E. EXECUTIVE SUMMARY

E.1 INTRODUCTION

1.1 General

Aarvee associates were awarded the work of preparation of DPR for development of Economic Corridors, Inter Corridors, Feeder Routes, Coastal Routes to improve the efficiency of freight movement in India under Bharatmala Pariyojana (Lot – 4 Tamil Nadu - Package – 8) vide agreement signed on 21.02.2018. The details of stretches included in the said package are given hereunder:

Table-E.1: List of Project Stretches

S.No	Classification	Corridor Name	Stretch Name	Road Category		Length (km)
				Old	New	
1	Feeder Route	Chennai-Puduchery	Mahabalipuram - Pondicherry	SH-49	NH-332A	99
2	Inter Corridor	Melur-Thanjavur-Kumbakonam-Sirkazhi	Kumbakonam - Sirkazhi	SH-64	NH-136B	59
3	Inter Corridor	Coimbatore – Trichy - Tanjavur	KUMBAKONAM - SIRKAZHI	SH-64/67	SH-64/67	77
4	Inter Corridor	Dindigal – Coimbatore-TN/Karnataka Border	Mettupalayam – Gudalur (NH-181)	NH-181	NH-181	98
5	Inter Corridor	Melur - Thanjavur	Tirupattur - Tanjavur	NH-36/226	NH-36/226	102
6	Inter Corridor	Melur – Thanjavur (Branch to Karaikudi)	Kotampatti – Tirupattur - Karaikudi	SH-35	NH-45B3 Ext.	52
7	Inter Corridor	Melur - Thanjavur	Melur - Tirupattur	SH-191	NH-338	35
8	Feeder Route	Chennai-Puduchery	Chennai - Mahabalipuram	SH-49	NH-332A	50
9	Coastal Route	Nagapatinam - Kanyakumari	Tuticorin – Kanyakumari	SH-176	-	115
Total Length in km						**687**

This section is the Executive Summary for the Final Feasibility Report for the project corridor Kumbakonam to Sirkazhi prepared based on the findings and up-gradation proposals.

1.2 Location of the Project

The project corridor Kumbakonam to Sirkazhi in the state of Tamil Nadu is chosen as one of the Inter-corridor route. The project corridor starts on NH-45C (Thanjavur – Ulunderpettai Section) at Kallappuliyur in the district of Thanjavur and ends at the intersection of NH-45A

near Sirkazhi in the district of Nagapattinam. The project road passes through Kallappuliyur, Veppathur, Ammanpettai, Parithikudi, Sooriyanarkoil, Manalur, Kottur, Mullukudi, Thirumancheri, Kadalangudi, Ponnur, Kaduvangudi, Aruvappadi, Keelamarudandanallur, Kanniyakudi, Thirupungur, Punganur, Vaitheeswarankovil,Thadalankoil and Agani. **The location map and index map of the project stretch are shown in Figure 1.1.**

Table-1.1: Location and Chainage of the Project stretch

Stretch	Coordinates	
	Starting Point	Ending Point
Kumbakonam - Sirkazhi	326056.06 m E,1217643.37 m N	360371.09 m E,1241504.30 m N

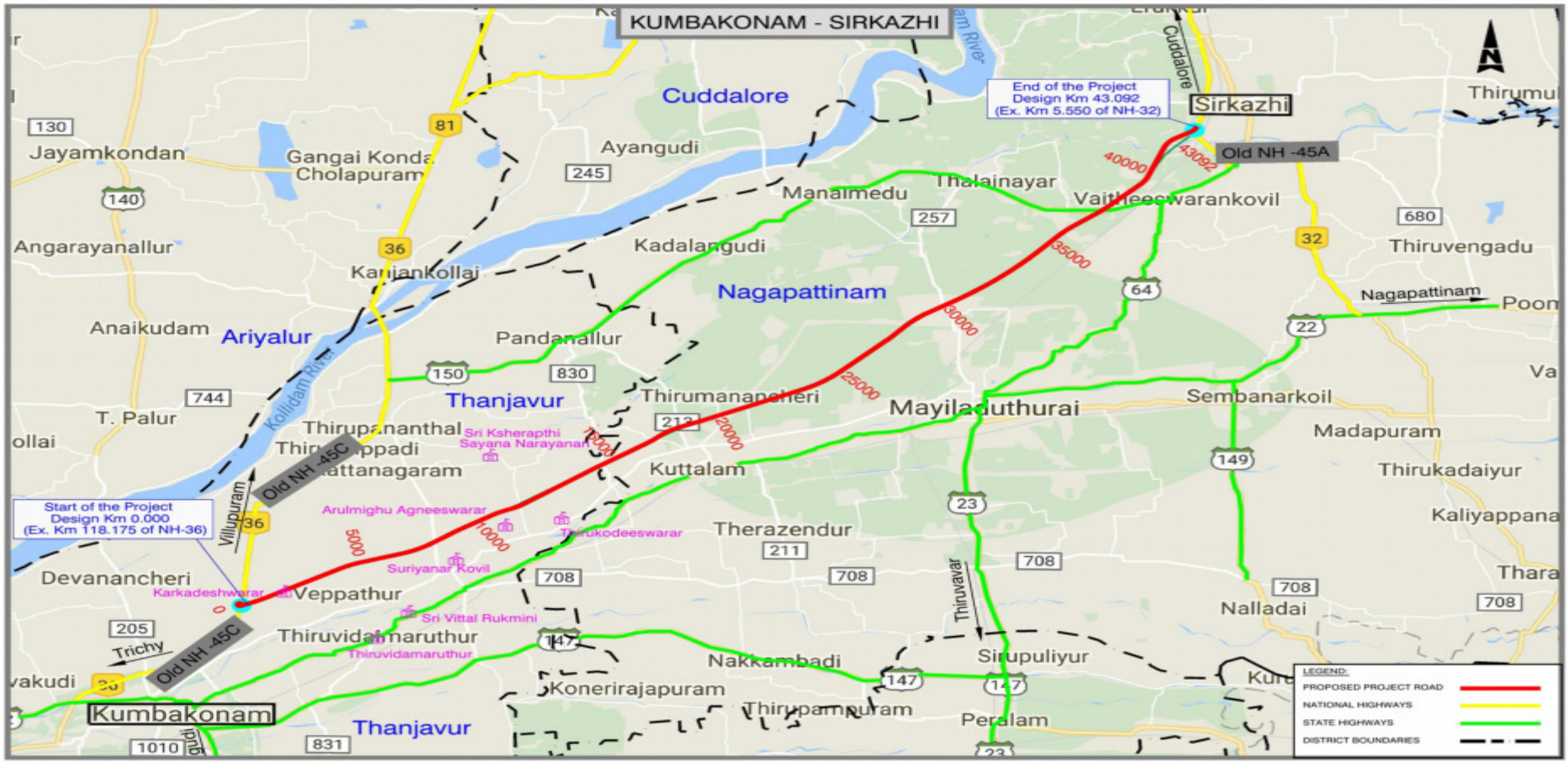


Figure 1.1: Representation of Entire Project Corridor

1.3 Objectives

The main objective of the consultancy service is to establish the technical, economic and financial viability of the project and prepare detailed project reports for development of the inter corridor for the existing two lane road to the necessary upgradable configuration by considering traffic studies and pavement life cycle costing analysis.

