Chapter 4: Improvement Proposals

Contents

Table List

Figure List

4. Improvement Proposals

4.1 General

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 Alignment Options

Option 1: As discussed above, the alignment of both the options are similar upto Ururkuppam and it continues along the existing beaches and joins ECR near Kottivakkam. Total length of this alignment option is 9.6km. At the end of the project road for about 700m, the alignment passes through residential area, and the rest of the length traverses through the coastal line along the beach.

Option 2: The initial 5km long section of alignment between Gandhi Statue and Ururkuppam is same as in the Option1. From Ururkuppam, it deviates from the line and runs along the existing Annai Velankanni road and LB road. This alignment options meet ECR at km 11/8 near Thiruvanmiyur and terminates at km 14/6 near Kottivakkam.

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. Snapshots of the presentation to the Hon'ble Chief Minister of Tamil Nadu on 15.04.2008 is shown in Plate 4.1

The salient features of the proposed alignment of Phase I from Kamarajar Salai to Besant Nagar is discussed below:

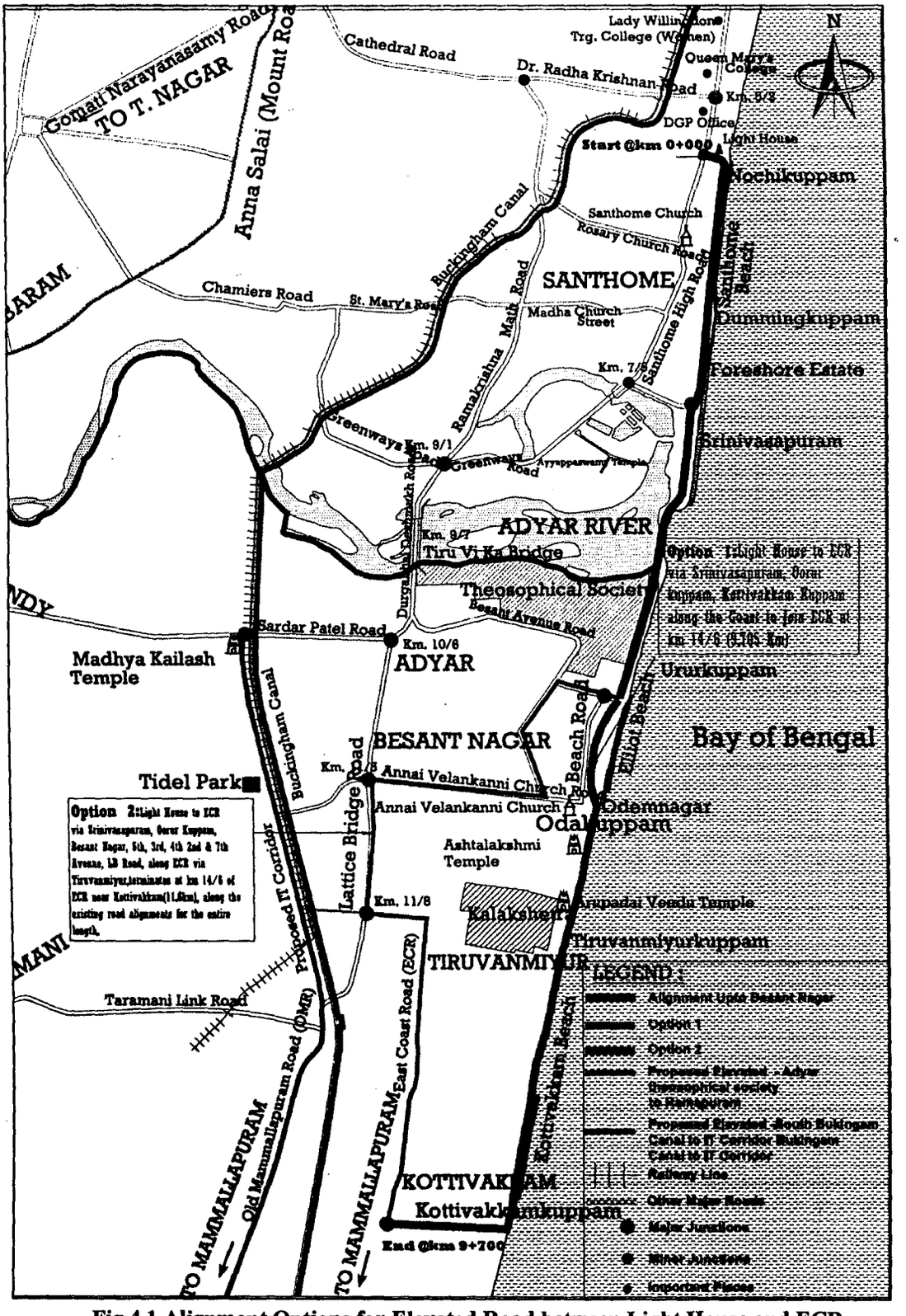


Fig 4.1 Alignment Options for Elevated Road between Light House and ECR

THE HINDU 16.04.2008

Karunanidhi meets officials

CHENNAI: Chief Minister M. Karunanidhi on Tuesday held a discussion with officials on elevated road corridors between Light House and Besant Nagar and the Chennai port and Maduravoyal.

They also discussed construction of roads on both sides of rivers in Chennai, a government press release stated.

PWD minister Durai Murugan, Highways minister M.P. Saminathan, Chief Secretary L.K. Tripathy, Finance Secretary K. Gnanadesikan, Highways secretary K. Allaudin and senior officials attended the meeting. – Special Correspondent

போக்குவரத்து நெரிசலை குறைக்க

அதிகாரிகளுடன் முதல்வர் ஆலோசனை

சென்னை, ஏப்.16: தமிழக அரசு நேற்று வெளியிட்டுள்ள செய்திக் குறிப்பு:

சென்னையில் ஏற்பட்டுள்ள போக்குவரத்து நெரிசலை குறைக்க செய்யவுள்ள திட்டங்கள் குறித்து அதிகாரிகளுடன் முதல்வர் கருணாநிதி நேற்று ஆலோசனை நடத்தினார்.

கலங்கரை விளக்கம் முதல் பெசன்ட்நகர் வரை உயர்மட்ட பாலம் கட்டுதல், மதுரவாயல் முதல் சென்னை துறைமுகம் வரை பறக்கும் சாலை திட்டம், கூவம் உள்ளிட்ட ஆறுகளின் கரையோரங்களில் சாலை அமைப்பது ஆகிய திட்டங்கள் குறித்து ஆய்வு செய்யப்பட்டது.

இந்தக் கூட்டத்தில், அமைச்சர்கள் துரைமுருகன், சாமிநாதன், தலைமைச் செயலாளர் திரிபாதி, நிதித்துறை செயலாளர் ஞானதேசிகன், நெடுஞ்சாலைத்துறை செயலாளர் அலாவுதீன் உட்பட பலர் கலந்து கொண்டனர்.

Plate 4.1 View of the Review meeting held with Hon'ble Chief Minister of Tamil nadu on 15.04.2008

4.3 Salient Features of the Approved alignment for Phase 1

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

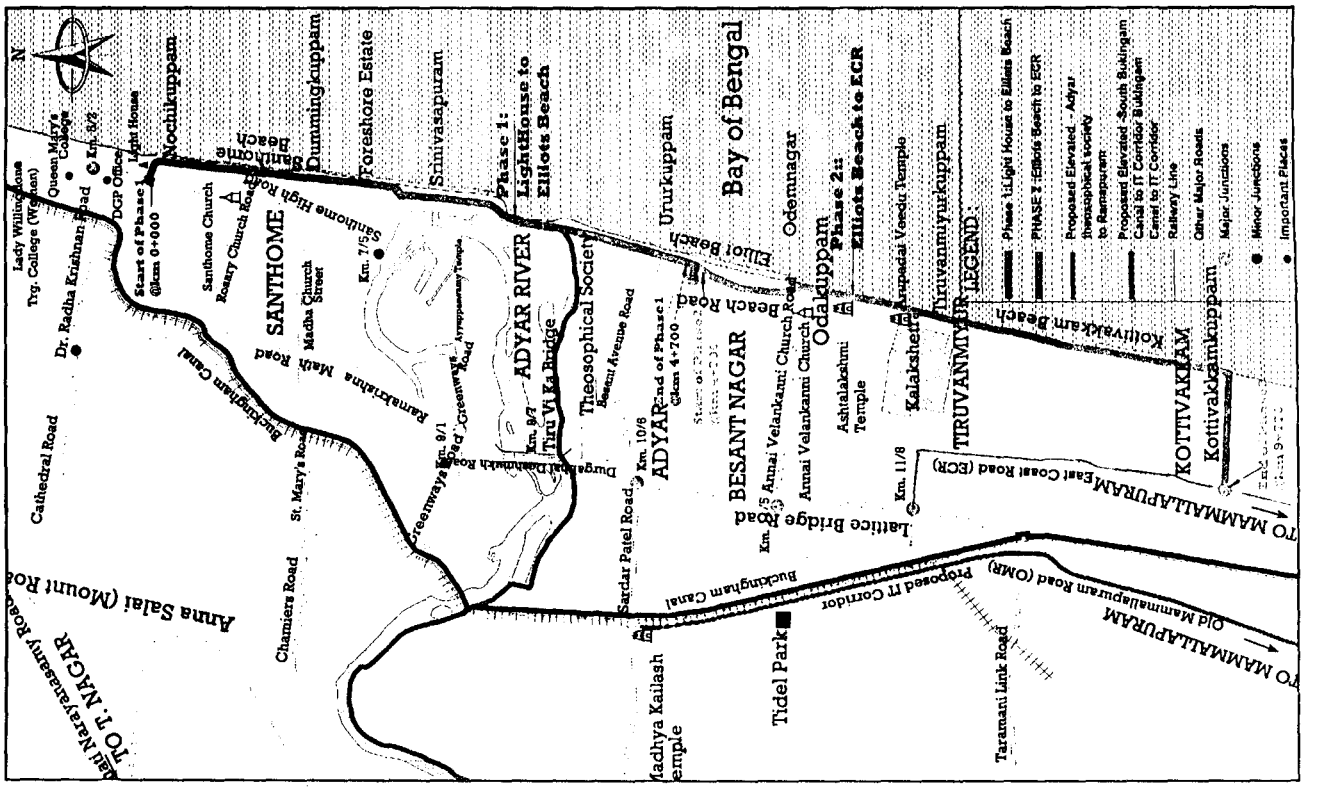


Fig 4.2 Phasing for Elevated Road between Light House and ECR

4.4 Geometric Design Standards

As this project road falls in Chennai City limits, relevant IRC design standards for urban roads with due consideration to the latest directive and guidelines of MORT&H/IRC was followed with reference to the Terms of Reference, as far as possible, while formulating the highway design standards. Other National and International standards and relevant technical papers/journals were also referred to wherever found relevant. Standards for the various components are briefed below.

Design Speed

The ruling design speed of 100 Kmph is adopted for the elevated road corridor portion, 30 kmph is adopted for the design of junction and approach curves at the start and end of the flyover. Entry and exit ramps are designed for 65kmph.

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

Based on the traffic requirement as per the projections, four lane configurations 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. ***However, during the presentation held with Government on 06.08.07, the committee has recommended to have only uniform four lane carriageway width for the entire length of the corridor and accordingly the present proposal is finalized with four lane configuration.***

Camber

Camber of 2.5% is proposed for carriageway. On super-elevated sections, the maximum super elevation is restricted to 4% as per urban standards.

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, it is 40m.

Vertical Alignment

Vertical alignment is designed based on the provision of IRC SP: 23. Details of rate of curvature (K Value) and minimum curve length adopted are given in **Table 4.1**.

Table 4.1: 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	
			Hog	Sag
30	1.5	15	2	3.5
65	0.8	40	19	18
80	0.6	50	33	26
100	0.5	60	74	42

While proposing the at grade features, high and low tide levels have been analyzed and minimum datum level kept around 2m above the high tide levels.

Road Signage and Markings

Proper signage and delineators are critical for safety and guidance of a driver. Signage drawings will show guide signs and regulating signs at appropriate locations. The signs will be of reflector type to be easily visible in the dark.

All road signs are designed in conformity with the provision of IRC SP 32 – 1992 New Traffic Signs and IRC 67 – 2001 Code of Practice for Road Signs. The signs are Mandatory / Regulatory, Cautionary / Warning and Informatory. Roadside lighting is provided in the median or in the absence of median it is proposed on the crash barrier. The road markings are also designed in conformity with the IRC Standards (latest versions):

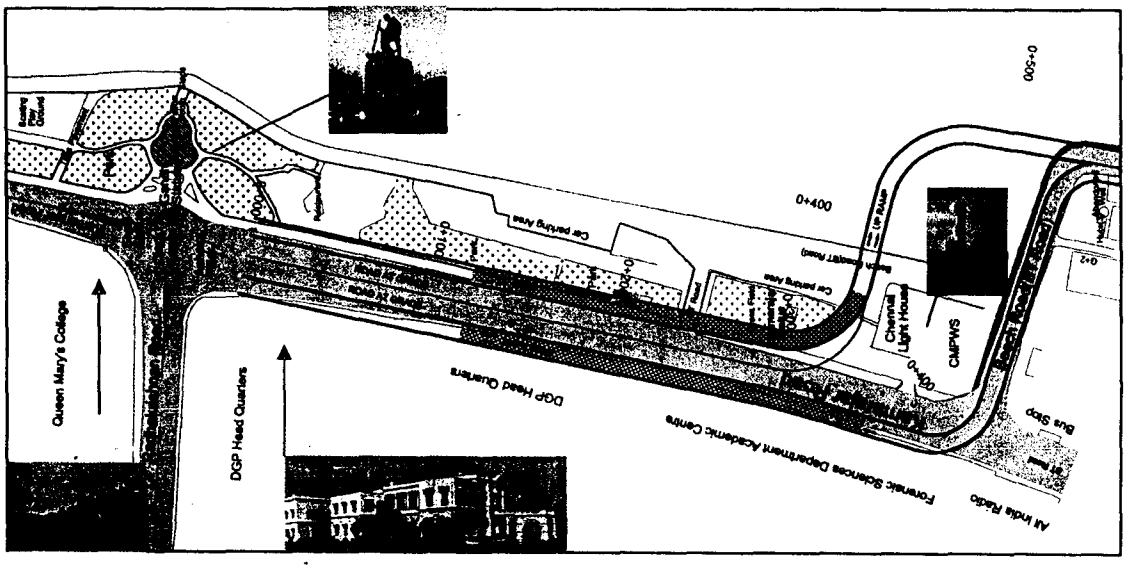
- IRC 35-1997 : Code of Practice for Road Markings with Paint;
- IRC 30-1968 : Standard Letters and Numerals of Different Heights Use in Highway Signs and
- IRC 31-1969 : Route Marker Signs for State Roads

Hot applied thermoplastic paints are proposed for better visibility and longer service life (Clause 803-MOST Specifications).

4.5 Improvement Proposals

4.5.1 Junction Improvement Arrangement on Kamarajar Salai

Alignment takes off at km 0/0 on Kamarajar Salai near Gandhi Statue. Considering the land availability and to make use of existing carriage way at starting location upramp and downramps are provided. Entry Ramp starts about 100m from Gandhi Statue, runs along the eastern edge of Kamarajar Salai for about 300m turn left and joins the elevated corridor and exit ramp follows the existing Nochikuppam road alignment, crosses the Kamarajar Salai near light house and joins at grade about 150m to the south of Gandhi Statute junction. The start point of the project road near Gandhi Statue is ideal for the commuters who are traveling from places such as Chennai port, Parrys corner, Secretariat and Marina Beach. Fig 4.2 gives the plan and proposed view of the arrangement at starting point of the project road on Kamarajar Salai.



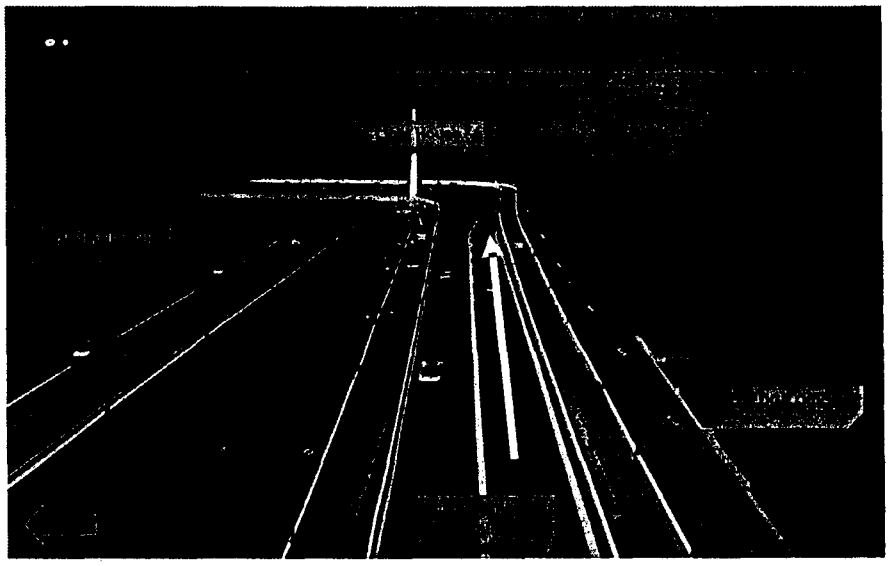


Fig 4.3 Proposed View of Improvements at Kamarajar Salai

4.5.2 Entry Exit Arrangement at Fore Shore Estate Junction

The alignment crosses the Fore shore estate junction at km 2/4, where provision for entry and exit arrangements are made. These ramps are provided in order to give access for the traffic from Santhome high road, Green ways road, Durgabhai Deshmukh road and Lattice Bridge road to use the elevated corridor. The proposed entry and exit arrangement at this location is given in Figure 4.3. Also provisions for pedestrians have been provided in the form of footpath on outer side of exit and entry tamps arrangements are shown in typical cross section XXX.

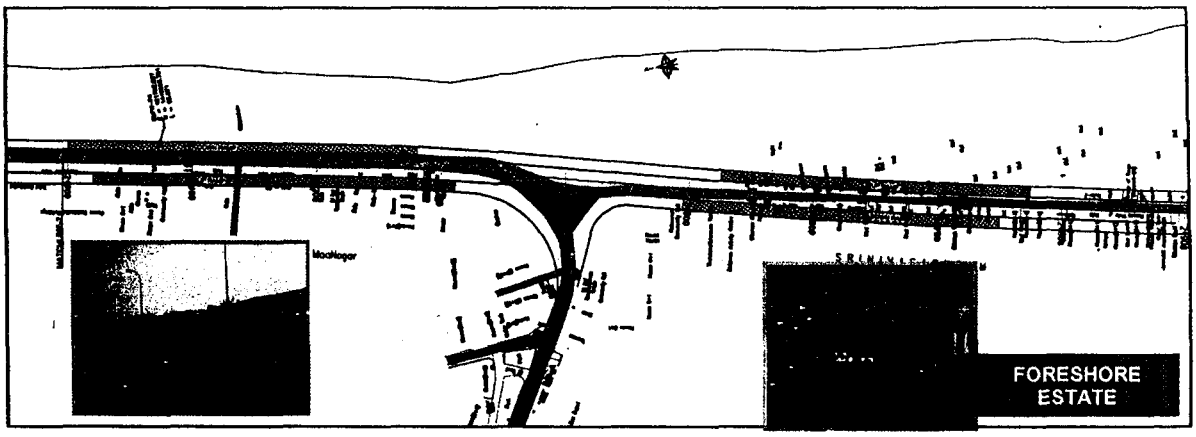


Fig 4.4 Proposed Entry and Exit Ramp Arrangements at Fore Shore Estate junction

4.5.3 Signature Bridge across Adyar River

The alignment crosses Adyar River near the existing broken bridge from km 3/0 to km 3/7. Hence it was decided to reconstruct the existing bridge as part of this project. The option of designing a "Signature bridge" was discussed with the committee during the meeting held on 06.08.07 and committee has welcomed the above idea and approved the design of Signature bridge across Adyar River. The following two options are studied for the reconstruction of the existing bridge:

I. Extradosed cable stayed bridge of length 220m. Approximate cost Rs.29 Crores
II. Steel arched bridge of length250m. Approximate cost Rs.32 Crores

View of alignment along Adyar estuary is shown in figure 4.4 and view of the proposed signature bridge is shown in figure 4.5.

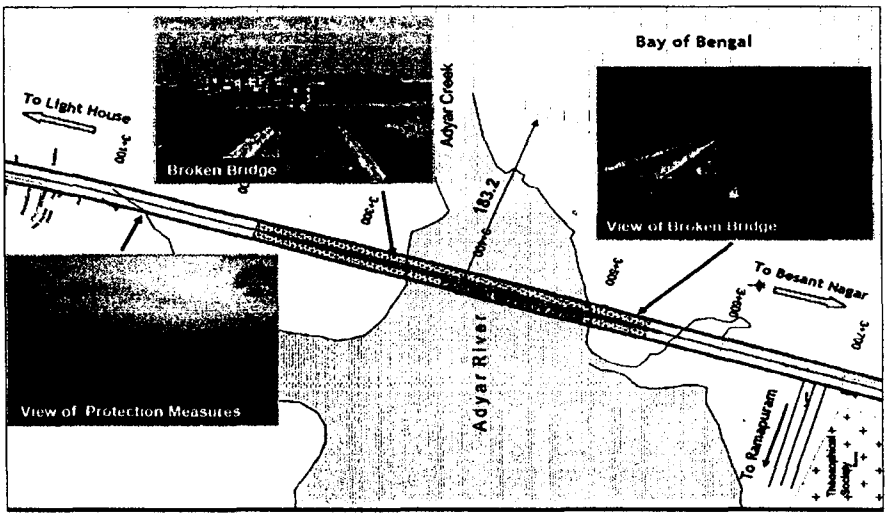
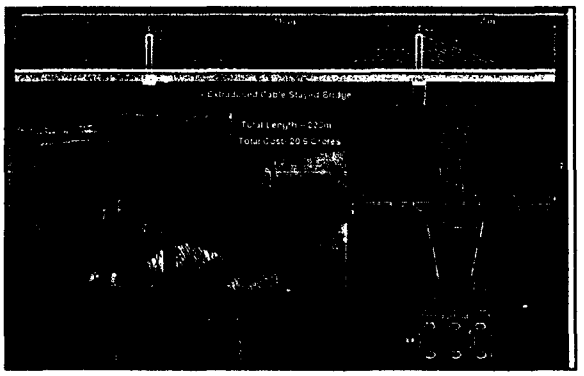
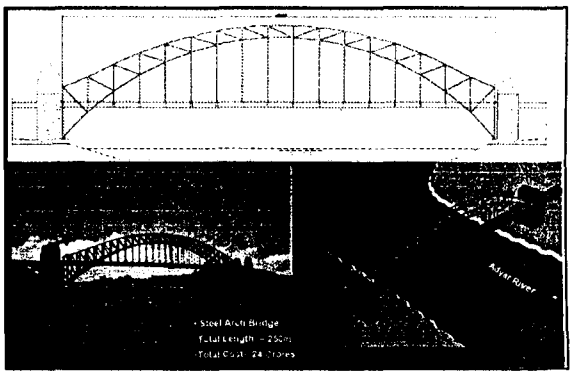


Figure 4.5 View of Alignment along Adyar Estuary





Signature Bridge - Extradosed cable stayed **Signature Bridge – Steel Arched**

Figure 4.6 View of proposed Signature Bridge across Adyar River

The committee has approved the option II with steel arched bridge during its meeting held under the Chairmanship of Chief Secretary on 01.03.2008.

4.5.4 Entry and Exit Arrangement at Besant Nagar

Exit and entry ramps are provided at Km 4/2 near the Elliot's beach to cater the needs of traffic from Besant Nagar and Adyar and the phase 1 terminates at km 4/7 and the proposed arrangements at this location are shown in figure 4.6. By terminating the main structure at km 4/2 and extending ramps up to Besant Nagar will help for linking the phase-1 with phase-2 with out much hassle. The arrangements are presented in fig 4.6 and detailed in drawing No SE-1-23-RAMP-001of drawing volume.

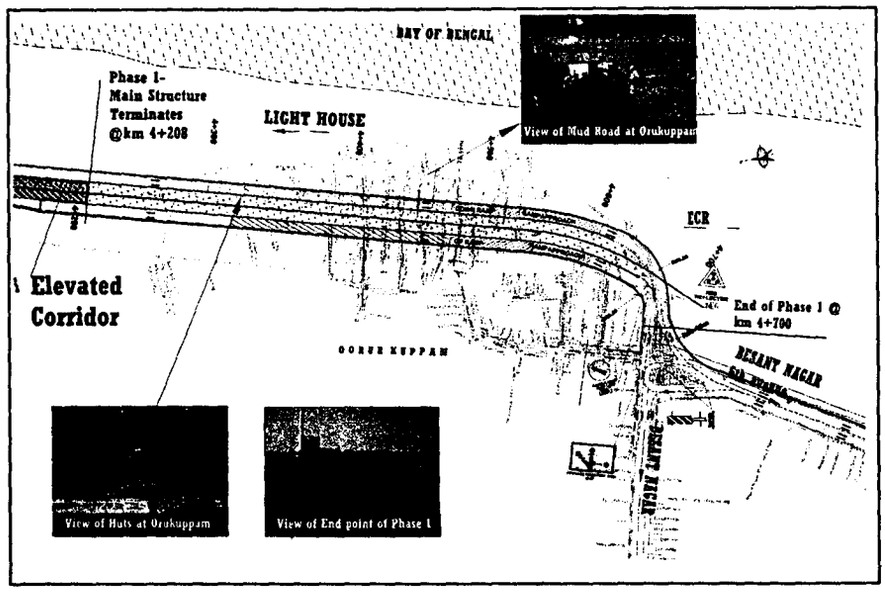


Figure 4.7 Entry and Exit Ramp with provision for Phase 2 arrangement at Besant Nagar

4.6 Connectivity for Proposed Southern Bund Road along Adyar River

In order to reduce congestion and delay at key intersections and other main roads, GoTN has decided to create additional road space along the existing waterways laying emphasis on connectivity to road network within city and the outskirts ensuring mobility to road user. In this connection, GoTN has entrusted the preparation of DFR work to Adyar Poonga Trust (APT). The proposed beltway includes development of a elevated corridor along the southern bund of Adyar River from Adyar esturary to Ramapuram for a length of 11.8km. As the proposed elevated corridor under the present study from Light house to Besant Nagar crosses the Adyar Estuary at km 3/0, the review committee during the meeting held on 19.03.2008 has decided to link this elevated corridor with the proposed southern bund road of Adyar River as shown in Figure 4.1. As both the proposed alignments are elevated, it is propsed to have three tier interchange at this location for the uninterrupted traffic flow. The proposed interchange arrangements at this location is shown in Figure 4.7.

