

**Preparation of Detailed Project Report (DPR) study for  
Chertalai – Thiruvananthapuram Section of NH-47 (New  
NH-66) (from KM 379/100 to KM 551/900)  
[Package –III] under NHDP Phase III in the State of Kerala**

**Final Detailed Project Report**

**VOL-I Main Report (Package III) Km 454.50 to Km 486.00**

September 2020



## DOCUMENT/REPORT CONTROL FORM

<b>File Location Name:</b>	Final Detailed Project Report
<b>Project Name:</b>	Preparation of Detailed Project Report (DPR) study for Chertalai – Thiruvananthapuram Section of NH-47 (New NH-66) (from KM 379/100 to KM 551/900) [Package –III] under NHDP Phase III in the State of Kerala
<b>Project Number:</b>	7061471
<b>Revision Number:</b>	0

### Revision History

Revision #	Date	Prepared by	Reviewed by	Approved for Issue by
0	30-09-2020	Anish , Jeshan, Neeraj,Alok Kumar,Harachand Jhankar	Manoj patro	Neeta Arora

### Issue Register

Distribution List	Date Issued	Number of Copies
National Highway Authority of India (NHAI) Project Implementation Unit, 1st Floor, T.C 36/574-1, Krishna Kripa, ERA-42, Palkulangara Jn., Vallakadavu. PO Thiruvananthapuram – 695008, Kerala		06
Office Library [SMEC office location]		
SMEC Project File	T:\Projects\7061471 Kerala\H - Deliverables\H1 - Reports\7. Final Detailed Project Report\Vol. I - Main Report	

### SMEC Company Details

<b>SMEC International Pty. Ltd. in association with SMEC India Pvt. Ltd.</b>			
1st Floor, West Wing, Novus Tower Plot No. 18, Sector 18 Gurugram 122 015 Haryana			
Tel:	+91 124 4552800, 4501100	Fax:	<b>0124 4501143</b>
Email:		Website:	<a href="http://www.smec.com">www.smec.com</a>

The information within this document is and shall remain the property of: **NHAI**

## TABLE OF CONTENTS

<b>ABBREVIATION</b> .....	vii
<b>CHAPTER 0 EXECUTIVE SUMMARY</b> .....	<b>1</b>
<b>0.1 PROJECT BACKGROUND</b> .....	<b>1</b>
<b>0.2 OBJECTIVES</b> .....	<b>1</b>
<b>0.3 PROJECT DESCRIPTION</b> .....	<b>2</b>
<b>0.4 SOCIO-ECONOMIC PROFILE OF THE PROJECT INFLUENCE AREA (PIA)</b> .....	<b>3</b>
<b>0.5 TRAFFIC STUDIES AND ANALYSIS</b> .....	<b>3</b>
<b>0.5.1 CLASSIFIED TRAFFIC VOLUME COUNTS</b> .....	<b>3</b>
<b>0.5.2 TURNING MOVEMENT SURVEY</b> .....	<b>1</b>
<b>0.5.3 ORIGIN DESTINATION SURVEY</b> .....	<b>1</b>
<b>0.5.4 AXLE LOAD SURVEY</b> .....	<b>1</b>
<b>0.5.5 SPEED AND DELAY SURVEYS</b> .....	<b>1</b>
<b>0.5.6 TRAFFIC FORECAST</b> .....	<b>1</b>
<b>0.5.7 TOLL</b> .....	<b>2</b>
<b>0.6 ENGINEERING SURVEYS AND INVESTIGATIONS</b> .....	<b>2</b>
<b>0.6.1 EXISTING CONDITIONS</b> .....	<b>2</b>
<b>0.6.2 PAVEMENT COMPOSITION</b> .....	<b>3</b>
<b>0.6.3 BRIDGES AND CULVERTS</b> .....	<b>4</b>
<b>0.6.4 PAVEMENT DESIGN</b> .....	<b>5</b>
<b>0.7 ENVIRONMENTAL SCREENING OF THE PROJECT</b> .....	<b>8</b>
<b>0.8 SOCIAL IMPACT ASSESSMENT</b> .....	<b>8</b>
<b>0.8.1 CENSUS AND SOCIO-ECONOMIC SURVEY</b> .....	<b>8</b>
<b>0.8.2 IDENTIFICATION OF STRUCTURES LIKELY TO BE AFFECTED</b> .....	<b>9</b>
<b>0.8.3 RESETTLEMENT ACTION PLAN</b> .....	<b>9</b>
<b>0.9 PRELIMINARY COST ESTIMATES</b> .....	<b>9</b>
<b>0.10 PROJECT COST</b> .....	<b>10</b>
<b>0.11 ECONOMIC ANALYSIS</b> .....	<b>11</b>
<b>0.12 FINANCIAL ANALYSIS</b> .....	<b>12</b>
<b>CHAPTER 1 INTRODUCTION</b> .....	<b>13</b>
<b>1.1 BACKGROUND</b> .....	<b>13</b>
<b>1.2 CONSULTANCY APPOINTMENT</b> .....	<b>13</b>
<b>1.3 PROJECT DESCRIPTION</b> .....	<b>14</b>
<b>1.4 MOBILIZATION, STAFFING AND SUBMISSIONS</b> .....	<b>14</b>
<b>1.1 FINAL DETAILED PROJECT REPORT</b> .....	<b>15</b>
<b>CHAPTER 2 Social Analysis of the Project</b> .....	<b>16</b>
<b>2.1 INTRODUCTION</b> .....	<b>16</b>
<b>2.2 DEMOGRAPHIC CHARACTERISTICS</b> .....	<b>18</b>
<b>2.2.1 POPULATION</b> .....	<b>18</b>
<b>2.2.2 POPULATION GROWTH AND URBANIZATION</b> .....	<b>18</b>
<b>2.3 LAND USE</b> .....	<b>19</b>
<b>2.4 STATE’S ECONOMY</b> .....	<b>19</b>
<b>2.4.1 SECTORAL COMPOSITION OF STATE INCOME</b> .....	<b>21</b>
<b>2.4.2 THE PER CAPITA INCOME</b> .....	<b>23</b>
<b>2.4.3 GROWTH TRENDS-STATE INCOME</b> .....	<b>23</b>
<b>2.4.4 DISTRICT WISE INCOME</b> .....	<b>23</b>
<b>2.5 WORK PARTICIPATION RATIO</b> .....	<b>24</b>

2.5.1.	ECONOMIC CLASSIFICATION OF WORKERS .....	25
2.6.	AGRICULTURE AND ALLIED ACTIVITIES .....	25
2.6.1.	AGRICULTURAL PRODUCTION .....	25
2.7.	INDUSTRY.....	27
2.7.1.	REGISTERED INDUSTRIAL UNITS IN KOLLAM .....	27
2.7.2.	SMALL SCALE INDUSTRIES .....	28
2.7.3.	REGISTERED INDUSTRIAL UNITS IN ALAPPUZHA .....	28
2.7.4.	SMALL SCALE INDUSTRIES .....	28
2.7.5.	REGISTERED INDUSTRIAL UNITS IN THIRUVANANTHAPURAM .....	29
2.7.6.	SMALL SCALE INDUSTRIES .....	29
2.8.	TRANSPORT NETWORK.....	30
2.8.1.	NATIONAL HIGHWAYS .....	30
2.8.2.	REGISTERED MOTOR VEHICLES .....	31
2.8.3.	BUS TRANSPORT SERVICES .....	31
2.8.4.	RAILWAYS .....	31
2.8.5.	AIR TRANSPORT .....	32
2.8.6.	WATER TRANSPORT.....	32
2.9.	TOURISM.....	32
2.10.	CONCLUSIONS.....	34
<b>CHAPTER 3</b>	<b>ENGINEERING SURVEYS AND INVESTIGATIONS .....</b>	<b>35</b>
3.1.	INTRODUCTION.....	35
3.2.	COLLECTION OF SECONDARY DATA.....	35
3.3.	STUDY OF THE EXISTING ALIGNMENT .....	35
3.4.	CURRENT AND PROPOSED DEVELOPMENT ACTIVITIES .....	36
3.5.	ROAD INVENTORY AND PAVEMENT CONDITION SURVEYS .....	36
3.6.	PAVEMENT ROUGHNESS.....	36
3.7.	HYDROLOGICAL AND HYDRAULIC INVESTIGATIONS .....	44
3.8.	BRIDGES / STRUCTURES.....	50
<b>CHAPTER 4</b>	<b>TRAFFIC SURVEY AND ANALYSIS .....</b>	<b>54</b>
4.1.	INTRODUCTION .....	54
4.2.	TRAFFIC SURVEYS.....	56
4.3.	SECONDARY DATA .....	56
4.4.	ANALYSIS OF TRAFFIC SURVEYS .....	56
4.4.1	TRAFFIC VOLUME COUNT .....	57
4.4.2	ANALYSIS OF O-D SURVEY DATA .....	64
4.4.3	ANALYSIS OF TURNING MOVEMENT COUNT .....	65
4.4.4	ANALYSIS OF SPEED AND DELAY SURVEY .....	66
4.4.5	WILLINGNESS TO PAY SURVEY.....	67
4.4.6	PEDESTRIAN COUNT SURVEY.....	68
4.5.	TRAFFIC FORECAST.....	68
4.5.1	PAST TRENDS IN TRAFFIC GROWTH IN THE REGION .....	68
4.5.2	SECONDARY DATA .....	69
4.5.3	VEHICLE REGISTRATION .....	69
4.5.4	ELASTICITY OF TRANSPORT DEMAND .....	70
4.5.5	TRAFFIC FORECAST BY ECONOMETRIC METHOD.....	70
4.5.6	ESTIMATION OF FORECAST TRAFFIC .....	72
4.5.7	CAPACITY AND LEVEL OF SERVICE ANALYSIS .....	73
4.6.	TRAFFIC CIRCULATION PLAN AND SAFETY CONSIDERATIONS .....	74
4.7.	RECOMMENDATION AND CONCLUSION .....	75

<b>CHAPTER 5</b>	<b>COST ESTIMATE .....</b>	<b>76</b>
<b>CHAPTER 6</b>	<b>ENVIRONMENTAL SCREENING AND PRELIMINARY ENVIRONMENTAL ASSESSMENT</b>	<b>80</b>
6.1.	<b>INTRODUCTION, OBJECTIVE AND LEGAL FRAMEWORK .....</b>	<b>80</b>
6.1.1	<b>INTRODUCTION .....</b>	<b>80</b>
6.1.2	<b>OBJECTIVE OF ENVIRONMENTAL SCREENING AND PRELIMINARY ENVIRONMENTAL ASSESSMENT.....</b>	<b>80</b>
6.1.3	<b>APPLICABLE ENVIRONMENTAL ACTS AND GUIDELINES.....</b>	<b>80</b>
6.2	<b>BASELINE ENVIRONMENTAL SETUP .....</b>	<b>84</b>
6.2.1	<b>STUDY AREA .....</b>	<b>84</b>
6.2.2	<b>PHYSIOGRAPHY.....</b>	<b>84</b>
6.2.3	<b>GEOLOGY &amp; SOIL.....</b>	<b>85</b>
6.2.4	<b>SEISMICITY .....</b>	<b>86</b>
6.2.5	<b>CLIMATE AND METEOROLOGY .....</b>	<b>88</b>
6.2.6	<b>LAND USE PATTERN .....</b>	<b>89</b>
6.2.7	<b>WATER RESOURCES .....</b>	<b>89</b>
6.2.8	<b>ECOLOGICAL ENVIRONMENT.....</b>	<b>91</b>
6.2.9	<b>EDUCATIONAL INSTITUTIONS.....</b>	<b>93</b>
6.2.10	<b>RELIGIOUS STRUCTURES .....</b>	<b>93</b>
6.2.11	<b>MEDICAL FACILITIES.....</b>	<b>94</b>
6.2.12	<b>COMMON PROPERTY RESOURCES .....</b>	<b>94</b>
6.2.13	<b>BUILT UP SECTIONS.....</b>	<b>95</b>
6.2.14	<b>DEMOGRAPHIC PATTERN .....</b>	<b>95</b>
6.3	<b>ENVIRONMENTAL SCREENING.....</b>	<b>96</b>
6.4	<b>CLEARANCES AND PERMISSIONS REQUIRED .....</b>	<b>97</b>
6.4.1	<b>ENVIRONMENTAL CLEARANCE.....</b>	<b>97</b>
6.4.2	<b>FOREST CLEARANCE .....</b>	<b>98</b>
6.4.3	<b>ROADSIDE TREE FELLING PERMISSION.....</b>	<b>98</b>
6.4.4	<b>CRZ CLEARANCE .....</b>	<b>98</b>
6.4.5	<b>CLEARANCES/PERMISSION TO BE OBTAINED BY CONTRACTOR.....</b>	<b>98</b>
6.5	<b>POTENTIAL ENVIRONMENTAL IMPACTS .....</b>	<b>99</b>
6.6	<b>PROJECT BENEFITS .....</b>	<b>105</b>
6.7	<b>ENVIRONMENTAL BUDGET.....</b>	<b>105</b>
<b>CHAPTER 7</b>	<b>INITIAL SOCIAL ASSESSMENT &amp; PRELIMINARY LAND ACQUISITION &amp; RESETTLEMENT PLAN</b>	<b>106</b>
7.1.	<b>INTRODUCTION.....</b>	<b>106</b>
7.2.	<b>PROJECT ROAD.....</b>	<b>107</b>
7.3.	<b>THE PROJECT AREA .....</b>	<b>107</b>
7.3.1	<b>PROJECT LOCATION .....</b>	<b>107</b>
7.3.2	<b>SOCIO-ECONOMIC ENVIRONMENT .....</b>	<b>107</b>
7.3.3	<b>DEMOGRAPHIC STRUCTURE OF PROJECT DISTRICTS .....</b>	<b>108</b>
7.3.4	<b>PROPOSED IMPROVEMENTS .....</b>	<b>108</b>
7.4.	<b>LEGAL FRAMEWORK .....</b>	<b>108</b>
7.5.	<b>METHODOLOGY .....</b>	<b>109</b>
7.6.	<b>LAND ACQUISITION.....</b>	<b>109</b>
7.7.	<b>RESETTLEMENT ACTION PLAN .....</b>	<b>110</b>
7.8.	<b>BROAD ENTITLEMENT FRAMEWORK.....</b>	<b>110</b>
7.9.	<b>PRELIMINARY STAKEHOLDER CONSULTATION .....</b>	<b>111</b>

---

7.10. CONCLUSION .....111

**CHAPTER 8 ECONOMIC AND FINANCIAL ANALYSIS .....116**

**8.1. Economic Analysis .....116**

8.1.1. Methodology for Appraisal .....116

8.1.2. Basic Input Data.....116

8.1.3. General Data.....117

8.1.4. Project Cost .....117

8.1.5. Homogenous Section Based on Traffic.....117

Existing Road Roughness and Geometry.....118

8.1.8. Economic Cost of Vehicle Parameters.....118

8.1.9. Sensitivity Analysis .....119

8.1.10. Economic Analysis Results.....119

8.1.11. Conclusions.....120

**8.2 Financial Analysis .....120**

8.2.1 **Project Background .....120**

8.2.2 **Salient Features of Hybrid Model .....120**

8.2.3 **Inputs to Financial Analysis .....121**

8.2.4 **Annexures and Appendices .....121**

8.2.5 **Results of Financial Analysis .....122**

**CHAPTER 9 CONCLUSION AND RECOMMENDATIONS.....123**

**9.1. CONCLUSIONS .....123**

**9.2. RECOMMENDATIONS.....124**

## ABBREVIATION

Abbreviation	Full Form
AADT	Annual Average Daily Traffic
ADT	Average Daily Traffic
AIV	Aggregate Impact Value
AMSL	Above Mean Sea Level
BBD	Benkelman Beam Deflection
BI	Bump Integrator
BIS	Bureau of Indian Standards
BM	Bench Mark
BOT	Build-Operate-Transfer
CBR	California Bearing Ratio
CC	Cement Concrete
CCEA	Cabinet Committee on Economic Affairs
CESS	Centre for Earth Science Studies
CGRA	Canadian Good Roads Association
CGWB	Central Ground Water Board
cm	Centimeter
COI	Corridor of Impact
CPCB	Central Pollution Control Board
CPR	Common Property Resources
CRRRI	Central Road Research Institute
CRZ	Coastal Regulation Zone
CTB	Cementitious Base
CTSB	Cementitious Sub base
CVC	Classified Volume Count
CVPD	Commercial Vehicle Per Day
CWC	Central Water Commission
CZR	Coastal Zone Regulation
dB	Decibel
DBFO	Design Build Finance & Operate
DCF	Discounted Cash Flow
DCP	Dynamic Cone Penetration
DDF	Directional Distribution Factors
DGPS	Differential Global Positioning System
DIC	Directorate of Industries and Commerce
DLC	Dry Lean Concrete

<b>Abbreviation</b>	<b>Full Form</b>
DoE	Department of Environment
DPR	Detail Project Report
DSV	Design Service Volumes
EC	Environmental Clearance
EIA	Environmental Impact Assessment
EIRR	Economic Internal Rate of Return
EMP	Environmental Management Plan
ENVIS	Environmental Information System
EPC	Engineering Procurement and Construction
EROW	Existing Right Of Way
FIRR	Financial/ Commercial Internal Rate of Return
FOB	Foot over Bridge
GAD	General Arrangement Drawings
GDP	Gross Domestic Product
GoI	Government of India
GOI	Government of India
GoK	Government of Kerala
GPS	Global Positioning System
GQ	Golden Quadrilateral
GSB	Granular sub-base
GSDP	Gross State Domestic Product
GTS	Great Trigonometrical Survey
HDI	Human Development Index
HFL	High Flood Level
HTL	High Tide Level
IMD	India Meteorological Department
in	inch
IRC	Indian Roads Congress
IS	Indian Standard
JBIC	Japan Bank for International Cooperation
kg	Kilogram
km	Kilometer
kmph	Kilometers per hour
KSPCB	Kerala State Pollution Control Board
KSRTC	Kerala State Road Transport Corporation
LA	Land Acquisition
LDF	Lane Distribution Factors



<b>Abbreviation</b>	<b>Full Form</b>
LGV	Large Goods Vehicle
LHS	Left Hand Side
LOS	Level of Service
LPS	Land Plan Schedule
LTL	Low Tide Level
LWL	Low Water Level
m	meter
MAV	Multi Axle Vehicle
MDD	Maximum Dry Density
MDR	Major District Road
mi	mile
MJB	Major Bridge
mm	Millimeters
MNB	Minor Bridge
MoEF&CC	Ministry of Environment, Forest & Climate Change
MoRT&H	Ministry of Road Transport & Highways
MPa	Mega Pascal
MSK	Medvedev–Sponheuer–Karnik scale
NAAQS	National Ambient Air Quality Standards
NABL	National Accreditation Board for Testing and Calibration Laboratories
NFL	Normal Flood Level
NH	National Highway
NHAI	National Highways Authority of India
NHDP	National Highways Development Project
NPV	Net Present Value
NSDP	Net State Domestic Product
NV	Not Visible
°C	Degree Celsius
OMC	Optimum Moisture Content
PCI	Per Capita Income
PCU	Passenger Car Unit
PIA	Project Influence Area
PIU	Project Implementation Unit
PQC	Pavement Quality Concrete
PROW	Proposed Right of Way
PSC	Pre Stressed Concrete
PUP	Pedestrian underpass

<b>Abbreviation</b>	<b>Full Form</b>
PWD	Public Works Department
RCC	Reinforced Cement Concrete
RDSO	Research Designs Standards Organisation
RHS	Right Hand Side
ROB	Rail over Bridge
ROW	Right of Way
RUCS	Road User cost Study
SCF	Seasonal Correction Factor
SEIAA	State Level Environment Impact Assessment Authority
SEIAA	State Environment Impact Assessment Authority
SG	Sub Grade
SH	State Highway
SLIP	Service Level Improvement Plan
SPCB	State Pollution Control Board
SPV	Special Purpose Vehicle
sqcm	Square Centimeter
TBM	Temporary Bench Mark
TCS	Typical Cross Section
ToR	Terms of Reference
VDF	Vehicle Damage Factor
VECs	Valued Environment Components
VOC	Vehicle Operating Cost
VUP	Vehicular underpass
WMM	Wet Mix Macadam
WWF	World Wildlife Fund

## CHAPTER 0 EXECUTIVE SUMMARY

### 0.1 Project Background

The National Highways Authority of India (NHAI) has been entrusted with the assignment of preparation of Detailed Project Report for 6 laning of Chertalai to Thiruvananthapuram Section of NH-47 (new NH-66) (from km 379.100 to km 551.900 under NHDP Phase III in the State of Kerala. The project stretch of NH 47 begins at Thuravoor Junction near Chertala Town and ends at Kazhakottam Junction near Thiruvananthapuram totalling a length of 172.80 km in Kerala State. The project stretch includes two bypasses at Alappuzha and Kollam and a new realigned stretch bypassing Attingal Town. The project road section is shown in **Figure 0.1**.



Figure 0.1: Index Map

### 0.2 Objectives

As per TOR the project preparation activities are split into three stages:

- Stage 1 : Inception Report
- Stage 2 : Feasibility Report
- Stage 3 : Detailed Project Report (DPR)

### 0.3 Project Description

The project road length is 170.7km. It starts from km 379.100 of NH-47 at the junction of Thuravoor and ends at Kazhakottam junction at km 549.801. This stretch of road passes through three districts viz. Alappuzha, Kollam and Thiruvananthapuram. The road passes through urban areas viz. Chertalai, Marary Kulam, Alappuzha, Ambalapuzha, Purakkad, Thottapally, Haripad, Nagiar Kulangara, Kayamkulam, Krishnapuram, Oachira, Vavvakkavu, Karunagapally, Chavara, Neendakara, Kavanadu (Kollam), Mevaram (Kollam), Kottiyam, Chathanoor, Paripally, Kallambalam, Attingal, Manglapuram, Pallipuram and Kazhakottam.

Generally the existing road is two laned with paved shoulders on either side. At most of the urban locations in the presence of Major Junction, carriageway has been upgraded to 4 lane divided carriageway configuration including the junction with approaches and also along the existing town section.

There are two bypasses under different stages of construction and one new bypass / realignment in this project road which are as given below:

1) Alappuzha bypass

Length of bypass is 6.70 km. 45m PROW for this bypass is already acquired by NHAI. Presently two 2 lane ROB's are being constructed in this bypass.

2) Kollam bypass

Length of bypass is 13.00 km, including 2 lane existing carriageway length of 4.60 km. 45m PROW for this bypass is already acquired by NHAI. Presently construction of 2 lane carriageway formation is in progress for the balance 8.3 km.

3) Attingal Town bypass / realignment

A new alignment length of 10.60 km has been proposed for bypassing Attingal Town.

The project has been divided into the six construction packages. The details are as follows:

Package	Design Chainage		Length (km)	Location	District
	From(km)	To(km)			
Package-1	379.100	417.000	37.90	Thuravoor-Paravoor	Alappuzha
Package-2	417.000	454.500	37.50	Paravoor- Kottankulangara	Alappuzha
<b>Package-3</b>	<b>454.500</b>	<b>486.000</b>	<b>31.50</b>	<b>Kottankulangara- Start of kollam Bypass</b>	<b>Alappuzha and Kollam</b>
Package-4	486.000	517.250	31.25	Start of kollam Bypass- Kadambattukonam	Kollam
Package-5	517.250	547.080	29.83	Kadambattukonam- Kazhakuttam jn	Trivandrum
Package-6	547.080	549.801	2.721	Kazhakuttam jn Technopark Jn.	Trivandrum
<b>Total</b>			<b>170.701</b>		

## Project Report is for 6 laning of Kottankulagara to Kollam bypass Section of NH-47 (New NH-66) (from km 454.50 to km 486.00 under NHDP Phase III in the State of Kerala (Package -3)

### 0.4 Socio-Economic Profile of the Project Influence Area (PIA)

The primary purpose of socio-economic analysis is to provide an overview of the State's, socio-economic status and the relative status of the Project Influence Area (PIA) within the State.

The Project Road, a section of NH 47 traverses through Alappuzha, Kollam and Thiruvananthapuram districts of Kerala State, a small State tucked away in the southwest corner of India (Latitude 10.00 N and Longitude 76.25 E). On the east, are high ghats of (Karnataka and Tamil Nadu) and in the west the Arabian Sea. The width of the State varies from 35 kms to 125 kms. Geographically, the State can be divided into hills, valleys, midland plains and coastal belt. Kerala state spreads over 38,863 sq. kms and accounts for 1.23 per cent of the country's area.

### 0.5 Traffic Studies and Analysis

To capture traffic flow characteristics and travel pattern of users passing through the project road and other characteristics related to miscellaneous requirements as per the ToR, the following primary traffic surveys have been conducted.

- Classified Traffic Volume Count (7 days) – 7 locations
- Intersection Turning Movement Count Survey– 26 locations
- Origin-Destination Survey (OD) – 3 locations
- Axle Load Survey – 3 locations
- Speed and Delay Survey – Entire length
- Pedestrian Count Survey – 17 locations

The details of survey locations are shown (Chapter 4 – Traffic Survey and Analysis)

#### 0.5.1 Classified Traffic Volume Counts

The Average Annual Daily Traffic (AADT) volume on the project road varies from 26841 PCUs to 52499 PCUs at various locations. Based on the traffic surveys complete project stretch has been divided into 7 homogeneous section, the current package lies in homogeneous section 3 and 4, as given in **Table 0.1** below:

**Table 0.1: Homogeneous Traffic Sections of Project Highway**

Sl. No	Homo-geneous Section (HS)	Existing Section (km)		Design Chainage (km)		Existing Length (km)	Traffic Volume AADT (PCU)	Assessment of Upgradation Requirement	
		From (Km)	To (Km)	From (Km)	To (Km)			2017	Based on 6 Lane Capacity Guidelines
							LOS B		LOS C
1	HS-3	435.000	465.000	433.700	462.770	30.000	32980	2027	2035
2	HS-4	465.000	490.000	462.770	487.280	25.000	36498	2025	2033

The average daily traffic was computed for the seven stations where the mid-block volume count survey was done. Daily traffic volumes were averaged to find the Average Daily Traffic (ADT). Location wise ADT & AADT values are given in **Table 0.2**.

**Table 0.2: Traffic Volume Counts Collected**

Average Daily Traffic (ADT)																
Station No.	Chainage	Location of Survey	Car/Van/ Taxi	Two Wheeler	3 Wheeler	Mini Bus	Bus	LCV	LMV /Mini LCV	2 Axle Truck	3 Axle Truck	Multi Axle Truck	Tractor with & withoutTrailer	Other Non motorized	Total ADT	Total ADT PCU
VC1	380	Thuravoor	17321	22406	1782	732	1717	2016	1844	1433	936	481	4	607	51278	51019
VC2	419	Punnapra	12884	17818	2164	322	2249	1897	1242	1427	826	349	5	467	41650	43864
VC3	458/4	Kayamkulam	11887	15192	1807	249	999	1115	973	914	400	286	3	367	34191	32729
VC4	482/8	Neendakara	12276	15240	2005	451	1687	1828	723	977	494	249	5	242	36177	36793
VC5	505/5	Mylakad	16838	18486	2803	382	1399	1278	1144	1050	439	216	2	58	44097	42198
VC6	520/1	Navaikulam	11869	7446	978	336	1092	1119	661	789	232	101	1	19	24642	26219
VC7	535	Palammoodu	15143	14746	1739	490	1480	886	531	768	215	104	0	13	36114	34714

Annual Average Daily Traffic (AADT)																
Station No.	Chainage	Location of Survey	Car/Van/ Taxi	Two Wheeler	3 Wheeler	Mini Bus	Bus	LCV	LMV /Mini LCV	2 Axle Truck	3 Axle Truck	Multi Axle Truck	Tractor with & withoutTrailer	Other Non motorized	Total AADT	Total AADT PCU
VC1	380	Thuravoor	17494	22630	1800	739	1735	2036	1862	1448	945	486	4	607	51785	51526
VC2	419	Punnapra	12892	17829	2188	326	2274	1918	1255	1442	835	353	5	467	41784	44117
VC3	458/4	Kayamkulam	11958	15283	1818	251	1010	1128	983	924	405	289	3	367	34419	32980
VC4	482/8	Neendakara	12276	15240	2005	442	1654	1791	709	957	484	244	5	242	36048	36498
VC5	505/5	Mylakad	16838	18486	2803	375	1371	1252	1122	1029	430	212	2	58	43978	41933
VC6	520/1	Navaikulam	11394	7148	939	336	1090	1117	659	787	231	100	1	19	23822	25537
VC7	535	Palammoodu	15143	14746	1739	495	1495	894	536	776	217	105	0	13	36159	34819

### **0.5.2 Turning Movement Survey**

Intersection turning movement surveys have been carried out at all the major intersection locations. Classified traffic volume counts of all types of vehicles have been made separately for each direction including left and right turning traffic. The surveys have been conducted for successive 15 minutes interval for a period 24 hours. Based on traffic growth rate as derived in later part of this report all junctions had been analyzed to understand the need of grade separation at these junctions as per IRC 92 and IRC SP 41. Highway grade separators without ramps are envisaged at intersection of divided rural road if the ADT (fast vehicles only) on the cross road within the next 5 years is likely to exceed 5000 and otherwise the need for such facilities could be kept in view for future consideration / construction. An interchange may be justified when an at-grade intersection fails to handle the volume of traffic resulting in serious congestion and frequent choking of the intersection. This situation may arise when the total traffic of all the arms of the intersection is in excess of 10,000 PCU/hours for Grade Separation with ramps. The understanding of grade separation warranted at various junctions are given in chapter 4 of main report.

### **0.5.3 Origin Destination Survey**

Origin-Destination (OD) surveys determine and relate the pattern of traffic flows to trip purpose and commodities transported. The information provided by the surveys enables estimates of the growth of future flows to be made on a more rational basis. The origin - destination surveys have been carried out by means of the roadside interview method at locations selected to capture major trip desires in each section. The surveys have been carried out on one working day for 24 hours on a random sampling basis. All categories of motorized vehicles (e.g. Cars, Jeeps, Buses, light as well as heavy goods vehicles), have been surveyed for its trip origin, destination, trip purpose, occupancy and weight of commodity carried. The survey crew was organized into 3 groups by 8-hour shifts with sufficient enumerators in each traffic direction as well as in groups. Classroom training were given to the enumerators in order to get acquainted the work and in the use of standard interview sheets. Police help was sought to ensure smooth flow of traffic and stoppage of randomly selected vehicles. Engineers supervised the whole survey activities. The location of OD survey is given in chapter 4 of Main report.

### **0.5.4 Axle Load Survey**

The axle load survey has been carried out at 3 locations to work out the Vehicle Damage Factor (VDF) and the axle load spectrum for design of pavement. Based on the survey, the VDF for 2-axle trucks has been computed in the range 3.7-5.27 while the VDF for 3-axle truck lies in the range 7.34-10.6. The VDF for multi- axle vehicle has been calculated to be in the range 7.98-11.26.

### **0.5.5 Speed and Delay Surveys**

A speed and delay survey using the moving car observer method was carried out by dividing the project road stretch in nine sections along NH-47. Section 4.4.4 of Vol I of Main Report gives the detail analysis of Speed and delay surveys at different control points.

### **0.5.6 Traffic Forecast**

The future traffic demand assessment is made based on the past available data. Traffic forecasts are made for the horizon year 2050 which will form the basis for further work on pavement design, planning/designing of toll plaza & wayside amenities, intersection/ interchange design and developing capacity augmentation proposals.



Traffic movement on the project road, as observed from OD surveys, shows that influence of Trivandrum and Alappuzha districts is predominant along with the other districts in Kerala. Accordingly, traffic projections have taken into consideration the transport demand arising out of future economic development of Kerala state.

Traffic forecast has been based on demand elasticity approach, wherein a relationship was established between traffic and socio-economic indicators. Traffic growth rates by vehicle type, for the project road corridor have been determined. The projection for future traffic involves critical analysis of some of the key Socio-economic indicators and the rate of change expected during the study period in the project influence area.

The projected traffic for each of the homogeneous sections is presented in **Appendix 4.3 Appendices to Main Report**.

### 0.5.7 Toll

An estimation of tollable traffic for levying toll on project road section is necessary since the project road is conceived as toll project with partial access control. Tollable traffic has been estimated considering various factors effecting such as local traffic and toll exempted traffic. The proportions of toll exempted vehicles and the local traffic are estimated at all the two locations (proposed by the consultant) based on the respective analysis of CVC Surveys. No Toll plaza is proposed in this package.

## 0.6 Engineering Surveys and Investigations

The consultants have carried out engineering surveys and investigations that include Topographic Surveys, Road Inventory and Pavement Condition Surveys, Alignment Studies, Pavement Surface Roughness Survey, Initial Environmental Screening and Assessment, Social Screening Assessment, Pavement Composition Investigations, Preliminary Material Investigations for Construction Materials, Inventory and Condition Surveys for Bridges, Culverts and other Structures.

### 0.6.1 Existing Conditions

#### *Land Use and Terrain*

The terrain classification of the Project road Sections are indicated below:

**Terrain Classification of the Project Road**

Section	Terrain Classification
(km 379.100 – km 507.0)* (km 509.500 – km 525.0) (km 533.500 – km 536.5) (km 543.000 – km 544.0) (km 548.000 – km 551.9)	Plain
(km 507.000 – km 507.5) (km 533.000 – km 533.5) (km 547.000 – km 547.5)	Plain/Rolling
(km 507.500 – km 509.5) (km 525.000 – km 533.0) (km 536.500 – km 548.0)	Rolling

*Note\**- this section includes Alappuzha bypass and Kollam bypasses.

The entire length of the road is passing through built up and commercial areas along with few agricultural areas. There are substantial built up areas with prominent urban settlements located on the project road, and at these locations, it would be difficult to widen the road beyond the existing available land width. There is also presence of major intersections at these locations and the existing carriageway is mostly widened already to 4 lane configuration at these junction locations.

### ***Geometrics***

Roadway horizontal alignment for majority portion of the road is generally conforming to IRC standards. However at few locations it was observed that horizontal alignment has small radius, also a S curve at km 460 & with sharp radius was observed. These locations have not been provided with required control devices i.e. curve warning signs, chevron signs and speed restriction signs. These locations are not provided with necessary warning signs.

### ***Carriageway, Shoulder and Roadway Width***

Currently, the majority of the road section is having two-lane flexible pavement with paved/earthen shoulders.

### ***Junctions***

There are about 2 major and 201 minor in Package 3.

### ***Roadside Drains***

Drainage along the Project stretch is predominantly non-existent. Field observations, secondary data and Local inquiries indicated that some road stretches get submerged during heavy rains. There are many valley locations/ dip portion where additional culverts are felt necessary for the effective drainage. There are number of culverts in the stretch mainly slab type which are either on small nallas or just catering for the drainage of the area. Most of the culverts are not visible as there is heavy vegetation on both sides of the road throughout. Many culverts are in fully / partially choked condition due to development of built up are along the road.

### ***Road Side Features***

Kilometer stones are missing or uprooted at most of the locations. Even though the traffic signs have been provided on the project road at some of the locations, but the traffic signage system on the project road is not comprehensive and extensive as necessary based on the standards guidelines and codes. Project road passes through several curves en-route but warning signs have been provided at only few locations. Chevron signs have been also provided at very few locations. Project road passes through various settlements but there is no treatment through traffic signs and other control devices, at these settlements as per the standard guidelines and codes. Similarly, there is no adequate provision of traffic signs at junctions as per the standard guidelines or informatory sign while approaching the settlements or junctions or any other facility provided along the project road.

### ***Railway Crossing***

There is no railway crossing in this package.

### ***Grade Separators***

No grade separated intersections are existing on the project road.

## **0.6.2 Pavement Composition**

### ***Existing Pavement***

The existing pavement section is flexible. Average, minimum and maximum pavement compositions for each layer and each homogeneous have been presented in **Table 0.3**.

**Table 0.3: Existing Pavement Compositions**

Homog. Section	Existing Chainage		Existing Pavement Composition (mm)								
	From (km)	To (km)	Bituminous Layer			Granular Base Layer			Hard Moorum /Natural GSB		
			Min.	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.
HS-3	435.000	465.000	70	180	105	100	240	176	100	320	115
HS-4	465.000	490.000	50	210	130	70	240	126	60	320	179

Based on an analysis of the various CBR values of identified borrow soils and the in-situ condition of the subgrade soil, the design sub-grade CBR has been adopted as per the **Table 0.4** below.