The viability of the project shall be established considering the requirements with regards to rehabilitation, upgrading and improvement based on highway design, pavement design, type of intersections, rehabilitation and widening of existing and/ or construction of new bridges and structures, road safety features, quantities of various items of works and cost estimates and economic analysis.

The Detailed Project Report would include detailed highway design, design of pavement and overlay with options for flexible or rigid pavements, design of bridges and cross drainage structures and grade separated structures, quantities of various items, detailed working drawings, detailed cost estimates, economic and financial viability analyses, environmental and social feasibility, social and environmental action plans as appropriate and documents required for tendering the project.

E.2 SCOPE OF SERVICES

The scope of consultancy services includes:

- Engineering surveys and investigations
- Traffic Surveys & Analyses
- Traffic Demand Estimation
- Highway & Structural design
- Environmental and Social Impact Assessment
- Estimation of Project Cost
- Economic & Financial Analyses
- Preparation of Feasibility study report and Detailed Project Report
- Preparation of Land Acquisition Plans
- Preparation of Bid Documents
- Obtain necessary Forest/ Environmental clearances etc.

E.3 SURVEYS & INVESTIGATIONS

The details of Surveys including Inventory and Investigations carried out during the feasibility study are presented below.

- Topographic surveys is being carried out all along the existing alignment by using LiDAR and as well as on proposed bypasses by using Total station.
- Detailed Inventory and condition surveys for road.
- Detailed Inventory and condition surveys for culverts and bridges.
- Traffic surveys including Classified traffic volume count (By using ATCC), Axle load, Origin – Destination study and Commodity movement study.
- Investigations of the existing pavement, road inventory and sub-grade, evaluation of the existing pavement as well as collection of samples of the existing pavement and laboratory testing of the collected samples.
- Collection of samples from pits adjacent to the existing road and along the proposed alignment to assess the existing sub-grade strength.
- Identification of borrow areas for construction of Embankment and Sub grade, material. Identification of source for other different materials which are used in the pavement and bridge construction.
- Environment based studies.
- Public Consultation.

E.4 EXISTING FEATURES OF THE PROJECT CORRIDOR

4.1 General

The project corridor Kumbakonam to Sirkazhi in the state of Tamil Nadu is chosen as one of the Inter-corridor route. The project corridor starts on SH-64 at Kumbakonam in the district of Thanjavur and ends on SH-64 at Sirkazhi in the district of Nagapattinam. The project road passes through the built-up areas of Kumbakonam, Ammachatram, Umamaheshwarapuram, Thirubuvanam, Thiruvidaimaruthur, Govindapuram, Narasingampettai, Mathirimangalam, Gunthalaipadi, Senniayanallur, Sitharkkadu, Koranad, Mayiladuthurai, Natham, Vaitheeswarankovil, Sirkazhi.

Table-4.1: Project Stretch Details

S. No	Kumbakonam to Sirkazhi Stretch	Length (Km)	Major settlements	Districts
1	Km 1.600 to Km 53.400	51.800	Kumbakonam,Mayiladuthurai,Sirkazhi	Thanjavur and Nagapattinam
Total length in Km		**51.8**		

Note:- This report has been described in an increasing chainage of existing kilometre stones from Kumbakonam - Sirkazhi. All chainages referred in this report refer to existing chainages unless otherwise specified.

The Consultant conducted inventory survey to get acquainted with the actual site conditions. All observations made are discussed in subsequent sections.

4.2 Intersections

There are 5 major and 210 minor intersections along the project corridor. Apart from these, there are local gravel and earthen roads leading to clusters of houses and hamlets in villages and small towns.

4.3 Cross Drainage Works

As a part of upgrading of the project, it is required to make an assessment of existing structures with regards to their inadequacies to ensure that they meet the objectives of the project. There are 13 minor bridges, 39 pipe culvert and 25 slab and box culverts along the project stretch. A list of existing cross drainage structures along the project stretch are listed in *Table-4.2*. to *Table-4.4.*

Table-4.2: Major Bridges

S. No.	Existing Chainage (Km)	Remarks	Span Arrangement(m)
-	-	-Nil-	-

Table-4.3: Minor Bridges

S. No.	Chainage (Km)	Span Arrangement(m)	Remarks
1	00.950	1 x 6.7	-
2	01.690	2 x 2.75 + 1 x 6	Arch + Solid slab
3	12.170	3 x 12.30	-
4	34.610	5 x 5.60	-
5	34.700	4 x 8.4	-
6	42.540	2 x 10.5	-
7	43.700	2 x 6.50	-
8	43.950	2 x 5.60	-
9	44.340	2 x 5.60	-
10	45.180	4 x 6.20	-
11	45.440	2 x 5.60	-
12	47.150	2 x 6.50	-
13	51.150	2 x 5.60	-

Table-4.4: Summary of cross drainage structures

S. No.	Major Bridges	Minor Bridges	Slab/Box Culverts	Pipe Culverts	Total
1	-	13	25	39	78

4.4 Railway Level Crossings/ RUB/ROB

There is 1 ROB along the project stretch.

Table-4.5: Railway crossings/RUB/ROB

S. No.	Existing Chainage (Km)	Location
1	30.880	Mayiladuthurai

4.5 Existing Underpasses/Overpasses

There are No Vehicular Overpass/Underpasses existing along the project corridor.

4.6 Built-Up Locations

The project stretch SH-64 passes through many towns and villages viz., Kumbakonam , New Agraharam , Umamahswarapuram , Tirubhuvanam , Thiruvidaimaruthur , Aduthurai , Kuttalam , Thiruvavaduthurai , katuvalavu , Mayiladuthurai , Dharmanathapuram , Vaitheeswarankovil , Sirkazhi. All the habitations along the project stretch are listed in the *Table-4.6*.