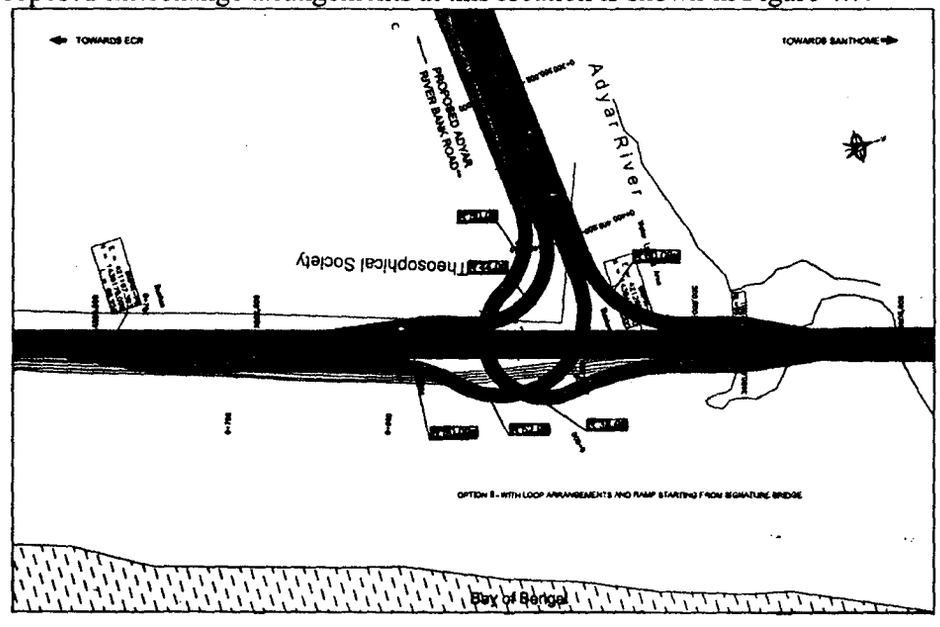


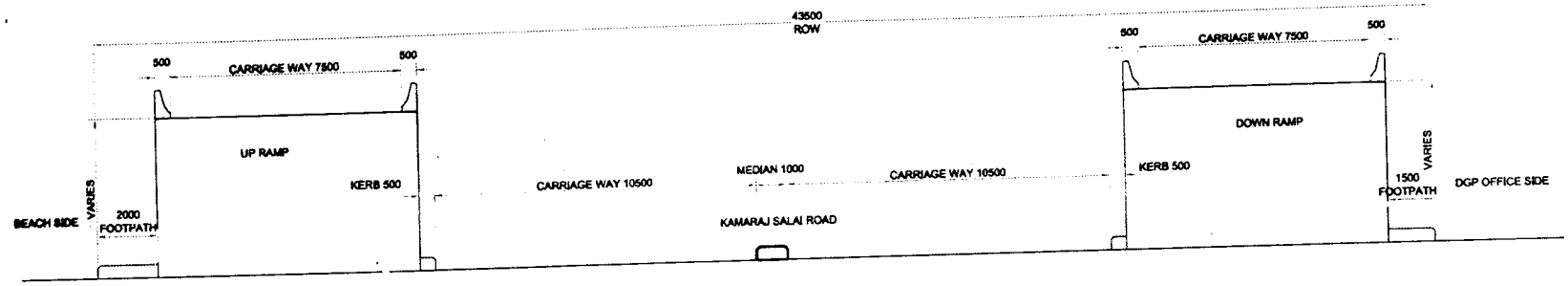
Figure 4.8 Proposed Interchange Arrangement at Besant Nagar

The main traffic (up and down traffic on the main corridor) between Light house and Besant Nagar will move in the central portion of the elevated corridor. The left turn traffic from Besant Nagar side towards Adyar Bund road will move on the free left arm at "+1 level", also the left turning traffic from Adyar bund road towards Light House will move in the free left at "+1 level". The right turning traffic from Light House side towards Adyar bund road will move at "+0 level" below the elevated corridor. The other right turning traffic of this junction from Adyar bund side towards Besant Nagar will move at "+2 level, over the elevated corridor.

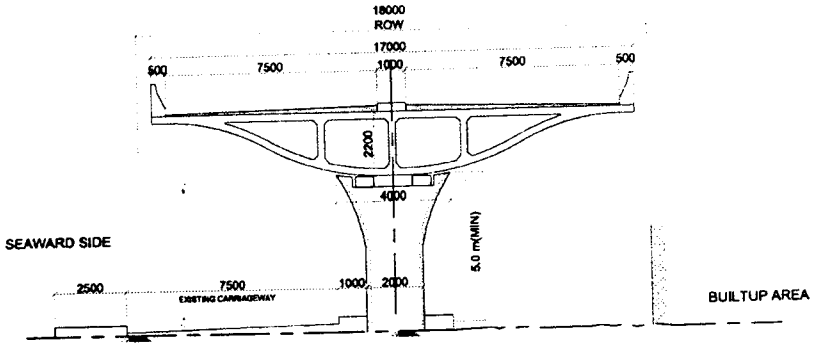
However, the provision of this interchange to be decided during the preparation of the detailed project report (DPR) based on the outcome of the proposed elevated road along the southern bund of the Adyar river.

4.7 Typical cross section

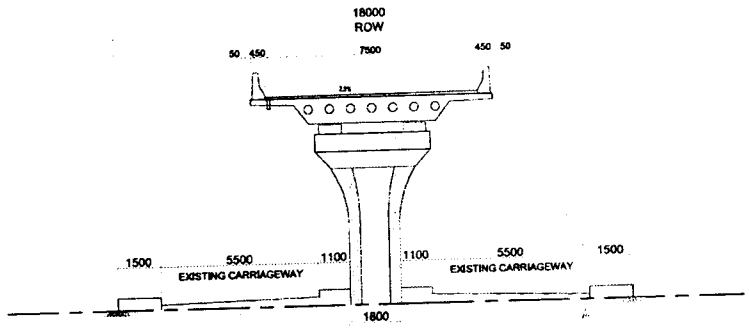
Single Pier with fish belly superstructure is provided at locations where the elevated road passes along the Santhome loop road for a length of 2.2 km at other locations two piers are provided for a length of 2.5 km. The proposed cross section at different locations are shown in figure 4.8.



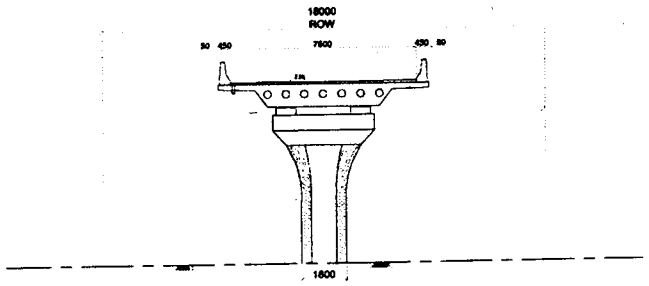
TYPE - A - TYPICAL CROSS SECTION FOR STARTING RAMP FROM KM 0+000 TO KM 0+400



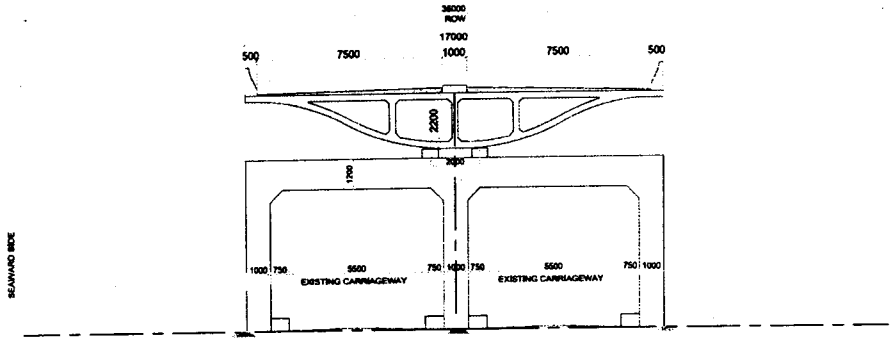
TYPE - B1 -TYPICAL CROSS SECTION FOR 7.5m CARRIAGEWAY ON SEAWARD SIDE
From KM 0+550 To KM 1+810



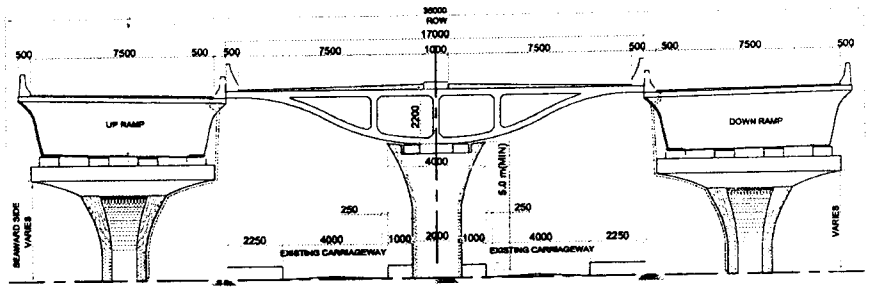
TYPE - B2 -TYPICAL CROSS SECTION EXIT RAMP AT KAMARAJAR SALAI



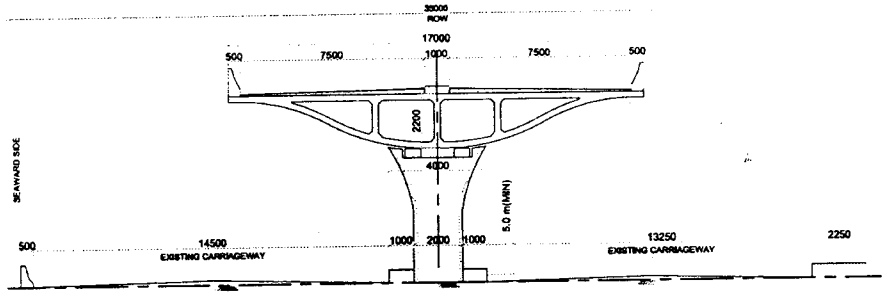
TYPE - B3 -TYPICAL CROSS SECTION ENTRY RAMP AT KAMARAJAR SALAI



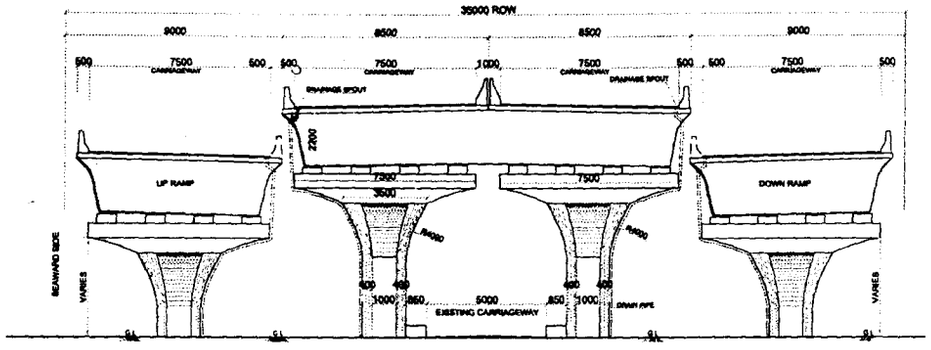
***TYPE - C - TYPICAL CROSS SECTION FOR SINGLE PIER AT RAMP APROACH (FROM KM 1+810 TO KM 1+910)**



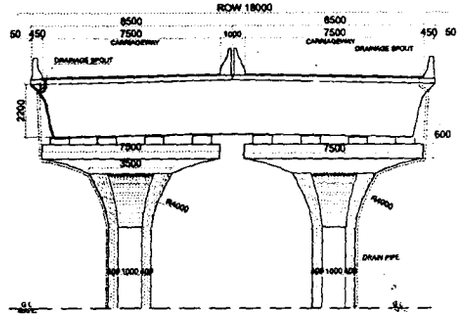
TYPE - C1 - TYPICAL CROSS SECTION FOR SINGLE PIER AT RAMP APROACH (FROM KM 1+910 TO KM 2+220)



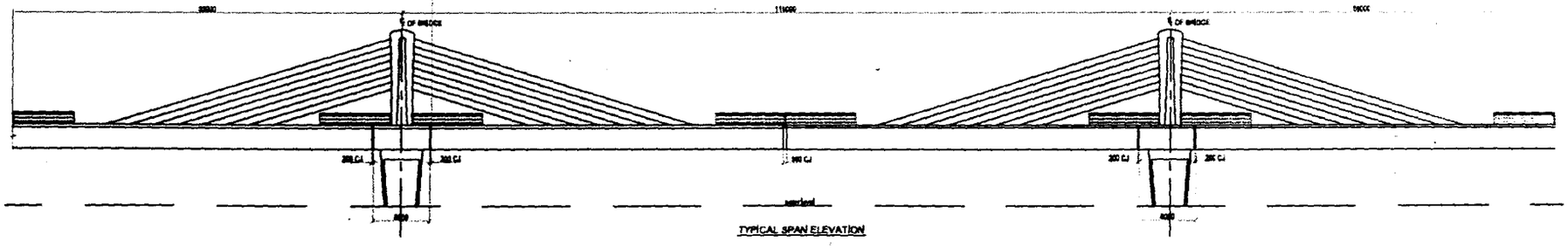
TYPE - C2 - TYPICAL CROSS SECTION FOR SINGLE PIER AT RAMP APROACH (FROM KM 2+220 TO KM 2+550)



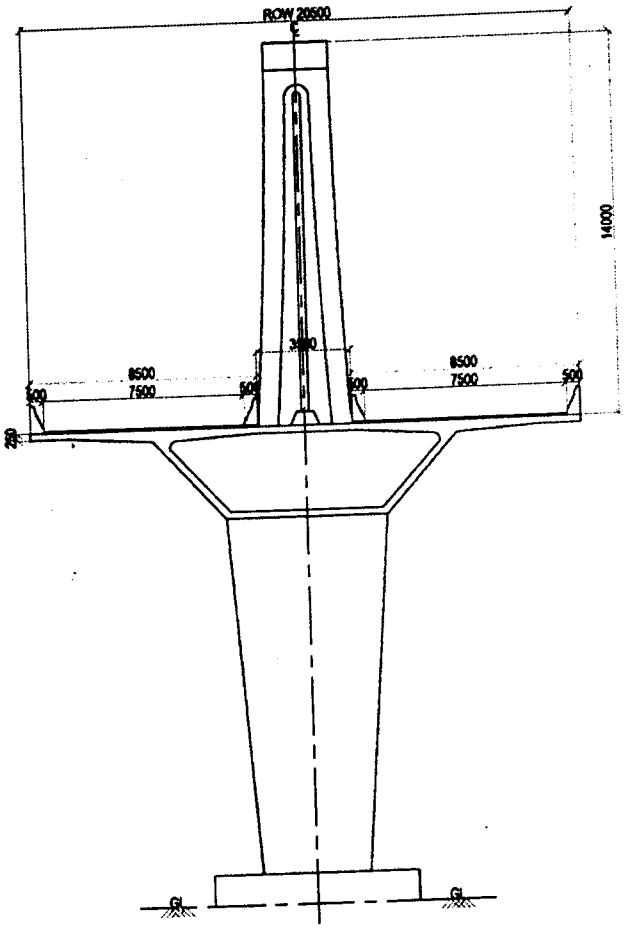
TYPE - D - TYPICAL CROSS SECTION AT DOUBLE PIER LOCATION-RAMP APROACH (FROM KM 2+550 TO KM 3+100)



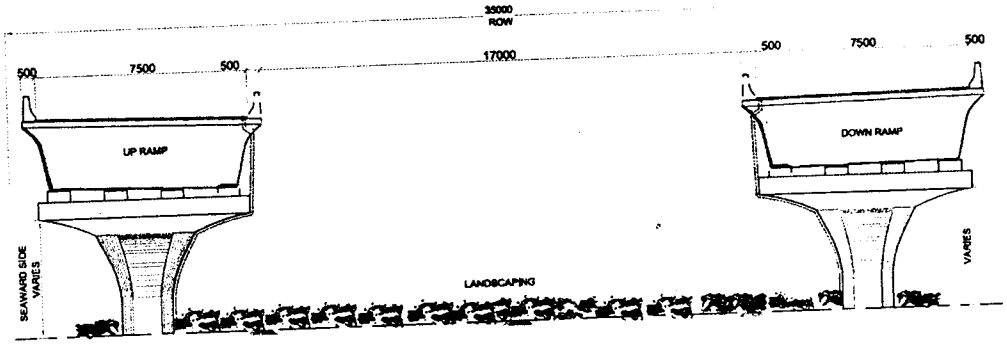
TYPE - E - TYPICAL CROSS SECTION AT TWO PIER LOCATION (FROM KM 3+100 TO KM 3+245),(FROM KM 3+525 TO KM 4+200)



TYPICAL SPAN ELEVATION



TYPE - G - TYPICAL CROSS SECTION AT BRIDGE LOCATION From KM 3+245 To KM 3+525



TYPE - F - TYPICAL CROSS SECTION AT BESANT NAGAR JUNCTION AT RAMP APROACH (FROM KM 4+200 TO KM 4+600)

4.8 Right Of Way (Row)

According to lane requirement and social issues the proposed right of way is formulated and presented in the **Table 4.2.**

Table 4.2: 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 Sa
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 includin the proposed two lane entry & exit ramp arrangemer
2+900	3+200	0.30	18.0	After Ramp at Foreshore Estate upto to Adyar Bridg 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

4.9 Pavement Design

Pavement design is carried out for the at grade road below the proposed elevated corridor and at the approach ramps. The pavement design is carried out based on IRC-37 2002 guidelines. The various design parameters considered for the pavement design is discussed below.

Design Life Period

A design life period of 20 years is adopted for the flexible pavement design.

Vehicle Damage Factor (VDF)

National average vehicle damage factor (number of standard axles per commercial vehicle) of 3.5 is adopted for the design as per IRC 37.

Design Traffic

Results of traffic survey and the projected traffic data given in Chapter 3 are made use for the pavement design. The design traffic is considered in terms of the cumulative number of standard axles to be carried by the pavement during the design life of the road and is derived from the initial volume of commercial vehicles per day after accounting for lateral distribution of traffic, growth rate, design life in years and the vehicle damage factor (number of standard axle per commercial vehicle) to convert commercial vehicles to standard axles. CSA for service roads are arrived with 10% of generated traffic.

A design CSA 25 MSA for at grade roads are adopted for the pavement design and to arrive at the pavement layer composition.

Design of Flexible Pavement for New construction

The thickness and the composition of the pavement layers were determined using pavement design thickness tables and charts as given in IRC: 37-2001. Proposed pavement compositions are given in **Table 4.3** and the typical pavement Cross Section details are shown in **Figure 4.9.**

Table 4.3: Proposed Pavement Layer Compositions for New Construction

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

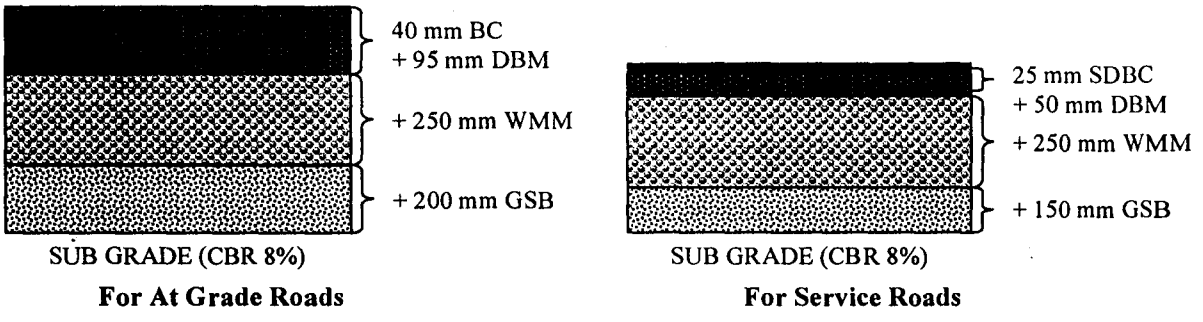


Figure 4.9: Typical Pavement Composition

Also Improvement for the pavement in the form strengthening/ widening has been considered for Kamarajar Salai, Nochikkuppam Road, Santhome link road and the road leads from Foreshore estate road to Adayar river northern bank.

4.10 Structural 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.

Numbering and identification of structures

The following numbering/naming system is adopted

The main flyover substructure starts from P1 to P248 and finally Abutment A2. The ramps are numbered separately. The up ramp substructures at the project start are numbered as R1P1 to R1P18 and that for down ramp, it is numbered as R2P1 to R2P20. The abutments at the project start are numbered as R1A1 and R2 A2 for up and down ramp respectively.

Ramps before Foreshore estate junction:

The down ramp has substructures numbered as R3P1 to R3P9 and abutment as R3A1. The up ramp substructures are numbered as R4P1 to R4P9 and abutment as R4A1.

Ramps after Foreshore estate junction:

The up ramp has substructures numbered as R5P1 to R5P10 and abutment as R5A1. The down ramp substructures are numbered as R6P1 to R6P9 and abutment as R6A1.

Ramps before Besant Nagar junction:

The down ramp has substructures numbered as R7P1 to R7P11 and abutment as R7A1. The up ramp substructures are numbered as R8P1 to R8P9 and abutment as R8A1.

to be deleted

Ramps after Besant Nagar junction:

The up ramp has substructures numbered as R9P1 to R9P12 and abutment as R9A1. The down ramp substructures are numbered as R10P1 to R10P12 and abutment as R10A1.

Two phases are considered for the project. Phase I shall end at CH 4+208 of Main flyover. Phase II shall start from CH 4+208. The pier at CH 4+208 shall become the connection point for both the phases. The substructure, including pedestals for Phase II and foundation at CH 4+208 shall be completed in full respect in Phase I, but shall be loaded only on one side. The loading on other side shall be affected in Phase II.

Out of the 10 ramps provided, Ramps 1 to 8 shall be constructed in Phase I. Ramps 9 and 10 shall be constructed in Phase II

What al
High ra
Univ
Ou

The details of structural arrangement for phase I are given in Table 4.4 and 4.5.

Foundation

The type of foundation to be adopted mainly depends on the sub-soil condition at the proposed location. Total 20 numbers of bore holes were taken to get a good idea of the composition of the sub soil at the location and to gather information regarding probable founding strata. Various tests to identify the composition of the soil strata at different levels and also to find out various parameters of the soil composition were also carried out at field and at the laboratory. These tests and test results suggest requirement of deep foundations. Pile foundations are proposed at an average founding level of 24m from the ground level.

Substructure

Substructure type is finalized considering the aesthetics, visibility for at grade facilities, superstructure type, spacing, other functional requirements etc

Substructure types proposed are:

- Hammer headed type with elliptical section
- Portal pier
- Trestle pier

Hammer headed pier: The basic type of substructure proposed is hammer headed type with Elliptical section for the shaft of the substructure. A wide flare upper portion above the pier shaft is proposed to reduce the cantilever portion of pier cap beyond the pier. At locations, with no built up are and no service roads at grade, having PSC I-girders and cast in place deck slab superstructure, two separate piers are

proposed for each direction of traffic. Each pier shall support two lane carriageway. At built up locations with at grade service roads, single pier for four lane carriageway is proposed. Only a mild flare and no distinct hammer head is proposed at top of pier shaft as the superstructure is fish belly type box and the bearings are placed closer. Height of the substructure is fixed based on the clearance requirement. 5.5m vertical clearance is ensured wherever vehicular movement needs to be permitted below the structure. Typical section of substructure and foundation is given in **Figure 4.10**.

The dimension of the pier at the base is kept as 1.8m x 1.3m. The top of flare is proposed as 3.5m and the length of pier cap is kept as 7.5m. The pier cap is given a root depth of 1.2m above the flared portion.

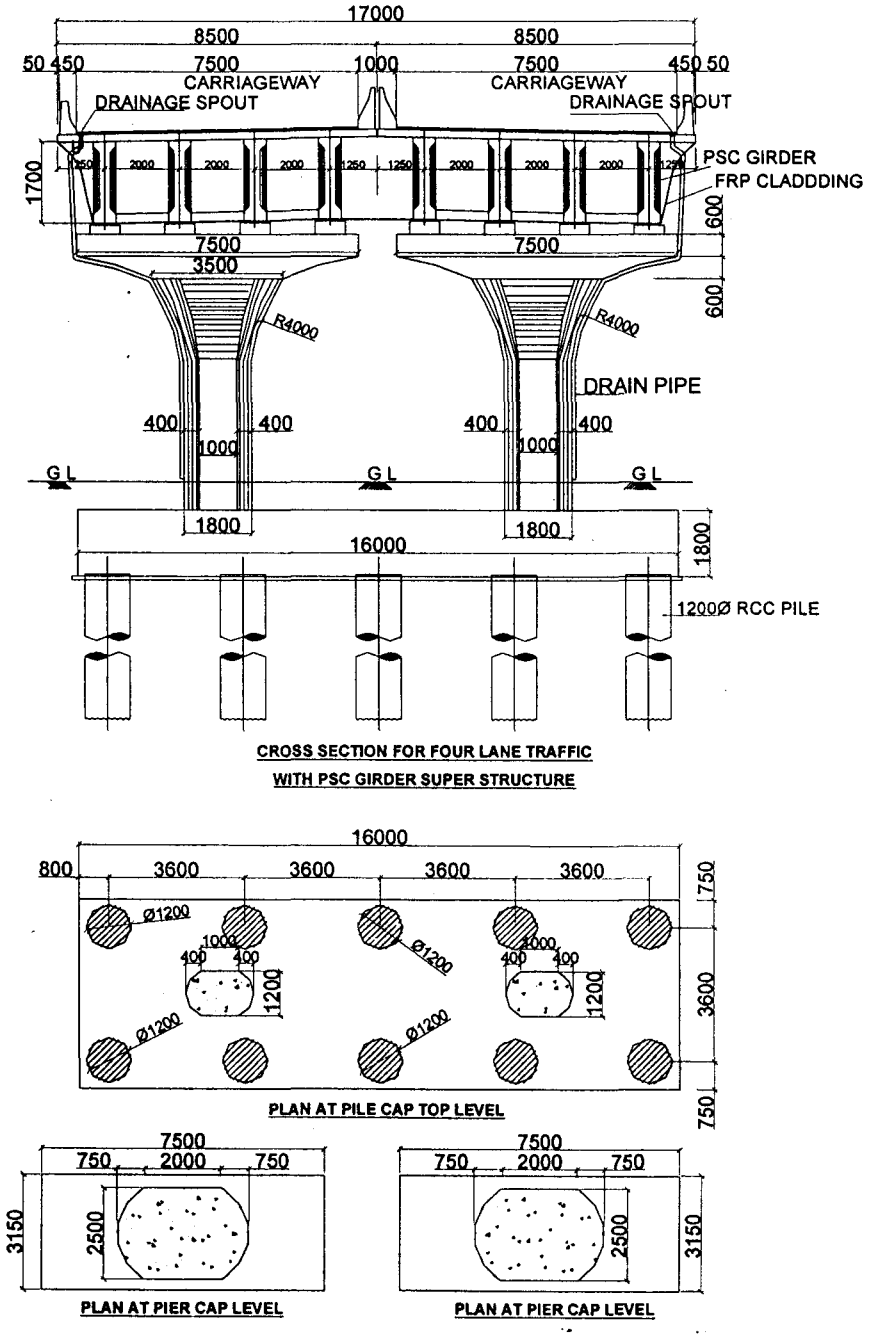


Figure 4.10a: Typical cross section of elliptical pier (double) and pile foundation

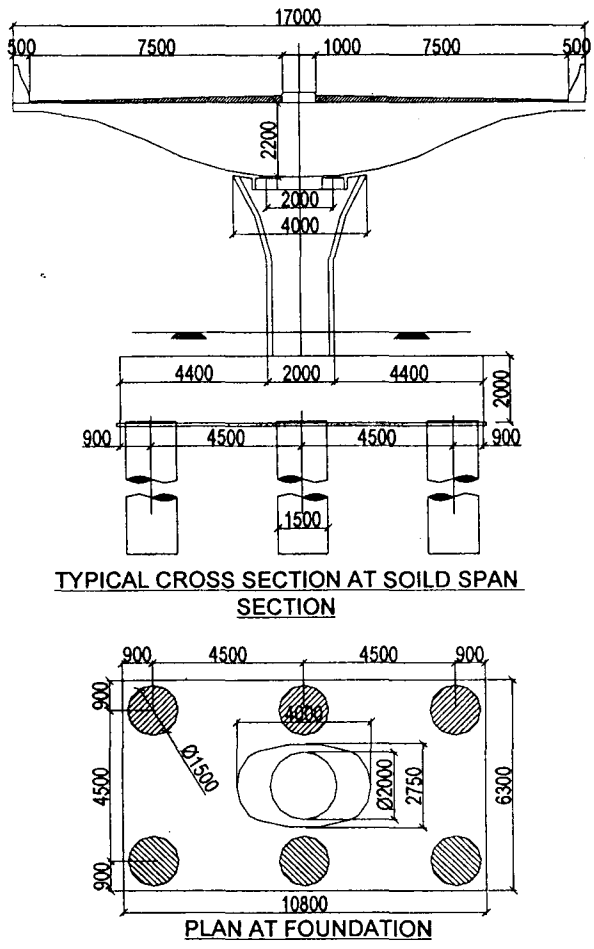


Figure 4.10b: Typical cross section of elliptical pier (single) and pile foundation

Portal pier: Portal piers are provided for transition between stretches with single pier arrangement to twin pier arrangement or vice versa (Piers P37, P43, P60, P119, P145 and P218). Typical section is given if **Figure 4.11**. Portal pier is also proposed at the location where the up and down ramp at the Project start comes closer forming the standard 17.0m cross section (Pier P1).