**Table 0.4: Recommended Sub-grade CBR**

Homogeneous Sections	Existing Chainage		Existing Subgrade CBR (%)						
	From (km)	To (km)	DCP CBR (%)			Lab CBR (%)			
			Min.	Max.	Average	Min.	Max.	Average	
HS-3	435.000	465.000	6.7	18.0	13.3	6.3	15.2	11.1	
HS-4	465.000	490.000	6.4	16.3	10.9	6.3	12.3	10.4	

### 0.6.3 Bridges and Culverts

Thee inventory of all bridges / structures having lengths more than 6.0 m were carried out and bridge wise inventory details is given in **Appendix 3.4** in Appendices to Main Report. The inventory of ROB was also carried out and inventory details are given in **Appendix 3.4** in Appendices to Main Report. These bridges / structures comprise the following: -

Major bridges (MJB) - (length $\geq$ 60m)	-	02 nos.
Minor bridges (MNB) - (length > 6m and < 60m)	-	03 nos.
ROB in NH-47	-	Nil
Vehicular underpass (VUP)	-	Nil
Pedestrian underpass (PUP)	-	01 no
<b>Total</b>	-	<b>06 nos.</b>

The total of existing culverts after compiling the data is found to be **44 (Pipe 07 nos., Slab 33 nos.4 nos. not visible)**. Many of these culverts has been found to be partially choked and seem inadequate. The culverts are also old and seem to be structurally as well as hydraulically poor. Many of these structures shall be replaced preferably by Box Culverts for better hydraulic performance.

### Proposed Improvements

The project road is proposed to be improved to 6-lane standards with 7.5m wide carriageway with 2.0 m wide paved shoulders and 7.0m wide service road. Thereafter the project road will be upgraded to 7.0 m wide carriageway with 2.5m wide paved shoulders and 7.0m service road either side. The alignment of the project roads will be improved to a ruling design speed of 100kmph in plain/rolling terrain with 80kmph as the minimum speed.

#### **0.6.4 Pavement Design**

Pavement has been designed on the basis of cumulative number of standard axles expected on the pavement for the design life of 20 yrs for Flexible Pavement. Proposed pavement composition based upon the design is given in **Table 0.5**. The existing pavement has been proposed to be reconstructed as new pavement.

**Table 0.5: Recommended Pavement Crust Details for New Construction (Flexible Pavement)**

Homogeneous Section	Existing Section			Effective Subgrade CBR (%)	Design Life (Years)	Design Traffic	Bitumen Grade	SG (mm)	Crust Composition in mm					
	From (Ex. km)	To (Ex. km)	Length (km)						CTSB (mm)	CTB (mm)	Crack Relief Layer (mm)	DBM (mm)	BC (mm)	Proposed Total pavement thickness (mm)
HS-3	435.000	465.000	30	10%	20	86.75 msa	VG-40 in binder course and NRMB for Surface course	500	200	100	100	60	40	<b>500</b>
HS-4	465.000	490.000	25	10%	20	104.93msa		500	200	100	100	60	40	<b>500</b>

**Note:**

**SG = Sub-Grade, CTSB = Cement Treated Sub-base, CTB = Cementitious Base, DBM = Dense Bituminous Macadam, BC = Bituminous Concrete**

### **Selection of Widening Scheme**

As per ToR, the original scope of proposed project is upgrading the existing highway to 4 lanes. However, considering existing traffic, later it was decided for 6 laning of existing highway.

As an initial proposal, the Alignment Options Study for Section from km 379.10 to km 465.00 was submitted on 7th. October 2016 and for Section from km 465.00 to km 551.90 on 4th November 2016, based on the methodology below (which was finalized in discussion with PIU, NHAI, Thiruvananthapuram, as well as, it was revised further based on advice by Member (T), NHAI during meeting on 18th. October 2016 at Thiruvananthapuram).

1. Proposed ROW (PROW) considered 45m for entire stretch.
2. Retain the existing carriageway to the extent possible to facilitate traffic diversion during construction and retaining existing asset of the state.
3. Existing ROW, EROW (mostly eccentric in respect of the existing carriageway) widths on LHS and RHS of the existing carriageway were used as a primary criteria to arrive at the additional land acquisition on LHS and RHS beyond EROW.
4. Utilizing Government Land wherever available while designing desirable geometry characteristics of the proposed alignment and providing the best possible Geometry Standards to the extent possible, including increasing radius of the deficient curves and facilitate better sight distance and visibility criteria at accident prone locations.

Subsequent to the submission of the Alignment Options Reports, a presentation was made to the Hon'ble Minister (Works and Registration) on 21st November 2016 at Thiruvananthapuram.

**During the presentation to the Hon'ble Minister, the above methodology was discussed explicitly, however, Minister advised that under all circumstances, to the extent possible, the Proposed Center Line of the 4 lane Section needs to be in the middle of the EROW, including densely inhabited Urban Towns.**

Therefore the above criteria is presently adopted in selecting the Proposed Center Line for 6 lane carriageway at substantial stretches. However, in certain sections, deviations to the above option is carried out to facilitate criteria as stated below:

1. Eccentric Widening at Structure/Bridge Locations.
2. Eccentric Widening to retain existing Religious Structures viz. Temples, Churches, Graveyards & Mosques etc. to the extent possible
3. Eccentric Widening to avoid encroaching on to Railway Right of Way (Cherthala Railway Station Stretch).

### **Bypasses and Realignments**

There are no bypasses in this package.

### **Service Roads**

Service roads are proposed throughout the project and are designed to carry traffic in both directions. They are running parallel to the main line and therefore are inheriting its geometric characteristics as far as horizontal and vertical alignments are concerned. Carriageway Width for service road in normal circumstances is 7.0m and 5.5m in extreme circumstances.

### **Toll Plaza**

The project is planned to be taken up by the Hybrid Annuity Model and No toll plaza have been considered in this package.

## **Busbays**

There are about 27 urban areas in this package corridor, and therefore bus stop requirements are generally considered at an interval of 1.5-2km along the project road.

## **0.7 Environmental Screening of the Project**

Environmental Screening and Preliminary Environmental Assessment of the study area has the following major objectives:

- To identify the potential environmental impacts;
- To categorize the project;
- To ensure that environmental considerations are given adequate weightage for carrying out proposed road improvement;
- Policy, legal and institutional issues for planning and for getting all approvals and for implementation of Environmental Management Plan during Design, Construction and Operational phases; and
- Scoping and future course of work for Environmental Impact Assessment Study

The preliminary environmental assessment for the proposed project is being undertaken as a parallel exercise with the Engineering Analysis, so as to bring out the environmental concerns in planning and the proposed design.

The environmental expert conducted the environmental screening to identify the hot spots along the project road. Special care will be needed for the sensitive stretches during designing and construction phase as well. Formulation of specific mitigation measures has to be done for adverse impacts in those sections during the detailed environmental assessment study.

The project road was subjected to screening considering the identified Valued Environment Components (VECs). These components are listed in chapter 6 of Main report.

## **0.8 Social Impact Assessment**

The objective of the social screening is to identify the probable adverse impacts due to the proposed road improvement works and ensuing land acquisition on the affected persons/families. Based on these assessments a Resettlement Action Plan is to be prepared meeting requirements of various guidelines and relevant Acts of Government of India and other funding agencies like the World Bank, the Asian Development Bank, etc.

The initial social screening has been carried out by the consultants through detailed reconnaissance of the project area, review of secondary information and preliminary consultation with various stakeholders. The major findings are listed in SIA report.

### **0.8.1 Census and Socio-Economic Survey**

Subsequent to preparation of the Land Plan Schedule (LPS), consultants will conduct Census and socio-economic surveys of Project Affected Persons/Families likely to be affected due to the project. A format of Social and Census Survey is proposed to be used to record the relevant information from all categories of property holder. Data will be collected at household level that will include family details, social category, religion, economic status, occupation, and education etc. along with details of

any structure that may be affected including type of structure, present use of structure and dimension of the structure.

### **0.8.2 Identification of Structures Likely to be affected**

The topographical survey map was also utilized to identify each structure on the ground. Structures falling within the proposed development corridor were identified in the site of preliminary basis. As already mentioned in earlier sections, the existing ROW is nearly about 30 meters and remaining land of 45 meters is to be acquired to accommodate the proposed developments. Bypasses and realignments have been proposed to avoid the congested habitation areas where land acquisition will be required.

### **0.8.3 Resettlement Action Plan**

Resettlement Action Plan will be prepared in accordance with the magnitude of impact detailing the project components involving land acquisition and involuntary resettlement, extent of impact, socio-economic profile of Affected Persons, efforts made to minimize involuntary resettlement, mitigation measures in accordance with approved resettlement framework, budget estimate, work plan, implementation arrangement, grievance redressal mechanism, and monitoring and evaluation.

## **0.9 Preliminary Cost Estimates**

### **0.9.1 Unit Rates**

The rates of various items of construction work have been analysed as per procedure laid down in the “MORT&H Standard Data Book”-2003 (Fourth Revision, Reprint 2006) and guidelines set therein. For road embankment borrow areas have been identified along the project road. For stone metal quarries have been identified along the road. Average lead has been worked out for earth and stone metal and cartage cost has been provided at State Schedule of Rates. The unit rates have been worked out by taking the cost of materials as provided in the State Schedule of Rates (except for cement steel and bitumen for which market rates have been provided).. The component of labour, material and machinery has been provided as per Standard Data Book of the Ministry of Road Transport and Highways.

### **0.9.2 Preliminary Estimate**

For Feasibility study the quantities of pavement have been worked out manually from preliminary drawings. But Quantities of earthwork have been worked out by computer.

The deck area of bridges has been worked out from their general arrangement drawings. Quantities of culverts have been worked out from their preliminary drawings. The cost of land acquisition, resettlement and rehabilitation costs, utility relocation costs and environmental mitigation measures have been provided as per preliminary assessment of their costs. Estimates for allowances for contingencies and supervision charges have been provided as percentage of total cost.



## 0.10 Project Cost

The cost of widening and strengthening the existing Highway **Package 3** works out as under:

ABSTRACT OF COST			
Bill No.	Description		Amount (Rs.)
1	SITE CLEARANCE AND DISMANTLING	31.5 km	21,238,863
2	EARTH WORK		773,754,566
3	SUB-BASE, BASE-COURSES		2,168,788,045
4	BITUMINOUS PAVEMENT COURSES		1,199,718,983
5	CROSS DRAINAGE WORKS	53 No's	220,444,565
5A	FOOT OVER BRIDGES	14 No's	107,560,800
6	MINOR BRIDGES , FLYOVERS & UNDERPASSES & RE WALL		
I)	VUP	3 No's	121,353,285
II)	LVUP	1 No's	7,206,423
III)	SVUP	9 No's	133,136,407
IV)	FLYOVER	1 No's	69,845,374
V)	MINOR BRIDGE	3 No's	206,776,392
VI)	MAJOR BRIDGES	2 No's	986,165,835
<b>VII)</b>	<b>Elevated Highway cum ROB</b>		
VIII)	ROB		
IX)	RUB		
X)	RE WALL	6.04 km	1,451,775,806
8	TRAFFIC SIGNAGES, ROAD MARKING & APPURTENANCES		775,775,989
9	DRAINAGE AND PROTECTION WORKS		1,139,465,547
10	REPAIR & REHABILITATION OF STRUCTURES		1,522,631
11	MAINTENANCE OF ROADS		3,142,125
12	GENERAL ITEMS		568,095
13	TRAFFIC MANAGEMENT SYSTEM		34,549,079
14	TOLLPLAZA		73,840,000
	<b>BASE CIVIL CONSTRUCTION COST (A)</b>		<b>9,496,628,811</b>
15	Escalation @ 5% up to bid due date		
16	<b>Total Civil Construction Cost as on Bid due date</b>		<b>9,496,628,811</b>
	<b>COST PER KM (Rs in Crores)</b>		<b>30.15</b>

<b>17</b>	<b>Centages(IC &amp; Pre-Operative cost+Finanace Cost+IDC)</b>		
	IC & Pre operative expences @ 1% of EPC Cost		94,966,288
	Financing Cost Debt at 70:30 DER		63,600,000
	Interest durning construction		529,600,000
	<b>Total Centages</b>		<b>688,166,288</b>
<b>18</b>	<b>TOTAL EPC COST</b>		<b>10,184,795,099</b>
<b>19</b>	<b>Pre-Construction activities</b>		
	Cost of land acquisition		16,400,700,000
	shifting of Utilities(KSEB)		599,500,000
	shifting of Utilities(Kerala Water Authority)		412,390,000
	Environmental measures etc		34,570,000
	<b>Total Pre-Construction activities</b>		<b>17,447,160,000</b>
<b>20</b>	<b>TOTAL CAPITAL COST (Estimated Project Cost + cost of Pre-construction activities)</b>		<b>27,631,955,099</b>
	<b>COST PER KM (Rs in Crores)</b>		<b>87.72</b>
	<b>TOTAL LENGTH (Kms)</b>		<b>31.50</b>

## 0.11 Economic Analysis

The appraisal has been carried out within the framework of ‘with’ and without’ the project situations. ‘Without’ the project situation is the one in which the projected traffic would continue to move on the existing two lane road which will require certain minimum routine and periodic maintenance for upkeep of the facility. In the case of ‘with’ project situation, the traffic would use the improved facility, which is two lane carriageways with paved shoulders facility.

The benefits due to improvements are the saving in vehicle operation cost, saving in time and other caused benefits. The cost of the project is subtracted from benefits accruing year wise and discounted to work out the Economic Internal Rate of Return. In the economic appraisal all the financial estimates of costs and benefits are converted to economic costs by applying necessary factors.

### Sensitivity Analysis

Two critical factors could affect the viability of the project and these are the Capital Cost and traffic level. The capital cost can increase or the expected traffic growth could not materialize or both factors could occur simultaneously sensitivity check using the following parameters has been carried out:

- Sensitivity Option S1      Increase in base costs by 15%
- Sensitivity Option S2      Decrease in base benefits by 15%
- Sensitivity Option S3      Increase in base costs by 15% and decrease in base benefits by 15%

The economic analysis is carried out only for 11 years as the existing facility in no condition will be able to cater additional traffic. The project road and all packages found to be economically viable with EIRR more than the resource cost of capital @ 12%. In case of sensitivity too project is economically viable and beneficial to public

**Table 0.6: Result of Economic Evaluation**

S. No.	Package	Sensitivity	NPV (Million Rupees)	EIRR (%)	Viability
1	Package 3	Base Case	40463.95	51.4	Yes
2	Package 3	S 1	39361.77	45.6	Yes
3	Package 3	S 2	35829.96	38.8	Yes
4	Package 3	S 3	34727.78	34.6	Yes

## 0.12 Financial Analysis

### PACKAGE 3

S.No.	Summary	Value/Data
1	Estimated Project Cost	1026.61 Crore
2	Estimated Bid Project Cost	1177.24 Crore
3	Estimated O&M Cost	16.13 Crore
4	Estimated Project Life Cycle Cost	1261.95 Crore
5	Variation in Estimated Project Cost	14.67%
6	Bid Equity IRR at Bid Project Cost	<b>15.00%</b>
7	Project IRR	9.79%
8	NPV of Equity IRR (@12%)	18.46 Crore

The financial Analysis presented in Chapter 8 of this report indicates that the project is feasible under Hybrid Annuity Model. The cost of the project is substantial and that makes unviable under PPP (DBFOT) Mode. The mode will be bankable considering the appropriate risk allocation between the Public and Private Sector.

## CHAPTER 1 INTRODUCTION

### 1.1 Background

The National Highways Authority of India (NHAI) has been entrusted with the assignment of preparation of Detailed Project Report for 6 laning of Chertalai to Thiruvananthapuram Section of NH-47 (new NH-66) (from km 379.100 to km 549.801 under NHDP Phase III in the State of Kerala. The project stretch of NH 47 begins at Thuravoor Junction near Cherthala Town and ends at Kazhakottam Junction near Thiruvananthapuram totalling a length of 170.7 km in Kerala State. The project stretch includes two bypasses at Alappuzha and Kollam and a new realigned stretch bypassing Attingal Town.

### 1.2 Consultancy Appointment

M/s SMEC International Pty. Ltd. in association with SMEC (India) Pvt. Ltd, 387, Udyog Vihar Phase II, Gurgaon 122016, Haryana, India have been appointed as Consultants vide **letter no NHAI/HQ/Kerala/NH-17&47/2015-16/42 dated 27<sup>th</sup> June 2016** to carry out the Feasibility Study and Detailed Project Report (DPR) for 4/6 laning of the section from Chertalai (km. 379.10) of NH-47 to Kazhakottam (km 549.801) of NH-47 in the State of Kerala. The contract with NHAI was signed on 3<sup>rd</sup> August 2016.

The scope and principal objectives of the consultancy services is contained in the Terms of Reference (TOR) of the consultancy services, which is part of the contract agreement. **The services were commenced with effect from 8<sup>th</sup> August 2016.**

An Index Map of the project corridor is shown in **Figure 1.1.**



Figure 1.1: Index Map

### 1.3 Project Description

The project road length is 31.50 km. It is from km 454.50 to km 486.00 of NH-47 Kottankulangara to Start of Kollam bypass. This stretch of road passes through Alappuzha & Kollam district. The road passes through urban areas viz. Krishnapuram, Oachira, K.S puram , Karunagapalli  
Generally the existing road is two laned with paved shoulders on either side. At most of the urban locations in the presence of Major Junction, carriageway has been upgraded to 4 lane divided carriageway configuration including the junction with approaches and also along the existing town section.

There is no bypass in Package 3.



Package	From(km)	To(km)	Length of package (km)	Tentative Civil Cost of Package (Rs. Cr)	Location	District
Package-3	454.50	486.00	31.50	949.6	Kottankulangara-Start of Kollam Bypass	Alappuzha & Kollam

### 1.4 Mobilization, Staffing and Submissions

#### Mobilisation

The Contract Agreement for the Consultancy Services was signed on 3<sup>rd</sup> August 2016 and the Consultancy Services commenced on 8<sup>th</sup> August 2016 in accordance with Clause 2.3 of the Contract Agreement.

#### Staffing

Key personnel and other staff mobilized as per the clause 6.3 (b) of the contract for the project.

## Project Office

The Consultant has a project office at Thiruvananthapuram in Kerala at the following address:

**M/s. SMEC (India) Pvt. Ltd.,**  
**TC- 2361-2**  
**TPJR-3A,**  
**Pattom PO**  
**Thiruvananthapuram - 695024**

## Submission

S. No.	Deliverables	Submission Dates
1.	Inception Report	
	<ul style="list-style-type: none"> <li>Draft Inception Report including QAP</li> </ul>	Submitted on 31.08.2016
	<ul style="list-style-type: none"> <li>Final Inception Report including QAP</li> </ul>	Submitted on 20.09.2016
2.	Feasibility Report	
	<ul style="list-style-type: none"> <li>Draft Feasibility Report</li> </ul>	Submitted on 24.01.2017
	<ul style="list-style-type: none"> <li>Final Feasibility Report</li> </ul>	Submitted on 31.03.2017
3.	Technical Schedules	<p><b>For Kazhakkottom technical schedules submitted on 25th October 2017 for other packages submitted on 30<sup>th</sup> November 2017.</b></p> <p>Draft schedules for <b>6 laning</b> are submitted for PKG-II on 09.01.2020</p>
4.	Detailed Project Report	<b>In Progress</b>
	<ul style="list-style-type: none"> <li>Draft Detailed Project Report</li> </ul>	<p><b>Draft DPR was submitted for I &amp; II packages in March 2019.</b></p> <p><b>Revised 6 laning DPR work in progress.</b></p>
	<ul style="list-style-type: none"> <li>Final Detailed Project Report</li> </ul>	-

### 1.1 Final Detailed Project Report

In accordance to TOR (clause 10.8) regarding submission of Final Detailed Project Report, the same is submitted herewith:

- Volume I : Main Report**
- Volume II : Design Report**
- Volume III : Material Report**
- Volume IV : EIA EMP Report**
- Volume V : Technical specifications**
- Volume VI : Rate Analysis**
- Volume VII : Cost estimate**
- Volume VIII : BOQ**
- Volume IX : DRAWINGS**
- Volume X : Civil work contract agreement**
- Volume XI : Project clearances**

## CHAPTER 2 SOCIAL ANALYSIS OF THE PROJECT

### 2.1. Introduction

The primary purpose of socio-economic analysis is to provide an overview of the State's, socio-economic status and the relative status of the Project Influence Area (PIA) within the State.

The Project Road, a section of NH 47 traverses through Alappuzha, Kollam and Thiruvananthapuram districts of Kerala State, a small State tucked away in the southwest corner of India (Latitude 10.00 N and Longitude 76.25 E). On the east, are high ghats of (Karnataka and Tamil Nadu) and in the west the Arabian Sea. The width of the State varies from 35 kms to 125 kms. Geographically, the State can be divided into hills, valleys, midland plains and coastal belt. Kerala state spreads over 38,863 sq. kms and accounts for 1.23 per cent of the country's area.

This chapter presents the socio economic profile of the Kerala, the Project Influence State, and Districts of Alappuzha, Kollam and Thiruvananthapuram, which comprises the Project Influence Area (PIA) of the proposed road.

#### Project Influence Districts

##### Alappuzha

Alappuzha is also known as Alleppey, is the administrative headquarters of Alappuzha District of Kerala state of southern India. Alappuzha is a municipality in Kerala with an urban population of 174,164 and third among the districts having highest literacy rate in Kerala. In 2016, Centre for Science and Environment rated Alappuzha as the top cleanest town in India followed by Panaji & Mysuru. Alappuzha is considered to be the oldest planned city in this region and the lighthouse built on the coast of the city is the first of its kind along the Laccadive Sea coast. Alappuzha is situated 28 km from Changanssery, 46 km from Kottayam and 53 from Kochi and 155 kilometres (96 mi) north of Trivandrum. A town with picturesque canals, backwaters, beaches, and lagoons, it was described as the one of the places known as the "Venice of the East" by Lord Curzon. Hence, it is known as the "Venetian Capital" of Kerala. Malayalam is the most spoken language. Hindi, English and Tamil are also spoken in the town.

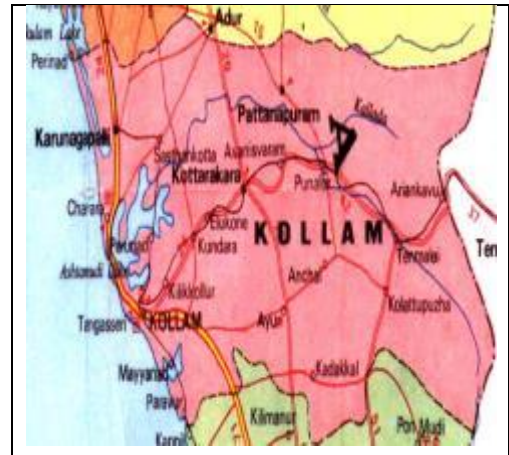


Alappuzha is an important tourist destination in India. The Backwaters of Alappuzha are the most popular tourist attraction in Kerala.

Alappuzha is the access point for the annual Nehru Trophy Boat Race, held on the Punnamada Lake, near Alappuzha, on the second Saturday of August every year. This is the most competitive and popular of the boat races in India.[6] The mullackal chirap is also one of the attractions of Allapuzha which is the festive season held for ten days every year in December.

## Kollam

Kollam or Quilon formerly Desinganadu, is an old seaport and city on the Laccadive Sea coast of Kerala, India. The city is on the banks Ashtamudi Lake. Kollam has had a strong commercial reputation since the days of the Phoenicians and Romans fed by the Chinese trade, it was mentioned by Ibn Battuta in the 14th century as one of the five Indian ports he had seen during the course of his twenty-four year travels. Kollam is a coastal city on the banks of Ashtamudi Lake that took the title God's Own Country without much demur. The braids of Ashtamudi Lake lie about 71 kilometres (44 mi) north of the state capital, Thiruvananthapuram. The city hosts the administrative offices of Kollam district and is a prominent trading city for the state. The proportion of females to males in Kollam city is second highest among the 500 most populous cities in India.



Kollam city had a population of 349,033 with a density of 5,900 persons per square kilometre. The sex ratio (the number of females per 1,000 males) was 1,112, the highest in the state. The district of Kollam ranked seventh in population in the state while the city of Kollam ranked fourth. As of 2010 Kollam had an average literacy rate of 93.77%, [47] higher than the national average of 74.04%. Male literacy stood at 95.83%, and female at 91.95%. In Kollam, 11% of the population was under six years of age.

Malayalam is the most spoken language in Kollam while Tamil is well understood in the city.

## Thiruvananthapuram

Thiruvananthapuram District is the southernmost district of the coastal state of Kerala. It is the largest city in Kerala. It came into existence in the year 1957. The headquarters is the city of Thiruvananthapuram (Trivandrum) which is also the capital city of Kerala. The district has an area of 2,192 square kilometres (846 sq mi) and a population of 3,307,284 (as per the 2011 census), [2] the second-most populous district in Kerala after Malappuram district. It is the densest district in Kerala with 1,509 inhabitants per square kilometre (3,910/sq mi). It is divided in 6 taluks:

Thiruvananthapuram, Neyyattinkara, Chiriyankkeezhu, Nedumangadu, Varkala and Kattakada. The urban bodies in the district are Thiruvananthapuram Corporation, Varkala, Neyyattinkara, Attingal and Nedumangad municipalities. Thiruvananthapuram district is situated between north latitudes 8°17' and 8°54' and east longitudes 76°41' and 77°17'.



The district has three major rivers, several freshwater lakes and more than 300 ponds. The eastern region is forested, northern regions are mostly under rubber cultivation and the remaining areas have mixed dry land crops of coconut, plantain, tapioca, etc. The city gets its name from the word "Thiru-anantha-puram", meaning the "Abode of Lord Anantha." The name derives from the deity of the Hindu temple at the center of the Thiruvananthapuram city. Anantha is the serpent Shesha on whom Padmanabhan or Vishnu reclines.



The climate of Thiruvananthapuram district is generally hot tropical. The mean maximum temperature is 95 °F (35 °C) and the mean minimum temperature is 69 °F (20 °C). As the district stretches from north to south with the Arabian Sea in the west side, the relative humidity is generally high. It rises up to about 95% during the South-West monsoon. The total annual average rainfall in the district is about 1,500 mm (59 in) per annum. The southwest monsoon, from June to September is the principal rainy season. The district receives most of its annual rainfall in this season. The second rainy season is the Northeast monsoon. It is from October to November.

## 2.2. Demographic Characteristics

### 2.2.1. Population

Kerala is home to 2.76% of India's population; with a density of 859 persons per km<sup>2</sup>, its land is nearly three times as densely settled as the Indian national average of 370 persons per km<sup>2</sup>. As of 2011, Thiruvananthapuram is the most populous city in Kerala.

Kerala's coastal regions are the most densely settled with population of 2022 persons per km<sup>2</sup>, 2.5 times the overall population density of the state, 859 persons per km<sup>2</sup>, leaving the eastern hills and mountains comparatively sparsely populated. Around 31.8 million Keralites are predominantly Malayali. The state's 321,000 indigenous tribal Adivasis, 1.10% of the population, are concentrated in the east.

### 2.2.2. Population Growth and Urbanization

In the state, the rate of population growth is India's lowest, and the decadal growth of 4.9% in 2011 is less than one third of the all-India average of 17.64%. Kerala's population more than doubled between 1951 and 1991 by adding 15.6 million people to reach 29.1 million residents in 1991; the population stood at 33.3 million by 2011.

Urban population was about 7.7 million in 1991 and about 8.3 million in 2001 which constitutes about 25.96 per cent of the total population. The decadal growth of urban population was 7.64 per cent during 1991 – 2001. **Table 2.1** shows the population growth trends in Kerala.

**Table 2.1: Population Growth in Kerala**

Census	Population	% + / -
1951	13,549,000	-
1961	16,904,000	24.8%
1971	21,347,000	26.3%
1981	25,454,000	19.2%
1991	29,099,000	14.3%
2001	31,841,000	9.4%
2011	33,388,000	4.9%

Source: Census of India 2011

## 2.3. Land Use

The total geographical area of the State is 3886287 Ha. Geographical area in Kerala has been classified according to thirteen different uses of land during 2008-09 which is presented in **Table 2.2**. The net area under cultivation during the year 2008-09 was 2088955 Ha, which occupies 53.75% of the total area in the State. The total cropped area is 2694943 Ha during the year 2008-09.

**Table 2.2: Land Use Pattern in Kerala**

S. No.	Classification of Land	2010-11	2011-12	Percent of Geographical Area	Change in Area Between 2010-11 and 2011-12	
					Actual	Percentage
1	Total Geographical Area	3886287	3886287	100	0	0
2	Forest	1081509	1081509	28	0	0
3	Land put to non-agricultural Uses	384174	399924	10	15750	0
4	Barren and Uncultivated Land	10573	17552	0.5	-2021	-10
5	Permanent Pastures and Grazing Land	153	85	0	-68	-44
6	Land under Miscellaneous Tree Crops	3690	336	0.1	-324	-9
7	Cultivable Waste	91665	95437	2	3772	4
8	Fallow other than current fallow	51943	57670	1	5727	11
9	Current Fallow	76028	77056	2	1028	1
10	Net Area Sown	2071507	2040132	53	-31375	-1.5
11	Area Sown more than once	575954	621625	15	45671	8
12	Total Cropped Area	2647461	2661757	68	14296	1
13	Cropping Intensity	128	130	0	2	0

Source: Directorate of Economics and Statistics

## 2.4. State's Economy

After independence, the state was managed as a democratic socialist welfare economy. From the 1990s, liberalisation of the mixed economy allowed onerous restrictions against capitalism and foreign direct investment to be lightened, leading to economic expansion and an increase in employment. In the fiscal year 2007–2008, the nominal gross state domestic product (GSDP) was 1,624 billion (US\$24 billion).

Kerala's economy depends on emigrants working in foreign countries, mainly in Arab states of the Persian Gulf, and remittances annually contribute more than a fifth of GSDP.[174] In 2008, the Persian Gulf countries together had a Keralite population of more than 2.5 million, who sent home annually a sum of US\$6.81 billion, which is the highest among Indian states and more than 15.13% of remittances to India in 2008.[175] In 2012, Kerala still received the highest remittances of all states: US\$11.3 billion, which was nearly 16% of the US\$71 billion remittances to the country.

The tertiary sector comprises services such as transport, storage, communications, tourism, banking, insurance and real estate. In 2011–2012, it contributed 63.22% of the state's GDP, agriculture and allied sectors contributed 15.73%, while manufacturing, construction and utilities contributed 21.05%. Nearly half of Kerala's people depend on agriculture alone for income. As of March 2002, Kerala's banking sector comprised 3341 local branches: each branch served 10,000 people, lower than the national average of 16,000; the state has the third-highest bank penetration among Indian states. On 1 October 2011, Kerala became the first state in the country to have at least one banking facility in every village.[191] Unemployment in 2007 was estimated at 9.4%; chronic issues are underemployment, low employability of youth, and a low female labour participation rate of only 13.5%.

The state's budget of 2012–2013 was 481.42 billion (US\$7.2 billion). The state government's tax revenues (excluding the shares from Union tax pool) amounted to 217.22 billion (US\$3.2 billion) in 2010–2011; up from 176.25 billion (US\$2.6 billion) in 2009–2010. Its non-tax revenues (excluding the shares from Union tax pool) of the Government of Kerala reached 19,308 million (US\$290 million) in 2010–2011. However, Kerala's high ratio of taxation to GSDP has not alleviated chronic budget deficits and unsustainable levels of government debt, which have impacted social services. A record total of 223 hartals were observed in 2006, resulting in a revenue loss of over 20 billion (US\$300 million). Kerala's 10% rise in GDP is 3% more than the national GDP. In 2013, capital expenditure rose 30% compared to the national average of 5%, owners of two-wheelers rose by 35% compared to the national rate of 15%, and the teacher-pupil ratio rose 50% from 2:100 to 4:100. In November 2015, the Ministry of Urban Development selected seven cities of Kerala for a comprehensive development program known as the Atal Mission for Rejuvenation and Urban Transformation (AMRUT). A package of 25 lakh (US\$37,000) was declared for each of the cities to develop service level improvement plan (SLIP), a plan for better functioning of the local urban bodies in the cities of Thiruvananthapuram, Kollam, Alappuzha, Kochi, Thrissur, Kozhikode, and Palakkad.

**Table 2.3: Sector-wise NSDP of Kerala**

		(Rs.LAKHS)			
Sl. No.	Industry	2011-12	2012-13	2013-14(Provisional)	2014-15(Quick)
1.	Agriculture, forestry & fishing	4026831	4089863	4519063	4804874
1.1	Crops	2156600	1773676	1971273	1947574
1.2	Livestock	1111658	1394256	1501245	1720212
1.3	Forestry & Logging	425567	464566	486858	503911
1.4	Fishing	333005	457365	559688	633176
2.	Mining & Quarrying	239593	235208	133614	223182
<b>A. Sub-Total of Primary</b>		<b>4266424</b>	<b>4325071</b>	<b>4652678</b>	<b>5028055</b>
3.	Manufacturing	3000616	3587813	3831881	4304444
4.	Electricity, Gas, Water Supply & other Utility Services	311148	352636	369898	379853
4.1	Electricity, gas & other utility services	277574	318060	336702	343730
4.2	Water Supply	33575	34575	33196	36123
5.	Construction	5058202	5251556	5634586	6061473
<b>B. Sub-Total of Secondary</b>		<b>8369967</b>	<b>9192005</b>	<b>9836365</b>	<b>10745771</b>
6.	Trade,hotels & restaurants	5125615	6266807	7116876	8327561
7.	Transport,Storage & Communication	2490301	2779788	3216040	3579652
7.1	Railways	80346	99329	108674	122012
7.2	Transport by means other than Railways	1937750	2173251	2491915	2761091
7.3	Storage	2839	3235	3325	3469
7.4	Communication & Services related to broadcasting	469366	503973	612126	693080
8.	Financial Services	1408254	1601339	1789363	1920767
9.	Real estate,ownership of dwellings & professional services	3549760	4431327	5320822	6121059
10.	Public Administration	1223566	1336124	1441766	1683372
11.	Other Services	3592748	4102938	4777668	5438046
<b>C. Sub-Total of Tertiary</b>		<b>17390244</b>	<b>20518324</b>	<b>23662535</b>	<b>27070457</b>
12.	<b>Net Value Added at basic Prices</b>	<b>30026634</b>	<b>34035399</b>	<b>38151578</b>	<b>42844283</b>
13.	Population (In Number)*	33501483	33666174	33832269	33999784
14.	<b>State Per Capita Income (Rs.) at Basic Price</b>	<b>89628</b>	<b>101097</b>	<b>112767</b>	<b>126013</b>
15.	Product Taxes	3407148	3997082	4535550	5212040
16.	Product Subsidies	631670	894069	882775	1004018
17.	<b>State Domestic Product ( market Price)</b>	<b>32802112</b>	<b>37138412</b>	<b>41804353</b>	<b>47052306</b>
18.	<b>State Per Capita Income (Rs.) (Market Price)</b>	<b>97912</b>	<b>110314</b>	<b>123564</b>	<b>138390</b>

#### 2.4.1. Sectoral Composition of State Income

Indian economy is classified in three sectors — Agriculture and allied, Industry and Services. Agriculture sector includes Agriculture (Agriculture proper & Livestock), Forestry & Logging, Fishing and related activities. Industry includes Manufacturing (Registered & Unregistered), Electricity, Gas, Water supply, and Construction. Services sector includes Trade, repair, hotels and restaurants, Transport, storage, communication & services related to broadcasting, Financial, real estate etc. At previous methodology, composition of Agriculture & allied, Industry, and Services sector was 51.81%, 14.16%, and 33.25%, respectively at current prices in 1950-51. Share of Agriculture & allied sector has declined at 18.20% in 2013-14. Share of Services sector has improved to 57.03%. Share of Industry sector has also increased to 24.77%. **Figure 2.1** shows the sectoral composition of State Income and trend line of NSDP growth.