Table-4.6: Settlements Limits

S.No	District	Taluk	Name of the Villages
1	Thanjavur	Kumbakonam	Kumbakonam
2			Ammachatram
3			Umamaheshwarapuram
4		Thiruvidaimarudur	Thirubuvanam
5			Thiruvidaimaruthur
6			Govindapuram
7			Narasingampettai
8	Nagapattinam	Kuttalam	Mathirimangalam
9			Gunathalaipadi
10			Senniayanallur
11		Mayiladuthurai	Sitharkkadu
12			Koranad
13			Mayiladuthurai
14			Natham
15		Sirkazhi	Vaitheeswarankovil
16			Sirkazhi

4.7 Existing Geometrics

The existing geometric alignment of the project stretch might have been designed as per National Highway standards and may not meet the present standards of a National Highway.

The design is deficient in sight distance, curve radii and super elevation at few locations. Further, there are several curves near village limits which might require improvement. It is also observed that at many locations the horizontal alignment is poor.

4.8 Carriageway

The existing carriageway width varies from 10 m to 20 m. Details of the Existing Carriageway is shown in the **Table 4.7.**

Table-4.7 Existing Carriageway Details

S. No	Stretch	Highway	Existing Chainage(Km)		Lane Configuration	Carriage way(m)	EROW (m)
			From	To			
1	Kumbakonam - Sirkazhi	SH-64	1.600	53.400	2 Lane	7 - 10	10 - 20

4.9 Existing Pavement Condition

Flexible pavement is observed throughout the project stretch. The riding quality/pavement condition varies from good to fair along the entire stretch with very few sections of the road showing various types of distresses such as Raveling, Potholes, undulations and cracks.

4.10 Right Of Way

The existing Right of Way (RoW) varies between 10 m to 20 m along the corridor. RoW pillars were found at few locations along the project stretch. The precise RoW details will be ascertained from the revenue records to clarify on the exact land available for construction. Land acquisition plans would be prepared to have uniform RoW in accordance with NHAI guidelines. Additional land acquisition will be proposed as per project requirements and in accordance with ToR/ NHAI guidelines.

Table-4.8 Existing Right of Way Details

S. No	Stretch	Highway	Existing Chainage(Km)		Existing Right of Way
			From	To	
1	Kumbakonam - Sirkazhi	SH-64	1.600	53.400	10 m to 20 m

E.5 TRAFFIC STUDIES

5.1 Traffic study

Traffic study has a key role in the proposing any new road network as it is a primary input. So consultant has gone through a detailed traffic study. Based on the reconnaissance survey conducted by the consultant, Mid block sections and major Intersections were identified to capture the traffic flow pattern. Classified traffic volume count, Origin & Destination surveys, Axle load surveys were carried out. Locations of the traffic surveys conducted are tabulated in table 5.1

Table 5.1: Location and schedule of the traffic surveys

S. No	Type of Survey	Location	Chainage (km)	Highway	Duration of Survey	Date of Survey
1	Classified Traffic Volume Counts	Aduthurai	14.000	SH-64	3 Days	29.03.2018
		Natham	43.000	SH-64		29.03.2018
		Thiruvoipaddi	109.5	NH-45C	24 Hours	02.04.2018
2	OD Survey	Aduthurai	14.000	SH-64	24 Hours	30.03.2018
		Natham	43.000	SH-64		29.03.2018
		Thiruvoipaddi	109.5	NH-45C		02.04.2018
3	Axle Load Survey	Aduthurai	14.000	SH-64	24 Hours	30.03.2018
		Natham	43.000	SH-64		29.03.2018
		Thiruvoipaddi	109.5	NH-45C		02.04.2018
4	Number plate Survey	Aduthurai	14.000	SH-64	24 Hours	30.03.2018
		Natham	43.000	SH-64		29.03.2018

S. No	Type of Survey	Location	Chainage (km)	Highway	Duration of Survey	Date of Survey
		Thiruvoipaddi	109.5	NH-45C		02.04.2018

5.1.1 Classified Traffic Volume Count

The Automatic Classified Traffic Volume Count (ATCC) surveys were conducted at 2 strategic points, i.e., at Km 14.000 (Aduthurai) on SH-64, at Km 43.000 (Natham) on SH-64 for 3 days and additional TVC survey was conducted at Km 109.500 at Thiruvoippadi on NH-45C of (Thanjavur – Ulunderpettai Section) for 1 day. The surveys were conducted using Pneumatic tubes and video graphic methods. The average daily traffic (ADT) was computed by using three day traffic data. By using secondary data (fuel data), Seasonal correction factor was derived which can be used as multiplication factor for converting average daily traffic (ADT) into Annual average daily traffic (AADT). The average daily traffic (ADT) and annual average daily traffic (AADT) for each location is mentioned in the table 5.2.

Table 5.2: ADT & AADT at survey locations

Existing Chainage (Km)	Survey location	ADT		AADT	
		Vehicles	PCUs	Vehicles	PCUs
14.000	Aduthurai (SH-64)	13896	11522	14364	11861
43.000	Natham (SH-64)	11631	10988	12017	11296

In additional location traffic survey carried out, The Traffic on Project Highway as shown in below table:

Existing Chainage (Km)	Survey location	ADT		AADT	
		Vehicles	PCUs	Vehicles	PCUs
109.500	Thiruvoippadi(NH-45C)	11253	11097	11093	10473

5.1.3 Vehicle Damage Factor

Axle load surveys were carried out for period of 24 hours 2 locations i.e., at Km 14.000 on SH-64 (Aduthurai) , at Km 43.000(Natham) on SH-64 Vehicle Damage Factor (VDF) was computed for each type of commercial vehicle and mentioned in table 5.3.

Table 5.3: Vehicle Damage Factor

Type of Vehicle	VDF Near Aduthurai @ Km 14.000 (SH-64)			VDF Near Natham @ Km 43.000 (SH-64)		
	Towards	Towards	Preferred	Towards	Towards	Preferred

Type of Vehicle	VDF Near Aduthurai @ Km 14.000 (SH-64)			VDF Near Natham @ Km 43.000 (SH-64)		
	Sirkazhi	Kumbakonam		Sirkazhi	Kumbakonam	
2 Axle	1.19	2.13	**2.13**	1.23	2.10	**2.10**
3 Axle	3.11	5.07	**5.07**	3.88	5.91	**5.91**
M Axle	7.50	3.61	**7.50**	6.52	6.59	**6.59**
LCV	0.42	1.77	**1.77**	0.55	1.06	**1.06**
Mini LCV	0.002	0.006	**0.006**	0.002	0.003	**0.003**

5.1.4 Homogeneous Sections

Considering the various AADT values along the stretch, as observed in various traffic survey locations, the total project road is divided into Two homogeneous road sections for the purpose of traffic analysis and forecast so as to examine the strategies for tolling and also for pavement design purpose. Table below gives the details of the homogeneous sections identified for the project road.