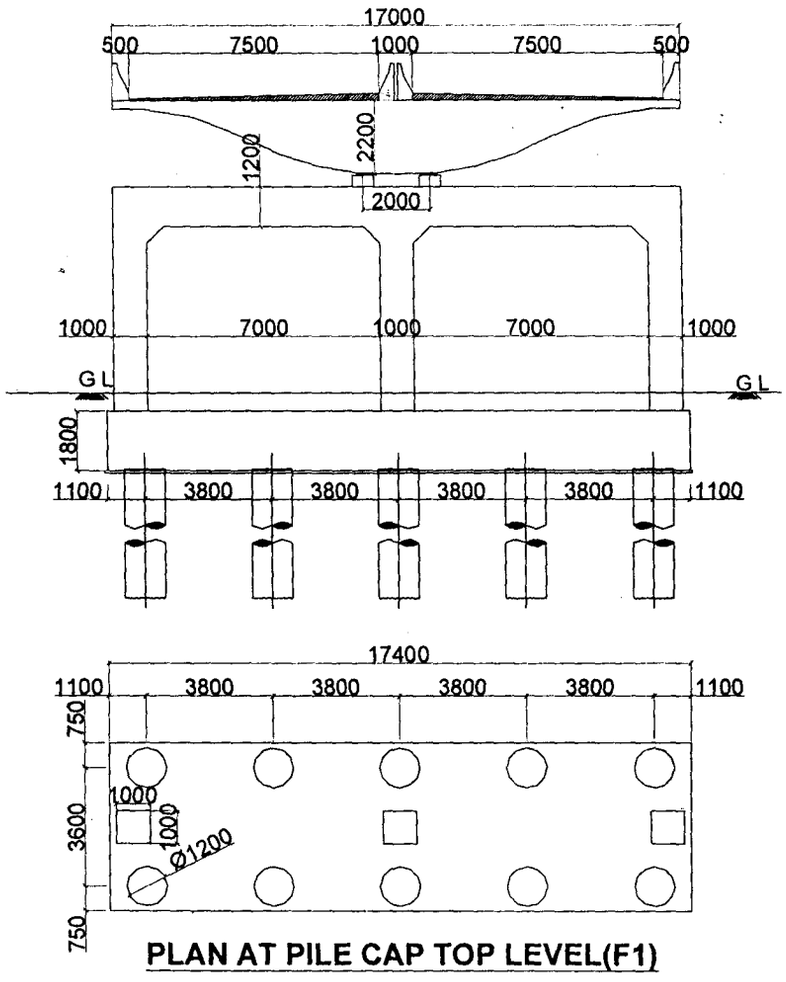


Figure 4.11: Typical cross section of portal pier and pile foundation

Trestle type pier is proposed at the abutment locations, near the earth filled approach. The cap of the trestle pier also have dirt wall to hold the approach slabs over the total width. Circular trestles are proposed on pile foundation. Typical section is given in **Figure 4.12**

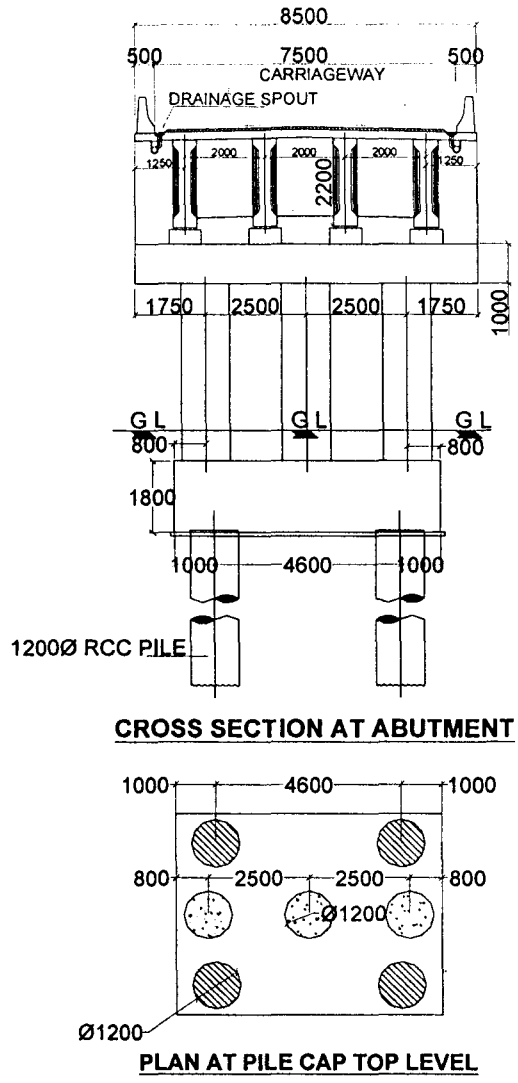


Figure 4.12: Typical Cross section of trestle pier and pile foundation (R5A1, R6A1, R7A1 & R8A1)

Superstructure systems considered are:

- Pre-stressed, voided slab
- Pre-stressed Post tensioned girders
- PSC Fish belly type box

Pre-stressed voided slab superstructure is proposed at locations where the alignment is at sharp curves or where the width of the roadway is varying. The purpose of adopting voided slab structure is to adjust the geometry as per the alignment. Further, voided slab structures need lesser depth and hence suitable for locations with depth restriction. In the proposed road, voided slab is provided at the start of the structural portion near light house where the alignment shifts towards the beach from the existing road. Depth of superstructure is restricted and profile of superstructure fitting to the horizontal curve is achieved by provision of voided slab superstructure. PSC voided slabs are also proposed at the ramp entry/exit points and locations where the ramps merge with the main carriageway and further tapers down to the standard cross section. Maximum span length proposed is 24m. Typical cross for voided slab superstructure for 4 lane deck is given in **Figure 4.13**.

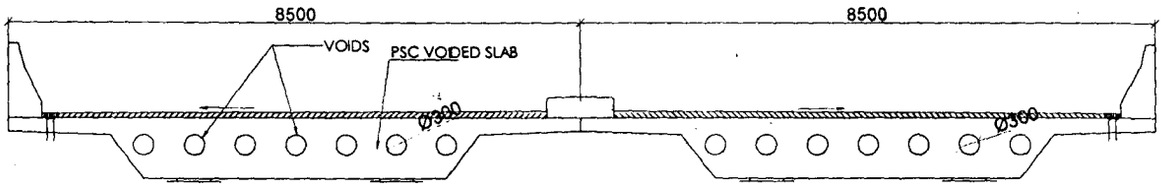


Figure 4.13: Typical cross section with PSC Voided slab for 4-lane deck

Post tensioned girders are proposed for straight spans where service roads are not provided at grade. Based on the sub-soil report and preliminary design, it is estimated that a span length of about 35.0m will be economical. Accordingly, Post tensioned I-girders with cast in place deck slab are proposed. Girders are spaced at 2m in the transverse direction. Typical cross sections for four lane arrangement are given in **Figure 4.14.**Though span length is kept as 35 m as standard, smaller spans are proposed near the merging point to adjust the span lengths between the stretches with fixed cross section and variable cross sectional width. Cross diaphragms are proposed at both the support locations.

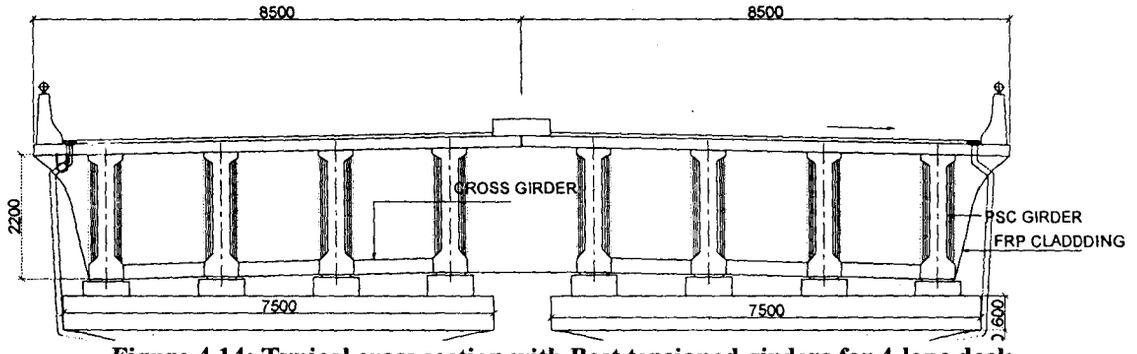


Figure 4.14: Typical cross section with Post tensioned girders for 4-lane deck

Fish belly type structure is provided as the superstructure where service roads are provided. Maximum individual span length proposed is 35m. Pre-stressed structure is proposed. This type of superstructure is fit for segmental construction. Also, this super structure will give good aesthetic appearance. Five span continuous and three span continuous spans are given depending on the span arrangement. Typical cross sections for four lane arrangement is given in **Figure 4.15**

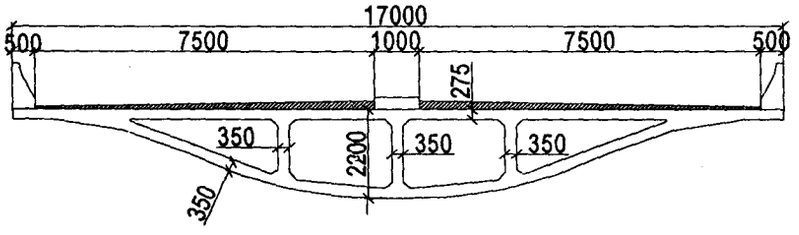


Figure 4.15: Typical cross section with Fish belly for 4-lane deck

Bridge Across Adayar Estuary

At the location where the alignment crosses Adayar Estuary, a steel Arch bridge is proposed. Single span 250m long arch bridge is proposed. The proposed bridge architecture is similar to the Sydney Harbour bridge. Two RCC pylons are proposed at each end of the Arch. RCC deck is proposed over steel beams connecting the arches on either side. The Arch structure consists of three dimensional trusses. View of the bridge is given in Figure 4.16

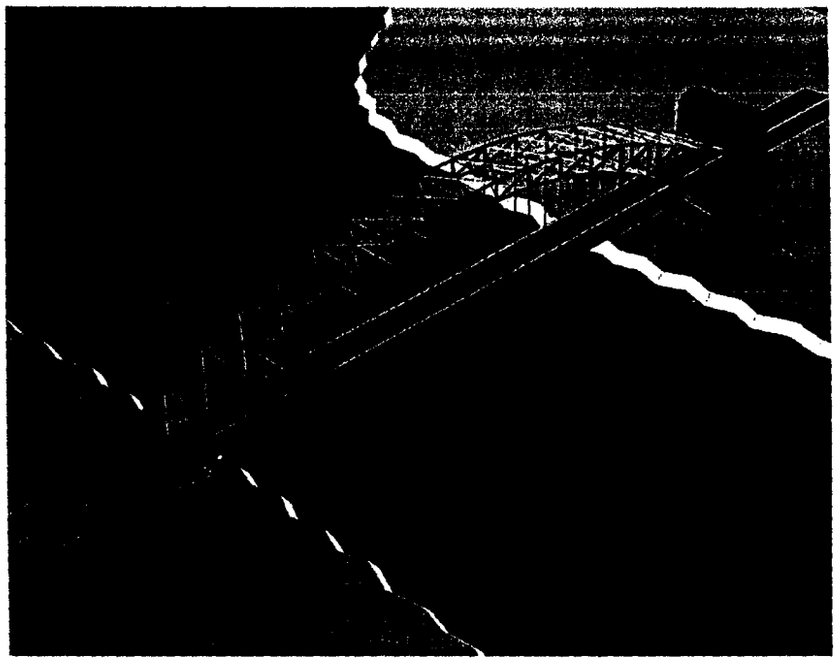


Figure 4.16: Steel arch bridge across Adayar River

Miscellaneous features:

Expansion joints

Strip seal expansion joints are proposed. To reduce the riding discomfort over expansion joints, it is proposed to keep three consecutive spans continuous. The continuity shall be achieved through deck slab continuity. Special flexible joints with asphalt rich wearing coat, MS "T" sections, PVC sealant etc should be used. Details of the joint are given in **Figure 4.17** below.

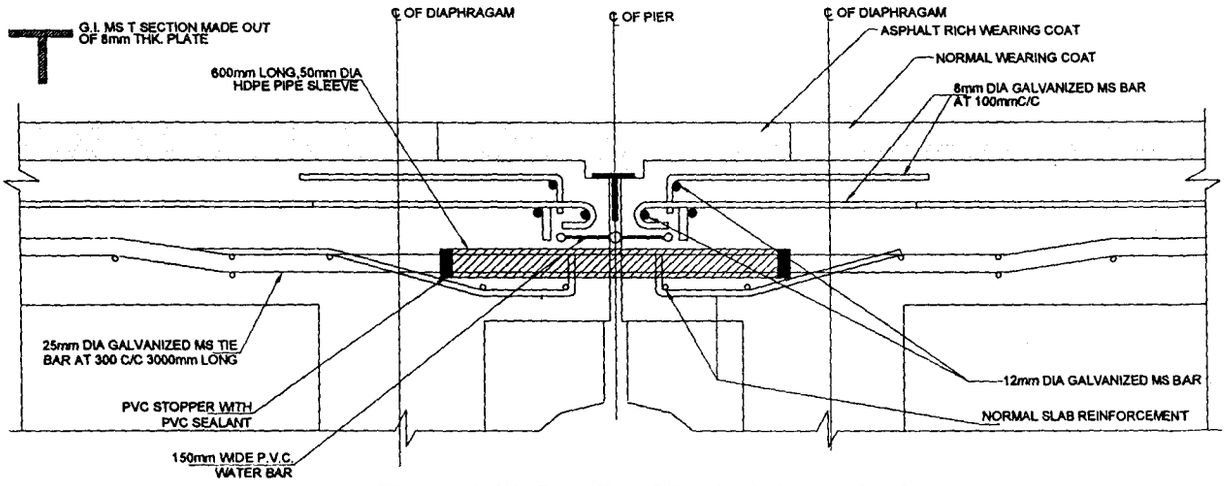


Figure 4.17: Details of Deck slab continuity

Bearings

Two types of bearings are proposed, viz, elastomeric and POT PTFE. Elastomeric bearings are proposed a locations where I girders are proposed. Bearings are proposed under each girder. POT-PTFE bearings ar proposed at the locations where voided slab and Fish belly box superstructures are proposed.

Storm water drains

Drainage spouts connected by longitudinal pipes under the deck and further connected to vertical down take pipes at pier locations for discharging storm water on to the drains at grade. Drainage spouts are proposed at regular intervals.

Cladding

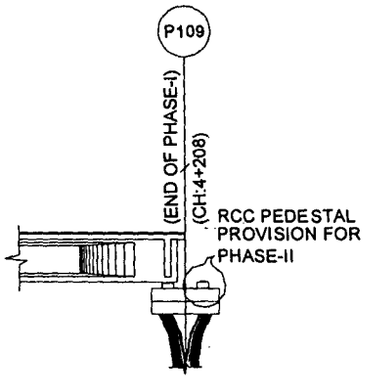
To enhance the aesthetics of the elevated roadway, it is proposed to provide FRP cladding to cover the soffit of the superstructure extending up to the bottom of the cantilever slab on both sides.

Corrosion protection

To the severe corrosive environment of the location, it is proposed to adopt corrosion protection coating for reinforcement and also to paint all the exposed surfaces with anti-corrosive paint.

Connection arrangement for Phase I and II

Phase I shall end at Ch 4+208. However, the pedestals for the Phase II on the common substructure at CH4+208 shall be constructed in Phase I only. The arrangement on substructure at Ch 4+208 is given in Fig 4.18.



4.11 Structural Design standards

The basic design standards adopted for the structural designs are as per the requirements laid down in the latest editions of IRC codes of practices & standards specifications, and guidelines of Ministry of Road Transport & Highways. Additional technical references are used wherever the provisions of IRC/IS codes are found inadequate.

Following IRC/IS Codes are used in the design

IRC:5 -1998	Standard Specifications & code of Practice for Road Bridges Section -I. General Features of Design
IRC:6-2000	Standard Specifications & code of Practice for Road Bridges, Section -II. Loads and Stresses
IRC:18-2000	Design Criteria for Prestressed Concrete Road Bridges (Post-Tensioned *Concrete) (Third Revision)*
IRC:21-2000	Standard *Specifications & code of Practice for Road Bridges, Section -III.* Cement concrete (Plain and reinforced)
IRC:22-1986	Standard Specifications and Code of Practice for Road Bridges, Section VI - Composite Construction (First Revision)
IRC:78-2000	Standard Specifications & code of Practice for Road Bridges, -Foundations & Substructure.
IRC:69-2005	Guidelines and Specifications of Expansion joint
IRC:83(Part-I)-1989	Standard Specifications and codes of Practices for Road Bridges, Section IX – Bearing , Part II: Elastomeric Bearing

IRC:83(Part-III)-2002	Standard Specifications and codes of Practices for Road Bridges, Section IX – Bearing , Part II: POT Bearings
IS 6403 -1981	Code of Practice for determination of Bearing Capacity of Shallow Foundations
IS 2911-1979	Code of practice for design and construction of pile foundations

For the items not covered in the above specifications, provisions of following standards are followed in the given order of priority:

- Provisions of IS codes of Practices:
- Relevant Provisions of BS coded of practice
- Sound Engineering Practices, technical Literature/ Papers & Provisions of relevant codes of advanced and developing countries.

The grades of concrete for various structural components are adopted based on the guidelines in IRC codes of practices. Fe415 grade is used as steel reinforcement for all the structural members. The design life of all the structures is 100 years.

4.12 Design Methodology

Based on the topographical data and the data collected at site, the span requirement is finalised. 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, span arrangements etc.

Loading standards adopted

The structural systems 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 relevant for 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 sea, severe exposure condition is considered in the design.

Span arrangement details

Based on subsoil investigation results, it is estimated that span length of 35.0m will be optimum for the proposed flyover. Span arrangement is carried out in such a way that to keep the span length as 35.0m as far as possible. Where the existing site conditions like presence of cross roads or other constraints like entry/ exit of ramps, location of merging lanes etc occur, the span lengths are adjusted to suit the specific requirements. Accordingly, two basic types of superstructure is proposed, viz., Post tensioned girders and PSC voided slabs. Post tensioned girder are provided for span lengths of 27m, 30m, 31m, 33m and 35m. Same cross section is proposed for the girders. Adjustments in the amount of pre-stressing shall be done based on requirement. Voided slab structures are proposed for smaller spans, adopted at location with constraints and at locations where the tapering in the superstructure is required for accomm

merging lanes. PSC voided slabs are provided for span lengths 15, 16m, 18m, 19m, 20m, 22m, 23m, 24m and 25.0m. 15.0m long voided slabs are provided where the alignment is along acute curves. All the other PSC voided slab spans are provided at locations of merging of ramp with the main flyover.

Details of superstructure arrangements adopted is shown below in **Table 4.4**

Table 4.4: Superstructure Details (Phase I)

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
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

4.13 Detailed layout presentation for Phase1

Table 4.5: Layout details along the Proposed Road for Phase 1

Stretch		Location	Distance(m)	Description	Superstructure	Substructure	Foundation
Start	End						
0+550	1+810	Dumminig kuppam	1260	4-lane road way on structure portion with thirty six spans of 35.0m each. Isolated pile caps provided for piers supporting the superstructure.	PSC Fish Belly type box	Elliptical hammer headed pier at Ch:0+550 and Portal pier at Ch:1+810	Pile foundation with 1.5m dia piles at single pier location, and 1.2m dia piles at portal pier location
1+810	1+825	Corporation Play Ground	15	Single span of 15.0m is proposed. The carriage way width varies from 15.0m to 16.82m for accommodating the ramp. Single pile cap provided for the portal piers supporting superstructure.	PSC Voided slab	Portal pier with three columns	Pile foundation with 1.20m dia piles
1+825	1+840		15	Single span of 15.0m is proposed. The carriage way width varies from 16.82 (7.5m + 9.32m) to 18.65 (7.5m + 11.15m) for accommodating the ramp. Portal piers provided as substructure on pile foundation. The carriageway beneath is maintained.	PSC Voided slab	Portal pier with three columns at 1+825 and with four columns at 1+840	Pile foundation with 1.20m dia piles

Stretch		Location	Distance(m)	Description	Superstructure	Substructure	Foundation
Start	End						
1+840	1+860	Corporation Play Ground	20	Single span of 20.0m is proposed. The carriage way width varies from 18.65 (7.5m + 11.15m) to 23.51 (9.9m + 13.61m) for accommodating the ramp. At 11.15m and 13.61m carriage way location combined pile cap is proposed for piers supporting superstructure. 7.5m and 9.9m carriageway locations isolated pile cap is proposed for piers supporting superstructure.	PSC Voided slab	Portal pier with four columns	Pile foundation with 1.20m dia piles
1+860	1+881		21	Single span of 21.0m is proposed. The carriage way width varies from to 23.51m (9.9m + 13.61m) to 28.60m (12.44m + 16.16m) for accommodating the ramp. At 13.61m and 12.44m carriage way location combined pile cap is proposed for piers supporting superstructure in each direction. 9.9m and 16.16m carriageway locations isolated pile cap is proposed for piers supporting superstructure.	PSC Voided slab	Elliptical hammer headed pier	Pile foundation with 1.20m dia piles
1+881	1+895		14	Single span of 14.0m is proposed. The carriage way width varies from 28.60m (12.44m + 16.16m) to 30.23m (14.13m + 16.10m) for accommodating the ramp portion. At 12.44m and 14.13m carriage way location combined pile cap is proposed for piers supporting superstructure. 16.16m and 16.10m carriageway locations isolated pile cap is proposed for piers supporting superstructure	PSC Voided slab	Elliptical hammer headed pier	Pile foundation with 1.20m dia piles
1+895	1+910		15	Single span of 15.0m is proposed. The carriage way width varies from At 30.23m (14.13 + 16.10m) to 31.97m for accommodating the ramp. At 14.13m carriage way location	PSC Voided slab	Elliptical hammer headed pier, At	Pile foundation with 1.20m dia

Stretch		Location	Distance(m)	Description	Superstructure	Substructure	Foundation
Start	End						
				combined pile cap is proposed for piers supporting superstructure. 16.10m carriageway location isolated pile caps are proposed for piers supporting superstructure. The up ramp and down ramp starts at Ch 1+910		Ch:1+910 Portal pier	piles
1+910	2+505	Mullimanagar	595	4-lane road way on structure portion with seventeen spans of 35.0m each. Isolated pile caps provided for piers supporting superstructure.	PSC Fish Belly type box type box	Elliptical hammer headed pier, At Ch: 1+910 and Ch: 2+505 Portal pier	Pile foundation with 1.5m dia piles at single pier location, and 1.2m dia piles at portal pier location
2+505	2+820	Srinivasa Puram	315	4-lane road way on structure portion with nine spans of 35.0m each. Combined pile cap for piers supporting superstructure in each direction. Down ramp starts at 2 +575.6 and Up ramp starts at 2 +645	PSC I Girder	Elliptical Hammer headed pier, At Ch: 2+505 Portal pier	Pile foundation with 1.2m dia piles
2+820	2+845	Srinivasa Puram	25	4-lane road way on structure portion with single span of 25.0m. Combined pile cap for piers supporting superstructure in each direction.	PSC I Girder	Elliptical Hammer headed pier	Pile foundation with 1.2m dia piles
2+845	2+869	Srinivasa Puram	24	4-lane road way on structure portion with single span of 24.0m. Combined pile cap for piers supporting superstructure in each direction.	PSC I Girder	Elliptical Hammer headed pier	Pile foundation with 1.2m dia piles

