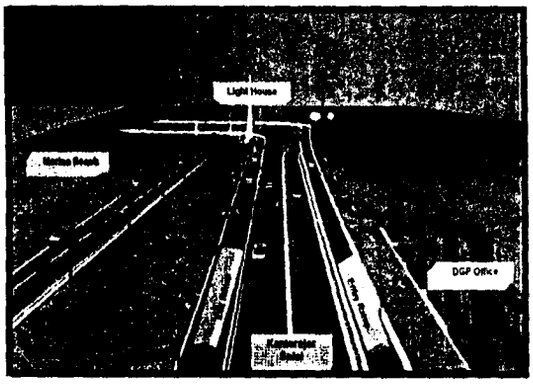
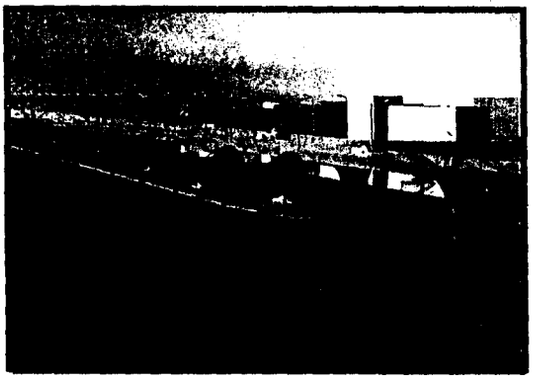
Highways Department

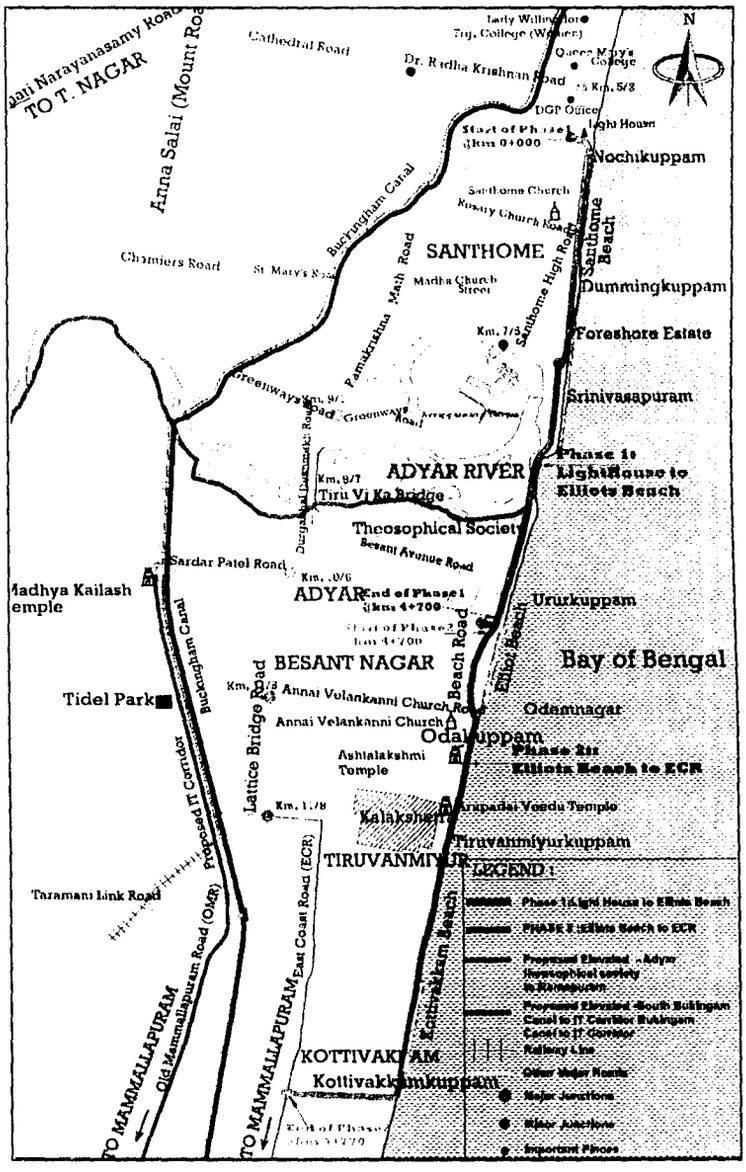
LINK ROAD FROM LIGHT HOUSE ON KAMARAJAR SALAI TO ECR VIA BESANT NAGAR

FINAL DETAILED FEASIBILITY REPORT

Phase 1 : Light House on Kamrajar Salai to Besant Nagar







Private Limited
ENGINEERS & PLANNERS
Wilbur Smith Associates

December 2008

Highways Department

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Volume I - Main Report

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Executive Summary

1. Project Introduction

Government of Tamil Nadu (GoTN) has formed a Beach committee to improve the existing beach along the east coast by enhancing the aesthetics and other facilities also to decongest the existing traffic along the marina beach. As part of the enhancement measures, Beach committee now intends to construct a link road from Light house on Kamarajar Salai to Besant Nagar (Via) Santhome Bypass, Sreenivasapuram, and Ururkuppam including construction of a high level bridge across Adyar Estuary to join ECR.

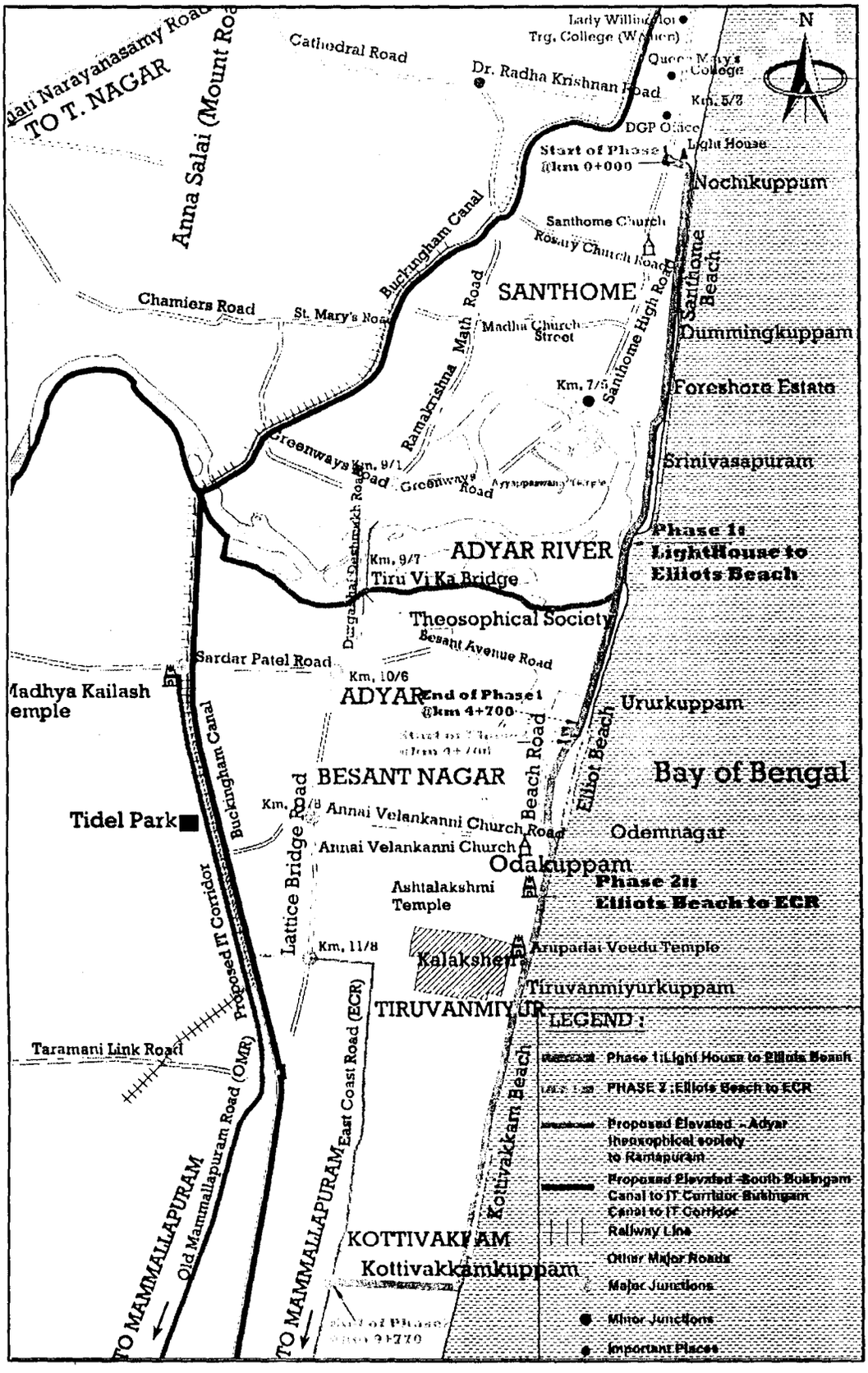
The draft feasibility report was submitted to the Highways Department during April, 2007 and further to this review meetings were conducted by the review committer on 06.08.07, 19.03.08, 16.04.08 and 22.11.08. During the above review meetings considering the availability of existing roads along the proposed alignment, it is proposed to implement the project under the following two phases:

Phase1 Reconstruction of existing road with Elevated Corridor from Light House to Besant Nagar near Ururkuppam including provision of entry & exit ramps near Foreshore estate road junction and reconstruction of existing bridge across river Adyar with "Signature bridge". (4.7km). This phase will also include necessary arrangement for linking with Phase 2 at Besant Nagar Junction in due course.

Phase 2 Construction of Elevated Corridor from Besant Nagar to East Coast Road (ECR) along the coast by making use of the existing road alignments

The Final feasibility report is also prepared for two phase's separately and this report discusses only on the Phase 1 of the project.

Key map of the project area is in shown in **Figure** below.



Key Map of the Project Area

1.1 Project Objective

The primary objectives of the study are:

- To establish the technical, economical, environmental, social and financial viability of the project
- To prepare detailed feasibility report including the Environmental and Social Management Plan (ESMP).

2. Surveys and Investigations

The various surveys and investigations, which have been carried out, cover the following

- Traffic Surveys
- Road Inventory Survey
- Pavement Condition Survey
- Topographical Survey
- Geotechnical Investigations

2.1 Traffic Surveys

The survey locations that were finalized in consultation with Highways Department are given in **Table** below.

Traffic Survey Locations and Duration

Sl No.	Location	Duration	Dates of Surveys
Link Count Surveys			
1.1	Santhome Beach Road	3 days (2 week days+ 1 weekend)	28- 12-2005 to 29-12 - 2005, 07-01-2006
1.2	Elliots Beach	3 days (2 week days+ 1 weekend)	28- 12-2005 to 29-12 - 2005, 08-01-2006
1.3	Thiru Vi Ka Bridge (Km 9/4 of Greenways Rd)	2 working days	03-01-2006 to 04-01-2006
1.4	Lattice Bridge Rd –Sardar Patel Junction (L & R turning movements only)	2 working days	05-01-2006 to 06-01-2006
O-D Surveys			
2.1	Thiru Vi Ka Bridge (Km 9/4 of Greenways Rd)	2 working days	03-01-2006 to 04-01-2006
2.2	Lattice Bridge Rd –Sardar Patel Junction (L & R turning movements only)	2 working days	05-01-2006 to 06-01-2006
Junction Count Surveys			
3.1	DGP Office Junction (Km 5/2)	2 days (1 week day+ 1 weekend) 14 hours (8 am to 10 pm)	09-12-2005, 07-01-2006
3.2	Marina Entrance Junction (Km 5/4)	1 weekend day -14 hours (8 am to 10 pm)	08-01-2006
3.3	Light House Junction (Km 5/6)	1 weekend day -14 hours (8 am to 10 pm)	09-01-2006
3.4	ECR Junction (Km 14/6 of ECR)	1 week day- 12 hours (8 am to 8 pm)	02-01-2006
Pedestrian Counts (crossing + along carriageway)			
4.1	Santhome beach	1 weekend day - 6 hours	07-01-2006

Sl No.	Location	Duration	Dates of Surveys
		(4 pm to 10 pm)	
4.2	Elliots beach	1 weekend day - 6 hours (4 pm to 10 pm)	08-01-2006
5. Parking Surveys			
5.1	Santhome beach	1 weekend day - 6 hours (4 pm to 10 pm)	07-01-2006
5.2	Elliots beach	1 weekend day - 6 hours (4 pm to 10 pm)	08-01-2006

2.2 Road Inventory Survey

The details collected are as follows:

- Project Stretch Details
- Terrain Type - Plain
- Width of Carriageway – 2.5m to 10.0m
- Earthen Shoulder – 1.0m to 2.0m
- Paved Shoulder – 1.0m to 4.0m
- Right of Way (ROW) – 7.0m to 28.0m
- Major Junction – 14
- Minor Junctions – 49
- Road Side Land Use and location of built-up sections – Residential / Sea
- Utility details
- Possible alignment options for the connecting existing alignment with ECR

2.3 Pavement Survey

The project Stretch consists of bituminous surface only on some portions. The existing pavement is of bituminous flexible type with varying compositions and characteristics. Pavement condition survey (Visual) has been carried out to assess the adequacy and effectiveness of existing pavement in serving the present traffic needs. The Following distresses were recorded as part of pavement condition survey;

- Rut depth on wheel path
- Edge break or Edge drop
- Cracking
- Pot hole & Patching areas
- Ravelling and stripping of aggregates

2.4 Geotechnical Investigations

The details of geotechnical investigation done are given in **Table** below.

Details of Geo-Technical Investigations

Sl. No.	Location	Bore Hole /Trial Pit No.	Termination Depth from GL(m)	Remarks
1	Light House	BH-1	24	N=>100
2	Adyar Bridge	BH-2	22.5	N=>100

Sl. No.	Location	Bore Hole /Trial Pit No.	Termination Depth from GL(m)	Remarks
3	Mahalakshmi Temple	BH-3	29	N=>100 Rock Encountered
4		BH-4	25	N=>100 Rock Encountered
5		BH-5	21	N=>100
6		BH-6	26.5	N=>100 Rock Encountered
7		BH-7	24	N=>100 Rock Encountered
8		BH-8	25	N=>100 Rock Encountered
9		BH-9	23	N=>100
10		BH-10	28	N=>100 Rock Encountered
11		BH-11	27	N=>100
12		BH-12	22.5	N=>100
13		BH-13	25.5	N=>100 Rock Encountered
14		BH-14	28.5	N=>100 Rock Encountered
15		BH-15	25	N=>100 Rock Encountered
16		BH-16	24.5	N=>100 Rock Encountered
17		BH-17	25.5	N=>100 Rock Encountered
18		BH-18	23	N=>100
19		BH-19	27	N=>100 Rock Encountered
20		BH-20	27	N=>100 Rock Encountered

The soil varies from fine to medium sand for shorter depths in all the bore hole locations. Hard strata or rock is encountered at about 23m in all the bore hole locations. Based on the sub soil findings, suitable foundations are proposed. The type, depth and safe bearing capacities of footings are described in the preliminary bridge design section.

3. Traffic Studies & Projections

3.1 Average Daily Traffic

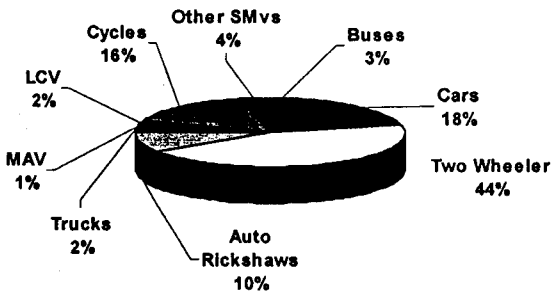
The Average Daily Traffic (ADT), Vehicle Composition and Peak Hour Traffic & Hourly variation for the following locations are as given below:

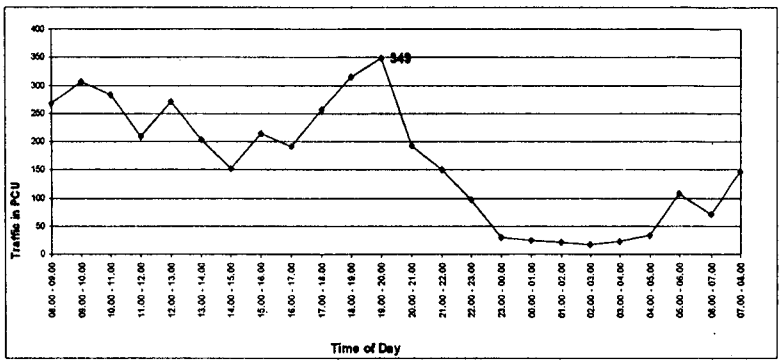
3.1.1 Santhome Beach Road

ADT on Santhome Beach Road, 2006 (No. of vehicles)*

Vehicle Type	Buses	Cars	Two Wheeler	AR	Trucks	MAV	LCV	Total FMVs	Cycles	Other SMVs	Total SMVs	Total Vehicles	Total PCU
Nos.	119	711	1715	368	66	47	85	3111	616	140	757	3868	3937

(Note *: ADT is the weighted average of 3 day count, giving a weightage of 2 for weekends and a weightage of 5 for working days)



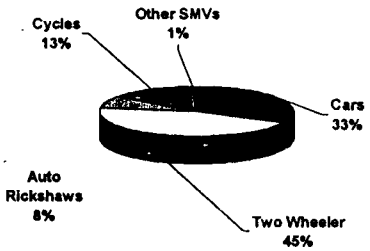


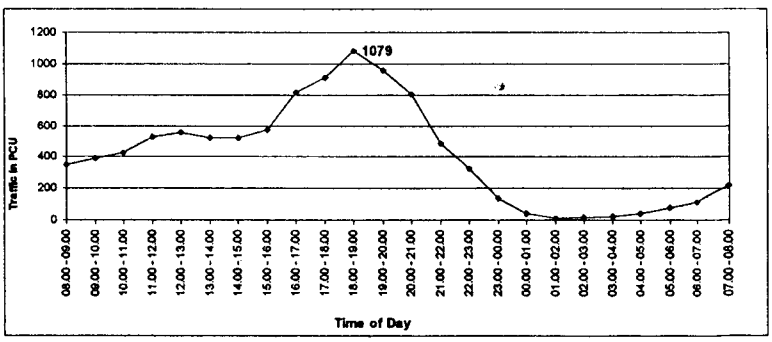
3.1.2 Elliot's Beach Road

ADT on Elliots beach Road, 2006 (No. of vehicles)*

Vehicle Type	Buses	Cars	Two Wheeler	AR	Trucks	MAV	LCV	Total FMVs	Cycles	Other SMVs	Total SMVs	Total Vehicles	Total PCU
Nos.	49	3439	4720	883	18	30	10	9148	1398	103	1501	10650	9905

(Note: ADT is the weighted average of 3 day count, giving a weightage of 2 for weekends and a weightage of 5 for working days)*

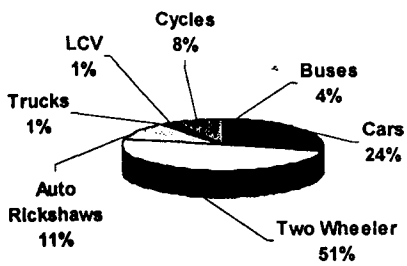


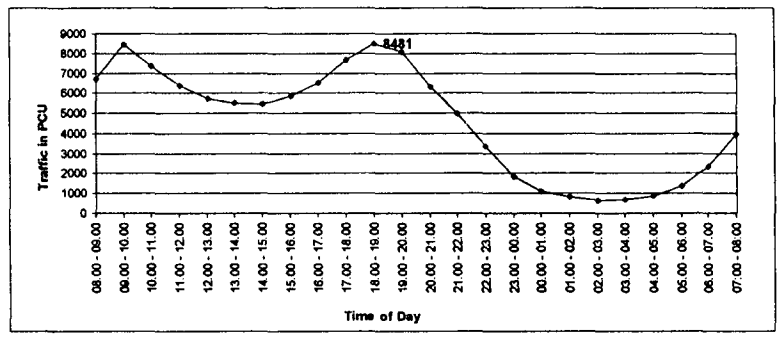


3.1.3 Thiru-Vi-Ka Bridge

ADT on Thiru- Vi- Ka Bridge, 2006 (No. of vehicles)*

Veh. Type	Bus	Cars	Two Wheeler	AR	Trucks	MAV	LCV	Total FMVs	Cycles	Other SMVs	Total SMVs	Total Vehicles	Total PCU
Nos.	4419	26762	55061	12111	1319	31	1483	101186	8929	78	9007	110193	110652





3.2 Junction Turning Counts

The peak hour traffic observed at the four junctions along the proposed elevated highway is given in **Table** below.