Table 5.4 : Homogeneous Sections along the project corridor

Section	Starting		Ending		Length of HS (km)
	Design Chainage (Km)	Location	Design Chainage (Km)	Location	
HS-1	0.000	Kallappuliyur	43.000	Sirkazhi	43.000

5.1.5 Traffic Assignment:

The traffic assignment is one of the major influential things for the demand assessment of traffic for any major road projects. Since the project road is greenfield alignment, Number Plate registration data and Road Side Interview has been carried out to find out the potential divertable traffic from the locations where the possibility of diversion of traffic on the proposed Stretch was observed.

5.1.5.1 Methodology

Based on Origin and Destination Studies at Natham on SH-64 and at Aduthurai on SH-64, It is observed that Traffic from Kumbakonam to Sirkazhi and vice versa uses project Stretch homogeneous section-I. Percentage of Traffic which is likely to be used by Homogeneous Section-1 (Kallappuliyur - Sirkazhi) is given Below:

Table-5.5: Assigned Traffic on to project Stretch Percentages

Table-5.5(a):Adopted for Assigned & Induced Traffic from Location Aduthurai at km 14.000 on SH 64– Kumbakonam to Sirkazhi

Type of Vehicle	Traffic at 14.000 km on SH-64 at Location -Aduthurai	Percentage of Traffic expected to use project stretch from OD Studies at Location 1 (Assigned Traffic)	Assigned Traffic	Induced Traffic (15%)	Final Volume
Car	1642	31	504	76	580
Bus	257	28	72	11	83
Mini Bus	120	16	19	3	22
LCV	56	20	11	2	13
Mini LCV	229	39	88	13	101
2 Axle	112	38	42	6	48
3 Axle	15	33	5	1	6
Multi Axle	2	50	1	0	1
Final ADT (Vehicles)					854
Final ADT (PCU)					1149

Table-5.5(b): Percentages Adopted for Assigned & Induced Traffic from Location - Natham at km 43.000 on SH 64– Kumbakonam to Sirkazhi

Type of Vehicle	Traffic at 43.000 km on SH-64 at Location -Natham	Percentage of Traffic expected to use project stretch from OD Studies at Location 2 (Assigned Traffic)	Assigned Traffic	Induced Traffic (15%)	Final Volume (Assigned + Induced Traffic)
Car	1801	84	1550	233	1783
Bus	346	80	277	42	319

Type of Vehicle	Traffic at 43.000 km on SH-64 at Location -Natham	Percentage of Traffic expected to use project stretch from OD Studies at Location 2 (Assigned Traffic)	Assigned Traffic	Induced Traffic (15%)	Final Volume (Assigned + Induced Traffic)
Mini Bus	97	81	78	12	90
LCV	85	90	73	11	84
Mini LCV	181	70	127	19	146
2 Axle	174	7	113	17	130
3 Axle	92	70	38	10	78
Multi Axle	22	50	11	2	13
Final ADT (Vehicles)					2643
Final ADT (PCU)					3830

Table-5.5(c): Percentages Adopted for Assigned & Induced Traffic from Location Aduthurai at km 14.000 on SH 64– Sirkazhi – Kumbakonam

Type of Vehicle	Traffic at 14.000 km on SH-64 at Location -Aduthurai	Percentage of Traffic expected to use project stretch from OD Studies at Location 1 (Assigned Traffic)	Assigned Traffic	Induced Traffic (15%)	Final Volume
Car	1702	20	346	52	398
Bus	237	23	54	8	62
Mini Bus	107	14	15	2	17
LCV	60	28	17	3	20
Mini LCV	219	14	32	5	37
2 Axle	73	28	20	3	23

Type of Vehicle	Traffic at 14.000 km on SH-64 at Location -Aduthurai	Percentage of Traffic expected to use project stretch from OD Studies at Location 1 (Assigned Traffic)	Assigned Traffic	Induced Traffic (15%)	Final Volume
3 Axle	43	19	8	1	9
Multi Axle	11	33	4	1	5
Final ADT (Vehicles)					571
Final ADT (PCU)					795

Table-5.5(d): Percentages Adopted for Assigned & Induced Traffic from Location - Natham at km 43.000 on SH 64– Sirkazhi - Kumabkonam

Type of Vehicle	Traffic at 43.000 km on SH-64 at Location -Natham	Percentage of Traffic expected to use project stretch from OD Studies at Location 2 (Assigned Traffic)	Assigned Traffic	Induced Traffic (15%)	Final Volume Assigned + Induced Traffic
Car	1465	57	886	133	1019
Bus	232	76	177	27	204
Mini Bus	67	57	38	6	44
LCV	79	70	56	8	64
Mini LCV	159	50	84	13	107
2 Axle	136	70	95	14	99
3 Axle	74	70	52	8	60
Multi Axle	47	70	32	5	37
Final ADT (Vehicles)					1632
Final ADT (PCU)					2558

Based on Origin and Destination Studies at Aduthurai Location at 14.000 on SH-64, and Natham at 43.000 on SH-64, Traffic is assigned onto project stretch.

5.1.6 Growth rates

The past motor vehicle registration data at the district, state & country level provides valuable data to calculate the growth for the project. A more rational method will be able to establish a relationship between the socio-economic variables such as Population, Net State Domestic Product (NSDP) and Per-Capita Income (PCI) on one hand and the past motor vehicle registration data of different vehicle categories of vehicles on the other to determine the elasticity of transport demand with respect to different categories of vehicles. The Estimated growth rates and adopted are given in the Table-5.6 & 5.7.