Stretch		Location	Distance(m)	Description	Superstructure	Substructure	Foundation
Start	End						
2+869	2+894	Srinivasa Puram	25	4-lane road way on structure portion with single span of 25.0m. Combined pile cap for piers supporting superstructure in each direction.	PSC I Girder	Elliptical Hammer headed pier	Pile foundation with 1.2m dia piles
2+894	2+909		15	Single span of 15.0m is proposed. The carriage way width varies from 31.99 to 30.42m (14.42m + 16.0m) for accommodating the ramp portion. At 14.42m carriage way location combined pile cap is proposed for piers supporting superstructure in each direction. 16.0m carriageway location isolated pile caps are proposed for piers supporting superstructure.	PSC Voided Slab	Elliptical Hammer headed pier	Pile foundation with 1.2m dia piles
2+909	2+924		15	Single span of 15.0m is proposed. The carriage way width varies from 30.42m (14.42m + 16.0m) to 28.82m (12.84m + 15.98m) for accommodating the ramp portion. At 14.42m and 12.84m carriage way locations combined pile cap is proposed for piers supporting superstructure in each direction. 16.0m and 15.98m carriageway locations isolated pile caps are proposed for piers supporting superstructure.	PSC Voided Slab	Elliptical Hammer headed pier	Pile foundation with 1.2m dia piles

Stretch		Location	Distance(m)	Description	Superstructure	Substructure	Foundation
Start	End						
2+924	2+941	Srinivasa Puram	17	Single span of 17.0m is proposed. The carriage way width varies from 28.82m (12.84m + 15.98m) to 25.16m (11.05m + 14.11m) for accommodating the ramp portion. At 12.84m, 11.05m and 14.11m carriage way locations combined pile cap is proposed for piers supporting superstructure in each direction. 15.98m carriageway location isolated pile caps are proposed for piers supporting superstructure.	PSC Voided Slab	Elliptical Hammer headed pier	Pile foundation with 1.2m dia piles
2+941	2+959		18	Single span of 18.0m is proposed. The carriage way width varies from 25.16m (11.05m + 14.11m) to 21.24m (9.19m + 12.05m) for accommodating the ramp portion. At 12.05m, 11.05m and 14.11m carriage way locations combined pile cap is proposed for piers supporting superstructure in each direction. 9.19m carriageway location isolated pile cap is proposed for pier supporting superstructure.	PSC Voided Slab	Elliptical Hammer headed pier	Pile foundation with 1.2m dia piles
2+959	2+976	Srinivasa Puram	17	Single span of 17.0m is proposed. The carriage way width varies from 21.24m (9.19m + 12.05m) to 17.66 (7.5m + 10.16m) for accommodating the ramp portion. At 12.05m carriage way location combined pile cap is proposed for piers supporting superstructure in each direction. 9.19m, 7.5m and 10.16m carriageway locations isolated pile caps are proposed for piers supporting superstructure.	PSC Voided Slab	Elliptical Hammer headed pier	Pile foundation with 1.2m dia piles

Stretch		Location	Distance(m)	Description	Superstructure	Substructure	Foundation
Start	End						
2+976	3+000		24	Single span of 24.0m is proposed. The carriage way width varies from 17.66m (7.5m + 10.16m) to 15.0m (7.5m + 7.5m) for accommodating the ramp portion. At 15.0m carriage way location combined pile cap is proposed for piers supporting superstructure in each direction. 10.16m and 7.5m carriageway locations isolated pile cap is proposed for pier supporting superstructure.	PSC Voided Slab	Elliptical Hammer headed pier,	Pile foundation with 1.2m dia piles
3+000	3+245	Orur Kuppam	245	4-lane road way on structure portion with seven spans of 35.0m each. Combined pile cap for piers supporting superstructure in each direction.	PSC I Girder	Elliptical Hammer headed pier, At Ch:3+245 Pylon	Pile foundation with 1.2m dia piles
3+245	3+524	Orur Kuppam	279	4-lane road way on structure portion with single span of 279.0m.	Steel Arch bridge	Pylon	Pile foundation
3+524	4+014		490	4-lane road way on structure portion with fourteen spans of 35.0m each. Combined pile cap for piers supporting superstructure in each direction.	PSC I Girder	At Ch: 3+524 Pylon, Elliptical Hammer headed pier.	Pile foundation with 1.2m dia piles.
4+014	4+062		48	4-lane road way on structure portion with two spans of 24.0m each. Combined pile cap for piers supporting superstructure in each direction.	PSC I Girder	Elliptical Hammer headed pier.	Pile foundation with 1.2m dia piles.

Stretch		Location	Distance(m)	Description	Superstructure	Substructure	Foundation
Start	End						
4+062	4+082		20	Single span of 20.0m is proposed. The carriage way width varies from 15.0m (7.5m + 7.5m) to 17.12m for accommodating the ramp portion. At 15m carriage way location combined pile cap is proposed for piers supporting superstructure in each direction. 17.12m carriageway locations isolated pile caps are proposed for piers supporting superstructure.	PSC Voided Slab	Elliptical Hammer headed pier.	Pile foundation with 1.2m dia piles.
4+082	4+102	Orur Kuppam	20	Single span of 20.0m is proposed. The carriage way width varies from 17.12m (7.5m + 9.62m) to 19.23m (7.5m + 11.73m) for accommodating the ramp portion. At 11.73m carriage way location combined pile cap is proposed for piers supporting superstructure in each direction. 7.5m, 9.62m carriageway locations isolated pile caps are proposed for piers supporting superstructure.	PSC Voided Slab	Elliptical Hammer headed pier.	Pile foundation with 1.2m dia piles.
4+102	4+122.5		20.5	Single span of 20.5m is proposed. The carriage way width varies from 19.23m (7.5m + 11.73m) to 23.83m (9.94m + 13.89m) for accommodating the ramp portion. At 11.73m and 13.89m carriage way locations combined pile cap is proposed for piers supporting superstructure in each direction. 7.5m, 9.94m carriageway locations isolated pile caps are proposed for piers supporting superstructure.	PSC Voided Slab	Elliptical Hammer headed pier.	Pile foundation with 1.2m dia piles.

Stretch		Location	Distance(m)	Description	Superstructure	Substructure	Foundation
Start	End						
4+122.5	4+142.5		20	Single span of 20.0m is proposed. The carriage way width varies from 23.83m (9.94m + 13.89m) to 28.33m (12.33m + 16.0m) for accommodating the ramp portion. At 12.33m and 13.89m carriage way locations combined pile cap is proposed for piers supporting superstructure in each direction. 16.0m, 9.94m carriageway locations isolated pile caps are proposed for piers supporting superstructure.	PSC Voided Slab	Elliptical Hammer headed pier.	Pile foundation with 1.2m dia piles.
4+142.5	4+158	Orur Kuppam	15.5	Single span of 15.5m is proposed. The carriage way width varies from 28.33m (12.33m + 16.0m) to 30.19m (16.0m + 14.19m) for accommodating the ramp portion. At 12.33m and 14.19m carriage way locations combined pile cap is proposed for piers supporting superstructure in each direction. 16.0m carriageway locations isolated pile caps are proposed for piers supporting superstructure.	PSC Voided Slab	Elliptical Hammer headed pier.	Pile foundation with 1.2m dia piles.
4+158	4+173		15	4-lane road way on structure portion with single span of 15.0m. Isolated pile caps provided for piers supporting superstructure in each direction.	PSC Voided Slab	Elliptical Hammer headed pier.	Pile foundation with 1.2m dia piles.

Stretch		Location	Distance(m)	Description	Superstructure	Substructure	Foundation
Start	End						
4+173	4+208 (end of phase-I)		35	4-lane road way on structure portion with one span of 35.0m. Combined pile cap for piers supporting superstructure in each direction.		Elliptical hammer headed pier	Pile foundation with 1.2m dia piles
RAMP1							
0+168	0+248	Light House	80	2-lane road way on structure portion with four spans of 20.0m each. Isolated pile caps provided for piers supporting superstructure.	PSC Voided Slab	Elliptical hammer headed pier	Pile foundation with 1.2m dia piles
0+248	0+268		20	2-lane road way on structure portion with single span of 20.0m. Isolated pile caps provided for piers supporting superstructure.	PSC Voided Slab	Elliptical hammer headed pier	Pile foundation with 1.2m dia piles
0+268	0+368			2-lane road way on structure portion with single span of 20.0m. Isolated pile caps provided for piers supporting superstructure.	PSC Voided Slab	Elliptical hammer headed pier	Pile foundation with 1.2m dia piles
0+368	0+384	Light House	16	2-lane road way on structure portion with single span of 16.0m. Isolated pile caps provided for piers supporting superstructure.	PSC Voided Slab	Elliptical hammer headed pier	Pile foundation with 1.2m dia piles

Stretch		Location	Distance(m)	Description	Superstructure	Substructure	Foundation
Start	End						
0+384	0+400		16	2-lane road way on structure portion with single span of 16.0m. Isolated pile caps provided for piers supporting superstructure. The horizontal profile is in curve.	PSC Voided Slab	Elliptical hammer headed pier	Pile foundation with 1.2m dia piles
0+400	0+460		60	2-lane road way on structure portion with three spans of 20.0m each. Isolated pile caps provided for piers supporting superstructure. The horizontal profile is in curve.	PSC Voided Slab	Elliptical hammer headed pier	Pile foundation with 1.2m dia piles
0+460	0+520		60	2-lane road way on structure portion with three spans of 20.0m each. Isolated pile caps provided for piers supporting superstructure.	PSC Voided Slab	Elliptical hammer headed pier	Pile foundation with 1.2m dia piles
			17.125	2-lane road way on structure portion with single span of 17.125m. Isolated pile caps provided for piers supporting superstructure.	PSC Voided Slab	Elliptical hammer headed pier	Pile foundation with 1.2m dia piles
0+520	0+537.125	Light House	17.125	2-lane road way on structure portion with single span of 17.125m. Isolated pile caps provided for piers supporting superstructure.	PSC Voided Slab	Elliptical hammer headed pier	Pile foundation with 1.2m dia piles
RAMP-2							
0+165	0+180	Light House	15	2-lane road way on structure portion with one spans of 15.0m. Isolated pile cap provided for piers supporting superstructure.	PSC Voided Slab	Elliptical hammer headed	Pile foundation with 1.2m dia

Stretch		Location	Distance(m)	Description	Superstructure	Substructure	Foundation
Start	End						
0+180	0+360		180	2-lane road way on structure portion with nine spans of 20.0m each. Isolated pile caps provided for piers supporting superstructure.	PSC Voided Slab	Elliptical hammer headed pier	Pile foundation with 1.2m dia piles
0+360	0+420		60	2-lane road way on structure portion with three spans of 20.0m each. Isolated pile caps provided for piers supporting superstructure. The horizontal profile is in curve.	PSC Voided Slab	Elliptical hammer headed pier	Pile foundation with 1.2m dia piles
0+420	0+540		120	2-lane road way on structure portion with six spans of 20.0m each. Isolated pile caps provided for piers supporting superstructure.	PSC Voided Slab	Elliptical hammer headed pier	Pile foundation with 1.2m dia piles
0+540	0+555	Light House	15	2-lane road way on structure portion with single span of 15.0m. Isolated pile caps provided for piers supporting superstructure. The horizontal profile is in curve.	PSC Voided Slab	Elliptical hammer headed pier	Pile foundation with 1.2m dia piles
0+555	0+570.675		15.675	2-lane road way on structure portion with single span of 15.675m. Isolated pile caps provided for piers supporting superstructure. The horizontal profile is in curve	PSC Voided Slab	Elliptical hammer headed pier	Pile foundation with 1.2m dia piles
RAMP-3							
2+155	1+910	Mullimaa Nagar	15	2-lane road way on structure portion with single span of 15.0m. Isolated pile caps provided for piers supporting superstructure	PSC Fish Belly type box	Elliptical hammer headed pier	Pile foundation with 1.2m dia piles

Stretch		Location	Distance(m)	Description	Superstructure	Substructure	Foundation
Start	End						
1+910	1+895	Mullimaa Nagar	14	2-lane road way on structure portion with single span of 14.0m. Isolated pile caps provided for piers supporting superstructure	PSC Fish Belly type box	Elliptical hammer headed pier	Pile foundation with 1.2m dia piles
1+895	1+881		14	2-lane road way on structure portion with single span of 14.0m. Isolated pile caps provided for piers supporting superstructure	PSC Fish Belly type box	Elliptical hammer headed pier	Pile foundation with 1.2m dia piles
RAMP-4							
1+910	2+225	Mullimaa Nagar	315	2-lane road way on structure portion with nine spans of 35.0m. Isolated pile caps provided for piers supporting superstructure	PSC Fish Belly type box	At Ch: 1+9+10 Trestle abutment, Elliptical hammer headed pier	Pile foundation with 1.2m dia piles
RAMP-5							
2+645	2+820	Srinivasa Puram	35	2-lane road way on structure portion with five spans of 35.0m. Isolated pile caps provided for piers supporting superstructure	PSC I Girder	Elliptical hammer headed pier	Pile foundation with 1.2m dia piles

Stretch		Location	Distance(m)	Description	Superstructure	Substructure	Foundation
Start	End						
2+820	2+845		25	2-lane road way on structure portion with single span of 25.0m. Isolated pile caps provided for piers supporting superstructure	PSC I Girder	Elliptical hammer headed pier	Pile foundation with 1.2m dia piles
2+845	2+869		24	2-lane road way on structure portion with single span of 25.0m. Isolated pile caps provided for piers supporting superstructure	PSC I Girder	Elliptical hammer headed pier	Pile foundation with 1.2m dia piles
2+869	2+894		25	2-lane road way on structure portion with single span of 25.0m. Isolated pile caps provided for piers supporting superstructure	PSC I Girder	Elliptical hammer headed	Pile foundation with 1.2m dia
2+894	2+924		30	2-lane road way on structure portion with two spans of 15.0m each. Isolated pile caps provided for piers supporting superstructure	PSC Voided Slab	Elliptical hammer headed pier	Pile foundation with 1.2m dia piles
2+924	2+941		17	2-lane road way on structure portion with single span of 17.0m. Isolated pile caps provided for piers supporting superstructure	PSC Voided Slab	Elliptical hammer headed pier	Pile foundation with 1.2m dia piles
2+941	2+959		18	2-lane road way on structure portion with single span of 18.0h. Isolated pile caps provided for piers supporting superstructure	PSC Voided Slab	Elliptical hammer headed pier	Pile foundation with 1.2m dia piles

Stretch		Location	Distance(m)	Description	Superstructure	Substructure	Foundation
Start	End						
2+959	2+976		17	2-lane road way on structure portion with single span of 17.0h. Isolated pile caps provided for piers supporting superstructure	PSC Voided Slab	Elliptical hammer headed pier	Pile foundation with 1.2m dia piles
2+976	3+000		24	2-lane road way on structure portion with single span of 24.0h. Isolated pile caps provided for piers supporting superstructure	PSC Voided Slab	Elliptical hammer headed pier	Pile foundation with 1.2m dia piles
RAMP-6							
2+576	2+820	Srinivasa Puram	245	2-lane road way on structure portion with seven spans of 35.0m. Isolated pile caps provided for piers supporting superstructure	PSC I Girder	Elliptical hammer headed pier	Pile foundation with 1.2m dia piles
2+820	2+845		25	2-lane road way on structure portion with single span of 25.0m. Isolated pile caps provided for piers supporting superstructure	PSC I Girder	Elliptical hammer headed pier	Pile foundation with 1.2m dia piles
2+845	2+869		24	2-lane road way on structure portion with single span of 24.0m. Isolated pile caps provided for piers supporting superstructure	PSC I Girder	Elliptical hammer headed pier	Pile foundation with 1.2m dia piles
2+869	2+894		25	2-lane road way on structure portion with single span of 25.0m. Isolated pile caps provided for piers supporting superstructure	PSC I Girder	Elliptical hammer headed pier	Pile foundation with 1.2m dia piles

Stretch		Location	Distance(m)	Description	Superstructure	Substructure	Foundation
Start	End						
2+894	2+924		30	2-lane road way on structure portion with two spans of 15.0m each. Isolated pile caps provided for piers supporting superstructure	PSC Voided Slab	Elliptical hammer headed pier	Pile foundation with 1.2m dia piles
2+924	2+941		17	2-lane road way on structure portion with single span of 17.0m. Isolated pile caps provided for piers supporting superstructure	PSC Voided Slab	Elliptical hammer headed pier	Pile foundatio with 1.2m di piles
2+941	2+959		18	2-lane road way on structure portion with single span of 18.0h. Isolated pile caps provided for piers supporting superstructure	PSC Voided Slab	Elliptical hammer headed pier	Pile foundati with 1.2m d piles
2+959	2+976		17	2-lane road way on structure portion with single span of 17.0h. Isolated pile caps provided for piers supporting superstructure	PSC Voided Slab	Elliptical hammer headed pier	Pile foundat with 1.2m d piles
2+976	3+000		24	2-lane road way on structure portion with single span of 24.0h. Isolated pile caps provided for piers supporting superstructure	PSC Voided Slab	Elliptical hammer headed pier	Pile founda with 1.2m piles
RAMP-7							
4+208	4+488	Besant Nagar	280	2-lane road way on structure portion with eight spans of 35.0m. Isolated pile caps provided for piers supporting superstructure	PSC I Girder	Elliptical hammer headed pier	Pile found with 1.2m piles

Stretch		Location	Distance(m)	Description	Superstructure	Substructure	Foundation
Start	End						
RAMP-8							
4+208	4+488	Besant Nagar	280	2-lane road way on structure portion with eight spans of 35.0m. Isolated pile caps provided for piers supporting superstructure	PSC I Girder	Elliptical hammer headed pier	Pile foundation with 1.2m dia piles

Preliminary foundation design is attached as Annexure 4.1 in this report.

4.14 Drawings

A separate drawing volume consist of following sets of drawings are given as Volume II Drawings are presented in drawing volume which is subdivided in to highways and structure. Detailed Plan and profile which shows proposed alignment along with existing details, proposed levels and geometric details are presented in drawing volume. Typical cross section, lane markings and sign boards, electrical arrangements, strip plan showing important features and land use along the alignment and junction drawings are also included in the drawing volume.

List of Drawings

Sl. No.	Drawing Number	Drawing Title
1	SE-1-00-001	LIST OF DRAWINGS
2	SE-1-00-002	KEY PLAN
		PLAN AND PROFILE
3	SE-1-23-001	PLAN AND PROFILE CH 0+000 - CH 1+000
4	SE-1-23-002	PLAN AND PROFILE CH 1+000 - CH 2+000
5	SE-1-23-003	PLAN AND PROFILE CH 2+000 - CH 3+000
6	SE-1-23-004	PLAN AND PROFILE CH 3+000 - CH 4+000
7	SE-1-23-005	PLAN AND PROFILE CH 4+000 - CH 4+7000
13	SE-1-23-RAMP-001	PLAN AND PROFILE - RAMP RAMPS AT STARTING, FORESHORE & BESANT NAGAR
		TYPICAL CROSS SECTIONS
14	SE-1-30-001	TYPICAL CROSS SECTIONS
		JUNCTION IMPROVEMENTS
15	SE-1-40-001	PROPOSED JUNCTION IMPROVEMENT AT FORESHORE ESTATE (CH 2+400)
16	SE-1-40-002	PROPOSED JUNCTION IMPROVEMENT BESANT NAGAR JUNCTION
		INTERCHANGE DRAWINGS
16	SE-1-40-003	INTERCHANGE ARRANGEMENTS OVER ADYAR ESTURARY
		STANDARD DRAWINGS
17	SE - 1-90-001	KERB AND DRAIN
18	SE - 1-90-002	ROAD MARKING AND KERB PAINTING
19	SE - 1-90-003	TRAFFIC SIGNS
20	SE - 1-90-003	TRAFFIC SIGNS
21	SE - 1-90-004	DETAILS OF LIGHT POLE
22	SE - 1-90-004	DETAILS OF LIGHT POLE
23	SE - 1-90-005	STREET LIGHT ARRANGEMENT DRAWING

4.15 CONCLUSION

The Consultants have proposed a link road from Light house to Kottivakkam to cater the hassle free traffic, bypassing busy lattice bridge road, Santhome high road and Kamaraj Road. Special care has been taken in to account for not disturbing the beach scenery and activities of people residing in kuppams. Entry and exit ramps are provided at Foreshore estate link road, Besant Nagar and Elliot's Beach near Ashtalakshmi Temple. It is proposed to implement the project into two phases with Phase I from Light House to Besant Nagar.

Chapter 5: Environmental Impact Assessment & Environmental Management Plan.

Contents

Table List

Figure List

5 ENVIRONMENTAL IMPACT ASSESSMENT AND ENVIRONMENTAL MANAGEMENT PLAN

5.1. 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 mitigaitive measures for each of the identified impact.

The screening exercise thus broadly, involves the preparation of environmental profile of the project area through detailed field inventories and investigations and evaluation of the project proposals. These reconnaissance surveys and field investigations were aimed at determining the environmental and social features such as meteorology, geology, hydrology, ecology, soil characteristics, land use and other demographic features of the project area. In addition to the above, a detailed inventory of the population, built up areas, sensitive features specific to the area on both sides of the project road, was also recorded.

Based on the primary and secondary data generated in the screening phase of the study, various impacts on the environmental components of the project area were identified in the assessment phase of the study and appropriate mitigitive measures were proposed.

5.2. Objectives of the Study

The phase one project is an elevated road network from its starting point at 0+000 km till 4/200 km and proposed ramp structures from 4+208 km till 4+700 km in the proposed Santhome bypass. The stretch falls within the CRZ II regulation zone and hence it is required to obtain the environmental clearance from MoEF. The alignment of this stretch is presented in **Figure 5.1**. 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

5.3. Scope of Environmental Impact Assessment

Environmental Impact Assessment would address the impact due to the project on either side of the Phase I stretch of the Santhome bypass and impacts assessed for a 100 m corridor.

The broad scope of the study include:

- To conduct a literature review and to collect additional data relevant to the study area;
- To undertake environmental monitoring so as to establish the baseline environmental status of the study area;
- To assess the impacts on environmental attributes due to the construction and operation of the proposed work.
- To prepare an Environmental Management Plan (EMP) outlining the measures for improving the environmental quality and budgetary cost estimation for implementation;
- To identify critical environmental attributes required to be monitored subsequent to the implementation of the proposed project

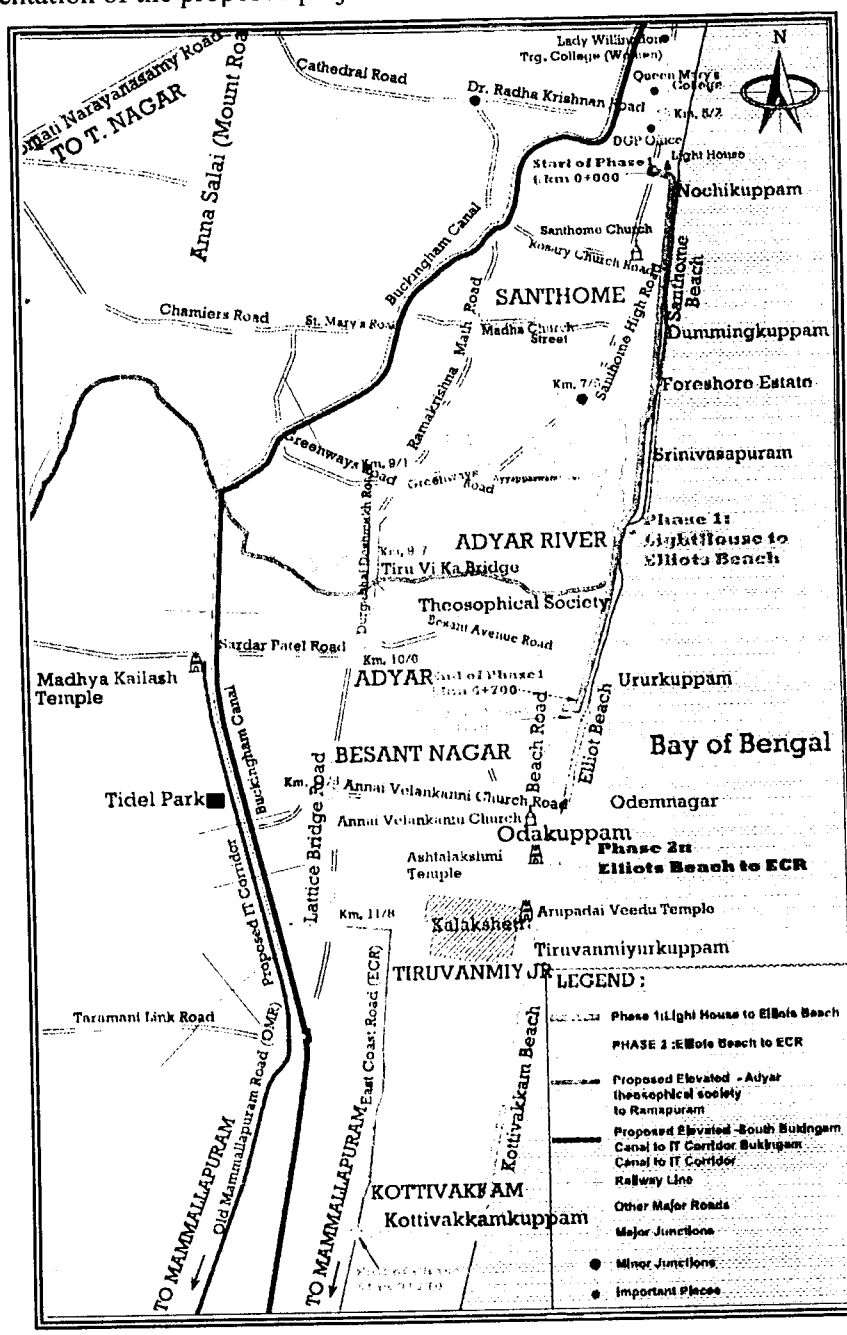


Figure 5.1. Proposed Bypass Alignment along the Coast under Phase I and Phase II

5.4. Study Approach

In order to accomplish the above objectives, studies were organised in line with the guidelines stipulated by the Ministry of Environment and Forests (MoEF), Government of India, for environmental impact assessment of highway projects.

Task 1 Field Reconnaissance Survey and Review of Earlier Studies

The approach to the entire study was formulated based on a detailed field reconnaissance survey and thorough understanding of the proposed project. The reconnaissance survey was carried out for the project road to understand the salient environmental features of the project area, sensitive areas with regards to the proposed project activities, and general understanding of the proposed project. Reports of previous studies were studied to obtain a clear understanding of the project activities.

Based on the above an environmental profile of the project area, primary and secondary data requirements for carrying out further activities of the study, environmental surveys necessary for assessing the project impacts, and the project influence area were identified.

Task 2 Review and Assessment of Applicable Environmental Regulations

Discussions with the pollution control board authorities and review of the various regulations and guidelines for EIA were conducted to assess the sampling and analysis requirements for the project and the procedural requirements for conducting an EIA. This primarily comprised of reviewing all relevant documents and studies available for the project area.