Peak Hour Junction Turning Volume , 2006 (No. of Vehicles)

Name of Junction	Bus	Car/ Jeep/ Van (O)	Car/ Jeep/ Van (N)	Two Wheelers	Auto	Trucks	MAV	LCV	Slow Moving Vehicles	Total Vehicles	Total PCU
DGP Office Junction	308	219	2127	3690	1481	16	1	28	297	8167	8429
Light House Junction	10	36	356	385	88	0	0	6	62	943	924
Beach Junction	3	140	320	775	73	0	0	0	36	1347	1203
Palavakkam Junction	173	76	828	1901	535	17	0	54	368	3944	3865

3.3 Speed & Delay Surveys

The speeds observed during peak hours are presented in **Table** below.

Speed – Delay Survey Results on the roads in the Available Routes

From	To	Length (Km)	Journey time(Min.)	Journey Speed (KMPH)
Dr. Radha Krishnan Road and Royapettah High road Jun	Light House Jun	1.80	5.25	20.57
Dr. Radha Krishnan Road and Royapettah High road Jun	Greenways road Junction (through Ramakrishna Math road)	3.10	11.25	16.53
Light House Jun	Santhome Church	0.60	2.50	14.40

From	To	Length (Km)	Journey time(Min.)	Journey Speed (KMPH)
Santhome Church	Greenways Road Jun	2.80	9.60	17.50
Greenways Road Jun	Besant Nagar road Jun	1.30	7.40	12.16
Besant Nagar road Jun	Annai Velankanni Church road	1.40	6.25	13.44
Annai Velankanni Church road	Thiruvanmiyur Jun	1.00	3.85	15.58
Thiruvanmiyur Jun	Kottivakkam Jun	2.80	6.90	24.35
Besant Avenue Road		1.8	9	20.0

3.4 Origin-Destination Surveys

Zoning system was adopted for the study in order to capture the possible movements along the proposed bypass. The study region was divided into 25 zones. The zone list and Estimated Movement wise traffic of the study area is shown in Table below. Various traffic movements are shown in Figure below.

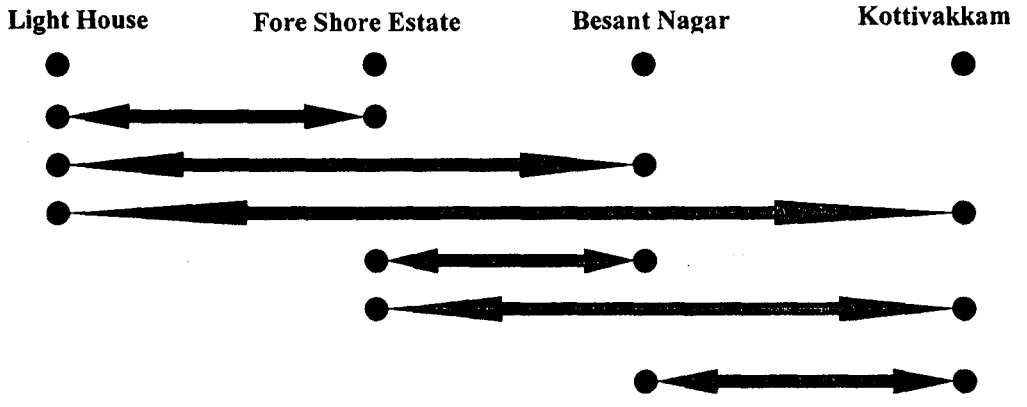
Zone List for the study area

Zone No.	Zone Description
1	Santhome
2	Santhome Beach
3	Foreshore Estate, Pattinappakkam, MRC Nagar and Srinivasapuram
4	Besant Nagar, Kalashethra colony and Shastri Nagar
5	Elliot's Beach
6	Ashtalakshmi Temple and Annai Velankanni
7	Thiruvanmiyur
8	Kottivakkam and Palavakkam
9	Adayar and Theosophical Society
10	Gandhi Nagar
11	Velachery, Tharamani, Tidal Park and Madipakkam
12	Injambakkam, Kovalam and other beach resorts along ECR and Mahabalipuram
13	Pondichery, Kanchipuram and other southern districts of Tamil Nadu
14	Nandanam, Saidapet, Kotturpuram and Guindy
15	Mylapore, Mandaveli, R.A Puram, Abhiramapuram and Music Academy
16	Alwarpet, Royapettah, Teynampet, Triplicane, Chepauk and Marina Beach
17	Parrys, George Town, Park Town, Chindadripet, Royapuram, Washermanpet and Tondiarpet
18	Purasavakkam, Egmore, Vepery, Perambur, Villivakkam, Annanagar, Aminjikarai, Chetpet, Nungambakkam, Avadi, Ambathur and Vyasarpadi
19	T.Nagar, West Mambalam, Vadapalani, Kodambakkam and nearby area
20	Other districts of Tamilnadu
21	Other States of India
22	Tambaram, Pallavaram, Chrompet and surrounding places
23	Thoraipakkam, Perungudi, Sholinganallur, Navalur and Kelambakkam

Estimated Movement wise Traffic

Movements	Origins	Destinations	Movements (No. of Trips)					
			Car	TW	Auto	LCV	MAV	Truck
Light House- Besant Nagar	16,17,18, 19	4,5,6	2674	6916	1423	91	4	139
Light House - Kottivakkam and beyond	16,17,18, 19	8,12,13	631	1929	161	91	3	239*
Fore Shore Estate to Besant Nagar	15	4,5,6	30	122	51	-	-	-
Fore Shore Estate to Kottivakkam & beyond	15	8,12,13	401	869	126	-	-	-
Besant Nagar – Kottivakkam and beyond	14,19,22	8,12,13	300	471	64	81	-	-

*(Note: *- trucks including coal carrying trucks from Chennai Port)*



Various Movements on the Proposed Elevated Road

3.5 Pedestrian count Survey

The pedestrian count was conducted at three locations. The count was taken up in the peak hours in the morning/evening. The summary of pedestrian count is given in the **Table** below. Since it is proposed to develop an elevated road for the entire length, no recommendations are made for pedestrian facilities along the road.

Peak Pedestrian counts

Sl. No	Road Stretch	Peak Hour	Pedestrians Along the Road	Pedestrians Across the Road
1	Elliots Beach Road	7pm- 8pm	3520	901
2	Santhome Beach Road	9.30 am- 10.30 am	1013	475

3.6 Parking Survey

Parking survey was conducted at three locations. The count was taken up in the peak hours. The summary of the parking survey is given in the **Table** below. Due to the same reasons listed above, no recommendations are made for parking also.

Summary of Parking Count Survey

Sl. No	Road Stretch	Peak Hour	Peak Hour Parking				
			Bus	Auto	Car	TW	Cycles
1	Elliots Beach Road (from Skating Ground to 5th Avenue)	7pm-8pm	-	-	531	2560	177
2	Santhome Beach Road	6 pm-7pm	9	135	152	644	117

3.7 Traffic Forecasting

3.7.1 Projection Based on Peak Hour Traffic

A peak hour factor of 8% is taken as observed on Thiru- Vi- Ka Bridge, to estimate the maximum traffic on the Section between Fore Shore Estate and Besant Nagar, as this section will carry the highest traffic. The peak hour traffic is also projected to the horizon year to verify the lane requirement based on peak traffic and is presented in **Table** below.

Projected Peak Hour Traffic on Section II

Year	Peak Hour Traffic (PCU)	Year	Peak Hour Traffic (PCU)
2006	1248	2018	2970
2007	1343	2019	3184
2008	1445	2020	3415
2009	1556	2021	3659
2010	1677	2022	3923
2011	1802	2023	4206
2012	1938	2024	4512
2013	2085	2025	4841
2014	2244	2026	5197
2015	2416	2027	5580
2016	2587	2028	5993
2017	2772	2029	6439

3.8 Recommendation

From the traffic projection and the growth potential along the corridor, it is proposed to have a six lane road from Foreshore to Besant Nagar and four lane road from Light house to Foreshore Estate and Besant Nagar to Kottivakkam with entry and exit ramps at Fore Shore Estate, and Besant Nagar.

4. Improvement Proposals

The improvement proposals are finalized based on the results of the surveys and investigations described in Chapters 2 and 3 and also based on the decisions taken during the discussions held with the client. As part of the study, the following two alignment options were studied for proposed elevated road from km 5/2 of Kamarajar Salai near Gandhi Statue to connect East Coast Road (ECR) at Km 14/6 near Kottivakkam. The proposed two alignment options are shown in **Figure 4.1**

1. **Option 1:** From Light House to ECR via Srinivasapuram, Oorur kuppam, Kottivakkam Kuppam along the Coast to Join ECR at km 14/6 (9.705 Km)

2. **Option 2:** From Light House to ECR via Srinivasapuram, Oorur Kuppam, Besant Nagar, 5th, 3rd, 4th 2nd & 7th Avenue, LB Road, along ECR via Tiruvanmiyur,terminates at km 14/6 of ECR near Kottivakkam(11.6km), along the existing road alignments for the entire length.

4.2.1 Alignment Approval

The above two alignment options were submitted to the Highways Department, GoTN during July, 2006 and approval for the section of Option 1 from Light House to Ururkuppam (5.0km) was given by Highways Department on 30.08.2006 ***(Letter No.11458/2006/D.1/dated 30.08.2006).*** Further to this, a joint site inspection was held with Superintending Engineer (H), Chennai Circle on August 16, 2006 to get the approval for the remaining sections and accordingly the stage II alignment between Ururkuppam to ECR along the coast was approved by Highways Department on 07.12.2006 ***(letter No.11458/2006/D1/dated 07.12.2006)***.

Further to the getting approval for the alignment along the coast (Option 1), the draft feasibility report (DFR) was submitted on 12.04.2007 and the same was presented to the Chief Secretary on 06.08.2007 and this committee has also approved the Option 1 alignment along the costal line on 28.08.2007 ***(Letter No.14283/HW1/2007-3 dated 28.08.2007)***. The project after incorporating the suggestions made during the review meeting held on 06.08.2007 was again presented to the review committee on 19.03.2008.

The project was also presented to the Hon'ble Chief Minister of Tamil Nadu on 16.04.2008. During the above meeting Hon'ble minister for PWD, Hon'ble minister for Highways, Chief Secretary, Finance Secretary, Highways Secretary, Chief Engineer (H), General and other officials from GoTN were also present. This committer has also decided to take up the improvement of Phase I from Light House to Besant Nagar on a priority basis.

4.1 Design Parameters

Design Speed	Camber	Maximum Super elevation
100kmph/30kmph	2.5%	4%

4.2 Carriageway Width

Based on traffic projection, the entire stretch is divided in to the following three different homogeneous sections.

- Section I – Gandhi Statute to Fore Shore Estate
- Section II – Fore Shore Estate to Elliots Beach
- Section III – Elliots Beach to Kottivakkam

Four lane configuration is proposed for the Section I and Section III and six lane width is proposed for the Section II. Ramps with two lane configuration are provided at Foreshore estate and Eliot beach.

4.3 Horizontal Alignment

Horizontal Alignment should be fluent and blend well with the surrounding topography. The horizontal curves are designed as per IRC standards with sufficient transition lengths. The minimum curve radius adopted for ruling design speed of 100 Kmph is 360m and for design speed of 30Kmph is 40 m.

4.4 Vertical Alignment

Vertical alignment is designed based on the provision of IRC SP: 23. Details of rate of curvature and minimum curve length adopted are given in Table below.

Minimum Length of Vertical Curves

Design Speed (Km/h)	Maximum grade change (%) not requiring a vertical curve	Minimum length of vertical curve (m)	K value	
			Sag	Hog
30	1.5	15	2	3.5
65	0.8	40	19	18
100	0.5	60	64	42

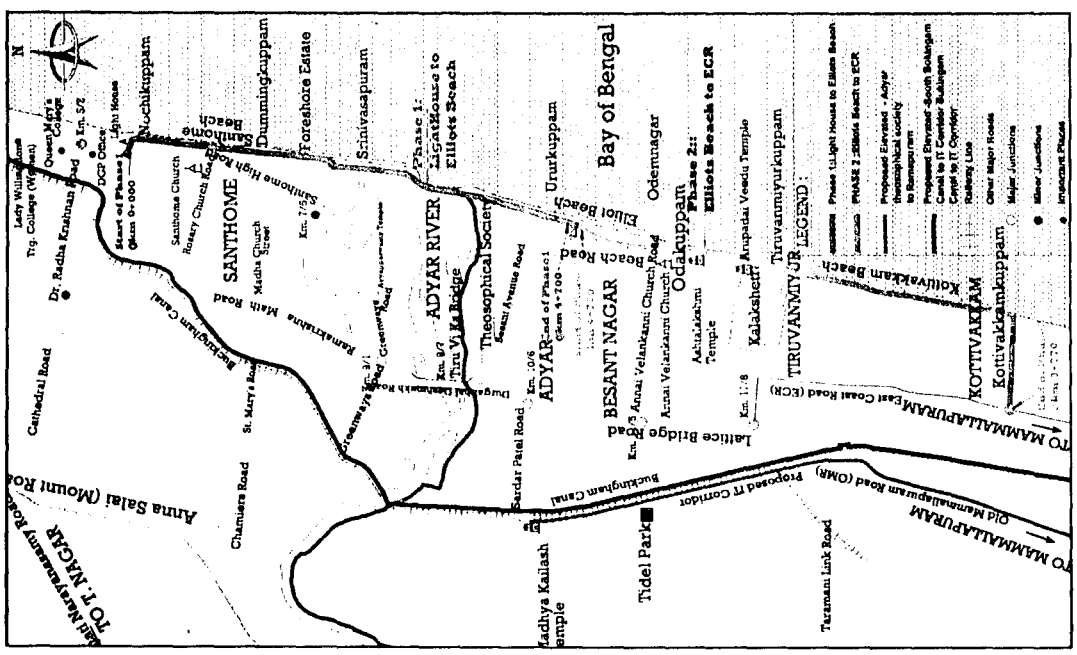
4.5 Alignment Details

The alignment takes off at km 5/4 of Kamarajar Salai near Gandhi Statute. Entry ramp for the elevated corridor runs on eastern side of the Kamarajar Salai for a length of 200m and takes a left turn before light house building, joins the elevated section over existing Santhome loop road. Exit ramp starts on western side of Kamarajar Salai and runs for a length of 300m then takes a left turn just after Light house building and passes though the middle of Nochikuppam road and joins the elevated section over existing Santhome loop road at the same point where entry ramp also joins. The elevated section along the western edge of the existing Santhome loop road is of 1.9 km, passing through Nochikuppam, Dumming Kuppam, Bhavani Kuppam and Mulliamman Nagar, where it joins with the Fore Shore Estate road. Total length of this section of alignment between light house to Fore Shore Estate junction is 2.4km including exit and entry ramps at Kamarajar Salai. Exit and entry ramps towards Light house and towards Besant Nagar are also provided at this junction.

The alignment further runs along settlements of Srinivasapuram along the western edge of the existing BT road upto Adyar River. Total length of this section of alignment between Santhome Loop road junction upto Adyar River is 0.7km.

The alignment crosses Adyar Estuary to the western side of the existing broken bridge, further runs along the existing single lane BT road upto Ururkuppam, where the alignment joins with the Besant Nagar 5th Avenue road near Elliot's beach. Total length of this section between Adyar Estuary and 5th Avenue road is 0.998 km.

Total length of the alignment approved for Phase I is 4.7km of elevated structure with 5.5m vertical clearance. As the proposed alignment is entirely elevated, entry and exit ramp arrangements are provided at junction of project road with Fore shore estate road and Besant Nagar 5th Avenue Road. Fig 4.2 will given the phasing arrangements



4.6 Right Of Way (Row)

According to lane requirement and social issues the proposed right of way required is formulated and presented in the **Table** below.

Proposed Right of Way (ROW)

Design Chainage (Km)		Length (km)	ROW Width (m)	Section / Location
From	To			
0+000	0+370	0.37	43.5	Approach Ramp and at grade roads in Kamarajar Salai
0+370	1+800	1.43	18.0	Elevated Corridor along Santhome loop road up to Foreshore Estate Road
1+800	2+900	1.10	35.0	Ramp location in Foreshore Estate. This is including the proposed two lane entry & exit ramp arrangements
2+900	3+200	0.30	18.0	After Ramp at Foreshore Estate upto to Adyar Bridge, along Srinivasapuram
3+200	3+600	0.40	20.5	Along bridge across Adyar Bridge
3+600	4+070	0.47	18.0	Along bridge across Adyar Bridge
4+070	4+700	0.63	35.0	From Adayar Bridge to Ramp at Orukuppam

4.7 Pavement Design

Pavement design for at grade roads dealt as design of pavement for new construction. For the purpose of pavement design, the entire length of the service road is taken as a single homogeneous section. Details of Pavement Composition are given in **Table** below.

Proposed Pavement Layer Compositions for New Construction

Road Section		At grade roads	Service roads
Design Life		20 Years	20 Years
Design Traffic		25 MSA	05 MSA
Design CBR		8 %	8 %
Proposed Pavement Composition in mm	**Wearing Course**	40 BC	25 SDBC
	Binder Course	95 DBM	50 DBM
	Granular Base	250 WMM	250 WMM
	Granular Sub Base	200 GSB	150 GSB

4.8 Structural Schemes

4.9Structural schemes

The structural system consisting mainly of superstructure, substructure and foundation are planned based on the suitability of the same at the proposed location, constructability, degree of impact during

construction on the beach goers and surrounding people, severe salinity of the atmosphere due to the proximity of sea, aesthetics, degree of hindrance to beach view etc. Accordingly, various options were planned for superstructure, substructure and foundation.

Criteria for finalization of structural type

The basic consideration in the planning and finalization of the structural scheme is to have least number of different types/arrangements to ensure speedy construction and to curb cost. Stretches with existing road at grade and the up/down ramps are also given due consideration in finalizing the structure type/locations. Suitable superstructure arrangement is proposed at the locations of entry/exit of ramps and their merging. Substructure type is mainly based on the locations of existing roads at grade and change over of stretches with and with out service roads at grade.

4.10 Design Methodology

Based on the topographical data and the data collected at site, the span requirement is studied. Span arrangement at each location is finalized for satisfying the functional requirement and also based on the subsoil characteristics at the location. Due consideration to the type of structure is given to ensure good aesthetics. General arrangement drawing is prepared after finalizing the type of structure. spans etc. Provision for up and down ramps is also provided as required.

Loading standards adopted

The structures are designed for loadings as per IRC 6: 2000. The basic loadings considered are

- Dead load constituting of self weight of structural members
- Superimposed dead load constituting of wearing coat, crash barrier, footpath and railing loads
- Live load constituting of loads due to IRC Class A vehicles or IRC 70R vehicles
- Wind load as applicable to the site based on the height
- Seismic load as per provisions in IRC code. Seismic zone II is considered for the design

Clearances adopted

Vertical clearance - 5.5m up to soffit of deck from the road at grade at locations of crossing.
5.5m up to the bottom of the pier cap where vehicles ply under the flyover at locations with restriction of available ROW.

Horizontal clearance - As per the junction requirement

Exposure Condition

Due to the proximity to the sea, severe exposure condition is adopted in the design.

Structural arrangement

Based on subsoil investigation report and site specific details, Post tensioned girders and PSC voided slabs are proposed as superstructure. Girder structure is proposed for straight stretches and voided slab structure is proposed at locations of merging of ramps with the main flyover. Hammer headed elliptical pier is proposed as substructure. Trestle pier is proposed as abutment piers on either end of the main flyover. Pile foundations with 4, 6 and 8 pile groups are proposed as per requirement.

Details of superstructure arrangements adopted is shown below in **Table** below **Superstructure Details**

Span length	Type of superstructure	Number of spans
Main Flyover		
35	Fish Belly	53
24	PSC I Girder	3
25	PSC I Girder	2
35	PSC I Girder	31
14	Voided Slab	1
15	Voided Slab	6
15.5	Voided Slab	1
17	Voided Slab	2
18	Voided Slab	1
20	Voided Slab	4
20.5	Voided Slab	1
21	Voided Slab	1
24	Voided Slab	1
Ramp Section		
14	Fish Belly	1
15	Fish Belly	1
35	Fish Belly	18

Span length	Type of superstructure	Number of spans
25	PSC I Girder	4
35	PSC I Girder	34
15	Voided Slab	6
15.7	Voided Slab	1
16	Voided Slab	2
17	Voided Slab	2
17.1	Voided Slab	1
20	Voided Slab	38

The proposed alignment passes the Adayar estuary and runs near the existing broken bridge between chainage 3+470 and 3+650. The existing bridge fouls with five pier points of the proposed elevated structure, which runs at a higher level than the existing broken bridge. Existing broken bridge at this location shall be dismantled.

5. Environmental Impact Assessment and EMP

Introduction

This section on Environmental Impact Assessment is organised in two specific components for the first phase of the project. The first component carries out the Environmental Screening of the project proposals vis-à-vis the base line environmental conditions and identifies the broad issues of environmental criticality. The second component then assesses the specific impacts of the proposed improvements and proposes mitigative measures for each of the identified impact.