Table 5.6: Estimated traffic growth rate

Year	2w	3w	Car	Bus	Goods	Tractor	Tractor with Trailor
Upto 2020	10.0%	10.0%	10.0%	7.5%	8.5%	9.0%	8.0%
2021-2025	9.50%	9.50%	9.50%	7.00%	8.00%	8.50%	5.50%
2026-2030	9.00%	9.00%	9.00%	8.50%	5.50%	8.00%	5.00%
2031-2035	8.50%	8.50%	8.50%	8.00%	5.00%	7.50%	4.50%
2036-2040	8.00%	8.00%	8.00%	5.50%	4.50%	7.00%	4.00%
2040-2045	7.50%	7.50%	7.50%	5.00%	4.00%	8.50%	3.50%
Beyond 2045	7.00%	7.00%	7.00%	4.50%	3.50%	8.00%	3.00%

Table 5.7 Adopted traffic growth rate

Year	2w	3w	Car (W)	Bus	Goods	Tractor	Tractor with trailor
Upto 2020	10.0%	10.0%	10.0%	7.5%	8.5%	9.0%	8.0%
2021-2025	9.50%	9.50%	9.50%	7.00%	8.00%	8.50%	5.50%
2026-2030	9.00%	9.00%	9.00%	8.50%	5.50%	8.00%	5.00%
2031-2035	8.50%	8.50%	8.50%	8.00%	5.00%	7.50%	5.00%
2036-2040	8.00%	8.00%	8.00%	5.50%	5.00%	7.00%	5.00%
2040-2045	7.50%	7.50%	7.50%	5.00%	5.00%	8.50%	5.00%
Beyond 2045	7.00%	7.00%	7.00%	5.00%	5.00%	8.00%	5.00%

5.1.6 Traffic Projections

Traffic was projected by using both estimated and adopted growth rates, but as per the ToR, traffic projected from adopted growth rate (5%) has been considered for capacity analysis.

National and State Highways in rural areas are normally designed for LOS B as per IRC:64. The maximum capacities per day for different types of carriageway for LOS B are:

- 15,000 PCUs for 2 lane carriageway with earthen shoulders
- 18,000 PCUs for 2 lane carriageway with paved shoulders
- 40,000 PCUs for 4 lane divided carriageway
- 60,000 PCUs for 6 lane divided carriageway

- **Recommendations:**

- As per a circular passed by MoRTH vide File No **NH-15017/21/2018** dated 26 Feb 2018.), Initially a 4-Lane carriageway with 4 lane structures shall be developed in case of green -field alignment is to be provided.

  Hence, 4 lane is proposed for entire stretch from Kumbakonam to Sirkazhi.

E.6 PAVEMENT DESIGN

6.1 Pavement Design

The Preliminary Pavement design is done for both flexible and rigid options. The flexible pavement design is done using IRC:37–2012. The rigid pavement design is done by using using IRC:58-2015.

6.1.1 Design MSA

Considering VDF and Growth rates, Million Standard Axle has been derived for design period of 15 years as per IRC 84.

Table 6.1: MSA for Homegeneous Sections

Section	Existing chainage		Million Standard Axles
	From (Km)	To (Km)	15 Years
Kumbakonam - Sirkazhi	0.000	43.000	20

6.1.2 Design of New Flexible Design

Pavement design is carried out in accordance with IRC 37:2012 for Granular base and sub-base layers. The design standards as given in plate-7 of IRC:37-2012, specifies the minimum thickness and specifications of various component layers for the given traffic in terms of cumulative standard axles and the subgrade CBR. The required pavement composition for the project corridor according to IRC:37-2012 is as given below:

Table 6.2: Flexible pavement crust composition

Homogeneous Sections	Design MSA (15 yrs)	CBR (%)	Crust Composition in mm					
			Bitumen Grade	BC	DBM	WBM	GSB	Total
HS -01	20	10	VG-40	40	80	250	200	**570**

6.1.3 Design for New Rigid Pavement

Rigid pavement for entire project corridor including toll plaza is designed in accordance with IRC:58-2015.

Table 6.3: Rigid Pavement Crust Composition

S.No	Item	Rigid pavement with Tied concrete shoulders
1	PQC of M40 grade, mm	260
2	DLC of M10 grade, mm	150
3	GSB, mm	150

S.No	Item	Rigid pavement with Tied concrete shoulders
4	Dia. of Dowel bar, mm	32
5	Length of Dowel bar, mm	450
6	Spacing of Dowel bar, mm	300
7	Dia. of Tie bar, mm (Plain bars)	12
8	Length of tie bar, mm	580
9	Spacing of tie bar, mm	450

6.1.4 Service Road Design

Pavement composition for service road is designed for 10 MSA.

Table-6.4: Pavement Composition for Service Roads

S.No	Pavement composition	Design thickness (mm)	Total thickness (mm)
1	Bituminous Concrete (BC)	40	540
2	Dense Bituminous Macadam (DBM)	50	
3	Wet Mix Macadam (WMM)	250	
4	Granular Sub-Base (GSB)	200	

