constituting 141,205 males and 131,364 females. Scheduled Castes and Scheduled Tribes accounted for 22.94% and 3.69% of the population respectively. The average literacy of the district was 66%, compared to the national average of 72.99%. The district had a total of 588,836 households. There were a total of 1,238,177 workers, comprising 265,183 cultivators, 351,310 main agricultural labourers, 37,020 in house hold industries, 316,559 other workers, 268,105 marginal workers, 27,458 marginal cultivators, 173,753 marginal agricultural labourers, 9,700 marginal workers in household industries and 57,194 other marginal workers.

Tiruvannamalai District has an area of 6,191 km2. It is bounded on the north by Vellore District, on the east by Kanchipuram District, on the south by Villupuram District, and on the west by Dharmapuri and Krishnagiri districts.

In the District Arani and Thiruvannamalai regions are highest revenue generations regions respectievely.In 2006 the Ministry of Panchayati Raj named Tiruvannamalai one of the country's 250 most backward districts (out of a total of 640). It is one of the six districts in Tamil Nadu currently receiving funds from the Backward Regions Grant Fund Programme (BRGF).

Tiruvannamalai District is known for its two major businesses, agriculture and silk saree weaving. Rice cultivation and processing is one of the biggest businesses in this district. 112013 hectares of paddy cultivation is irrigated by 1965 lakes and 18 reservoirs and small dams. It has 18 regulated markets through which the farmers sell their agri products directly to the government. Through these regulated markets, 271411 metric

tonnes of paddy harvested in 2007. There are lots of rice mills to process paddy found throughout the district. The modern rice mill near Cheyyar is the biggest government owned mill and Arani has around 278 rice mills. Kalambur is also has around 20 Rice mills and known for variety of rice called Kalambur Ponni rice.

The district has a large populace of weavers who are specialize in making Silk sarees. Hand looms are often engaged for weaving, although recently some have turned to mechanized methods of using Power looms. Arani taluk contributes high percent of Silk weaving. Arani is the most important revenue earning town in the district. Though the town is not popular off the state, a bulk of India's Silk apparels is produced by the people of Arani.

The district started to industrialize following the establishment of the industrial complex near Cheyyar by the State Industries Promotion Corporation of Tamil Nadu (SIPCOT). This is evidenced by the recent announcements of a 250-acre (1.0 km2) hi-tech Special Economic Zone for automotive components, a 300-acre (1.2 km2) electronics hardware park and the commitment from the Taiwanese Shoe Company to set up its unit. In November 2009 the Tamil Nadu cabinet approved the Mahindra & Mahindra's Rs 1800 core automobile project in 450 acres. This unit will produce tractors, SUVs and commercial vehicles and auto parts. Aluminum die cast unit by Ashley Alteams, a joint venture by Ashok Leyland and Finland-based Alteams Oy started its production in January 2010. This High pressure die cast will manufacture automobile and telecommunication components with initial capacity of 7000 ton per year. One of the largest sugar mills in the country - Cheyyar co-operative sugars - is situated near Cheyyar.

Since Tiruvannamalai District has its capital at Tiruvannamalai City, there are many factories around Tiruvannamalai. Scent factories are large in number due to the high production of flowers around Tiruvannamalai. They are listed as follows: 1. Hindusthan house hold factories, 2. Sarala birla factory of aroma oil, 3. Parthiban cottages aroma oil factory. The Tamil Nadu government is planning for a SIPCOT at naidumangalam and kilpennathur both near Tiruvannamalai. Arani has the factories related to Rice and Silk with in the town and in the Taluk area. As well, there are few other mills near Arani, such as Lakshmi Saraswathi Cotton mills Arni Pvt Ltd and some Engineering Industries.

Krishnagiri District

Krishnagiri district is a district in the western part of the state of Tamil Nadu, in India. This district is carved out from Dharmapuri District by 2004. The municipal town of Krishnagiri is the district headquarters. In Tamil NaduKrishnagiri district was formed as the 30th district of Tamil Nadu on February 9, 2004. Krishnagiri District was formed by carving out five taluks and ten blocks of the erstwhile Dharmapuri district. The first collector of Krishnagiri was Mangat Ram Sharma.

A district collector heads the district administration. Krishnagiri district is divided into two divisions and five taluks for the purpose of revenue administration. Revenue Divisional Officer heads the divisions and Tahsildar is the head of taluk level administration. Development administration in this district is coordinated by the panchayats (also called as blocks) for the rural areas. There are about ten panchayat unions, seven town panchayats, 352 village Panchayats and 874 revenue villages in this district. Krishnagiri district comprises two revenue divisions Krishnagiri and Hosur. There are seven taluks:

Krishnagiri, Hosur, Pochampalli, Uthangarai, Shoolagiri, Bargur and Denkanikottai. There are 12 panchayat unions: Kelamangalam, Thalli, Anchetti, Krishnagiri, Shoolagiri, Vepanapalli, Hosur, Kaveripattinam, Pochampalli, Mathur and Uthangarai.

According to the 2011 census, Krishnagiri district had a population of 1,879,809 with a sex-ratio of 963 females for every 1,000 males, much above the national average of 929. A total of 217,323 were under the age of six, constituting 112,832 males and 104,491 females. Scheduled Castes and Scheduled Tribes accounted for 14.22% and 1.19% of the population respectively. The average literacy of the district was 63.2%, compared to the national average of 72.99%.The district had a total of 448,053 households. There were a total of 877,779 workers, comprising 218,600 cultivators, 197,369 main agricultural labourers, 15,237 in house hold industries, 310,795 other workers, 135,778 marginal workers, 17,438 marginal cultivators, 65,959 marginal agricultural labourers, 6,681 marginal workers in household industries and 45,700 other marginal workers.

The State industrial Promotion Corporation of Tamil Nadu, (SIPCOT) has developed one of the largest industrial complexes in the country in Hosur in over an area of 1370 acres and to develop Large/Medium/Small industries with SIDCO offering comprehensive services for more than 500 industries.
The industries in Hosur are the source of raising the standard of living of people in Krishnagiri district. It is producing goods varying from Pin to Aeroplance. The credit goes to the good climate, incentives and inspiration provided by the State government and Central government. It is at an altitude of 10000m from mean sea level. It is very near to Bangalore, the capital of Karnataka. Industries of various kinds such as electrical, electronic, automobile, chemical, iron & steel are flourishing because of the favorable conditions and infrastructure availability. Information technology has a great scup for investment because of the proximity of Bangalore.

Several industrialist of repute have started their units in Hosur. Hosur has been able to attract some of the most prestigious industrial houses in the country including the Tatas, The Birlas, the Hindujas, TVS group companies, Murugappa group of companies, Lakshmi group and also a number of MNC's. Hosur Industrial area is consists of about 700 industries comprising of Large, Medium, Small and tiny industries. The location of these industries are SIPCOT phase I & II, SIDCO industrial estates, SIDCO electronic industrial estate and the outside industries are scattered in private lands within 20 Kms radius of Hosur towards Krishnagiri, Royakottai & Thalli Roads and few major industries in Harita, Bagalur, Belagondapalli, Thorapalli and other areas.

The units located at Hosur manufacture sophisticated products ranging from Trucks, Automobiles and Automobiles parts, Motor Cycles, Mopeds, Diesel Engines, Power shift Transmission, Castings, Forgings, Cigarettes, Watches & Jewellery, Abrasives, Hosiery knilling needles. Machineries, Aircrafts and Pharmaceuticals, Biotech textiles, Chemicals, Electronic, electrical and general engineering.

Dharmapuri district

Dharmapuri is a district in Western part of Tamil Nadu in South India. It is the first district created in Tamil Nadu after the independence of India by splitting from then Salem district on 10 October, 1965.

The district is located between latitudes N 11 47' and 12 33' and longitudes E 77 02' and 78 40'. Occupies an area of 4497.77 km² (i.e. 3.46% of Tamil Nadu) and has a population of 2,856,300 (as of 2001). It is bounded on the north by Krishnagiri District, on the east by Tiruvannamalai District and Viluppuram District districts, on the south by Salem District, and on the west by Karnataka's Chamarajanagar District. The Whole district is surrounded by hills and forests. The terrain of dharmapuri is of rolling plains type. Dharmapuri is located on the geographically important area in south India.