The present study in this perspective looks at

- Assessing the impacts on environmental attributes due to the construction and operation of the proposed works along the phase I stretch of the proposed Santhome bypass and to prepare an Environmental Impact Assessment (EIA) Report.
- Preparation of an Environmental Mitigation Plan (EMP) recommending management measures to minimize the negative environmental impacts due to the project and to keep the unavoidable impacts to the permissible level under regulatory norms and also to outline the measures for improving the environmental quality.
- To prepare budgetary cost estimation for implementation of EMP

The EIA Report has been prepared according to the structure of the EIA Report presented in the EIA Notification, 2006 by Ministry of Environment and Forests, Government of India. The EIA is based on detailed field reconnaissance surveys, inventories and available secondary information. Based on all these activities the following conclusions are made.

The project is an elevated road network and the proposed stretches of Santhome bypass falls under CRZ II. Hence, it is required to obtain the environmental clearance from MoEF. The entire road stretch is located in Chennai along the coast of Bay of Bengal.

Baseline Environmental Profile of the Project Area

In order to assess the baseline environmental status of the project influence area, monitoring of various environmental attributes were conducted by the Consultants. In addition to the baseline environmental monitoring, field inspection at all the sensitive locations, collection of secondary information for all the environmental components and discussions with the officials, NGO's and local public were conducted by the Consultants.

Land use of the area is primarily of urban type as the study area is within the Chennai Metropolitan Development Authority (CMDA) area limits. The stretch of Santhome bypass under study in this phase is adjacent to the coast of Bay of Bengal. Some stretches of the road is very close to the sea (within 50m from the shoreline). The land use pattern was dominated by the presence of beach with some fishermen settlements.

As part of the baseline environmental monitoring, noise levels were measured at 2 locations and samples were collected from 2 locations for ambient air quality, 2 locations for ground water quality, 5 locations for surface water quality and 2 locations for soil quality along the project road. The

sampling locations were identified to capture the different land use and the sensitive receptors along the Stretch.

The ambient air quality monitoring results demonstrated mmaximum TSPM concentration as 180 µg/m3 at Besant Nagar and also maximum concentration of SO2 and NOx was found as 8.6 µg/m3 and 11.7 µg/m3 respectively. CO was observed less than 114.5 ppm for all stations and HC less than 65 ppm for all stations.

Surface water quality at all the sampling locations showed high degree of alkalinity and also the presence of high chloride concentration represented the characteristics of typical sea water as the proposed road is very close to the sea.

High concentration of total hardness was recorded for all the stations in their ground water samples. The concentration exceeded the limitation prescribed by IS 10500 standard for drinking water. All other parameters were well within the drinking water standard.

The soil quality analysis results suggested that the soil was alkaline in nature with average electrical conductivity. Presence of organic matter was less. Considering NPK values, Nitrogen content was very less in S1 and good in S2, Phosphorus content was found to be less in all the two samples and ranged between 12 – 17 (Kg/ha) The presence of Potassium was very less in S1 and was found to be good in S2 and ranged from 90 – 247 (mg/100 gms).

Noise levels in all the locations monitored reflected the traffic noise being adjacent to the road. The observations of the noise monitoring indicated that all the values were within the standards set by the CPCB.

In order to study the aquatic ecology, surface water samples were collected from different location in the river and adjoining sea. The collected samples were preserved and analysed for the presence of the Phytoplankton and Zooplankton. From the analysis the phytoplankton population in the Adyar River showed a health environment than Adyar Creek and sea. The species like Cybbella Sp, Gyrosigma Sp, Pleurosigma Sp and Fragilaria Sp were dominant in the Estuary and the sea. Whereas the Species like Anabaena Sp, Microcyctis Sp, Oscillatoria Sp, Rivularia Sp and Ankistrodesum Sp, Euglena sp and Ceratium Sp showed their presence in the River. The common Zooplankton species like Ostracod Sp, Cyclops Sp, Vorticella Sp, Copepod Sp and Acartia Sp for the tropical water were observed in all the samples. The presence of the species network showed a healthy population in the surface water

Tree cutting is very minimal along the first bypass stretch, especially near the fishermen villages and mostly Coconut and Drumstick, Neem trees are the dominant species. Actual number of trees that would require falling will be less as the trees which do not fall under the carriageway can be retained

The project stretches of the Santhome Bypass (Elevated Expressway) falls under the category of CRZ II as per the Department of Environment (DoE), Tamil Nadu. This is because the entire Chennai shoreline is classified under the CRZ II, due to the Urbanisation of the growing population. However no development is envisaged in the present project on the seaward side.

Assessment of Potential Environmental Impacts

The assessment of the environmental impacts has been estimated as an overall impact caused by the execution of the proposed Santhome bypass project under two phases. The specific impacts have been assessed over a 100 m wide corridor with respect to the centre line of the proposed road whereas the study area for assessing broader environmental impacts was considered to be an area within 5 km on both the sides of the centre line of the proposed road.

Positive Impacts: The potential positive environmental impacts due to project apart from its economic importance include the following.

- Reduced noise and air pollution - With the construction of proposed bypass, noise and air pollution levels are expected to go down in the urban areas where human exposure is more. Though there will be rise in pollutant levels in the proposed road alignment, the overall human exposure to noise and air pollution will be minimal due to less congestion.

- Reduced risk of accidents - The proposed alignment shall provide adequate safety measures and proper sight distances thereby resulting in reduced accidents. Moreover with expected decrease in overall traffic density due to increased road carrying capacity, the chances of accidents will reduce considerably.

- Improved accessibility and connectivity. - The accessibility and connectivity increases as it will reduce the time of travel between places in the city.

- Reduced vehicle operating and maintenance cost. - With advent of the expressway, the vehicle operating and maintenance cost is expected to go down substantially. These benefits can be attributable to smooth and even roads and low congestion.

- Savings in fuel consumption. - Savings in fuel consumption can be attributed to low congestion and relatively less travel time due to proposed improvements.

- Improved quality of life. The proposed project is expected to improve the quality of life of the people residing in the project zone in terms of their economic, social and health status. Land value in the nearby areas of the proposed alignment will increase substantially.

- Improved Aesthetics. - The overall aesthetics of the area shall improve with proposed landscaping and avenue plantation in the project stretch.

- Generation of local employment. Both skilled and unskilled labours will be employed during the construction stage of the project.

Negative Impacts: Some of the potential direct and indirect negative impacts of the project during construction phase will be the following.

- Filling in low-laying areas for embankments of the road

- Loss of topsoil due to clearing and grubbing of new alignment, borrow area and quarry operation, construction of camps and material stacking yard

- Temporary impacts on flora and fauna due to the construction activities. The proposed construction activity has significant impact on fauna. The proposed site is known for the breeding ground of Olive Ridley Turtle (Green Turtle). The construction activities will have major impact on the turtle breeding.

- The first phase of the proposed road project crosses the marine environmental sensitive place of Adyar estuary. The estuary is also name demarcated as bird sanctuary by the Tamil Nadu Forest Department. Noise generation arising during the construction activity will drive the birds away and cause an ecological imbalance to the estuary and the fish population.

- Temporary impact on the drainage pattern due to embankment, culvert and bridge constructions

- Impact on traffic management system

- Increased air pollution (including dust) due to the movement of vehicles and construction activities

- Increased noise levels due to the movement of vehicles and construction activities

- Increased soil erosion leading to loss of top soil and pollution of surface water bodies such as run offs from construction sites

- Spillage of oils and other hazardous materials leading to pollution of surface and sub-surface waters.

- Some of the potential direct and indirect negative impacts of the project during operation phase are the following.

- Increased noise pollution due to the vehicular movement

- Impact on natural drainage pattern of the project area

- Pollution of water bodies and impacts on its ecosystem due to hazardous chemical or oil spillage into the canals and streams.

Mitigation of Impacts and Environmental Management Plan (EMP)

To mitigate the impacts during construction and operation stages of the project, an Environmental Management Plan has been prepared. An Environmental Monitoring Plan has been prepared as part of the EMP to evaluate the efficiency of implementation of mitigation measures recommended in the EMP and facilitate management decisions for the first phase of the project. The EMP shall be included in the contract document of the project for implementation by the contractor under supervision of the Construction Supervision Consultant and Project Implementation Unit (PIU).

The cost of implementing above mitigation measures is established in the **Table 5.25**. The construction cost for the first phase of the project stretch is estimated to be Rs. 3.7 lakhs and the operational cost is estimated to be Rs. 84000.

Cost Estimates for Environmental Management Plan

Sl No	Activities	Assumption	Cost in Rupees
Construction phase			
1	Landscaping	Lumpsum	3,600,000
2	Air Pollution Monitoring	Rs. 3000/- per location * 3 locations (based on settlement)* 1 days/ month * 4 seasons for fugitive sources.	36000
3	Noise Monitoring	Rs.1000/- for 24 hours * 1 day/month *3 location * 4 seasons	12000
4	Water Pollution Monitoring	Rs. 3000/- per sample* 3 locations/month * 4 seasons	36000
5	Dust Suppression at site	Rs.500/- per trip *10 trips a day/ 1 year	5000
6	Severances and Others (Including Training)	Lump Sum	25,000
Total Cost			**3,714,000**
Operational Cost			
7	Air Pollution monitoring	Rs. 3000/- per location * 3 locations (based on settlement)* 1 days/ month * 4 seasons for fugitive sources.	36000
8	Noise Monitoring	Rs.1000/- for 24 hours * 1 day/month *3 location * 4 seasons	12000
9	Water Pollution Monitoring	Rs. 3000/- per sample* 3 locations/month * 4 seasons	36000
Total Annual Operational Cost			**84000**

Environmental Clearances for Contractor

Apart from the CRZ clearance from MoEF, for overall project works, the following statutory requirements have to be complied by the contractor before and during the execution of the proposed work as presented in the table below

Environmental clearance required during construction

Sl.no	Construction activity for which clearance is required	Statutory authority	Statute under which Clearance is Required
1	Hot mix plants, Crushers and Batching plants	Tamilnadu State Pollution Control Board	Air (P & CP) Act, 1981
2	Discharges form construction activities	Tamilnadu State Pollution Control Board	Water (P&CP) Act, 1974
3	Storage, handling and transport of hazardous materials	Tamilnadu State Pollution Control Board	Hazardous Wastes (Management and Handling) Rules. 1989 Manufacturing, Storage and Import of Hazardous Chemicals Rules, 1989

Sl.no	Construction activity for which clearance is required	Statutory authority	Statute under which Clearance is Required
4	Sand mining, quarries and borrow areas	Department of Geology and mining, Govt of Tamilnadu	Tamil Nadu Minor Mineral Concession Rules, 1959 (corrected up to 31.3.2001)
5	Disposal of bituminous wastes	Tamil Nadu State Pollution Control Board	Hazardous Wastes (Management and Handling) Rules. 1989
6	Felling of trees	Department of Environment and Forest, Govt of Tamilnadu	Forest (Conservation) Act, 1980

Conclusions and Recommendations

Significant adverse impact anticipated due to the proposed project is the disturbance of breeding of Olive Ridley Turtles along the beach. However, this can be avoided by restricting the construction during the breeding season.

Temporary impacts are anticipated on air quality, noise levels, water quality, soil quality, flora & fauna and socio-economic environment of the project area. Further, an increase in ambient noise level is expected along the project road during the operation stage.

Proper mitigation measures are proposed in the EMP for mitigating the negative impacts. The environmental monitoring plan and reporting mechanism proposed as part of the EMP will ensure the proper implementation of the EMP. Thus the overall benefits of project outweigh the negative impacts of the project.

6. Social Assessment and Rehabilitation Action Plan

6.1 Introduction

This section summaries the R&R issues and the Social Cost involved in the Phase I .This phase starts from Kamaraj Salai near Light House to Oroor kuppam at Besant Nagar- Km 0/0 to Km 4/700 with the main objective of identifying the locations of social sensitivity and to assess the social feasibility of the phase-I of the project

6.2 Project Area Profile

Administratively, this phase of the project road falls in Chennai district in the state of Tamil Nadu. The proposed alignment takes off at km 5/4 of Kamarajar Salai near the Light House, passes along the Kamarajar Salai for about 200m, joins the existing Santhome loop road passing through Nochikuppam, Dumming Kuppam, Bhavani Kuppam and Mulliamman Nagar, and joins with the Fore Shore Estate road. From this junction the alignment run along settlements of Srinivasapuram upto Adyar River crossing Adyar estuary to the distance of 600m to the western side of the existing broken bridge. And further it runs through the eastern side of the Theosophical Society campus passing through Ururkuppam and joins Elliot Beach road. Population of the project area is 1.009 lakhs, which is hardly 0.162 percent of the total state population and urbanization rate in the project area is 100%. The Project area shows higher literacy levels for general at 77.37 % and female literacy level(47%) is less as the project area is along the coast and habituated by the fishermen community.

The project area has a main workforce participation rate of 94 percent which is very higher compared to state average of 38 percent and district average of 31.78. The project area has a large proportion of (64.22 percent) of population as non workers, a value higher than that for the state at 55.33 percent.

Chainage wise Settlements & Landuse along Project Road:

From	To	Terrain	Name of Village/Town	Landuse
Phase-I				
0/000	1/500	Plain	Nochi kuppam	Residential
1/500	1/800	Plain	Dumming kuppam	Residential
1/800	2/300	Plain	Rajiv Gandhi nagar, Mullaimanagar & Nambikkai nagar	Residential
2/300	3/100	Plain	Srinivasapuram	Residential
3/100	3/600	Plain	Adyar river	Water body
3/600	4/300	Plain	Uroor kuppam	Open land
4/300	4/600	Plain	Uroor kuppam	Residential

6.3 R&R process

Principles and objectives governing resettlement:

Addressing legitimate concerns of relevant stakeholders, especially project affected persons.

Avoiding or minimizing resettlement and rehabilitation due to land acquisition and transfer of government land under different tenure system through appropriate technical and management measures.

Ensuring appropriate resettlement and rehabilitation of project affected persons irrespective of legal status with a view to provide sustainable livelihood options that at least restore, if not improve, their standard of living.

Protecting the marginalized and vulnerable groups, including economically and socially disadvantaged.

Compensation and assistance: In general terms, the PAPs under the project will be entitled to five types of compensation and assistance: (i) Compensation for loss of land, (ii) Compensation for structures (residential/commercial) and other immovable assets; (iii) Assistance for loss of business/wage income; (iv) Assistance for shifting; and, (V) Assistance for re-building and/or restoration of community resources/facilities.

6.4 Assessment of Land Acquisition

Resettlement Action Plan (RAP) document describes the principles and approach to be followed in minimizing and mitigating negative social and economic impacts of the project.

Considering the huge traffic flow in the existing roads the proposed elevated alignment is designed with ROW of 18m and by providing entry and exit ramps at 3 locations. A signature bridge is been proposed to the western side of the broken bridge for the connectivity. Junctions at Kamarajar Salai and East Coast Road are improved. ROW details of the existing roads where the proposed alignment pass on can be ascertained by the department.

A broad landuse is already identified and based on that, total land area to be acquired is estimated. Additionally, a detailed structure count was undertaken to know the category wise number of affected structures.

. Based on the field reconnaissance and detailed walk through, the loss categories broadly identified are:

- Loss of Land
- Loss of Structures
- Loss of livelihood / trade / occupation
- Loss of Tenure

Loss of Land

As the entire Elevated alignment runs on the existing roads(owned by Highways and Chennai Corporation) Sea shore(Under PWDs control) and on opens lands, only Land Alienation has to be carried out from the respective departments(PWD, Tamil Nadu Police, Forensic science department and TNSCB) for this project. It is estimated that 61,500 sq.m (6.15 hectares) of land to be alienated from the other departments for the Proposed elevated highway.

Loss of Structures

Impact on various types of structures have been identified such as residential, commercial, community structures

Phase-I		
	Nos	**%**
Residential	529	95.8
Commercial	14	2.5
Religious	3	0.5
Public Utility	6	1.1
Total	**552**	**100**

Impact on Livelihood/ Tenure

There are 27 commercial establishments found affected at East Coast Road where the proposed elevated alignment meets. An average of two employees per establishment would be affected due to the proposed improvement. The exact number of employees whose livelihood would get affected is to be arrived at the time of implementation.

6.5 Public Consultation and Information Dissemination

To ensure that people's concerns are incorporated in the project design and to promote public understanding about the project and its implications, public consultation and information dissemination is treated as a two way process where the information is passed on to the public and their feed back is sought to understand their issues at the project preparatory stage itself. The major key stakeholders who participated in consultations at various stages include all Project Affected Families/Persons (PAF/Ps); elected representatives, Community leaders of PAPs, representatives of

CBOs; designated staff of Project Management Unit (PIU); DC / officials from DC's office and local Revenue officials; and representatives of local NGOs.

The consultative process is continuous through out the project period – design preparation, project initiation, project implementation and post implementation periods. In the project preparation stage the information gathered from field surveys are incorporated in the design phase of the project and preparation of RAP. At this stage methodologies used for public consultation and information dissemination includes reconnaissance survey; Focus Group Discussions; and public consultations.

FGDs were conducted at fishermen settlements to know about their perceptions and views about the project.

6.6 Institutional Framework

The implementing authority would have an Environmental and Social Development Unit which will undertake the revalidation of RAP before the start of RAP implementation and will engage services of Project Consultant (PC) for the same.

RAP Implementation

R&R Cell will be established as a part of PIU, and a District Resettlement and Rehabilitation Officer (DRRO), for the project district will be appointed to R&R Cell. DRRO will assist PD in all land acquisition and resettlement activities for the project implementation. Highways Department, GoTN will be the Executing Agency (EA) for project.

Implementation Schedule: Implementation of RAP will include land acquisition, and Resettlement and Rehabilitation (R&R) activities. The implementation process will cover (i) identification of cut-off date and notification; (ii) verification of properties of PAPs and estimation of their type and level of losses and distribution of identity cards; and (iii) Relocation and resettlement of the PAPs. It is assumed that implementation will take minimum 6 months to hand over land for civil works. No civil works should begin until all PAPs receive the approved compensation package.

Monitoring and Evaluation: RAP implementation will be closely monitored to provide Project Implementation Unit (PIU) with an effective basis for assessing resettlement progress and identifying potential difficulties and problems. For monitoring and evaluation (M&E), the PIU will appoint an independent agency to undertake external monitoring of the entire project.

6.7 RAP Budget

RAP budget, can be broadly subdivided into following three subsections:

(a) Assistance for Loss of Land

(b) Assistance for Loss of Structures, Assets & Developed Area within Resi /Com. Plots

(c) R&R Assistance

Final RAP Budget –Phase – I

Total budget-Phase I	Rs.p	Rs.in crores
Compensation-Land	0.00	0
Compensation-Structure	36943370.00	3.69
Total	**36943370.00**	**3.69**
Solatium 30%	11083011	1.11
Establishment charges 10%	3694337	0.37
Contingency 3%	1108301.1	0.11
Supervision 1%	369433.7	0.04
Grand Total	**53198452.80**	**5.32**

7. Project Cost Estimate

The project cost estimate chapter deals with the derivation of cost for Phase 1 from Light house on Kamarajar Salai (Beach Road) to Besant Nagar of length 4.7km long elevated corridor road The project cost is arrived based on the on the improvement proposals and quantities thereof. The unit rates arrived for the construction of a new elevated link road is adopted for arriving at the project cost, is arrived using Standard Data book of MoSRT&H after considering Market rate of material, PWD labour rate and Lead for different material.

Basic rates for material and labour have been adopted from Tamilnadu PWD schedule of rate 2007-2008. for items not covered by PWD schedule of rate, local market rates were considered.

7.1 Total Project Cost

As discussed in Chapter 4, the project costing is given in Table 7.1.

TABLE 7.1 SUMMARY OF PROJECT COST

Tentative Project Cost for Phase I - Light House to Oorurkuppam near Elliots Beach (4.7 km)

Item Description	**Cost (Rs. Crores)**
Elevated Corridor	377.0
Signature bridge across Adyar Estuary (250m)	32.0
Road works including junction improvements	8.0
Drainage and protective works	4.0
Road Furniture (Traffic signs, markings and other Appurtenances)	0.5
Shifting of utilities	2.0
Street Lighting & High Mast Lighting	1.5
Land Acquisition and Social cost	5.3
Environmental Mitigation Cost	0.4
Total Project Cost	**430.7**
Say, Rs. 431 Crores	
Provision of interchange to connect the proposed Adyar river bund corridor	40.0

8. Economic Analysis

8.1 Introduction

The objective of the cost benefit economic analysis is to identify and quantify the benefits and costs associated in developing a new bypass from Light House to Kottivakkam/Palavakkam on ECR in Chennai City, in order to select the optimum solution along with the economic viability in terms of its likely investment return potential. In broad terms, the society costs pertaining to the highway development, to be considered in this analysis include (a) agency cost and (b) road user cost.

