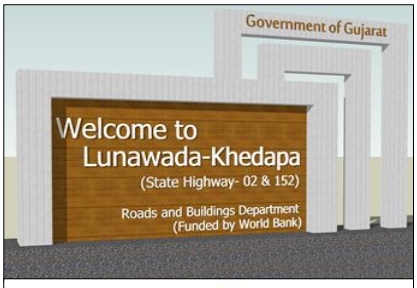
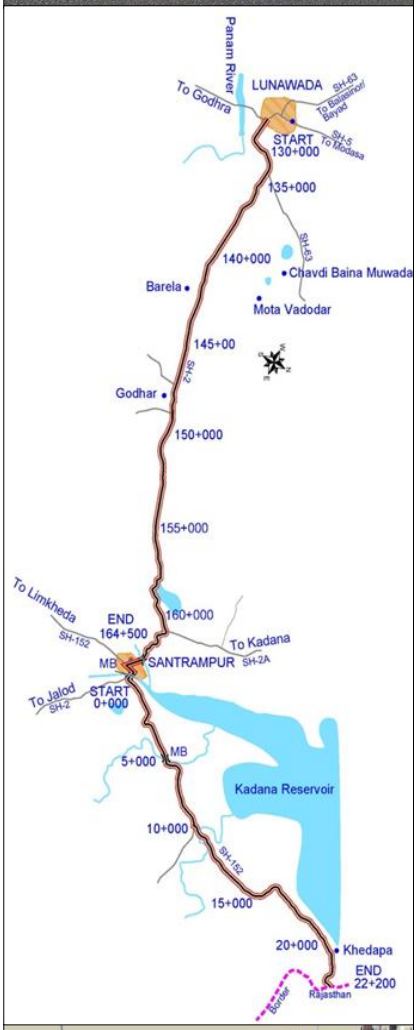




ROADS AND BUILDINGS DEPARTMENT
GOVERNMENT OF GUJARAT

Project Preparatory Works Consultancy Services for Gujarat State Highway Project - II

Detailed Project Report

Executive Summary
(LUNAWADA – KHEDAPA)

January 2013

LEA Associates South Asia Pvt. Ltd.
LEAdership in engineering & planning solutions

EXECUTIVE SUMMARY

CONTENTS

List of Tables

List of Figures

List of Maps

1 INTRODUCTION

1. Gujarat is one of the versatile and dynamic states in India. The state has established itself on stronger economic foundation. Over the last decade the name of "Gujarat" has emerged synonymous with progress and vibrancy. Government of Gujarat (GoG) through Roads and Buildings Department (R&BD) is thriving to deliver better than the best road infrastructure for the communities.

2. Gujarat roads, managed by R&BD, are known as one of the best in the country. R&BD is successfully managing its road assets through various flagship programs of GoG, besides multilateral funding and Public Private Participation. The Gujarat State Highway Project – I (GSHP-I) successfully implemented by R&BD, GoG through 2001 to 2007 with the World Bank assistance, has set many bench marks for other states to follow. The state appreciating need of sustenance of its economic growth, endorses that the infrastructure is one of the key and further its enhanced quality is a great value addition.

3. GSHP-I project umbrella before its closure itself rooted efforts towards second highway project for the state. The Updated Strategic Options Study (USOS) for the Core Road Network of the Gujarat State was carried out in 2005-06 to this respect and the same was duly revalidated in 2010. This study has prioritised road sections on strategic parameters to arrive at about 1,600 km road length. R&BD, GoG with in-principal agreement with the World Bank (WB) has finalised project budget as Rs. 2,100 crore. As a pre-requisite for loan appraisal process with the WB, R&BD, GoG selected about 397.9/460 km of road length for project preparatory works.

4. R&BD, GOG has taken a step forward by selecting LEA Associates South Asia Pvt. Ltd. (LASA) as Project Preparatory Works Consultant. Project Preparatory Works Consultancy Services (PPWCS) mandates the consultant for detailed engineering project report preparation along with procurement documents for selected 397.9 km road length.

1.1.1 Project Corridors

5. The corridors are selected by R&BD across the state to have representation of various project interventions like four laning, wide/two laning and maintenance. The list of project corridors at a glance is furnished through Table 1.1. The map showing project corridor is provided as Map 1.1.

Table 1.1: List of Project Corridors

Work Type	Sr. No.	Link Name	SH No.	Length (km)
Two Laning / Wide Two Laning	1	Lunawada – Khedapa (Border)	SH-02, SH-152	56.70
	2	Bayad – Lunawada	SH-69,SH-63, VR/MDR	44.56
	3	Dhansura – Meghraj	SH-145	46.65
	4	Gondal – Atkot	SH-01	35.40
	5	Dhandhuka – Dholera	SH-20	27.00
	6	Umreth- Vasad (including Kapadvanj-Ladvel)	SH-83,SH-188, SH-151	35.45
	7	Dabhoi – Bodeli	SH-11	38.60

Work Type	Sr. No.	Link Name	SH No.	Length (km)
Four laning	8	Mehsana-Himatnagar	SH-55	66.15
Rehabilitation	9	Paliyad-Dhandhuka	SH-001	46.00

Source: As provided in Terms of Reference (ToR)[1]