The whole district is predominantly covered with forests. Spider valley located near Hogenakkal is home to many wild animals. The district falls in the migratory path of elephants. Man and elephant conflicts are most common in these parts. Many tribal communities depend on these forests. Vathalmalai, a mountain hamlet on top of Shervarayan hill chain has suitable conditions to cultivate coffee and jack fruit. Wild boars and spotted deers are commonly seen in Morappur and Harur forest region. Gaurs sometimes stroll near villages near Bommidi region. Thoppur ghat section has one of the scenic highways surrounded by mountains and forests. This district lies in a geography where both Western and Eastern ghats make their presence.

Dharmapuri and Krishnagiri districts account for more than 60 -70% total mango production in Tamil Nadu. It is a major producer of Ragi and saamai crops in the state. Exotic crops like dates are also being cultivated by some farmers in the areas around Ariyakulam.

Dharmapuri district shows vigorous increasing performance in literacy and education. Where by the year 2011 it secured last position in Tamil Nadu by scoring 62%, whereas by the year 2016 it showed 92% literacy by securing 12th rank in Tamil Nadu out of 32. It also shows vigorous increase in educational hubs by having colleges and school in various fields of education.

Salem district

Salem District is a district of Tamil Nadu state in southern India.Salem was the biggest district before separating Dharmapuri in Tamilnadu. The district was now separated into Dharmapuri, Krishnagiri and Namakkal as individual district .Salem district is the best location to live in India.Salem is the district headquarters and other major towns in the district include Attur,Mettur Sankagiri and Edappadi. Salem two thousand years ago is evident from the discovery of silver coins of the Greek Emperor Tiberices Claudices Nero (37-68 A.D.) in Koneripatti of Salem in 1987. It was ruled by Mazhavar kings Adhiyamaan and Valvil Ori of sangam age. It comes under Mazhanadu a vast region dated 2nd century BC. Salem was the largest district of Tamilnadu, it was bifurcated into Salem – Dharmapuri districts in 1965 and Namakkal district in 1997.

According to 2011 census, Salem district had a population of 3,482,056 with a sex-ratio of 954 females for every 1,000 males, much above the national average of 929. A total of 344,960 were under the age of six, constituting 180,002 males and 164,958 females. Scheduled Castes and Scheduled Tribes accounted for 16.67% and 3.43% of the population respectively. The average literacy of the district was 65.64%, compared to the national average of 72.99%. The district had a total of 915,967 households. There were a total of 1,694,160 workers, comprising 247,011 cultivators, 396,158 main agricultural labourers, 132,700 in house hold industries, 785,161 other workers, 133,130 marginal workers, 9,993 marginal cultivators, 58,052 marginal agricultural labourers, 8,803 marginal workers in household industries and 56,282 other marginal workers.

The Salem handloom industry is one of the most ancient cottage industries and producing quality sari, dothi and angavasthram out of silk yarn and cotton yarn. In the recent past, home furnishing items are also woven, mainly for export purposes. More than 75,000 handlooms are working and the total value of cloth produced per annum is estimated at Rs.5,000 crores. With more than 125 spinning mills, with modern weaving units and garment units Salem established itself as one of the major textile center in Tamil Nadu .The history of handloom and spinning mills dates back to pre-independence period in Salem. But till 1960s there were fewer than 5 spinning mills. Private handloom weaving started thriving in the region along with the large scale cooperative sector handloom weaving and marketing units. Small scale hand dying units were started around the region to support the industry. Around 1980s the textile industry grew significantly. Many major spinning mills and waste spinning units came up into existence. Many Handloom societies and dying houses were established. New and increased numbers of Power Loom units were mushroomed in the places like Gugai, Ammapet, Attayampatti, Vennandur, Magudanchavadi, Rasipuram, Komarapalayam Pallipalayam, Jalakandapuram and Ellampillai.

The Salem region also houses the Tamil Nadu largest number of Sago industries which are engaged in the production Sago Foods and Starch.In Salem District alone, 34000 hectares of land is under tapioca cultivation which is the raw material for the sago industries and there are 650 units engaged in tapioca processing. In and around Salem the yield of tapioca is about 25-30 T/ha, highest in the World. National average is 19 T/ha and World average production stands at 10 T/ha. Hence it is called land of sago. In 1981, Salem Starch and Sago Manufacturers Service Industrial Co-operative Society Ltd(popularly called as SAGOSERVE) was established to promote the growth of sago industries. Nearly 80% of the national demand for Sago and Starch is being met by the Sagoserv.

Salem Steel Plant, a special steel unit of Steel Authority of India Ltd have their plant located in Salem which produces Cold rolled stainless steel and Hot rolled stainless steel/carbon steel. The plant can produce austenitic, ferritic, martensitic and low-nickel stainless steel in the form of coils and sheets with an installed capacity of 70,000 tonnes/year in Cold Rolling Mill and 1,86,000 tonnes/year in Hot Rolling Mill. In addition, the plant has country's first top-of-the-line stainless steel blanking facility with a capacity of 3,600 tonnes/year of coin blanks and utility blanks/circles. Expansion and modernisation of Salem Steel Plant is ongoing. The plan envisages installation of Steel Melting and Continuous Casting facilities to produce 1,80,000 tonnes of slabs along with expansion of Cold Rolling Mill complex, enhancing the capacity of Cold Rolled Stainless Steel Products from 65,000 TPA to 1,46,000 TPA and an additional Roll Grinding Machine for Hot Rolling Mill for increasing production to 3,64,000 TPA. The total project area is 1130 acres and cost of the project is 1780 crores.

Southern Iron & Steel Company Ltd (joint venture with JSW Steel) the first integrated steel plant of India at a cost of 2,235 Crores, located near Salem for the production of TMT corrosion resistant bars/alloy steels. The Salem plant is the largest special steel plant in India aims to develop the Kanjamalai, Kavuthimalai and Vediappanmalai iron ore mines in Tamil Nadu on receipt of requisite approvals to improve raw material security. This will facilitate expansion of production capacity to 2 MTPA. It will also allow the unit to diversify into the production of value-added products such as annealed, drawn and

peeled steel. The plant is continuously working to develop special grades for critical automotive applications.

The Madras Aluminium Company Ltd (MALCO) is part of Vedanta Resources Plc, a London Stock Exchange listed FTSE 100 diversified metals and mining major. MALCO has a state-of-the-art, coal-based Captive Power Plant at the same location which was commissioned in the year 1999. In the year 2004 MALCO augmented its smelter capacity from earlier 25,000TPA to 40,000TPA. It generates 100 MW power from 4 units of 25MW each through power plant located at Mettur, Tamil Nadu. Around 90% of the entire power generated is exported; the rest is used internally. Efficient plant operations enabled MALCO to achieve a higher plant load factor since existence.

The region around Salem is rich in mineral ores. Salem has one of the largest magnetite, and bauxite and also irons ore deposits in India. It has many magnesite factories operated by private and public sectors such as Burn Standard & Co, Dalmia Magnesites and Tata Refractories, SAIL refractoriness. The Leigh Bazaar market in Salem is the biggest regional market for agro products. Narasus coffee one of the famous coffee in Tamil Nadu, Nandhi Dall Mills the oldest flour mill company, BSP refineries (Usha Refined Sunflower Oil) are other few companies have their presence in Salem.

Being one of the fastest growing tier II cities, the Tamil Nadu government and ELCOT are planning to establish an IT park in Salem covering about 160 acres (0.65 km2). SAIL is planning a Steel SEZ inside the Salem Steel plant covering about 250 acres there is an exclusive Electrical and Electronics Industrial Estate in the Suramangalam area of Salem city. Coimbatore-Erode-Salem stretch was well known for Industries and Textile processing's and it is announced as Coimbatore-Salem Industrial Corridor and further development works are carried by SIPCOT Linking.