8.2 Upgradation Proposal

The analysis period of the project is taken as 35 years from the base year 2006 for different sections of the project road as follows:

- Base Year 2006
- Construction period – 2009 to 2010
- Project opening for traffic – 2011
- End of the analysis period –2040
- No. of operating years after project improvement, considered for economic analysis – 30 years

Thus, 30 years of operation, in effect, from the start of the proposed project road i.e. 2011, has been considered for economic evaluation for the project road.

8.3 Conclusions and Recommendations

The construction of Santhome bypass is found to be economically feasible, considering their positive values of feasibility criteria (EIRR and ENPV) both at normal scenario and at worst scenario under sensitivity analysis.

- In the normal scenario, the project has 16.6% EIRR and Rs. 2,323 Million as ENPV at 12% discount rate, considering all the project benefits. Even at the worst scenario of 15% increase in project cost combined with 15% reduction project benefits, 13% EIRR (for all benefits) is above the required minimum level of 12%.

Hence from the economy feasibility point of view, it is recommended to develop the bypass from Light House to Palvakkam/Kottivakkam with the recommended lane configuration.

Chapter 1 : Introduction

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1. INTRODUCTION

1.1 Background

Chennai is one of the four major metropolitan cities in India and is the largest metropolis in South India. The total extent of Chennai Metropolitan area (CMA) is 1177 sq.km of which the main City comprises an area of about 172 sq.km. The total population of CMA was about 64 lakhs in the year 2001, and Chennai city alone accounts for 42 lakhs. The population level of CMA is expected to reach 75 lakhs by the year 2011.

Government of Tamil Nadu (GoTN) has formed a Beach committee to improve the existing beach along the east coast by enhancing the aesthetics and other facilities also to decongest the existing traffic along the marina beach. As part of the enhancement measures, Beach committee now intends to construct a link road from Light house on Kamarajar Salai to Besant Nagar (Via) Santhome Byepass, Sreenivasapuram, and Ururkuppam including reconstruction of a high level bridge across Adyar Estuary to join ECR.

1.2 Need for the Study

1.2.1 Existing Situation

Residential/ historically important places such as Adyar, Besant Nagar, Thiruvanmiyur, Kottivakkam and Palavakkam are the major traffic attracting areas on south Chennai along the east coast. The famous Marina Beach, Santhome beach and Elliot beach are located along this corridor, which attract huge traffic during weekends. Also, the famous Ashtalakshmi Temple and Shrine of Velankanni are the major religious centres along the coastal corridor.

The traffic from places such as Chennai port, Parrys corner, Secretariat and Marina Beach to reach the above mentioned places located on the southern side is at present using Kamarajar Salai, Santhome High Road, Green ways road, Durgabhai Deshmukh road and Lattice Bridge road. Total length of the present route through the above roads is 6.8 km and the traffic congestion is heavy during the peak hours. The section between DGP office Junction (Km 5/2) and Greenways Road junction (9/1) through the Santhome high road is heavily congested during peak hour as the road is of two lane configuration.

The traffic bound to Adyar and places down South from Kamarajar Salai, Rama Krishna Mutt Road and Greenways Road has to cross the Thiru- Vi-ka bridge across river Adyar, as no other alternate crossing across River Adyar is available in the near locality. Hence the bridge is heavily congested during peak hours. Also the presence of famous Santhome Church and four major schools generate more traffic and heavy pedestrian movements makes the situation worse during the peak hours on these roads. Apart from this, the traffic bound to ECR from the city also have to detour this route, adding more traffic congestion. Due to heavy traffic on this route, major junctions are signalised and road stretches are made one ways to manage traffic, increase travel time on these routes. It is observed that the journey speed along this route during the peak hour is about 20 KMPH.

Traffic bound from places in the north of Adyar River to IT firms such as Tidel Park, SIPCOT Information Technology Park and other educational institutions located in South Chennai along the "IT CORRIDOR" also use the Thiru Vi Ka Bridge to cross the Adyar River which also adds more traffic on this link.

1.2.2 Project Road- Better Link to Adyar/ Besant Nagar

As the widening of the above roads on these routes is not possible as the present route is passing through thickly populated areas and land required for upgradation is restricted. The development of a

new bypass road along the sea shore including the reconstruction of a bridge across Adyar Estuary will ease traffic congestions on the existing traffic corridor, especially on Thiru Vi Ka bridge and nearby areas. Also the proposed road will act as a bypass to the existing Santhome High Road, Greenways road and ECR from city centre.

Considering the above problems and in order to decongest traffic on Santhome high road and LB road, Beach committee has decided to form a new link road connecting Kamarajar Salai on the north and ECR on the south by making use of the existing 2.0km long Santhome Loop Road from Light house up to Foreshore estate. Key map of the project area including the proposed alignment is shown in Figure 1.1.

In this connection, Highways Department, GoTN has retained the services of M/s Wilbur Smith Associates Private Limited (WSAPL) to prepare Detailed Feasibility Study Report (DFR) for the formation of the above link road.

1.3 Objective of the Study

The primary objectives of the study are:

- To establish the technical, economical, environmental, social and financial viability of the project
- To prepare detailed feasibility report including the preliminary Environmental and Social Management Plan (ESMP).

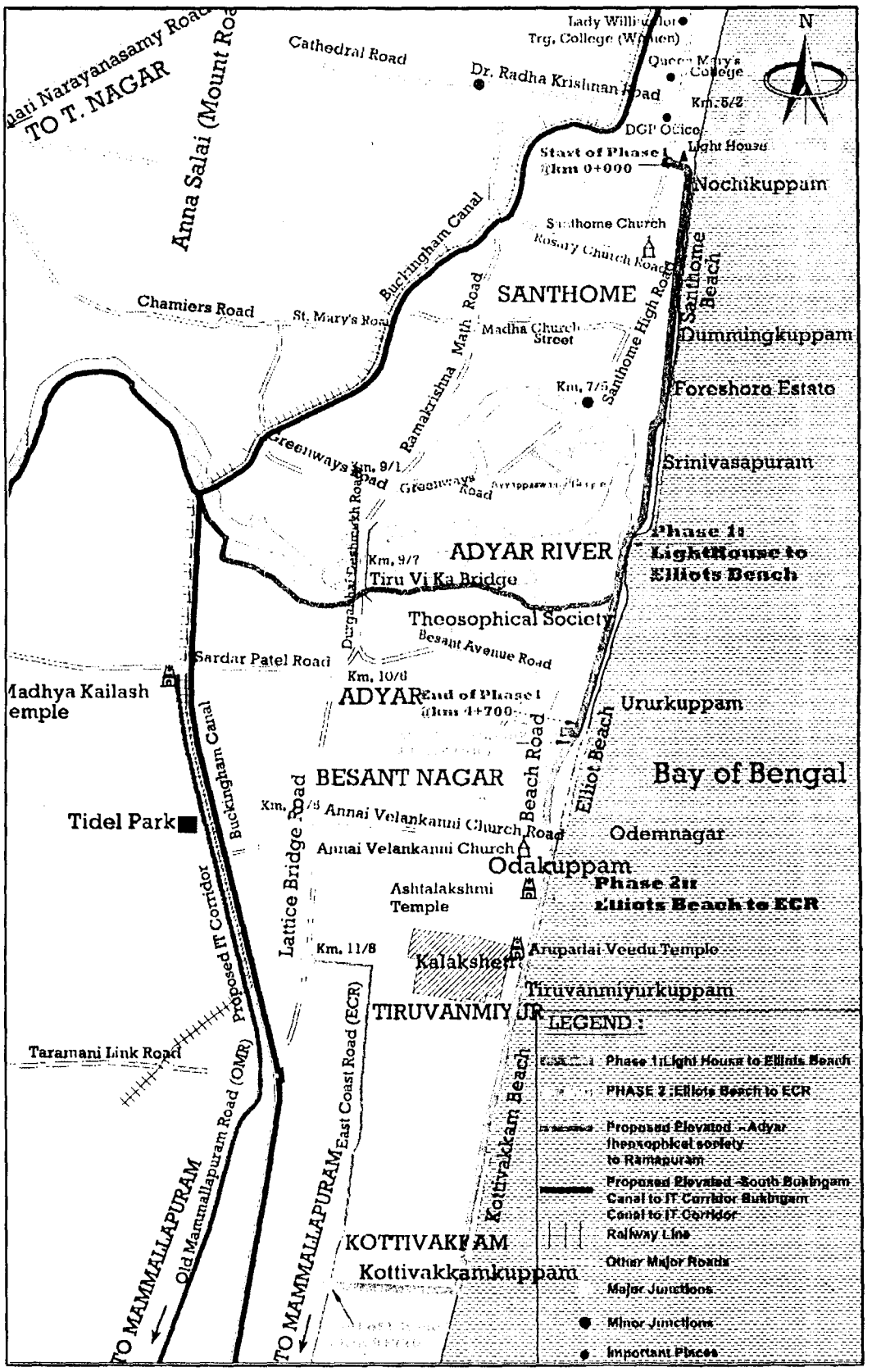

Figure 1.1: Key Map of the Project Area

1.4 Scope of the Consultancy Services

In order to achieve this objective, the feasibility study will address the following in particular.

- Collection of all Secondary Data & Review of data and documents related to the project roads and project influence area.
- Detailed reconnaissance Survey to study the existing situation in terms of engineering, environmental and social aspects
- Inventory and condition surveys for existing road, pavement, cross drainage structures and bridge
- Study of different alignment options including the Identification of possible improvement of the existing alignment
- Identification of problem areas, where formation of new link may not be possible for physical / environmental / social constraints within the parameters of ToR.
- Environmental and social screening to select the better alignment option.
- To carryout traffic volume count surveys for 7 days period on major link and 3days at other study area locations including OD surveys at two important locations at the present routes to estimate the possible diversions on the proposed link road.
- Parking surveys where predominant parking exists and pedestrian count at major built-up and busy areas
- Traffic demand forecasting for the next 20 years and Capacity Assessment based on IRC 64-1990
- Detailed Topographical Survey to collect and map the existing features along the proposed alignment
- Pavement Investigations including the necessary test to find out strength of the soil
- Geotechnical investigations for the proposed bridges at the appropriate locations
- Preliminary design of horizontal and vertical alignment including cross sections, Pavement Structure, Intersections, cross drainage structures and bridges, flyovers, interchanges, railway over bridges, user oriented facility along the road (road side amenities), road and other appurtenances.
- Preliminary design of complete drainage system and disposal point for storm water
- Traffic growth and traffic projection for next 15 years for different homogeneous sections of the project road
- Carry out preliminary design for each of the component of the road, bridges approaches, embankments, junctions etc., and prepare alignment plans, longitudinal sections and cross sections.
- Environment impact assessment, Environmental Management plan and Rehabilitation and Resettlement studies meeting the requirements of the prevailing act
- Prepare block cost estimate for the different project options incorporating the estimate for shifting of Service utilities (EB, Waterline, Drainage line etc.,) of all types involved from the concerned department.
- To carryout the social survey and analysis to assess the broad social impacts of the project, identify social issues of concern due to acquisition of land. Social Assessment study should also aims at identifying the impacts on the possible Project Affected People (PAPs).

- To identify all types of necessary clearance required for implementation of the project from the concerned agencies.
- Economical and financial viability of the project

1.5 Project Phasing

The draft feasibility report was submitted to the Highways Department during April, 2007 and further to this review meetings were conducted by the review committer on 06.08.07, 19.03.08, 16.04.08 and 22.11.08. During the above review meetings considering the availability of existing roads along the proposed alignment, it is proposed to implement the project under the following two phases:

Phase1 Reconstruction of existing road with Elevated Corridor from Light House to Besant Nagar near Ururkuppam including provision of entry & exit ramps near Foreshore estate road junction and reconstruction of existing bridge across river Adyar with "Signature bridge". (4.7km). This phase will also include necessary arrangement for linking with Phase 2 at Besant Nagar Junction in due course.

Phase 2 Construction of Elevated Corridor from Besant Nagar to East Coast Road (ECR) along the coast by making use of the existing road alignments

The Final feasibility report is also prepared for two phase's separately and this report discusses only on the Phase 1 of the project.

1.6 Report Organisation

The final feasibility report is structured into two volumes namely Volume I: Main Report, and Volume II: Drawings.

The Volume I, Main Report is presented in eight chapters and is detailed below:

- Chapter 1: **Introduction.** It describes the background of the project, need for the study objective and scope of the work, including the proposed phasing of the project.
- Chapter 2: **Surveys and Investigations**. This chapter describes the various surveys and investigations carried out by the consultants. Various surveys include topographic surveys, pavement and soil test pits and geotechnical investigations.
- Chapter 3: **Traffic Studies and Projections.** It deals with the existing traffic scenario and traffic projections. It includes various traffic surveys conducted along the project location and the analysis including the traffic forecast.
- Chapter 4: **Project Improvements Proposals.** This chapter describes various alternatives studied before finalising the proposals. The detailed analysis of pros and cons of each alternative is studied and consultants' proposal for implementation is described in this chapter.
- Chapter 5: **Preliminary Environmental Assessment and Environment management Plan.** This chapter deals environmental screening, base line environmental conditions, impact predictions and environmental management plan.
- Chapter 6: **Preliminary Social assessment and Rehabilitation Action Plan.** This chapter identifies key social issues relevant to the project, social screening, identification of stakeholders and project affected population. It also recommends specific action to be taken with regard to the Rehabilitation Action Plan.

- Chapter 7: **Project Cost Estimates.** It deals with the summary of project cost estimates for different project alternatives and proposed project scheme.
- Chapter 8: **Economic and Financial Studies.** This Chapter deals with the economic studies for different project alternatives and detailed financial analysis and for the final project proposals.

Volume II, Drawings consists of the following drawings:

- Location Map
- Plan and Profile
- Typical Cross sections
- Junction Drawings
- Road Furniture
- Structural Drawings
- Standard Drawings

Chapter 2 : Surveys & Investigations

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2. SURVEYS & INVESTIGATIONS

2.1 General

Surveys and investigation plays an important role in any project. The field surveys and Investigations aim at generating adequate database for preparing the most appropriate proposal to meet the functional and structural requirement of the project. Surveys and investigations were carried out as per the MOSRT&H / IRC / BIS codes and other relevant guidelines and specifications.

The various surveys and investigations, which have been carried out, cover the following

- Traffic Surveys
- Road Inventory Survey
- Pavement Condition Survey
- Topographical Survey
- Geotechnical Investigations

The following sections describe the conduct of the surveys.

2.2 Traffic Surveys

Various traffic surveys conducted and its analysis is described in Chapter 3: **Traffic Studies & Projections**. The assessment of base year (2005) traffic characteristics of the project road is essential for the selection of improvement Programmes on the road. It is also necessary to estimate the possible diversions from other alternate roads once the road will be improved. In this regard, the following traffic surveys were carried out:

- Parking Surveys
- Pedestrian Count Surveys
- Journey Speed and Delay Surveys
- Junction Turning Counts
- Origin Destination Surveys (OD-Surveys)
- Classified Link Traffic Counts

The traffic surveys were conducted in accordance with IRC SP19-2001.

2.3 Road Inventory Survey

The project stretch inventory was aimed at collecting available information and recording observed data for the road and structures so as to assess the existing status viz. nature of terrain, land use, road features, their condition and visible deficiencies so as to decide the extent of improvement required for the project stretch to conform it to the formulated design standards.

An inventory of project stretch has been prepared through dimensional measurement and visual inspection. The detail collected includes the following:

- Project Stretch Details
- Terrain Type
- Width of Carriageway, Shoulder & Right of Way (ROW)
- Location and details of junction
- Road Side Land Use and location of built-up sections
- Utility details
- Possible alignment options for the connecting existing alignment with ECR

The details collected from the road inventory survey are presented in **Annexure 2.1**.

2.3.1 General

Project Stretch

The existing Santhome bypass takes of from Kamarajar Salai at Km 5/6 near Light house and passes through Nochikuppam, Dumming Kuppam, Bhavani kuppam, Mullaiamman Nagar upto Foreshore estate and then the alignment joins back with the Santhome High Road at km 7/5. Total length of this section between light house and Fore shore estate is 2.0km and generally runs through the fisherman kuppam and slum clearance board housing colonies on the RHS and beach activities on the LHS.

The section of the road between Foreshore estate junction and mouth of the Adyar River is running entirely through Srinivasapuram and at present it is under the maintenance of the Chennai Corporation. The alignment from this point is discontinuous due to the broken bridge across river Adyar. The width of river crossing is about 400m as the river joins with Bay of Bengal at this point. From this point the alignment is running through the existing single lane carriageway on the east of the Theosophical Society campus and running through Ururkuppam before it joins with Elliot Beach road. From this point the alignment is running through the existing Elliots Beach corporation road and terminates at Annai Velankanni Church near Besant Nagar and is not having a proper link to join with ECR.

Santhome Bypass (Light House to Fore Shore Estate)

The existing 2.0km long Santhome byepass between Light House and Foreshore Estate is having a uniform undivided four lane carriageway and the width of carriageway varies from 10m to 13.7m. Footpath of 2.8m wide is available on the sea side (LHS) and it is absent on the RHS. The available ROW in this section is 20m with settlements is absent on the RHS and coastal line on the LHS. The entire 2km section is running at the ground level.

Srinivasapuram Section (Fore Shore Estate upto Adyar Estuary)

This section is about 1km long and the existing road configuration is having only a two lane carriageway with 6.0m wide carriageway and 1.0m wide earthen shoulders on either side. The available ROW of this section is about 10m with pucca structures on the RHS and kutcha huts of fisherman's on the LHS.

Olcot Ururkuppam Section (Adyar Estuary upto Elliots Beach)

This section is about 1.1km long and having only a single carriageway of width 3.5m for the entire length.

Table 2.1: List of Town/Village/Tourist Spot along the Road

Sl. No	Name of the Town/Village/Tourist Spot	Location
1	Nochikuppam	Km 0/2
2	Foreshore Estate	Km 2/0
3	Srinivasapuram	Km 3/0
4	Theosophical Society	Km 4/0
5	Ururkuppam	Km 5/1

2.3.2 Terrain

The entire corridor passes through plain terrain as it is along the coastline.

2.3.3 Carriageway & Shoulder

The existing road is of bituminous type for the entire section and the width of carriageway varies from 2.5 to 10.0 m and details of the carriageway width breakup are given in **Annexure 2.1.** Earthen shoulders of 1.0 m to 2.0m wide are available on either side for small stretch; however paved shoulder of 1.0 m to 4.0 m is available for large portion. It is observed that, existing shoulder is under poor condition.

2.3.4 Right of Way (ROW)

During the inventory, it was observed that the boundary stones were not available on both sides for the entire length. Hence, the distance between the permanent structures based on the measurement at field is considered as the available ROW. Based on road inventory, it is observed the Right of Way (ROW) varies from 7.0 m to 28.0 m. ROW details for the whole stretch is given in **Annexure 2.1.**

2.3.5 Junctions

The project road is having 14 important junctions and the details are given in **Annexure 2.1.** In addition to the important junctions discussed above, there are also 49 cross roads, which have direct access to the project stretch. Proper channelisation, traffic signs and road marking are absent at all the junctions.

2.3.6 Land Use along the project Corridor

As the project Stretch is generally running very close to the sea, the land use on the left hand side is beach and Kuppams of Srinivasapuram, Olcot Ururkuppam are located on the RHS. The section of the project stretch between Adyar Estuary to Ururkuppam is running very close to Theosophical society for a length of about 0.7 km.

Land Use along PR

2.3.7 Alignment Details

The alignment of the Stretch (both horizontal and vertical) is generally satisfactory for the entire length.

2.3.8 Broken Bridge across River Adyar

This bridge was constructed across river Adyar during 1966 and this bridge was washed away due to the heavy floods during 1977. The section of bridge for a length of about 100m alone is left out on the Besant Nagar side. This bridge is having a width of only 3.0 m wide. The bridge is resting on circular well foundation and substructure is RCC circular column with RCC beams.