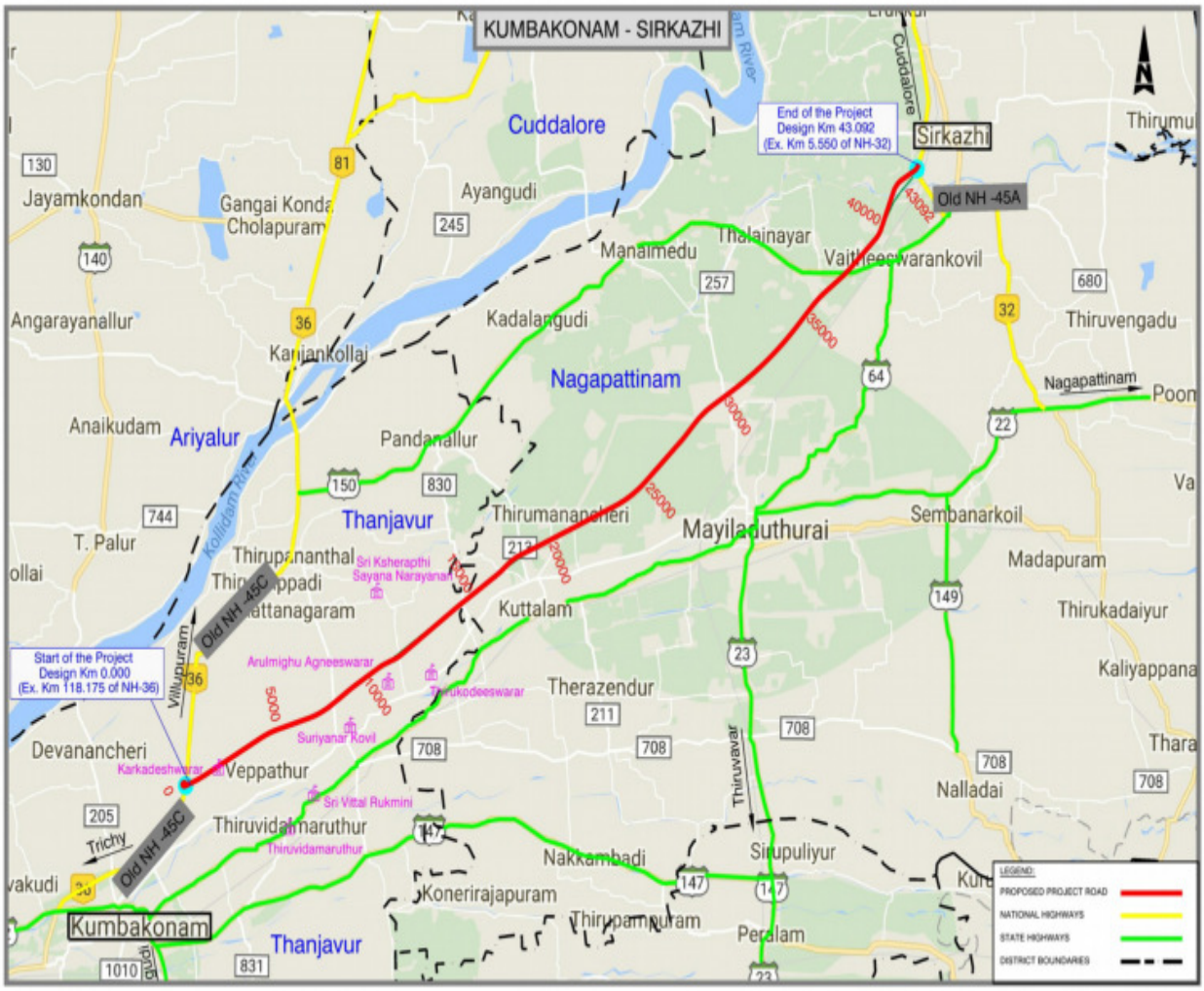
E.7 PROJECT PROPOSALS

7.1 Project Proposals:

The proposed project Highway starts with Design Chainage Km 00.000 Starts at Kallappuliyur on NH-45C and ends with Design Chainage Km 43.000 near Sirkazhi on NH-45A.

7.2 Greenfield Alignments:

Considering Builtup Locations along the existing road and poor geometry, a Greenfield Alignment is proposed from Kumbakonam to Sirkazhi.



Map Showing Proposed Project Stretch

7.1.1 Interchanges

To make traffic flow free from conflicts and considering the future developemt, Trumpets interchange have been proposed at Km 118.175 on NH 45 C and at Design Chainage 42.800 km of Kumbakonam-Sirkazhi Stretch.

Table 7.1: Details of Interchanges

S.No	Design Chainage(Km)	Type of Interchange	Proposed Span Arrangement (m)	Remarks
1	0.000	Trumpet	2 x 30 x 5.5	New
2	42.800	Trumpet	2 x 30 x 5.5	New

7.1.2 Proposed ROBs and RUBs

There are No ROB/RUB in the project corridor.

7.1.3 Major Bridges

One major bridge is proposed in the entire stretch. One major bridge is newly constructed and type of bridge is PSC girders. Details of major bridges are mentioned below.

Table 7.2: Details of Major Bridge

S. No	Design Chainage (Km)	Proposed Span Arrangement (m)	Remarks
1	20.800	2 x 30.0	MJB

7.1.4 Minor Bridges

A total number of 23 minor bridges are proposed in the entire stretch. Details of Minor Bridges to be reconstructed / widened / new construction are given below:

Table 7.3: Details of Minor Bridges

S. No	Design Chainage (Km)	Proposed Span Arrangement (m)	Remarks
1	5.239	1 x 6.0	-
2	6.330	1 x 12.0	-
3	8.752	1 x 6.0	-
4	9.295	1 x 6.0	-

S. No	Design Chainage (Km)	Proposed Span Arrangement (m)	Remarks
5	9.630	1 x 6.0	-
6	17.400	1 x 6.0	-
7	26.053	1 x 10.0	-
8	26.880	2 x 20.0	-
9	27.691	1 x 10.0	-
10	28.034	1 x 7.0	-
11	28.389	1 x 10.0	-
12	28.854	1 x 10.0	-
13	28.970	1 x 15.0	-
14	30.734	1 x 10.0	-
15	31.956	1 x 20.0	-
16	33.873	1 x 15.0	-
17	35.573	1 x 15.0	-
18	37.507	1 X 6.0	-
19	38.668	1x20.0	-
20	38.940	1 x 10.0	-
21	41.363	2x20	-

7.1.5 Culverts

Based on the information collected from reconnaissance survey and preliminary calculations, hydraulic performance of existing structures has been analyzed, and the following recommendations have been made.

Table 7.4: Culverts

.No.	Description	No. of Culverts	Recommendation
	Box Culvert	70	New
	Pipe Culvers	112	New

7.1.6 Proposed Underpasses

Underpasses were provided at locations where roads such as National Highways, State Highways & Major District Roads etc are intersected with project corridor and also locations where movement of local traffic is observed. Total 1 No. of Trumpet & 26 number of

underpasses including VUP , LVUP,VOP and SVUP were proposed and same mentioned in below table.

Table 7.5: List of Underpasses/Overpasses with dimensions

S. No	Design Chainage (Km)	Span (m)	Road to be carried over / under the structures	Remarks / Leads to Left/Right
1	2.104	1X7X4	SVUP	Thiruvisanallurpandarvadai
2	3.474	1X7X4	SVUP	Veppathur
3	5.636	1X7X4	SVUP	Parithikudi
4	6.849	1X7X4	SVUP	Parithikudi
5	8.081	1X12X4	LVUP	Sooriyanarkoil
6	9.287	1X7X4	SVUP	Manalur
7	10.631	1X7X4	SVUP	Kottur
8	11.697	1X12X4	LVUP	Kottur-Thuhili
9	12.779	1X7X4	SVUP	Kottur
10	14.043	1X7X4	SVUP	Keelasooriyamoolai
11	15.347	1X12X4	LVUP	Koothanur-Kathiramangalam
12	16.617	1X7X4	SVUP	Mullukudi
13	17.564	1X12X4	LVUP	Mullukudi-Kunathalapadi
14	18.616	1X12X4	LVUP	Crossing Pandanallur-Kutthalam Road
15	20.170	1X25X4.0	LVUP	Nagamangalam
16	21.306	1X7X4	SVUP	Kadalangudi
17	23.586	1X7X4	SVUP	Kadalangudi
18	25.505	1X7X4	SVUP	Ponnur-Vayalveliramapuram

S. No	Design Chainage (Km)	Span (m)	Road to be carried over / under the structures	Remarks / Leads to Left/Right
19	26.515	1X7X4	SVUP	Maharajapuram-Pandaravadaimappadugi
20	28.505	1X7X4	SVUP	Arulmolithevan
21	30.052	1X12X4	LVUP	Kondal-Kaduvangudi
22	33.078	1X12X4	LVUP	Keelamarudandanallur
23	35.948	1X7X4	SVUP	Thiruppungur-Kanniyakudi
24	37.433	1X20X5.5	VUP	Thiruppungur-Vaitheswarankoil
25	39.489	2X20X4.0	LVUP	Pundanur
26	42.703	2X30X5.5	VOP	Kovilpathu

7.1.7 Slip Roads & Service Roads

Slip roads, Service roads and Cart Tracks are proposed at following locations to move the local traffic along the proposed highway.