11.4 Scope of the Project

The general scope of work for this study comprises the following:

i. Review of all available reports and published information about the project road and the project influence area.

ii. Environmental and social impact assessment, including social related to cultural related properties, natural habitats, involuntary resettlement etc.

ii Public consultation, including consultation with communities located along the road, NGOs working in the area, other stake holders and relevant Government Departments at all the different stages of assignment (such as inception stage, feasibility stage, preliminary design stage and once final designs are concretized).

iii. Detailed Reconnaissance.

iv. Identification of possible alternative alignments for Green field highway along with improvements in the existing alignment, if any bypassing congested locations with alternatives, evaluation of different alternatives comparison on techno-economic and other considerations and recommendations regarding most appropriate option.

v. Traffic studies including traffic surveys and Axle load survey and demand forecasting for next thirty years.

vi. Inventory and condition surveys for the spurs (existing road), existing road portions other than the proposed green field highway.

vii. Inventory and condition surveys for bridges, cross-drainage structures, other Structures, river Bank training/Protection works and drainage provisions.

viii. Detailed topographic surveys using LIDAR equipped with minimum engineering grade system or any other better technology having output accuracy not less than

(a) Specified in IRC SP 19

(b) Total Station

(c) GPS/ DGPS

The use of conventional high precision instruments i.e. Total Station or equivalent can be used at locations such as major bypasses, water bodies etc. where it may not be possible to survey using LIDAR.

ix. Pavement investigations.

x. Sub-grade characteristics and strength: investigation of required sub-grade and sub-soil characteristics and strength for road and embankment design and sub soil investigation.

xi. Identification of sources of construction materials.

xii. Detailed design of road, its x-sections, horizontal and vertical alignment and design of embankment of height more than 6m and also in poor soil conditions and where density consideration require, even lesser height embankment. Detailed design of structures preparation of GAD and construction drawings and cross-drainage structures and underpasses etc.

xiii. Identification of the type and the design of intersections.

xiv. Identification and design of grade separated interchanges

xv. Design of complete drainage system and disposal point for storm water.

xvi. Value analysis / value engineering and project costing.

xvii. Economic and financial analysis.

xviii. Contract packaging and implementation schedule.

xix. Strip plan indicating the scheme for schedule for LA: reports documents and drawings arrangement of estimates for cutting/ transplanting of trees and shifting of utilities from the concerned department.

xx. To find out financial viability of project for implementation and suggest the preferred mode on which the project is to be taken up.

xxi. Preparation of detailed project report, cost estimate, approved for construction Drawings, rate analysis, detailed bill of quantities, bid documents for execution of civil works through budgeting resources.

xxii. Design of toll plaza and identification of their numbers and location and office cum residential complex including working drawings.

xxiii. Design of weighing stations, parking areas and road side amenities.

xxiv. Any other user oriented facility en-route toll facility.

xxv. Tie-in of on-going/sanctioned works of MORT&H/ NHAI/ other agencies.

xxvi. Preparation of social plans for the project affected people as per policy of the lending agencies / Govt. of India R&R Policy.

11.5 PROJECT APPRECIATION

Chennai Salem Greenfield Expressway

The present connection between Chennai to Salem is provided by two major routes first one is from NH-48and NH-44 (Chennai – Sriperambudur – Vellore – Krighnagiri – Dharmapuri – Salem which has distance – 372 Km) and the second route is from NH-32, NH-132 and NH-79 (Chennai – Tindivanam- Villupuram – Ulundurpet – Kalakurichi – Salem which has distance – 345 Km)which was four/Six-lane road and by connects by other state highways. However, since NH-44, NH-48, NH-32, NH-132 and NH-79are not fully access-controlled, speed of travel affected by considerable cross movement of traffic through the side roads and access of vehicles from the abutting settlements. In both the existing routes, the existing alignments have either reached their level of service or would be reaching in near future. Hence there is a need to have a larger corridor for high speed facility. Besides, the sections through mountainous terrain have lower radius curves at some places which restrict smooth movement of traffic at design speed.

The idea of construction of a high- speed facility like a fully access-controlled expressway has originated from the primary necessity to eliminate the bottlenecks and limitations that exist in the present corridor to reduce the travel time between Chennai –Salem to a considerable extent. It has been felt that substantial reduction of travel time. The Travel time from Chennai to Salem via NH-32, NH-132 and NH-79 is 6 hr 26 mins, which will be reduced to 3 hr 09 mins with travel along the access controlled green field Expreesway.This would,not only fetch direct benefits to the users due to less vehicle operating cost, passenger time saving and other intangible benefits as well. The connectivity provided through interchanges with residential, commercial and industrial hub would also fetch direct and indirect benefits. The project is expected to generate development around the abutting towns connected through proposed spurs from the expressway. Number of openings and employment opportunities to the local people and for the local and National contractors as well, which would satisfy the Federal Govt agenda of employment opportunities. There would be short and long term tangible and intangible benefits could be benefitted by this project.

All the above factors warrant the construction of access controlled expressway ensuring safety and high speed movement of men and materials from production units to consumers in shortest possible time.

11.5.1 Road Alignment

The project road is divided into three sections as given below.

1. Chennai Salem Greenfield Expressway including Salem Bypass and three connecting spurs
2. Tovarankurichi to Nathan existing road to be upgraded to 4 lane divided highway
3. Thanjavur to Trichi existing NH 83 to be upgraded to 6 lane facility

In order to be able to appreciate the site conditions, our team visited and inspected the project section of NH-48 and NH-44 (Chennai – Sriperambudur – Vellore – Krighnagiri – Dharmapuri – Salem which has distance – 372 Km) and NH-32, NH-132 and NH-79 (Chennai – Tindivanam- Villupuram – Ulundurpet – Kalakurichi – Salem which has distance – 345 Km) from Chennai to Salem and collected existing details of project road during reconnaissance survey.The cross roads, leading to the expressway alignment, were also inspected during the site visits.`

Photo 1: Existing SH-48 Road - Flyover Proposed at 2+200

Photo 2: Palur river crossing at 24+640

Photo 3: SH-18 (New NH-179A) - Road along valley portion at 51+000

Photo 4: Kalrayan hill forest at 39+320

Photo 5: End point of proposed alignment at 0+000 (NH-544)

11.6 SITE APPRECIATION AND RECONNAISSANCE DETAILS

Socio-Economic Characteristics

Tamil Nadu is one of the 28 states of India. Its capital is Chennai, the largest city. Tamil Nadu is a land most known for its monumental ancient Hindu temples and classical form of dance Bharata Natyam Population: 72.14 million (2011) Area: 130,058 km² Founded: 1773

Table 11-4: Socio-Economic Characteristics

Gross State Domestic Product in ₹Crores at Constant			
Year	**GSDP**	**Growth Rate**	**Share in India**
2000–01	142,065	5.87%	7.62%
2001–02	139,842	-1.56%	7.09%
2002–03	142,295	1.75%	6.95%
2003–04	150,815	5.99%	6.79%
2004–05	219,003	11.45%	7.37%
2005–06	249,567	13.96%	7.67%
2006–07	287,530	15.21%	8.07%
2007–08	305,157	6.13%	7.83%
2008–09	320,085	4.89%	7.70%
2009–10	350,258	9.43%	7.77%
2010–11	391,372	11.74%	8.01%
2011–12	428,109	9.39%	8.20%

According to the 2011 Census, Tamil Nadu is the most urbanised state in India (49 per cent), accounting for 9.6 per cent of the urban population while only comprising 6 per cent of India's total population and is the most urbanised state in India. CITEREFThe_Hindu18_May_2008 Services contributes to 45 per cent of the economic activity in the state, followed by

manufacturing at 34 per cent and agriculture at 21 per cent. Government is the major investor in the state with 51 per cent of total investments, followed by private Indian investors at 29.9 per cent and foreign private investors at 14.9 per cent. Tamil Nadu has a network of about 113 industrial parks and estates offering developed plots with supporting infrastructure.

According to the publications of the Tamil Nadu government the Gross State Domestic Product at Constant Prices (Base year 2004–2005) for the year 2011–2012 is ₹428,109 crores, an increase of 9.39 per cent over the previous year. The per capita income at current price is ₹72,993.