Bridge across Adyar River

2.3.9 Proposed alignment for the Project Stretch

The proposed alignment for the project stretch is shown in **Figure 2.1**

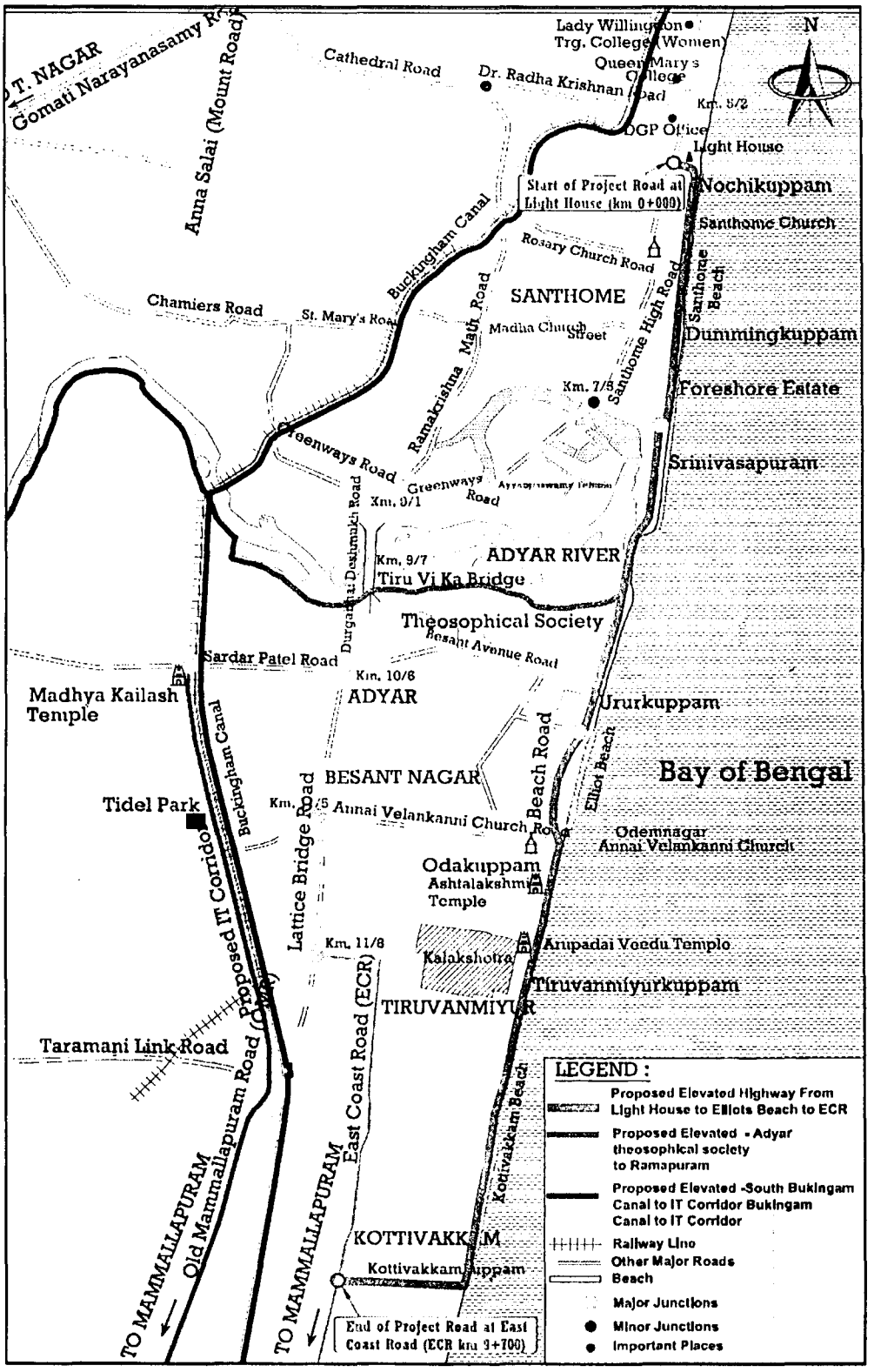


Figure 2.1: Proposed Alignment for the Project Stretch

2.4 Pavement Condition Survey

The project Stretch consists of bituminous surface only on some portions. The existing pavement is of bituminous flexible type with varying compositions and characteristics. Pavement condition survey (Visual) has been carried out to assess the adequacy and effectiveness of existing pavement in serving the present traffic needs. The Following distresses were recorded as part of pavement condition survey;

- Rut depth on wheel path
- Edge break or Edge drop
- Cracking
- Pot hole & Patching areas
- Ravelling and stripping of aggregates

Pavement Condition

The Condition of the pavement has been evaluated based on the field measurements of primary pavement surface distresses of cracking (narrow and wide), patching, ravelling and potholes at 200m interval. The extent of each distress has been visually estimated for every 100 m length of the road in terms of percentage area affected and then averaged for a kilometer length. Rutting has been measured (as rut depth) in the wheel path using a 3-metre straight edge, edge breaking has also been noted in terms of percentage length of road affected and shoulder drop-off in terms of "mm" depth. The condition survey of the existing pavement includes assessment of riding quality, pavement and shoulder condition, nature and extent of cracks and other pavement distresses like potholes, patching, ravelling, edge drop etc. The condition survey measures the distress in pavement, which is an important requirement to determine the remaining life of pavement or the amount of repair required to pavement.

A rating has been given to the pavement as per MOSRTH norms for maintenance of roads in India. The rating is based on the serviceability indicators as shown in **Table 2.2.**

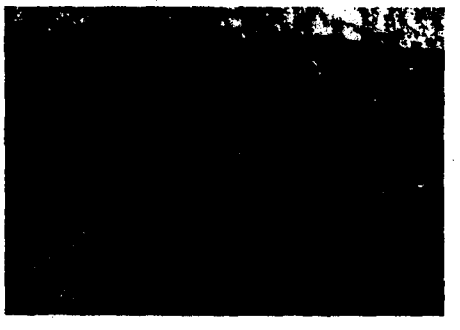
Table 2.2: Serviceability Indicators for Roads

Sl.No.	Serviceability Indicator	Level (1) (Good)	Level (2) (Average)	Level (3) (Acceptable)
1	Pothole / km	Nil	2-3	4-8
2	Cracking and Patch repairs (maximum permissible)	5%	10%	10-15%
3	Rutting (20mm) (maximum permissible)	1%	1.5%	2.5%

2.5 Topographic Surveys

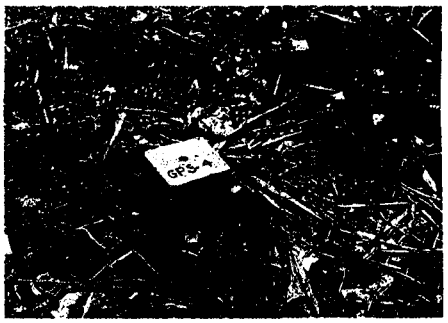
Topographical survey is carried out for detailed design purposes so as to:

- Establish control system both horizontally and vertically, to which the construction and rehabilitation plans be related;
- Establish a Digital Terrain Model containing the existing stretch, rivers, streams and other topographical features to form the basis for the new



designs;

- Prepare base plan containing all the natural and man made features like buildings, fences, walls, utilities, temples and other religious structures etc. which would govern the finalization of horizontal alignment.
- Utilize the same Terrain Model to form the basis for the estimation of engineering construction materials.



Horizontal Control Stations

As part of this survey, reference pillars with 30cm x 30cm x 45 cm concrete pillars with nail on the top have been established at 1km interval to form control stations along the Project Road. The control stations are located within the ROW and have been placed at locations where there is a clear visibility. These have been properly referenced and documented. Furthermore, secondary control stations were also located wherever the inter-visibility of adjacent control stations was not available.

Vertical Control Stations

The vertical control stations (benchmarks) along the proposed road have been established by Fly-leveling using auto levels. Control points set up for horizontal control are also used for setting up vertical as vertical control stations and RLs of these control points has been established with respect to GTS Bench mark. Besides control stations due consideration has been given to install as many additional Benchmarks as possible on culverts. Loop system has been adopted to ensure the accuracy of RLs within the permissible limits. The ultimate error was within the permissible limit of 12 $\sqrt{K}$ where K is the length in Km and error is in mm.

DTM Data Collection

After establishing horizontal and vertical control points, accurate data in digital format with respect to x, y, z co-ordinates for all breaks in terrain such as ridges and ditches has been collected perpendicular to the centre line at 25 m intervals in tangent sections and 5 m in curve sections using Total Stations. The survey extends to a minimum of 15 m beyond either side of the centerline of the existing carriageway or land boundary whichever is more. At major intersections the survey has been extended to 150 m to allow for design of intersections. All natural and man made features such as buildings, irrigation channels, drainage structures, temples, mosques, trees and utility installations etc. have been recorded in the description column. Spot leveling have been taken on the carriageway to make leveling more realistic. Large individual trees and agricultural land areas have also been surveyed.

River Bed Profiles and Cross-Sections

Where existing road cross the water courses, in accordance with the IRC recommendations for the hydraulic design of bridge and culverts, bed stream cross-sections and longitudinal sections have been taken at regular intervals on both upstream and down stream side of the structure including one at structure location. The longitudinal section to determine the bed slope has been taken at an interval of 20m following the channel course extending on both up stream and down stream side of the structure as per IRC: SP-13.

Generation of DTM

The Digital Terrain Model (DTM) is developed from the details collected through topographic survey. The DTM thus generated forms the base for the horizontal and vertical design in 'MX' software.

2.6 Geotechnical Investigations

The preliminary sub soil investigation has been carried out by Geo Global Consultants; Chennai. Subsoil condition is analyzed along with evaluation of field and laboratory data for determination of necessary physical and chemical characteristic of the in-situ soil strata.

Objective

The object of Geo-technical Investigation is to evaluate the following:

- To ascertain the sub-soil strata
- To study standing Ground Water Level
- To study the physical and engineering properties of soil strata and rock strata (if encountered).
- To evaluate allowable safe bearing capacity and settlements of soils/rock to design foundations for bridge.
- To Recommend type and depth of foundation
- To recommend improvements to the weak soil strata if any.

Scope and Methodology of the Work

The scope of work entrusted includes making twenty bore holes and five trial pits at proposed locations and conducting the following Field (in situ) investigations and Laboratory Tests.

Field (In-situ) Investigations

- Drilling bore holes of 150 mm diameter to a maximum depth of 20 to 30m or minimum of 3m in rock if rock is encountered earlier.
- Collecting disturbed and undisturbed soil samples at regular depth intervals
- Conducting field-testing such as Standard Penetration Tests as per IS 2131-1981 at every 1.5m depth intervals or wherever strata changes in Boreholes to determine N values as well as relative density and stiffness of the soil strata.
- To study and record the standing Ground Water Table Level.
- To ascertain the sub-soil strata and ground topography.

Laboratory Testing

The scope of Laboratory Testing is as follows:

- Grain Size Analysis as per IS 2720 part 4 – 1985.
- Specific Gravity as per IS 2720- part 3
- Atterberg Limits as per IS 2720 part 5 1985.
- Determination of natural moisture content as per IS 2720 part 2 - 1973.

- Determination of natural density as per IS 2720
- Determination of Strength Parameters(c & ϕ) as per IS 2720 - Part 13
- Determination of water absorption, Specific Gravity and Unit weight of rock core samples
- Modified Proctor Density on Trial Pit Sample

The details of geotechnical investigation done are given in **Table 2.3** and detailed geotechnical report is attached to this volume as separately bound document.

Table 2.3: Details of Geo-Technical Investigations

Sl. No.	Location	Bore Hole /Trial Pit No.	Termination Depth from GL(m)	Remarks
1	Light House	BH-1	24	N=>100
2	Adyar Bridge	BH-2	22.5	N=>100
3	Mahalakshmi Temple	BH-3	29	N=>100 Rock Encountered
4		BH-4	25	N=>100 Rock Encountered
5		BH-5	21	N=>100
6		BH-6	26.5	N=>100 Rock Encountered
7		BH-7	24	N=>100 Rock Encountered
8		BH-8	25	N=>100 Rock Encountered
9		BH-9	23	N=>100
10		BH-10	28	N=>100 Rock Encountered
11		BH-11	27	N=>100
12		BH-12	22.5	N=>100
13		BH-13	25.5	N=>100 Rock Encountered
14		BH-14	28.5	N=>100 Rock Encountered
15		BH-15	25	N=>100 Rock Encountered
16		BH-16	24.5	N=>100 Rock Encountered
17		BH-17	25.5	N=>100 Rock Encountered
18		BH-18	23	N=>100
19		BH-19	27	N=>100 Rock Encountered
20		BH-20	27	N=>100 Rock Encountered

Table 2.4: Sub soil Profile

Sl. No.	Location	Bore Hole No.	Depth from Ground Surface (m)	Description of Strata
1.	Light House	BH-1	5.2	Brownish fine to medium sand
			6.45	Brownish fine sand
			8.67	Brownish medium Sand and bottom of SPT greyish clay
			10.00	Brownish fine to medium sand
			13.5	Greyish soft to medium stiff silty clay
			19.5	Brownish fine to medium sand
			21	Brownish and greyish fine to medium sand
			24	Brownish and greyish soft rock es
2	Adyar Bridge	BH-2	6.5	Brownish fine to medium sand
			11.35	Brownish fine sand
			13.5	Greyish soft to medium silty clay
			22.5	Greyish clayey silty fine to medium sand with occasionally broken shells
3	Mahalakshmi Temple	BH-3	2.00	Brownish fine to medium sand
			4.5	Brownish medium to fine sand
			6.45	Brownish fine to medium sand
			20.50	Brownish silty medium to fine sand
			22.80	Greyish stiff clay
			26.5	Soft disintegrated rock
			29	Soft rock
4		BH-4	4.9	Brownish fine to medium sand
			6.5	Brownish fine sand
			7.8	Brownish medium sand

Sl. No.	Location	Bore Hole No.	Depth from Ground Surface (m)	Description of Strata
			12.6	Medium stiff silty clay
			18.6	Brownish fine to medium sand
			22.6	Brownish and grayish fine to medium sand
			25	Brownish soft rock
5			5.4	Brownish fine sand
			10.2	Brownish medium sand
			14	Soft to medium silty clay
			21	Greyish clayey silty fine to medium sand
6			3	Brownish fine to medium sand
			7	Brownish medium sand
			20	Brownish silty medium to fine sand
			23	Greyish stiff clay
			26.5	Soft disintegrated rock
7			5.2	Brownish fine to medium sand
			6.45	Brownish fine sand
			8.5	Brownish medium sand
			12	Brownish fine to medium sand

Sl. No.	Location	Bore Hole No.	Depth from Ground Surface (m)	Description of Strata
			16.5	Greyish stiff clay
			21	Soft disintegrated rock
			24	Soft rock
8			5	Brownish fine to medium sand
			8.5	Brownish medium sand and bottom of SPT grayish clay
			14	Greyish soft to medium stiff silty clay
			18.5	Brownish fine to medium sand
			21.5	Brownish and grayish fine to medium sand
			25	Brownish and grayish soft rock
9			4.8	Brownish fine to medium sand
			10.5	Brownish fine sand
			14.5	Greyish soft to medium silty clay
			23	Greyish clayey silty fine to medium sand with occasionally broken shells
10			2	Brownish fine to medium sand
			6.45	Brownish fine to medium sand
			18	Brownish silty medium to fine sand
			22	Greyish stiff clay
			25	Soft disintegrated rock.

Sl. No.	Location	Bore Hole No.	Depth from Ground Surface (m)	Description of Strata
			28	Soft rock
11			4.7	Brownish fine to medium sand
			8	Brownish medium sand
			12.5	Greyish soft to medium stiff silty clay
			18.6	Brownish fine to medium sand
			22.7	Brownish and Greyish fine to medium sand
			27	Brownish and grayish soft rock pieces
12			5	Brownish fine to medium sand
			11	Brownish fine sand
			17.5	Greyish soft to medium silty clay
			22.5	Greyish clayey silty fine to medium sand
13			5.5	Brownish fine to medium sand
			6.35	Brownish fine sand
			8.6	Brownish medium sand
			12.5	Brownish fine to medium sand
			16.5	Greyish stiff clay
			22.	Soft disintegrated rock
			25.5	Soft rock
14			4.8	Brownish fine to medium sand
			6.35	Brownish fine sand
			10.5	Brownish medium sand and bottom of SPT grayish clay
			16.8	Brownish fine to medium sand

Sl. No.	Location	Bore Hole No.	Depth from Ground Surface (m)	Description of Strata
			21.5	Greyish stiff clay
			26.5	Soft disintegrated rock
			28.5	Soft rock
15			4.8	Brownish fine to medium sand
			6.2	Brownish fine sand
			8.5	Brownish medium sand and bottom of SPT grayish clay
			10	Brownish fine to medium sand
			14.2	Greyish soft to medium stiff silty clay
			18	Brownish fine to medium sand
			21	Brownish and greyish fine to medium sand
			25	Brownish and greyish soft rock pieces
16			5.5	Brownish fine to medium sand
			7.5	Brownish fine sand
			9.6	Brownish medium sand
			13.5	Brownish fine to medium sand
			17	Greyish stiff clay
			20	Soft disintegrated rock
			24.5	Soft rock
17			5	Brownish fine to medium sand
			8	Brownish medium sand and bottom of SPT greyish clay
			14	Greyish soft to medium stiff silty clay
			18.5	Brownish fine to medium sand
			22	Brownish and greyish fine to medium sand
			25.5	Brownish and greyish soft rock
18			6	Brownish fine to medium sand
			11.5	Brownish fine sand

Sl. No.	Location	Bore Hole No.	Depth from Ground Surface (m)	Description of Strata
			16.8	Greyish soft to medium silty clay
			23	Greyish clayey silty sand
19			3.8	Brownish fine to medium sand
			7.3	Brownish fine to medium sand
			14.5	Brownish silty medium to fine sand
			18	Greyish stiff clay
			25	Soft disintegrated rock
			27	Soft rock
20			5.3	Brownish fine to medium sand
			8	Brownish medium sand
			13.2	Greyish soft to medium silty clay
			19.5	Brownish fine to medium sand
			23.5	Brownish and greyish fine to medium sand
			27	Brownish and greyish soft rock

The soil varies from fine to medium sand for shorter depths in all the bore hole locations. Hard strata or rock is encountered at about 23m in all the bore hole locations. Based on the sub soil findings, suitable foundations are proposed. The type, depth and safe bearing capacities of footings are described in the preliminary bridge design section.

2.7 Material Investigations

Preliminary material investigations have been carried out to find out the availability of adequate good quality materials for construction. Based on reconnaissance and local inquiries, including discussions with the highway department, a list of quarries which is near to the alignment is made and presented in the following table.

Table 2.5 List of Quarries

SI No	Material	Source	Lead in Km
1	Sand for Mortar	Palar River	60
2	Metal	Pallavaram	23
3	Gravel	Perumbakkam	25
4	Sand For Filling	Karanodai	36

Chapter 3 : Traffic Studies and Projections

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3. Traffic Studies and Projections

3.1. Objective

Traffic studies have been done with a view to establish the need for the bypass, identify the locations for ingress and egress to the bypass, decide on the lane requirements and geometrics taking cognizance of the constraints and to examine the economical feasibility of the project. The traffic study encompasses various aspects and these include:

- Assessing traffic on existing route
- Estimation of divertable traffic on the proposed facility
- Growth Factor estimation for Traffic Forecasting
- Lane requirement based on traffic forecasting.
- Economical feasibility analysis.
- Environmental impact assessment

3.2. Necessity of the Bypass

River Adyar separates areas in Central Chennai such as Triplicane, Royapettah, Mylapore, Foreshore estate, Mandavelli etc; from those in the southern side that include Adyar, Basant Nagar, Thiruvanmiyur, Kottivakkam and Palavakkam. Thiru-Vi-Ka Bridge between Greenways Road and Lattice Bridge Road is the only available connecting link on Adyar River near these areas. The present road network in the project region is presented in **Figure 3.1**. The road corridor connecting the two banks of the Bridge, i.e.; Santhome high road, Green ways road and Thiru Vi Ka Bridge are carrying substantial traffic with acute traffic congestions during morning and evening peak periods.

Piling up of vehicles on Thiru Vi Ka Bridge

Widening of the above said roads are not possible as they pass through thickly populated areas and due to restricted right of way. The development of a new bypass road along the sea shore connecting Kamarajar Salai in the north and EC road in the south including the construction of a bridge across Adyar Estuary is expected to ease traffic congestion on the existing traffic corridor, provide better connectivity to ECR from city centre and significantly improve traffic mobility.