Table 7.6: Slip Roads & Service Roads

S. No	Design Chainage		Length (Km)	SLIP/SR	REMARKS
	From	To			
1	7.680	8.500	0.820	Slip Road	LVUP @ 8.081 KM
2	11.260	12.080	0.820	Slip Road	LVUP @ 11.697 KM
3	14.960	15.750	0.790	Slip Road	LVUP @ 15.347 KM
4	18.250	19.030	0.780	Slip Road	LVUP @ 18.616 KM
5	27.820	28.180	0.360	Service Road	-
6	28.180	29.110	0.930	Slip Road	SVUP @ 28.505 KM

S. No	Design Chainage		Length (Km)	SLIP/SR	REMARKS
	From	To			
7	29.110	29.670	0.560	Service Road	-
8	29.670	30.410	0.740	Slip Road	LVUP @ 30.052 KM
9	30.410	32.670	2.260	Service Road	-
10	32.670	33.520	0.850	Slip Road	LVUP @ 33.078 KM
11	36.900	37.850	0.950	Slip Road	VUP @ 37.433 KM
12	38.600	39.050	0.450	Service Road	-
13	39.050	40.000	0.950	Slip Road	LVUP @ 39.489 KM

7.1.8 Green field Alignments

Green field Alignment is proposed at following location where existing road is passing through built-up area, Bad geometries.

7.1.9 Toll Plazas

One toll plaza has been proposed at mid block sections of the proposed project corridor and the same mentioned in the table

Table 7.7: Toll Plazas Locations

Sections	Design chainage (Km)	Remarks
Kumbakonam-Sirkazhi	22.800	New

7.1.10 Bus-Bays and Bus Shelters

Bus bays/shelters are proposed at built up areas. The following are the proposed bus bays/shelters.

Table 7.8: Locations of the bus bays

S.No	Existing Chainage (Km)	Design Chainage (Km)	Name of Village	Side (LHS/RHS)
-	-	-	-	-

Table 7.9: Locations of the bus shelters without bus bays

S.No	Existing Chainage (Km)	Design Chainage (Km)	Side (LHS/RHS)	Name of Village
1	-	8.030	LHS	Sooriyanarkoil
2	-	8.130	RHS	Sooriyanarkoil
3	-	11.640	LHS	Kottur
4	-	11.750	RHS	Kottur
5	-	15.300	LHS	Kathiramangalam
6	-	15.400	RHS	Kathiramangalam
7	-	18.560	LHS	Nagamangalam
8	-	18.665	RHS	Nagamangalam
9	-	28.450	LHS	Arumolithevan
10	-	28.560	RHS	Arumolithevan
11	-	30.000	LHS	Kaduvangudi
12	-	30.100	RHS	Kaduvangudi
13	-	37.330	LHS	Thiruppungur
14	-	37.530	RHS	Thiruppungur
15	-	39.390	LHS	Punganur
16	-	39.590	RHS	Punganur

7.1.11 Truck Lay bays and Truck Parking

Truck lay bays have been provided at following locations to make parking facility for trucks that are passing project corridor

Table 7.10 : Locations of Truck lay bays and Truck Parking

S.No	Existing Chainage (Km)	Design Chainage (Km)	Side	Village
1	-	2.500	LHS&RHS	Thiruvisanallurpandarvadai
2	-	40.300	LHS&RHS	Punganur

7.2.13 Rest Area

Rest area has been provided at following location.

Table 7.11: Locations of Rest Areas

S.No	Existing Chainage (Km)	Design Chainage (Km)	Side	Village
1	-	27.300	RHS	Neivasal
2	-	34.200	LHS	Ponmasanallur

E.8 COST ESTIMATES

8.1 Cost Estimate

Cost estimate provides vital input to the financial evaluation of the project. The cost estimates have been prepared for the project corridor separately for widening the existing road to four lane carriageway including strengthening /widening of the existing pavement, strengthening / widening of existing bridge structures, construction of new bridges, rehabilitation and reconstruction / widening of cross drainage structures, longitudinal drains, junction improvements, vehicular underpasses, light vehicular underpasses, road furniture, bus bays, truck lay byes, way side amenities, toll plazas, etc.

The summary of cost is as given below.

Total Project Cost	
Item Description	**Total cost in Rs.**
BILL NO: 1 - SITE CLEARANCE AND DISMANTLING	11,492,124
BILL NO: 2 - EARTHWORKS	1,025,331,001
BILL NO: 3 - BASE COURSES	1,491,544,999
BILL NO: 4 - PAVING COURSES	1,168,520,354
BILL NO: 5a - REPAIR AND REHABILATION OF STRUCTURES	-
BILL NO: 5b - BRIDGES	734,091,078
BILL NO: 5c - CULVERTS	462,023,474
BILL NO: 5d – UNDERPASSES	374,588,041
BILL NO: 5e – ROB, RUB, FLYOVER, VIADUCT AND OVERPASS, INTERCHANGE	-
BILL NO: 5f – DRAINAGE, PROTECTIVE WORKS AND OTHER SERVICES	609,632,627
BILL NO: 5g – REINFORCED EARTH AND TOE WALLS	343,445,492
BILL NO: 5h – INTERCHANGES	521,668,812
BILL NO: 6 – JUNCTIONS	4,372,777
BILL NO: 7 – TOLL PLAZA	80,774,209
BILL NO: 8 – USER AMINITIES	81,698,052
BILL NO: 9 - TRAFFIC SIGNS, MARKINGS AND APPURTENANCES	312,617,446

Total Project Cost	
BILL NO: 10 - MISCELLANEOUS	273,364,821
BILL NO: 11 – MAINTENANCE OF ROAD DURING CONSTRUCTION	-
Total Construction Cost	**7,495,165,308**

E.9 ECONOMIC ANALYSIS

9.1 Economic Analysis

The Economic Analysis has been done to check the viability of the Project. The analysis was done using the HDM-4 (version-2). The principle benefits considered are savings in vehicle operating costs, savings in travel time costs and reduction in accidents. The options considered are as follows:

The annual cost and benefit streams are used to derive the net cash flow for the project. The EIRR and NPV @ 12% discount rate are determined using the discounted cash flow technique for all the Sections. The results for the improvement scheme are presented below :

Table-9.1: EIRR & NPV

Total Package	EIRR (%)		NPV (Cr.)	
	20 Year	30 Years	20 Year	30 Years
Total Package	13.4	14.8	72.6	186.1

9.2 Conclusion

From the results of the Economic Analysis, it can be seen that the improvement scheme, the EIRR is getting higher than minimum threshold value of 12%.