Table 11-5 Districts of Tamil Nadu

	District	Headquarters	Area	Population (2011)	Population density
1	Ariyalur	Ariyalur	1,944 km³	752,481	387 /km²
2	Chennai	Chennai	174 km²	4,681,087	26,903 /km²
3	Coimbatore	Coimbatore	4,642 km²	3,172,578	648 /km²
4	Cuddalore	Cuddalore	3,705 km²	2,600,880	702 /km²
5	Dharmapuri	Dharmapuri	4,527 km²	1,502,900	332 /km²
6	Dindigul	Dindigul	6,054 km²	2,161,367	357 /km²
7	Erode	Erode	5,692 km²	2,259,608	397 /km²
8	Kanchipuram	Kanchipuram	4,305 km²	2,690,897	666 /km²
9	Kanyakumari	Nagercoil	1,685 km²	1,863,174	1,106 /km²
10	Karur	Karur	2,902 km²	1,076,588	371 /km²
11	Krishnagiri	Krishnagiri	5,091 km²	1,883,731	370 /km²
12	Madurai	Madurai	3,695 km²	2,441,038	663 /km²
13	Nagapattinam	Nagapattinam	2,416 km²	1,614,069	668 /km²
14	Namakkal	Namakkal	3,402 km²	1,721,179	506 /km²
15	Nilgiris	Udagamandalam	2,552 km²	735,071	288 /km²
16	Perambalur	Perambalur	1,748 km²	564,511	323 /km²
17	Pudukkottai	Pudukkottai	4,652 km²	1,618,725	348 /km²
18	Ramanathapuram	Ramanathapuram	4,180 km²	1,337,560	320 /km²
19	Salem	Salem	5,249 km²	3,480,008	663 /km²
20	Sivaganga	Sivaganga	4,140 km²	1,341,250	324 /km²
21	Thanjavur	Thanjavur	3,477 km²	2,302,781	661 /km²
22	Theni	Theni	2,872 km²	1,143,684	397 /km²
23	Thoothukudi	Thoothukudi	4,599 km²	1,738,376	378 /km²
24	Tiruchirappalli	Tiruchirappalli	4,508 km²	2,713,858	602 /km²
25	Tirunelveli	Tirunelveli	6,709 km²	3,072,880	458 /km²
26	Tirupur	Tirupur	5,192 km²	2,471,222	476 /km²
27	Tiruvallur	Tiruvallur	3,552 km²	3,725,697	1,049 /km²
28	Tiruvannamalai	Tiruvannamalai	6,188 km²	4,121,965	667 /km²
29	Tiruvarur	Tiruvarur	2,379 km²	1,268,094	533 /km²
30	Vellore	Vellore	6,081 km²	4,028,106	671 /km²

	District	Headquarters	Area	Population (2011)	Population density
31	Viluppuram	Viluppuram	7,185 km²	3,463,284	482 /km²
32	Virudhunagar	Virudhunagar	4,280 km²	1,943,309	454 /km²

Source: Provisional Population Totals, Paper -2 (volume -1) of 2011, Census of India

11.7 GENDER AND DEVELOPMENT

1. What are the key gender issues in the sector/subsector that are likely to be relevant to this project/program? The Project will enhance the urban road network and public transit system, which benefits women and men equally. The mobility of women in Xi'an is already very high and the Project will enhance the quality and frequency of transportation services in a safer manner. The main issue is to ensure women are well represented in consultation process during project design and implementation. This can be addressed in the C&P Plan.

2. Does the proposed project/program have the potential to promote gender equality and/or women's empowerment by improving women's access to and use of opportunities, services, resources, assets, and participation in decision making?

There is no serious gender equality or empowerment issues related to urban transport.

3. Could the proposed project have an adverse impact on women and/or girls or to widen gender inequality?

11.8 METHODOLOGY

Approaches to Screening Study

The social assessment process generally commences with screening stage. At this stage, social analysis is made of the project area and steps are taken from the beginning so that plans / designs / alignments are finalised in such a way that to the extent possible, adverse impacts are avoided / reduced at the design stage itself to make these roads people and environment friendly. Wherever avoidance / reduction of the adverse social impact is not possible, those affected should be compensated resettled and rehabilitated properly by adopting proper mitigation measures and the living condition of the people are improved. The key steps are:

- Avoiding / reducing the adverse social impacts at the design stage, especially while finalising the alignments;
- Mitigating the unavoidable adverse impacts at planning, construction and implementation phase; and
- Compensating the affected people and common properties at replacement costs and by adopting appropriate rehabilitation and resettlement measures.

Social Impact Assessment has been defined variously in different guidelines. For the study of this present project, the scope of work defined in the document (Term of Reference) prepared by the Chennai Corporation. Govt. of Tamilnadu. The major issues and items identified in the scope in brief are:

- Study of Background information on project and related policy and legal issues;
- Collection of data from secondary sources;
- Reconnaissance survey of the project impact zone, and
- Analysis of data and Screening exercise

11.8.1 Collection of Data from Secondary Sources

Data from secondary sources were collected on following aspects:

- Demographic profile of the area;
- Social profile of the area;
- Economic profile of the area; and
- Land use pattern

Table 11-6: Type of Information and Sources

Information	Source
Demography	District Census Handbook, Govt. Of India
Land use	District Census Handbook, Govt. Of India
Social profile of the area	NATMO maps, Govt. Of India
Economic profile of the area	Census Govt. of Tamilnadu
District Profile	Govt. of Tamilnadu websites

11.8.2 Reconnaissance Survey of the Project Impact Zone

The study team paid visits extensively throughout the project corridor to identify, carry out a reconnaissance survey or rapid screening survey and to collect social features along the road and other primary data collected by using structured and semi-structured questionnaires. The data about land use pattern, type of construction of the structures, number of structures, trade and economic activities along the road and community and religious characteristics are recorded through the primary survey.

The consultations were carried out with both individuals and groups during the screening survey involving local people, health workers, and administrators include local leaders & PRIs.

Public consultation during the feasibility stage of this project preparation involved information dissemination i.e. informing the people about the details of the project and to invite their suggestion and comments prior to the finalization of the engineering design. The consultations were carried out with both individuals and groups during the screening survey involving local people, health workers and administrators. During consultation the issue regarding to HIV/AIDS have been discussed with truck drivers and local people like awareness about disease, medium of propagation, information, preventive measures, and use of contraceptives. The presence of infected person, line of treatment, measure precautions and presence of commercial sex worker in the area have been asked during the consultation.

11.8.3 Analysis of Data and Screening Exercise

The data collected through the above steps were compiled to develop the social scenario of the project area and the sensitive components within that. The full road length and COI were put under screening. The collected data were analysed, tabulated and summarised and accordingly social features of the project road are assessed. The analysis will indicate the feasibility of the project and will help in suggesting various socially viable alignment options for engineering design and also come out with the mitigation measures to make the project socio-economically acceptable.

11.8.4 Preliminary Social Assessment & Baseline Scenario

The proposed up gradation will be mainly along the existing alignment.

A sample socio economic inventory for the entire project stretch was carried out. **Table 11-7** gives the details of structures along the project road. Private structures including both residential and commercial form the bulk of the structures along the project road. There are ab1out 1171 structures on the proposed project corridor out of Residential-455, Commercial-686 and Religious-30.

Table 11-7: Total Structure belongs to the project road

S.No.	Type of Structures	Nos
1	Residential	**455**
2	Commercial	**686**
3	Religious	**30**
	Total	**1171**

11.8.5 Impact of Land Acquisition

Brief analysis of impacts of land acquisition can be subdivided into the following subheads.

Loss of Land

Main Alignment

The total land to be acquired are **2791 Hectare** consists of agricultural land, community land under Chennai Corporation/ Panchayats, various structures of public interest, residential structures and residential plots, public utilities and others.