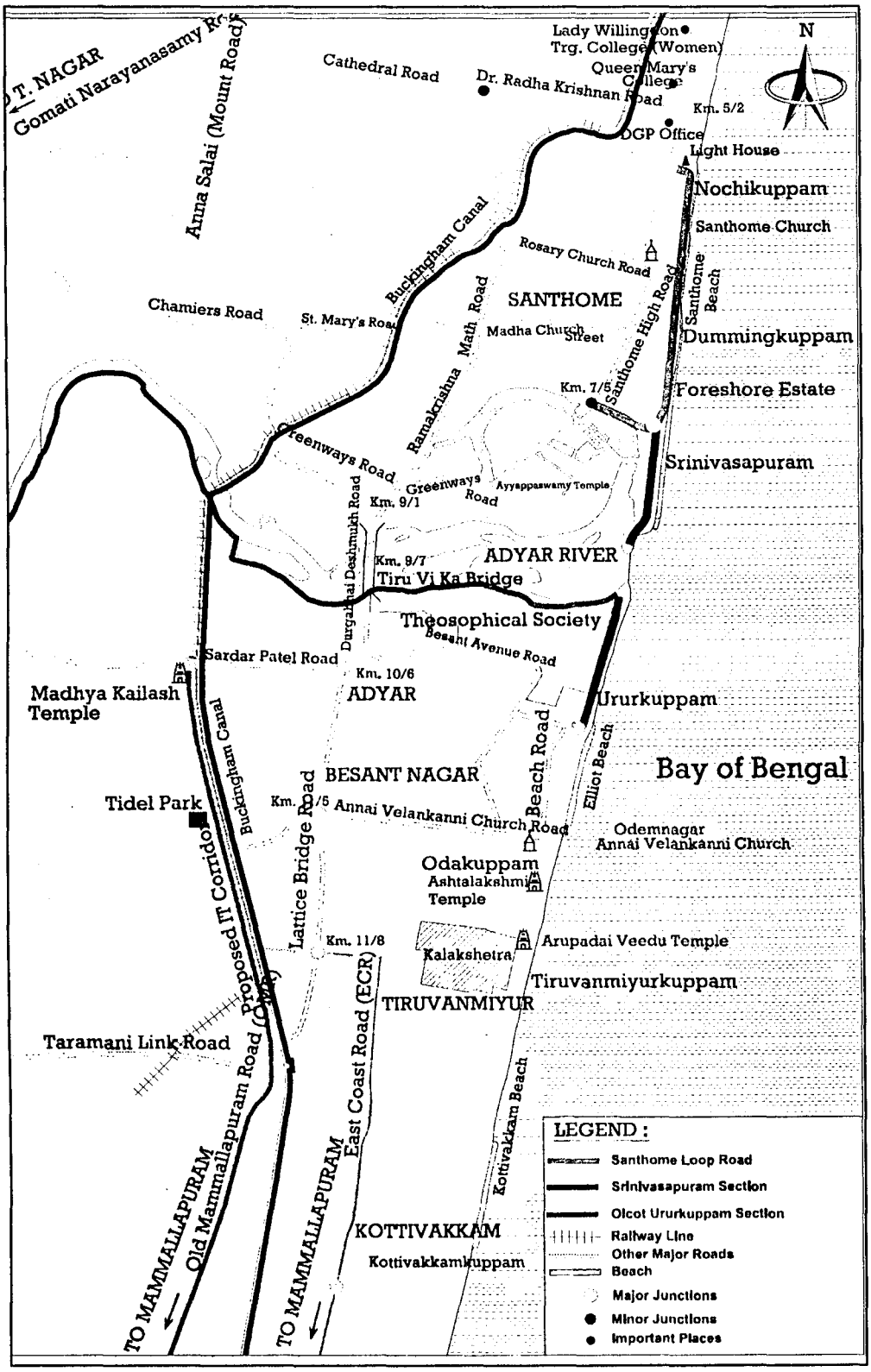


Figure 3.1: Present Road Network in the Project region

3.3. Primary Surveys

Primary surveys were conducted on the existing links of the project road and on present traffic route to assess the possible traffic on the project road in the future. The following surveys were carried out in this regard:

- Classified Volume Count Surveys at 4 locations
- Road side Interview surveys at two locations on alternate routes
- Turning Volume Counts at 4 junctions
- Speed and Delay Surveys along the alternate routes
- Parking Surveys at 2 locations
- Pedestrian Count Survey at 2 locations

The survey locations that were finalized in consultation with Highways Department are given in **Table 3.1** and in **Figure 3.2**.

Table 3.1: Traffic Survey Locations and Duration

Sl No.	Location	Duration	Dates of Surveys
1. Link Count Surveys			
1.1	Santhome Beach Road	3 days (2 week days+ 1 weekend)	28- 12-2005 to 29-12 - 2005, 07-01-2006
1.2	Elliots Beach	3 days (2 week days+ 1 weekend)	28- 12-2005 to 29-12 - 2005, 08-01-2006
1.3	Thiru Vi Ka Bridge (Km 9/4 of Greenways Rd)	2 working days	03-01-2006 to 04-01-2006
1.4	Lattice Bridge Rd –Sardar Patel Junction (L & R turning movements only)	2 working days	05-01-2006 to 06-01-2006
2. O-D Surveys			
2.1	Thiru Vi Ka Bridge (Km 9/4 of Greenways Rd)	2 working days	03-01-2006 to 04-01-2006
2.2	Lattice Bridge Rd –Sardar Patel Junction (L & R turning movements only)	2 working days	05-01-2006 to 06-01-2006
3. Junction Count Surveys			
3.1	DGP Office Junction (Km 5/2)	2 days (1 week day+ 1 weekend) 14 hours (8 am to 10 pm)	09-12-2005, 07-01-2006
3.2	Marina Entrance Junction (Km 5/4)	1 weekend day -14 hours (8 am to 10 pm)	08-01-2006
3.3	Light House Junction (Km 5/6)	1 weekend day -14 hours (8 am to 10 pm)	09-01-2006
3.4	ECR Junction (Km 14/6 of ECR)	1 week day- 12 hours (8 am to 8 pm)	02-01-2006
4. Pedestrian Counts (crossing + along carriageway)			
4.1	Santhome beach	1 weekend day - 6 hours	07-01-2006

Sl No.	Location	Duration	Dates of Surveys
		(4 pm to 10 pm)	
4.2	Elliots beach	1 weekend day - 6 hours (4 pm to 10 pm)	08-01-2006
5. Parking Surveys			
5.1	Santhome beach	1 weekend day - 6 hours (4 pm to 10 pm)	07-01-2006
5.2	Elliots beach	1 weekend day - 6 hours (4 pm to 10 pm)	08-01-2006

3.3.1 Classified Link Volume Count Survey

The classified traffic volume counts were conducted manually by counting vehicles on both directions. The vehicles were broadly classified into various categories i.e. Cars/Jeeps/Vans, Buses, Trucks, Multi Axle Vehicles (MAVs), Light Commercial Vehicles (LCVs), Two wheelers, Auto rickshaws and slow moving vehicles which includes cycles, cycle rickshaws and carts. Buses were classified into MTC Buses, Mofussil Buses, Company buses, Institutional Buses and minibus. The format used for the survey is given in **Annexure 3.1**.

3.3.2 Turning Movement Survey

Classified turning movement counts were carried out at four intersections. The survey was conducted for 14 hours to capture the peak hour traffic in the morning/evening. Since the DGP office junction carry traffic to Marina beach and to Institutions / Offices, the survey was done for two days including a working day and a weekend day.

3.3.3 Road Side Interview Surveys (RSI)

The proposed road is a new link connecting Santhome and EC road and will give access to various places located along the corridor. Being a new road, it is necessary to estimate the likely traffic that will use it once constructed. Hence OD surveys were conducted on the available alternate routes to estimate the possible traffic on the project road. Also OD surveys are useful for estimating the traffic influence region for estimation of traffic growth rates in the absence of past traffic data.

The locations were selected so as to capture the possible movements on the proposed road. The surveys were carried out for 2 working days by stopping the vehicles randomly with the assistance of police on sample basis. The volume count surveys were combined with the roadside interview surveys to calculate the expansion factors and to ensure a good sampling rate.

The information collected includes; Vehicle type, Frequency, Occupancy, Origin, Destination and purpose of the journey in case of the passenger traffic. For goods traffic, in addition to the above information, the type of the goods transported was also collected. The format prepared for the RSI survey is given in **Annexure 3.1**.

3.3.4 Speed and Delay survey

Speed and delay survey was conducted on a normal working day along the existing corridor by moving car observer method to estimate the running speed, average journey speed and associated delays. The survey vehicle travelled in the stream of general traffic at similar speeds as of other traffic during different times of the day. The delays and corresponding contributory factors such as intersections / major activity centres, etc. was collected to identify major bottlenecks along the route. The survey format is given in **Annexure 3.1**.

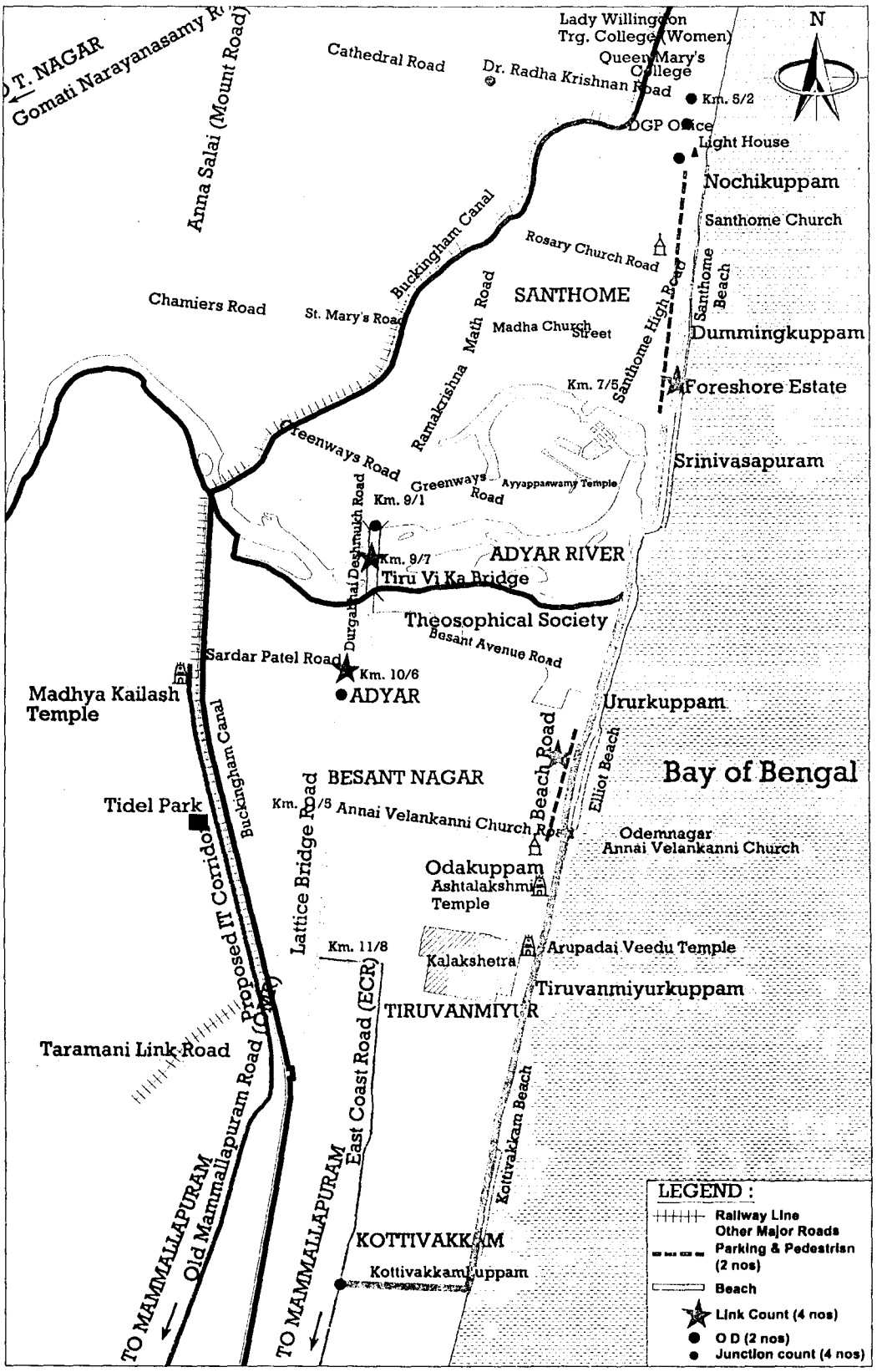


Figure 3.2: Traffic Survey Locations

3.3.5 Pedestrian count survey

Pedestrian count survey was carried out at two locations (Santhome Beach and Elliots Beach) where substantial pedestrian movement, both along the carriageway and across the road is observed. It was carried out during morning/evening peak hours on a weekend day to capture the maximum pedestrian count. Location details are given in **Table 3.2**.

3.3.6 Parking Surveys

Parking surveys were organized at Santhome beach and Elliot's beach to quantify the parking demand at these places. Since considerable parking occurs during weekends, the surveys were carried out during a weekend evening for six hours.

3.4. Homogeneous Sections

It is proposed to provide ramps at Fore Shore Estate road, Besant Avenue road, in addition to the ramps at the start and end points. Based on the expected traffic characteristics of the bypass and ramp locations, it could be divided into three homogeneous sections. They are given in **Table 3.2**.

Table 3.2: Homogeneous Sections Identified

Section No	Homogeneous Sections	Length (Km)
1	Light House – Foreshore Estate	2.1
2	Foreshore Estate- Besant Nagar	3.4
3	Besant Nagar – Kottivakkam	3.0

3.5. Findings of Primary Surveys

The findings of various traffic surveys are described in the following sections.

3.5.1 Mid Block Counts

PCU Values: As the project road falls within Chennai city limits, Passenger Car Units (PCUs) corresponding to urban roads as per IRC: 106-1990 is adopted and the values adopted is given in **Table 3.3**.

Table 3.3: Equivalency factors for Various Types of Vehicles on Urban Roads

Vehicle Type	Equivalent PCU Factors	
Vehicle Composition	**<5%**	**>10%**
Two Wheelers	0.5	0.75
Passenger Cars/ Pick Up Vans	1.0	1.0
Auto Rickshaw	1.2	2.0
Light Commercial Vehicle	1.4	2.0
Truck or Bus	2.2	3.7
MAV	4.0	5.0
Cycle	0.4	0.5
Cycle Rickshaw	0.5	2.0
Fish Cart	2.0	3.0
Hand Cart	2.0	3.0

(Source: IRC: 106-1990)

Classified link counts were conducted at two locations for two working days and one weekend day on the existing stretches of the project road, ie; at Santhome beach road and Elliot's beach road. Also a seven day count was carried out on Thiru Vi Ka Bridge, which is the available link for the project road. The results of the traffic counts at these three locations are presented in the following sections.

3.5.1.1 Santhome Beach Road

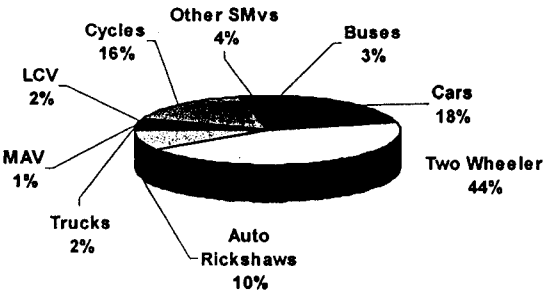
Average Daily Traffic (ADT): Average Daily Traffic observed on the road is 3937 PCU constituting 3836 vehicles. The summary of ADT, in terms of vehicles and PCU is given in **Table 3.4**. Traffic count details are given in **Annexure 3.2**.

Table 3.4: ADT on Santhome Beach Road, 2006 (No. of vehicles)*

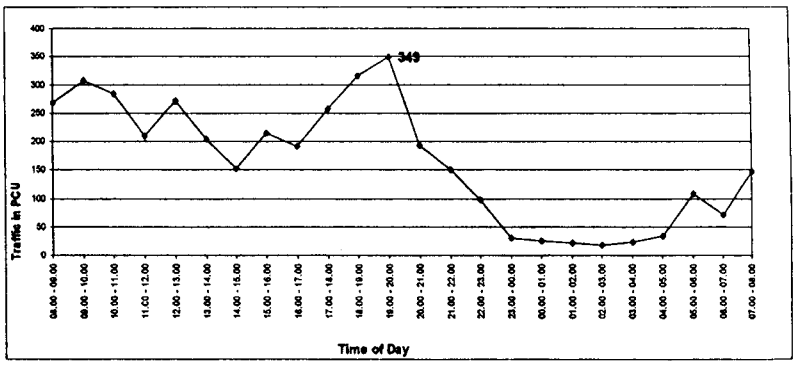
Vehicle Type	Buses	Cars	Two Wheeler	AR	Trucks	MAV	LCV	Total FMVs	Cycles	Other SMVs	Total SMVs	Total Vehicles	Total PCU
Nos.	119	711	1715	368	66	47	85	3111	616	140	757	3868	3937

*(Note *: ADT is the weighted average of 3 day count, giving a weightage of 2 for weekends and a weightage of 5 for working days)*

Vehicle Composition: Passenger vehicles form about 75% with two wheelers about 44% of the total traffic. It has been observed that institutional buses and mini buses ply on the road to park along the roadside during day time. The movement of goods vehicles is very less, forming about 5% of the total traffic, transporting fish from the beach. SMVs form a substantial share of 20% of the total traffic in which Cycles are about 85%, is due to the fishermen colonies along the stretch.



Peak Hour Traffic & Hourly Variation: Peak traffic of 349 PCU is observed at 7 PM to 8 PM and peak hour factor (peak hour traffic /total traffic) is 8.9%. Very less traffic is observed in the night (18% of total traffic is observed between 8PM and 6 A.M.



3.5.1.2 Elliot's Beach Road

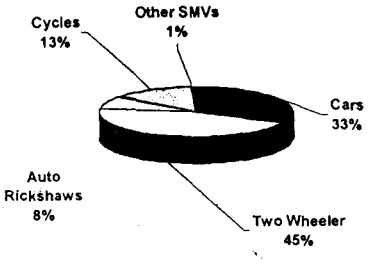
Average Daily Traffic (ADT) : Average Daily Traffic observed on the road is 9905 PCU (10650 vehicles). The summary of ADT, in terms of vehicles and PCU is given in **Table 3.5**. Traffic count details are given in **Annexure 3.2**.

Table 3.5: ADT on Elliots beach Road, 2006 (No. of vehicles)*

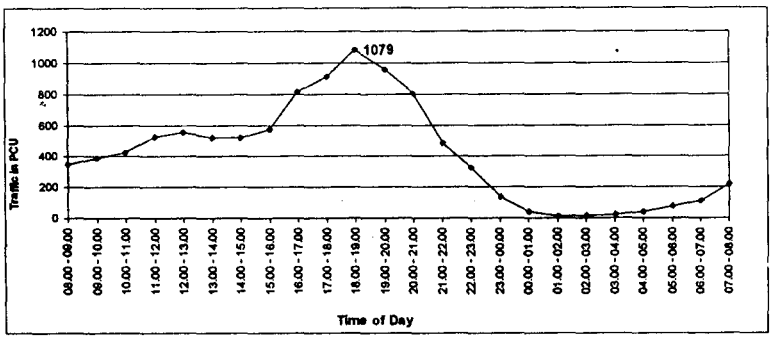
Vehicle Type	Buses	Cars	Two Wheeler	AR	Trucks	MAV	LCV	Total FMVs	Cycles	Other SMVs	Total SMVs	Total Vehicles	Total PCU
Nos.	49	3439	4720	883	18	30	10	9148	1398	103	1501	10650	9905

(Note: ADT is the weighted average of 3 day count, giving a weightage of 2 for weekends and a weightage of 5 for working days)*

Vehicle Composition: Since the traffic on this road is mostly beach based, passenger vehicles and slow moving vehicles form the major share of traffic. Passenger vehicles form about 86% including two wheelers (45%) of the total traffic and the remaining slow moving vehicles.



Peak Hour Traffic & Hourly Variation: High traffic is observed during evening due to the presence of beach. Peak traffic of 1079 PCU is observed at 6-7 PM and peak hour factor (peak hour traffic /total traffic) is 10.9%. Very less traffic is observed in the night (20% of total traffic is observed between 8PM and 6 AM.



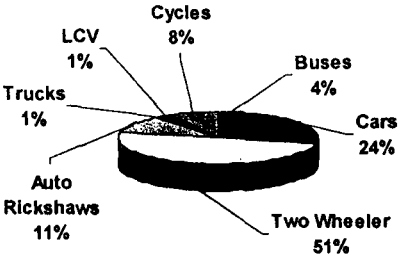
3.5.1.3 Thiru- Vi-Ka Bridge

Average Daily Traffic (ADT): Very high traffic is observed on this bridge as it is the only link connecting the two sides of the river. Average Daily Traffic observed on the road is 1, 10,652 PCU (110193 vehicles). The summary of ADT, in terms of vehicles and PCU is given in **Table 3.6**. Traffic count details are given in **Annexure 3.2**.

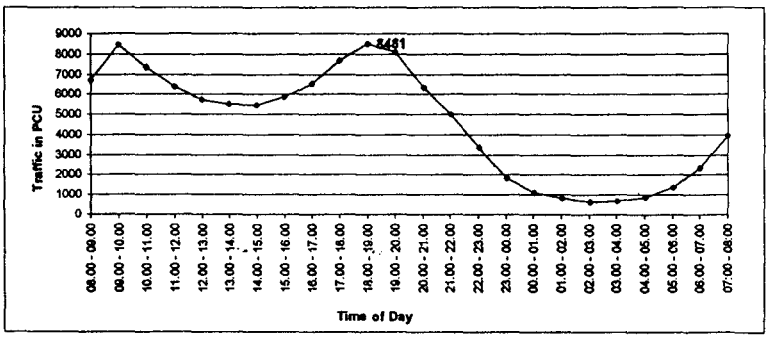
Table 3.6: ADT on Thiru- Vi- Ka Bridge, 2006 (No. of vehicles)*

Veh. Type	Bus	Cars	Two Wheeler	AR	Trucks	MAV	LCV	Total FMVs	Cycles	Other SMVs	Total SMVs	Total Vehicles	Total PCU
Nos.	4419	26762	55061	12111	1319	31	1483	101186	8929	78	9007	110193	110652

Vehicle Composition: Passenger vehicles form about 90% including two wheelers 51% and Car 24% of the total traffic. SMVs form about 8%. Trucks are merely 1% of the traffic, mostly carrying coal from Chennai Port to southern districts and Corporation garbage trucks to the Zonal office at Mylapore.