Task 3 Delineation of Study Area for Assessment

The above tasks identified the survey and analysis requirements for assessing the impacts of the proposed project activities. Based on which, the study area that is critical for assessing the project impacts was identified and delineated. While the influence area varies for each of the environmental component, the study area was considered as 100 m wide corridor (50 m either side of the centre line of the road).The project influence area also considered those areas that are directly or indirectly influenced by the project activities during construction or operation of the proposed road work.

Task 4 Assessment of Base Line Environmental Conditions

This task comprised of field surveys for assessing the baseline environmental conditions and collecting secondary information regarding physical, biological and socio-economic conditions of the study area. In addition, existing environmental quality of the study area was assessed based on the field environmental monitoring surveys. For monitoring the air, noise, surface and ground water, and soil quality, monitoring stations were set up and samples were collected and analyzed for relevant parameters.

Task 5 Prediction of Impacts

The task identified the likely future impacts through changes in the physical, biological or socio-economic environment based on the analysis of the base line environmental data collected in the earlier tasks. The assessment considered both positive and negative impacts due to the project and also due to the construction, and operation and maintenance of the road.

Task 6 Environment Management and Monitoring Plan

The major components of the environment management plan comprised preparation of mitigation plan for all the negative impacts identified in the earlier tasks to avoid, minimise or compensate the impacts, and the post-project monitoring plan for the measures suggested in the management plan to ensure that the impacts of the project are within the regulatory standards.

5.5. Baseline Environmental Status

An Environment Impact Assessment (EIA) study includes identification, prediction and evaluation of the potential impacts of a proposed project on the environmental quality within the study area. For the proposed road works, the following environmental components are identified as the major receptors of the project impacts, although not in the same order.

- Surface and ground water
- Ambient air
- Noise environment
- Land environment
- Terrestrial ecology
- Aquatic ecology
- Local socio-economy

The specific impacts have been assessed over a 100 m wide corridor with respect to the centreline of the proposed road whereas the study area for assessing broader environmental impacts is considered to be an area within 5 km on both the sides of the centre line of the proposed road. The baseline setting for the above-mentioned environmental components is documented and presented summarily. As mentioned earlier in the report initial environmental assessment suggests that Santhome bypass stretch falls under CRZ - II.

5.5.1 Data Collection

The present study being a Rapid EIA (REIA) study, the baseline data was collected for one season. Following tasks were undertaken by the Consultant for development of the baseline environmental scenario.

- Reconnaissance survey of the study area
- Field environmental monitoring for primary data generation
- Collection of available secondary data from government agencies and research institutes
- Review of reports of previous feasibility studies, Social assessment studies and Environmental assessment.
- Discussions with officials of State highways and officials of the concerned state departments

Primary data was collected during the study period to establish baseline scenario for micrometeorology, ambient air quality, noise levels, soil quality and water quality, in the month of April, 2006. In addition, the Consultant also collected data on the terrestrial ecology and socio-economy through secondary data. Moreover, the available secondary data on these environmental components and the socio-economic factors has been used to understand the baseline environmental status of the impact zone. The secondary data was collected from available literature including various technical reports, research papers, census data and discussions with the concerned government officials and local people.

5.5.2 Environmental Attributes Covered under the Study

The environmental parameters expected to be most significantly impaired by the project activities needs to be identified together with determining their existing status by direct observation and/or available records. Data on land use, meteorological conditions, sources of pollutants and local environmental conditions that influence the magnitude of the impacts primarily on sensitive receptors is obtained. This further delineates baseline status of the project area.

Table 5.1. Environmental Attributes Covered Under Field Studies

Attribute	Frequency / Coverage
Land Use Pattern	Keeping the Project area as core zone, a 100m wide corridor along the project road and a secondary impact area of 5 Km buffer zone was also taken for studying land use pattern
Meteorology	Wind speed and direction at one location continuously for one month using automatic Met station with monitoring frequency of 30 min.
Ambient air Quality SPM, RPM, SO2 and NOX CO, HC	24 hourly samples for SPM and RPM and 8 Hourly Samples for SO2 and NOX, CO, HC for two days a week and for four weeks including a Sunday at two locations. The locations are selected to cover the project area characteristics
Noise levels	Continuous noise level monitoring was done at two locations for a period of 24 hours to determine Leq values during day and night time.
Water quality	Samples were collected from surface and ground water at two locations and analysed for Physical, Chemical and Bacteriological parameters to provide the baseline status and assess impacts due to project on the water quality.
Ecology	Existing terrestrial and aquatic flora, fauna and endangered species along the stretch were listed.
Soil Quality	Two samples were collected along the proposed project road and analysed for various parameters to establish the baseline conditions.

In addition, secondary data was also collected to supplement the field data, as mentioned in **Table 5.2.**

Table 5.2. Environmental Attributes Covered under Secondary Data

Attribute	Coverage
Land use	Landuse pattern information are collected from Statistical and District Information Centre
Meteorology	Published meteorological data for a period of 10 years is obtained form IMD (Indian Meteorology Department), Chennai

Attribute	Coverage
Water quality	Secondary data on ground water quality was collected from office of Central Ground Water Board.
Ecology	Listing of species for flora and fauna in the general study area was done based on the published secondary data from Department of Environment and Forest, Saidapet.
Socio-economic aspects.	Socio-economic aspects and general demographic characteristics were compiled from secondary data.
Geology	Geology profile for the project area is collected from the secondary data obtained from CGWB, PWD and published literatures.
Hydrology	Groundwater and surface water details are collected from Institute for water studies, Chennai
Industrial Data	Field observation was used to Identify the existing industries along the project corridor

5.5.3 Land Environment

5.5.3.1 Land use

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.

5.5.3.2 Soil Quality

Soil characteristics depend on the geo-morphology and climatology of the area as well characteristices of the parent material, relief and time. Soil analysis is required to assess the plantation and afforestation potential of the soil. The study area is covered by soil made up of clay brought by rivers and mixed with shale and fine sand with grey and dark grey in colour.

In order to assess the soil quality of the study area, soil sampling and analysis were carried out at two locations **(Figure 5.2)** along the stretch. The details of the sampling locations are given in **Table 5.3**. At each location, soil samples were collected from three different depths viz. 30 cm, 60 cm and 100 cm below the surface and were mixed to prepare composite sample. The soil samples were then analysed for the parameters responsible for the fertility of the soil. The results of soil analysis are given in **Table 5.4**. The results are compared with standard classification given in **Table 5.5**.

Table 5.3. Details of Soil Sampling Locations

Location Code*	Description
S 1	Light House – Opposite To Commissioner Office
S 2	Besant Nagar – Near the Besant Nagar Church

The collected soil samples were analysed and the results are presented in **Table 5.4**

Table 5.4. Soil Sampling Results

Parameters	S1	S2
Texture	Sandy loam	Sand Clay Loam
pH	8.22	8.62
Moisture content (%)	3.11	5.10
Organic Carbon (%)	0.321	0.463
Chlorides (Kg/ha)	48.3	62.1
Nitrogen (Kg/ha)	48	112
Phosphorous (Kg/ha)	12.0	17.0
Potassium (mg/100 gms)	90	247
Electrical Conductivity (m-mhos/cm)	0.085	0.113
Sodium Adsorption Ratio	1.12	0.79

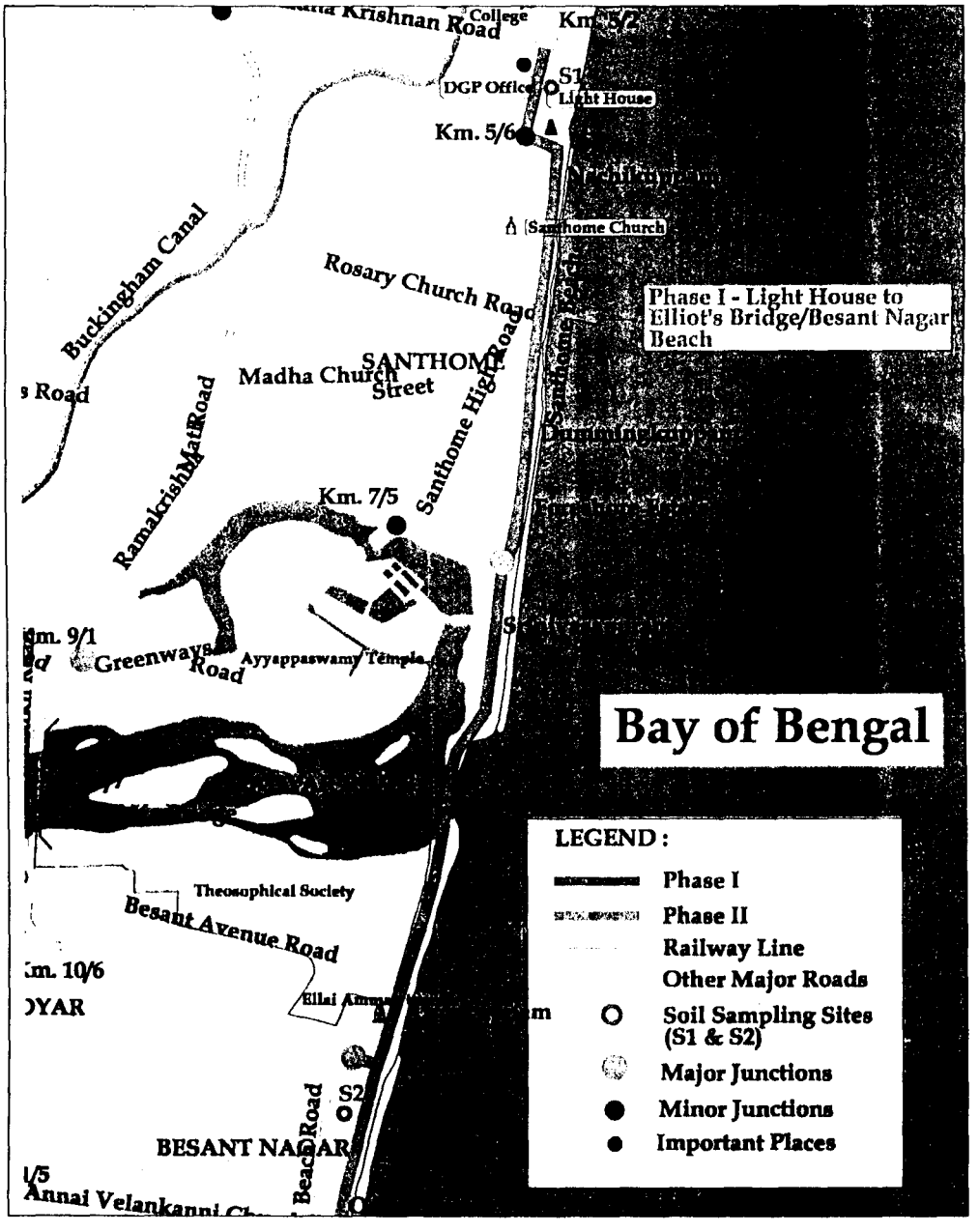


Figure 5.2. Soil Sampling Sites along the Proposed Alignment in Phase I

Table 5.5. Standard Soil Classification

Sl No.	Soil Test	Classification
1	pH	<4.5 Extremely acidic 4.51- 5.00 Very strongly acidic 5.51-6.0 moderately acidic 6.01-6.50 slightly acidic 6.51-7.30 Neutral 7.31-7.80 slightly alkaline 7.81-8.50 moderately alkaline 8.51-9.0 strongly alkaline 9.01 very strongly alkaline
2	Salinity Electrical Conductivity (mmhos/cm) (1mmho/cm = 640 ppm)	Upto 1.00 Average 1.01-2.00 harmful to germination 2.01-3.00 harmful to crops
3	Organic Carbon	Upto 0.2: very less 0.21-0.4: less 0.41-0.5 medium, 0.51-0.8: on an average sufficient 0.81-1.00: sufficient >1.0 more than sufficient
4	Nitrogen (Kg/ha)	Upto 50 very less 51-100 less 101-150 good 151-300 better >300 sufficient
5	Phosphorus (Kg/ha)	Upto 15 very less 16-30 less 31-50 medium, 51-65 on an average sufficient 66-80 sufficient >80 more than sufficient
6	Potassium (Kg/ha)	0 -120 very less 120-180 less 181-240 medium 241-300 average 301-360 better >360 more than sufficient

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

5.5.3.3. Geology, Hydrogeology and Hydrology

Study of Geology, Hydrogeology and Hydrology of the project area was through the data collected from the secondary sources such as Central Ground Water Board (CGWB) and Geological Survey of India. No primary survey was carried out. The information collected is presented in the following sections

Geology

The study area is predominantly covered by thick soil alluvium followed by Gondwana sediments viz. sand stone, shale and silt stone for which, the Archaean crystalline formation charnockite and granitic gneisses are basements. These litho units are dipping towards east and the thickness of formation varies from place to place.

The litho units, which persist in and around the study area, belong to Archaean to Recent geological system. No crystalline exposure is seen in and around the study area since it is covered by thick soil alluvium. The crystalline rocks which are in deeper levels are moderately weathered and fractured.

The presence of bedding joints, shears and micro folding are indicative of the extensive tectonic disturbance in the post Gondwana period. There is an erratic thickness of sand and silt layer, which could be fluvial in origin. The coastal areas have sand dunes and beach ridges resulting from the recent marine and fluvial interaction. The presence of shell bed at shallow depth is also an indication of old lagoon and marine regression activity

Hydrogeology

Ground water in study area occurs in almost all the geological formations and is extracted by means of ring wells, filter point wells and tube wells. Ground water potential of the area varies from place to place. The soil alluvium which is predominantly covered in the study area is highly porous and, forms a potential ground water zone. The discharge of the tube well and ring wells, which are sunk in this zone, is about 2 to 6 litres per second and 1 to 3 litres per second respectively.

Ground water occurs in water table and semi-confined to confined conditions in the porous alluvial formations. Gravels, coarse to fine sands, clay and silty clay constitute the alluvial material, and of these, the gravels and sands form potential aquifers. The moderate ground water yielding zones occurs under semiconfined condition in tertiary sandstones and shales, which are less weathered and fractured. Ground water occurs in water table condition and confined condition in Gondwana sand stones. The shales and clays are highly consolidated and fractured and act like weathered crystallines. Moderate yield is obtained by tapping this zone.

In deeper zones i.e. in crystalline formations, which are heterogeneous in nature and forms semi confined aquifer, ground water is available. The average yield of the bore wells which are sunk in this zone is 1 to 3 liters per second. Different hydrogeological studies were made by CGWB and the brief information is given below. Rainfall is the major source of recharge to the phreatic aquifer and the water level fluctuations are in response to recharge and draft. The study indicates that generally the water table is shallow in November-January period and is deeper in May-August period.

The depth to water level varies from season to season. The depth to water level in pre-monsoon period ranges between 1.15 and 7.93 m below ground level, where as it is shallow in the range of 0.15 and 5.63 m below ground level in post monsoon period. The over development of beach aquifer had led to lowering of the water table below mean sea level, which may possibly lead to the inland movement of the fresh water –sea water interface. The water table elevation varies from 3.49 m above MSL to 2.2 m below MSL.

5.5.4 Water Environment

This section describes the hydrology and baseline quality of the surface and ground water bodies of the study area.

Hydrology

The study area is influenced by coastal hydrodynamics of river -sea interface. Adyar is a short and Non-perennial River of about 42 km length, originating near the Chemberambakkam tank, flows through the industrial and residential areas of the city and confluences with the Bay of Bengal at Foreshore Estate. This river is rain fed, flows only for about two to three months in a year during northeast monsoon season. The flow in this river mainly includes discharge of domestic wastewater and effluent through several outfalls during rest of the year, leaving the waterway as a storage basin for wastewater. Industries such as Indian Drug and pharmaceuticals, Guindy Industrial Estate, Hindustan Tele printers, Standard Battery and hospitals, release their waste into the river. Untreated or partially treated hospital wastes contribute most, to the entry of certain pathogenic organisms into the river. This poses major health hazards to the coastal population and the aquatic organisms. Continuous deposition of sediments at the mouth of the river leads to stagnation of water body, thus converting the river into a mosquito breeding ground. The river and canal is influenced by tidal action and backwater enters upto 3 to 4 km during high tide.

Water Quality

Understanding the water quality of the project area is an integral part of Environmental Impact Assessment to identify critical issues with a view to suggest appropriate mitigation measures for implementation. Water samples were collected from the project area to represent the baseline condition. Water samples from Adyar Estuary and Adyar creek are collected and analysed for the surface water quality. Details of surface water sampling locations are given in **Table 5.6**. Even though impact on ground water is not envisaged in the proposed road work, two groundwater samples were collected from bore wells to get the existing status of ground water quality. Details of water sampling locations are given in **Table 5.7**. In the study area ground water is tapped at different places. Ground water quality of the area is influenced by a complex system of marine water, pollutants and over exploitation of ground water. The surface water and ground water sampling locations are presented in **Figure 5.3** respectively.

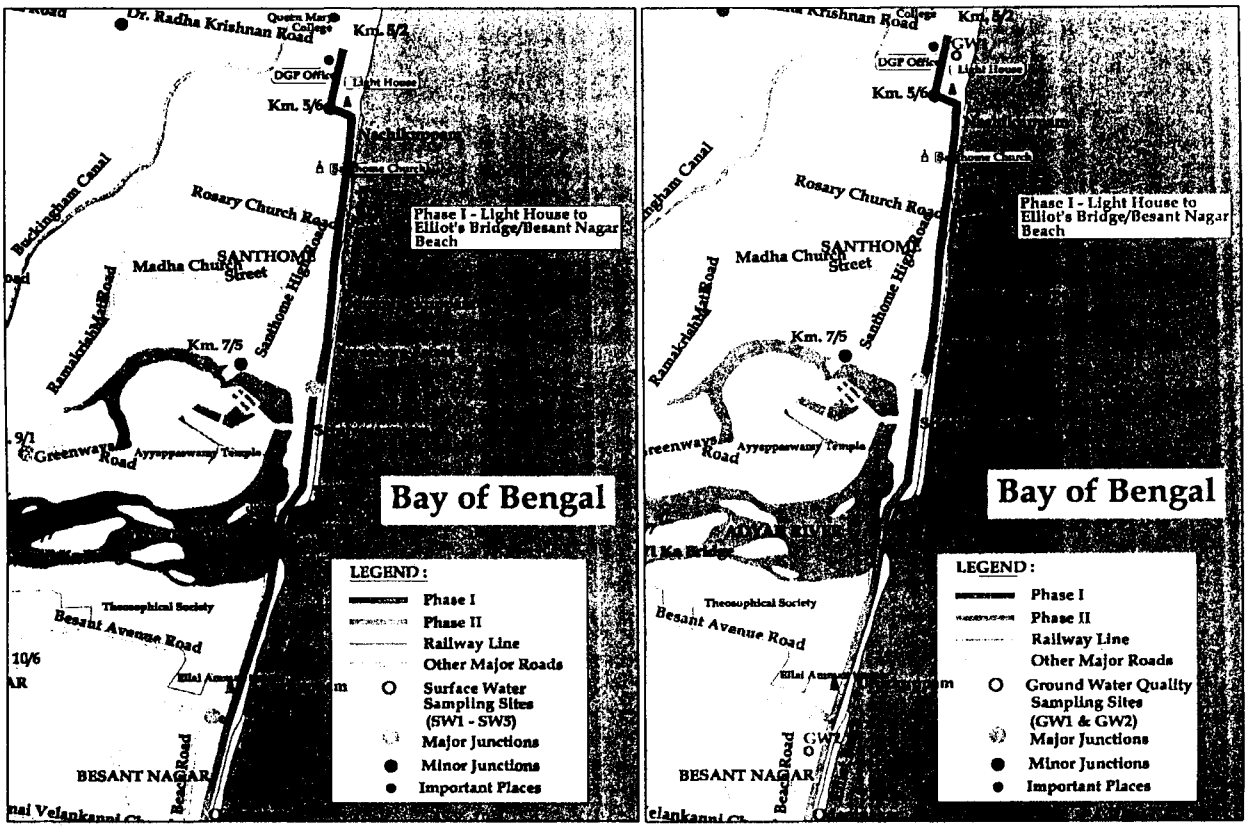


Figure 5.3. Surface Water and Ground Water Sampling Sites

As part of this study, the following assessments were done:

- Assessment of the existing water quality characteristics for critical parameters;
- Evaluation of the impacts on habitat conditions, recreational resources and aesthetics in the vicinity; and
- Assessment of the impact on water quality by the construction of road and related activities.

Table 5.6. Details of Surface Water Sampling Locations

Location Code*	Description/Observations
SW1	0.5 km from the river mouth (in the river).
SW2	In the mouth of the river.
SW3	0.5 km from the river mouth (in the sea).
SW4	0.5 km north of SW3 (in the sea).
SW5	0.5 km south of SW3 (in the sea).

* SW – Surface water

Table 5.7. Details of Ground Water Sampling Locations

Location Code*	Description/Observations
GW 1	Bore well water near the Light House was collected which is used for Drinking purpose
GW 2	Open well water was collected near the Besant Nagar residential place

* GW – Ground water

The collected samples have been analysed as per the procedure specified in "Standards Methods for the Examination of Water and Wastewater" published by American Public Health Association (APHA).The ground water quality has been compared with the Indian Drinking Water Quality Standards IS:10500 given in **Table 5.8**

Table 5.8. Standard Drinking Water - Specification (BIS 10500: 1991)

Sl No.	Substance or Characteristic	Unit	Requirement (Desirable Limit)	Permissible Limit in the Absence of Alternate Source
1	Colour, Max	Hazen units	5	25
2	Odour		Unobjectionable	Unobjectionable
3	Taste		Agreeable	Agreeable
4	Turbidity, Max	NTU	5	10
5	pH Value		6.5 to 8.5	No Relaxation
6	Total Hardness (as CaCo3) Max	mg/l	300	600
7	Iron (as Fe) Max	mg/l	0.3	1.0
8	Chlorides (as Cl) Max.	mg/l	250	1000
9	Residual, free chlorine, Min	mg/l	0.2	--
10	Desirable Characteristics			
11	Dissolved solids, Max	mg/l	500	2000
12	Calcium (as Ca), Max	mg/l	75	200
13	Copper (as Cu), Max	mg/l	0.05	1.5
14	Manganese (as Mn), Max	mg/l	0.10	0.3
15	Sulfate (as SO4), Max	mg/l	200	400
16	Nitrate (as NO3), Max	mg/l	45	100
17	Fluoride (as F), Max	mg/l	1.9	1.5
18	Phenolic Compounds (as C6H5OH), Max.	mg/l	0.001	0.002
19	Mercury (as Hg), Max	mg/l	0.001	No relaxation
20	Cadmiun (as Cd), Max	mg/l	0.01	No relaxation
21	Selenium (as Se), Max	mg/l	0.01	No relaxation
22	Arsenic (as As), Max	mg/l	0.05	No relaxation
23	Cyanide (as CN), Max	mg/l	0.05	No relaxation
24	Lead (as Pb), Max	mg/l	0.05	No relaxation
25	Zinc (as Zn), Max	mg/l	5	15
26	Anionic detergents (as MBAS), Max	mg/l	0.2	1.0
27	Chromium (as Cr6+), Max	mg/l	0.05	No relaxation
28	Polynuclear aromatic hydro carbons (as PAH), Max	g/l	--	--
29	Mineral Oil, Max	mg/l	0.01	0.03
30	Pesticides, Max	mg/l	Absent	0.001
31	Radioactive Materials			
32	i. Alpha emitters, Max	Bq/l	--	0.1
33	ii. Beta emitters, Max	pci/l	--	1.0
34	Alkalinity. Max	mg/l	200	600
35	Aluminium (as Al), Max	mg/l	0.03	0.2
36	Boron, Max	mg/l	1	5

Table 5.9. Surface water Analysis Results

Sl. No.	Parameters	Unit	SW 1	SW 2	SW 3	SW 4	SW 5
1	pH		8.38	8.3	8.27	8.36	8.35
2	Temp	°C	26.9	26.6	26.5	26.6	26.7
3	D.O	mg/L	5.17	5.2	6.01	6.54	6.15
4	salinity	mg/L	27.2	28.9	30.4	29.8	30.1
5	turbidity	NTU	1.85	2	4.13	4.56	4.62
6	chloride	mg/L	13342.2	13668.9	14836.71	14751	15506.3
7	phosphate	mg/L	93	84	77	78	75
8	nitrate	mg/L	77	58	35	32	37
9	BOD	mg/L	63	52	30	35	35

From the analysis of the surface water, it is evident that the water is alkaline and presence of high chloride concentration represents the characteristics of typical sea water. The DO concentration is low in the SW 1 and SW 2; this is due to the presence of the organic pollution in the river water. BOD concentration is found to be high in the Adyar River at SW 1 and SW 2; due to the high pollution concentration.

Table 5.10. Ground Water Analysis Results

Sl. No.	Parameters	Unit	GW 1	GW 2
1	pH	Mg/L	7.35	7.80
2	Colour	NTU	5	<5
3	Total Dissolved Solids	Mg/L	1922	1025
4	Total Suspended Solids	Mg/L	11	10
5	Oil & Grease	Mg/L	-Nil-	-Nil-
6	BOD (3 days at 270C	Mg/L	3	2
7	COD	Mg/L	39	30
8	Dissolved Oxygen	Mg/L	3.4	3.3
9	Total Hardness as CaCO3	Mg/L	1030	434
10	Chlorides as Cl	Mg/L	810	294
11	Sulphates as SO4	Mg/L	112	83
12	Fluorides as F	Mg/L	0.18	0.17
13	Sodium as Na	Mg/L	196	141
14	Potassium as K	Mg/L	23	16
15	Iron as Fe	Mg/L	0.33	0.27
16	Manganese as Mn	Mg/L	0.01	<0.01
17	Total Coliform	MPN/ 100ml	-Nil-	-Nil-
18	Faecal Coliform	MPN/ 100 ml	-Nil-	-Nil-

High concentration of total hardness is recorded for the two stations, the concentration exceed the limitation prescribed by IS 10500 standard for drinking water. All other parameters are well within the drinking water standard.

5.5.5 Air Environment

This section documents the baseline scenario of the ambient air environment in the study area. The baseline scenario is established based on the micrometeorology and ambient air quality monitoring carried out in the study area.

5.5.5.1. Climate and Rainfall

The project area has a hot and humid climate, which can be termed as tropical maritime monsoon type. The temperature is always on the higher side and it is being compensated to a considerable degree due to the proximity to the coast.

The winter season sets in during the month of December and continues till end of February. Winter is followed by the summer season which starts from February and continues till May. Temperature is very hot and humid during this period. Occasional summer showers with gusty wind and lightning are a characteristic of this season. The North-East Monsoon commences in October, dry weather setting in by the end of December.

The area receives the maximum rainfall from the North East Monsoon. The minimum rainfall ranges from 6mm - 10mm in the month of February and Maximum rainfall of around 320mm is recorded in the month of November with an annual average of 1215 mm.

The minimum temperature ranges from 210C to 240C in the month of December to February and maximum temperature recorded 370C in the month of May. Mean relative humidity is high through out the year, and varies from 65% in May-July to 80% in October – December.