Table 11-8: Land Acquisition Required

SL. No.	District	Length (kms)	Average Circle Rates (Rs. in Lacs / Hectare)	Proposed ROW - 70/90m	
				Area (Hectare)	Cost (Rs. in Crores)
1	Kanchipuram	44	75	345	259
2	Thiruvanamalai	137	7	1229	86
3	Krishnagiri	5	9	45	4
4	Dharmapuri	43	9	298	27
5	Salem	49	25	406	102
6	Additional area at trumpet locations			232	58
	Total	**277**		**2554**	**535**

SL. No.	District	Length (kms)	Average Circle Rates (Rs. in Lacs / Hectare)	Proposed ROW - 70/90m	
				Area (Hectare)	Cost (Rs. in Crores)
Four times of above cost as compensation to be paid to the farmers/ land owners					**2140**

Spur Roads

Table 11-9: Land Acquisition Required

SL. No.	Proposed ROW - 60m (Existing ROW - 18m - Approx)			
	Spur Road	Area (Hectare)	Average Circle Rates (Rs. in Lacs / Hectare)	Cost (Rs. in Crores)
1	Kanchipuram - Chengalpet	138.16	75	104
2	Chetpet	22.84	7	2
3	Tiruvannamalai	75.52	7	5
		237		**111**
Four times of above cost as compensation to be paid to the farmers/ land owners				**442**

Loss of Public Infrastructure

Construction of road would entail shifting of public infrastructure. These include places structures of worships, some roads, piped water lines etc. These will be relocated at new sites as per the community's requirement, subject to allotment of land by authorities before actual demolition begins.

Loss of Income

Those losing agricultural lands will lose income opportunity. However, this will be a permanent setback, unless provided with adequate compensation amount and / or training facilities for new trades with sufficient seed capital.

11.8.6 Increase in Employment Opportunities

Commencement of road project will benefit the community through generation of direct and indirect employment within the project areas due to construction activity, minor repairs and maintenance works. The project will require a good number of unskilled workers and they can form a cooperative, which will supply labourers to contractors whenever required. Up gradation of roads and community development programs in the project plan will benefit the communities at large.

11.9 PUBLIC CONSULTATION

11.9.1 Introduction

As part of the project preparation, to ensure that the community support is obtained and the project supports the felt needs of the people; public consultations are carried out as an integral component. A continuous involvement of the stakeholders and the affected community are thus obtained. The feedback on the consultation sessions leads to substantial inputs into the project preparation – including influencing the design part. Consultation involves soliciting people's views on proposed actions and engaging them in

a dialogue. It is a two-way information flow, from project authorities to people and, from people to project authorities. While decision making authority would be retained by the project authority, interaction with people and eliciting feedback allows affected populations to influence the decision making process by raising issues that should be considered in designing, mitigation, monitoring and management plans and the analysis of alternatives. The objectives of consultation sessions, the procedure adopted and the outputs of the consultation conducted have been briefly described in the following sections.

11.9.2 Need

As part of the Environmental and social assessments of the project, the views of affected groups including NGOs and the affected groups (particularly those with potentially significant impacts) are taken into account through the public consultation process. People affected by the project are those, living and working along the corridor, and include residents, Commercial artisians workers etc.

11.9.3 Objectives

The main objective of the consultation process is to minimise negative impacts of the project and to maximise the benefits from the project to the local populace. The objectives of public consultation as part of this project are:

- Promote public awareness and improve understanding of the potential impacts of proposed projects
- Identify alternative sites or designs, and mitigation measures
- Solicit the views of affected communities / individuals on environmental and social problems
- Improve environmental and social soundness
- Clarify values and trade-offs associated with the different alternatives
- Identify contentious local issues which might jeopardise the implementation of the project and
- Create accountability and sense of local ownership during project implementation.

11.9.4 Process of Consultation

Public consultation conducted at the screening stage shall play an important role in determining the level and extent of consultation that has to be taken up during the project preparation stage. Public consultations for this project shall be done at three levels as follows:

- Local level (village level) involving villagers whose properties, land, etc are being affected by the project;
- District level consultations involving various district level governmental departments and NGOs, Chennai Corporation officials; and
- Institutional level consultations with Forest Department, State Pollution Control Board etc.

Public Consultation was done using various tools including, interviews with government officials and questionnaire-based information with stakeholders etc. A reconnaissance survey was carried out informally drawing people into dialogue to obtain an overview of likely impacts and concerns of the community. These informal discussion and consultations were held at several locations along the project road alignment, covering settlements close to proposed alignment, thus covering the general public & property owners on the proposed RoW.

A checklist of questions was kept ready and responses were elicited from people and guidelines were issued to field assistants for the purpose. The questions were kept simple for people to comprehend and notes were made for the responses and viewpoints presented by the people.

11.9.5 Identification of issues

Based on the community consultation the key social issues identified were:

- Employment opportunity during civil works
- Location of labour camp and hot mix plant sites
- Location of dumping sites
- Health issues, such as water borne diseases, HIV & STD
- Safety issues
- Impact on property and land acquisition
- Resettlement Options

The consultation programme has been undertaken for both Social screening process- Many people were very positive about the project and during the discussions, many benefits were identified.

- Better access to the facilities
- Organised market facilities
- Increased customers
- Less travel time

- The people were insisting that proper compensation has to be offered in case of relocation and prefer to relocate in their existing neighbourhood.
- The safety of school children was another popular issue raised during consultation. As the schools are often located near highways travelling at high speeds through villages will have an impact on the safety of school students. Similarly in sharp curves, accidents occur frequently.
- Some of the individuals asked whether the project has the provision for more bus stops.
- Many people worried, whether the work will be taken up due to political conflicts. The construction work should be taken up on urgent basis, rather than conducting surveys again and again.

11.10 MITIGATION AND ENHANCEMENT MEASURES

Most of the mitigation measures can be incorporated as good engineering practice during the design phase itself thus ensuring the mainstreaming of environmental concerns early in the project. Adherence to design drawing and specifications will reduce; to within acceptable levels, the adverse impacts during construction.

11.10.1 Suggested Mitigation Measures

The following considerations may be kept in view at the design stage:

- Construction and Up gradation of approach roads to the highway
- Up gradation of the existing road
- Ambulance service to transport serious cases to district hospital in case of accidents

11.11 POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK

Government of Tamil Nadu is currently implementing the World Bank supported Third Tamil Nadu Urban Development program (TNUDP-III) to improve the delivery of urban services. Improvement in the Traffic and Transportation Sector within Chennai Metropolitan Area (CMA) is one of the Urban Investment components covered under the above program. This component is coordinated by Chennai Metropolitan Development Authority (CMDA) and implemented by Department of Highways (DoH), Government of Tamil Nadu.Tamil Nadu Urban Infrastructure Financial Services Ltd. (TNUIFSL) Chennai are the fund Managers. To implement this component (Road component only) additional land parcels totalling about 76 hectares, of which 36 ha is private land belonging to 2000 land owners is required. In addition, another 1270 non-title holder likely is affected by this project.

11.11.1 Broad Principles

The broad principles of the R&R are as below:

- The negative impact on persons affected by the project would be avoided or minimized.
- Where the negative impacts are unavoidable, the affected persons will be assisted in improving or regaining their standard of living. Vulnerable groups will be identified and assisted to improving their standard of living.
- All information related to resettlement preparation and implementation will be disclosed to all concerned, and people's participation is being ensured in planning and implementation of the project.
- Before taking possession of the acquired lands and properties, compensation and R&R assistance will be made in accordance with this policy.
- There would be no / or minimum adverse social, economic and environmental effects of displacement on the host communities and specific measures would be provided in the Resettlement Plan.
- Broad entitlement framework of different categories of project-affected people has been assessed and is given in the entitlement matrix. Provisions will be kept in the budget for those who were not present at the time of enumeration. However, anyone moving into the project area after the cut-off date will not be entitled to assistance.
- Appropriate grievance redress mechanism will be established at the district level to ensure speedy resolution of disputes.
- All activities related to resettlement planning, implementation, and monitoring would ensure involvement of women. Efforts will also be made to ensure that vulnerable groups are included.
- All consultations with APs will be documented. Summary results are appended to the RP. Consultations will continue during the implementation of resettlement and rehabilitation works, and
- The Resettlement Plan includes a fully itemized budget and an implementation schedule linked to the civil works contract.