Peak Hour Traffic & Hourly Variation: Even though two peaks are observed during morning and evening, the bridge is carrying high traffic during day time. Maximum traffic is observed in the evening between 6PM and 7PM with 8481 PCU, and is about 8% of the total traffic. Very less traffic is observed in the night (20% of total traffic is observed between 9 PM and 6 AM.



The Design Service Volume (at LoS C) of a four lane divided subarterial carriageway is about 2900. But the peak hour traffic observed is about 8500 PCU, which is very much high, indicating heavy traffic congestion on the bridge. It is observed that the traffic on the bridge comes to a standstill during peak hours leading to long queues along the entire length of the bridge.

To reduce traffic congestion on this route and remove the traffic bottleneck, one option is to develop a new alternate route to bypass the congested bridge. The proposed elevated highway is seen to be a suitable measure to decongest the entire route from Santhome to Thiruvanmiyur.

3.5.2 Junction Turning Counts

The peak hour traffic observed at the four junctions along the proposed elevated highway is given in Table 3.7 and details are given in Figure 3.3. The DGP Office junction and Pallavakkam junctions have high traffic as they form junction of the project road with two major roads i.e.; Kamarajar Salai (Beach Road) and East Coast road (SH 56). Peak traffic observed at these junctions is about 8500 PCU and 3800 PCU respectively.

Table 3.7: Peak Hour Junction Turning Volume , 2006 (No. of Vehicles)

Name of Junction	Bus	Car/ Jeep/ Van (O)	Car/ Jeep/ Van (N)	Two Wheelers	Auto	Trucks	MAV	LCV	Slow Moving Vehicles	Total Vehicles	Total PCU
DGP Office Junction	308	219	2127	3690	1481	16	1	28	297	8167	8429
Light House Junction	10	36	356	385	88	0	0	6	62	943	924
Beach Junction	3	140	320	775	73	0	0	0	36	1347	1203
Palavakkam Junction	173	76	828	1901	535	17	0	54	368	3944	3865

3.5.3 Speed & Delay Surveys

It is observed that the existing roads carry heavy traffic during peak hours particularly Santhome area and at Thiru. Vi. Ka Bridge location, the journey speeds being very less, in the range of about 15 km/hour, resulting in high Vehicle Operating Cost (VoC) and extensive Travel Time. The speeds observed during peak hours are presented in **Table 3.8** and in **Figure 3.3**.

Table 3.8: Speed – Delay Survey Results on the roads in the Available Routes

From	To	Length (Km)	Journey time(Min.)	Journey Speed (KMPH)
Dr. Radha Krishnan Road and Royapettah High road Jun	Light House Jun	1.80	5.25	20.57
Dr. Radha Krishnan Road and Royapettah High road Jun	Greenways road Junction (through Ramakrishna Math road)	3.10	11.25	16.53
Light House Jun	Santhome Church	0.60	2.50	14.40
Santhome Church	Greenways Road Jun	2.80	9.60	17.50
Greenways Road Jun	Besant Nagar road Jun	1.30	7.40	12.16
Besant Nagar road Jun	Annai Velankanni Church road	1.40	6.25	13.44
Annai Velankanni Church road	Thiruvanmiyur Jun	1.00	3.85	15.58
Thiruvanmiyur Jun	Kottivakkam Jun	2.80	6.90	24.35
Besant Avenue Road		1.8	9	20.0

The data is analysed to arrive at the average speed and time for traffic from various areas of the city as there exists two alternate routes to access the Bridge from the city. Traffic from Parrys area using Kamarajar Salai- Santhome road, Greenways road, while traffic from Anna Salai using RK Mutt road or Dr. Radhakrishnan road – Santhome High road and Greenways road to access the bridge. These routes with the proposed route through the bypass are presented in Figure 3.4.

It is proposed to provide ramps at Light House Junction (Starting point), Fore Shore Estate road, Besant Avenue road and at Kottivakkam (End point). It is evident from the traffic surveys at Thiru Vi Ka bridge and speed delay surveys that the proposed bypass will benefit the following users;

- From Parrys / Alwarpet/ Chepauk and Anna Salai (can use ramp at Light House) bound either to Besant Nagar/ Elliots Beach or to Kottivakkam/EC road.
- The traffic from Mylapore/Santhome area bound to Elliots Beach, Besant Nagar and Kottivakkam/ EC road will benefit as they can access the bypass through the second ramp at Fore Shore Estate road.
- Traffic from Sardar Patel Road bound to Kottivakkam/ EC road is also expected to use the bypass through the ramp from Besant Avenue road.

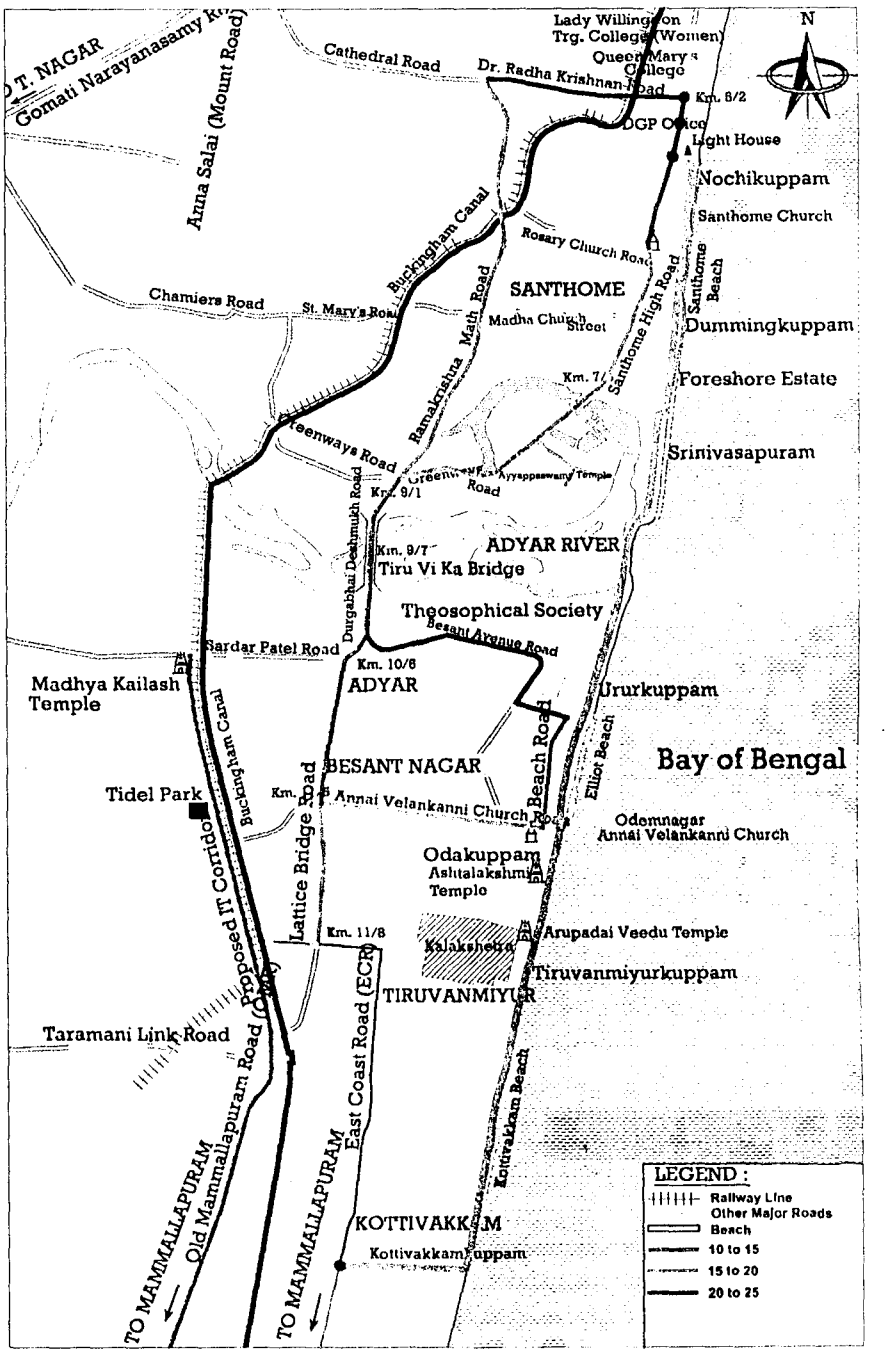
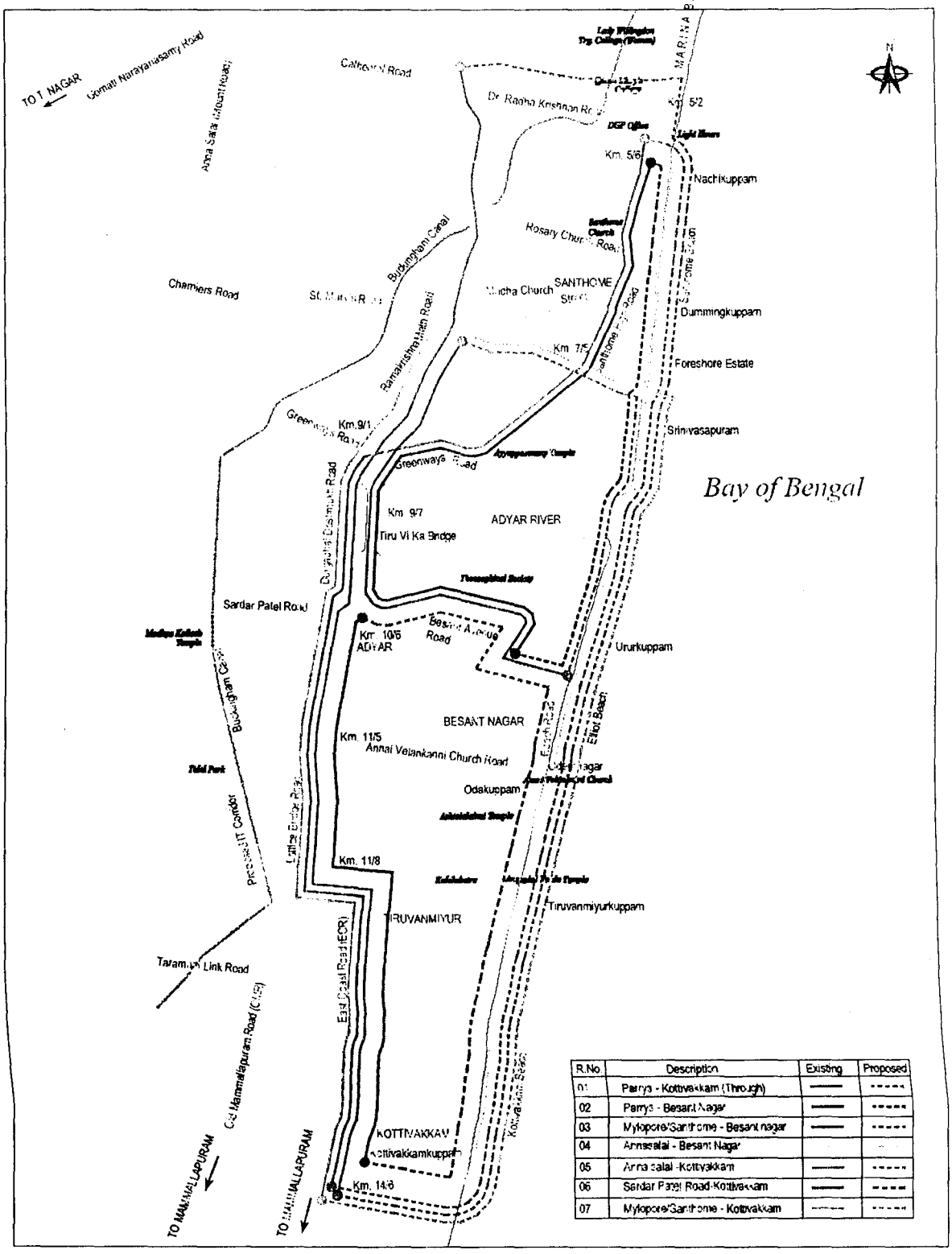


Figure 3.3: Speeds on present roads

The VoC and VoT for these traffic is estimated for using the present route and using the bypass and are compared to estimate the benefits accrued due to the development of the bypass and duly presented in Table 3.9. It is observed that though the route through the bypass will be a slightly longer one for a section of road users they will benefit due to the reduction in VoC and decrease in travel time due to higher speed (assumed 50KMPH) and relief from congestion on the bypass.



R.No	Description	Existing	Proposed
01	Parrys - Kottivakkam (Through)	———	- - - - -
02	Parrys - Besant Nagar	———	- - - - -
03	Mylapore/Santhome - Besant nagar	———	- - - - -
04	Annasalai - Besant Nagar		
05	Annasalai -Kottivakkam	———	- - - - -
06	Sardar Patel Road-Kottivakkam	———	- - - - -
07	Mylapore/Santhome - Kottivakkam	———	- - - - -

Figure 3.4: Present and proposed routes

Table 3.9: Savings Estimated due to Bypass

Movements		Distance (Km)	Time (minutes)	VoC	VoT	Total Cost (Rs/Trip)
Parrys/ Chepauk areas to Besant Nagar						
Present Route	Light House- Santhome High Road- TVK bridge- Besant Avenue road	6.3	22.50	49	13.00	62.0
Through Santhome Bypass	Light House- Santhome Bypass- Besant Avenue road	5	6.0	28	4.00	32.0
Savings		**1.3**	**16.5**	**21.00**	**9.00**	**30.00**
Anna Salai to Besant Nagar						
Present Route I	Ramakrishna Math Road- TVK Bridge- Besant Avenue Road	6	21.65	47	13.00	60.0
Through Santhome Bypass	Dr. Rathakrishnan Road- Light House- Santhome Bypass- Besant Avenue road	7	8.4	39	5.00	44.0
Savings		**-1**	**13.25**	**8.00**	**8.00**	**16.00**
Present Route II	Dr. Rathakrishnan Road- Light House- Santhome High road- TVK Bridge- Besant Avenue road	8.5	27.75	66	16.00	82.0
Through Santhome Bypass	Dr. Rathakrishnan Road- Light House- Santhome Bypass- Besant Avenue road	7	8.4	39	5.00	44.0
Savings		**1.5**	**19.35**	**27.00**	**11.00**	**38.00**
Parrys to Kottivakkam (Through Traffic)						
Present Route	Light House- Santhome High Road- TVK bridge- LB Road- EC Road- Kottivakkam	10	36.50	78	21.00	99.0
Through Santhome Bypass	Light House- Santhome Bypass- EC Road- Kottivakkam	9.6	11.5	53	7.00	60.0
Savings		**0.4**	**24.98**	**25.00**	**14.00**	**39.00**
Anna Salai to Kottivakkam (Through Traffic)						
Present Route	Ramakrishna Math Road- TVK bridge- LB Road- EC Road- Kottivakkam	9.6	35.65	75	21.00	96.0
Through Santhome Bypass	Dr. Rathakrishnan Road- Light House- Santhome Bypass- Besant Avenue road	11.1	18.6	61	11.00	72.0
Savings		**-1.5**	**17.08**	**14.00**	**10.00**	**24.00**
Mylapore/Santhome to Elliot's Beach						
Present Route	Greenways road- TVK bridge- Besant Avenue road	3.8	12.40	30	7.00	37.0
Through Santhome	Fore Shore Estate- Santhome Bypass	4	7.8	22	5.00	27.0

Movements		Distance (Km)	Time (minutes)	VoC	VoT	Total Cost (Rs/Trip)
Bypass						
Savings		**-0.2**	**4.6**	**8.00**	**2.00**	**10.00**
Mylapore to Kottivakkam						
Present Route	Greenways road- TVK bridge- LB road- EC road- Kottivakkam	7	27.40	55	16.00	71.0
Through Santhome Bypass	Fore Shore Estate- Santhome Bypass- Besant Avenue road	9.2	11.0	51	6.00	57.0
Savings		**-2.2**	**16.36**	**4.00**	**10.00**	**14.00**
Sardar Patel road to Kottivakkam						
Present Route	Greenways road- TVK bridge- Besant Avenue road- LB road- EC road- Kottivakkam	6.70	24.40	52	14.00	66.0
Through Santhome Bypass	Fore Shore Estate- Santhome Bypass- Besant Avenue road	7.5	9.0	41	5.00	46.0
Savings		**-0.8**	**15.4**	**11.00**	**9.00**	**20.00**

3.5.4 Origin - Destination Survey

OD surveys were conducted on (1) Thiru Vi Ka Bridge as this being the major alternate route for the expected traffic on Santhome bypass and at (2) Lattice Bridge Rd –Sardar Patel Junction for L & R turning movements to analyse the possible traffic on Besant Nagar –Kottivakkam stretch of the road. The analysis and results of the survey are described below.

O-D Survey

3.5.4.1 Zoning System Adopted

The zoning system adopted for the study is such as to capture the possible movements along the proposed bypass. The study region is divided into 25 zones. **Table 3.10** and **Figure 3.5** present the zoning system adopted for coding of the collected OD data.

Table 3.10: Zone List for the study area

Zone No.	Zone Description
1	Santhome
2	Santhome Beach
3	Foreshore Estate, Pattinappakkam, MRC Nagar and Srinivasapuram
4	Besant Nagar, Kalashethra colony and Shastri Nagar
5	Elliot's Beach
6	Ashtalakshmi Temple and Annai Velankanni
7	Thiruvanmiyur
8	Kottivakkam and Palavakkam
9	Adayar and Theosophical Society
10	Gandhi Nagar

Zone No.	Zone Description
11	Velachery, Tharamani, Tidal Park and Madipakkam
12	Injambakkam, Kovalam and other beach resorts along ECR and Mahabalipuram
13	Pondichery, Kanchipuram and other southern districts of Tamil Nadu
14	Nandanam, Saidapet, Kotturpuram and Guindy
15	Mylapore, Mandaveli, R.A Puram, Abhiramapuram and Music Academy
16	Alwarpet, Royapettah, Teynampet, Triplicane, Chepauk and Marina Beach
17	Parrys, George Town, Park Town, Chindadripet, Royapuram, Washermanpet and Tondiarpet
18	Purasavakkam, Egmore, Vepery, Perambur, Villivakkam, Annanagar, Aminjikarai, Chetpet, Nungambakkam, Avadi, Ambathur and Vyasarpadi
19	T.Nagar, West Mambalam, Vadapalani, Kodambakkam and nearby area
20	Other districts of Tamilnadu
21	Other States of India
22	Tambaram, Pallavaram, Chrompet and surrounding places
23	Thoraipakkam, Perungudi, Sholinganallur, Navalur and Kelambakkam

3.5.4.2 Sample Size

The collected data was coded, processed and expanded to total traffic using the expansion factors for each vehicle type, since the survey was conducted on sample basis. Average sample size obtained for various categories of vehicles for the OD survey location is given in **Table 3.11**. The matrices developed from the OD data are given in **Annexure 3.3**.

Table 3.11: Average Sample size obtained for OD Survey

Location		Car	Two Wheeler	Auto	MAV	Trucks*	LCV
Thiru Vi Ka Bridge	Sample	3211	5668	1694	14	171	254
	Volume	28535	55520	13603	34	823	1549
	%	**11.3%**	**10.2%**	**12.5%**	**41.8%**	**20.8%**	**16.4%**
LB road Junction	Sample	526	1198	265	3	14	87
	Volume	2672	7721	1176	3	14	120
	%	**19.7%**	**15.5%**	**22.5%**	**100.0%**	**100.0%**	**72.5%**

*(Note: *- excluding Garbage trucks)*

3.5.4.3 Candidate Traffic

The traffic expected to use the proposed bypass is arrived from the OD conducted at two locations. The section wise traffic is arrived by combining various movements on the stretch. Various nodes from where the movements originate from/destine to are Light House, Fore Shore Estate, Besant Nagar and Kottivakkam. Hence the entire road has been divided into three homogeneous sections. The various movements are presented in Figure 3.6. All other movements except the one between Besant Nagar and Kottivakkam are arrived at from the OD data at Thiru Vi Ka Bridge. The movements between Besant Nagar and Kottivakkam are estimated from LB road junction OD. Various zone pairs considered for analysing the candidate traffic and expected movement wise traffic is given in Table 3.10. The section wise candidate traffic for the three sections is given in Table 3.11. Due to the better east – west connectivity between Anna Salai and Kamarajar Salai, near the start of proposed bypass, (Avai Shanmugham road and Dr. Radhakrishnan Road), a part of traffic bound between Besant Nagar (and surrounding areas) and Anna Salai are assigned on the starting section of the bypass from Light House, once the bypass will be constructed.