1.1 BROAD OBJECTIVES AND SCOPE

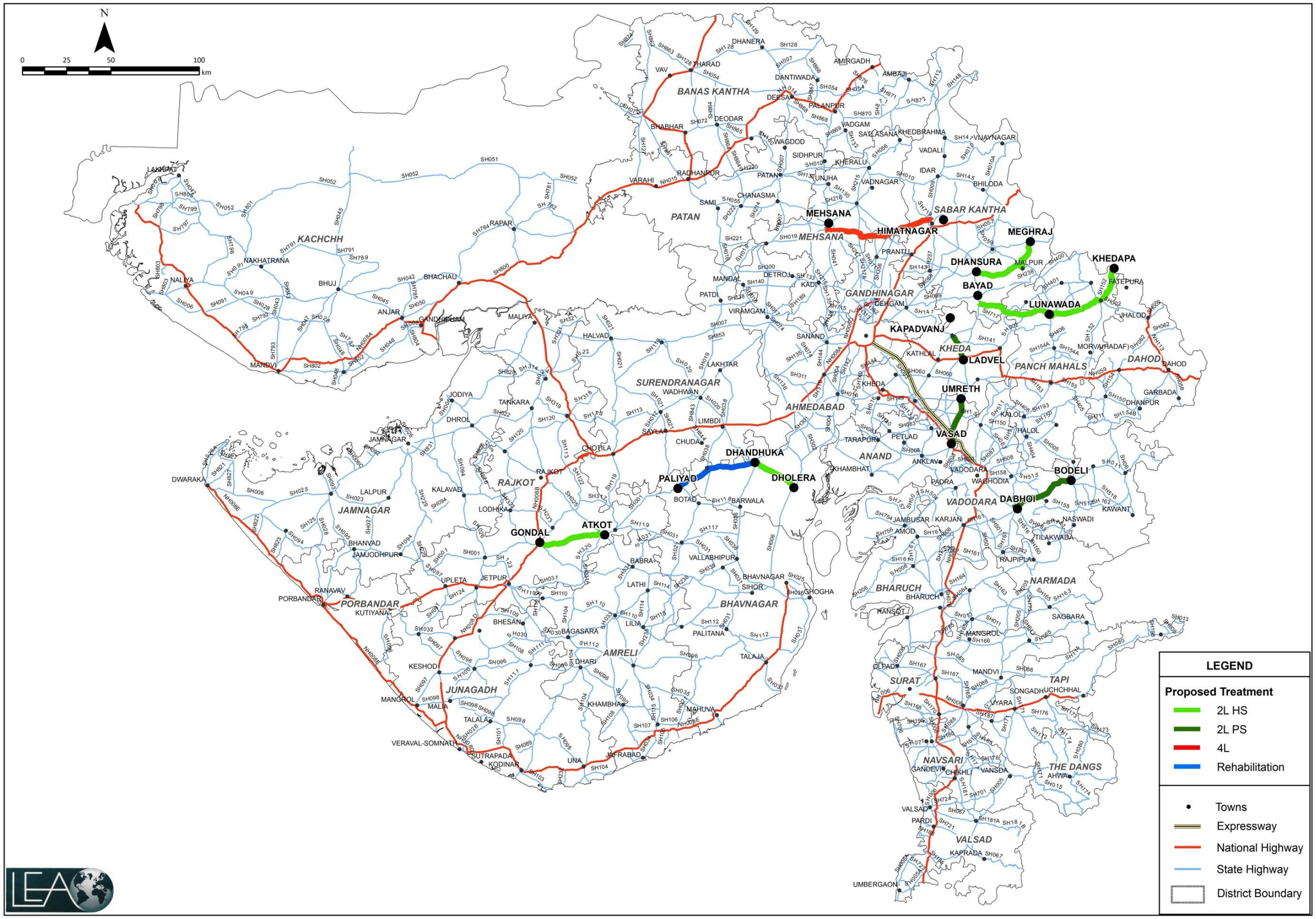
Project Intervention	Total Length (Km)
Widening to Wide 2L	286.9 km
Widening to 4L	66 km
Maintenance/Rehabilitation	45 km
Total length	**397.9 km**

6. The broad objective of the assignment is to have detailed engineering project ready for bidding. It includes economic analysis for each section, integration of road safety audit in final design, implementation and O&M along with Environmental Impact Assessment, Environmental Management Action Plan and Rehabilitation and Resettlement Studies as per World Bank Guidelines.