5.5.5.2. Micrometeorology

Micro-meteorological data for the study area was collected from the India Meteorological Department's (IMD). In addition to the secondary data, the field monitoring data collected in the month of April and May 2006 was used for assessing the baseline meteorological conditions in the study area. For this purpose, one meteorological monitoring station was fixed in the project area so as to get representative data. Hourly maximum, minimum and average values of wind speed, wind direction, relative humidity, temperature and solar radiation, cloud cover were recorded continuously at the site. The summarised daily results of the micrometeorological monitoring are given in **Table 5.11**

Table 5.11. Meteorology observation along the project corridor

Sl.no	Date of Sampling	Wind velocity (Km/Hr)		Wind Direction (Km/Hr)	Temp °C		Relative Humidity (%)		Cloud Cover (Oktas)	Rainfall (mm)
		Min	Max		Min	Max	Min	Max		
1	15/04/05	3.2	16.8	SW	27.50	39.00	46.0	82.0	clear	0
2	16/04/05	1.9	12.8	SW	28.00	38.50	41.0	83.0	clear	0
3	17/04/05	2.5	13.8	SW	29.00	38.50	41.0	82.0	clear	0
4	18/04/06	2.9	15.5	SW	29.00	39.00	42.0	82.0	clear	0
5	19/04/06	3.9	10.3	SW	29.00	38.50	40.0	79.0	clear	0
6	20/04/06	3.8	11.4	SW	29.00	39.00	41.0	81.0	clear	0
7	21/04/06	3.6	13.1	SW	29.00	38.50	40.0	80.0	clear	0
8	22/04/06	2.9	11.2	SW	28.50	38.50	42.0	80.0	clear	0
9	23/04/06	3.1	13.2	SW	28.50	38.00	41.0	80.0	clear	0
10	24/04/06	3.0	12.6	SW	26.5	36.5	41.0	81.0	clear	0
11	25/04/06	3.1	12.5	SW	28.5	38.5	41.0	82.0	clear	0
12	26/04/06	1.9	8.4	SW	28.0	38.5	43.0	80.0	clear	0

Sl.no	Date of Sampling	Wind velocity (Km/Hr)		Wind Direction (Km/Hr)	Temp °C		Relative Humidity (%)		Cloud Cover (Oktas)	Rainfall (mm)
		Min	Max		Min	Max	Min	Max		
13	27/04/06	3.0	11.1	S	28.5	37.5	40.0	80.0	clear	0
14	28/04/06	3.6	11.8	SW	28.0	38.0	44.0	79.0	clear	0
15	29/04/06	2.4	10.1	SW	28.5	39.0	41.0	79.0	clear	0
16	30/04/06	2.4	8.4	SW	28.5	38.0	40.0	79.0	clear	0
17	01/05/06	2.5	8.1	SW	28.5	38.5	40.0	78.0	clear	0
18	02/05/06	2.1	15.1	SW	29.0	38.5	39.0	79.0	clear	0
19	03/05/06	2.1	7.8	SW	27.0	38.0	40.0	78.0	clear	0
20	04/05/06	2.2	10.3	SW	27.5	38.5	46.0	80.0	clear	0
21	05/05/06	2.4	8.3	W	27.0	38.0	38.0	81.0	clear	0
22	06/05/06	2.2	8.0	SSW	27.0	37.5	40.0	82.0	clear	0
23	07/05/06	3.1	14.5	SW	27.5	37.0	42.0	80.0	clear	0
24	08/05/06	2.0	13.3	W	27.0	38.0	38.0	77.0	clear	0
25	09/05/06	2.8	12.3	WSW	27.0	38.0	37.0	77.0	clear	0
26	10/05/06	2.0	12.2	SSW	27.5	38.0	40.0	75.0	clear	0
27	11/05/06	2.3	12.5	S	27.0	38.5	38.0	78.0	clear	0
28	12/05/06	3.5	11.3	SW	27.0	39.0	36.0	79.0	clear	0
29	13/05/06	2.1	10.3	SW	28.0	39.0	40.0	78.0	clear	0
30	14/05/06	2.2	12.4	SSW	27.5	39.0	36.0	76.0	clear	0

From the results obtained, the minimum wind velocity ranges from 1.9 to 3.9 Km/Hr and maximum ranges from 7.8 to 16.8 Km/Hr. The minimum temperature ranges from 26.5°C to 29°C and maximum ranges form 36.5°C to 39°C respectively. Relative humidity shows a minimum range between 36 (%) to 46 (%) and a maximum of 75 (%) to 83 (%).

5.5.5.3. Ambient Air Quality (AAQ)

Major sources of air pollution in the study area are emissions from vehicular traffic, dust arising from the roads due to vehicular movement. A baseline air quality survey was carried out to assess the air quality of the area. Air quality of the study area is assessed by a network of Ambient Air Quality Monitoring (AAQM) stations. AAQM is also useful in assessing conformity to the standards of the ambient air quality during the operation of the road. The study zone for air quality includes regions up to approximately 500 meters from the project road.

The design of monitoring network in the air quality surveillance program has been based on the following considerations:

- Network of project roads
- Meteorological conditions
- Topography of the study area
- Likely impact areas

Location of AAQM stations was selected along the proposed stretch to represent the impact due to the road traffic. Accordingly the stations were selected considering residential, commercial and mixed development areas.

The AAQ was monitored for the following parameters.

- Suspended Particulate Matter (SPM)
- Respirable Particulate Matter (RPM)
- Sulphur di-oxide (SO2)
- Oxides of Nitrogen (NOx)
- Carbon monoxide (CO) and
- Hydrocarbons (HC)

List of the AAQM locations is given in **Table 5.12**. The monitoring locations are also shown in **Figure 5.4**. Summary of the baseline ambient air quality data in the study area is given in **Table 5.13**. The National Ambient Air Quality Standards (NAAQS) prescribed by CPCB are given in **Table 5.14**. The relevant standard values are also given in ambient air quality tables for easy reference

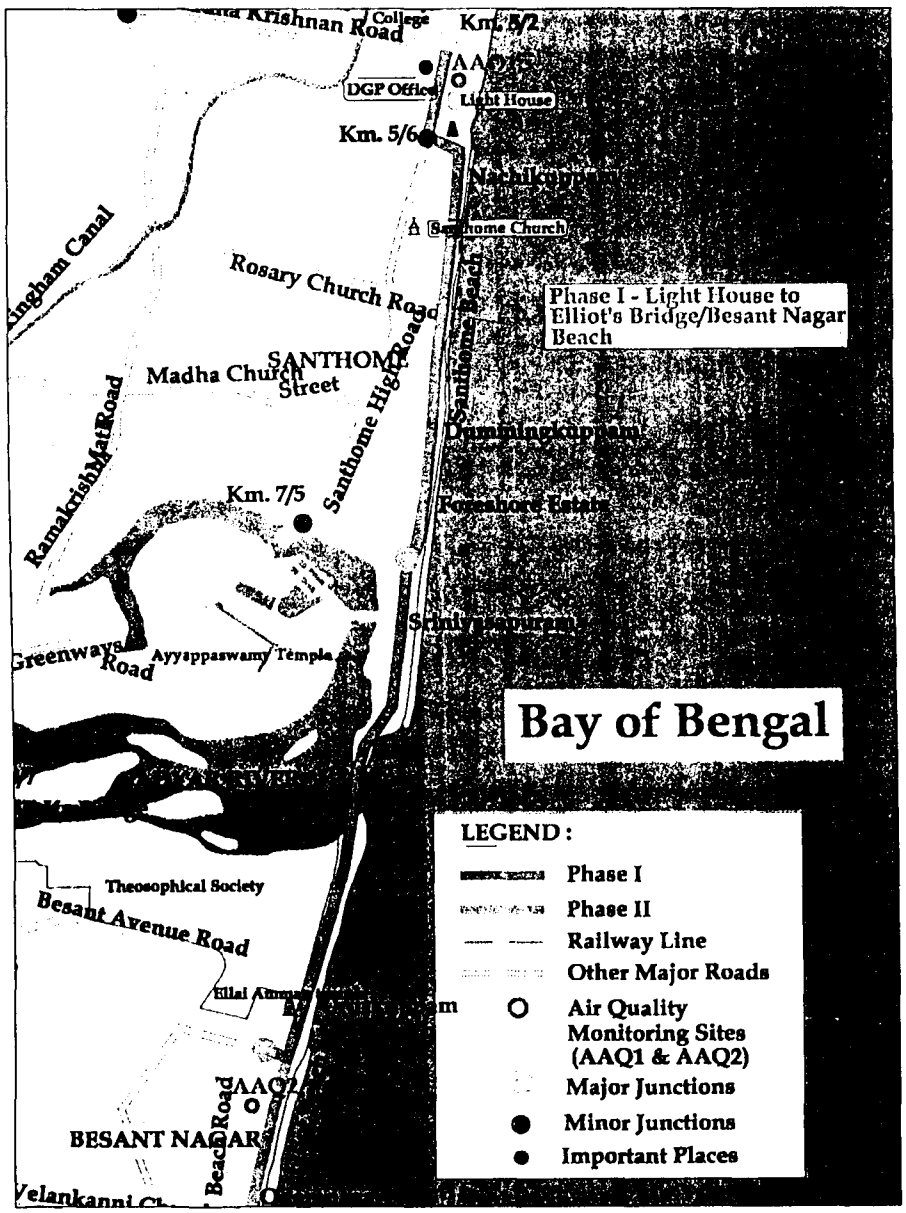


Figure 5.4. Ambient Air Quality Monitoring Sites

Table 5.12. Ambient Air Quality Monitoring (AAQM) Locations

Station Code	Location	Environmental setting
AQ -1	Light House (Santhome)	Residential / Commercial
AQ-2	Besant Nagar – Near the Besant Nagar Church	Residential / Commercial

Table 5.13. Summary of AAQM Results (Average Values)

Location	SPM	NOx	SO2	CO	HC
	µg/m3	µg/m3	µg/m3	ppm	ppm
Light House (Santhome)	155	10.78	7.9	<114.5	<65
Besant Nagar – Near the Besant Nagar Church	180	11.70	8.6	<114.5	<65

Table 5.14. National Ambient Air Quality Standards (CPCB, New Delhi, India)

Pollutant	Time weighted Average	Concentration in ambient air (µg/m3) unless otherwise specified			Measurement method
		Industrial area	Residential, Rural and Other areas	Sensitive area	
Suspended Particulate Matter (SPM)	Annual Average 1	360	140	70	High Volume Sampler,(average flow rate not less than 1.1 m3/min)
	24 hours 2	500	200	100	
Respirable Particulate Matter (RPM)	Annual Average	120	60	50	Respirable Particulate Matter Sampler
	24 hours	150	100	75	
Sulfur Dioxide (SO2)	Annual Average	80	60	15	Improved West and Gaeke method Ultraviolet fluorescence
	24 hours	120	80	30	
Oxides of Nitrogen (as NO2)	Annual Average	80	60	15	Jacob & Hochheiser modified (Na-Arsenite) method Gas phase chemiluminescenc
	24 hours	120	80	30	
Lead (Pb)	Annual Average	1	0.75	0.5	AAS Method after sampling using EPM 20006Y equivalent filter paper
	24 hours	1.5	1	0.75	
Carbon Monoxide (CO)	8 hours	5000	2000	1000	Non-dispersive Infrared technique
	1 hour	10000	4000	2000	

[1] Annual arithmetic mean of minimum 104 measurements in a year taken twice a week 24 hourly at uniform interval.

[2] 24 hourly/8 hourly values should be met 98% of the time in a year. However, 2% of the time it may exceed, but not on two consecutive days.

From the AAQ observation, it is inferred that Maximum TSPM concentration was recorded as 180 µg/m3 at AQ2 (Besant nagar) and also maximum concentration of SO2 and NOx is found as 8.6 µg/m3 and 11.7 µg/m3 respectively. CO is observed as less than 114.5 ppm for the two stations and HC as less than 65 ppm for the stations.

5.5.6 Noise

The main objective of noise monitoring in the study area is to establish the baseline noise levels in the different zones and assess the impact of the total noise expected to be generated by the proposed project in the surrounding community. Noise level monitoring has been conducted in the study area while considering that locations represent, commercial and residential zones. Noise monitoring was undertaken for 24 hours for three days at each location. The instrument used was an integrated sound level meter with attached out put device.

This section documents the baseline noise levels in the study area. In order to establish the baseline noise scenario, results of noise level monitoring carried out during the study period at two locations in the study area have been considered. These locations are given in **Table 5.15** and are also shown in **Figure 5.5.** The monitored noise level data is given in **Table 5.16**. Similarly, the ambient noise standards prescribed by the CPCB are given in **Table 5.17**.

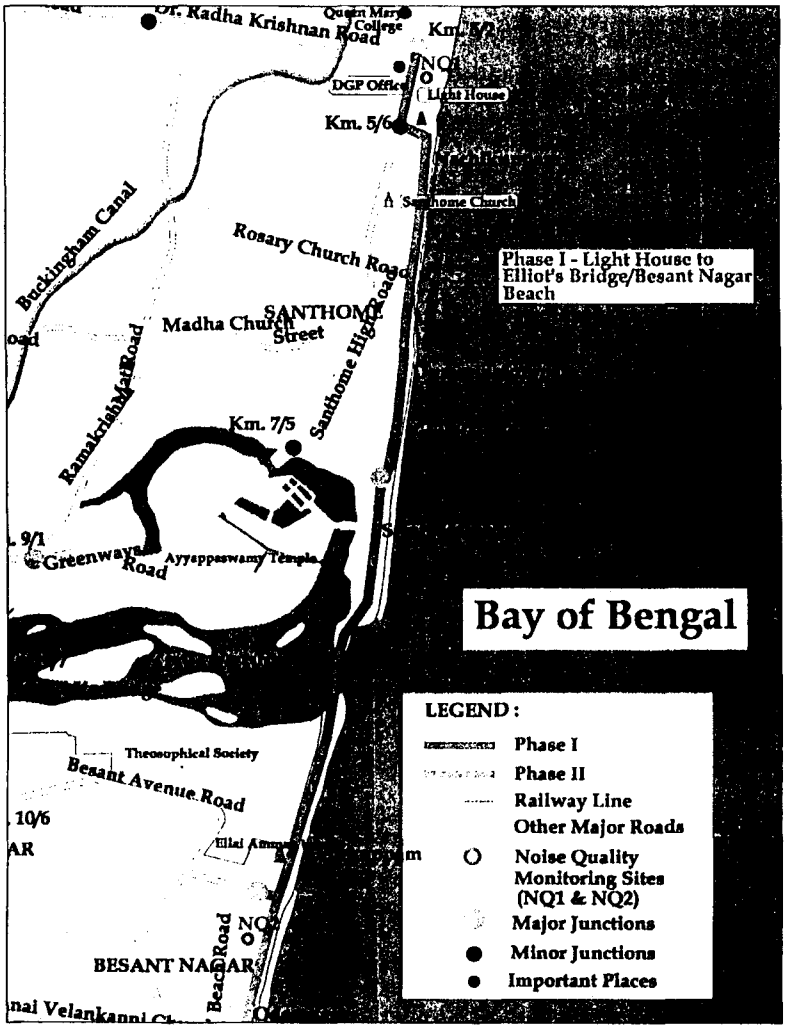


Figure 5.5. Noise Monitoring Sampling Sites

Table 5.15. Details of Noise Monitoring Locations

Sl.no	Location (Location Code)	Description
1	Light House (Santhome)	Residential / Commercial
2	Besant Nagar – Near the Besant Nagar Church	Residential / Commercial

Instrument for Noise monitoring was programmed to monitor noise levels in terms of Sound Pressure Levels. Hourly readings of L90, L50, L10, L eq and further L day (6 am to 9 pm), L night (9pm to 6 am), L dn were monitored and recorded.

- L10 is the noise level exceeded 10 per cent of the time;
- L50 is the noise level exceeded 50 per cent of the time; and
- L90 is the noise level exceeded 90 per cent of the time.

Using L90, L50, and L10 equivalent sound pressure levels (L eq) can be calculated. The L eq is the equivalent continuous sound level that is equivalent to the same sound energy as the actual fluctuating sound measured in the same period. This is necessary because sound from noise source often fluctuates widely during a given period of time. Each hour L eq is monitored by setting the instrument in the slow pulse mode, i.e. the recording interval and response time is set to 1 second. After 3600 recording (since the time interval set is one hour) the instrument calculates L eq, L 90, L 50 and L10 using standard integration technique.

- L day is defined as the equivalent noise level measured over a period of time during day (6 am to 9 pm).
- L night is defined as the equivalent noise level measured over a period of time during night (9 pm to 6 am).
- 24 hours L eq is calculated by logarithmically averaging the 24 values of hourly L eq.

Table 5.16. Noise Monitoring Observations

Location	Time	L eq	L 10	L 50	L 90	L max
Light House	Day	55.5	58.2	54.8	49.2	60.1
	Night	42.2	44.2	42.2	39.2	45.2
Besant Nagar	Day	48.6	52.3	47.2	45.2	54.6
	Night	41.2	43.6	41.2	38.2	45.1

The monitored noise levels are compared with the CPCB ambient noise standards presented in **Table 5.16.** All the locations monitored are reflecting the traffic noise being adjacent to the road. In such case the distance between road (noise source) and monitoring location is also a determining factor for ambient noise levels.

Monitored noise levels are presented in **Table 5.15.** The Leq in the range of 48.6 – 55.5 dB (A) in day time and 41.2 – 42.9 dB (A) in night time. The observations of the noise monitoring indicate that all the values are within the standards set by the CPCB.

Table 5.17. CPCB Ambient Noise Standards

Area Code	Category of Area	Limits in dB(A)	
		Day Time	Night-Time
(A)	Industrial area	75	70
(B)	Commercial area (C)	65	55
(C)	Residential area (R)	55	45
(D)	Silence zone	50	40

Note: Daytime is reckoned between 6 a.m. to 9 p.m and Night-time is reckoned between 9 p.m. to 6 a.m.

5.5.7 Aquatic Ecology

In order to study the aquatic ecology, surface water samples are collected from different location in the river and adjoining sea. The collected samples are preserved and analysed for the presence of the Phytoplankton and Zooplankton. The analysed results are shown in the **Tables 5.18 and 5.19.**

Table 5.18. Details of Phytoplankton Species in the surface water

Phytoplankton	River	River Mouth	Sea
Anabaena sp.	S	A	A
Microcystis sp.	D	R	A
Oscillatoria sp.	S	A	R
Rivularia sp.	R	A	A
Ankistrodesmus sp.	D	R	R
Chlorella sp.	S	A	A
Pandorina sp.	S	R	A
Scenedesmus sp.	S	R	A
Ulothrix sp.	R	A	A
Volvox sp.	R	A	A
Cymbella sp.	S	D	S
Gyrosigma sp.	S	D	D
Pleurosigma sp.	S	D	D
Fragilaria sp.	R	D	S
Amphora sp.	R	S	S
Navicula sp.	D	D	D
Nitzschia sp.	D	D	D
Pinnularia sp.	D	S	S
Synedra sp.	S	S	S
Chaetoceros sp.	R	R	A
Pandorina sp.	R	A	A
Ceratium sp.	R	A	A
Euglena sp.	R	A	A

* D- Dominant, S- Subdominant, R- Rare and A - Absent

From the analysis the phytoplankton population in the Adyar River shows a health environment than Adyar Creek and sea. The species like Cybbella Sp, Gyrosigma Sp, Pleurosigma Sp and Fragilaria Sp are 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 shows their presence in the River.

Table 5.19. Details of Zooplankton Species in the surface water

Zooplankton	River	River Mouth	Sea
Cyclops Sp.	D	S	R
Keratella Sp.	S	S	D
Vorticella Sp.	S	R	R
Nauplius Larva	S	D	D
Ostracod Sp.	R	R	S
Tintinopsis Sp.	S	R	R
Copepod Sp.	D	D	D
Nebaliad Sp.	S	D	D
Philodina Sp.	R	S	R
Favella Sp.	S	S	A
Evadne Sp	R	R	R
Acartia Sp.	S	S	R

* D- Dominant, S- Subdominant, R- Rare and A - Absent

The common Zooplankton species like Ostracod Sp, Cyclops Sp, Vorticella Sp, Copepod Sp and Acartia Sp for the tropical water are observed in all the samples. The presence of the species network shows a health population in the surface water

5.5.8 Area under Coastal Regulation Zone (CRZ)

Under the Environment Protection Act, 1986 a notification was issued in February, 1991, for regulation of activities in the coastal area by the Ministry of Environment and Forests (MoEF). As per the notification, the coastal land up to 500 m from the High Tide Line (HTL) and a stage of 100 m along banks of creeks, estuaries, backwater and rivers subject to tidal fluctuations, is called the Coastal Regulation Zone(CRZ). The above notification includes only the inter-tidal zone and land part of the coastal area and does not include the ocean part. The notification imposed restriction on the setting up and expansion of industries or processing plants etc. in the said CRZ. CRZ along the country has been placed in four categories as described in **Table 5.20.**

Table 5.20. Classification of Costal Regulation Zone

Sl No	Category	Criteria
1	CRZ-I	Ecologically sensitive and important areas, such as national parks/marine parks, sanctuaries, reserved forests, wild habitats, mangroves, corals/coral reefs, area close to breeding and spawning grounds of fish and other marine life, areas of outstanding natural beauty, historical and heritage areas, areas rich in genetic biodiversity, areas likely to be inundated due to rise in sea level consequent upon global warming and such areas as may be declared by the authorities. Areas between LTL and HTL
2	CRZ-II	Areas that have already been developed up to the shoreline For this purpose, 'Developed Area' is referred to as that area within the municipal limits or in other legally designated urban areas which is already substantially built up and

Sl No	Category	Criteria
		which has been provided with drainage and approach roads and other infrastructural facilities, such as water supply and sewerage mains.
3	CRZ-III	Areas that are relatively undisturbed and those which do not belong to either category I or II. These will include coastal zone in the areas (developed and undeveloped) and also areas within Municipal limits or in other legally designated urban areas which are not substantially built up.
4	CRZ-IV	Coastal stretches in Andaman and Nicobar islands, Lakshadweep and small islands, except those designated as CRZ-I, CRZ-II and CRZ-III.

The first phase of the project area comprising of the Santhome Bypass (Elevated Expreassway) falls under the category of CRZ II as per the Department of Environment (DoE), Tamilnadu. This is because the entire Chennai shoreline is classified under the CRZ II, due to the Urbainisation of the growing population. However no development is envisaged in the present project on the seaward side.

5.6. Environmental Impact Assessment

The assessment of the environmental impacts and their mitigation measures have been estimated as an overall impact caused by the execution of the proposed Santhome bypass project under two phases. The proposed road along the sea coast is expected to have varying degree of impacts on the following environmental components in its different stages of development.

1 Land
2 Ambient air
3 Water
4 Noise
5 Local socio-economy

In this chapter, the potential impacts of the proposed project on these environmental components are predicted and evaluated. The baseline environmental data collected, the various project activities and their extent along with the impact mitigation measures, form the basis for impact evaluation. The environmental impacts due to proposed road works can be categorised as direct or primary impacts and indirect or secondary impacts. Primary impacts are attributed directly by the project whereas secondary impacts are indirectly induced and typically include the associated investment and changing patterns of social and economical activities due to proposed action.

For the purpose of impact evaluation, the project activities are assessed in two phases such as Construction Phase including project planning and Operation Phase.

Construction Phase Activities

The major activities during the construction phase of the proposed project will be

1 Clearing of encroachments
2 Land clearing, levelling etc.
3 Excavation of land
4 Disposal of excavated material

5 Construction Resettlement colony
6 Other developmental works

Operation Phase Activities

7 Vehicular Movement along the road
8 Resettlement colony

The impacts due to project activities during construction and operation phases are different. The potential environmental impacts due to the project activities are studied for the two phases of the project viz. construction phase and operation phase. The potential environmental impacts due to project activities considered are presented in **Table 5.21**.

Table 5.21. Potential Environmental Impacts due to Proposed Project Activities

Project Activities	Environmental Impacts
Construction Phase	
Site clearance	Loss of vegetation Change in land use
Production of construction material	Dust emission/air pollution Loss of vegetation
Transportation of construction material	Air and noise pollution
Construction of labour camps	Sewage and solid waste generation
Road construction operation	Air and noise pollution
Operation Phase	
Vehicular traffic	Air and noise pollution
Landscape development	Improved aesthetics Reduction in noise levels Improved air quality
Infrastructure development	Improved road facility

5.6.1. Construction Phase Impacts

5.6.1.1. Impact On Topography / Land Use

Construction phase starts from taking possession of the site. The work in this phase comprises of site clearance, land development, building of infrastructural facilities and all construction work till commissioning. Duration of this phase is dependent on many factors such as finance, size of the project, location and infrastructural support, etc.

Land acquisition of private land is not envisaged in the current project; however removal of the fisherman villages on a temporary basis is required. The proposed project stretch has a monument in the Besant Nagar beach alias Elliots beach, but the monument is not recognised by Archaeological Survey of India (ASI) except this there are no archaeological monuments. Depending on the RoW requirement obstruction, relocation and protection measures along these places shall be suggested. Since the project involves only elevated structure, changes in existing topography are not expected and the construction phase impact is negligible.

The project implementation involves construction of office buildings, labour camps, mixing plants etc during construction period. This may result in a change in the local landuse. How ever, these impacts are marginal and exist only during the construction phase. Similarly the construction of the

resettlement site for rehabilitating the project affected families will cause local land use changes in the identified location.

It is estimated that the first phase of the project would generate around 35,500 cum of excavated waste. Disposal of the construction waste can also affect the local topography of the area if accumulated or indiscriminately dumped in the project area. However these excavated waste will be tested for their CBR values and if found suitable will be used for subgrade or else will be used for filling in Resettlement sites or disposed off in identified designated dumping site and low lying areas to avoid major impacts.

The material required for the road construction would include around 66000 cum of aggregates and 5000 cum of sand to be acquired from the identified stone quarries, which operate under lease agreements with the Department of Mining and Geology. The lease agreement will stipulate implementation of Environmental Management Plan incorporated in the mining plan during and at the closure of mining operations. In the case of the present works, no hot mix plant or quarry or borrow areas are planned along the project road stretch and will be planned outside the project area. Necessary clearance for such operations shall be responsibility of the contractor and suitable clauses for such clearances will be provided in the contract conditions. Hence impacts on the local environment due to the quarrying operation are not envisaged for the project.

5.6.1.2. Impact on Water Quality

Even though the proposed works do not have any direct impact on the water quality, use of water for construction purposes and disposal of construction waste into the water bodies may affect the quality of water in the project area. It is expected that around 17500 Kilo litre of water is required for the construction purpose. In the absence of any surface water bodies along the project road the only alternative will be ground water. However the results of the water quality monitoring indicate that the ground water along the project stretch is high in TDS and it is not suitable for the construction purposes. For the construction purpose the water can be purchased (or) outsourced from government bodies like Metro water or private water supplying agencies. Being close to the sea dumping of construction and bitumen waste in to the coastal waters will have an impact on the quality of the coastal waters along this stretch.