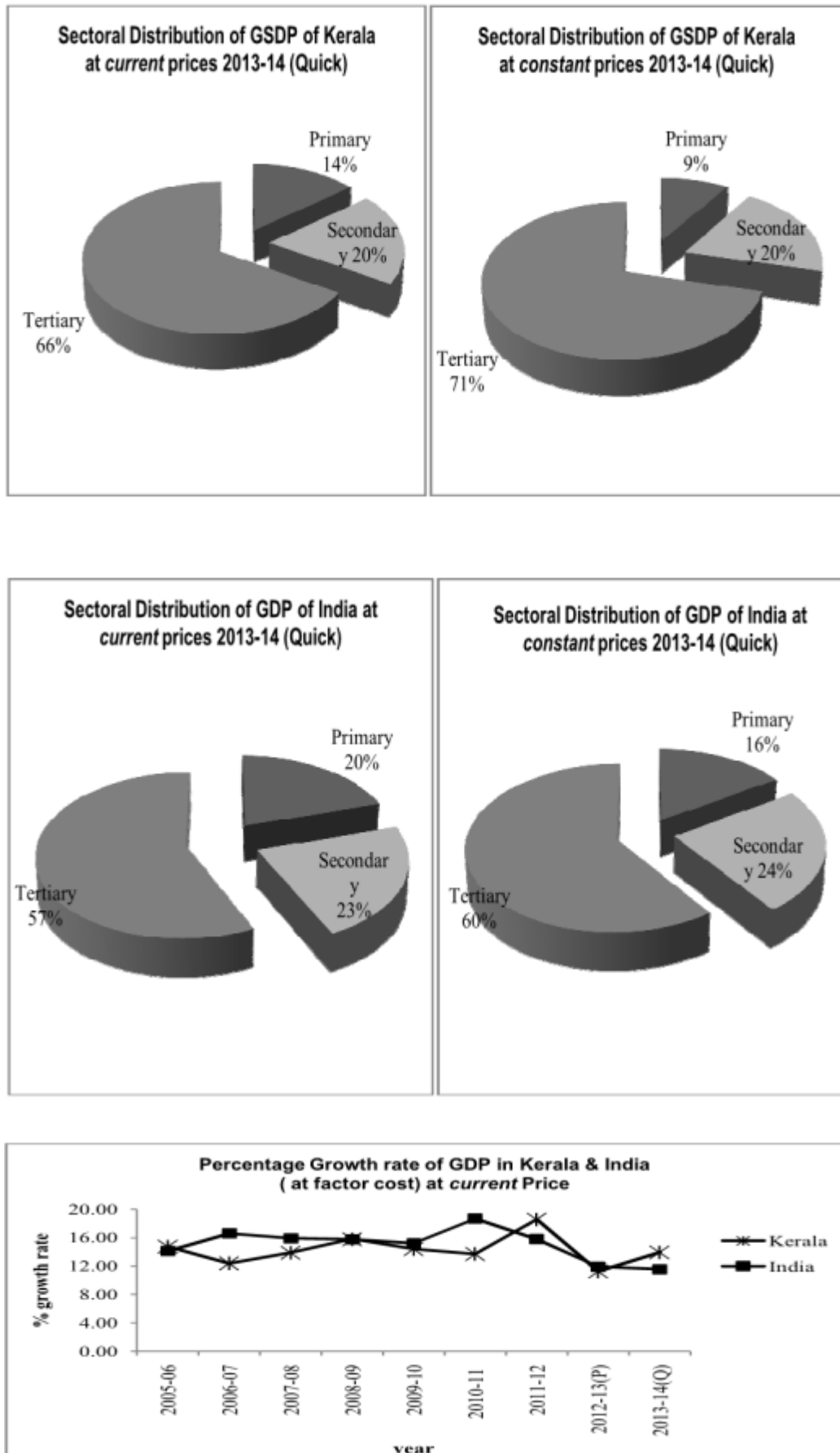


Figure 2.1: Sectoral Composition of State Income

## 2.4.2. The Per Capita Income

The per Capita income of Kerala has raised in year 2013-14 by 2.73 percent in comparison with previous year of 2012-13. Details of per capita income are given in **Table 2.4**.

**Table 2.4: Per Capita Income**

Year	Per Capita Income	Percentage change in Per Capita Income over previous year
2012-13	91567	10.65
2013-14	103820	13.38
2014-15	NA	NA

## 2.4.3. Growth Trends-State Income

According to Kerala Economic Review state has recorded a growth rate of 6.49 per cent in the last fiscal, which is above the national average (4.04) and the second highest among South Indian States. It said the state's growth rate was above that of Karnataka (5.79 per cent) and Andhra Pradesh (5.97 per cent).

According to the review, the service sector continues to dominate the Kerala economy which is heavily depended on overseas remittance. Segments such as transport, communication, trade, hotels, banking and insurance, and real estate have performed well.

## 2.4.4. District wise Income

The analysis of district wise per capita income shows that Ernakulam district stands first with the per capita income of Rs. 85070 at constant (2004-05) prices in 2010-11 as against Rs. 78351 in 2009-10 Kottayam District has the second largest per capita income of Rs. 64648 in 2010-11 at constant prices followed by Thiruvananthapuram (Rs. 60945), Pathanamthitta (Rs. 60370), Thrissur (Rs. 59127), and Alappuzha (Rs. 57298). The lowest per capita income was recorded in Malappuram District (Rs. 36740) in 2010-11 at constant prices preceded by Wayanad (Rs.39051), Kasargod (Rs. 44572) and Kozhikode (Rs. 53298). The highest rate of growth of per capita income of 9.31% was recorded in Pathanamthitta District in 2010-11 followed by Thiruvananthapuram (8.98 %), Thrissur (8.84%), Ernakulam (8.57%), and Allappuzha (8.37%). The lowest growth rate was recorded in Idukki District (6.84%) preceded by Wayanad District (7.74%), Malappuram (7.75%), and Kasargod (7.97 %). The district wise per capita income with growth rate is given here:

The analysis of district wise per capita income shows that Ernakulam district stands first with the per capita income of Rs.86267 at constant (2004-05) prices in 2013-14 as against Rs. 81557 in 2012-13. The given **Table 2.5** reveals that the districts Ernakulam, Thrissur, Kozhikode and Kannur had a much higher growth rate than the average growth in per capita income in 2012-13. However, the districts of Wayanad, Kollam, Palakkad and Idukki showed much lower growth in per capita income than the state average. District wise and sector wise analysis of GSDP reveals that Ernakulam district contributions in all these sectors are highest.

**Table 2.5: District wise NSDP (Current Prices)**

District-wise Per Capita Income at Basic Price-Constant (2011-12) Prices						
SL No.	District	2013-14 (P)	Rank	2014-15 (Q)	Rank	Growth Rate (%)
1	Thiruvananthapuram	114495	3	122030	3	6.58
2	Kollam	113369	4	121251	4	6.95
3	Pathanamthitta	84900	9	87111	9	2.60
4	Alappuzha	104243	6	111674	5	7.13
5	Kottayam	104424	5	107622	6	3.06
6	Idukki	114708	2	124298	2	8.36
7	Ernakulam	151210	1	161472	1	6.79
8	Thrissur	96647	7	102552	7	6.11
9	Palakkad	79552	11	84461	11	6.17
10	Malappuram	71727	13	76467	13	6.61
11	Kozhikode	82243	10	86919	10	5.69
12	Wayanad	72909	12	77593	12	6.43
13	Kannur	93906	8	98960	8	5.38
14	Kasaragod	65216	14	67579	14	3.62
	STATE	98246		104198		6.06

P: Provisional Q: Quick

(Source: Department of Economics and Statistics)

## 2.5. Work Participation Ratio

The **Table 2.7** indicates the percentage of workers to total population in Kerala according to Census 2011 is 34.78%. Compared to 2001 Census, an improvement of 2.48% is observed in WPR. The highest WPR is Idukki (46.6%) and the lowest in Malappuram (25.83%). Among males the Work Participation rate is 52.73%. In 2001 the same was 50.20%. Highest Male Work Participation Rate is observed in Idukki (60.00%) and the lowest in Malappuram (45.82%).

Among females the work participation rate is 18.23%. In 2001, the same was 15.38%. Highest Female Work Participation Rate is observed in Idukki (33.20%) and the lowest in Malappuram (7.63%).

**Table 2.6: Total Workers Main and Marginal**

Total Working and Non-Working Population of Kerala		
Total Workers	Main Workers	Marginal Workers
11619063	9329747	2289316

Source: Economic Survey 2011

## 2.5.1. Economic Classification of Workers

The broad categories of economic activities, also known as a four-fold classification of the workers are cultivators (CL), Agricultural Labours (AL), working in Household Industries (HHI) and other Workers (OW).

**Table 2.7: Percentage Distribution of Total Workers by Broad Economic Classification**

Classification of Workers	Kerala in Year 2011 (%)
Cultivators	5.77
Agricultural labour	11.39
Household Industries	2.35
Others	80.50
Total	100
<b>Total Workers</b>	<b>11619063</b>

## 2.6. Agriculture and Allied Activities

The growth performance of the agriculture and allied sectors has been fluctuating across the Plan period. It witnessed a positive growth of 1.8 percent in Xth Plan period but a negative growth rate of -1.3 percent in XIth Five Year Plan. In the Twelfth Plan based on the new series brought out by the Directorate of Economics and Statistics (DES) with 2011-12 as base year, the agriculture and allied sectors recorded a positive growth rate of 1.43 per cent in the first year (2012-13), and a negative growth rate of -2.13 per cent in second year (2013-14). In 2014-15, the sector has recorded a negative growth rate of -4.67 per cent. Consequently, the share of agriculture and allied sectors in total GSDP of the State has also declined from 14.38 percent in 2011-12 to 11.6 percent in 2014-15. But, the switch from 2004-05 to new series with 2011-12 as base has resulted in higher share of agriculture and allied sectors in the total GSDP of the State from 8.83 per cent to 12.9 per cent for 2013-14. The details of share of Agriculture and allied sectors in GDP at the National and State level (Base 2011-12) is shown below.

**Table 2.8: Contribution of Agricultural sector to the State income in Kerala**

Years	Share of Agriculture and Allied Sectors (India)	Share of Agriculture and Allied Sectors (Kerala)
2011-12	18.4	14.38
2012-13	18.0	13.76
2013-14	18.0	12.9
2014-15	NA	11.6

Source: Directorate of Economics and Statistics

### 2.6.1. Agricultural Production

Food grain production in country has reached a record value of 244.8 million tons in 2010-11. Production of rice alone was to the tune of 96.0 million tons in 2010-11. The estimated production of rice for the country is 102.8 million tons in 2011-12. Data regarding the area, production and productivity of important crops grown in Kerala are shown below. Out of a gross cropped area of 26.69 lakh ha. in 2009-10, food crops comprising rice, pulses and tapioca occupy only 11.74 percent. But in 2010-11, it reduced to 8.13%. Kerala state which had a low base in food production is facing serious challenges in retaining even this meager area. Kerala agricultural economy is undergoing structural transformation from the mid-seventies by switching over a large proportion of its traditional crop area which was devoted to subsistence crops like rice and tapioca to more



remunerative crops like banana and other plantations. **Table 2.9** represents production of principal crops in Kerala:

**Table 2.9: Production of Principal Crops**

Principal Crops	Area (Ha)			Production (Tonnes)		
	2001-02	2013-14	% Variation	2001-02	2013-14	% Variation
Paddy	322368	199611	-38	703504	564325	-20
Tapioca	111189	67589	-39	2455880	2479070	1
Coconut	905718	808647	-11	5479	5921	8
Pepper	203956	84065	-59	58240	29408	-50
Cashew	89718	49105	-45	65867	33375	-49
Rubber	475039	548225	15	580350	648220	12
Groundnut	2437	710	-71	1812	868	-52
Sesamum	878	265	-70	284	88	-69
Cotton	3760	177	-95	6069	284	-95
Pulses	8191	2989	-64	6281	3019	-52
Ginger (Dry)	10706	4538	-58	40181	21521	-46
Turmeric	3558	2430	-32	7895	6253	-21
Banana	50871	62261	22	345903	531299	54
Tobacco	71	9	-87	395	17	-96
Total Cereals	329875	199937	-39	708624	564635	-20
Arecanut	93193	100008	7	84681	100018	18
Coffee	84795	85359	1	66690	66645	0
Tea	36899	30205	-18	66090	62938	-5

*Coconut Production is in million nuts.*

*Source : Department of Economics and Statistics*

### **Fisheries**

With 590 kilometres (370 miles) of coastal belt, 400,000 hectares of inland water resources and approximately 220,000 active fishermen, Kerala is one of the leading producers of fish in India. According to 2003–04 reports, about 1.1 million people earn their livelihood from fishing and allied activities such as drying, processing, packaging, exporting and transporting fisheries. The annual yield of the sector was estimated as 608,000 tons in 2003–04. This contributes to about 3% of the total economy of the state. In 2006, around 22% of the total Indian marine fishery yield was from Kerala. During the southwest monsoon, a suspended mud bank develops along the shore, which in turn leads to calm ocean water, peaking the output of the fishing industry. This phenomenon is locally called chakara. The waters provide a large variety of fish: pelagic species; 59%, demersal species; 23%, crustaceans, molluscs and others for 18%. Around 1.050 million fishermen haul an annual catch of 668,000 tonnes as of a 1999–2000 estimate; 222 fishing villages are strung along the 590-kilometre (370-mile) coast. Another 113 fishing villages dot the hinterland. Kerala's coastal belt of Karunagappally is known for high background radiation from thorium-containing monazite sand.



## 2.7. Industry

The study traces the trends in industrial growth against the backdrop of the overall economic growth in Kerala under the influence of the ongoing economic reforms and evaluates it against the performance of Karnataka, Tamilnadu and all-India. The analysis reveals that a phase of growth revival has set in the overall economy since the late eighties. Though the manufacturing industry has improved its growth performance over time, the growth rates recorded during the nineties are not higher than the corresponding figures for the eighties. The relatively low growth profile of the manufacturing industry, when the general economy is growing remarkably well, appears a riddle of the recent growth trends under the reform process in Kerala.



It is argued that inadequate growth of investment has constrained the pace of modernisation of old units and establishment of new units based on 'state-of-art' technology needed for the survival and growth of industries in a globally competitive environment. The study suggests that the lack of a clear and pragmatic approach of the state in its response to the reform process and a positive attitude in its own policies for encouraging private investment makes Kerala a less investor friendly location for manufacturing industry. It underlines the need for a new vision and strategy, which could fully utilise Kerala's comparative advantage in human resources, and place greater emphasis on developing knowledge-based and service industries, for accelerating the growth of income and employment in industry.

### 2.7.1. Registered Industrial Units in Kollam

#### A. Medium and Large Scale Industries

**Table 2.10: Registered Working Factories (Medium and Large Scale) & employment in the State**

Year	Number of Registered Units	Employment	Investment (in lacs)
2006-2007	2	1	14
2007-2008	12	135	98
2008-2009	136	994	1283
2009-2010	2346	31509	-
2010-2011	652	5389	9248
2011-2012	806	6287	12435
2012-2013	201	971	4628
<b>TOTAL</b>	<b>4155</b>	<b>45286</b>	<b>27706</b>

Source: DIC, Kollam

## 2.7.2. Small Scale Industries

**Table 2.11: Registered Working Factories (Small Scale) in 2013-14**

S. No.	Type of Industry	No. of Units
1	Food Products	1967
2	Textile & Garments	1269
3	Glass & Ceramics	33
4	Mechanical Engineering	1145
5	IT & ITES	587
6	IT Hardware	233
7	Rubber Products	125
8	Chemical	248
9	Plastic	348
10	Paper & Paper Products	431
11	Fruit & Food based products	493
12	Service Activities	1072
13	Miscellaneous	8400
	<b>TOTAL</b>	<b>16349</b>

Source: DIC, Kollam

## 2.7.3. Registered Industrial Units in Alappuzha

### B. Medium and Large Scale Industries

**Table 2.12: Registered Working Factories (Medium and Large Scale) & employment in the State**

Year	Number of Registered Units	Employment	Investment (in lacs)
2006-2007	166	664	531.2
2007-2008	1378	8348	13981.63
2008-2009	4114	26567	34251.93
2009-2010	5246	34000	38129.31
2010-2011	5922	40604	43778.11
2011-2012	6442	45947	50708.9
<b>TOTAL</b>	<b>20738</b>	<b>108143</b>	<b>140201.86</b>

Source: DIC, Alappuzha

## 2.7.4. Small Scale Industries

**Table 2.13: Registered Working Factories (Small Scale) in 2011-12**

S. No.	Type of Industry	No. of Units
1	Agro Based	7690
2	Soda Water	312
3	Jute and Jute Based	NA
4	Readymade Garments & embroidery	4379
5	Wood/wooden based furniture	1257
6	Paper & Paper Products	585
7	Leather Based	212
8	Chemical/Chemical based	1081
9	Rubber, Plastic & Petro based	1701

S. No.	Type of Industry	No. of Units
10	Mineral based	82
11	Metal based	283
12	Engineering Units	1444
13	Electrical Machinery & transport equipment	306
14	Repairing & Servicing	1590
15	Others	2726
	<b>TOTAL</b>	<b>23648</b>

Source: DIC, Alappuzha

## 2.7.5. Registered Industrial Units in Thiruvananthapuram

### B. Medium and Large Scale Industries

**Table 2.14: Registered Working Factories (Medium and Large Scale) & employment in the State**

Year	Number of Registered Units	Employment	Investment (in lacs)
2006-2007	333	2792	2985.35
2007-2008	1076	9657	12108.71
2008-2009	1139	8306	2894.23
2009-2010	1410	9061	8322.71
2010-2011	1077	9725	5752.27
2011-2012	1198	7646	10153.43
<b>TOTAL</b>	<b>21963</b>	<b>124710</b>	<b>106483.35</b>

Source: DIC, Thiruvananthapuram

### 2.7.6. Small Scale Industries

**Table 2.15: Registered Working Factories (Small Scale)**

S. No.	Type of Industry	No. of Units
1	Agro Based	4994
2	Readymade garments & embroidery	2495
3	Wood/Wooden Based furniture	499
4	Paper & Paper products	250
5	Rubber, Plastic & Petro based	998
6	Miner Based	NA
7	Metal based	NA
8	Engineering Units	2987
9	Electrical Machinery and transport equipment	499
10	Repairing & Servicing	250
11	Others	8991
	<b>TOTAL</b>	<b>21963</b>

Source: DIC, Thiruvananthapuram

## 2.8. Transport Network

Transport system of any state plays an important role in development. In Kerala there are various modes of transport in the state i.e. Road, Airports, Railways and finally the major mode is waterways.

### 2.8.1. National Highways

Kerala has 145,704 kilometres (90,536 mi) of roads, which accounts for 4.2% of India's total. Roads in Kerala include 1,524 kilometres (947 mi) of national highway; 2.6% of the nation's total, 4,341.6 kilometres (2,697.7 mi) of state highway and 18,900 kilometres (11,700 mi) of district roads. Most of Kerala's west coast is accessible through two national highways, NH 47 and NH 17; and the eastern side is accessible through state highways. There is also a hill highway proposed, to provide access to the eastern hills. National Highway 17, with the longest stretch of road (421 kilometres (262 mi))



connects Edapally to Panvel; it starts from Kochi and passes through Kozhikode, Kannur, Kanhangad, Kasaragod and Uppala. NH 47 runs from Salem to Kanniyakumari, via Coimbatore, Palakkad, Thrissur, Ernakulam, Kochi, Alapuzha, Kollam, Thiruvananthapuram & Nagercoil, connecting Kerala's political capital (Thiruvananthapuram) to its commercial capital (Kochi). Details are given in **Table 2.16**.

**Table 2.16: National Highways in Kerala**

NH No.	NH Portion in Kerala	Length (kms)
17	Thalappady - Edapally	420.77
47	Walayar - Kaliyikkavila	416.800
49	Bodimdettu - Muvatupuzha - Kochi	167.593
208	Kollam - Aryankavu - Muvattupuzha	81.280
212	Kozhikode - Muthanga	117.600
213	Palakkad - Kozhikode	125.304
220	Kollam - Kumily	189.300
47A	Kundannoor - Willington Island	5.900
<b>Total Length</b>		<b>1524.547</b>

The length of roads maintained by different agencies is given in **Table 2.17**.

**Table 2.17: Agency-wise Distribution of Road Length in Year 2009-10**

Name of Department	Length (km)	Percentage
Panchayat	104257	68.748
PWD (Roads & Bridges)	23242	15.32
Municipalities	8917	5.88
Corporation	6644	4.381
Forest	4075	2.689
Irrigation	2664	7.757
PWD (NH)	1525	1.006
Others (Railway, KSEB)	328	0.216
<b>Total</b>	<b>151652</b>	<b>100</b>

## 2.8.2. Registered Motor Vehicles

Total number of vehicles registered in the State as on 31.03.2016 stood at 16, 97,387. Out of the total vehicles population 63,809 are transport vehicles, 7, 96,401 are non-transport vehicles and 837177 are two wheelers.

## 2.8.3. Bus Transport Services

Road Transport is the dominant mode of transport for moving goods and passenger traffic. Road transport act as the feeder service to the rail traffic, air traffic and Port & harbours. The vehicle density in the State is very high compared to many other States in India. Road Transport Industry is dominated by private service providers. The road freight services are wholly owned and operated by the private sector.



Kerala State Road Transport Corporation (KSRTC) is the largest single public sector undertaking, which carries out transport operation in the State. The State owned KSRTC has only 14.71 per cent of the total number of stage carriages in the State. The passenger transport operation in Kerala is mainly carried out by private operators. There are 29,249 buses in the State as on 3/2003 including private buses. The number of schedules operated as on 3/2003 has increased from 3576 to 3651 in 2002-03. The corporation operated its bus services to a length of 4124.44 lakh kms as against 4148.15 lakh kms in the previous year with a marginal decrease of 0.59 per cent. About 11306.79 lakh passengers travelled in the KSRTC buses during 2002-03 as against 11087.16 lakh passengers in the previous year. The average km run by a bus in a day was 365 km during the period.

## 2.8.4. Railways

The railway network runs multi-gauge operations extending over 1148 kms in Kerala of which 94.14 kms is meter gauge. The railway operations in the State are controlled by the Thiruvananthapuram, Palghat and Madurai Divisions of Southern Railway. The entire railway route length of the State is spread along 13 railway routes of which highest number of railway stations (92) is in Thiruvananthapuram – Walayar route. The route length has remained stagnant in the State for a number of years.



### Thiruvananthapuram Railway Station

The railway network in the state is controlled by two out of six divisions of the Southern Railway; Thiruvananthapuram Railway division and Palakkad Railway Division.[253] Thiruvananthapuram Central (TVC) is the largest railway station in the state.[254] Kerala's major railway stations are TVC, Ernakulum Junction (South) (ERS), Kozhikode (CLT), Shornur (SRR), Palakkad Junction (PGT), Kollam Junction (QLN), Kannur (CAN), Thrissur Railway Station (TCR), Ernakulum Town (North)(ERN), Alappuzha railway station(ALLP), Kottayam (KTYM) Kayamkulam Junction (KYJ) and Chengannur.

## 2.8.5. Air Transport

Kerala has three international airports: Trivandrum International Airport, Cochin International Airport and Calicut International Airport. All civilian airports functioning in the state are international airports, a feature which is unique to Kerala. Upon completion of the Kannur International Airport, Kerala will join Tamil Nadu as the state with the most international airports. Unlike in other states where the capital city has the highest air traffic, in Kerala, air traffic is distributed evenly over Kochi, Thiruvananthapuram and Kozhikode. Despite this, all these three airports are among the top 15 busiest airports in India.

### Thiruvanthapuram Airport

Kollam Airport, established under the Madras Presidency and closed before the inauguration of Trivandrum International Airport in the capital, was the first airport in Kerala.[258]Trivandrum International Airport, managed by the Airport Authority of India, is among the oldest existing airports in South India. Cochin International Airport is the busiest in the state and the seventh-busiest in the country. It was the first Indian airport to be incorporated as a public limited company; it was funded by nearly 10,000 non-resident Indians from 30 countries. Cochin Airport is the primary hub of Air India Express and the secondary hub of Air Asia India



## 2.8.6. Water Transport

Kerala has one major port, 17 minor ports and a few mini ports. The state has numerous backwaters, which are used for commercial inland navigation. Transport services are mainly provided by country craft and passenger vessels. There are 67 navigable rivers in the state while the total length of inland waterways is 1,687 kilometers (1,048 mi). The main constraints to the expansion of inland navigation are; lack of depth in waterways caused by **Kerala State Water Department**



silting, lack of maintenance of navigation systems and bank protection, accelerated growth of the water hyacinth, lack of modern inland craft terminals, and lack of a cargo handling system. A canal 205 kilometers (127 mi) long, National Waterway 3, runs between Kottapuram and Kollam, which is included in the East-Coast Canal.

## 2.9. Tourism

Kerala's culture and traditions, coupled with its varied demographics, have made the state one of the most popular tourist destinations in India. In 2012, National Geographic's Traveller magazine named Kerala as one of the "ten paradises of the world" and "50 must see destinations of a lifetime". Kerala's beaches, backwaters, lakes, mountain ranges, waterfalls, ancient ports, palaces, religious institutions and wildlife sanctuaries are major attractions for both domestic and international tourists. The



city of Kochi ranks first in the total number of international and domestic tourists in Kerala. Kerala tourism is a global brand and regarded as one of the destinations with highest recall. In 2006, Kerala attracted 8.5 million tourists, an increase of 23.68% over the previous year, making the state one of the fastest-growing popular destinations in the world. In 2011, tourist inflow to Kerala crossed the 10-million mark.

Ayurvedic tourism has become very popular since the 1990s, and private agencies have played a notable role in tandem with the initiatives of the Tourism Department. Kerala is known for its ecotourism initiatives which include mountaineering, trekking and bird-watching programmes in the Western Ghats as the major activities. As of 2005, the state's tourism industry was a major contributor to the state's economy, growing at the rate of 13.31%. The revenue from tourism increased five-fold between 2001 and 2011 and crossed the 190 billion mark in 2011. Moreover, the industry provides employment to approximately 1.2 million people.

Kerala's ecotourism destinations include 12 wildlife sanctuaries and two national parks: Periyar Tiger Reserve, Parambikulam Wildlife Sanctuary, Chinnar Wildlife Sanctuary, Thattekad Bird Sanctuary, Wayanad Wildlife Sanctuary, Muthanga Wildlife Sanctuary, Aralam Wildlife Sanctuary, Eravikulam National Park, and Silent Valley National Park are the most popular among them. The Keralas Padmanabhapuram Palace and the Mattancherry Palace are two notable heritage sites.

**Table 2.18: Growth of Tourist Traffic in Kerala**

Year	Foreign Exchange Earning (Rs. In Crores)	Percentage of Increase	Total Revenue Generated from Tourism (Direct & Indirect)	Percentage of Increase
2004	1266.77	28.82	6829.00	15.01
2005	1552.31	22.54	7738.00	13.31
2006	1988.40	28.09	9126.00	17.94
2007	2640.94	32.82	11433.00	25.28
2008	3066.52	16.11	13130.00	14.84
2009	2853.16	-6.96	13231.00	0.77
2010	3797.37	33.09	17348.00	31.12
2011	4221.99	11.18	19.037.00	9.74
2012	4571.69	8.28	20430.00	7.32
2013	5560.77	21.63	22926.55	12.22
2014	6398.93	15.07	24885.44	12.11
2015	6949.88	8.61	26689.63	7.25

**Variation of Domestic and Foreign Tourists in Kerala are as follows:**



**Table 2.19: Trends in Domestic & Foreign Tourists in Kerala**

Year	Domestic Tourists	Percentage of Variation	Foreign Tourist	Percentage of Variation
2004	5972182	1.7	345546	17.3
2005	5946423	-4.3	346499	0.27
2006	6271724	5.47	428534	23.7
2007	6642941	5.92	515808	20.37
2008	7591250	14.28	598929	16.11
2009	7913537	4.25	557258	-6.96
2010	8595075	8.61	659265	18.31
2011	9381455	9.15	732985	11.18
2012	10076854	7.41	793696	8.28
2013	10857811	7.75	858143	8.12
2014	11695411	7.71	923366	7.60
2015	12465571	6.59	977479	5.86

## 2.10. Conclusions

Proposed project road will directly serve about 7.9 million people out of which about 72 per cent is rural population and 11.63 per cent schedule caste and schedule tribes of the total population. Since, a significant proportion of the population is rural in the project influence area and belongs to lower strata of the society up-gradation of project road is going to have significant socio-economic implications on the growth and development of the region. The upgraded road will facilitate smooth movement of men and material and reduce the overall transportation cost on the corridor. Besides this it will help in spreading the impact of economic development from one particular district to other districts of the area.

## CHAPTER 3 ENGINEERING SURVEYS AND INVESTIGATIONS

---

### 3.1. Introduction

This chapter deals with the Engineering Surveys and Investigations carried out during the course of the Feasibility Study. Alignment study, Topographical surveys and other field investigations like road inventory, condition surveys for road including pavement roughness, Inventory and Condition surveys of culverts and bridges and Soil and Material investigations have been discussed in this chapter.

### 3.2. Collection of Secondary Data

All relevant reports and data, development plans concerning to the proposed project and the project influence area was collected directly or with the help of the Client from concerned Departments of Government of India (GOI) and Government of Kerala.

### 3.3. Study of the Existing Alignment

The project road length of NH 47 is 170.7km. It starts from km 379.100 of NH-47 at the junction of Thuravoor and ends at Kazhakottam junction at km 549.801. This stretch of road passes through three districts viz. Alappuzha, Kollam and Thiruvananthapuram. The road passes through urban areas viz. Cherthala, Marary Kulam, Alappuzha, Ambalapuzha, Purakkad, Thottapally, Haripad, Nagiar Kulangara, Kayamkulam, Krishnapuram, Oachira, Vavvakkavu, Karunagapally, Chavara, Neendakara, Kavanadu (Kollam), Mevaram (Kollam), Kottiyam, Chathanoor, Paripally, Kallambalam, Attingal, Manglapuram, Pallipuram and Kazhakottam.

Generally the existing road is two laned with paved shoulders on either side. At most of the urban locations in the presence of Major Junction, carriageway has been upgraded to 4 lane divided carriageway configuration including the junction with approaches and also along the existing town section.

This package is described in detail in the following sections:

#### a) NH 47 Section from km 454.50 to km 486.00 (2 Laned section)

This part of the road falls in Alappuzha and Kollam districts. The alignment in this section mostly conforms to the desired geometry standards of NH.

There are a number of urban settlements and major junctions where, 4-lane divided carriageway width is available at most of the major junctions.

The width of each carriageway in this stretch is 7.25m with paved shoulder 1.5m. AT the 4 lane divided sections in the vicinity of Major Junctions, median width varies from 1.5m to 2.5m. At the built up locations, there is less possibility of further widening as the area is very congested and the existing ROW is nearly 30m.

Width of carriageway in the rest of the section of project road is 9.5-10m. ROW in this stretch is 30m.

This stretch of road passes through built up areas and commercial areas and industrial areas. Pavement condition in this stretch is fair and satisfactory.

Pavement condition of the stretches of this section is satisfactory.

In some stretches of this section, the vertical profile has roller coaster formation with gradient about 4% and above with substandard sight distance. There are several built up section along the project road which imposes some constraints on the development proposals in regards to land acquisition.

Main Bridges in this section are as follows:

**Table 3.1: Bridges**

S. No.	Location (ex. km.)	Name	Length (m)	Remarks
1	474.600	Kannetti Bridge	80.2	Major Bridge
2	483.100	Chavara Bridge	42.0	Minor Bridge

The total of existing culverts after compiling the data is found to be **44 (Pipe 07 nos., Slab 33 nos.4 nos. not visible )**. Many of these culverts has been found to be partially chocked and seem inadequate. The culverts are also old and seem to be structurally as well as hydraulically poor. Many of these structures shall be replaced preferably by Box Culverts for better hydraulic performance.

### 3.4. Current And Proposed Development Activities

At present NH-47 (PKG-III) is being developed and maintained by State PWD Kerala acting as executing agency of MORTH.

### 3.5. Road Inventory and Pavement Condition Surveys

To know the existing road characteristics in terms of its geometry, data on roadside land use, right of way, width of carriageway, junctions, road safety features, submergence and utilities were collected along the road. The road inventory survey has been carried out for the entire project alignment. The data is tabulated and presented in **Appendix 3.1** in **Appendices to Main Report**.

### 3.6. Pavement Roughness

#### 3.6.1. Introduction

It is an accepted principle that all pavement surfaces should be as even as possible so that ride is comfortable, fatigue free and safe to users as well as stresses in both pavement structure & vehicles are minimum. The quality of construction & maintenance of a road is reflected in the riding quality. Vehicle speed, road safety & VOC (vehicle operating costs) are function of road roughness. A periodic measurement of roughness is, therefore, of vital importance to a highway engineer.

The discomforts & disturbances to which road users are subjected are influenced to some extent by the vehicle characteristics, but are essentially a function of road surface irregularity & hence it is necessary to evaluate the same for necessary action & correction. A careful consideration during initial construction & subsequent maintenance is mandatory.

#### 3.6.2. Project Details

The project road length is 31.50 km. It starts from km 454.50 of NH-47 at Kottankulangara and ends at at km 486.00 at Start of kollam bypass.

### 3.6.3. Speed

As per IRC - SP - 16 - 2004, a standard speed of  $32 \pm 1$  km/hr. has an important meaning in roughness measurements. The road roughness is affected by the vehicle speed. A bump gets magnified if the vehicle speed is not maintained. A standard pneumatic tyre wheel inflated to a tyre pressure of 2.1 kg/sqcm is mounted within the trailer chassis. The distance travelled is measured by a distance measuring unit. The test is conducted at a speed of  $32 \pm 1$  km/hr. Unevenness/roughness Index is defined as the ratio of the cumulative vertical displacement to the distance travelled and is expressed in mm/km. For measurement of roughness, one measurement in each lane is recommended for riding comforts evaluation.

### 3.6.4. Roughness Survey

#### 3.6.4.1. Recommended Standard for Roughness Values (As Per IRC-SP: 16-2004)

The bump integrator gives BI values for different surfaces. Maximum permissible values, BI in mm/km as per guidelines, are given in the table herein. Condition of the road surface is categorized in three groups, 'good', average & 'poor' based on BI values.

Good category indicates newly constructed surfaces with respect to roughness values. Values under 'Average' & 'Poor' correspond to level of service & intervention level for maintenance.

Surfaces with very low roughness values lose skid resistance & are dangerous as regards safety.

**Table 3.2: Maximum Permissible Values of Roughness of Road Surface (BI Value) (mm/km)**

S. No.	Type of Surface	Condition of Road Surface		
		Good	Average	Poor
1.	Bituminous Concrete	< 2000	2000 – 3000	> 3000

#### 3.6.4.2. Overall Observations

First of all, accuracy of Bump Integrator was checked by calibrating it with ARUR-IU (mm/Km) at Central Road Research Institute (CRRI), New Delhi.

$$UI = 1.272 (BI) - 132.6$$

$$R^2 \text{ (Regression Coefficient)} = 0.990$$

Where UI Roughness as measured by ARUR (STECO-257) – mm/Km

BI Reference Roughness – mm/Km

Fifth wheel Bump Integrator was used on site to get BI values every 100 m.

The survey was carried out along the wheel path. Average of readings represents BI for that particular kilometer. The speed must be maintained at  $32 \pm 1$  km/hr.

Roughness survey is done to obtain the following:

- Degree of surface finish or the riding quality of the road can be assessed,
- Surface irregularities of highways can be immediately attended for rectification,
- Classifying pavement surfaces for serviceability of the pavement and stage for repair or up gradation,
- Evaluates the performance of the Specifications adopted for roads and the developments of unevenness of the pavement with age and under traffic.