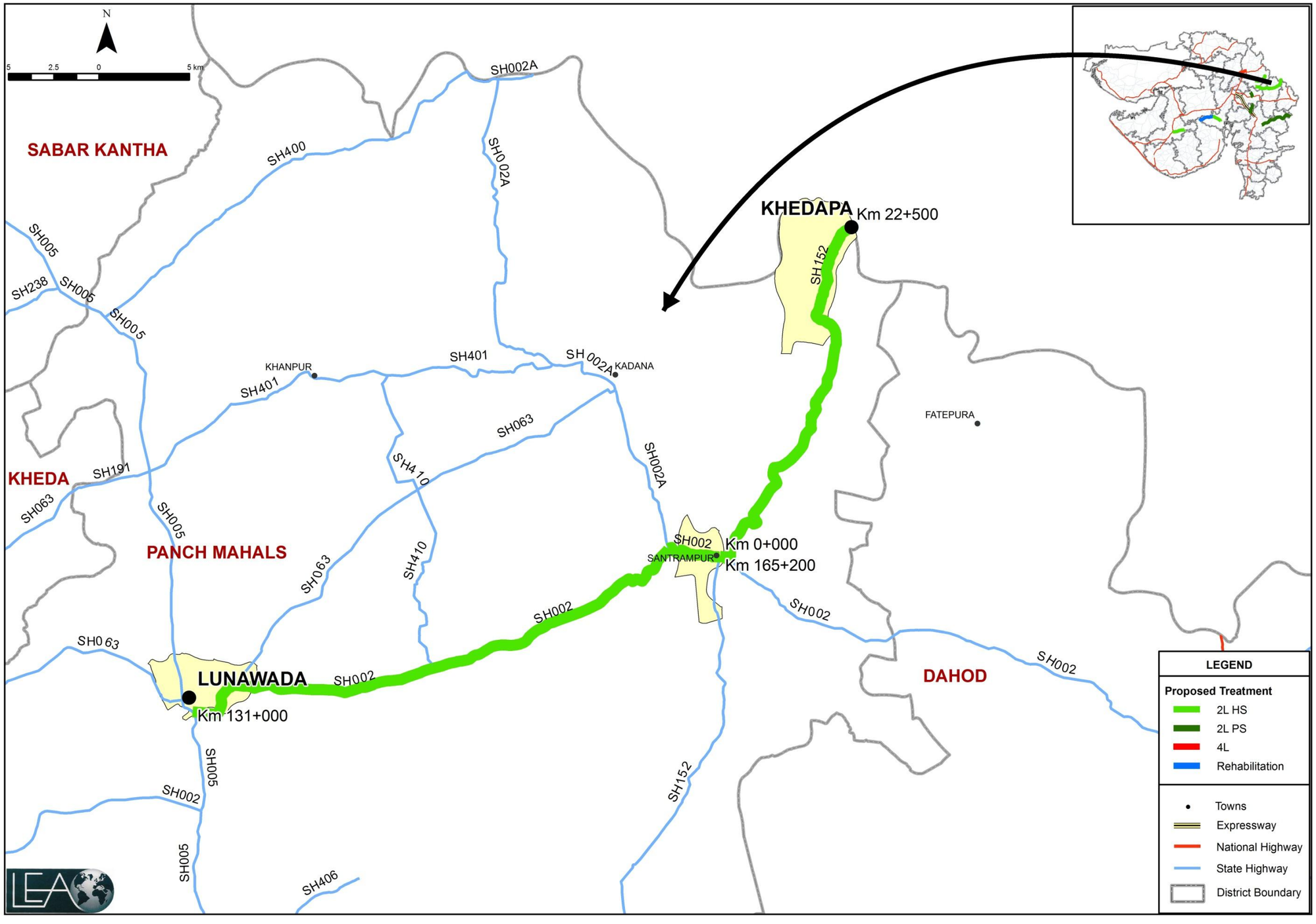
1.2 DETAILED PROJECT REPORT

7. This Executive Summary of DPR pertains to two laning with hard shoulder for the project corridor Lunawada-Khedapa. The key map showing project corridor is presented in Map 1.2.

[1] Bodeli-Alirajpur Corridor left out as part of GSHP-II as it is being declared as National Highway



Map 1.1: Project Corridors



Map 1.2: Key Map Showing Project Corridor

2 SOCIO-ECONOMIC PROFILE OF THE CORRIDOR

2.1 POPULATION DISTRIBUTION

8. The talukas through which the project corridor traverses comprises a total population of 6.52 lakh in 2011 which was 5.59 lakh during 2001. The population of these talukas grew at an Average Annual Growth Rate (AAGR) of 1.6 percent during the year 2001 to 20112..

9. A total of 39 census villages and 2 towns (Lunawada and Santrampur) abut the project corridor. Total population of villages and towns abutting corridor is 1.12 lakhs, which is almost 20 percent to the talukas population (Census 2001). Settlements seen along the corridor are Lunawada, Chavadia, Barela, Santrampur, Moti Saran, Nani Saran, Patharia, Semaliya, Rampatel and Khedapa.

10. The total number of households along project corridor is 20,042. Average Household (HH) size along the project corridor villages is 5.6. The average HH size varies from 4.2 in Rampatelna Muvada village to 7.1 in Khedaya Alias Pratapgadh village.

2.2 AGE AND SEX RATIO

11. The overall population below 6 years age in project corridor talukas is 16 percent.

12. The average sex ratio3 for project corridor talukas during Census 2001 was 908 which increased to 946 during Census 2011. Project corridor villages revealed the sex ratio of 932 females per thousand males.

13. Similarly, with respect to juvenile sex ratio4, it was analysed that as against the juvenile sex ratio of 788 for project corridor talukas, the project corridor villages had sex ratio of 892.

2.3 LITERACY RATE

14. As per the Provisional Census 2011, project corridor talukas possess literacy rate of 85 percent which was 62 percent during Census 2001. The male literacy ratio in project corridor talukas is 84 percent as against the female literacy rate of 61 percent in 2011.

15. Average literacy rate in project corridor villages as per Census 2001 was 70 percent, which constitutes 82 percent and 58 percent of male and females literates. Amongst all the villages and settlements along corridor, Lunawada town followed by Santrampur have evinced higher literacy rates i.e. 85 and 84 percent.

[2] Village/ settlement wise analysis for the project corridor has been done based on 2001 Census information. Taluka level analysis is based on 2001 census information and 2011 Provisional census data base information.
[3] Sex Ratio: Number of females per thousand males
[4] Juvenile Sex Ratio is the sex ratio of population in age-group 0-6 years

2.4 URBAN RURAL POPULATION

16. The project corridor abuts Lunawada and Santrampur towns comprising a total population of 37,005 as per Census 2001. Urban population in project corridor talukas during 2001 was 49,146 which increased to 56,473 in 2011.

2.5 OCCUPATIONAL STRUCTURE

17. Total workers according to census 2001 in project corridor talukas was 2.80 lakh, this comprises 64 percent workers classified as main workers[5] and rest 36 percent as marginal workers[6]. Taking into account the composition of workers majority of workers are cultivators (58 percent) followed by workers engaged in agricultural activities (26 percent). The total workers in project corridor settlements are 46,145. Workers composition for the villages/settlements along the corridor shows highest share of workers as cultivators (43.2 percent) followed by workers engaged in others sector[7] (37 percent).

2.6 WPR

18. The Workforce Participation Ratio (WPR) for project corridor taluka in 2001 was 50 percent. Comparing and analyzing the male and female WPR, it was recorded that the female WPR is 52 percent as against male WPR of 48 percent. The average WPR for project corridor settlements is 42 percent which is lower than the taluka's WPR. Male WPR in project corridor settlements is 51 percent as against 33 percent for female WPR.

2.7 SCHEDULE CASTE AND SCHEDULE TRIBE POPULATION

19. Analysis of social groups for the project corridor has been done on the basis of concentration of Schedule Caste (SC) and Schedule Tribe (ST) population in talukas and project corridor settlements. As mentioned above, Santrampur and Kadana taluka are predominantly tribal talukas and are part of Fifth Schedule Areas. More than 70 percent population of Santrampur and Kadana taluka belong to ST community. The predominant tribal groups residing in above tribal talukas are Bhil, Nayak and Patelia. SC population for project corridor talukas is 5 percent.