Some of the salient features of the National Rehabilitation and Resettlement Policy, 2007 are listed below;

- The benefits to be offered to the affected families include; land-for-land, to the extent
- Government land would be available in the resettlement areas; preference for employment in the project to at least one person from each nuclear family subject to the availability of vacancies and suitability of the displaced person; training and capacity building for taking up suitable jobs and for self-employment; scholarships for education of the eligible persons from the affected families; preference to groups of cooperatives of the affected persons in the allotment of contracts and other economic opportunities in or around the project site; wage employment to the willing affected persons in the construction work in the project; housing benefits including houses to the landless affected families in both rural and urban areas; and other benefits.
- Financial support to the affected families for construction of cattle sheds, shops, and working sheds; transportation costs, temporary and transitional accommodation, and comprehensive infrastructural facilities and amenities in the resettlement area including education, health care, drinking water, roads, electricity, sanitation, religious activities, cattle grazing, and other community resources, etc.
- A special provision has been made for providing life-time monthly pension to the vulnerable persons, such as the disabled, destitute, orphans, widows, unmarried girls, abandoned women, or persons above 50 years of age (who are not provided or cannot immediately be provided with alternative livelihood).
- Special provision for the STs and SCs include preference in land-for-land for STs followed by SCs; a Tribal Development Plan which will also include a program for development for alternate fuel which will also include a program for development for alternate fuel and non-timber forest produce resources, consultations with Gram Sabhas and Tribal Advisory Councils, protection of fishing rights, land free of- cost for community and religious gatherings, continuation of reservation benefits in resettlement areas, etc.
- A strong grievance redressal mechanism has been prescribed, which includes standing R&R Committees at the district level, R&R Committees at the project level, and an Ombudsman duly empowered in this regard. The R&R Committees shall have representatives from the affected families including women, voluntary organizations, Panchayats, local elected representatives, etc. Provision ahs also been made for post-implementation social audits of the rehabilitation and resettlement schemes and plans.
- For effective monitoring of the progress of implementation of R&R plans, provisions have been made for a National Monitoring Committee, a National Monitoring Cell, mandatory information sharing by the States and UTs with the National Monitoring Cell, and Oversight Committees in the Ministries/Departments concerned for each major project, etc.
- For ensuring transparency, provision has been made for mandatory dissemination of information on displacement, rehabilitation and resettlement, with names of the displaced persons and details of the rehabilitation packages. Such information shall be placed in the public

domain on the Internet as well as shared with the concerned Gram Sabhas and Panchayats, etc. by the project authorities.

- A National Rehabilitation Commission shall be set up by the Central Government, which will be duly empowered to exercise independent oversight over the rehabilitation and resettlement of the affected families.
- Under the new Policy, no project involving displacement of families beyond defined thresholds2 can be undertaken without a detailed Social Impact Assessment, which among other things, shall also take into account the impact that the project will have on public and community properties, assets and infrastructure; and the concerned Government shall have to specify that the ameliorative measures for addressing the said impact, may not be less than what is provided under any scheme or program of the Central or State Government in operation in the area. The SIA report shall be examined by an independent multidisciplinary expert group, which will also include social science and rehabilitation experts. Following the conditions of the SIA clearance shall be mandatory for all projects displacing people beyond the defined thresholds.
- The affected communities shall be duly informed and consulted at each stage, including public hearings in the affected areas for social impact assessment, wide dissemination of the details of the survey to be conducted for R&R plan or scheme, consultations with the Gram Sabhas and public hearings in areas not having Gram Sabhas, consultations with the affected families including women, NGOs, Panchayats, and local elected representatives, among others.
- The Policy also provides that land acquired for a public purpose cannot be transferred to any other purpose but a public purpose, and that too, only with prior approval of the Government. If land acquired for a public purpose remains un-utilized for the purpose for five years from the date of taking over the possession, the same shall revert to the Government concerned. When land acquired is transferred for a consideration, eighty per cent of any net unearned income so accruing to the transferor, shall be shared with the persons from whom the lands were acquired, or their heirs, in proportion to the value of the lands acquired.
- The entitled persons shall have the option to take up to twenty per cent of their rehabilitation grant and compensation amount in the form of shares, if the Requiring Body is a company authorized to issue shares and debentures; with prior approval of the Government, this proportion can be as high as fifty per cent of the rehabilitation grant and compensation amount.

11.11.2 Land Acquisition Act, 1894

In India, compensation for land acquisition and resettlement assistance for project-affected people are governed by the Land Acquisition Act (1894), which has been amended from time to time.

The Act covers only legal titleholders and provides for (i) market value of the land; (ii) additional amount for trees, crops, houses or other immovable property; (iii) damage due to severing of land, residence, place of business.

Followings are the limitations of the LA Act:

- The Act does not include compensation for non-titleholders;

- It provides compensation for acquired properties and structures only;
- It does not recognize loss of income due to the acquisition of commercial establishments and agricultural land;
- It does not provide economic rehabilitation to vulnerable categories.

11.11.3 Project Specific Resettlement framework

However, in this instance a project-specific resettlement framework will be prepared consistent with the existing norms and guidelines of the state government and WB policy on involuntary resettlement to cover losses identified in this project. This framework will reflect the borrowers land acquisition laws / regulations, state policies on resettlement and to some extent WB's policy on involuntary resettlement and other social safeguard guidelines. It will stipulate eligibility and provisions for all types of losses (land, crops / trees, structures, business / employment and workdays / wages). Where land-for-land is not a feasible option, APs will be compensated at full replacement cost. Affected families compensated by the Competent Authority, according to the LA Act 1894, for lost assets, will also receive additional assistance such as shifting allowance, compensation for loss of workdays / income due to dislocation.

11.11.4 Land Acquisition- Mitigation Measures

Based on the survey conducted and information on ROW obtained so far, the land required for widening of the existing road and acquisition to provide a 60m wide ROW including bypasses for the project. Due to the ribbon development almost all throughout the area, care shall be taken to minimise land acquisition. In order to mitigate the ensuing negative impacts of the land acquisition a Resettlement and Rehabilitation (R&R) policy shall be prepared based on the Tamilnadu R&R policy. The salient features of the mitigation measures are:

- Where displacement is unavoidable, those displaced will have their living standard improved.
- PAPs will be compensated, at replacement cost, for assets lost. Adequate social and physical infrastructure will be provided.
- PAPs and lost community would be encouraged to participate in the implementation of RAP.
- An Entitlement Policy shall be worked out as part of the RAP and will deliver a comprehensive package of compensation and assistance to entitled persons, families groups suffering losses as a result of the project.

11.11.5 RESETTLEMENT FRAMEWORK PRINCIPLES AND ENTITLEMENT MATRIX

Based on the above analysis of government provisions and the policy following key resettlement principles, definitions and Entitlement Matrix have been adopted for the Project.

Key Resettlement Principles

(i) land acquisition, and other involuntary resettlement impacts will be avoided or minimized exploring all viable alternative sub-project designs;
(ii) where unavoidable, time-bound resettlement plans (RPs) will be prepared and APs will be assisted in improving or at least regaining their pre-

program standard of living;

(iii) consultation with APs on compensation, disclosure of resettlement information to APs, and participation of APs in planning and implementing sub-projects will be ensured;

(iv) vulnerable and severely affected households will be provided special assistance;

(v) payment of compensation to APs including non-titled persons (e.g., informal dwellers/squatters, and encroachers) for acquired assets at replacement rates;

(vi) payment of compensation and resettlement assistance prior to the contractor taking physical acquisition of the land and prior to the commencement of any construction activities;

(vii) provision of income restoration and rehabilitation;

(viii) Establishment of appropriate grievance redress mechanisms.

TERMS AND DEFINITIONS

The following definitions are used in the documents:

Cut-off Date: In the cases of land acquisition affecting legal titleholders, the cut-off date would be the date of issuing the publication of preliminary notification u/s 11(I) of RFCTLAR Act, 2013 & for the Non-Titleholders cutoff date would be the date of Census Survey.

Project Affected Person: Person who is affected in respect of his/her land including homestead land and structure thereon, trade and occupation due to construction of the project

Project Displaced Person: A displaced person is a person who is compelled to change his/her place of residence and/or work place or place of business, due to the project.