### 3.6.5. Results & Discussions

Bump integrator readings are converted into Uneven Index (UI) values and summarized in **Table-3.4** below.. Survey was conducted on along the project road and the results are also shown in graphical representation in **Figure 3.11**:

**Table 3.3: Summary of Road Surface Roughness**

Chainage, Km		Roughness Index (mm/Km)		Road Surface Condition	
From	To	Left Side	Right Side	Left	Right
454+000	455+000	2385.96	2818.44	AVERAGE	AVERAGE
455+000	456+000	2195.16	2608.56	AVERAGE	AVERAGE
456+000	457+000	2074.32	1896.24	AVERAGE	GOOD
457+000	458+000	1762.68	1959.84	GOOD	GOOD
458+000	459+000	1737.24	2525.88	GOOD	AVERAGE
459+000	460+000	1902.60	3206.40	GOOD	POOR
460+000	461+000	1947.12	2271.48	GOOD	AVERAGE
461+000	462+000	1877.16	1858.08	GOOD	GOOD
462+000	463+000	1832.64	1972.56	GOOD	GOOD
463+000	464+000	1807.20	1966.20	GOOD	GOOD
464+000	465+000	1928.04	1889.88	GOOD	GOOD
465+000	466+000	1762.68	2074.32	GOOD	AVERAGE
466+000	467+000	2067.96	1991.64	AVERAGE	GOOD
467+000	468+000	1934.40	2182.44	GOOD	AVERAGE
468+000	469+000	2080.68	1985.28	AVERAGE	GOOD

Chainage, Km		Roughness Index (mm/Km)		Road Surface Condition	
From	To	Left Side	Right Side	Left	Right
469+000	470+000	1864.44	2017.08	GOOD	AVERAGE
470+000	471+000	1775.40	2137.92	GOOD	AVERAGE
471+000	472+000	2125.20	2169.72	AVERAGE	AVERAGE
472+000	473+000	2112.48	2029.80	AVERAGE	AVERAGE
473+000	474+000	2099.76	2118.84	AVERAGE	AVERAGE
474+000	475+000	2169.72	2157.00	AVERAGE	AVERAGE
475+000	476+000	2405.04	2436.84	AVERAGE	AVERAGE
476+000	477+000	2284.20	2201.52	AVERAGE	AVERAGE
477+000	478+000	2188.80	2176.08	AVERAGE	AVERAGE
478+000	479+000	2087.04	2201.52	AVERAGE	AVERAGE
479+000	480+000	2990.16	2252.40	AVERAGE	AVERAGE
480+000	481+000	2169.72	2252.40	AVERAGE	AVERAGE
481+000	482+000	2061.60	2144.28	AVERAGE	AVERAGE
482+000	483+000	2366.88	2296.92	AVERAGE	AVERAGE
483+000	484+000	2634.00	3021.96	AVERAGE	POOR
484+000	485+000	2290.56	2226.96	AVERAGE	AVERAGE
485+000	486+000	2303.28	2182.44	AVERAGE	AVERAGE

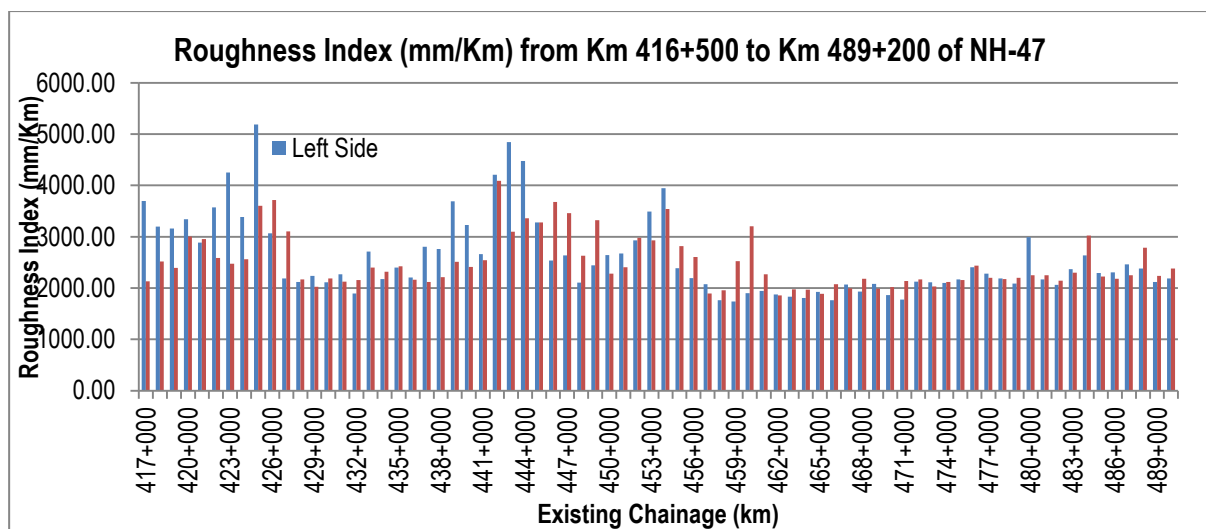


Figure 3.1: Illustrative Representation of Roughness Index between Km 416+500 to Km 489+200

## Topographical Survey

### Scope of Work

Scope of Work for the Survey of the stretch Kottankulangara to start of Kollam bypass on the National Highway 47 has been defined but not limited to, in this section as below. In addition to the TOR provided, Topo Surveyors interacted with the Executive Engineer of NH Division in Allapuzha and the Executive Engineer of NH Division in Kollam. Consultants had physically identified the Start and End Points of the Proposed Stretch. Their inputs were taken to ensure a proper Detailed Topographical survey.

- Construction of Pillars of the Size 15x15x60 Cm to be embedded in concrete and painted for marking of Bench Marks
- Pair of GPS stations to be established every 5 Km
- Total Station Travers shall be completed from GPS to GPS. The Maximum length of each loop shall not be more than 5 Kms. The Stations established shall be at a distance of 200 to 250M.
- Closed circuit Levelling shall be completed along the entire proposed stretch. The length shall not be more than 5 Kms.
- Detailed Topographical survey shall be conducted using Electronic Total Stations. The survey shall cover all important features above the ground. The extent of survey shall be 30 M on either side of the Proposed Centre Line. The Long Section shall be at intervals of 25m and the Cross Section at intervals of 50m. All culverts, Minor and Major Bridges shall be covered in its entirety. The U/s and D/s for Minor Bridges shall be 250m and for Major Bridges it shall be 500m.
- Other Non-Spatial Data Like details of Culverts and permanent features shall be incorporated into the drawings. Floor information of all buildings along the proposed stretch shall also be taken and incorporated into the drawings. Approximated height of the High Tension Line crossing across the proposed stretch shall be recorded.

### Survey Methodology

Survey is the field activity of measuring coordinates of all topographical features, in order to prepare a digital map of all the topographical features of a particular geo-graphical area. In this project, survey has been conducted on the proposed stretch from Kottankulangara to start of Kollam bypass passing through substantial sized towns of Karunagapally, Kollam etc. The Survey Methodology is further segregated in to the following sections:

- Laying of Pillars along the Proposed Stretch wherever necessary.
- Establishment of Control Points using DGPS.
- Horizontal Traverse between GPS Stations using Electronic Total Stations
- Leveling between GPS Stations using Auto Levels.
- Detailed Topographic Survey using Electronic Total Stations.
- Validation of the Drawing and collection of Non Spatial Data along the proposed Stretch.
- Transfer of GTS Bench Marks wherever available.

### 1. Erection of Bench Mark Pillars

The Erection of Pillars was started after getting them constructed as per the specification given in the ToR. The Pillars were of the size 15 Cm X 15 Cm X 60 Cm. They were erected after being concreted with cement and gravel for stability and longer durability. The Pillars were erected ensuring that 45 Cm was below ground and the remaining 15 Cm is above the ground. These Pillars were embedded wherever Permanent Structures were not available. The details of each TBM with their locations and coordinates are included in **Appendix 3.2**



### 2. Establishment of Control Points using DGPS:

Observation of permanent bench mark pillar (BM) and temporary bench mark pillars (TMB), can otherwise be called as control point survey, has been carried out with the help of DGPS/GPS equipment. In order to measure the geographical coordinates of a particular station, we need another station with known coordinate (reference pillar). One of the pool of control point pillar will be observed and processed in single point processing (SPP) method, in case of unavailability of known pillar. SPP pillar in general will be measured for longer observation time, say 8 to 24hrs, depends upon the order of accuracy required for the project.



This DGPS activity can be done in either static method or real time kinematic (RTK) method. Such observed geodetic coordinate comprise Latitude (N), Longitude (E) and ellipsoidal height. Data observed in static method to be processed (post process) in a software dedicated to the particular equipment.

Differential Global Positioning Systems were used to establish Control Points. The Control Points were established all along the proposed stretch from Thuravoor to Kazhakuttam. They were established at a distance of 5 Kms along the entire road. Pair Points were established with the bearing Points not more than 150M apart and within Visual range. Coordinates of the Points established, were then recorded, to help in the detailed Topographical Survey.



### 3. Horizontal Traverse Using Electronic Total Stations

Traversing is observing/fixing station point between two pair of control pillars, for this purpose geodetic coordinates have been used as reference. Upon completion of traversing traverse error has been computed and the error has been distributed throughout the traverse stations. This process has been repeated throughout the stretch from each and every traverse point.

The Traverse along the entire stretch was conducted using Electronic Total Stations. Traverse was conducted between two GPS stations with the maximum length of each loop not more than 5 Kms. The Traverse stations were established at a distance of 150 to 200m apart. Care was taken to ensure that the desired levels of accuracy were maintained for each loop and verified before continuing to the next loop.



#### 4. Levelling Survey using Auto Level

Levelling is nothing but migrating the elevation of topographical data in to MSL reference from the temporary level. This level transfer has been conducted with the help of levelling equipment. Upper, middle and bottom cross hair readings have been recorded from the levelling staff using levelling equipment and the average has been computed from those readings. This process has been repeated for each forward and back stations still reach the required control point pillar.



Rise/Fall in elevation has been computed from a pair of such readings. Level has been transferred from GTS bench mark pillar to the control point pillar of the stretch and again backward to the GTS pillar. Now the loop closing error has been computed and distributed along the station points.

#### 5. Detailed Topographic Survey Using Electronic Total Stations.

The Detailed Topographical Survey was conducted using Electronic Total Stations. The Data obtained after corrections of both Horizontal traverse and Leveling were used to start the Topographic Survey. The Survey involved the collection of all features along the proposed stretch. All features along the ground within the RoW of 30M on either side of the Proposed Center Line were taken. Care was taken to ensure that all Intersections of MDR, Minor and Major were also covered to a distance of 200M. Minor Bridges had an u/s and d/s of 250M and Major Bridges had an u/s and d/s of 500M. No Under Ground features were covered.



#### 6. Collection of Non Spatial Data and Validation

The Drawings were finalized and plotted before taking to the field for Validation. This exercise of Validation included the collection of Non Spatial Data including the details of all the structural features along the Proposed Stretch including Culverts, Minor Bridges and Major Bridges. Floor information was collected for all the buildings along the proposed Stretch including details of building with relation to type of Buildings. All these Non Spatial Data were incorporated into the Drawings.

#### 7. GTS Bench Mark Location with Photographs

Two GTS BM values were obtained for this project.

First BM value was found at the Light House Entrance in Alapuzha Bypass. The value was mentioned as 3.387m by CVCC Contractor, who are currently involved with the construction of 2 Lane Alapuzha Bypass project. The same is adopted in our Topographic Survey.

Second BM value of 11.051 m is obtained at the step of Padmanabha Swamy Temple Location. This RL is adopted by the OLD DPR Study as well as verified from Local Authority.

### GTS Benchmark Available In Allapuzha In Light House Entrance, Fifth Step Of The Lighthouse Entrance GTS Marked



Bench mark location photo in Padhmanaba Swamy temple, after the 12 step of temple entrance right side one small pillar available in this pillar no RL only old stone pillar is available.

### 8. Permanent Benchmark and TBM Pillars

Pillars were erected wherever Permanent Structures were not available. These pillars were placed as near as possible to the proposed stretch without possible damage.. The Pillars so erected confirms to the TOR with respect to the size of the individual pillars at 15 x 15 x 60 cm. The Pillars were painted yellow on all the sides and embedded with concrete for strength.



The possibility of the destruction of the Temporary Bench Marks due to the expansion of the Road leads us to the fact of establishing Permanent Bench Marks along the entire stretch. We have in any case placed the Bench Marks on permanent structures like bridges and culverts for longevity as these structures will not be changed



### 9. Quality Control and Field Validation

All efforts were taken to ensure that there was a control on the quality of the output, from fixing of control pillars to preparation of this report.

Extensive validation with the check plots were carried out along the entire stretch. Non Spatial Data like the details of the Permanent Structure, Floor information and Type of Buildings were collected and the same was incorporated in the drawings. The sample drawings were provided to the client and valuable suggestions and needs of the client were taken into account. The same have also been incorporated in the drawings.

### **3.7. Hydrological and Hydraulic Investigations**

Hydrological investigation was carried out for economical design of cross drain structures. These investigations included performance of existing structures, assessment of discharge, HFL and other data as required for design.

Local enquiries were made regarding HFL, and telltale watermarks were observed. For detailed study, site conditions, survey data, meteorological data were studied. Survey for taking cross sections, long sections of existing rivers/nallahs were carried out as per IRC code requirements.

#### **Main Objective**

The main objective of the hydrological Investigation is to determine the required size of drainage structures to allow the estimated design flow of the streams to cross the road safely, and to check whether waterways of existing structures are sufficient to transmit the flow without risk so that appropriate decisions could be taken concerning their rehabilitation.

The hydrological and hydraulic study for the project has been based on:

- ⇒ Topographic survey data of drainage structures
- ⇒ Topographical data and maps of streams, upstream and downstream
- ⇒ Rainfall pattern of the project site
- ⇒ Site study of the characteristics of the catchment areas, HFL from local enquiries and tell-tale marks, and hydraulic conditions at the existing drainage structures.

#### **Location, River System, Topography, Rainfall and other Characteristics**

The Project area falls in the Malabar sub zone 5(b) as demarked by the Central Water Commission. There are large numbers of coastal streams flow in the subzone area.

The coastal areas have an elevation ranging from 0 to 150m. The south west and north east monsoon causes rainfall in the subzone in between May to October and the annual rainfall generally varies from 1000 mm to 4000 mm.

#### **3.7.1. Overview of the Existing condition of the study area**

Project road starts from km 379.100 of NH-47 at the junction of Thiurvoor and ends at Kazakuttam junction at km 551.900. This stretch of road passes through many populated areas and crosses many rivers/channels/lakes in its entire stretch. Throughout the project road, built up area is observed in major portion. The entire stretch of existing road is generally on ground level barring few stretches in embankment. In the last stretch of the alignment, there are many undulations observed including many valley and crest locations.

Part of the alignment is very close to Sea shore in some section it is just 30-50 m way from the road. The Allapuzha bypass is proposed near to the sea shore. Kollam bypass is passing through Ashtamudi Lake and many major bridges are required to cross the lake.

There are many bridges in the entire stretch which are either on canal, river/ small local nallah or on the backwater of sea. Some of the major River in the stretch are Pampa River, Ithikara, Vannapuram and mammon where major bridge are existing. There are many canals namely Thotapally, A S canal, Kayamkulam, Kanneetti-Pallikal Canal and T S Canal. In addition there is Asthamundi Lake where one major Neendkara bridge is existing and three additional major bridges are being made on the Kollam bypass locations.

There are number of culverts in the stretch mainly slab type which are either on small nallhas or just catering for the drainage of the area. Most of the culverts are not visible as there is heavy vegetation on both sides of the road throughout. Many culverts are in fully / partially choked condition due to development of built up are along the road. These culverts are required to be reconstructed some at the same location and some required to be shifted nearby to connect the drain on both sides.

There are many valley locations/ dip portion where additional culverts are felt necessary for the effective drainage.

### 3.7.2. Data Collected

Hydrographic surveys have been done at the major and minor rivers crossings with a view to obtain the cross section of the rivers at the centre line of the road and up to a reasonable distance at upstream and downstream. The High Flood Levels (HFL) have also been obtained from existing flood marks or ascertained from local PWD and local enquiry.

The characteristics of the catchment areas is generally ascertained from Survey of India topo-sheets, to a scale of 1:50,000, from which, catchment area at the proposed bridge site, length of the stream and fall in elevation from originating point to the point of crossing, is determined. Since toposheets for the alignment was coming in restricted zones, these were not available.

The Hydrological Data collected for calculation of bridges are as follows:

- Various data such as terrain, soil and cover condition, nature and size of bed material, river bed and plan forms etc. are collected from field through local inquiry made during site inspection by engineer. Data are also collected for the Existing Canal wherever available.
- **Toposheet**  
Toposheet Number NC 43 11a, NC 43 12 and NC 43 16a has been taken from Texas Library site and catchment of streams has been demarcated. Equivalent Slope of stream, terrain slope and land uses are also studied in the toposheet.
- **Rainfall/runoff**

Rainfall/runoff data published in the Flood Estimation Reports for West Coast Region Sub zone 5a & 5b, prepared jointly by Central Water Commission (CWC), Indian Meteorological Department (IMD), Research Designs Standards Organisation (RDSO) and Ministry of Shipping Road Transport & Highways (MOSRT&H) are used for information regarding stream flow and rainfall. From Isopluvial maps in Flood Estimation Report, 24 hour rainfall of 100 year return period is found to be 280 mm for this stretch of road. The rainfall data has been given in **Table 3.5**.

**Table 3.4: Rainfall Data**

Stretch	Mean Annual Rainfall	24 hours Rainfall for Return period of		
		25 Years	50 Years	100 Years
Thiruvananthapuram to Cherthala	1000 mm to 4000 mm	240 mm	~260 mm	280 mm

For rain fall of shorter duration less than 24 hrs a conversion ratio has been adopted from same CWC report (FIG –10 of CWC Report). Mean average Time distribution curves of storms of various duration are also adopted from CWC report subzone 5a and 5b (Fig-12). Aerial to point rainfall ratio for various duration over different catchment is adopted from CWC report of Subzone 5a and 5b (Fig 11a and 11b). The general land use data and Soil Data are also adopted from the same report.

### 1. Stream Data

For all the bridges, the longitudinal section of the river extending from about 100m to 500m on the U/S and 100m to 500 m on the D/S (depending on stream size) has been drawn on the basis of actual survey data at site. Several river cross-sections, one at the bridge site, others both U/s and D/S of the bridge are drawn on the basis of field survey data. Longitudinal section of the stream along deep channel is plotted for each stream to find the longitudinal bed slope and compared with terrain slope found from topo sheets.

### 2. Existing bridges

There are total 5 bridges on existing main road out of which 2 bridges are existing on lined /Unlined canal 1 bridge is on small defined nallah and 1 number bridges are on defined lakes & rivers.

Among Existing bridges 1 bridge is on defined nallah Krishnapuram Thodu at 461.0 . One of major bridges is at 474.600

Other 3 number bridges are on canal at, 458.0 (Kayamkulam), 474.6 (Kannetttil-pallikal canal) and chainage 483.1 (T.S.Canal).

**Table 3.5: Details of existing bridges**

S.No	Ex. Location (km)	Name of Stream / Canal	Existing Arrangement			
			Existing Arrangement of span (No. x Span Exp.c/c)	Length of bridge (m)	Existing carriageway width as per Inventory (m)	Skew angle (in degrees)
1	458.0	Kayakulam branch canal	7.5+23.5+7.5	38.50	7.0	-
2	461.0	Krishnapuram Thodu Nala	13.1+12.6+13.2	38.90	7.5	-
3	474.6	Kannetti-Pallikal Canal	20+19.8+20.4+20	80.20	7.0	-
4	483.1	T.S.Canal / National Waterway 3	5+32+5	42.00	7.0	-
5	484.909	Neendakara Bridge	8.75 + 15x27.0 + 8.75 Bridge	422.5	-	-

Following are the photographs of the conditions of the existing bridges:



Bridge at km 458.0

Bridge at km 461.0



Bridge at km 474.6

Bridge at km 483.1

### Existing culverts

The inventory of the existing structures has been done. The project area has lot of vegetation adjacent to the road and on its shoulders. It is very difficult to locate the structures during inventory. However, all the structures visible and accessible have been inventorised. This has been compiled from the Topo survey data and details in Topo survey. The total of existing culverts after compiling the data is found to be 43. The summary of the culverts can be categorised in the following manner:

Culvert Type	Number
Pipe	11
Slab/Box	32

The details are as follows:

Table 5.6: Details of existing culverts

S. No.	Location in km.	Type of structure Arch/ Box/ Slab	Number x Clear width (m) x Clear height (m)		Remarks
			Left side	Right side	
1	454.700	SLAB	1x1x1	1x1x1	Cleaning Required. Structure not visible
2	454.930	SLAB	1x1x1	1x1x1	Cleaning Required. Structure not visible
3	456.735	SLAB	1x1x0	NF	Cleaning Required.

S. No.	Location in km.	Type of structure Arch/ Box/ Slab	Number x Clear width (m) x Clear height (m)		Remarks
			Left side	Right side	
4	456.925	SLAB	1x1x1	NF	Cleaning Required.
5	460.290	SLAB	1 x 5.0 x 3.0	NV	Cleaning Required.
6	461.000	SLAB	1 x 2.5 x 3.0	NV	Cleaning Required.
7	462.800	SLAB	2 X 0.9 m dia	1 x 1	Cleaning Required.
8	463.850	SLAB	1X1.5	1X1.5	Cleaning Required.
9	464.140	SLAB	1X1.5	1X1.5	Fully Choked. Road build on right side of the culvert
10	464.450	SLAB	1X4.5	1X4.5	Cleaning Required. Large Crack in Wall
11	465.980	SLAB	1X1.5	1X1.5	Fully Choked.
12	466.015	SLAB	NV	NV	Fully Choked.
13	469.000	SLAB	1 x 0.8 x 0.2	NV	Fully Choked.
14	470.815	SLAB	1 x 1.5	1 x 1.5	Cleaning Required. Left side not visible.
15	471.540	SLAB	1 x 1.5	1 x 1.5	Cleaning Required. Left side not visible.
16	472.350	SLAB	1X1.5	NV	Cleaning Required.
17	472.465	SLAB	1 x1 x 1	NV	Cleaning Required.
18	472.775	NV	NV	NV	Cleaning Required.
19	472.820	NV	NV	NV	Cleaning Required.
20	473.185	PIPE	0.9M DIA	NV	Cleaning Required.
21	473.575	NV	NV	NV	Cleaning Required.
22	473.750	SLAB	1X0.9	NV	Cleaning Required.
23	474.225	SLAB	NV	1 x 2.5 x 2.5	Cleaning Required.
24	474.500	PIPE	1.5M DIA	NV	Cleaning Required.
25	474.750	SLAB	1 x 3 x 3	NA	Cleaning Required.
26	475.075	PIPE	0.6M DIA	NV	Cleaning Required.
27	475.225	SLAB	1X3X2	NV	Cleaning Required.
28	476.265	PIPE	2 X 0.9 m dia	NV	Cleaning Required.
29	476.630	NV	NV	NV	Cleaning Required.
30	476.900	NV	NV	NV	Cleaning Required.
31	477.175	SLAB	1X2.0	NV	Cleaning Required.
32	478.290	SLAB	1 x 0.8 x 0.2	NV	Cleaning Required.
33	479.010	SLAB	NV	1X1.2X1	Cleaning Required.
34	479.725	SLAB	NV	1 x 2 x 1.5	Cleaning Required.
35	480.585	PIPE	NV	0.75M DIA	Cleaning Required.
36	481.005	SLAB	1X0.9	NV	Cleaning Required.
37	481.815	SLAB	1X0.7x0.3	NV	Choked. Cleaning Required.
38	482.670	SLAB	1x1.2x0.7	NV	Cleaning Required.
39	483.560	SLAB	NV	NV	Cleaning Required.
40	483.990	SLAB	NV	NV	Cleaning Required.
41	484.450	PIPE	NV	NV	Cleaning Required.
42	485.350	SLAB	1X4.0	1X4.0	Cleaning Required.
43	485.625	SLAB	1X5.5X2.5	1X5.5X2.5	Cleaning Required.

Many of these culverts have been found to be partially choked and seem inadequate. The culverts are also old and seem to be structurally as well as hydraulically poor. Many of these structures shall be replaced preferably by Box Culverts for better hydraulic performance.

Some of the culverts and their conditions have been shown here below:



**Choked culvert at 481.810**

### 3. Raising Stretches

During site visit, local enquiry was done to get the information about hydraulic condition for each structure and drainage conditions along the road. As per the local enquiry and observation at site, requirement of raising and additional culverts along the road for effective disposal of storm water and to improve the drainage conditions of road was assessed.

It is seen that many of stretches of the project road are very near to the coast and liable to flooded during the high tide. In addition to this, there are many locations of valley point where water is likely to get accumulated during rains. At all these places, addition cross drainage structure is required and raising of the stretches are proposed. All these observations based on site visit have been corroborated with detail inventory done to summarise the requirement of provision of additional structures and raising stretches.

A detailed list of stretches where raising is required and list of addition culverts required has been tabulated road wise in **Table 3.9** respectively.

**Table 3.7: Additional culverts required along the road**

S.No	Chainages
1	457.795
2	458.172
3	464.325
4	467.165
5	468.918
6	469.667
7	477.342



### 3.8. Bridges / Structures

#### Existing Bridges

There are major and minor bridges on the project roads and their break up is given hereunder: -

Sl. No.	NH	Major Bridge	Minor Bridge	PUP	VUP	ROB	Total
1	47(new NH-66)	2	03	1	-	-	06

#### 3.8.1. General

In the project road there are 05 existing Bridges which consist of 02 Major bridge and 03 Minor Bridge, in NH-47 (New NH 66).

#### Available Data from Secondary Sources

Before undertaking field surveys of existing structures, all concerned authorities were contacted to ascertain the availability of any past inventory and condition survey reports of existing bridges, sub-surface and geotechnical data, hydraulic data, as-built drawings, etc. and available few details could be obtained from there. Accordingly, detailed field survey, site investigation and collection of data were carried out by the Consultant's team of Engineers.

#### Field Surveys

The following field surveys were carried out in accordance with the provisions of IRC: SP: 35-1990:

- Inventory of existing bridges / structures
- Visual condition survey of existing bridges / structures

The inventory details collected from field are presented bridge-wise in **Appendix 3.4** in **Appendices to Main Report**.

The visual condition survey report for each bridge is presented Bridge wise at **Appendix 3.5** in **Appendices to Main Report**.

#### Inventory of Existing Bridges

The inventory of all bridges / structures having lengths more than 6.0 m were carried out and bridge wise inventory details is given in **Appendix 3.4** in Appendices to Main Report. The inventory of ROB was also carried out and inventory details are given in **Appendix 3.4** in Appendices to Main Report. These bridges / structures comprise the following: -

Major bridges (MJB) - (length $\geq$ 60m)	-	02 nos.
Minor bridges (MNB) - (length > 6m and < 60m)	-	3 nos.
ROB in NH-47	-	Nil
Vehicular underpass (VUP)	-	Nil
Pedestrian underpass (PUP)	-	Nil
<b>Total</b>	-	<b>5 nos.</b>

#### Details of Existing Bridges / Structures

Salient features of existing bridges/ Structures such as name, location, span arrangement, type of superstructures, type of substructures and other details are given in the **Table 3.10** below.

**Table 3.8: Details of Existing Bridges**

S.No	Des. Ch (km)	Location Name	Structure Type		Total length of Bridge	Type of Superstructure	Type of Substructure	Type of Foundation	Overall depth of Superstructure(m)	Carriage way width(m)	Total width(m)	Skew as per inventory
			Bridge Category	Span arrangement								
1	456.125	Kayamkulam Bridge	MNB	7.5 + 23.5 + 7.5	38.5	RCC Beam & slab (arch typr)	Spill through abutment	Pile	8.5	2.00	7	10.4
2	458.984	Krishnapuram bridge	MNB	13.2 + 12.6 + 13.2	39	T-Beam & slab	RCC Wall type	Pile	3.4	1.60	7.5	8.5
3	471.917	Kannetti River	MJB	20 + 19.8 + 20.4 + 20	80.2	I-Girdir & deck slab	RCC Wall type	-	6.8	2.2	7.0	12.0
4	480.193	Chavara Br	MNB	5 + 32 + 5	42	Concrete bow string arch girder and deck slab	RCC Wall type	Pile	7.9	0.75 at centre and 1.2 at support	7.0	7.5
5	484.909	Neendakara Bridge	MJB	8.75 + 15x27.0 + 8.75	422.5	I- Girder & deck slab	RCC Wall type	Double Well		1.8	7.0	10.0

**Type of Existing Bridges**

As per details summarized above, the existing bridges and other structures can be classified according to their type of superstructure, substructure and foundations as under: -

**Type of Superstructure**

RCC solid slab	Nil
RCC box	Nil
RCC I / T or box beam and slab	03 nos.
Concrete box girder	Nil
Under construction	Nil
Others	01 nos.

**Total**

**4 nos.** Type of Substructure

CC/RCC wall type	03 nos.
Box structure	Nil
Other type	Nil
Under Construction	Nil
Others	01 nos.

(GFC drawings are required)

**Total** **04 nos.**

#### **Type of Foundation**

For NH-168A

Open	Nil
Well	Nil
Pile	03 nos
Box structure	Nil
Others	01 nos.
<b>Total</b>	<b>04 nos.</b>

#### **Carriageway Width**

The existing bridges on NH-47 have got carriageway width varying from 7.0m to 10.0m in 2-Lane stretch and 7.0 to 8.6 for one side traffic in 4-lane stretch.

#### **Overall Deck Width**

The existing bridges on NH-47 have got Overall deck width varying from 7.5m to 12.5 in 2-Lane stretch and 21.0 for one side traffic in 4-lane stretch.

#### **Hydraulic Performance of Existing Bridges (from Hydrology team)**

As per visual inspection and hydraulic calculations so far carried out some bridges are found to be hydraulically deficient. Detailed hydraulic studies been carried out to ascertain this and are presented in the relevant section of this report.

#### **Bridges on Streams / Nallah**

There are 05 nos. existing bridges on Rivers / Streams out of which 02 no. is major, 03 nos. are minor in NH-47 (New NH-66).

It has been informed vide local enquiry that during tsunami in past, HFL for one bridges were recorded high & hence it causes to encroachment in allowable vertical clearances.

#### **Condition Survey of Existing Bridges**

The visual condition survey of all the existing bridges was carried out as per provisions of IRC: SP: 35 and condition survey report of each bridge is given in **Appendix 3.5 in Appendices to Main Report.**

The information obtained from the condition survey and inspection has been used to identify the bridges which can be retained after carrying out minor repairs and rehabilitation work or which are having inadequate carriageway width and can be retained after widening or which are to be replaced due to being narrow, in poor structural condition, inadequate waterway, poor geometrics of approaches and old bridges in poor condition.

#### **General Condition of Existing Bridges**

ROB/Bridges is in distress condition and proposed to be replaced.

Following distresses have generally been noticed in bridges: -

- Excessive vegetation growth around the bridges and in stream bed.
- Damaged Wearing coat
- Poor maintenance and protection works of existing bridges
- Damaged expansion joints

- Exposed reinforcement and honeycombing / spalling of concrete of superstructure
- Non-movement of bearings
- Damage to slope pitching and bed protection
- Blockage of waterway by debris and garbage
- Honey combing in different component of structures

### **Retention / Replacement of Existing Bridges**

We have find that following One structure is not fit from structural aspect and has been proposed for new adjacent location construction. The same would be abandoned if needed.

### **Major Bridge at Km 484.909 (Neendakara Bridge)**

The existing bridge has a span arrangement of 8.75m + 15x27.0m + 8.75m with carriageway width of 7.0m. The overall depth of superstructure is approx. 1.8m. The overall width of deck is 10m with footpath on either side. The bridge was built in 1972 and designed to cater for IRC Class A 2-Lanes or one lane of Class-AA type loading. The substructure and superstructure have already been treated with shotcrete all around and crack pattern is still visible.

This indirectly indicates that the reinforcement in sub structure and superstructure have been corroded and there may be other distress in the bridge. It may also be noted here that bridge was designed for lower category of loading and hence and wouldn't be capable to take the present day loading of IRC i.e. Class 70RT & 70RW.

As such looking into the above indicated factors, the bridge has been recommended to be replaced by a new bridge with a deck configuration as per IRC SP 84:2014.



## CHAPTER 4 TRAFFIC SURVEY AND ANALYSIS

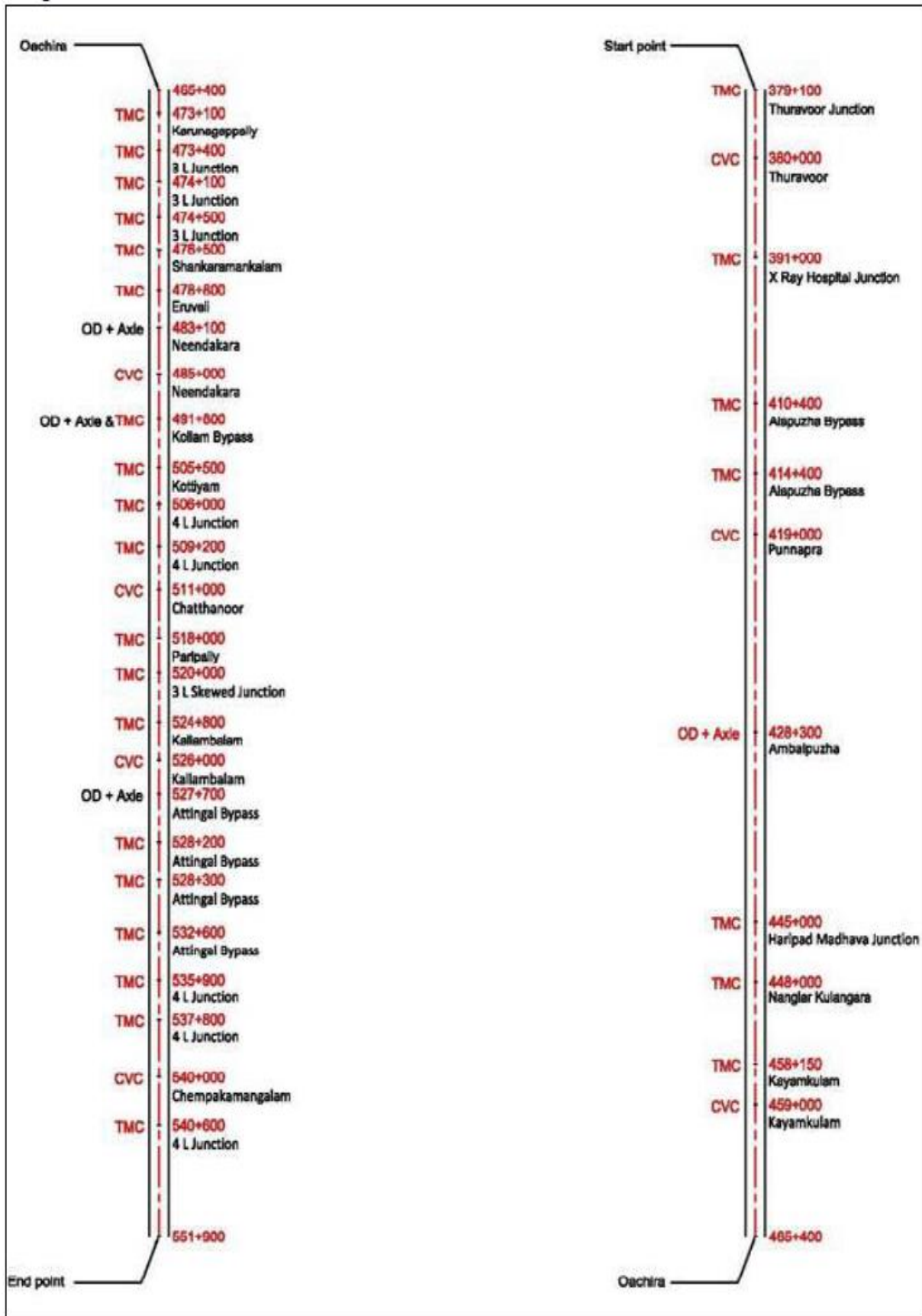
---

### 4.1. Introduction

In order to capture and assess the traffic characteristics, travel pattern, the Consultants have conducted the following primary traffic surveys.

- Classified Traffic Volume Count surveys
- Origin - Destination and Commodity Movement Surveys
- Turning Movement Surveys
- Speed & Delay Surveys
- Wayside Amenities Surveys
- Truck Parking survey
- Pedestrian/Animal Count Surveys

These features facilitated a framework for carrying out the necessary count surveys in accordance with the guidelines specified in IRC codes of practice. The various survey locations have been selected with careful assessment of the traffic characteristics including entry and exit point along the NH 47 corridor. These points were further refined jointly at site as required by the NHAI. The survey schedule is given as under:



## 4.2. Traffic Surveys

Data collected at the site was computerized for further analysis. The various vehicle types having different size and characteristics were converted into passenger car equivalents. Passenger car unit values (PCU) suggested in IRC-64-1990, 'Guidelines for Capacity of Roads in Rural Areas' have been adopted. The PCU values are presented in **Table 4.1** below:

**Table 4.1: Adopted PCU Factors**

Vehicle Type	PCU	Vehicle Type	PCU
Car	1.0	Mini LCV / LMV	1.0
Mini Bus	1.5	Auto Rickshaw	1.0
Standard Bus	3.0	Van/Tempo	1.0
LCV	1.5	Agricultural Tractor	1.5
2 Axle Truck	3.0	Agricultural Tractor & Trailer	4.5
3 Axle Truck	3.0	Horse Drawn	4.0
MAV (4 to 6 Axles)	4.5	Bullock Drawn	8.0
Over sized Vehicles (>=7 Axles)	4.5	Cycle Rickshaw	2.0
Two Wheeler	0.5	Cycle	0.5

Specification of IRC 92 and IRC SP 41 has been adopted for junction analysis.

## 4.3. Secondary Data

Secondary data required for traffic analysis and forecast were collected during course of traffic survey. These data are necessary for analyzing AADT, Seasonal Correction Factor and growth rate of traffic on project road.

In order to convert ADT (Average Daily Traffic) into AADT (Annual Average Daily Traffic) fuel sales data of following stations has been procured.

For future traffic growth secondary data were collected from respective Government agencies and websites.