So it can be concluded that the project of four lane with paved shoulder option is economically viable and recommended for implementation.

E.10 FINANCIAL ANALYSIS

10.1 Location of Toll Plaza

The fee levied and collected for use of a National highway shall be due and payable at the toll plazas. The toll revenue has been calculated considering the proposed toll plazas at the following locations as shown below.

Table-10.1:Location of Toll Plazas and their tolling lengths

Toll Plaza Location	Existing Chainages (km)			Bypass/Green Field Length if any (km)
	From	To	Length	
Km 22.8	0	43	43	Total Green Field

10.2 Tollable Traffic

The classified traffic volume count data collected has been analyzed to assess the traffic intensity at the proposed toll plaza location. The summary of Annual Average Daily Traffic (AADT in number of vehicles) at the proposed toll plaza location is given below.

Table-10.2: Tollable Traffic

At Toll Plaza Location	Tollable Traffic								
	Cars	M. Bus	Bus	LCV	2 AT	3 AT	M AT	M. LCV	Total
Km. 22.800	4005	217	1030	192	408	169	53	386	**6460**

10.3 Toll Revenue

Toll revenue is the product of the forecast traffic expected to use the road and the appropriate toll fee for the vehicle category. Toll indexing has been carried out as per the new toll policy and rounded off to nearest five rupee multiples. As per the new toll policy the toll revenue calculations for through traffic, local traffic and vehicles making frequent trips are given below:

Table-10.3: Toll Revenue Per Year

Years		Toll Plaza	
From	To	Rs Crores per Year	Rs Lakhs / Day
2018	2019	15.70	4.30
2019	2020	17.58	4.82
2020	2021	19.21	5.26
2021	2022	21.41	5.87
2022	2023	23.31	6.39
2023	2024	25.87	7.09
2024	2025	28.92	7.92
2025	2026	31.38	8.60
2026	2027	34.99	9.59
2027	2028	38.56	10.56
2028	2029	42.71	11.70
2029	2030	47.39	12.98
2030	2031	52.24	14.31
2031	2032	58.05	15.91
2032	2033	63.80	17.48
2033	2034	70.58	19.34
2034	2035	77.88	21.34
2035	2036	85.85	23.52
2036	2037	95.52	26.17
2037	2038	105.40	28.88
2038	2039	116.43	31.90
2039	2040	129.22	35.40
2040	2041	143.70	39.37
2041	2042	158.38	43.39
2042	2043	175.56	48.10
2043	2044	194.77	53.36
2044	2045	215.79	59.12
2045	2046	238.71	65.40
2046	2047	265.81	72.83
2047	2048	293.55	80.42
2048	2049	326.59	89.48
2049	2050	360.53	98.77

10.4 Financial Viability

Based on the project structure traffic study and toll rate analysis, financial feasibility analysis has been carried out as per the methodology outlined in earlier sections. The objective of the financial analysis is to ascertain the existence of sustainable project returns, which shall successfully meet the expectations of its financial investors. The

analysis reveals various FIRR values corresponding to each year of toll operation. FIRR for the Returns on Investment and Returns on Equity for the concession period of 20 years has been examined and tabulated below :

Table-10.4.: Financial Analysis Results

Tolling Lengths (km)			Grant (%)	Concession Period	Civil Cost in Cr. Year 2018	Project FIRR (%)	Equity FIRR (%)
From	To	Length					
00.000	43.000	43.000	40	20	750	1.70%	"-"ve

10.5 Conclusion

A minimum return on equity of around 15% could be considered satisfying the requirement of prospective concessionaire. The project is not yielding any return on equity even with 40% grant and 20 years concession period. In view of this, it can be concluded that the option with BOT (Toll) is not viable for taking up the project on BOT -Toll basis.

In view of the above it is recommended to taken up the project on one HAM Mode.

E.11 CONCLUSIONS AND RECOMMENDATIONS

Some of the important aspects which require the attention of the authority have been presented below for consideration, along with the recommendations of the consultants.

1. Right of Way

The Right of Way required is 60m for the design TCS proposed as per IRC SP: 84-2014.

2. Traffic

Based on the traffic survey carried out, the traffic on Project Highway as shown in below table.

Existing Chainage	Survey location	AADT	
		Vehicles	PCUs
Km 14.000 on SH-64	Aduthurai	14364	11861
Km 43.000 on SH-64	Natham	12017	11296

In additional location traffic survey carried out, The Traffic on Project Highway as shown in below table:

Existing Chainage	Survey location	AADT	
		Vehicles	PCUs
Km 109.500 on NH-45C	Thiruvoippadi	11093	10473

3. Pavement Type

Flexible pavement is recommended for main carriageway for the entire Project Highway. Rigid pavement is recommended for Toll Plaza locations.

4.Bypass

A Greenfield alignment is proposed from Kumbakonam to Sirkazhi to avoid the built-up locations, Granite mines .

5. Up-gradation of the structures

All major, Minor Bridges, Vehicular under pass and VUP(Grade-II) is 4 lane configuration were proposed in the Project Highway.

6. Land Acquisition

254.31 hectares of land is required to be acquired for development of the Project Highway.

7. Project Facilities

1 Toll plaza , 18 bus shelters and 2 truck lay bay have been proposed all along the Project Highway. Road side furniture like Traffic signs/over head signs, pavement markings, crash barriers, road studs is proposed as per four laning manual.

8. Mode of Execution

The mode of execution for the Project Highway is not viable under BOT Toll. Hence the mode of execution is recommended to taken up on HAM Mode.

9. Implementing contract packages:

The quantities and costs that have been worked out considering the project may be executed in single constructional package.

Section	Design Chainage(Km)	
	From	To
Kumbakonam - Sirkazhi	Km 0.000 (Kallappuliyur)	Km 43.000 (near Sirkazhi)

E.12 DECISIONS REQUESTED

The following are the decisions/ approvals requested from client/Authority so as to expedite the work progress.

1. Approval for the greenfield alignment options proposed for Kumbakonam to Sirkazhi for conducting public consultations.
2. Approval for the proposed up-gradation proposals.
3. Mode of execution.
4. Type of Pavement to be adopted.