Projected Affected Family: Family includes a person, his or her spouse, minor children, minor brothers and minor sisters dependent on him. Provided that widows, divorcees and women deserted by families shall be considered separate families;

Explanation - An adult of either gender with or without spouse or children or dependents shall be considered as a separate family for the purpose of this Act.

Land Owner: Land owner includes any person -

Whose name is recorded as the owner of the land or building or part thereof, in the records of the authority concerned; or

Any person who is granted forest rights under the Scheduled Tribes and other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006 or under any other law for the time being in force; or

Who is entitled to be granted Patta rights on the land under any law of the State including assigned lands; or any person who has been declared as such by an order of the court or Authority.

Marginal Farmers: Marginal farmer means a cultivator with an un-irrigated land holding up to one hectare or irrigated land holding up to one half hectare, or as may be defined by the concerned state government.

Small Farmer: Small farmer means a cultivator with an un-irrigated land holding up to two hectares or irrigated land holding up to one hectare, but more than the holding of a marginal farmer, or as may be defined by the concerned state government.

Encroacher: A person who has trespassed Government/ private/community Land, adjacent to his or her land or asset to which he/she is not entitled and who derives his/her livelihood and housing there from prior to the cutoff date.

Squatter: A squatter is a person who has settled on publicly owned land for housing or livelihood without permission or who has been occupying publicly owned building without authority prior to the cutoff date.

Landless/Agriculture Labour: A person who does not hold any agriculture land and has been deriving his main income by working on the lands of others as sub-tenant or as an agriculture labour prior to the cut-off date.

Below Poverty Line: A household, whose annual income from all sources is less than the designed sum as fixed by the planning commission of India, will be considered to be below poverty line (BPL).

Vulnerable Person: The Vulnerable group may include but not be limited to the following:

Those people falling under Below Poverty line category as defined by the state government.

- Member of Scheduled caste/tribe community community.
- Women Headed households.
- Senior citizen-person above the age of 60 years.

Project Affected Persons (PAPs), any persons who have economic interests or residence within the project impact corridor and who may be adversely affected directly by the project. PAP include those losing commercial or residential structures in whole or part, those losing agricultural land or homestead land in whole or part, and those losing income sources as a result of project action. PAPs would be of two broad categories, 'PAPs with Major Impact' and 'PAPs with Minor Impact'.

Major Impact (Fully): those properties where the major part of the structure/land is affected and becomes untenable and the affected party is unable to live/do business in the unaffected portion of the property, OR, 10% or more portion of the property is affected.

Minor Impact (Partial): all other impacts other than major impact will be treated as minor impacts, OR, those properties where a part of the structure/land is acquired and the remaining portion is intact and the affected party can continue to live/do business in the unaffected portion of the property.

Entitlement Matrix

All persons affected by the project and meeting the cut-off date requirements will be entitled to a combination of compensation packages and resettlement assistance depending on the nature of ownership rights on lost assets and scope of the impacts:

a) Compensation for the loss of land ,crops/trees at their replacement cost;
b) Compensation for structures (residential/ commercial) and other immovable assets at their Replacement cost;
c) Assistance in lieu of the loss of business/ wage income and income restoration assistance;
d) Assistance for shifting and provision for the relocation site (if required), and
e) Rebuilding and/ or restoration of community resources/facilities.
f) Additional Support to Vulnerable Families

An Entitlement Matrix, delineated in **Table 8.21** has been developed to summarize entitlements.

Table 11-10: Entitlement Matrix

	Type of Loss	Definition of Entitled Person	Compensation Policy	Responsible Agency
	Land			
1.a	Loss of private land - agricultural land,[1] - homestead/ commercial land - vacant plot	Legal titleholders/ traditional titleholders[2]	Land for land if available.[3] Compensation at replacement cost or as calculated under section 26 of LARR Act 2013 If according to the landowner, the residual land is economically unviable, option to be compensated for entire parcel. One time 50,000 Resettlement Allowance as per LARR Act 2013 if family needs to physically relocate to different area 90 days advance notice to relocate	IA/CSC will ensure sufficient provision of notice NGO/Consultant will validate and verify AP list jointly with IA.
1.b	Loss of rented private land and government land	Tenants, leaseholders and Sharecroppers (with lease documents)	Assistance for rental deposit or unexpired lease deducted from the land owner's compensation. 60 days advance notice to harvest standing seasonal crops prior to damage, if notice cannot be given, compensation for share of crops will be provided (see entitlement No. 3.a).	NGO/Consultant will confirm tenants' eligibility IA/ CSC will ensure provision of notice.
1.c	Loss of Government land	Non-titled holders (i.e. Squatters[4], Encroachers[5])	Compensation for assets lost at replacement cost (see	IA/ CSC will ensure provision of

[1] The RFCLARRA 2013 outlines that no irrigated multi-cropped land shall be acquired under this Act, expect in exceptional circumstances, as demonstrable last resort. Wherever such land is acquired, an equivalent area of cultivable land shall be developed for agricultural purposes or an amount equivalent to the value of land acquired shall be deposited with the appropriate Government for investment in agriculture for enhancing food security. Such costs must be reflected in the resettlement budget.

[2] Traditional land rights refer to households with customary rights to land, and shall be treated equivalent to titleholders

[3] During the preparation of the Resettlement Plan for the subproject road, the availability of land will be assessed and this option will be retained/dropped depending on this assessment

[4] Squatters are those who have no recognizable legal rights on the land they are occupying

Type of Loss		Definition of Entitled Person	Compensation Policy	Responsible Agency
			EM 2.a). 90 days advance notice to shift 60 days advance notice to harvest standing seasonal crops prior to damage, if notice cannot given, compensation for share of crops will be provided (see entitlement No. 3.a).	notice. NGO/Consultant will confirm affected household's eligibility
1.d	Temporary loss of land	Legal titleholders	Rent at market value for the period of occupation. Restoration of land to previous or better quality Location of construction camps will be fixed by contractors in consultation with Government and local community.	Contractor negotiates amount with landowner – supervised by CSC. IA/CSC ensures compensation paid prior to take-over. Contractor responsible for site restoration.
2	Structures			
2.a	Loss of residential, commercial structures and other assets	Legal titleholders Encroachers and squatters	If partially affected[6]: Replacement cost of the affected part or assets with right to salvage materials. If remainder of the structure is unviable, the owner has the option to claim compensation for entire structure (see below). If Residential/Commercial structure fully affected: Replacement Cost of the structure If relocating outside	NGO/Consultant will confirm titleholder's eligibility IA/ CSC will ensure provision of notice.

[5] Encroachers are those who use land or build structures which are in whole or in part of an adjacent property to which they have no titles.

[6] External to the living/commercial areas (i.e. verandahs, stairs)

Type of Loss		Definition of Entitled Person	Compensation Policy	Responsible Agency
			RoW, Resettlement Allowance of Rs. 50,000 per family as per LARR Act 2013.[7] Monthly Subsistence Allowance of Rs. 3,000 for one year (total Rs. 36,000) for families having to relocate their homesteads as per LARR Act 2013.[8] Shifting allowance of 10% of replacement cost of structure up to a maximum of Rs 50,000, as per the LARR Act 2013 Right to salvage materials from structure and other assets with no deductions from replacement cost. 90 day notice to vacate structure.	
2.b	Loss of residential/commercial structure and other assets	Tenants (without documentation) and leaseholders	Replacement cost of part/whole of structure – if latter has been constructed by the tenant/leaseholder with right to salvage material Compensation for rental deposit or unexpired lease (only for AP with legitimate lease documentation). This will be deducted from the compensation amount of the structure owner. Lump-sum equivalent to two month lease to support search of alternative housing.	NGO/Consultant will confirm tenants' eligibility IA/ CSC will ensure provision of notice.
2.c	Loss and temporary	Titled and non-titled	Replacement or	IA/ CSC will

[7] Not cumulative if Resettlement Allowance has been given for loss of land (Entitlement 1.a)
[8] Households losing commercial structures are not eligible