**Table 4.2: Data Collected from Govt. Agencies and Websites**

Sl No	Data	Source
1	Vehicle Registration Data	Kerala Motor Department
2	Time Series NSDP - Kerala	Niti Aayog Web Site
3	Time Series PCI - Kerala	Niti Aayog Web Site
4	Population Data	India Stats
5	GDP India Forecast	RBI Web Site

## 4.4. Analysis of Traffic Surveys

As mentioned above analysis of traffic survey has been performed in accordance of various IRC codes. In subsequent sections detailed analyses of various traffic surveys will be presented in sequence.

#### **4.4.1 Traffic Volume Count**

Traffic survey has been conducted as per IRC line guidelines and has been analyzed accordingly. Following table gives the average daily traffic at 7 locations as mentioned above.



**Table 4.3: Traffic Volume Counts Collected**

Average Daily Traffic (ADT)																
Station No.	Chainage	Location of Survey	Car/Van/ Taxi	Two Wheeler	3 Wheeler	Mini Bus	Bus	LCV	LMV /Mini LCV	2 Axle Truck	3 Axle Truck	Multi Axle Truck	Tractor with & without Trailer	Other Non motorized	Total ADT	Total ADT PCU
VC1	380	Thuravoor	17321	22406	1782	732	1717	2016	1844	1433	936	481	4	607	51278	51019
VC2	419	Punnapra	12884	17818	2164	322	2249	1897	1242	1427	826	349	5	467	41650	43864
VC3	458/4	Kayamkulam	11887	15192	1807	249	999	1115	973	914	400	286	3	367	34191	32729
VC4	482/8	Neendakara	12276	15240	2005	451	1687	1828	723	977	494	249	5	242	36177	36793
VC5	505/5	Mylakad	16838	18486	2803	382	1399	1278	1144	1050	439	216	2	58	44097	42198
VC6	520/1	Navaikulam	11869	7446	978	336	1092	1119	661	789	232	101	1	19	24642	26219
VC7	535	Palammoodu	15143	14746	1739	490	1480	886	531	768	215	104	0	13	36114	34714

**Homogeneous section**

Based on the character, composition, traffic movements at different intersections and from the results of the traffic volume counts, homogenous sections have been considered for the entire length which are as follows:

1.	Section III	Km 435.00 to Km 465.00	--
2.	Section IV	Km 465.00 to Km 490.00	Kayamkulam to Kavanadu

1.

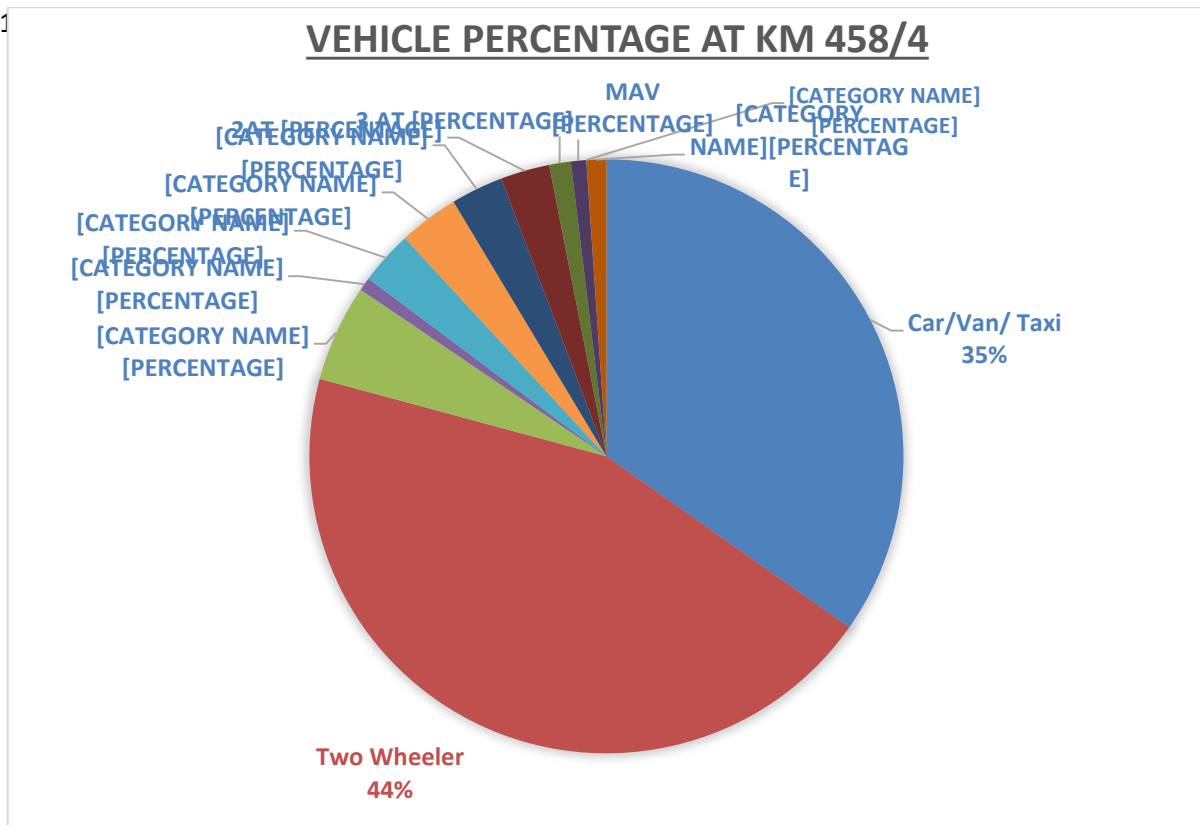
Percentage contribution of various categories of vehicle gives us the perception of users commuting on the project road. Following figures give the percentages of various categories of vehicles at different locations in **Figure 4.1**

1.

1.

1.

1



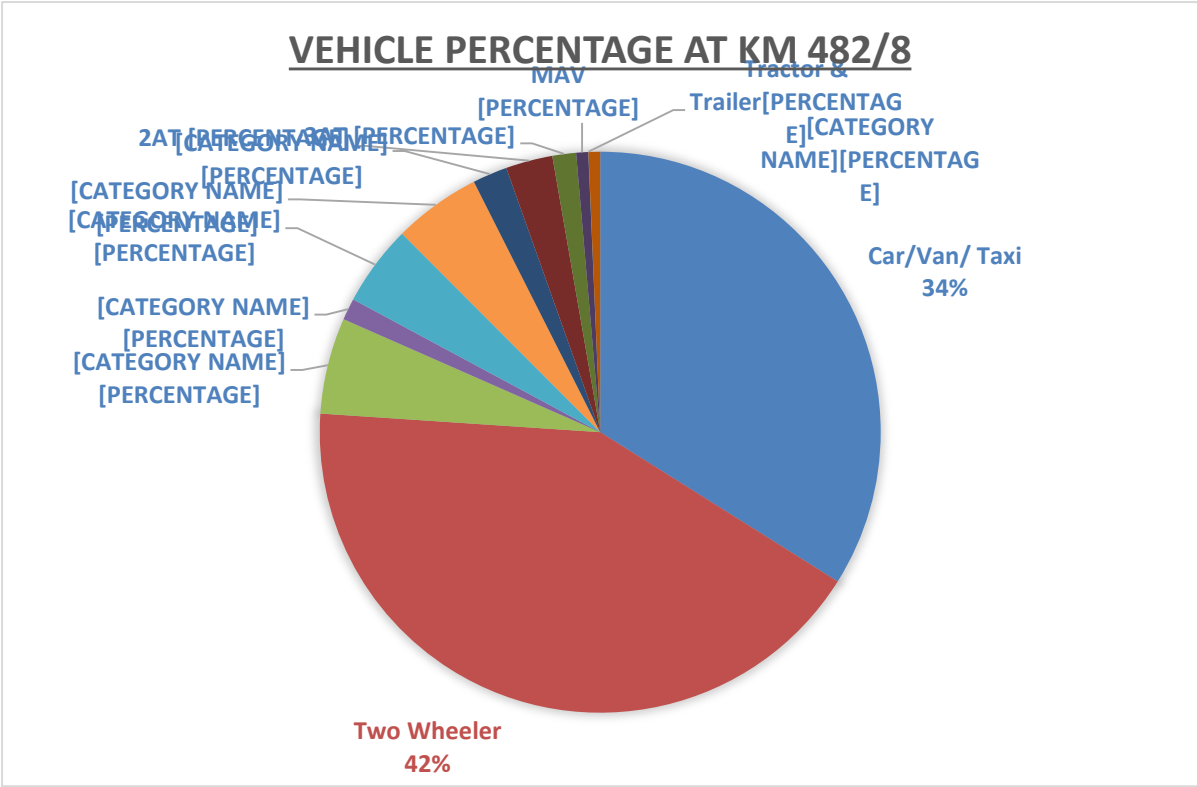


Figure 4.1 Percentage Contributions of Vehicles at Various Locations

The above figure show high contribution of passenger vehicles mainly due project road falling in urban localities.

Following chart gives day to day variability of traffic at different survey locations.

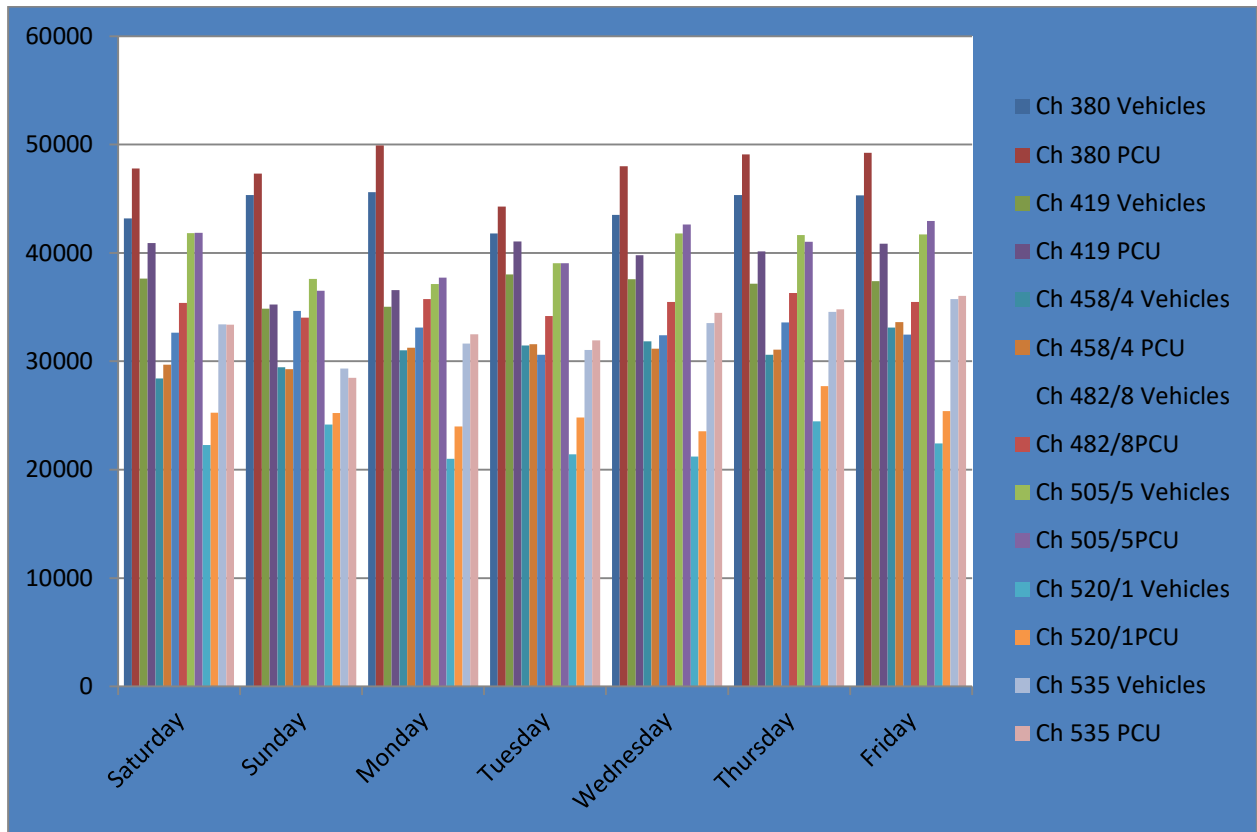


Figure 4.2 Traffic Variation Day Wise at different location

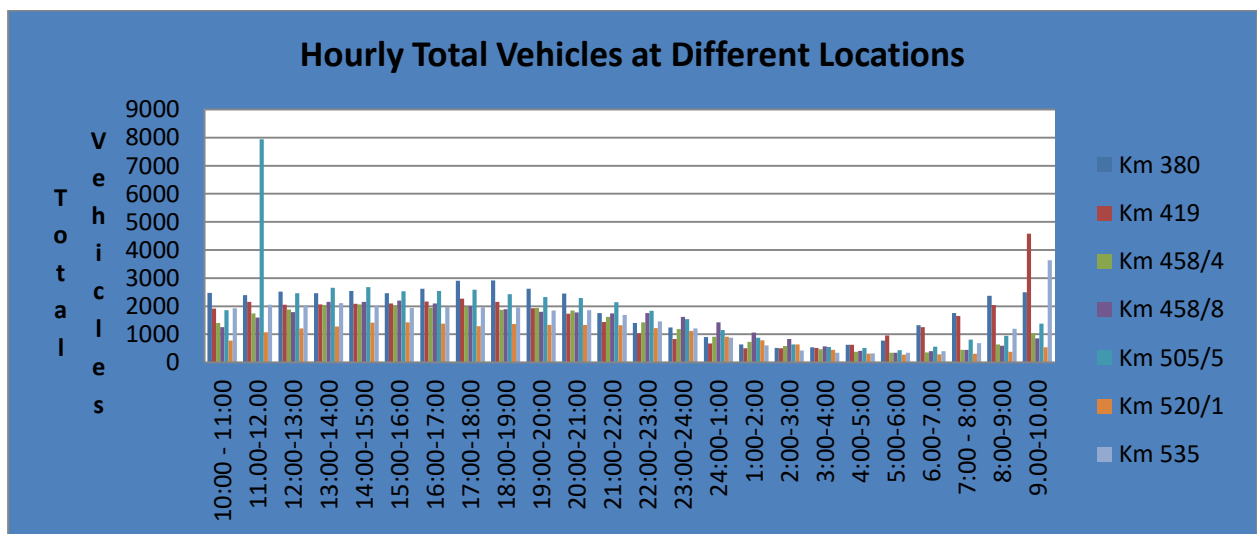


Figure 4.3: Hourly Traffic Variation at different location (Total Vehicles)

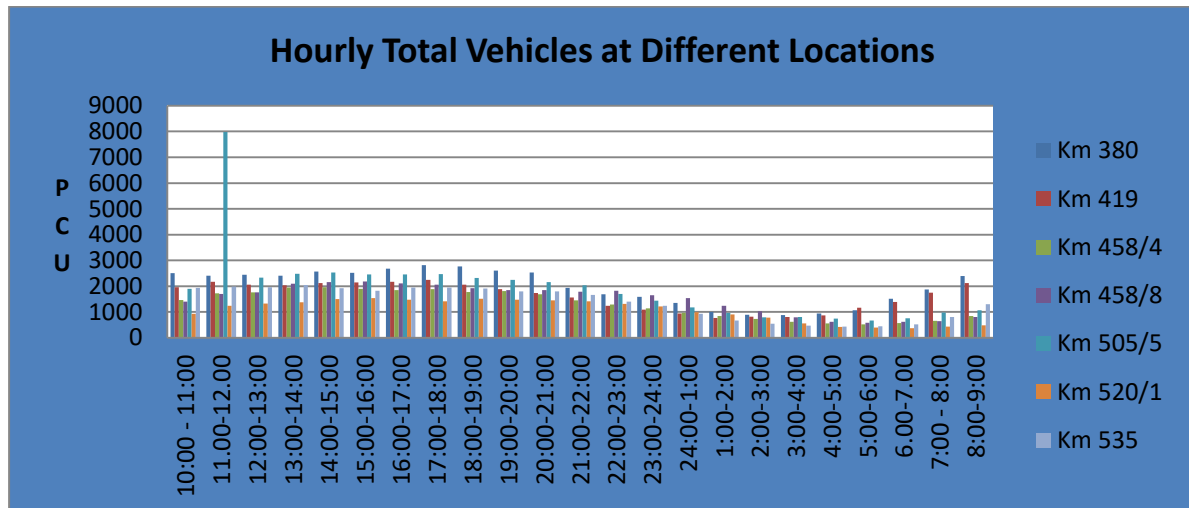


Figure 4.4: Hourly Traffic Variation at different location (PCU)

### AADT and SCF

In order to convert ADT into AADT consultant has collected fuel sales data at various location to understand SCF (Seasonal Correction Factor). Following figure gives average fuel sales of petrol and diesel at various pump stations.

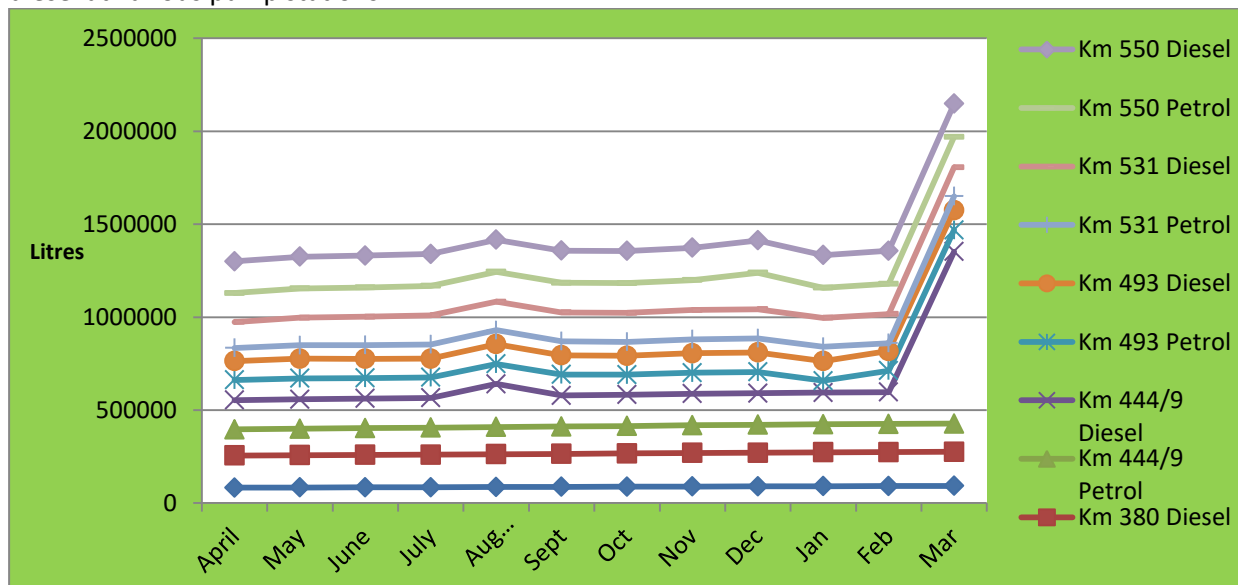


Figure 4.5: Fuel Sales at Various Pump Stations of Project Corridor.

From fuel sales data seasonal correction factor has been derived at various TVC locations for various vehicle category as given in following table.

Table 4.4: Seasonal Correction Factors.

	Car/3w/2w	Mini Bus	Bus	LCV	2 A Truck	3 A Truck	MAV
Km 458+400	1.01	1.01	1.01	1.01	1.01	1.01	1.01
KM 482+800	1.00	0.98	0.98	0.98	0.98	0.98	0.98

Based on above data Average Annual Daily Traffic (AADT) at all locations are given in following table.

**Table 4.5: Annual Average Daily Traffic (AADT) at Survey Locations**

Chainage	Station No.	Car/Van/ Taxi	Two Wheeler	3 Wheeler	Mini Bus	Bus	LCV	LMV /Mini LCV	2 Axle Truck	3 Axle Truck	Multi Axle Truck	Tractor with & withoutTrailer	Other Non motorized	Total AADT	Total AADT PCU
458/4	VC3	11958	15283	1818	251	1010	1128	983	924	405	289	3	367	34419	32980
482/8	VC4	12276	15240	2005	442	1654	1791	709	957	484	244	5	242	36048	36498

Details of traffic volume counts and fuel sales data are provided in **Appendix 4.1**.

For the purpose of pavement design following traffic numbers has been used based on traffic derived from survey.

**Table 4.6: Commercial Traffic Homogenous Sections**

Sl. No.	Commercial Vehicle Type	Base Year 2016 CVPD (Homogeneous Section wise)	
		HS-3	HS-4
1	LCV	1128	1791
2	Mini Bus	251	442
2	Bus	1010	1654
3	2-Axle Trucks (2 AT)	924	957
4	3-Axle Trucks (3 AT)	405	484
5	Multi Axle Truck (MAV)	289	224
<b>Total Commercial Vehicles</b>		<b>4007</b>	<b>5552</b>

For rigid pavement design the time of day traffic used are given in following table.

**Table 4.7: Percentage Distribution of Traffic during Different Time of Day**

	HS-3	HS-4
<b>0 AM - 4 PM</b>	31.34%	32.89%
<b>4 PM - 0 AM</b>	29.13%	35.64%
<b>0AM - 6 AM</b>	20.42%	16.04%
<b>6 AM - 10 AM</b>	19.11%	15.44%

#### 4.4.2 Analysis of O-D Survey Data

Origin-Destination (OD) surveys determine and relate the pattern of traffic flows to trip purpose and commodities transported. The information provided by the surveys enables estimates of the growth of future flows to be made on a more rational basis. The origin - destination surveys have been carried out by means of the roadside interview method at locations selected to capture major trip desires in each section. The surveys have been carried out on one working day for 24 hours on a random sampling basis. All categories of motorized vehicles (e.g. Cars, Jeeps, Buses, light as well as heavy goods vehicles), have been surveyed for its trip origin, destination, trip purpose, occupancy and weight of commodity carried. The survey crew was organized into 3 groups by 8-hour shifts with sufficient enumerators in each traffic direction as well as in groups. Classroom training were given to the enumerators in order to get acquainted the work and in the use of standard interview sheets. Police help was sought to ensure smooth flow of traffic and stoppage of randomly selected vehicles. Engineers supervised the whole survey activities. The location of OD survey conducted given in **Table 4.9**.

**Table 4.8: OD Survey locations**

S. No.	Chainage (Km)	Location
1	482.800	Neendakraa

#### 4.4.3 Analysis of Turning Movement Count

Intersection turning movement surveys have been carried out at all the major intersection locations. Classified traffic volume counts of all types of vehicles have been made separately for each direction including left and right turning traffic. The surveys have been conducted for successive 15 minutes interval for a period 24 hours. Based on traffic growth rate as derived in later part of this report all junctions had been analyzed to understand the need of grade separation at these junctions as per IRC 92 and IRC SP 41. Highway grade separators without ramps are envisaged at intersection of divided rural road if the ADT (fast vehicles only) on the cross road within the next 5 years is likely to exceed 5000 and otherwise the need for such facilities could be kept in view for future consideration / construction. An interchange may be justified when an at-grade intersection fails to handle the volume of traffic resulting in serious congestion and frequent choking of the intersection. This situation may arise when the total traffic of all the arms of the intersection is in excess of 10,000 PCU/hours for Grade Separation with ramps. Following table gives the understanding of grade separation warranted at various junctions.

**Table 4.9(a): Junction Analysis as Per IRC 92 Criteria**

Junction Traffic Analysis				IRC 92 Criteria			
SL NO.	Existing Km	Jn. Category	Name of Intersection	PCU (2017)	PCU (2027)	PCU (2037)	Year (Grade Separation Warranted)
1	457+700	4 Leg	Kayamkulam junction	4365	8274	12597	2032
2	472+600	4 Leg	Karunagapally Junction	3960	7597	12597	2034
3	475+670	3 Leg	Junction	2165	4140	6342	NA
4	476+300	3 Leg	Junction	2073	4091	6379	NA
5	476+780	3 Leg	Vettamuttam Junction	2407	4642	7144	NA
6	478+660	3 Leg	Shankaramankalam Junction	1930	3712	5720	NA
7	480+960	3 Leg	Eruveli Junction	1997	3730	5646	NA
8	-	4 Leg	Kollam City Junction	7187	13687	20852	2022

**Table 4.10(b): Junction Analysis as Per IRC SP 41 Criteria**

Junction Traffic Analysis				IRC SP 41 Criteria ( Vehicle Per Day)					
SL NO.	Existing Km	Jn. Category	Name of Intersection	2017		2027		2037	
				Project Road	Cross Road	Project Road	Cross Road	Project Road	Cross Road
1	457+700	4 Leg	Kayamkulam Junction	46854	13186	92036	24998	142688	37890
2	472+600	4 Leg	Karunagapally Junction	47234	20765	93377	39596	145185	60018
3	475+670	3 Leg	Junction	27193	7358	48977	12780	71693	18283
4	476+300	3 Leg	Junction	26521	3108	52779	6049	82480	9315
5	476+780	3 Leg	Vettamuttam Junction	27981	1072	55682	1999	87049	3004
6	478+660	3 Leg	Shankaramankalam Junction	24660	3081	49331	5791	77478	8725
7	480+960	3 Leg	Eruveli Junction	26803	2214	53648	4204	84238	6370
8	-	4 Leg	Kollam City Junction	69151	12127	137434	23941	214122	37147

Details of turning movement analysis is provided in **Appendix 4.2**



#### 4.4.4 Analysis of Speed and Delay Survey

The survey data was analyzed to assess the Journey and Running speeds on different control points of the project road. Table 4.9 gives the detail of survey.

**Table 4.10(a): Speed and Delay Control Points**

Speed And Delay Survey							
Control Point No	Section		Distance (km)	Direction	Control Point No	Direction	Chain age
	From	To					
				Chertala-THIRUVANANTHAPURAM		THIRUVANANTHAPURAM -Chertala	
				Chertala-THIRUVANANTHAPURAM		THIRUVANANTHAPURAM -Chertala	
3-4	Karunagapalli Junction	High School Junction	23.2	Chertala-THIRUVANANTHAPURAM	3	THIRUVANANTHAPURAM -Chertala	472+700

**Table 4.11(b): Speed and Delay from Chertalai - Thiruvananthapuram**

Speed and Delay Study Direction : Chertalai - Thiruvananthapuram								
S. No	Control points	Time	Speedometer Reading	Duration (Mins) of Delay		Cause for Delay	Location of Delay	Remarks
				Start	End			
1	472+700	07:25						

**Table 4.11 (c): Speed and Delay from Thiruvananthapuram – Chertalai**

Speed and Delay Study Thiruvananthapuram - Chertalai								
S. No	Control points	Time	Speedometer Reading	Duration (Mins) of Delay		Cause for Delay	Location of Delay	Remarks
				Start	End			
1	472+600	15:02		15:51	15:52	Signal	Nangiarkulanga	

The section wise delays are shown in the table 4.11 b and table 4.11 c. It is observed that all major junctions have contributed significantly for the delays occurred on the both sides movements.

Following table gives the category of vehicle movements during speed and delay survey.

**Table 4.11: Vehicle Movement during Speed Delay Survey.**

	Overtaken		Overtaking		Oncoming	
	Passenger	Commercial	Passenger	Commercial	Passenger	Commercial
Chertalai - Thiruvananthapuram	146	15	825	175	4958	561
Thiruvananthapuram - Chertalai	111	54	186	256	1293	783

#### 4.4.5 Willingness to Pay Survey

WTP survey has been conducted understand the psychology of road users for assessing extent of paying toll. Following table gives the extent and percentage of users willing to pay toll for traveling on the project road.

**Table 4.12: Willingness to Pay Analysis**

	Toll Amount in Rupees					
	Not Willing	< 30	30-40	40-50	50-60	60-70
Car	12%	19%	40%	21%	8%	0%
Mini Bus	6%	0%	44%	38%	13%	0%
LCV	0%	0%	24%	38%	22%	16%
	Not Willing	< 100	100-110	110-120	120-140	140-160
Bus	0%	21%	29%	43%	7%	0%
Truck	0%	29%	20%	37%	15%	0%
MAV	0%	0%	0%	0%	74%	26%

The above table show few passenger vehicles are not willing to pay and also people are willing to pay median toll as compared to higher toll.

#### 4.4.6 Pedestrian Count Survey

Intensity of pedestrians/animals crossing the project road will be used for deciding on locations requiring grade separators in the form of RUB, pedestrian or cattle crossing.

Pedestrian-vehicular conflict can be effectively studied through the indicator suggested in IRC 103-1988, 'Guidelines for Pedestrian Facilities'. The code suggests some form of control measure at mid blocks and intersections where the indicator  $PV^2$  is greater than or equal to  $2 \times 10^8$ . Where 'P' is the peak hour pedestrian volume and 'V' is the number of vehicles in that peak hour. The analysis was undertaken separately for each of the intersection where traffic surveys were conducted. A summary of the peak values for  $PV^2$  and the hour in which the same is observed is presented in **Table 4.14**.

**Table 4.13: Pedestrian Vehicular Conflict**

Name of Intersection	Peak Hour	P	V	$PV^2 \times 10^8$	Proposal
Km 456.300 Kayakulam	8:15-9:15	157	2019	6.40	Grade Separation
Km 470.400 Karunagapaly	9:45-10:45	413	1695	11.87	-do-
Km 473.400 Eruveli	8:30 - 9:30	270	1198	3.88	-do-

- Grade Separation can be either PUP or FOB.

#### 4.5. Traffic Forecast

The future traffic demand assessment is made based on the past available data. Traffic forecasts are made for the horizon year 2050 which will form the basis for further work on pavement design, planning/designing of toll plaza & wayside amenities, intersection/ interchange design and developing capacity augmentation proposals.

Traffic movement on the project road, as observed from OD surveys, shows that influence of Trivandrum and Alappuzha districts is predominant along with the other districts in Kerala. Accordingly, traffic projections have taken into consideration the transport demand arising out of future economic development of Kerala state.

Traffic forecast has been based on demand elasticity approach, wherein a relationship was established between traffic and socio-economic indicators. Traffic growth rates by vehicle type, for the project road corridor have been determined. The projection for future traffic involves critical analysis of some of the key Socio-economic indicators and the rate of change expected during the study period in the project influence area. These broadly include:

- Macro economic scenario-Growth rate(s) and composition of Net State Domestic Product (NSDP), at the State and Project Influence Area (PIA level)
- PIA economy, sectoral production and potential
- PIA, Population and Urbanisation
- Perspective growth of PIA

##### 4.5.1 Past Trends in Traffic Growth in the Region

The past available data is insufficient for estimation of traffic growth rates.

## 4.5.2 Secondary Data

Secondary data used to estimate traffic growth rate are NSDP, PCI (Per Capita Income), Population data of relevant states. Following table gives the historical data of Kerala for above categories.

**Table 4.14: Time Series NSDP of Kerala**

	NSDP - Constant Price (Rs)	PCI (Rs)
2014	58961	103820
2013	56115	91567
2012	52095	88527
2011	48504	71434
2010	45921	60264
2009	42433	49316

Following table gives the decadal census of Kerala state.

**Table 4.15: Historic Population Data of Kerala**

1981	25403217
1991	29098518
2001	31838619
2011	34563000

## 4.5.3 Vehicle Registration

If the area of influence is well defined and the general development pattern of influence area remains the same, then it can be assumed that traffic growth rate is approximately equal to the average growth rate of vehicle registration. **Table 4.17** gives the growth rates of the motor vehicles in operation of Kerala. Following table gives motor vehicle growth in Kerala in time series fashion.

**Table 4.16: Time Series Traffic Growth in Kerala**

	2011	2012	2013	2014	2015
Trucks	21731	23394	27346	21015	14044
3 Wheeler	9041	10132	9485	7818	5787
Buses	1769	886	1875	933	469
Mini Bus	2433	2473	2696	2414	2723
Cars	165326	183383	186645	206750	186647
2 Wheeler	389603	529293	654085	636993	633635
Tractors,Articulated	241	1449	690	189	104
Tractors	528	556	590	471	280

#### 4.5.4 Elasticity of Transport Demand

As the traffic contribution on of the project corridor is mainly from the Kerala State, Consultants have developed the transport demand elasticities with respect to socio economic indicators of Kerala. The methodology involved fitting regression equations to the time series data. The NSDP is considered as independent variable for both freight and passenger vehicles and Population is considered as independent variables for passenger vehicles only. Elasticity values for freight vehicles in operation with respect to NSDP and Passenger vehicles with respect to population and NSDP have been worked out and presented in the **Table 4.18**

**Table 4.17: Travel Demand Elasticity of Various Vehicles.**

Car	2 W	3 W	Mini Bus	Bus	LCV	Trucks
2.43	1.79	1.47	1.32	1.32	1.04	0.9

It will be seen that the elasticity values for car are large as compared with the other passenger vehicle categories. Generally, the demand for travel by car is found to be comparatively higher as incomes go up and people are able to afford this desired means of personal travel. The same is true for two-wheelers, although this is not reflected in the low elasticity value. For the other (commercial) vehicle categories, elasticities should be lower than the personalized categories since the incentive for greater use of these modes with rising incomes is comparatively less.

#### 4.5.5 Traffic Forecast by Econometric Method

Given the transport demand elasticities, the growth rates of traffic on road by different modes have been projected on the basis of assumed growth rates of NSDP. Following are projected NSDP of Kerala State based on regression analysis.

**Table 4.18: NSDP Growth of Kerala.**

Year	NSDP Growth
2016-2017	5.10%
2017-2022	4.45%
2023-2027	2.84%
2028-2032	2.41%
Beyond 2032	2.10%

Based on NSDP growth and Elasticity consultant has derived following traffic growth rates for the project.

**Table 4.19: Mode wise Traffic Growth Rate**

Optimistic							
	Car	2 Wheeler	3 Wheeler	Buses & Mini Buses	LCV	Trucks	MAV
2016-2017	13.01%	9.59%	7.88%	7.04%	5.57%	4.83%	4.83%
2017-2022	11.34%	8.36%	6.87%	6.20%	4.83%	4.20%	4.20%
2023-2027	7.26%	5.34%	4.39%	3.99%	3.15%	2.73%	2.73%
2028-2032	6.16%	4.54%	3.73%	3.36%	2.63%	2.31%	2.31%
Beyond 2032	5.36%	3.94%	3.23%	2.94%	2.31%	2.00%	2.00% <b>NJ</b>
Realistic							
2016-2017	12.39%	9.13%	7.50%	6.70%	5.30%	4.60%	4.60%
2017-2022	10.80%	7.96%	6.54%	5.90%	4.60%	4.00%	4.00%
2023-2027	6.91%	5.09%	4.18%	3.80%	3.00%	2.60%	2.60%
2028-2032	5.87%	4.32%	3.55%	3.20%	2.50%	2.20%	2.20%
Beyond 2032	5.10%	3.75%	3.08%	2.80%	2.20%	1.90%	1.90%
Pessimistic							
2016-2017	11.77%	8.67%	7.13%	6.37%	5.04%	4.37%	4.37%
2017-2022	10.26%	7.56%	6.21%	5.61%	4.37%	3.80%	3.80%
2023-2027	6.56%	4.84%	3.97%	3.61%	2.85%	2.47%	2.47%
2028-2032	5.58%	4.10%	3.37%	3.04%	2.38%	2.09%	2.09%
Beyond 2032	4.85%	3.56%	2.93%	2.66%	2.09%	1.81%	1.81%

Traffic growth rate adopted for pavement design is based on weighted average of clubbed vehicles together as given below.

**Table 4.20: Traffic Growth Rate for Pavement Design**

Period	LCV & Mini Bus	BUS	2 AT	3 AT	MAV
<b>2017-2020 (4 Years during Design, Tendering &amp; Const.)</b>	5.7%	6.7%	5.0%	5.0%	5.0%
<b>2021-2025 (5 years' time horizon)</b>	5.0%	5.9%	5.0%	5.0%	5.0%
<b>2026-2030 (5 years' time horizon)</b>	5.0%	5.0%	5.0%	5.0%	5.0%
<b>2031-2035 (5 years' time horizon)</b>	5.0%	5.0%	5.0%	5.0%	5.0%
<b>2036-2040 (5 years' time horizon)</b>	5.0%	5.0%	5.0%	5.0%	5.0%
<b>2041-2045 (5 years' time horizon)</b>	5.0%	5.0%	5.0%	5.0%	5.0%
<b>2046-2050 (5 years' time horizon)</b>	5.0%	5.0%	5.0%	5.0%	5.0%

#### Growth Rates for Slow Moving Traffic

The slow moving vehicles essentially cater to short haul traffic, meeting localized demand for transportation of passengers and goods from rural areas in up country to the nearest market towns and urban centers'. The slow moving traffic is thus not expected to have high growth rates on NHs. Motorized vehicles are gradually replacing animals drawn vehicles. Agricultural tractors, in fact are replacing animal drawn vehicles both for agricultural activities and transportation of goods and passengers. A growth rate of 2 % is assumed for this traffic.