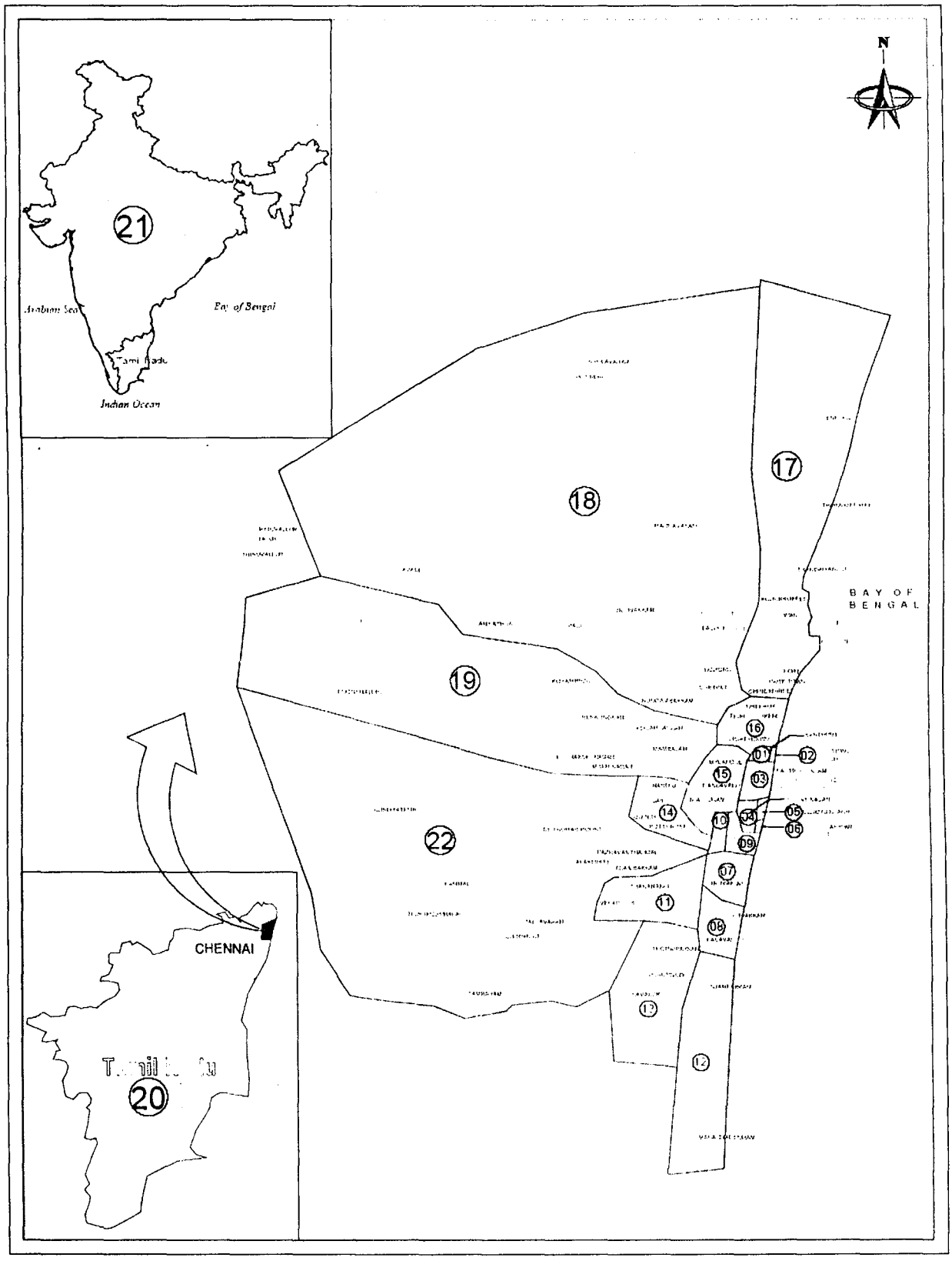


Fig 3.5: Zone Map

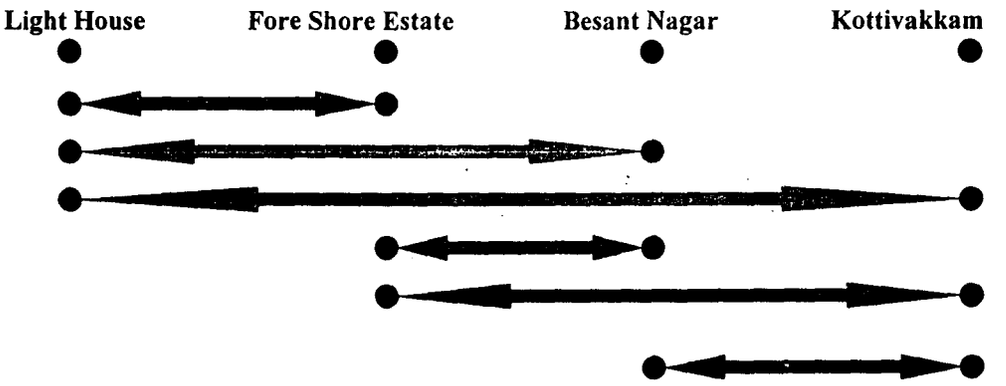


Fig 3.6 Various Movements on the Proposed Elevated Road

Table 3.12: Estimated Movement wise Traffic

Movements	Origins	Destinations	Movements (No. of Trips)					
			Car	TW	Auto	LCV	MAV	Truck
Light House-Besant Nagar	16,17,18, 19	4,5,6	2674	6916	1423	91	4	139
Light House - Kottivakkam and beyond	16,17,18, 19	8,12,13	631	1929	161	91	3	239*
Fore Shore Estate to Besant Nagar	15	4,5,6	30	122	51	-	-	-
Fore Shore Estate to Kottivakkam & beyond	15	8,12,13	401	869	126	-	-	-
Besant Nagar – Kottivakkam and beyond	14,19,22	8,12,13	300	471	64	81	-	-

*(Note: *- trucks including coal carrying trucks from Chennai Port)*

On an average, about 650 institutional/ company buses are plying through the Bridge every day. Since no OD survey is carried out for buses, a less percentage of these buses are assumed to use the proposed facility in the future. MTC buses are not expected as they have to ply along the existing route only. Lot of trucks are plying between Light House and Besant Nagar, carrying building materials and carrying fish from Eliots Beach. Corporation zonal office is located in Mylapore and due to which garbage trucks (about 450 nos.) are plying through the bridge in a day. These trucks are also not included for estimating the sectional traffic. It is also observed that about 100 trucks carrying coal from Chennai Port to southern districts of Tamil Nadu use the bridge to access EC road. This traffic is occurring during night as trucks are not allowed during day time in the city. Since Chennai Port Trust proposes to shift the coal handling facility to Ennore Port in the near future, the trucks carrying coal are not included for traffic projection

Table 3.13: Section wise Traffic

Section	Car	TW	Auto	Bus	LCV	MAV	Truck*	Total PCU
Light House-Fore Shore Estate	1685	5507	739	50	137	5	309	8266
Fore Shore Estate- Besant Nagar	3736	9836	1761	50	182	7	378	15713
Besant Nagar – Kottivakkam	1332	3269	351	50	172	3	239	5230

*(Note: *- trucks including coal carrying trucks from Chennai Port)*

3.5.5 Pedestrian count Survey

The pedestrian count was conducted at three locations. The count was taken up in the peak hours in the morning/evening. The summary of pedestrian count is given in the **Table 3.14**. Since it is proposed to develop an elevated road for the entire length, no recommendations are made for pedestrian facilities along the road.

Table 3.14: Peak Pedestrian counts

Sl. No	Road Stretch	Peak Hour	Pedestrians Along the Road	Pedestrians Across the Road
1	Elliots Beach Road	7pm- 8pm	3520	901
2	Santhome Beach Road	9.30 am- 10.30 am	1013	475

3.5.6 Parking Survey

Parking survey was conducted at three locations. The count was taken up in the peak hours. The summary of the parking survey is given in the **Table 3.15**. Due to the same reasons listed above, no recommendations are made for parking also.

Table 3.15 Summary of Parking Count Survey

Sl. No	Road Stretch	Peak Hour	Peak Hour Parking				
			Bus	Auto	Car	TW	Cycles
1	Elliots Beach Road (from Skating Ground to 5th Avenue)	7pm- 8pm	-	-	531	2560	177
2	Santhome Beach Road	6 pm- 7pm	9	135	152	644	117

3.6. Traffic Forecasting

The lane requirement of the proposed road would be decided by the expected future traffic on the road. Traffic projection is done by adopting appropriate growth rates for various vehicle types. Since the project road is a new facility, no past traffic data is present to analyse the growth of traffic in the past. Hence growth rates were estimated using Elasticity method. The details on the traffic forecasting carried out are described in the following sections.

3.6.1 Project Influencing Region

The project road is located in the city; hence the major influencing area will be Chennai city itself. It is proposed to link the road with EC road near Kottivakkam. Hence there can be traffic bound from/to southern districts of Tamil Nadu, especially Kancheepuram and Pondichery as is evident from the OD analysis.

3.6.2 Socio-Economic Profile

Socio-economic profile of Tamil Nadu is considered to derive the future growth prospects of the region and correspondingly the traffic growth in the region, as district wise data is not available for the recent past years. The performance of the economic indicators was collected for the past period with the objective of establishing elasticity of traffic demand to the different economic indicators. The economic indicators considered for the analysis include:

- Population
- Per Capita Income (PCI)

- Tourism
- NSDP

The per capita, population and tourism data is used for estimating the growth rates for passenger vehicles, while the NSDP, Secondary sector and fishing sector growth are used for commercial vehicles growth rate estimation.

3.6.3 Growth Rates for Passenger Vehicles

Growth in population, per capita income from 1998-99 to 2003-04 of Tamil Nadu and growth in tourist arrivals in Chennai are considered for the growth rate estimation. Since the road give access to Elliot's Beach and various beach resorts/ Amusement Parks on EC road, factor indicating the growth in tourism sector of Chennai is also taken into account. The indicators with weightages adopted for each sector is given in **Table 3.16**.

Table 3.16: Growth Rates for Social Indicators

Indicators	Compound Growth Rate (%)	Weightage (%)
Per Capita Income	2.98	70
Population	0.94	5
Tourism	7.05	25

(Source: Statistical Hand book, Tamil Nadu 2004-05)

The weighted growth rate of the social indicators is multiplied with elasticity factor for obtaining the final growth rate for passenger traffic. The elasticity values adopted is given in **Table 3.17**.

Table 3.17: Elasticity Values Adopted

	2006-2011	2011-2016	2016-2021
Truck/MAV	1.4	1.2	1.1
Car	1.6	1.5	1.4
Bus	1.3	1.2	1.1

(Source: Elasticity Values suggested by IRC (Road Development Vision Plan: 2021)

3.6.4 Estimation of Growth Rates for Commercial Vehicles

The growth trend for economic indicators listed above for the period 1998-99 to 2003-2004 are used for arriving growth rates for commercial vehicles. The growth in NSDP, Secondary sector and fishing sector of Tamil Nadu are taken and shown in **Table 3.17**. These combined growth rates were multiplied with the elasticity values to obtain the final growth rates. The factors and corresponding weightages adopted for the analysis are given in **Table 3.18**.

Table 3.18: Growth Rates of Economic Indicators

Indicators	Compound Growth Rate (%)	Weightage (%)
NSDP	3.95	60
Secondary	2.10	15
Fishing	1.08	25

3.6.5 Growth Rate from Vehicle Registration Data

The vehicle registration data for 2001-2002 and 2003-2004 for the district of Chennai was obtained. The same is given in **Table 3.15** for comparison of the derived growth rates.

Table 3.19 Growth Rates in Vehicle Registration

	Car	TW	Auto	LCV	Bus	Truck		Grand Total
						Lorries	MAV	
Chennai								
2001-2002	244363	1011072	43227	6254	4502	21905	2391	1333714
2003-2004	284076	1187684	42854	8837	4731	19654	2592	1550428
Growth Rate	**8%**	**8%**	**-**	**19%**	**3%**	**-**	**4%**	**8%**

(Source: Statistical Hand book, Tamil Nadu, 2004-05)

3.6.6 Recommended Growth Rates for the Project Road

It was observed that the growth rates arrived on the basis of socio economic growth of the project area gave more realistic results. As such, it is adopted for the projection of traffic for the design period. The final recommended growth rates are given in **Table 3.20**.

Table 3.20 Annual Growth Rates Adopted for the Project Road (%)

Vehicle Type	2006-2010	2011-2015	2016-2021	>2021
Car (New Tech)	6.3	7.0	6.0	5.4
Car (Old tech)	3.0	3.3	3.3	3.0
TW	7.9	7.0	6.0	5.4
Auto	3.8	4.2	3.6	3.2
Bus	3.1	3.5	3.6	3.4
Truck	4.5	4.3	3.9	3.5
MAV	5.0	4.7	4.3	4.1
LCV	5.0	4.7	4.3	4.1

3.6.7 Projected ADT

Using the above growth rates, the traffic projection is carried out for the next twenty five years (from the year 2006 to 2029) and the projected traffic for the three sections are given in **Table 3.17** to **Table 3.19.** (Note: Trucks carrying coal from Chennai Port are not included for projection). It is assumed that the bypass will be operational from 2011.

3.6.8 Generated Traffic

The road will act as a vital link between Palavakkam/ Kottivakkam/ places beyond south and Chennai city. Considering the existing land use and potential for growth of these areas, it is felt that there is better scope for new traffic generation due to the project road. But the generated traffic is not included in the traffic projection.

Table 3.21: Projected Traffic on Stretch between Light House and Fore Shore Estate

Year	Two Wheelers	Car(N)	Car(O)	Auto	Bus	MAV	LCV	Truck*	Total vehicles	Total PCU
2011	7984	2073	195	893	59	6	174	260	11646	10980
2012	8543	2218	201	931	61	7	183	271	12414	11664
2013	9140	2373	207	970	63	7	191	283	13234	12393
2014	9780	2539	213	1011	65	7	200	295	14110	13170
2015	10464	2717	220	1053	67	8	209	308	15045	13997
2016	11094	2880	226	1091	70	8	218	320	15908	14760
2017	11763	3054	233	1131	72	8	228	332	16821	15566
2018	12472	3238	240	1172	75	9	237	345	17788	16418
2019	13224	3433	247	1214	78	9	248	358	18811	17318
2020	14021	3640	255	1258	80	9	258	372	19894	18269
2021	14781	3837	263	1299	83	10	269	385	20927	19176
2022	15583	4045	270	1341	86	10	280	399	22014	20128
2023	16428	4265	279	1385	89	11	291	413	23160	21130
2024	17319	4496	287	1430	92	11	303	427	24365	22182
2025	18258	4740	295	1476	95	11	315	442	25635	23289
2026	19249	4997	304	1524	98	12	328	458	26971	24452
2027	20293	5268	313	1574	102	12	342	474	28378	25675
2028	21393	5554	323	1625	105	13	356	491	29860	26962
2029	22554	5855	333	1678	109	13	370	508	31420	28314

*(Note: *-Trucks carrying coal from Chennai Port are not included for projection)*

Table 3.22: Projected Traffic on Stretch between Fore Shore Estate and Besant Nagar

Year	Two Wheeler	Car(N)	Car(O)	Auto	Bus	MAV	LCV	Truck*	Total vehicles	Total PCU
2011	14261	4596	433	2129	59	9	232	346	22064	21187
2012	15258	4917	446	2219	61	9	242	361	23514	22500
2013	16325	5261	459	2312	63	10	254	376	25061	23898
2014	17467	5629	473	2409	65	10	266	392	26712	25386
2015	18689	6023	487	2510	67	11	278	409	28475	26971
2016	19816	6386	502	2600	70	11	290	425	30100	28432
2017	21010	6771	517	2695	72	12	302	442	31820	29974
2018	22276	7179	533	2792	75	12	315	459	33641	31604
2019	23619	7612	549	2893	78	13	329	477	35568	33325
2020	25042	8070	565	2998	80	13	343	495	37607	35143
2021	26400	8508	582	3095	83	14	357	513	39552	36874
2022	27832	8970	600	3196	86	14	372	531	41599	38694
2023	29342	9456	618	3300	89	15	387	549	43755	40607
2024	30933	9969	636	3407	92	15	403	569	46024	42617
2025	32611	10510	655	3518	95	16	419	589	48412	44730
2026	34380	11080	675	3633	98	17	436	609	50927	46951
2027	36244	11681	695	3751	102	17	454	631	53574	49286
2028	38210	12314	716	3873	105	18	472	653	56362	51740
2029	40283	12982	737	3999	109	19	492	676	59296	54320

(Note: Trucks carrying coal from Chennai Port are not included for projection)

Table 3.23: Projected Traffic on Stretch between Besant Nagar and Kottivakkam

Year	Two Wheeler	Car(N)	Car(O)	Auto	Bus	MAV	LCV	Truck*	Total vehicles	Total PCU
2011	4740	1639	154	424	59	4	219	173	7411	6984
2012	5071	1753	159	442	61	4	229	181	7900	7421
2013	5426	1876	164	461	63	4	240	188	8421	7887
2014	5805	2007	169	480	65	4	251	196	8978	8383
2015	6211	2147	174	500	67	5	263	205	9572	8912
2016	6586	2277	179	518	70	5	274	213	10121	9401
2017	6983	2414	184	537	72	5	286	221	10702	9917
2018	7403	2560	190	556	75	5	298	229	11317	10463
2019	7850	2714	196	577	78	5	311	238	11968	11039
2020	8323	2877	201	597	80	6	324	248	12657	11649
2021	8774	3033	208	617	83	6	337	256	13315	12230
2022	9250	3198	214	637	86	6	351	265	14007	12842
2023	9752	3371	220	658	89	6	366	275	14736	13485
2024	10281	3554	227	679	92	7	380	284	15504	14160
2025	10838	3747	234	701	95	7	396	294	16312	14871
2026	11426	3950	241	724	98	7	412	305	17163	15618
2027	12046	4165	248	748	102	7	429	315	18059	16404
2028	12699	4390	255	772	105	8	446	326	19002	17230
2029	13388	4629	263	797	109	8	465	338	19996	18099

(Note: Trucks carrying coal from Chennai Port are not included for projection)

3.6.9 Projection Based on Peak Hour Traffic

A peak hour factor of 8% is taken as observed on Thiru- Vi- Ka Bridge, to estimate the maximum traffic on the Section between Fore Shore Estate and Besant Nagar, as this section will carry the highest traffic. The peak hour traffic is also projected to the horizon year to verify the lane requirement based on peak traffic and is presented in **Table 3.24**.

Table 3.24 Projected Peak Hour Traffic on Section II

Year	Peak Hour Traffic (PCU)	Year	Peak Hour Traffic (PCU)
2006	1248	2018	2970
2007	1343	2019	3184
2008	1445	2020	3415
2009	1556	2021	3659
2010	1677	2022	3923
2011	1802	2023	4206
2012	1938	2024	4512
2013	2085	2025	4841
2014	2244	2026	5197
2015	2416	2027	5580
2016	2587	2028	5993
2017	2772	2029	6439

3.6.10 Lane Requirements

The lane requirement of the bypass is verified with the warrants given in "IRC 106-1990, Guidelines for Capacity of Urban Roads". The bypass is taken as sub arterial category of urban roads and as per the listed IRC, the Design Service Volume (DSV) based on ADT and peak hour traffic is given inn **Table 3.25.**

Table 3.25: Recommended Design Service Volume/ Maximum Capacity on Sub Arterial Urban Roads

Type of Carriageway	Peak Hour Traffic (PCU/ Hr)		ADT (PCU)	
	DSV (at LoS C)	Maximum Capacity (LoS E)	DSV (at LoS C)	Maximum Capacity (LoS E)
2 lane two way	1200	1700	15000	21400
4 lane Divided	2900	4100	36300	51900
6 lane Divided	4300	6100	53800	76900

It is clear from **Table 3.18** (for ADT projection) and **Table 3.20** (for peak hour traffic projection) on section II will cross the DSV (at LoS C) of 2 lane two way carriageway in the current year and the DSV of 4 lane divided carriageway in 2018. A six lane bypass is proposed for the 2nd section, while four lane is proposed for the first and third section from Besant Nagar to Kottivakkam. Though the expected traffic on the second section reach the DSV of 6-lane divided carriage way in 2024, the road will cater for another five years, but at lower LoS.

3.7. Recommendation

From the traffic projection and the growth potential along the corridor, it is proposed to have a six lane road from Foreshore to Besant Nagar and four lane road from Light house to Foreshore Estate and Besant Nagar to Kottivakkam with entry and exit ramps at Fore Shore Estate, and Besant Nagar.