5.6.1.3. Impact on Air Quality

Impact on air quality during construction phase is due to

- Material transport
- Operation of construction yard
- Fugitive emissions

The vehicular movement due to project is not expected to cause a significant rise in existing traffic and it is distributed over time (of the day) and span (the entire project road). The fugitive dust emission due to loading and unloading of construction material (stone aggregate and sand) will be minimum and much localised due to the size and rapid settling. Cement will be transported in bags. Mitigative measures are suggested for further reduction of impact due to material transport.

Use of equipments and machinery using diesel as fuel will contribute to air pollution. The air pollution due to operation of construction yard will be mainly ground based with localised effect for the construction period.

5.6.1.4. Impact on Noise Levels

The noise levels are expected to increase during the construction phase of the project due to the movement of vehicles transporting the construction material to the construction yard and the noise generating activities at the yard itself. Cement concrete mixers; hot mix plants, crushers etc are the other sources of noise. Operation of Earthmovers, Pavers, Rollers, Generators, and activities like concreting, mixing, casting and material movement are primary noise generating activities in the yard and will be distributed over the entire construction period.

Construction activities are expected to produce noise levels in the range of 80 - 95 dB (A). The major work will be carried out during the daytime. Considering the drop-off rate of 6 dB (A) with the doubling of receptor distance from the point source the noise produced will not exceed 55 dB (A) beyond a distance of 250 meters from the boundary of the construction yard. This suggests the noise produced during the construction phase will not have a significant impact on the existing ambient noise levels if the construction yard is located 500 m away from the sensitive receptors.

The construction equipment will have high noise levels that can affect the personnel operating the machines. Use of proper personal protective equipment like ear muffs (or) ear plugs will mitigate any adverse impact of the noise generated by such equipment. The noise levels in the working environment are compared with the standards prescribed by Occupational Safety and Health Administration (OSHA - USA) which in-turn are being enforced by Government of India through Model rules framed under the Factories Act. The acceptable limits for each shift being of 8 hour duration, the equivalent noise level exposure during the shift is 90 dB (A). Hence noise generated due to various activities in the construction camps may affect workers, if equivalent 8-hour exposure is more than the safety limit.

The noise likely to be generated during excavation, loading and transportation of material will be in the range of 90 to 105 dB (A) and this will occur only when all the equipments operate together and simultaneously. This will be a remote possibility. The workers in general are likely to be exposed to an equivalent noise level of 80-90 dB(A) in an 8 hour shift for which all statutory precautions should be taken into consideration. The personnel protective devices such as earplug / muff should be provided to the workers working in the vicinity of the high noise generating machine. Careful planning of machinery operations and scheduling of operations can reduce these levels.

5.6.1.5. Impact on Ecology

Impact on Flora

The proposed project site doesn't have endangered Flora. Very few common trees like drumstick, Neem and coconut trees are observed in some fishermen settlements. Due to the proposed construction activity the loss of trees are not envisaged.

Impact on Fauna

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.

Moreover, 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.

5.6.1.6. Other Impacts

The construction phase covers the arrangement for housing and living requirements for the construction workers. Most of the work in construction phase is moderately labour intensive. In fact, the site will be having more workers during construction phase than operating phase. As most of the construction job will be done by contractors, workers will be provided with proper shelter facilities. The workers will be provided with safe drinking water and proper sanitation facilities. The workers will be provided with fuel in order to avoid cutting of any near by wood for fuel purpose at the construction site.

During construction phase a good number of workers will be working on the site. There is a possibility that some of them will be coming from beyond immediate neighbourhood. Unless steps are taken in advance to meet the construction stage demand, short term immigration may have some impact on the local housing, civic facilities, health and culture. To avoid this problem, contractors will be asked to provide suitable camps for their work force

5.6.2. Operation Phase Impacts

In the operation phase of the project, the impact is mainly due to the vehicular movement resulting in air and noise pollution and the functioning of the resettlement site. After commissioning of the project there are benefits associated like economic upliftment, reduction in traffic congestion etc

5.6.2.1. Impact on Topography/ Landuse

During the operation phase of the road, the impact on the topography and the change in the land use pattern is negligible. Due to these changes minor land use variations are expected. However the project road falling under CRZ and the restriction on the development within CRZ the impact is considered to be very minimum.

Similarly the development of the resettlement colony is expected to induce ancillary development around the proposed site resulting in the localised land use changes. However this is expected to improve the local economy of the area.

5.6.2.2. Impact on Water Quality

Vehicular movements are not expected to cause any impacts on the water quality of the project area.

5.6.2.3. Impact on Air Quality

During operation phase of the project it is expected that the improved road network will ensure smooth flow of traffic by reducing congestion, delay and fuel consumption and thereby reducing the vehicular emissions. However, the new road alignment would attract more traffic over a period of time there by increasing the overall mass emissions. As a result the air quality along the narrow corridor of the roadway is likely to be lower.

5.6.2.4. Impact on Noise Level

The Sound Pressure Level (SPL) generated by noise sources decreases with increasing distance from the source due to wave divergence. An additional decrease in SPL with distance from the source is expected due to atmospheric effect or its interaction with objects in the transmission path.

Unlike the construction phase, the noise level generated during the operation phase is very minimal. During the commissioning of the project the increase in traffic load along the first phase stretch of the Santhome bypass is expected to be very minimal, due to this scenario the chances of increasing noise level will be under controlled condition and it won't be a threat to the local communities. This activity will add a positive impact during the operation phase due to the free flow of traffic.

5.6.2.5. Other Impacts

Reduction in Travel Time and Traffic Congestion

The overall proposed project ensures smooth traffic flow between Lighthouse (Marina beach), Besant Nagar Beach to the ECR - Kottivakkam. This will reduce traffic congestion on the Adyar, Kamarajar Salai, Rama Krishna Mutt Road and Greenways Road. For all the categories of vehicle rise in the travel speed will reduce the travel time and fuel consumption thereby reducing idling of engines and the associated vehicular emissions.

Impact on Ecological Resources

The project stretch of the Santhome Bypass is within the Coastal Regulation Zone (CRZ-II). This ensures restricted development along the coast and that will help in preserving the flora and fauna in the project area. In the operation phase no adverse impact on the aquatic ecology is expected.

5.6.3. Summary of Impacts

A summary of significant project impacts is presented in **Table 5.22**. Details of mitigation measure are covered in Chapter 5, Environmental Mitigation Plan.

Table 5.22. Summary of Potential Environmental Impacts of the overall Santhome Bypass

Sl No.	Project Activities	Environmental Components										
		Topography	Water Resource	Soil	Geology	Air	Noise	Sensitive Receptors	Land use	Vegetation	Aesthetics	Infrastructure/ Community
I	Construction Phase											
1	Site clearance	-ve/t	-ve/t	-ve/p		-ve/t	-ve/t	-ve/t	-ve/t	-ve/p	-ve/t	
2	Mobilisation of construction equipment	-ve/t	-ve/t	-ve/t		-ve/t	-ve/t	-ve/t				
3	Setting up of construction camps		-ve/t	-ve/t				-ve/t	-ve/t	-ve/t	-ve/t	
4	Use of construction camps		-ve/t	-ve/t		-ve/t	-ve/t	-ve/t		-ve/t		
5	Quarrying	-ve/p		-ve/p	-ve/p	-ve/t	-ve/t		-ve/p		-ve/p	
6	Transportation of materials		-ve/p			-ve/t	-ve/t	-ve/t		-ve/t		
7	Materials storage					-ve/t						
8	Construction activities		-ve/t	-ve/t		-ve/t	-ve/t	-ve/t				
9	Employment											+ve/p
II	Operational Phase											
1	Improved transport corridor					-ve/p	-ve/p	-ve/p	+ve/p			+ve/p
2	Vehicular traffic movement		-ve/t	-ve/t		-ve/p	-ve/p	-ve/p			+ve/p	+ve/p

Legend: t – Temporary, p – Permanent

5.7. Environmental Mitigation Plan

The Environmental Mitigation Plan (EMP) is designed to address the requirement of successfully mitigating the likely adverse impacts of the proposed project. It also identifies the post project monitoring requirements needed for the successful implementation of the suggested mitigation measures. The institutional arrangements needed for implementing the mitigation measures and conducting post project monitoring are also been identified.

5.7.1. EMP for Construction Phase Impacts

5.7.1.1. Impacts on Vegetation

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

5.7.1.2. Impacts on Air Quality

The impacts on air quality during construction are mainly due to the material movement and the actual construction activities. By material movement air quality over a large area is affected due to emissions and increase in the dust levels though, not in significant levels.

The emissions from the construction machinery are the major source of ambient air pollution during the actual construction. The fugitive dust emissions will be mainly from quarrying, crushing, blasting, hot mix plants, machinery equipment and access roads. Continuous use of construction machinery and generator sets may cause rise in ambient air pollution levels. The degree of impact may be higher during winter season and in the early morning hours and night time.

Mitigation measures

- In order to curb the increased fugitive dust emissions in the area due to vehicular movement and raw material transport, provisions should be made for sprinkling of water on the entire haul roads in the area. Sprinkling of water should be carried out at least twice a day on a regular basis during the entire construction period.
- Weekly inspection of haul roads and the construction site should be carried out to ensure removal of construction debris to the land fill sites.
- Dust covers should be used over the beds of trucks that will be used for the transportation of materials prone to fugitive dust emissions. Additionally any of these materials which may collect on the horizontal surfaces of these trucks during loading should be removed before transportation.
- Construction requiring road closings in heavy traffic areas should be performed during off-peak hours.
- Idling of delivery trucks or other equipments should not be permitted during periods when they are being unloaded or are not in active use.

- Low emission (diesel) construction vehicles and generator sets conforming to the latest emission standards should be used wherever possible.
- The construction machinery and the equipments should maintain sound condition. Stationary equipment within the construction yard should be located as far as possible from receptor locations in order to allow dispersion of emitted pollutants.
- Crushing and grinding machinery should be enclosed. All the drilling operations are to be coupled with dust collectors.
- Areas prone to fugitive dust emissions such as demolition, excavation and grinding sites should be stabilised by spraying water.
- As soon as the construction is over the surplus earth should be utilised to fill up low-lying areas or removed to disposal site immediately.

5.7.1.3. Impacts on Noise Levels

The prime sources of noise levels during the construction phase are the construction machinery like hot mix plants, crushers, earth moving equipments, construction drilling and the vehicular noise due to material movement at the site. Some of these sources are confined to construction yards that will be located at least 500 m away from the habitations.

Mitigation Measures

- Construction contracts should specify that the construction equipments should meet the noise and air emission control norms and to be covered with mufflers.
- Extensive use of machinery in the night time should be avoided.
- The main stationary noise producing sources such as generator sets should be provided with noise shields around them. The noise shields can either be a brick masonry structure or any other physical barrier that is effective in adequate attenuation of noise levels.
- For protection of construction workers, earplugs should be provided to those working very close to the noise generating machinery.

5.7.1.4 Sanitation at Workers Colony

Sewage and the domestic solid waste generated at the construction workers colony would have a negative impact on the aesthetics and environment of the surrounding area, if not disposed off in an efficient manner.

Mitigation Measures

The construction workers should be allotted a specified area of land on which the temporary colony of workers should be built. Adequate sanitary facilities, drainage, washing and toilet facilities with septic tanks and refuse collection and disposal should be provided to the workers. The provision of water supply and toilet facilities should be made as per the stipulated guidelines in Indian Labour Act.

5.7.1.5. Impact on Flora and Fauna

The construction activity doesn't have impact on the flora of the project site but it has significant impact on the existing fauna. As discussed in section 4 of this chapter, the site is known for Olive Ridley Turtles breeding ground. In order to preserve the endangered turtle the construction activities shall be hold for the month of December to March. The construction of the Bridge across the Adyar Estuary also has significant impact on the birds. It is suggested that proper preplanning is required for any construction activity across the estuary. Noise control measures shall be strictly followed to avoid inconvenience to the birds and the construction activity shall be hold for during the monsoon seasons, due to the flooding in the river and fish breeding season.

5.7.2. EMP for Operation Phase Impacts

5.7.2.1. Impacts on Air Quality

After the project implementation the ambient air quality levels in future years will be better due to increased level of service for the project roads. However, as the traffic increases, the ambient air quality levels will decrease marginally. The effect will be more pronounced during winter season when night time/early morning ground level inversion is observed.

Mitigation Measures

- The most effective control methods of air pollution due to vehicular emissions is to use fuel efficient engines, introduction of catalytic converters for petrol vehicles and use of smoke traps for diesel vehicles.
- It should be made compulsory for all vehicles to adhere to the engine maintenance schedules and CPCB standards to reduce air pollution due to vehicular emissions.
- Development of landscape along the road can bring about 30% reduction of concentration of pollutants at the ground level. It is therefore recommended that the area available in the median shall be used for growing small plants and grasses to minimise the air pollution impacts. Such development will also improve the general aesthetics in the region.

5.7.2.2. Impacts on Noise Levels

An increase in the ambient noise levels of the region along the proposed project is expected due to continuous traffic movement at higher speeds. Ambient night time noise levels would experience high levels due to movement of heavy traffic. The noise levels from the proposed project can be attenuated up to 5 dB (A) by the development of landscape with avenue plantations.

Mitigation Measures

- Minimisation of use of horns near sensitive locations and air horn should be restricted along the Santhome bypass. This can be achieved through the use of sign boards in proper positions.
- Noise barrier of 3 m height on either side of the sensitive receptors.
- Development of landscape along the proposed road will reduce noise levels by 5 dB

(A). The area available in the median shall be used for growing small plants and grasses to minimise the noise pollution.

Summary of the detailed environmental impacts and the mitigations measures are presented in **Table 5.23.**

Table 5.23. Summary of Environmental Impacts and Mitigation Measures – Light House to Besant Nagar Beach (0+000 km - 4+700 km) of Santhome bypass

Environmental Component	Environmental Impact	Mitigation Measures
CONSTRUCTION PHASE		
1. Soil		
Soil Erosion	Although no burrow pits are planned along the project road, excavations of borrow pits at approved locations for the present project will increase soil erosion	In borrow pits, the depth of the pit should be regulated so that the sides of the excavation will have a slope not steeper than 1 vertical to 4 horizontal from the edge of the final section of bank The device for checking soil erosion include the formulation of sediment basins, slope drains etc. Such works and maintenance thereof will be deemed as incidental to the earthwork
Loss of topsoil	Loss of productive soil during the leasing of land to contractors for storing, stock yards and workers camp Borrowing pits during project construction	The top soil will be stripped and stored The stored topsoil will be spread back to maintain the physico-chemical and biological activity of the soil The borrow pit areas could be developed into ponds for fisheries Land taken for borrow areas should be infertile
Compaction of soil	The excavations in borrow areas may lead to marginal loosening of soil The compaction of soil may not be affected largely	It should be ensured that the stability of excavation of fills is maintained Construction vehicles, machinery and equipment shall move, or be stationed in the designated areas If operating from temporarily hired land, it will be ensured that the topsoil for agriculture remains preserved & not destroyed by storage, material handling or any other construction related activities Earth, if required, should be dumped in areas selected & approved by the authorized representatives of the project implementing agency.
Borrowing of earth	Earth is needed for raising the level of the widening portion of the road which will be sourced from approved borrow areas.	If new borrow areas are selected, there should be no loss of productive soil, and environmental considerations are met with If vehicles are passing through some villages, the excavation and carrying of earth will be done during day time only The borrow areas should not be dug continuously, and the size and shape of borrow pits to be decided by the authorized representatives of the project implementing agency Borrow pits should be redeveloped by dumping of spoils; by creating a pond for fisheries, etc. or by leveling an elevated, raised earth mounds

Environmental Component	Environmental Impact	Mitigation Measures
Contamination of soil from fuel and lubricants	The impact will be negligible since the chemical nature of the soil will not change much. Negligible impact on the growth of vegetation	Vehicles and machines are maintained and refilled in such a fashion that old diesel spillage does not contaminate the soil Fuel storage and refilling sites should be kept away from cross drainage structures and important water bodies All spoils shall be disposed off as desired and the site shall be fully cleaned before handing over
Contamination of soil from construction wastes	The impact will be marginal on the soil quality The growth of vegetation will be partially disturbed	The construction wastes should be dumped in selected pits, developed on infertile land Follow the norms of TNPCB Borrow pits to be filled by such wastes
2 Water		
Water bodies	Water quality may be deteriorated due to surface runoff from the construction site, dumping of construction debris etc. Community water sources may be affected	Plantation along these water bodies may be undertaken. No labour camps, stone crushers, hot mix plants and other heavy machinery should be located near water bodies. Debris dumping to be strictly avoided Any source of water for the community such as ponds, wells, tube-wells etc. lost incidentally shall be replaced immediately All desired measures will be taken to prevent temporary or permanent flooding
Other water sources	Dumping of construction waste into the coastal waters due to its proximity to the coast will have an impact on the near shore environment.	Sites for the Disposal of construction and related wastes should be identified and approved by the authorized representatives of the project implementing agency before the start of construction work.
Drainage and run-off water	The flow of run off water will not be affected largely, except at certain stretches where the drainage problem already exists	At cross drainage channels, etc. the earth, stone or any other construction material should be properly disposed of so as not to block the flow of water
Contamination of water from fuel and lubricants	The fuel and lubricants may affect water bodies especially the coastal water due to its proximity to the project site.	To avoid contamination from fuel and lubricants, the vehicles and equipment shall be properly maintained and repaired.
Sanitation and waste disposal in construction camps	Absence of proper sanitation may lead to many human diseases which are mostly water-borne	The construction labourers` camp shall be located away from the habitation and from major water bodies The sewage system for such camps shall be properly designed and built so that no water pollution takes place to any water-body or water course
Use of water for	The use of water from sources, already in use	Arrangement for supply and storage of water will be made by the contractor in such a

Environmental Component	Environmental Impact	Mitigation Measures
construction	by local community may cause scarcity of water for community	way so that the water availability and supply to nearby communities remain unaffected. If a new tube-well is to be bored, proper sanction and approval by Underground Water Department is needed The wastage of water during the construction should be minimised
3 Air		
Emission from construction vehicles and machinery	Effect on human health Dust settled on leaves may reduce growth rate of the plants	All vehicles, equipment and machinery used for construction shall be regularly maintained to ensure that the pollution emission levels are as per norms of TNPCB Monitoring of suspended particulate matter to be conducted at least once a month at the sites where crushers are used The human settlements should be at least 500 m down windward direction of Hot (asphalt) mix plant
Dust and its treatment	The impact of dust at construction sites is rather adverse, but localized in nature No serious health problem is likely to be caused	All precautions to reduce the level of dust emissions from the hot mix plants shall be taken The hot-mix plants are sited at least 500 m from the nearest habitation and from major water bodies. They should be fitted with dust extraction units Water should be sprayed on the earth mixing sites, asphalt mixing site and service roads. During sub grade construction, water spraying is needed to compact the soil properly. After the compaction, water should be sprayed regularly to prevent dust Vehicles delivering material should be covered
4 Noise Levels		
Noise from construction vehicles, asphalt plants and equipment	The activities using heavy machinery and equipment are localized and intermittent No serious impact on human health like loss of hearing ability though some sleep disorders may result	The plants and equipment used in construction shall strictly conform to CPCB noise standards Vehicles and equipment used should be fitted with silencers Noise standards will be strictly enforced to save construction workers from damage At construction sites within 150 m of human settlements, noisy construction should be stopped between 10:00 pm and 8:00 am Noise to be monitored at construction sites
5. Fauna		
Olive Ridley Turtles, birds and fish species	Construction activites will affect the breeding phases of the endangered Green Turtle, the birds in the Bird Sanctuary and fish species in the Adyar River.	Construction activities shall be hold for the month of December to March. The construction of the Bridge across the Adyar Estuary also has significant impact on the birds. It is suggested that proper preplanning is required for any construction activity across the estuary. Noise control measures shall be strictly followed to avoid

Environmental Component	Environmental Impact	Mitigation Measures
		inconvenience to the birds and the construction activity shall be hold for during the monsoon seasons, due to the flooding in the river and fish breeding season
6 Safety and Accidental Risk		
Accident risk from construction activities	The type of accidental risks may be due to ill-maintains machines and vehicles, due to poor light conditions at the work place, or due to carelessness and poor management of the work involved	To ensure safe construction in the temporary accesses during construction, lighting devices and safety signal devices shall be installed. Traffic rules and regulations to be strictly followed Safety of workers undertaking various operations during construction should be ensured by providing them helmets, masks, safety goggles etc The electrical equipment should be checked regularly to avoid risks to workers At every work place, a readily available first aid unit including an adequate supply of dressing materials, a mode of transport (ambulance), nursing staff and an attending doctor to be provided Lighting device and signals at workplace to be installed
Health issues	The prevalence of unhygienic conditions at work place of construction workers The non-availability of good drinking water	At every workplace, good and sufficient water supply shall be maintained to avoid waterborne diseases and securing the health of workers. Adequate drainage, sanitation and waste disposal to be provided at workplaces Medical care to be provided to workers if falling ill
7 Aesthetics & Common Amenities		
Roadside landscape development	There will be positive impact on bio-aesthetics and beauty	Avenue plantation with Korean grass and small flowering plants and shrubs
		OPERATION PHASE
Contamination from spills due to traffic and accidents	The chances of accidents are likely to be reduced with improved width and quality of the road. The contamination of soil and water due to spills will be minor	Cleaning of the spills at the accidental site and the left over spill may be scrapped to a small nearby pit within ROW
Dust generation	Though dust is a common feature of tropical climate, yet the situation will improve by developing new vegetation	Roadside tree plantation to be developed and maintained
Air pollution	The degree of air pollution is likely to be on a lower scale with improvement in road surface and with better maintenance	SPM, RSPM, CO, SO2, NOx to be monitored monitoring plan Roadside tree plantation to be maintained Public awareness programmes to be launched

Environmental Component	Environmental Impact	Mitigation Measures
Accidents involving hazardous materials	The chances of such accidents will be minimum, yet not unavoidable	The rules as defined in Environmental (Protection) Act, 1986 should be complied For delivery of hazardous substances, three certificates namely permit license, driving license and guarding license issued by transportation department are required Vehicles delivering hazardous substances will be printed with unified signs Public security transportation and the fire fighting departments will designate a special route for these vehicles The project hazardous substances will be administrated by highway management department registration system In case of spillage, the report to relevant department is made and instructions followed
Safety measures	The chances of accidents would be reduced in view of improved road conditions	Traffic management plan to be developed, especially in congested locations Traffic control measures including speed limits to be enforced strictly Further growth of encroachment and squatting on ROW to be discouraged Widening of the existing carriageway will reduce accidents Strengthening the pavement Improving upon the curves in road geometrics Proposing service lanes for local approaches Providing proper median. Improving upon road crossings. Putting warning signals and signboards

5.7.3. Environmental Clearances for Contractor

Apart from the clearance 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 **Table 5.24**

Table 5.24. 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
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	Tamilnadu 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

5.7.4. Cost Estimation of EMP

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.

Table 5.25. Cost Estimation of Implementing EMP

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	Rs.500/- per trip *10 trips a day/ 1 year	5000

Sl No	Activities	Assumption	Cost in Rupees
	site		
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**

Chapter 6: Social assessment & Rehabilitation Action Plan

Contents

Table List

Figure List

6. Social Impact Assessment and RAP Budget

6.1 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 and also to decongest the existing traffic that creates chaos and time spillage for the vehicles plying along the roads that lead to the east coast from the world fame marina beach and other tourist spots around it. As part of the enhancement measures, Beach committee now intends to construct a link road from Lighthouse 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.

This report illustrates the proposed improvements, 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

6.1.1 Objectives of Social Assessment Exercise

A Rapid Social Assessment was conducted with the main objective of identifying the locations of social sensitivity to assess the social feasibility of the project. The objectives also include the following:

Providing inputs to the project design team about the social concerns

- Understanding the type of social impacts
- Quantifying the extent of social impact
- Estimating the land acquisition cost and
- Volume of R&R issues

Considering the above and the Terms of Reference (ToR) of the study, the following methodology has been adopted to carry out the social assessment.

6.1.2

Task 1: Collection and Analysis of Secondary Data

Secondary data pertaining to various socio-economic parameters was collected from government departments like Census of India, Department of Industries, Department of Economics and Statistics, Directorate of Settlements and Land Records etc. This helped to understand the socio-economic profile of the project area with respect to indicators like population growth rate, literacy rate, work force participation rate (WFPR) etc. in comparison with the project districts and Tamil Nadu state.

Task 2: Initial Field Reconnaissance

Initial field reconnaissance was conducted in the beginning of the study to gather a preliminary understanding of the project location with respect to following features:

- Social and physical features like settlement pattern, density, typology of buildings, especially presence of religious buildings, Institutional and commercial building, land use etc.
- Topography of the land,

Task 3: Detailed Field reconnaissance

Further to initial reconnaissance, a detailed reconnaissance was undertaken to record and document the above socio-environmental features in detail.

Sub-task 3.1: Preparation of strip plans

The land use on either side of the proposed alignment was mapped at every 20metres for indicating the distance of private property line from the proposed centerline, the location of buildings within 20m ROW, type of building, number of floors, use of buildings etc.

Sub-task 3.2: Counting of structures within 20m. ROW

This task was undertaken to quantify the impact on structures that would be affected by the proposed construction of the road. The number of residences, commercial buildings, public utility buildings and religious structures were counted along the stretch separately and an inventory of the count was prepared for every 20m length of the road.

Sub-task 3.3: Detailed study of socially sensitive features

Along with sub-task 3.2, detailed study of socially sensitive features like mosques, churches and temples were studied with respect to their location, distance from the edge of the carriageway, type of building, ownership, historical importance etc. This task helped to document these features and identify the critical stretches from a social perspective.

Sub-task 3.4: Focused Group Discussions (FGD)

Focus Group Discussions were conducted at project location to understand the people's perception about the project as well as their issues and concerns. The willingness of the people to part with their land for the project and the compensation anticipated.

Sub-task 3.5: Collection of Land Value

The market values of land at various locations were collected from the people, in addition to the guideline values fixed by the government of Tamil Nadu to facilitate calculation of land acquisition cost.

Task 4: Social Impact Assessment

Based on the data collected from detailed field reconnaissance the social impact assessment of the project was carried out with the objective of identifying socially sensitive areas along the project stretch. The critical issues pertaining to social sensitivities were analyzed and potential hotspots where social impact could be more were identified. Based on this, inputs were given to the project design team so that social concerns are incorporated in the design of the junction from the very beginning and any adverse social impacts are minimized to the extent possible.