### Development/Generated Traffic

This represents the increase in traffic, if any, that may arise from improvements and development of adjacent land uses due to added accessibility and mobility provided by the new/improved facility, and also due to the associated new policy and decisions to locate development activities within the influence area of the project road in view of the added dimension to the transport infrastructure. This is generally considered to be over and above the development, which would have taken place otherwise, had the new or improved highway not been constructed.

### Diverted Traffic

This represents the traffic attracted to the improved highway by way of loss to alternative routes when the improvements are completed and the better facility is in use. Traffic generally get attracted to better level of service, particularly in terms of saving of travel time.

### Induced Traffic

This represents the increase in traffic as a result of the increased demand for transport, if any, induced by the improvement of the highway. In other words, this is the release of suppressed or latent demand. It is believed that there is travel demand which is not manifested (trips not made or avoided) in terms of traffic on road unless better facilities are provided. Such trips are induced with an improved facility.

Based on OD survey and available parallel route NH 183 and existing rail road on this route a shift of 20% traffic to the project road is expected after completion of widening work of NH 47 through diverted and induced traffic.

### 4.5.6 Estimation of Forecast Traffic

Based on realistic traffic growth rate and AADT derived and traffic generated/induced following tables give the forecast traffic on project road.

**Table 4.21A: Mode wise Traffic Forecast**

Year	Km 458+400		Km 482+800	
	Vehicle	PCU	Vehicle	PCU
2016	34419	32980	36048	36498
2017	37717	35934	39473	39696
2018	40907	38814	42785	42810
2019	44383	41946	46392	46190
2020	48170	45352	50320	49863
2021	52299	49060	54600	53853
2022	68088	63704	71062	69798
2023	71994	67383	75132	73795
2024	76131	71281	79442	78027
2025	80513	75411	84006	82509
2026	85154	79787	88841	87257
2027	90071	84426	93962	92285
2028	94575	88781	98668	97039
2029	99309	93365	103616	102042
2030	104287	98191	108818	107308

Year	Km 458+400		Km 482+800	
	Vehicle	PCU	Vehicle	PCU
2031	109521	103271	114288	112851
2032	115024	108620	120040	118685
2033	120138	113710	125404	124275
2034	125486	119044	131014	130132
2035	131077	124633	136881	136271
2036	136925	130490	143018	142704
2037	143040	136626	149437	149447
2038	149435	143057	156151	156513
2039	156124	149796	163174	163920
2040	163119	156858	170521	171683
2041	170436	164260	178206	179819
2042	178090	172016	186247	188348
2043	186095	180146	194659	197289
2044	194470	188667	203460	206660
2045	203231	197597	212669	216484
2046	212396	206958	222305	226782
2047	221984	216769	232387	237578
2048	232016	227053	242938	248896
2049	242513	237834	253978	260762
2050	253495	249135	265532	273202

**Table 4.22 b Mode wise Traffic Forecast**

Traffic forecast for all three scenarios are given in **Appendix 4.3**.

#### 4.5.7 Capacity and Level of Service Analysis

Capacity analysis for the project corridor is carried out in order to assess the Level of Service (LOS) offered by road sections under prevailing roadway and traffic conditions.

Capacity and Design Service Volumes (DSV) specified in IRC-64-1990, Capacity of Roads in Rural Areas have been adopted for determining the Level of Service offered by road sections during the design period. Based on the average rise & fall observed from the field surveys, the project corridor runs through Plain terrain. As there are no guidelines for capacity of 6-lane highway the same is estimated based on per lane hourly capacity estimated from capacity guidelines given in IRC -64-1990 for 6-lane highway. The per lane capacity estimated is 2150 PCUs/hour. Apply 8% peak hour factor and 60% directional distribution, capacity thus estimated for 6-lane Highway. The capacity and design service volumes for various lane configurations in case of plain terrain at different LOS's are presented in **Table 4.23** below.

**Table 4.22: Capacity and Design Service Volume**

Road	Shoulder Type	Plain Terrain			
		Capacity (PCU/day)	DSV (PCUS/day)		
			LOS B	LOS C	LOS D
4 Lane*	Earthen Shoulders	70000	35000	49000	59500
	Paved Shoulders	80500	40250	56350	68425



	With 7 m Service Road	134000	67000	94000	114000
6 Lane**	Paved Shoulders	134000	67000	94000	114000
6 Lane	Paved Shoulder with 5.5m Service Road on Both Sides	146375	73188	102463	124419
6 Lane***	Paved shoulders	90,000	-	-	-

The projected sectional traffic is compared with DSV to assess the upgradation requirement for the corridor under prevailing roadway conditions. Capacity augmentation is generally warranted for roads that cater to traffic volumes in excess of the DSV at LOS B.

The Consultants have attempted to assess upgradation requirement to the existing road based on the projected traffic in horizon years. Comparison of projected traffic with the DSV at various LOS indicates the following upgradation requirement show in **Table 4.24**.

**Table 4.23: Assessment of Upgradation Requirement**

Sl. No	Homo-geneous Section (HS)	Existing Section (km)		Design Chainage (km)		Existing Length (km)	Traffic Volume AADT (PCU)	Assessment of Upgradation Requirement	
		From (Km)	To (Km)	From (Km)	To (Km)			2016	Based on 6 Lane Capacity Guidelines
							LOS B		LOS C
1	HS-3	435.000	465.000	433.700	462.770	30.000	32980	2027	2035
2	HS-4	465.000	490.000	462.770	487.280	25.000	36498	2025	2033

#### 4.6. Traffic Circulation Plan and Safety Considerations

IRC SP55 is the guideline to be followed for circulating traffic during construction. Following picture gives the work zone safety criteria during construction.

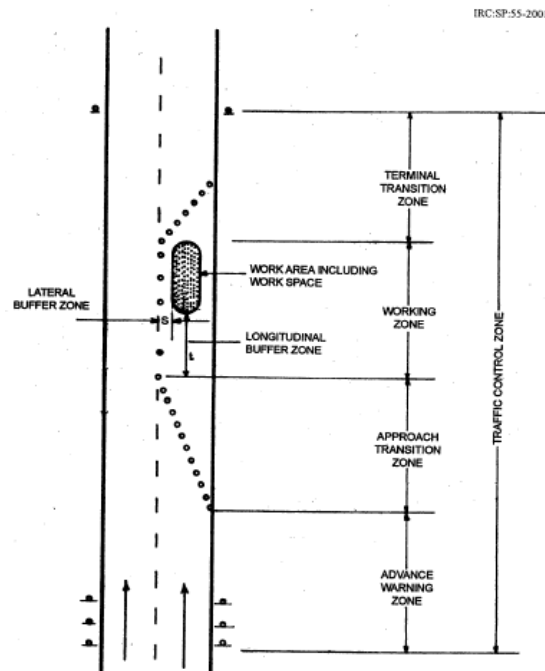


Figure 4.6: Work Zone Safety during Construction.

IRC SP 55 should be strictly adhered for safety of pedestrian, workers and vehicular traffic during construction

#### 4.7. Recommendation and Conclusion

Based on traffic analysis at midblock, junctions this project road is running on dense traffic and immediate widening is needed on this stretch. All the recommendation of grade separation at candidate junctions, pedestrian facilities require immediate attention.

**Following Appendices are enclosed to main report.**

- Appendix 4.4 Axle Load Survey
- Appendix 4.5 Passenger Vehicle Origin – Destination Survey
- Appendix 4.6 Pedestrian Crossing Survey
- Appendix 4.7 Speed & Delay Survey

## CHAPTER 5 COST ESTIMATE

---

### 5.1. GENERAL

This chapter provides deals with the cost estimate for widening and strengthening of NH-66 (old NH-47) from km 454+500 to km. 486+000.

The cost estimation has been prepared for the project corridor, as per the recommended improvement proposal for widening/ strengthening the existing roads from 2 lane with paved shoulder to 6 lane configuration with paved shoulder.

### 5.2. METHODOLOGY

The following procedure has been adopted for the estimation:

- The rates of various items of construction work have been analysed as per procedure laid down in the “MORT&H Standard Data Book”-2003 (Fourth Revision, Reprint 2006) and guidelines set there in.
- The Rates of Hire Charges for Machinery with effect from 01-11-2015 approved by Chief Engineer (NH) has been considered and escalated with 5% per year to arrive at the present rate. The unit rates of Labour and material considered as per DSR 2016 with Cost Index applicable, which are not available, then those items are considered as per SOR or Market Rates and. Cost index applied as per Circular, and escalated with 5% per year to arrive at the present rate.
- The rates of cement, Steel and Bitumen which have been provided as per current market rates.
- Computation of quantities of earthwork and other components of road worked out from TCS drawings and computed.
- Computation of cost of bridges from their General Arrangement Drawings by working out the quantities.
- Estimation of cost of land acquisition, resettlement and rehabilitation costs, utility relocation and environment mitigation measures as per detailed assessment of their costs.
- Estimation of allowances for contingencies and supervision charges as percentage of civil cost.
- Estimation of total project cost.

### 5.3. UNIT RATES

The rates of various items of construction work have been analysed as per procedure laid down in the “MORT&H Standard Data Book”-2003 (Fourth Revision, Reprint 2006) and guidelines set therein. For road embankment borrow areas have been identified along the project road. For stone metal quarries have been identified along the road. Average lead has been worked out for earth and stone metal and cartage cost has been provided at State Schedule of Rates. The unit rates have been worked out by taking the cost of materials as provided in the State Schedule of Rates (except for cement steel and bitumen for which market rates have been provided).. The component of labour, material and machinery has been provided as per Standard Data Book of the Ministry of Road Transport and Highways.

### 5.4. CONSTRUCTION QUANTITIES

For Final Detailed Project study the quantities of pavement have been worked out as per proposed TCS drawings.

Quantities of culverts and Minor/Major/ROB/VUP/PUP Structures have been worked out from GAD drawings. The cost of land acquisition, resettlement and rehabilitation costs, utility relocation costs and environmental mitigation measures have been provided as per preliminary assessment of their costs. Estimates for allowances for contingencies and supervision charges have been provided as percentage of total cost.

#### **5.5. PAVEMENT DESIGN OPTIONS**

Flexible Pavement has been considered for main carriageway and service road/ slip road as per the Improvement proposal and Pavement Composition.

#### **5.6. COST COMPONENTS**

The estimated cost has been worked out under the following sub heads: -

##### ***Site clearance and dismantling***

Under this sub head provision has been made for removing the roots of trees of girth more than 300 mm and dismantling the structures, which are proposed to be reconstructed.

##### ***Earth Work***

This sub head provides for items of earth work in excavation, embankment, sub grade and shoulders.

##### ***Sub Base and Base Courses***

Cement treated sub-base and cement treated base with aggregate crack relief layer has been proposed for the pavement.

##### ***Bituminous Courses***

This sub head provides for items of bituminous courses for flexible pavement.

##### ***Culverts***

Additional new Culverts is provided based on hydrological investigation. The schedule of widening and providing new culverts are fixed up and accordingly the different types of culverts (viz pipe, slab, box) quantities are worked out from the standard drawings or from the available drawings of the particular project. Further the abstract of Quantities is prepared for all the culverts and the Abstract of cost is prepared by multiplying the rates.

##### ***Minor / Vehicular and Pedestrian Underpasses/ Flyover/Grade Separators***

The quantities for reconstruction/widening/rehabilitation of Minor / Vehicular and Pedestrian Underpasses/ Flyover/Grade Separators are considered under this head. The quantities for Earth Retaining structures provided in the approaches of proposed Underpasses are covered here.

##### ***ROBs /Major Bridges***

The quantities for rehabilitation of existing ROBs/Major Bridges are considered under this head. The quantities for Earth Retaining structures provided in the approaches of proposed Structures are covered here.

##### ***Repair & rehabilitation of structures***

The Provisional Quantities are considered under this head for the Structures which are to be retained.

##### ***Traffic signs, Markings & Road Appurtenances***

The road traffic signs and road markings for the project are provided as per IRC standards. This includes the quantities of road markings, road signs (all kinds), crash barriers and street lightings required for main highway as well as service roads.

#### **Drainage and Protective Works**

All works relating to longitudinal drainage requirements, lined and unlined drains/ditches, embankment slope protection works are covered here.

#### **Maintenance during Construction**

The existing road will be maintained during construction for running the traffic smoothly. Provision for maintaining the existing road during construction has been made under this sub head.

#### **General items**

Under this sub head provision has been made for the following main items:

#### **Toll Plaza**

This section includes the items required for providing additional extra lanes at the toll plaza locations.

### **5.7. CONTINGENCIES AND SUPERVISION COSTS**

The following provision has been made for contingency and supervision cost:

- Contingency Charges - 1%

### **5.8. PROJECT COST**

The Packages are in a corridor has been divided as per the guidelines given vide Ref NHA/BOT-2/11102/Phase-IV/NH-209/2010/949 dated 03.11.2016.

The total cost includes Contingencies, Supervision charges, Administrative charges, Quality Control charges, Road Safety cell audit charges and cost of Resettlement and Rehabilitation, Land acquisition cost, Environmental cost and shifting of utilities. A copy of General Abstract of cost is enclosed as follows.

<b>ABSTRACT OF COST</b>			
<b>Bill No.</b>	<b>Description</b>		<b>Amount (Rs.)</b>
1	SITE CLEARANCE AND DISMANTLING	31.5 km	21,238,863
2	EARTH WORK		773,754,566
3	SUB-BASE, BASE-COURSES		2,168,788,045
4	BITUMINOUS PAVEMENT COURSES		1,199,718,983
5	CROSS DRAINAGE WORKS	53 No's	220,444,565
5A	FOOT OVER BRIDGES	14 No's	107,560,800
6	MINOR BRIDGES , FLYOVERS & UNDERPASSES & RE WALL		
I)	VUP	3 No's	121,353,285
II)	LVUP	1 No's	7,206,423
III)	SVUP	9 No's	133,136,407

IV)	FLYOVER	1 No's	69,845,374
V)	MINOR BRIDGE	3 No's	206,776,392
VI)	MAJOR BRIDGES	2 No's	986,165,835
<b>VII)</b>	<b>Elevated Highway cum ROB</b>		
VIII)	ROB		
IX)	RUB		
X)	RE WALL	6.04 km	1,451,775,806
8	TRAFFIC SIGNAGES, ROAD MARKING & APPURTENANCES		775,775,989
9	DRAINAGE AND PROTECTION WORKS		1,139,465,547
10	REPAIR & REHABILITATION OF STRUCTURES		1,522,631
11	MAINTENANCE OF ROADS		3,142,125
12	GENERAL ITEMS		568,095
13	TRAFFIC MANAGEMENT SYSTEM		34,549,079
14	TOLLPLAZA		73,840,000
	<b>BASE CIVIL CONSTRUCTION COST (A)</b>		<b>9,496,628,811</b>
15	<b>Escalation @ 5% up to bid due date</b>		
16	<b>Total Civil Construction Cost as on Bid due date</b>		<b>9,496,628,811</b>
	<b>COST PER KM (Rs in Crores)</b>		<b>30.15</b>
17	<b>Centages(IC &amp; Pre-Operative cost+Finanace Cost+IDC)</b>		
	IC & Pre operative expences @ 1% of EPC Cost		94,966,288
	Financing Cost Debt at 70:30 DER		63,600,000
	Interest durning construction		529,600,000
	<b>Total Centages</b>		<b>688,166,288</b>
18	<b>TOTAL EPC COST</b>		<b>10,184,795,099</b>
19	<b>Pre-Construction activities</b>		
	Cost of land acquisition		16,400,700,000
	shifting of Utilities(KSEB)		599,500,000
	shifting of Utilities(Kerala Water Authority)		412,390,000
	Environmental measures etc		34,570,000
	<b>Total Pre-Construction activities</b>		<b>17,447,160,000</b>
20	<b>TOTAL CAPITAL COST (Estimated Project Cost + cost of Pre-construction activities)</b>		<b>27,631,955,099</b>
	<b>COST PER KM (Rs in Crores)</b>		<b>87.72</b>
	<b>TOTAL LENGTH (Kms)</b>		<b>31.50</b>

## CHAPTER 6 ENVIRONMENTAL SCREENING AND PRELIMINARY ENVIRONMENTAL ASSESSMENT

---

### 6.1. Introduction, Objective and Legal Framework

#### 6.1.1 Introduction

The National Highways Authority of India (NHAI) has been entrusted with the assignment of preparation of Detailed Project Report for 6 laning of Chertalai to Thiruvananthapuram Section of NH-47 (new NH-66) from km 379.100 to km 549.801 under NHDP Phase III in the State of Kerala.

The project road length is 170.7km. It starts from km 379.100 of NH-47 at the junction of Thuravoor and ends at Kazhakottam junction at km 549.801. This stretch of road passes through three districts viz. Alappuzha, Kollam and Thiruvananthapuram. The road passes through urban areas viz. Chertalai, Marary Kulam, Alappuzha, Ambalapuzha, Purakkad, Thottapally, Haripad, Nagiar Kulangara, Kayamkulam, Krishnapuram, Oachira, Vavvakkavu, Karunagapally, Chavara, Neendakara, Kavanadu (Kollam), Mevaram (Kollam), Kottiyam, Chathanoor, Paripally, Kallambalam, Attingal, Manglapuram, Pallipuram and Kazhakottam.

The project stretch includes two bypasses at Alappuzha and Kollam and a new realigned stretch bypassing Attingal Town

#### 6.1.2 Objective of Environmental Screening and Preliminary Environmental Assessment

Environmental Screening study determines the environmental sensitivity of the project road that in turn helps the level of planning in terms of time, budget and effort required to take up the particular project for development.

Environmental Screening and Preliminary Environmental Assessment of the study area has the following major objectives:

- To identify the potential environmental impacts;
- To categorize the project;
- To ensure that environmental considerations are given adequate weightage for carrying out proposed road improvement;
- Policy, legal and institutional issues for planning and for getting all approvals and for implementation of Environmental Management Plan during Design, Construction and Operational phases; and
- Scoping and future course of work for Environmental Impact Assessment Study

The preliminary environmental assessment for the proposed project is being undertaken as a parallel exercise with the Engineering Analysis, so as to bring out the environmental concerns in planning and the proposed design.

#### 6.1.3 Applicable Environmental Acts and Guidelines

Environmental regulations and legislations relevant to this project, along with their competent authority for implementation are presented in **Table 6.1**.

**Table 6.1: Summary of Relevant Environmental Acts and Guidelines**

S. No	Act/Rules	Year	Objective	Applicable Yes/No	Reason for applicability	Authority
1.	Environmental (Protection) Act	1986	To protect and improve overall environment	Yes	As all environmental notifications, rules and schedules are issued under this act	MoEF & CC GoI, DoE, GoK, CPCB, KSPCB
2.	Environmental Impact Assessment (EIA) Notification	2006	To provide environmental clearance to new development activities following environmental impact assessment	No	The project does not attract the conditions of EIA Notification 2006 and further amendments	MoEF & CC, SEIAA
3.	Forest (Conservation) Act	1980	To check deforestation by restricting conversion of forested areas into non-forested areas	No	There is no forest along the project road	Forest Department, GoK
4.	Water (Prevention and Control of Pollution) Act and Cess Act of 1977 as amended in 1988	1974	To control water pollution by controlling emission & Water pollutants as per the prescribed standards	Yes	This act will be applicable during construction, for establishments of hot mix plant, stone crusher, construction camp, workers' camp, etc.	KSPCB
5.	Air (Prevention and Control of Pollution) Act as amended in 1987	1981	To control air pollution by controlling emission and air pollutants according to prescribed standards	Yes	This act will be applicable during construction; for obtaining NOC for establishment of hot mix plant, workers' camp, stone crusher, construction camp, etc.	KSPCB
6.	Noise Pollution (Regulation and Control) rules	2000	Noise pollution regulation and controls	Yes	This act will be applicable as vehicular noise on project routes required to assess for future years and necessary protection measure need to be considered in design.	KSPCB
7.	The Kerala Ground Water (Control And Regulation) Act	2002	Conservation of ground water and for the regulation and control of its extraction and use in the State of Kerala	Yes	This act will be applicable during construction for extraction of use of groundwater	State Ground Water Authority, GoK



S. No	Act/Rules	Year	Objective	Applicable Yes/No	Reason for applicability	Authority
8.	Ancient Monuments and Archaeological sites & Remains Act	1959	Conservation of Cultural and Historical remains found in India	No	The project route is not close to any Ancient Monument, declared protected under the act.	Archaeological Dept. Gol, Dept. of Archaeology, GoK, Indian Heritage Society and Indian National Trust for Art and Culture Heritage (INTACH).
9.	Notification for use of fly ash	2016	Promoting the utilization of fly ash in the manufacture of building materials and in construction activity within a specified radius of 300 kilometers from coal or lignite based thermal power plants	Yes	No coal based thermal power plant in Kerala. However, few coal based thermal power plants are located within 300 km.	MoEF&CC
10.	The Explosives Act (& Rules)	1884	An Act to regulate the manufacture, possession, use, sale, transport, import and export of Explosives	Yes	For transporting and storing diesel, bitumen etc.	KSPCB
11.	Public Liability Insurance Act	1991	Insurance for the purpose of providing immediate relief to the persons affected by accident occurring while handling any hazardous substance and for matters connected therewith or incidental thereto	Yes	Contractor need to stock hazardous material like diesel, Bitumen, Emulsions etc. safely	KSPCB
12.	Coastal Regulation Zone	2011	To regulate activities in the coastal zone to protect ecologically sensitive areas	Yes	The project road passes through CRZ	KCZMA, MoEF&CC
13.	Hazardous and Other Wastes (Management and Transboundary Movement) Rules	2016	Storage, handling, transportation and disposal of hazardous waste	Yes	Storage and handling of hazardous waste during construction	KSPCB
14.	Solid Waste Management Rules	2016	Management and handling of solid waste	Yes	For disposal of solid waste generated during construction	KSPCB

S. No	Act/Rules	Year	Objective	Applicable Yes/No	Reason for applicability	Authority
15.	Construction and Demolition Waste Management Rules	2016	Management of construction and demolition waste	Yes	For disposal of solid waste generated due to construction and demolition	KSPCB
16.	Batteries (Management & Handling) Amendment Rules	2010	Management and handling of used lead batteries	Yes	Safe disposal of used lead batteries	KSPCB
17.	E-Waste (Management) Rules	2016	Effective mechanism to regulate generation, collection, storage, transport, import, export, recycling, treatment and disposal of e-wastes	Yes	Handling of e-waste	KSPCB
18.	Central Motor Vehicles Act	1988	To control vehicular air and noise pollution.	Yes	This rule will be applicable to road users and construction machinery	Motor Vehicle Department
19.	Minor Mineral and concession Rules	1960	For opening new quarry	Yes	Regulate use of minor minerals like stone, soil, river sand etc.	District Collector
20.	The Mining Act	1952	The mining act has been notified for safe and sound mining activity	Yes	The construction of project road will require aggregates. These will be procured through mining from quarries	Department of mining, GoK
21.	National Forest Policy(Revised)	1988	To maintain ecological stability through preservation and restoration of biological diversity	No	This policy will not be applicable as NO eco sensitive feature exists along the project corridor	Forest Department, Gol and GoK
22.	The Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act	2013	Set out rules for fair compensation and acquisition of land	Yes	This act will be applicable as there will be acquisition of land for widening, geometric improvements and bypasses	Revenue Department State Government

S. No	Act/Rules	Year	Objective	Applicable Yes/No	Reason for applicability	Authority
23.	The National Highway Act	1956	For Land Acquisition	Yes	This act will be applicable as there will be acquisition of land for widening, geometric improvements and bypasses	NHA Revenue Department, GoK

## 6.2 Baseline Environmental Setup

### 6.2.1 Study Area

The study area for the environmental screening has been categorized in two influence areas:

- i) Direct influence area: PROW of the project road i.e., 45m
- ii) Indirect influence area: 10km around the project road

Sensitive environmental components along the corridor of impact were recorded during reconnaissance survey. Those were, road side trees, water bodies, public utilities, religious structures, educational institutes/schools, hospitals/health centers, community resources, congested areas, archaeological site etc.

Secondary data was collected on physiography, land use pattern, soil & geology, seismicity, meteorology, demography and related other environmental aspects.

### 6.2.2 Physiography

The project road lies between Latitude 9°46'5.521"N to 8°33'55.538" N and Longitude 76°19'5.494"E to 76°52'30.714"E.

The project road passes mainly through plain terrain with some patches through rolling terrain. The altitude varies between 2 m and 75 m above mean sea level.

The physiography of the project districts and physiographical map of Kerala state (**Figure 6.1**) showing the project area is as follows:

### Alappuzha

Sandy strip of land intercepted by lagoons, rivers and canals. There are neither mountains nor hills in the district except some scattered hillocks lying between Bharanikkavu and Chengannur blocks in the eastern portion of the district.

### Kollam

Divided into three distinct units viz. the coastal plains, the midlands and the eastern highland regions. The coastal plains with an elevation ranging between 0-6 m amsl occur as narrow belt of alluvial deposits parallel to the coast.

### Thiruvananthapuram

Rugged topography which is present in the coastal city of Thiruvananthapuram and towns like Vizhinjam, Varkala and Edavai. Three distinctive topographic units can be identified in the district from west to east – (1) lowland (coastal plains), (2) midlands and (3) highlands.



Source: ENVIS Center, Kerala

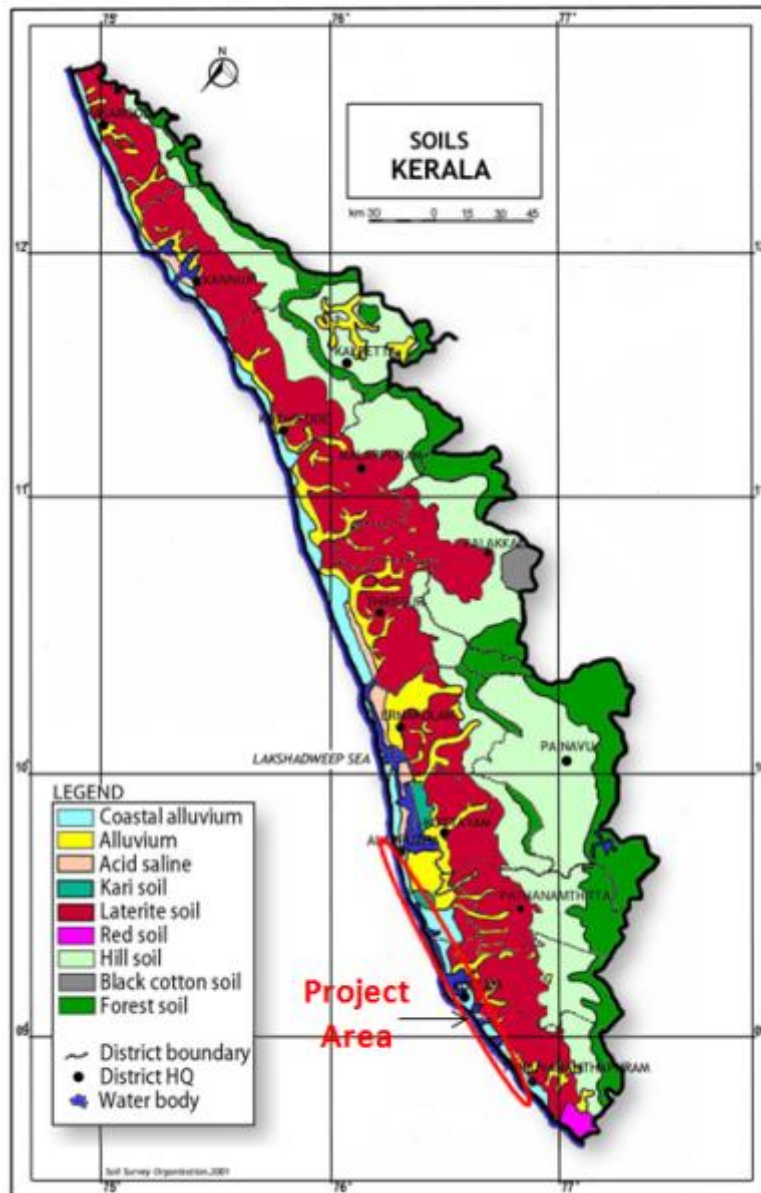
Figure 6.1: Physical Map of Kerala showing Project Area

As evident from the above information and map, the project road passes through low land along the coast.

### 6.2.3 Geology & Soil

Geological rock formations include a variety ranging from the Achaeans to the recent crystallines Tertiaries, are represented by the Warkalli group whereas the recent deposits are represented by the westernmost coastal belt.

Soil map of Kerala state (Figure 6.2) showing the project area is as follows:



Source: Directorate of Soil Survey & Soil Conservation

**Figure 6.2: Soil Map of Kerala showing Project Area**

As seen from the above figure, the soil type along the project road is coastal alluvium. These soils of marine origin are identified along the coastal plains and basin lands as a narrow strip. The area has high water table and in some areas it reaches above the surface during rainy season. The soils of the coastal plains are very deep with sandy texture. The texture generally ranges from sand to loamy sand with grayish brown to reddish brown and yellowish red colour. Sand content ranges from 80% and clay up to 15%. Even though these soils have high water table, the water holding capacity is poor due to the predominance of sand.

#### 6.2.4 Seismicity

According to 2014 seismic zoning map of India, the state of Kerala falls in Zone III, moderate zone of seismic hazard (**Figure 6.3**). This zone is classified as moderate damage risk zone which is liable to MSK VII. The IS code assigns zone factor of 0.16 for Zone III. The project road falls in Zone III.

Also, as per Global Seismic Hazards Assessment Program (GSHAP) data (**Figure 6.4**) the state of the Kerala falls in a region of low to moderate seismic hazard. The project road falls in low to moderate hazard zone.



Figure 6.3: Seismic Zonation Map of India

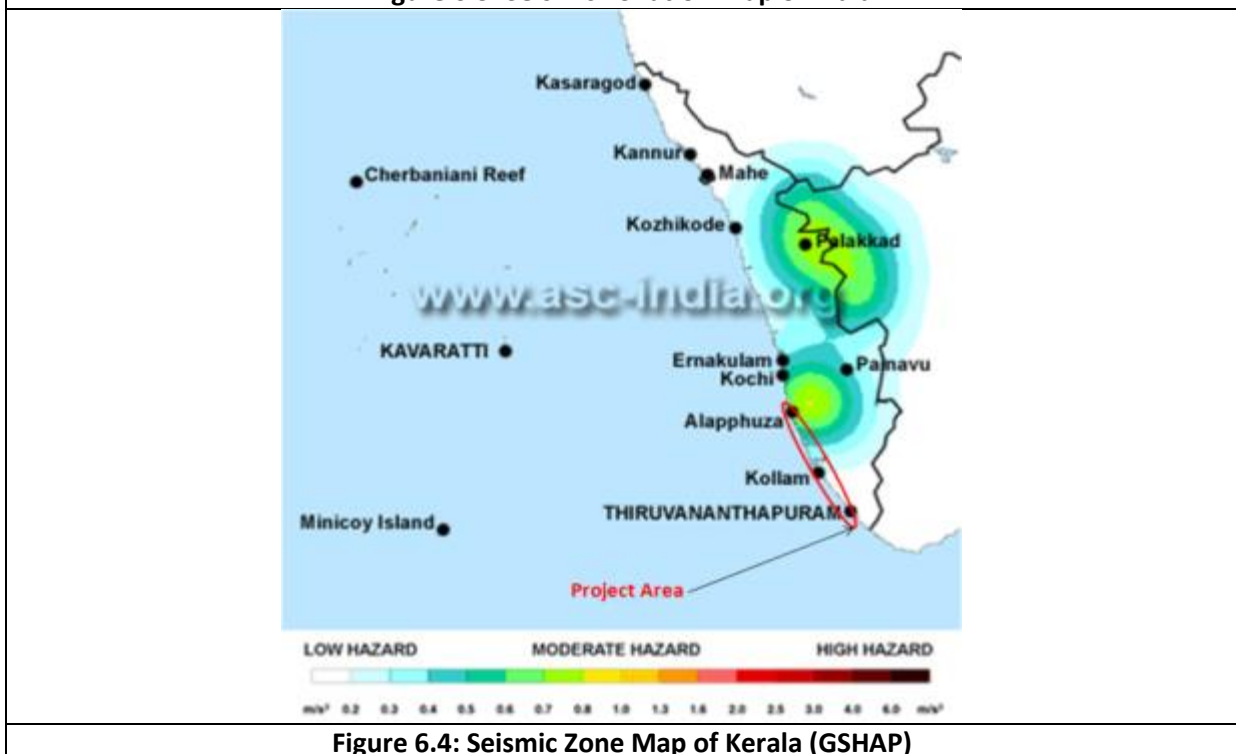


Figure 6.4: Seismic Zone Map of Kerala (GSHAP)

## 6.2.5 Climate and Meteorology

### Climate

The climate is hot and humid along the coast and drier in the interior parts of the districts. The year may be divided into four seasons. The period from March to the end of May is the hot season. This is followed by Southwest Monsoon season that continues till the beginning of October. Northeast Monsoon season is from October to December and the two months January & February are winter season. The climate is pleasant from September to February. Summer months March to May is uncomfortable due to high temperature and humidity.

### Rainfall

The rainfall in the study area increases from south to north. The monthly rainfall data of project districts is provided in **Table 6.2**. The annual total rainfall in Alappuzha, Kollam and Thiruvananthapuram was 2469mm, 2688.9mm and 1912mm respectively in 2014. May, June, July and August months receive heavy rainfall. June receives highest rainfall in the year.

**Table 6.2: Rainfall in Project Districts in mm (2010-2014)**

Month	Alappuzha					Kollam					Thiruvananthapuram				
	2010	2011	2012	2013	2014	2010	2011	2012	2013	2014	2010	2011	2012	2013	2014
January	16.6	30.5	44.1	24	0.2	11.5	57.1	13.7	10.3	0.5	108.3	43.6	14.4	10.5	45.8
February	2.2	48	19.9	88.4	23.3	0	98.6	20.9	58	15.7	0	73.6	35.1	63.1	13.1
March	92.7	35.7	60.7	49.8	32.7	59.1	46.7	77.4	49.2	51.4	73.1	15	26.1	46.8	35.1
April	161.6	183.5	210.1	40.3	143.8	221.1	177.4	228.6	90.2	151.7	109.4	157.1	164.7	31.7	136.4
May	322	251	159.5	137.4	250.6	203.5	148	145.8	159.6	290.8	216.7	92.7	88.7	120.9	272.6
June	529.3	554.3	215.7	935.9	362.8	357	417.4	167.5	749.5	283.5	237	270.2	99.1	525.3	142.4
July	474.6	377	271.5	637.6	355.6	362.3	283	210.6	449	287.9	234.9	97.6	146.2	247.9	118.7
August	255.9	294	407.1	245.3	615.3	304.8	219.6	272.6	205.3	591.5	118.7	84.4	169.7	115.8	458.6
September	242.3	359.4	195.4	292.1	227.6	258.3	242.2	149.8	373.6	260	114.1	131.5	77.7	219.7	189.4
October	555.1	160.3	151	186.4	311	527.8	233.5	240.2	290.9	386.6	414.3	141.2	159.3	155.9	288.3
November	309.3	136.6	105.2	171.5	93.8	388.4	267	111.1	213.8	151.7	326	233.4	140.7	273.9	128.6
December	96.8	169.8	5.5	15.2	52.3	95	100.9	17.4	39.5	40.1	188.3	168.9	32.7	33.6	83
<b>Average</b>	<b>3058.4</b>	<b>2600.1</b>	<b>1845.7</b>	<b>2823.9</b>	<b>2469</b>	<b>2788.8</b>	<b>2291.4</b>	<b>1655.6</b>	<b>2688.9</b>	<b>2511.4</b>	<b>2140.8</b>	<b>1509.2</b>	<b>1154.4</b>	<b>1845.1</b>	<b>1912</b>

Source: India Meteorological Department (IMD)

### Humidity

Humidity level in the project area is moderate to high. In drier months (between December to February), the humidity at Alappuzha has been recorded at 66% whereas in wettest month (July) it is as high as 92%.

The humidity level is 63% in Thiruvananthapuram (during hours of evening in January) during the driest months (between December to February). Highest level of humidity is observed as 89 % at Thiruvananthapuram during the month of July.

### Temperature

Temperature variation in the study area is mild due to the vicinity of the Arabian Sea. Monthly maximum and minimum temperatures at Alappuzha have been observed to be 33.1 °C and 22.5 °C in April and January respectively. Monthly average temperature varies between 22.2°C to 33.1 °C. In Thiruvananthapuram, March is the warmest month with an average temperature of 28 °C and January is the coldest month having a mean temperature of 26 °C.