20. As per Census 2001, ST population for settlements and villages along the corridor accounts for the figure of 49,353 which is nearly 44 percent of total population for settlements along the project corridor.

[5] Main workers were those who had worked for the major part of the year preceding the date of enumeration i.e., those who were engaged in any economically productive activity for 183 days (or six months) or more during the year

[6] Marginal workers were those who worked any time at all in the year preceding the enumeration but did not work for a major part of the year, i.e., those who worked for less than 183 days (or six months).

[7] Census Definition of Other Workers: All workers, i.e., those who have been engaged in some economic activity during the last one year, but are not cultivators or agricultural labourers or in Household Industry, are 'Other Workers (OW)'. The type of workers that come under this category of 'OW' include all government servants, municipal employees, teachers, factory workers, plantation workers, those engaged in trade, commerce, business, transport banking, mining, construction, political or social work, priests, entertainment artists, etc. In effect, all those workers other than cultivators or agricultural labourers or household industry workers, are 'Other Workers'

3 CORRIDOR CHARACTERISTICS

3.1 PROJECT CORRIDOR

21. The project road from Lunawada to Khedapa, bridges the transport connection between the state capital Gandhinagar and Rajasthan via Dehgam, Bayad[8] and Santrampur. Project corridor while traversing a distance of about 56 km from Lunawada till Khedapa, facilitates tribal connectivity to mainstream. This road section falls under central region of Gujarat state.

Table 3.1: Existing Corridor Characteristics

<table>
<tr><th>Sr. No.</th><th>Components</th><th colspan="2">Details</th></tr>
<tr><td>1</td><td>Corridor Name and SH Number</td><td colspan="2">Lunawada-Khedapa</td></tr>
<tr><td>2</td><td>Sections</td><td>Lunawada- Santrampur (SH-002)</td><td>Santrampur-Khedapa (SH-152)</td></tr>
<tr><td>3</td><td>Start Chainage (km)[9]</td><td>130+000</td><td>0+000</td></tr>
<tr><td>4</td><td>End Chainage (km)</td><td>164+500</td><td>22+200</td></tr>
<tr><td>5</td><td>Total Length of Corridor (km)</td><td colspan="2">56.7</td></tr>
<tr><td>6</td><td>Right of Way (m)</td><td>24</td><td>24</td></tr>
<tr><td>7</td><td>Carriageway width (m)</td><td>7</td><td>3.7</td></tr>
<tr><td>8</td><td>Intersection/Junction</td><td colspan="2">6</td></tr>
<tr><td rowspan="2">9</td><td>Traffic</td><td>km 144+500</td><td>km 2+000</td></tr>
<tr><td></td><td>3,341 Vehicles (3,736 PCU)</td><td>3,055 Vehicles (2,676 PCU)</td></tr>
<tr><td>10</td><td>Terrain type</td><td>Plain</td><td>Rolling</td></tr>
<tr><td>11</td><td>Soil Classification</td><td>Silty Clay</td><td>Gravel/Red Soil</td></tr>
<tr><td>12</td><td>Pavement Condition</td><td>Fair</td><td>Fair</td></tr>
<tr><td rowspan="6">13</td><td colspan="3">CD Structures</td></tr>
<tr><td>Major Bridge</td><td colspan="2">2</td></tr>
<tr><td>Minor Bridge</td><td colspan="2">16</td></tr>
<tr><td>Pipe Culvert</td><td colspan="2">93</td></tr>
<tr><td>Slab Culvert</td><td colspan="2">7</td></tr>
<tr><td>Box Culvert</td><td colspan="2">4</td></tr>
<tr><td>14</td><td>Total Number of Structures</td><td colspan="2">122</td></tr>
<tr><td>14</td><td>Riding Quality- IRI (m/km)</td><td>2.31-6.55</td><td>3.46-8.88</td></tr>
<tr><td>15</td><td>Existing Crust Thickness (mm)</td><td>180-600</td><td>120-420</td></tr>
<tr><td>16</td><td>Soaked CBR</td><td>3.80-14.90</td><td>2.80-18.7</td></tr>
<tr><td>17</td><td colspan="3">Vehicle Damage Factor
<table>
<tr><th>Vehicle Type</th><th>Lunawada-Khedapa</th><th>Khedapa-Lunawada</th></tr>
<tr><td>Mini Bus</td><td>0.12</td><td>0.12</td></tr>
<tr><td>LCV</td><td>0.14</td><td>0.26</td></tr>
<tr><td>BUS</td><td>0.50</td><td>0.48</td></tr>
<tr><td>2-Axle Truck</td><td>3.44</td><td>1.30</td></tr>
<tr><td>3-Axle Truck</td><td>3.05</td><td>4.24</td></tr>
<tr><td>M-Axle Truck</td><td>4.35</td><td>0.12</td></tr>
</table></td></tr>
</table>

[8] Bayad-Lunawada is another corridor under this consultancy assignment for up gradation intervention of two laning for about 45 km length. Both project corridors Bayad-Lunawada-Khedapa, together traverse for about 101 km length while linking state border till Bayad. Onwards facilitates reaching state capital with existing Bayad-Dehgam-Gandhinagar state highway linkage.

[9] Chainages are existing chainages as observed along the project corridor.

4 TRAFFIC ANALYSIS AND FORECAST

4.1 INTRODUTION

22. Road development projects are meant for achieving multi-objectives while meeting the basic needs of the road user - *Mobility and Accessibility*. Key functionalities and upcoming utilization of the project corridor in years to come is the essential task for which the highway facility needs to be upgraded or improved. All proposed solutions from traffic point of view have appropriately been incorporated with respect to issues related to geometry, environmental and social.