6.1.3 Report Structure

Section – 6.1 of the report gives an introduction about the project, the objectives of Resettlement Action Plan (RAP), methodology of the study and the organisation of this chapter.

Section – 6.2 gives the Socio economic profile of the project area in terms of the administrative units along the project road, demographic and socio-economic profile, rapid social assessment of the project road, based on which critical stretches are identified. The summary of the proposed highway design is also given in this chapter.

Section – 6.3 discusses the legal framework applicable for the project and includes the review of guidelines which provides basic parameters for preparation of compensation and resettlement benefits.

Section – 6.4 identifies major loss categories and quantifies them based on the data from census surveys. The total area of land to be acquired, the number of affected structures, number and type of common properties affected etc. will be provided here.

Section – 6.5 discusses the different stages of public consultations, different methods adopted etc.

Section – 6.6 discusses the institutional framework for implementation of the project, implementation schedule, monitoring and evaluation framework and mechanisms envisaged for grievance redress.

Section – 6.7 gives the RAP budget.

6.2 SOCIO ECONOMIC PROFILE

6.2.1 Profile of the Project Area

Following analytical section presents the profile of the project area in terms of its geography, administrative units and socio-economic features. It uses various socio-economic parameters like literacy, work force participation etc. and draws a picture of development status of the project area in comparison with state and project district.

6.2.2 Geographical Profile

Chennai District: Chennai is situated on the north-east end of Tamil Nadu on the coast of Bay of Bengal. It lies between 12* 9' and 13* 9' of the northern latitude and 80* 12' and 80* 19' of the southern longitude on a `sandy shelving breaker swept beach'. It stretches nearly 25.60 kms. Along the Bay coast from Thiruvanmiyur in the south to Thiruvottriyur in the north and runs inland in a rugged semi-circular fashion. It is bounded on the east by the Bay of Bengal and on the remaining three sides by Kancheepuram and Thiruvallur Districts.

Chennai is one of the leading cities in India today from the point of view of trade and commerce, with the fourth largest port in the country and the first to have developed a full-fledged container terminal to international standards. The port is providing trade links with Japan, Singapore, Malaysia, Burma, Bangladesh, Ceylon and other far eastern countries. Chennai is also one of the most important IT Hubs of the sub-continent.

6.2.3 Administrative Profile

Administratively, this phase of the project road falls in Chennai district in the state of Tamil Nadu. A stretch of 4.7 Kms. starts at Km 5/600 of Kamarajar Salai and ends at 5th avenue road of Besant Nagar. Administrative profile of the project area is given in **Table 6.1**.

Table 6.1: Administrative Profile of the Project Area

District	Taluk	Revenue Villages	Zone/Wards
Chennai	Mylapore-Triplicane	Mylapore Urur	Chennai corporation zone – X Wards - 145,146, 150, 152,

6.2.4 Demographic and Socio-economic Profile

(i) Chennai District.

Chennai is situated on the north-east end of Tamil Nadu on the coast of Bay of Bengal. It lies between 12* 9' and 13* 9' of the northern latitude and 80* 12' and 80* 19' of the southern

longitude on a `sandy shelving breaker swept beach'. It stretches nearly 25.60 kms. along the Bay coast from Thiruvanmiyur in the south to Thiruvottiyur in the north and runs inland in a rugged semi-circular fashion. It is bounded on the east by the Bay of Bengal and on the remaining three sides by Kancheepuram and Thiruvallur Districts.

A large number of institutions which are known in India and abroad are found located in the city, of which mention may be made of the Theosophical Society, the Kalakshetra and colleges of Arts and Crafts. Chennai is one of the leading cities in India today from the point of view of trade and commerce, with the fourth largest port in the country and the first to have developed a full-fledged container terminal to international standards.

The Chennai district is under the Chennai corporation, the second oldest corporation in the country next to Kolkatta corporation. For administrative reason it has been divided into 10 zones which is further divided into 155 wards. The Project area comes under Chennai corporation zone X and the wards are 145, 146, 150, and 152. In revenue administration, the project area comes under Mylapore-Triplicane Taluk.

Table 6.2: Demographic and Socio-economic Profile of the Project Area

Demographic Indicators	Tamil Nadu	Chennai District	Project Area
Population 2001	62,405,679	4,343,645	100984
Urbanization Rate (%)	44.04	100.00	100.00
Area (Sq. km.)	1,30,267	178.20	6.05
Density	479	24,963	16,691
No. of households	14,665,983	962213	23630
Average Household Size	4.26	4.51	4.27
Sex Ratio - Females per 1000 males	987	957	994.11
Sex Ratio - Females per 1000 males (Below 6 years)	942	972	1015.09
SC Population – % of total population)	19.00	13.76	9.82
ST Population - % total population	1.04	0.15	0.06
Literacy Rate (percent)	64.94	85.33	77.37
Female Literacy Rate (percent)	28.39	80.44	47.08
Work Participation Rate (percent)	44.67	34.27	35.78

Demographic Indicators	Tamil Nadu	Chennai District	Project Area
Female Work Participation Rate (WFPR) (percent)	31.54	13.52	24.23

Source: Census of India, 2001

6.2.5 Project Area

Population and Urbanization Rate. Population of the project area is 1.009 lakhs, which is hardly 0.162 percent of the total state population. Urbanization rate in the project area is 100% since the project alignment falls in the Chennai city. Population density of project area is less (16,691)when compared with chennai district(24,963) the state. As per census details 9.82 percent of the project area population belongs to Schedule Caste (SC) while a small percentage (0.06%) belongs to Schedule Tribe (ST). Both the values are lower than that for the state.

Sex Ratio and Literacy. Adult sex ratio of the project area at 994 is comparable with state figure at 987, while child sex ratio shows a comparatively higher value (1015) than state. 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 as given in **Figure 6.1.**

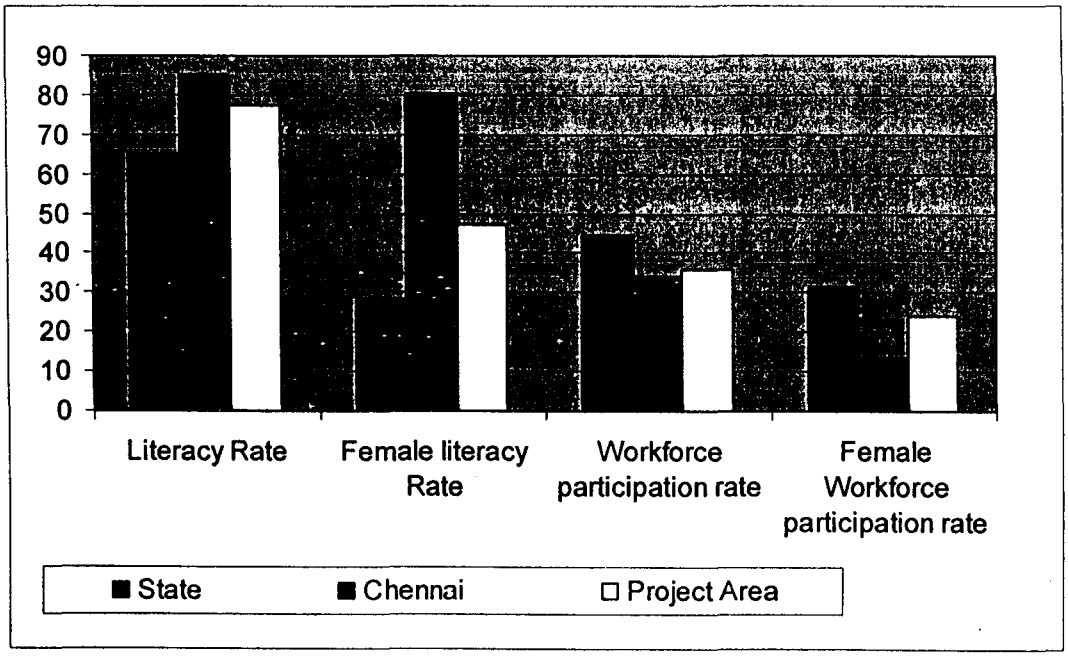


Figure 6.1 Literacy level and work force participation

Workforce Participation. Higher literacy levels of project area are not commensurate with employment opportunities. Total and female workforce participation rate indicates lower values at 36 and 23 percent respectively than that for the state at 35 and 28 percent respectively. The project district show lower values of total and female workforce participation rates than that for the state. The project area shows 100% urbanization rate as it is inside the Chennai district. The details are given in the following **Table 6.3**

Table 6.3: Worker Participation in the State, Project Districts and Project Area

Category	Tamilnadu State	Chennai District	Project Area
Total workers	2,78,78,282	14,88,364	36135
	44.67%	34.27%	35.78%
Total main workers	2,37,57,783	5,523,028	34,190
	38.07%	31.78%	94.62%
Marginal workers	41,20,499	4,30,428	1,945
	6.60%	2.47%	5.38%
Non-workers	3,45,27,397	11,421,124	64,849
	55.33%	65.73%	64.22%

Source: Census, 2001

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.

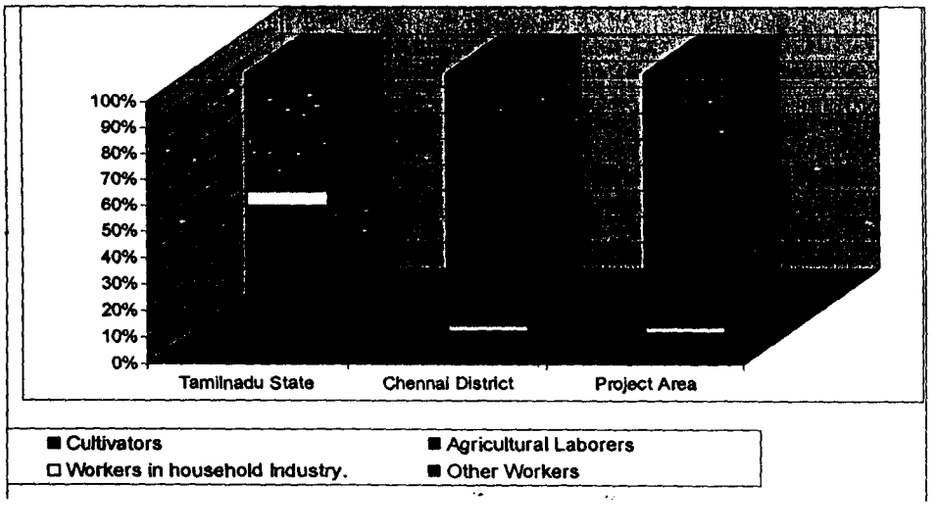


Figure 6.2 Composition of workforce among the state, project districts and project area

Table 6.4 & Figure 2.2 shows composition of work force in state, districts and project stretch. Classification of workers in the four categories – cultivators, agricultural laborers, workers in household industry and other workers. Since the project area is totally a urban area only one percent of workforce in project area are cultivators and agricultural laburers are still less with 0.3%. But ratio of agricultural laboureres are comparitively high in Kancheepuram district(17.10) than chennai district(0.42%). The ratio of other workers is also less in kancheepuram district when compared with chennai district. A large proportion of the project area workforce (97 percent) are other workers, which is reflection of high urbanisation rate.

Table 6.4: Workforce Composition in the State and Project Districts

Category	Tamilnadu State	Chennai District	Project Area
Cultivators	5,116,039 18.35%	17,175 1.15%	495 1.01%
Agricultural Laborers	8,637,630 30.98%	7,082 0.48%	203 0.30%
Workers in household Industry.	1,499,761 5.38%	30,992 2.08%	768 1.73%
Other Workers	12,624,852 45.29%	1,433,115 96.29%	34,669 96.94%

Source: Census, 2001

Health. The project district registers less birth rate as that of the state and it is good indication that the project district shows much lower value of IMR than the state value.

Table 6.5: Health Status in the State and Project District

Health Indicators	Tamil Nadu State	Chennai District
	(%)	*(%)*
Birth Rate	19.2	16.2
Death Rate	7.9	3.0
Infant Mortality Rate (IMR)	51	15

Source: District Statistical Handbooks, 2004-05.

Human Development Index (HDI). The HDI measures the average achievements in three basic dimensions of human development – i) A long and healthy life, as measured by life expectancy at birth; ii) Knowledge, as measured by the adult literacy rate (with two-thirds weight) and the combined primary, secondary, and tertiary gross enrolment ratio (with one-third weight); iii) A

decent standard of living, as measured by gross domestic product (GDP) per capita at purchasing power parity (PPP) in USD. HDI is used mainly to distinguish whether the country/state/district is a developed, developing, or under developed. HDI value for India (Year 2003, UNDP report 2005) is 0.602, which ranks country at 127th position in the list of 177th countries all over the world. Tamilnadu state shows a higher value of HDI at 0.657 than that of country, while Chennai district shows HDI values at 0.757.

6.2.6 Summary of Project Area Profile

The Phase-I of the project highway comprises of 4.7 kms along the coast of Bay of Bengal. The project area falls in urban area and the project road starts near Light house on Kamarajar Salai passing along the coast and ends at 5th avenue road of Besant Nagar. Socio-economic indicators for the project area show a satisfactory picture, with higher literacy rate and comparable adult sex ratio as that of state.

The proposed project once completed will provide the traffic free connectivity between the Santhome and Besant Nagar without entering the existing congested road networks thereby giving increased access to urban facilities and reducing the travel time and a marine drive experience. The development is likely to have both direct and indirect benefits due to improved connectivity for the Chennai city to the southern part of the state and has no major Impact on the population of the project area.

6.2.7 Land use along Project Road

To know the landuse along project road, a detailed walk through was conducted. Since the proposed elevated alignment passes along the shore line the land use along the project corridor is primarily residential. The fisherman huts and Tamil Nadu slum clearance board colonies are found along the project road. Very few kutcha commercial structures(house hold shops) and few community structures are found in that area.. The Chainage wise broad landuse is given in **Table 6.6**

(i) <u>Description of alignment</u>.

The project stretch commences from Kamarjar salai near Light House and crosses fisherman settlements like Nochikuppam, Dumming kuppam, Foreshore estate, Srinivasapuram, and Oroor kuppam in Besant nagar.

The initial section of road is from Kamarajar Salai near Light house junction (Km. 0/000 to 2/350) to Foreshore estate junction runs through the existing alignment. At the start (Km 0/0) of the alignment, Office of the Directorate General of Police and Forensic Department are located on the RHS of the Kamarajar Salai. After that Tamil Nadu slum clearance Board Multi storied(G+2) tenements are located on the RHS at Nochikuppam and Dumming kuppam.and shore activities are there on the LHS. In the section Km 0/500 to 0/800 fishermen and women sell their daily catchments on the foot path on the LHS of the road. And apart from the TNSCB tenements there are numerous encroachments on the RHS abutting these structures which are kutcha in nature. There are very few kutcha house hold shops in between these settlements. Other than this, there are no commercial activities. Open vacant lands and corporation play ground are also available in between these settlements on RHS.

The stretch between Foreshore estate (Km 2/350 to 3/350) and the Adyar river end is Srinivasapuram which is also residential. There is a fisherman community hall, a temple and a child welfare centre at the RHS of this stretch.

The stretch from the other side of the Adyar river to Besant Nagar (Km 3/600 to 4/650) runs on the open land on the shore at rear side of the Theosophical Society. After that, a fishermen settlement called Oroor Kuppam is located on the RHS of the proposed alignment.

Table 6.6: 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

6.2.8 Analysis of landuse along the project road highlights following key issues:

(i) Impact on densely populated settlements of Nochi kuppam, Dumming kuppam, Bhavani kuppam, Srinivasapuram, Uroor Kuppam,

(ii) Major bridge across Adyar River

(iii) Socially and historically important/sensitive features (temple, theosophical society etc.) along the road,

6.2.9 Socially Sensitive Stretches And Critical Issues for Road Design

Based on the detailed study of socially sensitive features, certain critical sections have been identified, which are considered at various stages of preparing the highway design. A summary of the same is given in **Table 6.8**.

Table 6.7: Preliminary Critical Stretches Identified

Area Name	Type of criticality	Design proposals from WSAPL (LHS and RHS are given with reference from the junction)
Kamarajar salai	Presence of Light House, Government buildings, TNSCB tenements,	Proposed centre line is taken on the existing road
Santhome	Presence of existing road junction and bus terminus	Exit ramp is proposed
Adyar river crossing	Absence of bridge connectivity	A new signature bridge is proposed
Besant Nagar	Presence of famous temples and church	Phase-I of the proposed alignment terminates before the shrines

***Source**: Social Assessment undertaken by WSAPL*

6.2.10 Proposed Project Design

Considering the social sensitive features and to avoid serious R& R issues, the proposed C/L is taken according to the availability of the land and presence of multi storied structures.

6.3 R&R POLICIES AND ENTITLEMENT FRAMEWORK

6.3.1 Introduction

This Resettlement Action Plan (RAP) document describes the principles and approach to be followed in mitigating negative social and economic impacts of the project. The guidelines prepared for addressing the issues is limited to study for design of proposed elevated alignment. The RAP has been developed based on the prevailing guidelines. This Resettlement Action Plan (RAP) document describes the principles and approach to be followed in mitigating negative social and economic impacts of the project. The guidelines prepared for addressing the issues is limited to the construction of elevated santhome bypass. Resettlement policy for this project has been prepared in accordance with the Policies for Involuntary Resettlement and the GoI/GoTN legislation pertaining to land acquisition and resettlement. This chapter details the legal provisions involved in the implementation of the R&R provisions in the project. The highlights, principles and provisions of the R&R policy are also detailed.

6.3.2 Legal Frame work for Land Acquisition

The Land Acquisition Act of 1894, amended by GoTN in 1996, guides all land acquisition in the state. As per the LA act, the District Collector will function as the Land Acquisition Officer on behalf of the Government. As has been the experience with similar development projects within the state and elsewhere, the LA process is time consuming and contributes to delays in the projects. A major cause of the delays in LA has been regarding the amount of compensation for the land and structures lost leading to legal proceedings. To overcome these difficulties during the implementation of TNRSP, the HD, GoTN vide G.O. Ms. No. 174 dated 25.09.2001 has empowered the District Collectors to acquire land through private negotiations with the PAPs. Only in cases where the mutual agreement cannot be reached about the purchase price, the provisions of the LA Act, 1894 will be invoked. The relevant provisions of the LA Act (applicable only for cases where the land is acquired as per the LA act) are summarized below.

- **Section 4(1)** provides for notification to landowners about the interest of the Government to acquire the notified land;
- **Section 5(a)** permits landowners to express their objections against such land acquisition;

- **Section 11** empowers the Collector to award all compensations;
- **Section 18** allows the land owner who has not accepted the award by the collector to approach the court (sub-court) to seek enhanced compensation;
- **Sections 23** provides matters apart from the market value, to be considered for the determination of compensation;
- **Section 24** provides for matters which are to be neglected in determining compensation;
- In addition to the market value, a solatium of 30% on market value is allowed to be paid under **section 23 (2);**
- Under **section 25** of LA Act the compensation amount fixed by the court should not be lesser than the compensation awarded by the District Collector under **section 11;**
- **Section 28** empowers the court to order the District Collector to pay interest at 9% on the amount awarded by the court in excess of the compensation granted by the Collector;
- **Section 30** allows the District Collector to refer the case to the court in case of any disputes as to apportionment of the compensation, ownership etc;
- **Section 49** permits acquisition of part of house or building in the desire of the land/building owner; and,
- **Section 51** of Land Acquisition Act exempts the lands or the buildings acquired under this act from stamp duty and registration fees.

6.3.3 TamilNadu Encroachment Act,1905

The Tamil Nadu Encroachment Act provides for both an assessment and a penalty to be levied against illegal occupiers of publicly owned land, as well as the forcible eviction of such occupiers and forfeiture of their property, if any, subject only to service of a notice. This Act, framed in 1905 has not recognized the provision of any compensation for shifting squatters or encroachers. However, the R&R policy for the project provides for both resettlement assistance and compensation for the benefit of squatters and encroachers. As the present R&R provision envisages the betterment of the existing provisions, the PIU does not envisage any difficulties in implementing the R&R policy provisions for squatters and encroachers. To ensure that the provisions of the R&R policy shall be followed as against the provisions of TN Encroachments

Act, guidelines for implementing R&R provisions will be issued (before 31st March 2003) to District Collectors and revenue authorities.

6.3.4 TamilNadu Highways Act, 2001

In relation to land and other property under the control of the highway authority, the Tamil Nadu Highways Act, 2000 has superseded the Tamil Nadu Encroachments Act 1905. The TN Highways Act differs from the TN Encroachments Act in:

- The Highways Act recognizes the right of the illegal occupiers to their property unlike the Encroachment Act, and,
- The Highways Act empowers the Government to exempt any land or other property under the control of highways authority from the exemption of the Act.

The following provisions of the Tamil Nadu Highways Act empower the highway authority to take up measures to prevent any further encroachments onto the RoW:

- **Section 26** of the Highway Act of Tamil Nadu, 2001 provides for the prevention of unauthorized occupation of, and encroachment onto the highway and removal of encroachments.
- **Section 28 (1)** of the Act empowers the highways authority to conduct checks and periodical inspection of highway boundaries with a view to ensure the prevention of unauthorized encroachments and the removal of such encroachments.
- **Section 28 (2)** of the Act empowers the highway authority to remove without any notice, any structure encroaching the highway or in any area where the construction or development of a highway is undertaken or proposed to be undertaken.
- **Sections 47 and 48** of the Highway Act authorize the Highways Department to penalize the encroachments or illegal occupation of the highway land.

6.3.5 Governing Acts and Policies

In India, compensation for land acquisition is governed by the Land Acquisition Act, 1894. In addition, National Policy on Resettlement and Rehabilitation (NPRR), 2007 formulated by Ministry of Rural Development (MoRD) gives the guidelines for resettlement and rehabilitation of project affected families (PAFs), if the affected families are 500 or more in plain area and 250 or more in hilly area. However, for the purpose of maintenance, sustenance and management of

State Highways, The Tamil Nadu State Highways 2001 has been promulgated. Hence, Land acquisition in this project will be carried out under this Act.

Key points in the policy:

- Ensures that all PAPs will be resettled and rehabilitated with the aim of improving their livelihoods and standards of living or at least restored to earlier levels and in such a manner that PAPs have a share in project benefits
- When PAPs lose land/structures and will be displaced and/or economically affected adversely, detailed planning will be made along with implementation arrangements in an operational Resettlement Plan
- Defines PAPs, lists entitlements, details peoples' participation, supervision by NGOs and supervision and monitoring
- Mentions an implementation schedule that would be broken up into specific activities and coordinated with the chronogram of construction
- The cost would be part of the overall project budget and adequate provision would be made for contingencies and inflation

Relevant provisions in this policy prepared by GoTN have been incorporated into procedures keeping in view the practical issues related to urban infrastructure projects.

Compensation under Land Acquisition Act 1894: Compensation to land will be paid at replacement cost to all titleholders, by the state government, from whom land will be acquired for the project.

i Where possible and permitted by regulations, the required land will be acquired by implementing agencies through direct purchase based on 'willing buyer willing seller' principle, as the first option. Negotiations for direct purchase would be carried in a public place and in transparent manner. All proceedings will be documented and final agreement would be signed by the negotiating parties.

ii Where direct purchase by implementing agencies is not materialized, negotiated settlement can be reached through the provisions of the TN Highway Act 2001, Clause 19(2), i.e. through the GoTN designated authorities (district collectors or specific authority to be authorized for the sub project) for that purpose, in respect of sub projects for Transportation Component.

iii Where negotiated settlement under the procedures specified under (ii) above is not possible, and for other urban projects, required land for the sub-projects would be acquired following the provisions of the LA Act (Emergency clause will not be applied) and the ESF.

iv The negotiated amount will be paid within three months from the date of final agreement of the negotiated settlement by the negotiating parties. Interest @12% p.a. will be added for any delay exceeding three months in payment of compensation.

v. In case of payment of compensation under the TN Highway Act or Land Acquisition Act, all other additional assistance will be as per the entitlement matrix.

Compensation for Land: Compensation to land will be paid by the state government at replacement cost to all titleholders from whom land will be acquired for the project as per the below procedures.

6.3.6 Entitlements for PAPs

The entitlement for different category of impacts is explained in the entitlement matrix. The principles of the entitlement matrix are in accordance with the National Policy on R & R, 2007.

Estimate of Affected Persons: A full survey will be undertaken to register and document the socio –economic status of the affected population in the project area.

The start date of the census survey will be the cut –off date for entitlements under the project, to determine who all will be entitled for resettlement and rehabilitation.

Consultative process for developing a Rehabilitation Action Plan (RAP): GoTN will adopt a consultative process for developing a Rehabilitation Action Plan and monitor the implementation. The people will be informed and consulted about the project, its impacts, their entitlements and the options.

Redress Mechanism for Grievances: Initially any aggrieved PAP will be directed to approach the appropriate Commissioner of ULB and subsequently if not satisfied to District Collector during the Collectors weekly grievance redress day. The third level for grievance redress will be the high level committee which would respond within 30 days from the date of receiving the petition. The action taken on the grievance will be communicated to the aggrieved PAP through registered letter within 45 days from the date of receipt of the petition. The project affected person can go through these three grievance redress forum and if not satisfied can appeal in the court of law.

Step-by step process for registering and redressing of grievance, response time communication modes, mechanism for appeal and the provisions to approach civil courts in case of other provision fail will be disseminated. These will be prepared in the local language and distributed to all the PAPs.

Institutional Arrangements for Monitoring and Evaluation: At PIU, the social Assessment report will be reviewed and the Resettlement Action Plan will be prepared. Based on the outcome of the RAP, the R & R will be monitored by a social safeguard manager who would be totally responsible for social safeguards related issues. And in case of complicated R & R, the R & R will be monitored with the help of the external consultants.

6.4 ASSESSMENT OF LAND ACQUISITION

6.4.1 Implementation of the projects

Due to the practical difficulties in implementing the recommended alignment(Option-I) at a single phase, it was decided to implement the project in two phases.

Phase I –This phase starts from Kamaraj Salai near Light House to Oroor kuppam

Phase II – This phase starts from Oroor Kuppam and Joins ECR at Palavakkam

6.4.2 Identification of Impact-

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.

6.4.3 Impact Categories

The impact of the proposed project has been identified, inclusive of both title and non-title holders. Since the Proposed alignment is an elevated highway the major Impact to the fishermen settlements are not expected. Based on the field reconnaissance and detailed walk through, the loss categories broadly identified are:

- Loss of Land
- Loss of Structures
    a) Residential
    b) Commercial
    c) Religious
    d) Public utility
    e) Community structures like religious structures, schools, public Structures / institutions, hospitals, bus stands, community taps, public toilets, etc
- Loss of livelihood / trade / occupation
- Loss of Tenure

Since the proposed road is an elevated alignment and runs on the existing alignment, only the outer edge of the kutcha structures are affected. The field reconnaissance revealed that there are encroachments/squatters found along the alignment. However, it is not possible to precisely