### Wind Speed

Maximum and minimum monthly average wind speed has been observed to be 13.40 kmph and 8.4 kmph respectively at Alappuzha. Maximum monthly average wind speed observed is 10.4 kmph (August) at Thiruvananthapuram whereas minimum monthly average wind speed observed is 4.9 kmph (December).

### 6.2.6 Land Use Pattern

Land use pattern along the project road is predominantly built up area in urban and semi urban centers followed by commercial areas. Around 8.5km length of the project road in Kollam district passes through an area close to the Arabian Sea. Also the project road passes through backwaters at few places.

Representative photographs of the Project road sections are indicated below:



**Built up/Commercial area at Attingal junction.**



**Vegetation/ Agricultural land along the project road.**



**Thottapally Spillway (km 432.600)**



**Ashtamudi Lake Bridge (km 487.200) under construction**



**Built up/Commercial area at Karunagapally (km 470.00)**



**Rolling Terrain stretch on project road (km 504.00)**

### 6.2.7 Water Resources

The study area is rich in water sources. Such water resources include the rivers streams, backwaters, lakes, irrigation tanks, ponds, brackish water etc. A large number of people depend on these water resources for their livelihood through fishery. The list of water bodies is as follows:



**Table 6.3: Water Bodies crossing the project road**

Sl. No.	Chainage (Km)	River/Canal/ Nallah/Lake
1.	458.000	Kayamkulam branch canal
2.	461.000	Krishnapuram Thodu
3.	474.600	Kennettil – Pallikal Canal
4.	483.100	T S Canal

Source: Primary Survey, October 2016

#### Rivers:

Alappuzha district is drained mainly by *Pamba* River and its tributaries viz. *Achankovil* and *Manimala* Rivers. The *Manimala* River enters the Kuttanad area at Thondara and confluences with Pamba River at Neerettupuram. Achankovil enters Kuttanad at Pandalam and joins Pamba River at Veeyapuram. Vembanad Lake, the largest back water in the State lies on the north eastern part of the district separating Alappuzha from Kottayam district.

Kollam district is drained by three west flowing rivers, viz *Achankovil*, *Kallada* and *Ithikkara*, originating in the eastern hilly region. The Ithikkara River originates from the *Madatharaikunnu* hills, south west of Kulathupuzha and drains into the Paravoor backwaters near Meenad. The Kallada originating from the Western Ghats drains into Ashtamudi backwaters near Kollam.

#### Back Waters

##### Vembanad Lake:

The Vembanad Lake has the most important west coast canal system stretching from Alappuzha to Kochi. The Thannermukom regulator constructed across the Vemband Lake is the largest mud regulator in the country.

Vembanad has been declared as a Ramsar Wetland in 2002.

##### Kayamkulam Lake:

Stretching between Panmana and Karthikappally, Kayamkulam Lake is a shallow lake which has an outlet to sea at Kayamkulam barrage. It has an area of 59.57 Sq.Km, a length of 30.5 Km and an average breadth of 2.4 Km. It connects Ashtamudi lake by the Chavara Panmana canal.

##### Ashtamudi Lake:

Ashtamudi Lake is one of the largest wetland ecosystems in Kerala. It is located at 8°57'N, 76°35'E and it has an area of 61,400 ha. This estuarine system lies near to the Kollam Bypass on right hand side and is the second largest of the State having a spread over Karunagappally and Kollam Taluks of Kollam district. This estuary is the deepest among all the estuaries of Kerala with a maximum depth of 6.4 m at the confluence zone.

Ashtamudi estuary is of extraordinary importance for its hydrological functions biodiversity, rich fishery resources and an annual production of 23,000 tonnes of fish. This estuary has been declared as a Ramsar Wetland in 2002.

True mangroves *Avicenna officinalis*, *Bruguiera gymnorrhiza* and *Sonneratia caseolaris* are present and around 43 species of marshy and mangrove associates are present along with two endangered species *Syzygium travencoricum* and *Calamus rotang*. The biological diversity is represented by 43 marsh and mangrove species. 57 bird (6 migrants and 51 residents), 97 fish species and 21 partly unique copepode-species (Source: WWF and forests, 2004a)

## Ground Water:

In Kerala State, groundwater has been the mainstay for meeting the domestic needs of more than 80% of rural and 50% of urban population besides, fulfilling the irrigation needs of around 50% of irrigated agriculture.

In the project districts, the depth to ground water level varies between 0.72 to 25.4m bgl during pre-monsoons (April 2011) and 0.07 to 22.86m bgl during post monsoon (November 2011) season.

Source: Ground Water Information Booklet, Alappuzha, Kollam and Thiruvananthapuram districts, CGWB

## 6.2.8 Ecological Environment

- a) **Forest Cover:** The recorded forest area of the state is 19,239 sq. km., which constitutes 46.50% of its geographical area. Reserved Forests constitute 100%, Protected Forests 0% and Unclassed Forests constitutes 0% of the total forest area. The forest cover in project districts is presented in **Table 6.4** and the forest cover map with marked project area is presented in **Figure 6.5**.

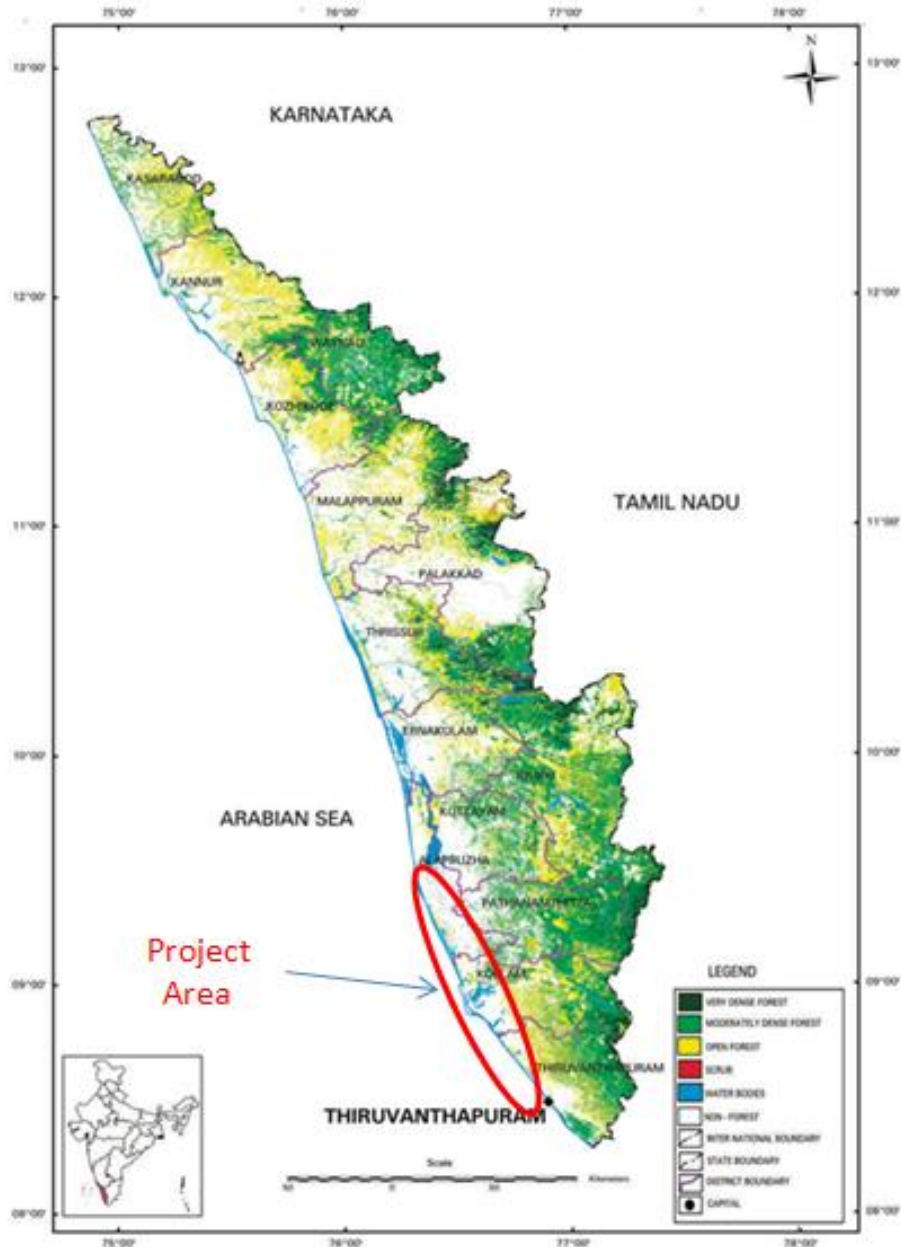
**Table 6.4: Forest Cover in the Project Districts (km<sup>2</sup>)**

District	Geographical Area (GA)	VDF	MDF	OF	Total	% of GA
Alappuzha	1,414	0	45	67	112	7.92
Kollam	2,491	99	671	632	1,402	56.28
Thiruvananthapuram	2,193	60	718	539	1,317	60.05
<b>Kerala State</b>	<b>38,863</b>	<b>1,523</b>	<b>9,301</b>	<b>8,415</b>	<b>19,239</b>	<b>49.50</b>

Source: India State of Forest Report, 2015

VDF: Very Dense Forest, MDF: Moderately Dense Forest, OF: Open Forest

Above information shows that the Alappuzha district has minimal forest cover. Kollam and Thiruvananthapuram districts have good forest cover having all classes of forest. Also, the percentage of forest cover in the project districts (except Alappuzha) is more than the Kerala State.



Source: India State of Forest Report, 2015

**Figure 6.5: Forest cover map of Kerala**

## b) Flora

The major ecological component in the project corridor is represented by the roadside vegetation all along the stretch varying in densities and composition. There are approximately 2423 trees along the road. There is considerable difference in distribution of age classes. These are primarily broad-leaved species and include *Cocos nucifera*, *Areca nut*, *Casuarina equisetifolia*, *Anacardium occidentale*, *Acacia auriculiformis*, *Tamarindus indica*, *Eucalyptus spp*, *Cassia spp.*, *Lagerstroemia sp.* *Samanea saman*, *Delonix regia*, *Buchanania lanzan*, *Ailanthus excelsa*, *Azadirachta indica*, *Swietenia spp.* etc. These types of vegetation not only provide shade but also provide fruits, flowers, fuel wood and small timber for the roadside communities. These are also habitat for common birds of the region.

The aquatic flora of the different water bodies in the project area of influence is represented by a variety of floating, emergent, marginal and submerged vegetation. Blue green algae, green algae, diatoms represent phytoplanktons, dinoflagellates etc.

### c) Fauna

Fish resources of the variety of water bodies constitute the major fauna of the project area of influence. The Arabian Sea, brackish water bodies and fresh water rivers have distinct assemblages of fishes. Common wetland birds and birds of the rural, semi-urban and urban areas are also components of the faunal assemblage. Snakes, rodents, frogs etc are also found along the project corridor. Ashtamudi estuary is a rich bio-diversity spot because of its fish resources and the wetland birds both resident and migratory

### d) Eco sensitive zone/Wildlife Sanctuary

Project Road does not pass through or fall within 10 Km of any notified eco-sensitive zone or Wildlife Sanctuary.

### e) Coastal Environment

The 590 km length Kerala coast faces the Arabian Sea. The coastline of Kerala is more or less straight trending in NNW-SSE direction from north till the Thangassery headland near Kollam. The coastline orientation south of Thangassery is in the NW-SE direction. The offshore continental shelf bathymetry is steeper to the south.

The project road is passing through Costal Zone Regulation (CRZ) area at 13 locations as submitted in CRZ status report prepared by Centre for Earth Science Studies (CESS). Applications were submitted by ICT for obtaining CRZ Clearance. MoEF&CC has accorded CRZ clearance for improvement of 2 lane to 4/6 lane Cherthala - Kazhakuttam Road except Alappuzha and Kollam Bypass vide letter dated 13.10.2014. Clearance for Alappuzha and Kollam Bypass was accorded by MoEF&CC vide letter dated 30.12.2013. (Ref. Annexure 6.1).

The Ministry of Road Transportation and Highways has made a Special Purpose Vehicle for implementation of Kollam and Alappuzha bypasses and they were treated as standalone projects.

## 6.2.9 Educational Institutions

Four (4) schools are located along the project road. The detailed list is provided in **Table 6.5**.

**Table 9.5: Educational Institutions along the project road**

S. No.	Existing Chainage (km)	Name of Property	LHS/RHS
1.	459.500	Angel Arc School	RHS
2.	470.150	Government School	LHS
3.	470.800	Ahamad Jamat School	LHS
4.	486.300	Girls High School	RHS

## 6.2.10 Religious Structures

A number of religious structures are located along the project road. The detailed list is provided in **Table 6.6**.

**Table 6.6: Religious Structures along the Project Road**

S. No.	Existing Chainage (Km)	Religious Structures	Side
1.	455.350	Masjid	LHS
2.	460.400	Mosque	RHS
3.	462.700	Valiyakulangara Masjid	LHS
4.	463.680	Sri Sarada devi Mata Temple	RHS
5.	465.100	Vavakkavu Masjid	LHS
6.	465.600	Krishna temple	RHS
7.	467.100	Puthankavu Muslim Jam-aat	RHS
8.	468.200	Shiekh Taj Mahal Masjid	RHS
9.	468.500	Jimma Masjid	RHS
10.	470.400	Temple	LHS
11.	472.200	St Thomas church	LHS
12.	473.300	Mosque	RHS
13.	475.100	Pekukada Mosque	LHS
14.	478.600	Temple	RHS
15.	479.350	Temple	LHS
16.	481.550	Temple	LHS
17.	483.500	St. Jude’s church	RHS
18.	485.250	Church	RHS
19.	464.900	Mosque	LHS
20.	466.000	Mosque	LHS
21.	475.400	Mosque	RHS
22.	475.400	Mosque	RHS
23.	475.400	Mosque	RHS
24.	485.700	Church	RHS

### 6.2.11 Medical Facilities

Hospitals/health centers are located along the project road. The detailed list is provided in **Table 6.7**.

**Table 6.7: Medical Facilities along the Project Road**

S. No.	Existing Chainage (Km)	Religious Structures	Side
1.	468.000	Aman Nursing Home	LHS

### 6.2.12 Common Property Resources

A number of CPRs are located along the project road. The detailed list is provided in **Table 6.8**.

**Table 6.8: CPRs along the Project Road**

S. No.	Existing Chainage (Km)	Religious Structures	Side
1.	458.000	Office of Insurance Company	RHS
2.	458.100	C.P.I. Party Office	RHS

S. No.	Existing Chainage (Km)	Religious Structures	Side
3.	470.500	K.S. Electricity Board	LHS

### 6.2.13 Built up Sections

The chainage wise built up areas are detailed as below:

**Table 6.9: Built up sections along the Project Road**

S. No.	Location (km)		Village
	From	To	
1	454.500	455.000	Kareelakulangara
2	455.000	456.000	Kottukulangara
3	456.000	459.000	Kayamkulam
4	459.000	460.400	Kunnathalumoodu
5	460.400	461.000	Mukkada
6	461.100	461.600	Krishnapuram
7	461.600	465.400	Oachira
8	465.400	466.790	Changankulangara
9	466.790	467.700	Vavvakkavu
10	467.700	468.300	Puliyankulangara
11	468.300	468.750	K.S. Puram
12	468.750	470.000	Puthentheruvu
13	470.000	471.000	Puthiyakavu
14	471.000	471.320	Pallimukku
15	471.320	474.160	Karunagapalli
16	474.400	474.800	Kuttivattion
17	475.100	476.320	Vettamukku
18	476.320	476.770	Edappallikotta
19	476.770	478.600	Panmana
20	479.830	480.400	Sankaramangalam
21	480.400	480.770	Thattassery
22	480.770	483.080	Chavara
23	483.080	484.600	Puthenthura
24	484.600	485.190	Parimanam
25	485.400	485.650	Vettuthara Mukku
26	485.750	487.100	Neendakara
27	487.540	488.1090	Sakthikulangara
Kollam Bypass			

### 6.2.14 Demographic Pattern

The project road passes through three districts viz. Alappuzha, Kollam. As per Census of India 2011, the population details of the project districts are given in **Table 6.10**.

**Table 6.10: District Wise Population**

Districts/ State	Population		
	Total	Male	Female
Alappuzha	2,127,789	1,013,142	1,114,647
Kollam	2,635,375	1,246,968	1,388,407
Thiruvananthapuram	3,301,427	1,581,678	1,719,749

Districts/ State	Population		
	Total	Male	Female
<b>Kerala State</b>	<b>33,406,061</b>	<b>16,027,412</b>	<b>17,378,649</b>

Source: Census of India, 2011

The detailed socio- economic data is presented separately in subsequent chapter.

### 6.3 Environmental Screening

The environmental expert conducted the environmental screening to identify the hot spots along the project road. Special care will be needed for the sensitive stretches during designing and construction phase as well. Formulation of specific mitigation measures has to be done for adverse impacts in those sections during the detailed environmental assessment study.

The project road was subjected to screening considering the following identified *Valued Environment Components (VECs)*:

**Table 6.11: Findings of Environmental Screening**

S. No.	Valued Environment Components (VECs)	Along Project Road
<b>A</b>	<b>Physical environment</b>	
a)	Land use	Predominantly built up
b)	Wetlands, Rivers, Rivulets and other Surface water bodies	Wetland : Ashtamudi Lake Crosses various surface water bodies including rivers, canals, backwaters, lakes, nallah etc. The details of water bodies crossing the project road are listed in Table 9.3.
c)	Soil erosion	Mainly at river bank during monsoon
d)	Natural hazards such as Cyclone	Less prone to cyclone
e)	Air/Water/Noise pollution	Relatively clean environment. Pollution levels may be low.
<b>B</b>	<b>Bio-Environment</b>	
a)	Number of trees	Approximately 2423
b)	Coastal Regulation Zone	The project road is passing through CRZ at 13 locations as submitted in CRZ status report prepared by Centre for Earth Science Studies (CESS) (Reported in EIA report prepared by ICT). MOEF&CC has accorded CRZ clearance for improvement of project road vide letter dated 13.10.2014 and for Alappuzha and Kollam vide letter dated 30.12.2013. Strict compliance of specific and general conditions of Clearance letter is to be ensured during construction stage.
c)	Wildlife/nesting places/migratory routes and other habitats	Nil
d)	Ecologically sensitive areas	Project Road does not pass through or fall within 10 Km of any ecologically notified eco-sensitive zone or
e)	Biosphere Reserve, National Parks and Wildlife Sanctuaries	Project Road does not pass through or fall within 10 Km of any Biosphere Reserve, National Parks and Wildlife Sanctuaries
f)	Protected Forests and	The project road does not pass through any protected or

S. No.	Valued Environment Components (VECs)	Along Project Road
	Reserved Forests	reserved forest
g)	Unprotected and Community Forests	NA
<b>C</b>	<b>Socio-Economic Environment</b>	
a)	Drinking water sources	Mainly through government water supply
b)	Schools/hospitals/college (declared silence zones)	A number of educational institutes are located along the project corridor. The locations of these institutes have been indicated in Table 9.5.
c)	Cultural and Religious properties	A number of religious structures are located along the project corridor. These structures are socially critical issue and hence make the section containing them as high sensitive impact zones. The locations of these structures have been indicated in Table 9.6.
d)	Archaeological monuments and properties	No archeological site listed under Archeological Survey of India, has been identified in close vicinity of the project road. However, Krishnapuram Palace (Historical site) is located approx. 2 km on the right hand side of the existing road at Kayamkulam.
e)	Medical Facilities	Few medical facilities are located along the project corridor. These structures are socially critical issue. The locations of these facilities have been indicated in Table 9.7.
f)	Common Property Resources	A number of CPRs are located along the project corridor. The locations of these structures have been indicated in Table 9.8
g)	Settlement /built up	27 villages/towns along the project road. Chainage wise list provided in Table 9.9.
h)	Tourism locations	Important tourist places falling in the project area: i) Mullackal Rajarajeswari Temple ii) Mannarsala Sree Nagaraja Temple iii) Latin Catholic Church iv) ST. Andrews Forane Church at Arthunkal v) Kottamkulangara Mahavishnu and Devi temple vi) Kollam Beach vii) Krishnapuram Palace viii) Kollam backwaters & Beach famous for Boat Race

All the sensitive road stretches shall be carefully analyzed during Environmental Impact Assessment study and accordingly safeguard measures will be provided in Environmental Management Plan.

## 6.4 Clearances and Permissions Required

### 6.4.1 Environmental Clearance

The Environment Impact Assessment (EIA) Notification 2006, Ministry of Environment, Forests & Climate Change, Government of India, came into effect from 14<sup>th</sup> September 2006. The EIA Notification, 2006 specifies the requirement of prior clearance from MOEF & CC for certain development projects specified under the schedule of the Notification. The projects and activities under the Notification have been classified into two categories- Category A and Category B, based on the spatial extent of potential impacts on human health, natural and man-made resources. As per



Schedule of the Notification, the Highway project has been classified under Physical Infrastructure including Environmental Services and is listed under item no. 7(f), including new highways or expansion of existing highways. The categorisation related to highway projects are as follows:

*Category A:* New National Highways and Expansion of National Highways greater than 100 Km involving additional right of way or land acquisition greater than 40 m on existing alignments and 60 m on re-alignments or by-passes.

*Category B:* All new State Highway projects and State Highway expansion projects in hilly terrain (above 1000 m AMSL) and or ecologically sensitive areas.

Moreover, any project or activity specified in Category B will be treated as Category A if located in whole or in part with in 5 km from the boundary of:

- i) Protected areas notified under the Wild Life (Protection) Act, 1972,
- ii) Critically Polluted areas as notified by Central Pollution Control Board from time to time,
- iii) Eco sensitive areas as notified under section 3 of Environment Protection Act, 1986 such as Mahabaleshwar, Panchangi, Matheran, Pachmarhi, Dahanu, Doon Valley and
- iv) Inter State boundaries and international boundaries.

Provided that the requirement regarding distance of 5 km of the inter-state boundaries can be reduced or completely done away with by an agreement between the respective States or U.Ts sharing the common boundary in the case the activity does not fall within 5 kilometres of the areas mentioned at item (i), (ii) and (iii) above.

***The proposed project does not attract conditions of obtaining prior Environmental Clearance from Ministry of Environment, Forests & Climate Change (MOEF & CC) as additional land required along existing alignment is less than 40m and in bypasses its less than 60m.***

#### **6.4.2 Forest Clearance**

As the project road does not pass through any protected or reserved forest, forest clearance is not required.

#### **6.4.3 Roadside Tree Felling Permission**

Road side tree felling permission is to be obtained from Department of Forest, Kerala before the commencement of construction.

#### **6.4.4 CRZ Clearance**

As mentioned in **section 6.2.8 e**, the required CRZ clearance has been applied for the project.

#### **6.4.5 Clearances/Permission to be obtained by Contractor**

Following clearances/permissions are to be obtained by the Contractor for the project before commencing the construction work:

**Table 6.12: Clearances/Permissions to be obtained by Contractor**

S. No.	Type of Clearance / Permission	Statutory Authority	Applicability	Project stage
1.	Consent to Establish under the Air (Prevention & Control of Pollution) Act, 1981 and the Water (Prevention & Control of Pollution) Act, 1974	KSPCB	For establishment of construction camp, construction plant, crusher, batching plant etc.	Pre-construction
2.	Consent to Operate under the Air (Prevention & Control of Pollution) Act, 1981 and the Water (Prevention & Control of Pollution) Act, 1974	KSPCB	For operating construction plant, crusher, batching plant etc.	Construction stage (Prior to initiation of any work)
3.	Permission to withdraw water for construction from surface water sources such as Rivers/Ponds	Kerala Irrigation Department	Use of surface water for construction	Construction stage (Prior to initiation of any work)
4.	Permission to withdraw ground water for construction from new sources	State and Central Ground Water Boards	Extraction of ground water	Construction stage (Prior to initiation of any work)
5.	Permission for storage, handling and transport of hazardous materials	KSPCB	Manufacture storage and Import of Hazardous Chemical	Construction stage (Prior to initiation of any work)
6.	Explosive License	Chief Controller of Explosives,	For storing fuel oil, lubricants, diesel etc. at construction camp	Construction stage (Prior to initiation of any work)
7.	Quarry Lease Deed and Quarry License from State Department of Mines and Geology	Dept. of Mining; Concerned District Administration; SEIAA; KSPCB	Quarry operation (for new quarry) Environmental Clearance from SEIAA and CTE/CTO from TNPCB.	Construction stage (Prior to initiation of any work)
8.	PUC for vehicles for construction under Central Motor and Vehicle Act 1988	Motor Vehicle Department of Kerala State	For all construction vehicles	Construction stage (Prior to initiation of any work)
9.	Labour license	Labour commissioner office	Engagement of Labour	Construction stage (Prior to initiation of any work)

## 6.5 Potential Environmental Impacts

After studying the existing baseline environmental scenario, initial field surveys, reviewing the process and related statutory norms, an attempt has been made to identify the probable impacts on different environmental parameters due to planning, construction and the operation of the proposed road improvement.

Road construction related impacts occur at three stages of the project:

- i) Design and Pre-construction
- ii) Construction
- iii) Operation

Matrix of potential environmental impacts due to the project and preliminary mitigation measures has been developed and is presented in **Table 6.13**.

**Table 6.13: Matrix of Potential Environmental Impacts due to the project and Preliminary mitigation measures**

Environmental Components	Impacts	Direct/ Indirect	Significance (High/ Medium/Low)	Duration of Impacts (Long/ Short)	Mitigation
<b>Design &amp; Preconstruction</b>					
Land	Land Acquisition	D	H	L	<ul style="list-style-type: none"> <li>The alignment finalization should be in such manner to minimize the acquisition of land. As far as possible the productive land area should be avoided to acquire.</li> </ul>
Trees	Tree cutting	D	H	L	<ul style="list-style-type: none"> <li>Cut only those trees affected by permanent works</li> <li>Compensatory plantation</li> </ul>
Socio-Economic	Problem of Resettlement and Rehabilitation	D	H	L	<ul style="list-style-type: none"> <li>Adjustment in alignment to avoid displacement</li> <li>Early identification and entitlement of the project affected people</li> <li>Early planning of rehabilitation and resettlement</li> </ul>
	Impact on public utilities , cultural sites	D	H	L	<ul style="list-style-type: none"> <li>Utility shifting as per R&amp;R Plan</li> <li>Alignment to be finalized considering minimum damage to the cultural properties</li> </ul>
<b>Construction</b>					
<b>Physical Resources</b>					
Soil	Loss of top soil due to site clearance and excavation	D	H	L	<ul style="list-style-type: none"> <li>Top soil should be removed &amp; stored separately during excavation.</li> <li>Re-vegetate the disturbed slope as early as possible</li> </ul>
	Soil compaction due to storage of quarry materials and other heavy equipment, movement of heavy vehicles at the site	D	H	L	<ul style="list-style-type: none"> <li>Regulation of movement and parking of vehicles and equipment outside ROW. Storage of materials should be allowed only at wasteland or barren area.</li> </ul>
Air Quality	Reduced buffering of air pollutants, hotter, drier microclimate due to tree felling and vegetation loss during site clearance	I	L	L	<ul style="list-style-type: none"> <li>Tree plantation</li> </ul>
	Localized increase in pollutants due to increase in number of construction vehicles and equipment	D	L	S	<ul style="list-style-type: none"> <li>Vehicles should be maintained such that exhaust emissions are minimum</li> </ul>

Environmental Components	Impacts	Direct/ Indirect	Significance (High/ Medium/Low)	Duration of Impacts (Long/ Short)	Mitigation
	Dust generation due to earth excavation, transportation & heavy vehicles maintenance or operation, Construction of structures and earth works, asphalt & crusher plants	I	L	S	<ul style="list-style-type: none"> <li>Vehicles delivering materials should be covered</li> <li>Regular water sprinkling over exposed surfaces</li> </ul>
	Toxic gas emission during asphalt preparation, bituminous heating	D	M	S	<ul style="list-style-type: none"> <li>The asphalt mixing plant should be located in conformity with the statutory requirements</li> <li>Consent to Establish and Consent to Operate from SPCB should be obtained prior to operation of plant</li> </ul>
Noise Quality	Increased noise level due to excavators/ machinery etc., operation and maintenance of heavy vehicles and equipment's, Asphalt preparation and crushing	D	M	S	<ul style="list-style-type: none"> <li>Noise standards of industrial enterprises shall be strictly enforced. Proper scheduling of the operation of equipment.</li> <li>The stationary noise generating equipment should be installed sufficiently away from habitation area.</li> </ul>
Surface Water	Additional pressure on water demand due to the water requirement for construction works	D	M	S	<ul style="list-style-type: none"> <li>Alternative water supply system for construction should be ensured in such a way to prevent the additional pressure on public water supply system</li> </ul>
	Blockage of water flow channels due to unmanaged excavation and earth filling	D	M	S	<ul style="list-style-type: none"> <li>Proper excavation and disposal of the extra fill material away from stream</li> <li>Provision of cross drainage during construction along the water bodies</li> </ul>
	Contamination of water due to spillage, construction wastes	I	M	L	<ul style="list-style-type: none"> <li>Strict regulation of traffic flow, waste disposals, bunding around fuel storage site, proper disposal system at equipment and vehicle service stations</li> </ul>
	Impairment of surface water bodies, new water bodies due to Quarries/ borrow pits	I	H	L	<ul style="list-style-type: none"> <li>Controlled quarrying and borrowing</li> </ul>
Ground water	Ground water exploitation for construction works and workforce camp	I	L	S	<ul style="list-style-type: none"> <li>Regulation of ground water extraction</li> <li>Surface water should be used for construction</li> </ul>

Environmental Components	Impacts	Direct/ Indirect	Significance (High/ Medium/Low)	Duration of Impacts (Long/ Short)	Mitigation
Drainage Pattern	Interference with natural drainage flow due to earth excavation dumping, disposal of wastes and surplus earth materials, and construction of structures and earthworks	D	M	S	<ul style="list-style-type: none"> <li>Regulation of dumping of waste materials and proper care should be taken at the site of construction to minimize the wastage. Clean fill material devoid of soil particles to prevent siltation and deposition on the way of natural drainage</li> </ul>
<b>Ecological Resources</b>					
Vegetation	Fire risks during vegetation clearance and asphalt preparation	I	H	L	<ul style="list-style-type: none"> <li>Kerosene or gas cylinders should be supplied to campsite to avoid use of firewood</li> <li>Prohibition of clearing of trees for firewood</li> </ul>
Wild Fauna	Ashtamudi Estuary, a conservation site in the project corridor - Disturbance or hunting of fauna	I	H	S	<ul style="list-style-type: none"> <li>construction camps to be located away from the estuary</li> <li>Control workforce, awareness programme for the workforce, strict enforcement of Wildlife protection Act,</li> <li>Prohibition of hunting of animals</li> </ul>
Aquatic fauna	Adverse impact due to increased turbidity and alkalinity	I	H	S	<ul style="list-style-type: none"> <li>Sediment flow will be kept at minimum level through a mix of management measures during construction near water bodies or construction of bridges</li> <li>Prohibition of unauthorized fishing</li> </ul>
<b>Social Environment</b>					
Livelihood	Economic losses as a result of property loss due to land take for widening	D	M	L	<ul style="list-style-type: none"> <li>The widening should be done in a way to minimize the land acquisition</li> </ul>
Employment	Employment on road construction, and resultant flow	D	H	S	<ul style="list-style-type: none"> <li>Encourage local recruitment</li> </ul>
Religious / Cultural feature	Impact on religious/ cultural structure	D	H	L	<ul style="list-style-type: none"> <li>Shifting and restoration of structures through public consultation</li> </ul>
Health	Health problems to the local people settled near the construction sites because of toxic gaseous emissions due to asphalt preparation and crushing Asphalt odour and dust due to asphalt and crusher plant and laying of pavement	D	M	S	<ul style="list-style-type: none"> <li>Appropriate siting of plant establishment</li> <li>Strict adherence to the emission standards laid by the Central Pollution Control Board, regular monitoring of emissions.</li> <li>Provision of emergency medical facility</li> </ul>
		D	M	S	

Environmental Components	Impacts	Direct/ Indirect	Significance (High/ Medium/Low)	Duration of Impacts (Long/ Short)	Mitigation
	Insanitation condition at Campsite	D	H	S	<ul style="list-style-type: none"> <li>Suitable medical facilities for workers</li> <li>First Aid facilities at camp/ construction site</li> </ul>
Safety at Work site	Accidents at work and on the road	D/I	M/H	S	<ul style="list-style-type: none"> <li>Safe working techniques; safety clothing; proper training to workers and drivers</li> </ul>
<b>Operational Phase</b>					
Air Quality	Deterioration of air quality due to stimulation of traffic flow, intense human activity, congestion	D	L	L	<ul style="list-style-type: none"> <li>Providing lateral buffer zones in design, regular regulation of air pollution by legislation and public awareness</li> <li>Regulate development activities along the corridor</li> </ul>
Noise	Noise generation due to increased traffic flow and congestion	D	L	L	<ul style="list-style-type: none"> <li>Noise level for different automobiles has been prescribed in Environment (Protection) Rules, 1986</li> <li>Signs will be posted to restrict blowing of horns in front of sensitive locations</li> <li>With the establishment of strip plantations along the project corridor the noise level will get attenuated</li> </ul>
Surface runoff	Deterioration of surface water quality due to surface run off	D	M	L	<ul style="list-style-type: none"> <li>Surface runoff from the road will not be disposed directly in the water bodies used by people for bathing etc. This will also not be disposed directly in to any watercourse with good water quality.</li> </ul>

## **6.6 Project Benefits**

The proposed widening of NH47 shall provide various benefits to the region and people. It will enhance economic development, provide employment opportunities to locals, strengthen tourist development, ensure road safety, provide better transportation facilities and other facilities such as way side amenities. Vehicle operating cost will also be reduced due to improved road quality. The proposed road widening project will ensure the smooth flow of traffic, which will reduce the emissions and noise level. The compensatory plantation and road side plantation done will further improve the air quality of the region.

## **6.7 Environmental Budget**

The lump sum budgetary cost estimated for environmental management activities refer Volume IV of DPR.



## CHAPTER 7 INITIAL SOCIAL ASSESSMENT & PRELIMINARY LAND ACQUISITION & RESETTLEMENT PLAN

---

### 7.1. Introduction

The National Highways Authority of India (NHAI) has been entrusted with the assignment of preparation of Detailed Project Report for 6 laning of Chertalai to Thiruvananthapuram Section of NH-47 (new NH-66) (from km 379.100 to km 551.900 under NHDP Phase III in the State of Kerala. The project stretch of NH 47 begins at Thuravoor Junction near Cherthala Town and ends at Kazhakottam Junction near Thiruvananthapuram totaling a length of 172.8 km in Kerala State. The project stretch includes two bypasses at Alappuzha and Kollam and a new realigned stretch bypassing Attingal Town.

M/s SMEC International Pvt. Ltd. in association with SMEC (India) Pvt. Ltd, 387, Udyog Vihar Phase II, Gurgaon 122016, Haryana, India have been appointed as Consultants to carry out the Feasibility Study and Detailed Project Report (DPR) for 4/6 laning of the section from Chertalai (km. 379.10) of NH-47 to Kazhakottam (km 551.90) of NH-47 in the State of Kerala.

The Initial social assessment and preliminary land acquisition/resettlement plan is being taken up as per the Terms of Reference (ToR) of the consultants, World Bank and ADB guidelines and as per requirements of laws at State and National level for social impact assessment, land acquisition and preparation of Resettlement Action Plan (RAP). As part of feasibility social impact assessment is being taken up to identify social issues due to widening. The Resettlement Action Plan (RAP) will be prepared for finalised alignment and as per LA Report.

The current volume covers Initial social assessment and preliminary land acquisition/resettlement report.

The objective of the social screening is to identify the probable adverse impacts due to the proposed road improvement works and ensuing land acquisition on the affected persons/families. Based on these assessments a Resettlement Action Plan is to be prepared meeting requirements of various guidelines and relevant Acts of Government of India and other funding agencies like the World Bank, the Asian Development Bank, etc.

The initial social screening has been carried out by the consultants through detailed reconnaissance of the project area, review of secondary information and preliminary consultation with various stakeholders. The following are the major findings:

- The existing ROW lies from 24 meters to 30 meters.
- Structures and common property resources that are likely to be affected on both sides of the road.
- Subsequent to preparation of the Land Plan Schedule (LPS), and detailed designs consultants will conduct Census and socio-economic surveys of Project Affected Persons/Families likely to be affected due to the project. A broad entitlement framework and entitlement matrix has been prepared to mitigate the adverse social impacts due to the project improvement proposals.
- Preliminary consultations were held to know the views of public on widening, realignments and proposed bypasses, local issues relating to road safety, vulnerable road users etc. In future, consultations are planned at strategic locations that will be taken up during the next stage of the social impact assessment study. The follow up consultations will be taken up after completion of design.