4.2 EXISTING TRAFFIC CHARACTERISTICS

23. The analysis of traffic volume data indicates an ADT of 3,444 vehicles, equivalent to 3,851 PCU, at km 144+500 (Lunawada-Santrampur) while 3,149 vehicles, equivalent to 2,759 PCU, are observed at km 2+000 (Santrampur-Khedapa). Two wheelers comprise the maximum share of vehicular traffic of about 44% at km 144+500, and about 61% at km 2+000. Around 7.2 to 7.3% of the total traffic is travelling within peak hour as observed at km 144+500 and km 2+000.

24. Travel desire pattern on the corridor indicates most of the traffic travelling within the state. Lunawada and Santrampur are identified as major intersection/junctions at which peak hour volume observed is 2,593 and 875 respectively. Speed and delay study indicates the existing average speed on the corridor as 30 kmph on Lunawada-Santrampur section and 28 kmph on Santrampur-Khedapa section. The maximum VDF values are observed as 3.44 and 4.24 for 2-axle trucks and 3-axle trucks respectively.

25. The passenger and goods traffic characteristics indicate that most of the trips are made for shorter distances and accordingly shorter durations. The analysis indicates around 23% and 22.7% on 144+500 and 38% and 31% on 2+000 of the passenger and goods trips, respectively, to be made daily.

26. The major commodity being carried on the corridor is building materials. Lunawada-Modasa (SH-005) and Santrampur-Zalod (SH-002) are identifies influencing corridors on which an AADT of 9,738 vehicles (20,263 PCU) and 3,738 vehicles (3,588 PCU) are observed respectively.

27. The traffic analysis for the corridor and influence area is taken as deep as to study and analyse traffic levels for each homogeneous section of the corridor for present and future conditions. Traffic sections with present and proposed lane configuration as well as traffic levels are tabulated in Table 4.1.

Table 4.1: Homogenous Sections with Details

Sections	Existing Chainage and Length			Proposed Chainage and Length			Section	Present Lane Configuration	Total	PCU
	Start	End	Length	Start	End	Length				
1	130	130.4	0.4	130	132	2	Urban	2L	10,736	11,738
2	130.4	162.825	32.425	132	162.825	30.825	Rural	2L	3,341	3,736
3	162.825	163.425	0.6	162.825	163.85	1.025	Urban	2L	3,341	3,736
4	0	0.3	0.3	0	2	2	Urban	SL	5,218	4,193
5	1	23.7	22.7	2	23.7	22.738	Rural	SL	3,055	2,676

4.3 TRAFFIC FORECAST

28. Traffic forecast is done using both – Trend Based and Econometric Method. In addition, incorporating Client and World Bank view points, appropriate options are worked out. The growth of registration vehicles in state as well as flat 5% growth of vehicles each year is worked out to better ensure the realistic assessment of traffic forecast. Growth rates estimated from Trend Based Method is adopted. The forecasted traffic using Trend Based, Econometric and Flat 5% growth rates are presented in Table 4.2.

Table 4.2: Total Forecasted Traffic

Traffic/ Year	km 144+500							km 2+000						
	2011	2015	2020	2025	2030	2035	2040	2011	2015	2020	2025	2030	2035	2040
Forecasted Traffic by Econometric Method														
Vehicle	3,341	4,358	6,078	8,048	10,361	13,117	16,660	3,055	4,026	5,664	7,458	9,517	11,870	14,834
PCU	3,736	4,761	6,502	8,677	11,388	14,860	19,502	2,676	3,438	4,720	6,216	8,002	10,162	12,962
Forecasted Traffic by Trend Based Method														
Vehicle	3,341	4,057	5,102	6,429	8,007	9,459	10,583	3,055	3,722	4,692	5,922	7,357	8,671	9,684
PCU	3,736	4,499	5,604	7,003	8,702	10,273	11,495	2,676	3,229	4,030	5,043	6,242	7,341	8,189
Forecasted Traffic by Flat 5% Growth Rate														
Vehicle	3,341	4,063	5,186	6,618	8,447	10,780	13,759	3,055	3,713	4,739	6,048	7,719	9,851	12,573
PCU	3,736	4,546	5,802	7,405	9,450	12,061	15,394	2,676	3,253	4,152	5,299	6,763	8,631	11,015

4.4 IMPROVEMENT OPTIONS

29. The improvement options are recommended for LOS B. An appreciation of present lane configuration, base year traffic level and corresponding projection simulates a clear picture of likely congestion levels or the utilization level of project corridor. A number of parameters are considered into forming final improvement options. From traffic point of view, it is to state that where the existing lane configuration and condition is inadequate to cope with the urban versus rural traffic volume, augmentation is essential. It is adopted to have two lanes with wide hard shoulder configuration as continuity all through, except junction improvements.

5 ROAD SAFETY AUDIT

5.1 PROJECT BRIEF

30. Lunawada-Khedapa is proposed to be improved with better riding quality and enhanced safety. Road Safety Audit addresses identification of safety related deficiencies as well as behavioral safety issues while subsequently recommending countermeasures in approaching towards sustainable design solution. All sections of the project corridor are visited and studied well. Review and audit of safety measures of the corridor are followed with the prevailing best practices. With proposed improvement option of two lane with granular shoulders, the objective of the exercise focuses on abating road accidents and their severity while improving riding quality.

5.2 ACCIDENTS STATISTICS

31. First Information Report (FIR) details relating to the accidents, fatalities and injuries in the project corridor and its immediate influence area are collected and studied. Though such information is recorded by police stations, there is a potential scope of other minor injury and property damage accidents to not have reported. However, efforts are extended in preparing safety improvement options beyond available accident data and the same is incorporated in final improvement proposals. 27 fatalities and 17 injuries reported in a span of 6 years (2006 – 2011). The data indicates most accidents concentrated at Denavada chokdi, Rampatel na muvada, Barela, Ukhareli, Batakwada and Simaliya.

5.3 SAFETY ISSUES FOR PROJECT CORRIDOR

5.3.1 Carriageway

32. It is observed that shoulders are inadequate in width for Lunawada to Santrampur section. It is essential to increase the width in this entire stretch at least up to 1.0 meter on either side for improved safety.