	Type of Loss	Definition of Entitled Person	Compensation Policy	Responsible Agency
	impacts on common property resources	owners/communities	restoration of the affected community facilities Best efforts need to be made to avoid impacts on sensitive sites (i.e. religious, sacred). If these need to be relocated or rehabilitated additional level of consultation with community is required to ensure proper process	assess how to avoid sensitive sites NGO/Consultant will conduct additional consultations
3	Loss of crops and trees			
3.a	Loss of trees and crops	Legal titleholder/ tenant/lease-holder/share-cropper/non-titled AP	60 days advance notice to harvest standing seasonal crops prior to damage, fruits and timber Compensation for standing crops (or share of crop for sharecroppers) based on an annual crop cycle at market value. Compensation for trees based on timber value at market price, and compensation for perennial crops and fruit trees at annual net product market value multiplied by remaining productive years; to be determined in consultation with the Forest Department for timber trees and the Horticulture Department for other trees/crops.	NGO/Consultant will confirm affected household eligibility IA/ CSC will ensure notice is provided.
4	Loss of livelihood			
4.1	Loss of livelihood income	Legal Titleholder/ tenant/leaseholder/non-titled holder of fully	Loss of business income/wages: One time financial	NGO/Consultant will confirm affected

	Type of Loss	Definition of Entitled Person	Compensation Policy	Responsible Agency
		affected commercial structure[9] Employee of affected commercial structure. Farmer/ agricultural worker of land acquired.	assistance based on three month income[10] or Rs. 25,000 as per RFCLARRA 2013, whichever is higher	household eligibility
4.2	Temporary disruption of livelihood	Legal titleholders, non-titled Ahs	90 days advance notice regarding construction activities, including duration and type of disruption. Economic Disruption Grant of Rs. 3,000/week when commercial structure is partially affected and owner loses income to rebuild part of structure or because of construction activities. Assistance[11] to mobile vendors/hawkers to temporarily shift for continued economic activity during construction activities.	IA/ CSC will ensure notice is provided.
5	Special assistance to Vulnerable Households			
5.1	Impacts on Vulnerable Households (VAHs) and Severely Affected Households (SAHs)[12]	Vulnerable Households Severely Affected Households	Rs. 50,000 for each physically displaced family[13]. Participation of one member of household in Livelihood Improvement and Skills Development Training Priority of employment	NGO/Consultant to confirm VAH/SAH list NGO/Consultant to conduct assessment of skills development

[9]When core commercial space is affected – when external sections of the structures such as verandahs, stairs, balcony are affected the owner will not be eligible to this entitlement.

[10] Based on income tax return

[11]Assistance will be provided in accommodating a temporary space for commercial activities during construction, dismantling and reassembling mobile structure and in physically relocating structure

[12] Severely Affected Households (SAHs): defined as losing 10% or more of their total productive assets and/or physical displacement

[13] Severely Affected Households (SAHs) and Vulnerable Households (VAHs) losing their homestead and having to physically relocate from affected area

Type of Loss		Definition of Entitled Person	Compensation Policy	Responsible Agency
			under the project during construction and implementation for one family member to extent possible.	
6	Other losses			
6.1	Any other loss not identified		Unanticipated involuntary impacts will be documented and mitigated based on Safeguard Policy (SPS)	NGO/Consultant to identify other potential losses

The resettlement rehabilitation for compensation of the specified entitlement matrix for loss of Public Infrastructure, Residential Houses, Agricultural land and Land other structures should be followed as per RR Policy:

11.12 SAFETY

The road safety issues were raised by the community and what issues were observed during the field survey are:

- Location of dumping sites
- Health issues, such as water borne diseases, HIV & STD
- Safety issues

The project design shall take care of safety measures for road users. Safety of pedestrians as well as of the vehicles plying on the road shall be given highest importance and adequate measures shall be incorporated in the design of the alignment. Beside the divided carriageway designed for the project, service roads are also proposed. Signboards indicating construction sites on the road and flags shall be erected. All the signboards giving caution, barricades for diverting the traffic shall be as per MoRT&H specifications.

11.12.1 Enhancement Opportunities

Enhancements specifically refer to these positive actions to be taken up during the implementation of the project for the benefit of the road users and the communities living close to project road alignment. The following enhancement opportunities have been explored as part of the detailed project report:

- Day-tourism potential along roadsides
- Water storage capacity for settlements
- Bus bay and Truck lay-by
- Wayside amenities
- Road signs, illuminations and markings
- Introduction of ambulance services to transport serious accident cases

The enhancements shall be carried out with the following objectives:

- To enhance the appeal and environmental quality of the project road considers to the users;
- To enhance visual quality along the highway; and

- To generate goodwill amongst the local community towards the project, by the enhancement of common property resources

11.13 PROPOSED ACTION PLAN

The proposed action plan for social assessment would include the following:

- A detailed Census and Socio-Economic survey of the Project Affected Persons based on the Corridor of Impact and alignments provided by the design engineers.
- Analysis of the Primary and secondary data.
- Preparation of the Resettlement Action Plan (RAP)

11.14 TENTATIVE BUDGET FOR RESETTLEMENT AND REHABILITATION ACTIVITIES R&R PROGRAM

It has already been stated that the list of affected properties is yet to be firmed up. However, a tentative estimate of cost for Rehabilitation & Resettlement has been worked out to **Rs. 3002.9168crores**, which covers all components of compensation, assistance and entitlements. The broad break up of R & R budget is given below in **Table 8.22.**

Table 11-11: Estimated Tentative budget for R&R Activities

Sl. No	Particulars	Amount (Rs.)
A	**Compensation for Land Acquisition**	
1	**#**Compensation for Structure/Agriculture/barren land 2791 hectars (See table 8.19 & 8.20)	2582,00,00,000
2	Value of the 1141 structures x200000	22,82,00,000
3	Value of Wooden/Koisks @25000x104	26,00,000
	Total	**2605,08,00,000**
B	**R&R Entitlements**	
4	Subsistence Allowance Rs3000x12 months=36000 x1141structures	4,10,76,000
5	Subsistence Allowance Rs3000x12 months=36000 x104 Squatters	37,44,000
	Total	**4,48,20,000**
C	**Religious**	
9	Temples/Samadhis/Mazars 30x2,00,000	60,00,000
	Total	**60,00,000**
D	**Others Services**	
10	N.G.O Service Charges	25,00,000
11	Administrative Cost	30,00,000
12	M & E consultant Lump sum	40,00,000
13	HIV/AIDS awareness	20,00,000
	Total	**1,15,00,000**
	A+B+C+D	**2611,23,20,000**
14	Contingency 15%	391,68,48,000
15	**Grand Total**	**3002,91,68,000**

*Based on assessment conducted by the consultant on the market value of land through interviewing local revenue officer and Affected Persons.

11.15 CONCLUSIONS

The initial social assessment report is a step towards preparation of the Social Impact Assessment and RAP. The initial assessment process as described in previous sections has primarily tried to focus on the relevant legislations, potential impacts due to the proposed project and to propose mitigation measures at different phases of the project. Based on the findings during the initial assessment study some measures have to be considered from the inception of the project, which will reduce the detrimental effects of project appreciably.

- Alternative alignments such as eccentric or concentric widening, realignment / bypass etc shall be attempted in order to find a suitable alignment that would have minimum adverse impact on social aspects.
- The alignment for widening would be designed considering minimum land acquisition.
- The alignment widening would try to avoid schools, places of worships, public utilities and other common resources.
- An amicable solution with regard to shifting of religious structures (if required) shall be explored in consultation with community leaders, religious leaders and other prominent persons in the local area.
- It will be ensured that the likely affected common properties used by local people are suitably rehabilitated before the start of civil construction work and budgetary provision for the same shall be made in the project estimates.

With the above approach to design, construction and operation the project will be socially feasible.

12. CONCLUSION AND RECOMMENDATION

12.1 CONCLUSION AND RECOMMENDATION

The project road is one of the most important project highways in the State of Tamil Nadu, providing connectivity commercial and tourist centres such as Chennai, Salem, Coimbatore, Erode, Karur and Subsequently to Ooty.

The traffic on project highway is grown in many folds, thus reducing the average journey speeds. The traffic forecast recommends for immediate development to Six/Eight lane divided carriageway from Chennai – Salem along with four lane divided carriageway for Spur Roads.