## 7.2. Project Road

The project road length is 31.50 km. It is from km 454.50 to km 486.00 of NH-47 Kottankulangara to Start of Kollam bypass. This stretch of road passes through Alappuzha & Kollam district. The road passes through urban areas viz. Krishnapuram, Oachira, K.S puram , Karunagapalli

Generally the existing road is two laned with paved shoulders on either side. At most of the urban locations in the presence of Major Junction, carriageway has been upgraded to 4 lane divided carriageway configuration including the junction with approaches and also along the existing town section.

A list of the settlements along the project road is shown in table 7.1.

**Table 7.1: Settlements along the Existing Road**

Sl. No.	Name of the Settlements	Existing Chainage (km)
1	Kayamkulam	453.475 – 459.775
2	Krishnapuram	459.775 – 460.775
3	Oachira	460.775 – 465.225
4	Kulasekharapuram	465.225 – 466.950
5	Adinadu	466.950 – 468.150
6	Karunagapally	468.150 – 471.025
7	Ayanivelikulangara	471.025 – 472.025
8	Vadakkumthala	472.025 – 475.750
9	Panmana	475.750 – 477.800
10	Chavara	477.800 – 480.275
11	Neendakara	480.275 – 484.975
12	Shakthikulangara	484.975 – 486.750

Source: The Consultants' Primary Survey

## 7.3. The Project Area

### 7.3.1 Project Location

It is from km 454.50 to km 486.00 of NH-47 Kottankulangara to Start of Kollam bypass. This stretch of road passes through Alappuzha & Kollam district. The road passes through urban areas viz. Krishnapuram, Oachira, K.S puram, Karunagapalli

### 7.3.2 Socio-economic Environment

The state of Kerala extends over an area of 38863 sq. km. According to 2011 census, the population of Kerala is 33,387,677 with a density of 859 persons per sq. km. Kerala is the thirteenth-largest state by population and is divided into 14 districts with the capital being Thiruvananthapuram. Malayalam is the most widely spoken language and is also the official language of the state. Kerala has the lowest positive population growth rate in India, 3.44%; highest Human Development Index (HDI), 0.790 in 2011; the highest literacy rate, 93.91% in the 2011 census. The highest life expectancy, 77 years; and the highest sex ratio, 1,084 women per 1000 men. The state has witnessed significant emigration, especially to Arab states of the Persian Gulf during the Gulf Boom of the 1970s and early 1980s, and its economy depends significantly on remittances from a large Malayali expatriate community. Hinduism is practised by more than half of the population, followed

by Islam and Christianity.

### 7.3.3 Demographic Structure of project Districts

The study area spreads over three districts of Kerala namely Alappuzha, Kollam and Thiruvananthapuram. Baseline data regarding socio-economic profile with reference to demographic structure such as population have been collected using secondary sources viz. Primary Census Abstract of Kerala (2011). District wise population details are given in **Table 7.2**.

**Table 7.2: District wise Population Details of Project Districts**

Attributes	Alappuzha	Kollam	Thiruvananthapuram
Total	2121943	2629703	3307284
Male	1010252	1244815	1584200
Female	1111691	1384888	1723084

The significant demographic features are:

- The total area of the three project districts is 6097 sq.km.
- The total population of the project influence area in the 3 districts is 4243886 with density of 2058 persons per sq. km.
- Sex ratio (no. of females per thousand Males) of project area is 1000 males as against state average of 1084 females per thousand males.
- The literacy rate in the study area is 91.29 % which is low compare to state level statistics (94.0%).Female literacy rate (92.07%) is significantly lower than the male literacy rate that stands at 96.11%.

### 7.3.4 Proposed Improvements

#### Right-of-Way

The consultant has collected the existing right of way (EROW) information from the Topographic Survey and form National Highways Divisions of Allapuzha, Kollam and Thiruvananthapuram Districts. The EROW is nearly from 24 to 31 meters in Thuravor to Kazhakottam section and in Bypasses of Alappuzha and Kollam the EROW is 45 m (already acquired by state authorities) and construction work is already in progress.

#### Proposed improvements and Lane Configuration

Based on the traffic demand forecast and considering a Level of Service (LoS) “B” as the desired LoS, as recommended by IRC. It is apparent that the existing 2-lane roadway needs to be widened from 2 lane to 6 lane with paved shoulder consisting of various curve improvements, realignments, bus bays, truck lay byes and bypasses at the project road. The improvement proposal envisages widening of the existing road to 6 lane carriageway.

#### Bypasses in the Project Road

No bypass is proposed in this package 3.

## 7.4. Legal Framework

Land for the project will be acquired under the provisions of the National Highways Act 1956 and its subsequent amendments.

The Resettlement and Rehabilitation policy is based on the basic principle that the project affected persons should improve or at least maintain their living standards in the post resettlement period and share the benefits of the project. The Resettlement Action Plan (RAP) will be prepared as per the provisions complying with Government of India relevant Policies and Acts and Policies of International Funding Agencies like the World Bank (OP 4.12) and Asian Development Bank (SPS 2009).

Relevant in this context is to mention that the guiding principle for the land acquisition and Resettlement & Rehabilitation will take into account the provisions under the National Resettlement and Rehabilitation Policy, 2007 (NRRP) and the “The Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013” (RFCT-LARR) by Government of India.

## **7.5. Methodology**

Both primary and secondary methods were adopted for conducting the screening exercise for preparation of this report. Various stages at which the screening was conducted are as follows:

### **i) Reconnaissance**

A reconnaissance of the entire stretch was undertaken together with engineering and environmental teams. The purpose of the reconnaissance was to have an overview of the likely extent of impact on people because of the impending development work of the proposed project.

### **ii) Review of Secondary Sources**

Secondary sources such as District Gazetteer and Census of India, 2011 publications viz. District Census Handbook; household tables etc. of the project districts were reviewed to understand the physical, social, economic and cultural setup in the project area before undertaking actual field work.

### **iii) Identification of Structures Likely to be Affected**

The topographical survey map was also utilised to identify each structure on the ground. Structures falling within the proposed development corridor were identified in the site of preliminary basis. As already mentioned in earlier sections, the existing ROW is nearly about 30 meters and remaining land of 45 meters is to be acquired to accommodate the proposed developments. Bypasses and realignments have been proposed to avoid the congested habitation areas where land acquisition will be required.

### **iv) Census and Socio-Economic Survey**

Subsequent to preparation of the Land Plan Schedule (LPS), consultants will conduct Census and socio-economic surveys of Project Affected Persons/Families likely to be affected due to the project. A format of Social and Census Survey is proposed to be used to record the relevant information from all categories of property holder. Data will be collected at household level that will include family details, social category, religion, economic status, occupation, and education etc. along with details of any structure that may be affected including type of structure, present use of structure and dimension of the structure.

## **7.6. Land Acquisition**

It is evident from the screening and secondary records obtained from the Roads and Building Department, National Highways Divisions and Govt. of Kerala that the available ROW is not sufficient to accommodate the proposed improvements except for the proposed bypasses and realignments also in Alappuzha, Kollam section. In Alappuzha and Kollam section 45 meters ROW is already planned/ designed but in Attingal Realignment a new acquisition is needed. For accommodating 6 laning ROW of 45 m is planned. Land acquisition will be required at these proposed locations that will be carried out as per the provisions of the National Highways Act, 1956 and further amendments.

As per the policy for Roads and Building Department, land acquisition for ROW of the realignment and bypasses will be 45 m. In balance portion where the existing ROW is 30 meters an extra 15 meters is to be acquired for improvement process of NH-47 on the basis of 6 laning.

The details of ownership, effect on any structure on the acquired land etc. will be assessed subsequent to the preparation of the detailed LPS.

## 7.7. Resettlement Action Plan

Resettlement Action Plan will be prepared in accordance with the magnitude of impact detailing the project components involving land acquisition and involuntary resettlement, extent of impact, socio-economic profile of Affected Persons, efforts made to minimise involuntary resettlement, mitigation measures in accordance with approved resettlement framework, budget estimate, work plan, implementation arrangement, grievance redressal mechanism, and monitoring and evaluation..

## 7.8. Broad Entitlement Framework

A summary entitlement framework for the project is provided below:

Rehabilitation and Resettlement : Broad Entitlement Framework					
Impacts and assistance criteria		Land acquisition		Inside Right-of-Way	
Sl. No.		Vulnerable	Non-Vulnerable	Vulnerable	Non-Vulnerable
<b>A. Corridor of Impact : Loss of land and other assets Support given to families and households</b>					
1	Consultation, counselling regarding alternatives and assistance in identifying new sites and opportunities.	√	√	√	√
<b>Sl. No.</b>		<b>Vulnerable</b>	<b>Non-Vulnerable</b>	<b>Vulnerable</b>	<b>Non-Vulnerable</b>
2	Compensation for land at replacement cost, plus allowances for fees or other charges.	√	√		
3	Advance notice to harvest non-perennial crops, or compensation for lost standing crops.	√	√	√	√
4	Compensation for perennial crops and trees, calculated as annual produce value for one season	√	√		
5	Compensation or R&R assistance for structures or other non-land assets.	√	√	√	
6	Right to salvage materials from existing structures.	√	√	√	√
7	Shifting assistance.	√	√	√	
8	Option of moving to resettlement sites (in a group of minimum 25 families) incorporating needs for civic amenities.	√	√	√	
<b>B. Corridor of Impact : Lost or diminished livelihood Support given to adult individuals</b>					

Rehabilitation and Resettlement : Broad Entitlement Framework					
Impacts and assistance criteria		Land acquisition		Inside Right-of-Way	
Sl. No.		Vulnerable	Non-Vulnerable	Vulnerable	Non-Vulnerable
9	Rehabilitation and assistance for lost or diminished livelihood.	√	√	√	
10	Additional support mechanisms for vulnerable groups in re-establishing or enhancing livelihood.	√		√	
11	Employment opportunities in connection with project, to the extent possible.	√		√	
12	Any other impacts not yet identified, whether loss of assets or livelihood.	Unforeseen impacts shall be documented and mitigated based on the principles agreed upon in this policy framework.			
<b>C. Indirect, group oriented impacts in the vicinity of the road corridor</b>					
Group oriented support will be given to mitigate negative impacts on the community and to enhance development opportunities. Addressing traffic safety needs of pedestrians will target particular support at more vulnerable groups.					

## 7.9. Preliminary Stakeholder Consultation

Stakeholder consultation is one of the integral issues of the road project. Stakeholder consultation is a two way process which involves the interaction of various stakeholders and the project proponent. It is highly desirable for all key stakeholders arrive at a consensus on sensitive features, issues, impacts and remedial actions. It is useful for gathering and making them understand the project alternatives and mitigation and enhancement measures and last but not the least the compensation packages arrived for the affected population. The preliminary consultations were held with the population residing along the project road. The consultations were to know the views of public on widening, realignments and proposed bypasses, local issues relating to road safety, vulnerable road users etc. The stakeholders identified are potential PAFs, Field offices of the Roads and Building Department of Government of Kerala and local community based organisations/NGOs.

In future, consultations are planned at strategic locations along with social team, at district and state levels. These will be taken up during the next stage of the social impact assessment study. The follow up consultations will be taken up after completion of design.

The preliminary consultations with the stakeholders were used to improve the plan of design of the project road.

## 7.10. Conclusion

The initial social screening has been carried out by the consultants through detailed reconnaissance of the project area, review of secondary information and preliminary consultation with various stakeholders. The following are the major findings:

- The existing ROW is not adequate for the proposed project improvement works and additional ROW is needed in total stretch.

- **It is understood that owing to various engineering proposals viz. Bus Bays, Toll Plaza, Major Intersections & at Certain Bridge locations, Additional ROW apart from the 45m regular PROW requirements need to be acquired in order to accommodate the proposed improvement options.**
- Subsequent to preparation of the Land Plan Schedule (LPS) and detailed designs, Consultants will conduct Census and Socio-economic Surveys of Project Affected Persons/Families likely to be affected due to the project. A broad entitlement framework and entitlement matrix would be prepared to mitigate the adverse social impacts due to the project improvement proposals prior to Socio-economic Surveys of Project Affected Persons.
- Preliminary consultations were held to know the views of public on widening, realignments and proposed bypasses, local issues relating to road safety, vulnerable road users etc. In future, consultations are planned at strategic locations that will be taken up during the next stage of the social impact assessment study. The follow up consultations will be taken up after completion of design.

**Annexure - 1**

Form No.

**Social Impact Assessment Survey  
(Census & Socio-economic Data)**

Name of the Enumerator: \_\_\_\_\_

Field Supervisor: \_\_\_\_\_ Structure No.: \_\_\_\_\_

<b>1.0</b>	<b>GENERAL IDENTIFICATION:</b>		
1.1	Road section (Name):	1.6	Side: 1 - Left      2 - Right
1.2	District:	1.7	Chainage: From Kms. _____ to Kms. _____
1.3	Block:		
1.4	Village/Town:		
1.5	Location: (1-Rural, 2-Semi-urban, 3-Town)		

**2.0 HOUSEHOLD IDENTIFICATION:**

2.1 Name of the head of the Household: \_\_\_\_\_

2.2 Name of the Respondent: \_\_\_\_\_

2.3 Relationship of the respondent with the head of the household:

<b>3.0</b>	<b>DETAILS OF AFFECTED STRUCTURE:</b>				
Sl. No.	Type of Loss*	Typology of Structure 1.Katcha 2.Semi Pucca 3.Pucca			Present use 1 - In use, 2 - Not use
1	Residential	7	Toilets	13	Well/Tubewell
2	Commercial (Shop)	8	Bus Stand	14	Hand Pump
3	Resi.-Cum-Comm.	9	Govt. Building (Specify)	15	Kiosks (Mudakara)
4	Factory	10	Cattle Shed	16	Orchard
5	Petrol Pump	11	Pvt. Hospital	17	Agricultural Land



6	Religious Structure	12	Boundary Wall	18	Others (Specify)
3.1	Measurement of the structure				
	a) Touching Point from Center of the Road _____ (in mtrs.)				
	b) Along the Road _____ (in mtrs.)				
	c) Perpendicular to the Road _____ (in mtrs.)				
3.2	Topology of Construction				
	(a) Roof	(b) Floor	(c) Wall	(d) Boundary wall	
	1. RCC/RBC	1. Mud	1. Mud	1. Barbed fencing	
	2. Tin/Zinc sheets	2. Stone	2. Brick Masonry	2. Stone Masonry	
	3. Stone masonry	3. Concrete	3. Stone Masonry	3. Brick Masonry	
	4. Thatched	4. Others (specify)	4. Others	4. Stone/Bricks	
				5. Mud	
3.3	Number of storey: _____				
3.3	Do you have legal rights of this affected structure?			1 - Yes	2 - No
3.4	Is there any tenant in this affected structure?			1 - Yes	2 - No
3.5	If 'Yes' number of tenants: _____				
3.6	What is the market values of this affected structure as on today? _____				
3.7	How much house tax you are paying? _____				

#### 4.0 SOCIO-ECONOMIC PROFILE OF HOUSEHOLD

##### 4.1 Religious Group:

1. Hindu      2. Muslim      3. Sikh  
 4. Christian      5. Jain      6. Others \_\_\_\_\_  
 (specify)

##### 4.2 Social Stratification:

1. SC      2. ST      3. OBC      4. General      5. Others (specify): \_\_\_\_\_

##### 4.3 Name of Caste:

\_\_\_\_\_

##### 4.4 Type of family:

1. Nuclear      2. Joint      3. Extended

#### 5.0 RESETTLEMENT AND REHABILITATION OPTION

##### 5.1 What is your opinion about resettlement and rehabilitation option:

In case of Structure Loss		In case of Agricultural Land Loss	
1.	Constructed structure	1.	Land for land
2.	Land for structure	2.	Cash compensation
3.	Cash compensation	3.	Assistance for allied activities
4.	Employment	4.	Employment
5.	Others (specify) :	5.	Others (specify) :

#### 6.0 DETAILS OF BELOW POVERTY LEVEL (BPL):

- 6.1 Do you have a BPL card?      1. Yes      2. No

6.2 Do you have land? 1. Yes 2. No

a) If 'Yes', please give us details?

Land	Acre (,dj)	Kattha (dVk)
Irrigated		
Non-irrigated		
Barren		
Others		

6.3 Do you have Pucca house?

1. Yes 2. No

6.4 Details of household assets

a) Do you have following items in your house?		b) Do you have following Agriculture Implements?	
Items	1-Yes, 2-No	Items	1-Yes, 2-No
i) Television		i) Tractor	
ii) Refrigerator		ii) Power tiller	
iii) Ceiling fan		iii) Thresher	
iv) Motorcycle / Scooter		iv) Harvester	
v) Car/Jeep		v) Harvester-cum-Combiner	

**Signature of Investigator**

**Signature of Supervisor**

## CHAPTER 8 ECONOMIC AND FINANCIAL ANALYSIS

---

### 8.1. Economic Analysis

The appraisal has been carried out within the framework of ‘with’ and without’ the project situations. ‘Without’ the project situation is the one in which the projected traffic would continue to move on the existing two lane road which will require certain minimum routine and periodic maintenance for upkeep of the facility. In the case of ‘with’ project situation, the traffic would use the improved facility, which is two lane carriageways with paved shoulders facility.

The benefits due to improvements are the saving in vehicle operation cost, saving in time and other caused benefits. The cost of the project is subtracted from benefits accruing year wise and discounted to work out the Economic Internal Rate of Return. In the economic appraisal all the financial estimates of costs and benefits are converted to economic costs by applying necessary factors.

#### Sensitivity Analysis

Two critical factors could affect the viability of the project and these are the Capital Cost and traffic level. The capital cost can increase or the expected traffic growth could not materialize or both factors could occur simultaneously sensitivity check using the following parameters has been carried out:

- Sensitivity Option S1      Increase in base costs by 15%
- Sensitivity Option S2      Decrease in base benefits by 15%
- Sensitivity Option S3      Increase in base costs by 15% and decrease in base benefits by 15%

The economic analysis is carried out only for 11 years as the existing facility in no condition will be able to cater additional traffic. The project road and all packages found to be economically viable with EIRR more than the resource cost of capital @ 12%. In case of sensitivity too project is economically viable and beneficial to public.

#### 8.1.1. Methodology for Appraisal

The appraisal has been carried out within the framework of ‘with’ and without’ the project situations. ‘Without’ the project situation is the one in which the projected Traffic Would Continue to move on the existing two-lane road which will require certain minimum routine and periodic maintenance for upkeep of the facility. In the case of ‘with’ project situation, the traffic would use the improved facility, which is two lane carriageways with paved shoulders facility.

The benefits due to improvements are the saving in vehicle operation cost, saving in time and other caused benefits. The cost of the project is subtracted from benefits accruing year wise and discounted to work out the Economic Internal Rate of Return. In the economic appraisal, all the financial estimates of costs and benefits are converted to economic costs by applying necessary factors.

#### 8.1.2. Basic Input Data

Implementation of the project road improvements is conceived to be carried out in package 3 as follows.

**Table 8.1: Project Detail Package Wise**

Package	From (km)	To(km)	Length of package (km)	Tentative Civil Cost of Package (Rs. Cr)
Package-3	454.500	486.000	31.5	949.66

### 8.1.3. General Data

Physical characteristics data of each link pertains to altitude/rainfall, existing road geometry, pavement (structure, strength and condition) sub grade strength and construction/maintenance history and derived from field survey and investigations carried out for the project and presented in the earlier Chapter. The data reveals that the physical characteristics for entire project length are quite uniform and homogeneous.

### 8.1.4. Project Cost

Project costs based on engineering design have been worked out and given in earlier chapter. A conversion factor of 0.9 has been used to convert financial costs to economic costs. For economic evaluation, base costs have been taken as factor costs of civil works and other costs related to social, environmental and utility relocations. Link-wise economic and financial costs are given below:

**Table 8.2: Package – Wise Costing in Rupees in Crore/Km**

Package 3	Economic Cost	Financial Cost
	30.12	33.47

In addition to project cost routine and periodic maintenance cost has been worked out for the project road. The following table gives the maintenance cost of the project.

**Table 8.3: Maintenance Cost in Rupees (six lane/km)**

	Routine Maintenance		Periodic Maintenance	
	Economic	Financial	Economic	Financial
Package 3	269325	299250	39310223.2	43678025.8

### 8.1.5. Homogenous Section Based on Traffic

Following are the traffic numbers of different packages used for economic analyses.

**Table 8.4: Traffic Details**

Year	Location of survey	Car+Taxi	3-Wheeler	2-Wheeler	Bus & Mini Bus	2 Axle & 3 Axle Trucks	MAV	Tractor & Tractor With Trailer	Non Motorized Vehicle
2020	458.4	18282	2363	20986	1598	1615	352	3	397
2020	482.8	18767	2607	20927	2655	1752	297	6	257

## Existing Road Roughness and Geometry

Prevailing road conditions are provided in earlier part of feasibility report. Physical condition of project road used for economic analyses is derived from road condition survey and geometrical survey. Details of data used for economic analyses are provided in below table.

**Table 8.5: Package-Wise Present Road Condition**

	Package 3
End of Year	2016
IRI	2.66
Area of Cracking	10.3
Raveled Area	9.27
Number of Potholes	4.00
Edge Break Area m <sup>2</sup> /km	5.90
Mean Rut Depth	6.39
Texture Depth	0.70
Skid Resistance	0.50
Drainage	Poor

### 8.1.8. Economic Cost of Vehicle Parameters

Economic Costs of vehicle and tyre are derived from the market survey in Kerala. Representative retail price for each category of vehicle have been collected. Elements of taxes and duties applicable have been removed to arrive at the economic costs. The fuel costs considered are from Oct 2020. Details of derived economic costs for each vehicle category are presented in **Table 8.8**. Summary is given below:

**Table 8.6: Details of Vehicle Category (year 2020)**

Category	Two Wheeler	Three Wheeler	Car/taxi	Bus	LCV	2 Axle Truck	3 Axle Truck	Multi Axle Truck
Vehicle	60000	160000	430000	2033856	482500	1820000	2430000	3020000
Tyre	922	586	1100	5500	4100	5500	5500	5500

### Maintenance Labour and Crew Costs

Based on the market survey and inquiries from the various organisations in Kerala, the maintenance labour cost/hr and wages/hour has been evaluated. Rates have been compared with that adopted for the recent studies before arriving at reasonable values.

**Table 8.7: Maintenance Labour and Crew Costs Details**

Category	Two Wheeler	Three Wheeler	Car/taxi	Bus	LCV	2 Axle Truck	3 Axle Truck	Multi Axle Truck
Maint. Labour	75	75	75	75	75	75	75	75
Crew Wage	0	70	70	70	70	70	70	70

### Passenger Time-delay Costs

Value of travel time saving of passengers was first quantified in “Road User cost Study (RUCS)” carried out in India in 1982 on the basis of wage rate approach. The results so obtained were updated to 1990 values using wage index and subsequently validated by limited primary survey carried out on various secondary and trunk routes in the “Study for Updating Road User Cost Data”, 1992. Adopted time delay cost for the project in year 2017 is given below.

**Table 8.8: Maintenance Labour and Crew Costs Details**

	Eq. Work-	Eq. Non-work	Eq. Work-	Eq. Non-work
	Time Value in 2009	Time Value in 2009	*Time Value in 2020	*Time Value in 2020
Car/ Taxi	55.9	14.0	102.53	30.15
2 W/ 3W	28.0	8.0	52.49	15.44
Minibus	33.6	9.8	64.80	19.05
Bus	21.4	5.3	71.36	20.99
*Taking Consideration of WPI				

#### Interest

An economic interest rate of 12% has been adopted based on opportunity cost of capital.

#### 8.1.9. Sensitivity Analysis

Two critical factors could affect the viability of the project and these are the Capital Cost and traffic level. The capital cost can increase or the expected traffic growth could not materialise or both factors could occur simultaneously sensitivity check using the following parameters has been carried out:

- Sensitivity Option S1      Increase in base costs by 15%
- Sensitivity Option S2      Decrease in base benefits by 15%
- Sensitivity Option S3      Increase in base costs by 15% and decrease in base benefits by 15%

#### 8.1.10. Economic Analysis Results

The economic analysis is done for the period of 11 years as the existing two lane has reached to its ultimate capacity and no further increase can be entertained. Due to this limitation and HDM-4 not being able to further compare the alternatives the analysis is stopped at the end of 11 years. However, the results assure about the economic viability in all the sensitivity cases. Hence the project is economically viable. The EIRR and NPV (at 12%) for each link and section along with sensitivity analysis have been presented as follows.

**Table 8.9: Economic Analysis Summary**

S. No.	Package	Sensitivity	NPV (Million Rupees)	EIRR (%)	Viability
1	Package 3	Base Case	40463.95	51.4	Yes
2	Package 3	S 1	39361.77	45.6	Yes
3	Package 3	S 2	35829.96	38.8	Yes
4	Package 3	S 3	34727.78	34.6	Yes

### 8.1.11. Conclusions

All the packages found to be economically viable. In case of sensitivity too project is economically viable and beneficial to public.

## 8.2 Financial Analysis

### 8.2.1 Project Background

The National Highways Authority of India (the “Authority”) is engaged in the development of National Highways and as part of this endeavour, the Authority has decided to undertake development of following National Highway Project (the “Project”) through public-private/public sector partnership (PPP) to be executed on BOT (Annuity) Hybrid Basis, and has decided to carry out the bidding process for selection of the bidder[s] to whom the Project may be awarded.

**“Preparation of Detailed Project Report (DPR) study for 4 laning of Chertalai – Thiruvananthapuram Section of NH-47 (New NH-66) (from KM 379/100 to KM 551/900) [Package –III] under NHDP Phase III in the State of Kerala (Package 3 - Km 454.50 to Km 486.00)”**

### 8.2.2 Salient Features of Hybrid Model

Model Concession Agreement and RFPs on procurement with HAM mode are being issued by MoRTH along with circulars. They all become the basis for financial analysis.

As per the Finance Act 2016 proviso to section 80-IA (4) the deduction available for Infrastructure Projects shall not be available to the enterprises which starts the development or operation and maintenance of the infrastructure facility on or after the 1st day of April, 2016. However Infrastructure facilities have been included in the scope of section 35AD (Deduction for Specified Businesses). As per section 35AD deduction for capital expenditure incurred for the project shall be allowed in the previous year in which such expenditure is incurred and any business loss for such specified business can be carried forward for any number of years. As per the finance bill 2020, local companies which will opt for reduced normal tax rates such deductions will not be available.

The Hybrid Annuity Financial Model has been prepared as per the guidelines mentioned in the MoRTH circular dated 01st February, 2016 whereby interest rate on balance annuities has been taken as per Bank Rate+3%, all cost assumptions including O & M cost as per applicable circular of MoRTH/NHAI. Based upon the above assumption the Estimated Bid cost has been calculated corresponding to Equity IRR of 15% from the project (without changing the O&M).

We have also considered MoRTH circular no. NH-24028/14/2014-H(Vol II) dated 9th February 2016 read with Circular no. RW/NH-24036/27/2010-PPP dated 19th February,2016 and Circular no NH-24028/14/2014-H(Vol-II) dated 7th March 2016, hereby, Life Cycle Cost {Net Present Value (NPV) of the quoted Bid Project Cost+NPV of the O & M cost for the entire operation period has been considered for comparison of Bid parameters. Cash Construction Support of 40% of the Bid Project Cost payable to the Concessionaire by the Authority has been considered in five equal instalments linked to the Project Completion Milestones. Remaining 60% of the Project Cost has been considered through a combination of Equity & Debt. Concession Period shall comprise of Construction period which is project specific and fixed operation period of 15 years. Also Escalation in the Base Civil Construction Cost at the rate of 5% p.a. is taken upto Bid Due Date and EPC of the project is

calculated as per financial analysis in accordance with Ministry’s Circular dated 16.10.2015 and 19.02.2016 rather than assuming it as 115% of Base Civil Construction Cost.

We have gone by NHA Circular no. 24028/14/2014-H(Vol III) (Pt.) dated 4th August 2016, whereby Bank rate for the purpose of Financial Modelling shall be considered as applicable on actual Bid Due Date.

### 8.2.3 Inputs to Financial Analysis

A number of assumptions have been considered for the analysis. They have been listed in the Assumptions and a few are mentioned below:

1. The period of financial analysis has been taken as 17.5 years including 2.5 years (913 days) of construction period.
2. The current package 3(three) is a part of the Project. Following table provides chainage and respective length. The bifurcation between Rigid and Flexible Pavement has also been shown in the table below:

Package	Proposed Chainage of each Package (Km.)		Length (km.)	Length of Rigid Pavement (km.)	Length of Flexible Pavement (km.)
	From	To			
PKG-3	454.50	486.00	31.5	0.93	30.57

3. The debt-equity ratio has been taken as 70:30.
4. The rate of inflation has been taken as 5% pa.
5. **The Bid Project Cost is set to achieve 15% Equity IRR, as per the norms of NHA.**
6. All the assumption that has been considered are mentioned in the Annexures 1.

### 8.2.4 Annexures and Appendices

- Annexure 8.1: Assumptions
- Appendix-8.2: Estimated Project Cost
- Appendix-8.3: Order of Investment for Estimated Project Cost during Construction Period on Monthly Basis
- Appendix 8.4: Calculation of Completion Cost as per Clause 23.6.1 of MCA
- Appendix-8.5: Bid Project Cost
- Appendix 8.6: Calculation of Completion Cost as per Clause 23.6.1 of MCA
- Appendix-8.7: Project Bid : Order of Investment for Bid Project Cost during Construction Period on Monthly Basis
- Appendix-8.8: Disbursement of Capital Support (Considering 0% inflation for Indexing Purpose) under Clause 23.3 and 23.4 of MCA
- Appendix-8.9: Operation and Maintenance Cost as per NHA Circular (Considering 0% inflation for indexing purpose)
- Appendix-8.10: Projected Profit & Loss Account
- Appendix-8.11: Computation of Annuity Payment under Clause 23.6
- Appendix-8.12: Depreciation
- Appendix-8.13: Taxation.
- Appendix-8.14: Loan Repayment Schedule
- Appendix-8.15: Debt Service Coverage Ratio



- Appendix-8.16: Cashflow Statement for Equity IRR
- Appendix 8.17: Equity IRR
- Appendix-8.18: Project Life Cycle Cost based on Estimated Bid Project cost and Estimated Bid O&M Cost

## 8.2.5 Results of Financial Analysis

### PACKAGE 3

S.No.	Summary	Value/Data
1	Estimated Project Cost	1026.61 Crore
2	Estimated Bid Project Cost	1177.24 Crore
3	Estimated O&M Cost	16.13 Crore
4	Estimated Project Life Cycle Cost	1261.95 Crore
5	Variation in Estimated Project Cost	14.67%
6	Bid Equity IRR at Bid Project Cost	<b>15.00%</b>
7	Project IRR	9.79%
8	NPV of Equity IRR (@12%)	18.46 Crore

## CHAPTER 9 CONCLUSION AND RECOMMENDATIONS

---

### 9.1. Conclusions

The existing National Highway NH-47 (new NH-66) alignment comprising of 2 lane single carriageway with few stretches of divided 4-lane in built-up areas, need to be up graded to divided 6-lane carriageway configuration as per IRC:SP:87-2019 with capacity augmentation. The alignment passes through one coastal district of Kerala namely, Allapuzha.

As per revenue records/maps provided by the district authorities the existing ROW along the alignment is varying between 24-30m with few isolated places of course it is wider than 30m. The Proposed Right of Way has been decided as 45 m as a mandate of the State Government for accommodating the 6 Lane carriageway configurations with service roads on both side. The improvement proposal has been generally contained within the PROW of 45m. In addition extra land area would be required for Bus Bay, Toll Plaza, Junction improvement, Wayside Amenity etc.

The proposed 6 lane alignment centre line has been finalised primarily at the middle (concentric) of the EROW as per the advice of **Hon'ble Minister (Works and Registration) of Kerala**. However, in certain sections, the proposed centre line is designed with eccentricity, to cater for,

- Eccentric Widening at Structure/Bridge Locations.
- Eccentric Widening to retain existing Religious Structures viz. Temples, Churches, Graveyards & Mosques etc. to the extent possible

The entire project road is classified into 7 homogeneous sections with AADT ranging from 25537 PCU to 51526 PCU. It is observed that homogeneous sections HS-1, HS-2 and HS-5 of the project alignment with AADT respectively 51526 PCU, 44117 PCU and 41993 PCU already exceeded the capacity (LOS B) for 4 lane alignment with paved shoulder and warrants for six lane highway. For the remaining homogeneous sections HS-3, HS-4, HS-6 and HS-7 the threshold limit of traffic for LOS-B (40000 PCU) for 4 lane will appear respectively in 2019, 2018, 2022 and 2018. Hence, it is decided to upgrade all sections to 6 lane configurations in one go now.

The existing alignment geometry generally conforms to IRC standards and has fair riding quality however would require capacity augmentation. At places there are sub-standard curves, which has been upgraded to suit the NH standards.

The pavement has been proposed of flexible type with cement treated base and cement treated sub-base with aggregate interlayer as crack relief layer. VG 40 bitumen has been proposed for binder course and NRMB for wearing course.

The proposed improvement proposal is mainly within the existing ROW in entire stretch. The project will have social impact in terms of loss of livelihood or shelter, which will have to be studied and a suitable mitigation plan prepared.

The project road package found to be economically viable with EIRR more than the resource cost of capital @ 12%. In case of sensitivity too project is economically viable and beneficial to public

## 9.2. Recommendations

Based on the findings of this feasibility study the following recommendations are made:

1. Considering the projected traffic and the results of economic evaluation for the project it is recommended that the project road be improved to standard Six Lane divided carriageway with each carriageway consist of 3 lanes (3.5m each), 2m wide paved shoulders. Since the road generally passes through fair to heavy built up stretches, service road 7m wide is proposed on both sides for almost entire stretch.
2. Pavement type recommended is Flexible Pavement having design life of 20 years. Pavement shall be with cement treated sub-base, cement treated base and aggregate interlayer as crack relief layer. Existing Pavement has been recommended to be reconstructed as new pavement.
3. Existing and Proposed Structure Proposals comprise of:

Items	NH-47
<b>Existing Structure Details</b>	
Number of existing Bridges	<b>05</b>
Number of Major Bridges	<b>02</b>
Number of Minor Bridges	<b>03</b>
Number of ROB	-
Number of Causeways	-
Number of VUPs	<b>03</b>
Number of PUPs	-
Number of SVUPs	<b>09</b>
Number of LVUPs	<b>01</b>
Number of FOBs	<b>14</b>
Number of existing Bridges to be replaced-fully/Abandoned/partially (including ROB)	<b>01</b>
Number of existing Bridges to be retained (including ROB)	<b>04</b>
<b>Proposed Structure Details</b>	
Number of Bridges to be widened (including MJB / MNB / VUP/ PUP/LVUP) either with additional 3+2-Lane structure or with 3-Lane structure	<b>04</b>
Number of New 3 Lane ROB	-
Number of New Major Bridges – 6 Lane	<b>01</b>
Number of New Major Bridges – 3 Lane (along side existing)	<b>01</b>
Number of New Minor Bridges – 6 Lane	-
Number of New Minor Bridges – 3 Lane (along side existing)	<b>01</b>
Number of New Minor Bridges – 3 Lane + 2 lane (along side existing) (3 lane for main carriageway and 2 lane for service road)	<b>02</b>
Number of New VUP – 6 Lane	<b>03</b>
Number of New LVUP – 3 Lane (along side existing)	<b>01</b>
Number of New SVUP – 6 Lane	<b>09</b>
Number of New Gas Pipe Line Bridges	-
Number of New Flyovers – 6 Lane	<b>01</b>

Number of New Elevated Highways	-
Number of New Overpass	-
Number of New Foot Over Bridges (FOBs)	14
<b>Total Number of Structures</b>	<b>33</b>

4. There are 43 existing culverts and additional 10 culverts are proposed to cater for the drainage adequacy of the project road.
5. The financial Analysis presented in Chapter 8 of this report indicates that the project is feasible under Hybrid Annuity Model. The cost of the project is substantial and that makes unviable under PPP(DBFOT) Mode. The mode will be bankable considering the appropriate risk allocation between the Public and Private Sector. The revenue risk will be taken by NHA and Concessionaire will receive the annuity. The NHA will have to upfront pay only 40% of the Bid Project Cost. The balance will be paid to Concessionaire over the Operation Period. This, reduces the financial constraint on NHA.

The Concession Period as per model concession agreement of HAM shall be 17.5 years including 2.5 years of construction duration.

Considering the recent procurement by NHA on HAM, this model is recommended for the package mentioned above.