33. For Santrampur to Khedapa it is observed that carriageway and shoulders are inadequate in width. It is essential to increase the carriageway width in this entire stretch at least up to 7.0 meters + edge strips 1.0 m on either side for improved safety.

5.3.2 Geometric Design

34. During the audit, it is identified that sight distance at sharp curves lack in standards and needs to be improved with geometric design. Curve passing through villages needs proper signage. Appropriate control measures are essential.

5.3.3 Intersections/Junctions

35. There are four major junctions observed on the project corridor. It is observed that considerable habitants gather near these junctions; thereby generating local trips. It is audited that the existing junction design lacks in incorporating local travel behaviour and influence of habitations in proximity, which makes them potential accident prone spots. It is identified that

careful attention needs to be given in developing appropriate designs for these junctions. In addition, provision of suitable location of bus stops near junction needs to be considered.

5.3.4 CD Structures

36. The cross drainage works, especially culverts are narrow in width and the parapets of the culverts are potential hazards.

5.3.5 Traffic Management and Control Issues

37. It is identified that traffic signs needs to be provided at many places. Existing signages are in a poor condition. It is identified that provision of pavement markings lack at various places on the project corridor.

5.4 IDENTIFIED ISSUES AND SUGGENTIONS

38. Suggestions, recommendation as well as issues identified from safety audit are incorporated into final improvement options which include, but not limited to:

39. For Lunawada-Santrampur section

a. Deficient 51 horizontal curves;
b. Identified 81 major/minor intersections (including access roads);
c. Identified 10 highway sections near habitations and;
d. Identified deficient 69 structures.

40. For Santrampur-Khedapa section

a. Deficient 106 horizontal curves;
b. Identified 38 major/minor intersections (including access roads);
c. Identified 6 highway sections near habitations and;
d. Identified deficient 53 structures.

41. The details of the recommended interventions are presented in Volume III Road Safety Audit.

6 DESIGN OF CORRIDOR

6.1 INTRODUCTION

42. This particular chapter deals with detailed analysis of roadway geometrics, developmental aspects, safety and road furniture requirements, towards providing pleasant and aesthetic highway for road users. This chapter also discusses about pavements, design and rehabilitation proposals of CD structures and bridges.

6.2 TOPOGRAPHIC SURVEYS

43. Topographical survey forms backbone for detailed engineering design. Topographic survey is carried out on the corridor during September 2011 and October 2011, as per the requirements for project preparation. Accuracy of the information collected during the survey has direct bearing on almost all the design activities involved in project preparation. Collection and review of toposheets and available maps/images helped in planning of topographic surveys towards establishing existing geometrics of the road corridor.

44. Also the topographic features are examined in the entire stretch of the corridor so as to explore the suitability of pavement widening. The options of eccentric widening, symmetrical widening and realignments are examined so that the most appropriate solutions are arrived at. The locations requiring geometric improvements are surveyed and improvement proposals are prepared. Horizontal/Vertical control points are established and detailed topographic surveys are carried out for evolving the Digital Terrain Model to study the various alternatives and firm up horizontal and vertical alignments.

6.3 BASE MAPS

45. Base Maps showing the alignment of existing roads, ROW and pertinent topographic features such as buildings, factory boundaries, irrigation channels, drainage structures, religious structures, trees and utilities (OFC, water pipe lines, electrical poles, telephone poles) overhead tanks, open wells are prepared using the DTM data collected. Data collected from various authorities on underground utilities are overlaid on the layout plans. Base plans are updated with walk over surveys on the corridors.

6.4 GEOMETRIC DESIGN

46. The highway geometric design deals with road geometrics such as horizontal and vertical alignment, interventions due to social impact, design safety and road furniture details. The section shall be read in conjunction with design drawings provided as Volume VIII of this DPR.

47. Highway design has been carried out by considering two aspects:

- **Functional Aspects:** The functional aspects address geometric improvement and visible dimensions of the roadway.

- **Structural Aspects:** The structural aspects deal with designs for pavement, CD structures, bridges and embankments i.e. the ability of the highway to adequately carry and support the vehicle/ wheel loads over the design period.

48. Functional aspects manifested in appropriate horizontal and vertical alignments, sight distance availability, lateral and vertical clearances, intersection treatment, improved design speed, road safety and also cover related facilities.

49. Structural aspects on the other hand calls for detailed evaluation of widening options, concentric or eccentric of the existing road; as dictated by site situations like available ROW, existing utilities, terrain, etc., and importantly the existing structural conditions, both for pavement and CD structures.

6.5 IMPROVEMENT OPTION

50. The project corridor is having the existing carriageway widths as 7.0m, i.e. Two Lane (2L) up to Santrampur, thereafter 3.7m (SL) configuration for Santrampur- Khedapa section. Project scope is for widening of existing roads from 2L/Single lane to 2L+HS configuration, width of hard shoulder is 2.5m[10] either sides. The project corridor has right of way of 24m. The improvement option for project corridor is seen with respect to traffic, safety, speed and mobility. World Bank advises and shared iRAP[11] reports are also taken into consideration.

51. The projected traffic on Lunawada-Santrampur section does not call for any higher order improvement which is already two lane; but Santrampur-Khedapa section being single lane at present triggers higher order improvement. This need to be seen beyond traffic numbers to bridging the tribal villages and talukas to mainstream. Seamless connectivity with upgraded facility shall boost up mobility towards social up-liftment of the project influence area. Accordingly strengthening and widening to Two Lane with Hard Shoulders (2L+HS) is adopted as improvement option. The emerging traffic scenario and feasibility of improvement options can be simulated through Table 6.1.

Table 6.1: Emerging Traffic Scenario and Improvement Needs

Section	Traffic/Year	2011	2015	2020	2025	2030	2035	2040
Lunawada-Santrampur	PCU	3,735	4,499	5,604	7,003	8,702	102,73	11,495
	Configuration	2LHS						
Santrampur-Khedapa	PCU	2,676	3,229	4,030	5,043	6,242	7,341	8,189
	Configuration	2LHS			2LHS			
	V/C with 2LHS	0.09	0.11	0.13	0.17	0.21	0.24	0.27

52. The project corridor is proposed to be widened and strengthened to two lanes with hard shoulder (2L+HS). The cross-section depicting placement of existing carriageway and proposed improvement is presented through Figure 6-1 and Figure 6-2.

[10] In Sanrampur-Khedapa section as per rolling terrain 1m Hard Shoulder is considered techno-economically.
[11] iRAP: International Road Assessment Programme, Gujarat is also covered under the programme with selected corridors. Findings of IRAP and recommendations at particular stage are shared.

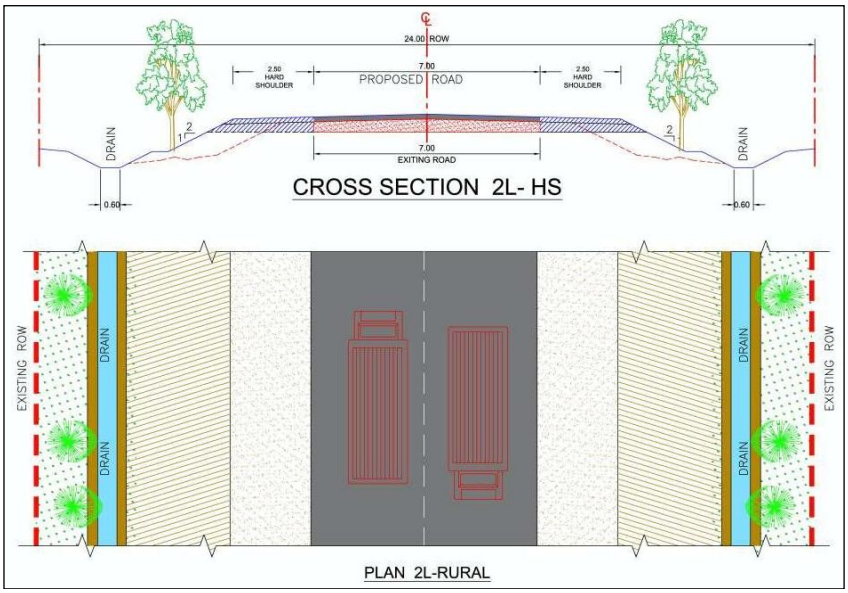


Figure 6-1: Proposed Improvement Option (2L to 2L+HS Lunawada-Santrampur)

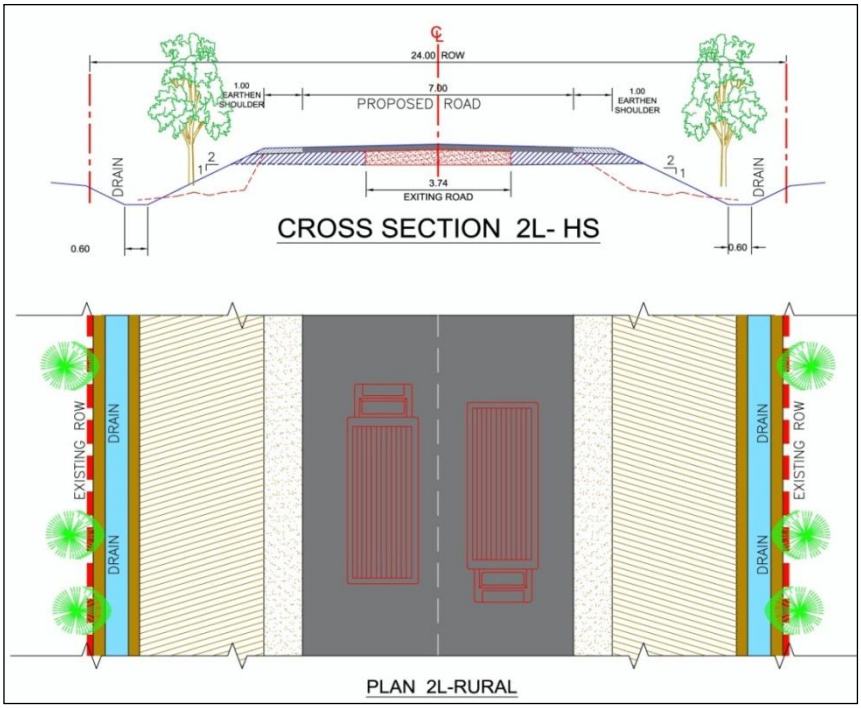


Figure 6-2: Proposed improvement option (SL to 2L+HS, Santrampur-Khedapa)

53. The project corridor predominantly traverses through agriculture/barren land up to Santrampur. Santrampur-Khedapa section passes through rolling terrain and Reserve forest. Environmental and social aspects are duly integrated in improvement scheme within available right of way width.

6.5.1 Widening Scheme

54. Existing road is placed concentrically within available ROW of 24m, in general. The condition of the existing pavement is fair except few places where ravelling is observed in Lunawada-Santrampur section and poor to fair in Santrampur- Khedapa Border stretch.

55. The project section from Lunawada to Santrampur is proposed for reconstruction along with improvement in geometry from km 130+030 to km 153+00 and remaining length about 10km comes under shoulder widening and strengthening of existing road. The Santrampur-Khedapa section is proposed for widening and strengthening for most of the length except geometric improvements. The detailed widening scheme is provided in subsequently on pavement design section.

6.6 GEOMETRIC DESIGN

56. Base plan of the corridor showing all existing natural and manmade features has been prepared using the topographical survey data. All the features within a band width of 60m have been captured with an unique "description code" during the survey along with the details of existing carriageway centerline, edge of pavement, edge of shoulder, toe line of the embankment etc. Survey data is formatted to suit the requirements of Civil 3D environment.

6.6.1 Horizontal Alignment Design

57. Design of the horizontal alignment has been carried out in CIVIL 3D environment as per the finalised widening scheme. Extensive field checks to verify the feasibility of the proposed alignment have been carried out and suitable modifications to the alignment have been effected wherever considered essential to safeguard sensitive elements.

58. The project road design chainages are given herewith:

Project Section	Start Chainage (km)	End Chainage (km)	Length (km)
Lunawada-Santrampur (SH-002)	130+010	163+800	33.790
Santrampur-Khedapa Border (SH-152)	0+000	22+689.956	22.689

59. Geometric design of project corridor has been conceptualized for a design speed of 80-100 kmph in rural sections and 40-60 kmph in village/urban sections as per the design standards formulated for the project except Santrampur-Khedapa section. The Santrampur-Khedapa section is set to design for maximum speed of 65 kmph. The project corridor has fair horizontal geometrics but several locations of horizontal curves, low degree of curvature are identified. A total of 25 deficient curves are identified and the details of such locations having geometric deficiency is given in Volume-II Part-1.

60. Geometric improvement has been carried out, with due consideration of project features, social impact assessment, along with interventions due to green tunnels. Crossroads have been realigned at the junction with main carriageway to reduce the skew angle of the crossing and to ensure the safety. The list of access roads with realignment is provided Volume VIII of this report. The process involved in design intervention is depicted to in the following Figure 6.3. A total of 0.67 ha land acquisition is proposed and details are given in Volume-II Part-1.

6.6.2 Design interventions

6.6.2.1 Speed

61. The horizontal geometry with speeds less than 65 kmph in rural sections is improved. Largely following the mandate improvements are proposed within available RoW. Efforts are also made to provide safe designs in settlements considering speeds 40-65kmph. Santrampur-Khedapa section is conceptualized for a design speed of 65kmph, where project road is passing through rolling terrain and along the hillocks.

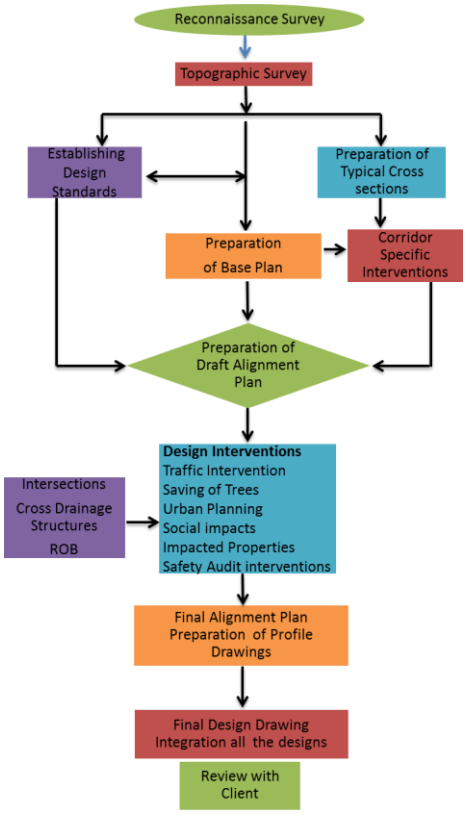


Figure 6-3: Design Interventions

6.6.2.2 Intervention on saving of Trees

62. The project corridor is considered mainly for strengthening with widening of shoulders, in locations of dense green tunnels the shoulder is restricted 1.0m with safety measures.

6.6.2.3 Social Impact

63. The issues and concerns raised by the community have been documented and discussed in detail with the Design Team. The views and suggestions of the community are integrated into the road design wherever feasible. This includes road safety measures such as pedestrian crossings, warning signs, markings, provision for parking spaces, limiting curve improvements within the existing RoW, shifting of alignment etc.

64. Efforts have been made to minimize impacts on structures, trees and other assets located within RoW. A total of 8 structures located within the existing RoW have been saved by way of design modification - shifting the alignment. The structures that have been saved include 4 houses located at chainage 134+850(R), 139+390(L), 16+625 and 16+650, one shrine located at 134+875 (R), Chavdi Mata temple located at 134+890(R), one Dargah located at 161+360(L) and one school located at 12+750(R).

6.6.2.4 Safety

65. The safety is very much incorporated in the design process; interventions include provision of speed humps at exit and entry of settlements, foot paths, improved junction layouts, advanced warning signs, rumble strips, provision of guard rails etc. The safety aspects are discussed in sub-sections 6.7 and 6.8. The detailed interventions on safety are provided through Volume III of this DPR.

6.6.3 Vertical Alignment Design

66. The existing vertical geometry for majority of project road calls for attention. The project road is in place since long, but the proper design of project corridor has probably not taken place in recent times.

67. The design Finished Road Levels (FRL) at the centreline of the roadway is determined from existing road level, embankment and new pavement design. The pavement design necessitates reconstruction, and overlay in sections as discussed in subsequent chapters.

6.6.4 Side slopes

68. The average embankment height of existing project road is about 0.5-1.0m. The side slopes of highway embankments shall be as flat as possible so that drivers accidentally leaving the roadway have better chances of survival. This has been also recommended in IRC-36, which provides a side slope of 1:4 for low embankment upto1.5m height, although due to limited RoW and accommodating the longitudinal drains the slope is kept as 1:2.0. Where required essential safe guards are proposed.

6.6.5 Road Side Drainage

69. Project corridor is adjoining to agro fields, call for attention on drainage. The longitudinal drain is proposed all along project corridor. The drain width is 0.6m at bottom and 1.2:1 side slopes. The drainage analysis along the project road is provided in Volume-II Part-2 of this report.

6.7 INTERSECTION/JUNCTION DESIGN

70. At-grade intersections, unless properly designed can be accident-prone and can reduce the overall capacity of the road. The basic requirements for the design of intersections are not only to cater safe movements of road users, but also to provide them full traffic information by way of signs and pavement markings. Simplicity and uniformity is the guiding principles for intersection design.

71. The project corridor is having four major junctions, 93 minor junctions/intersections and 35 access roads and cart tracks. The location of intersections along the project corridor with various categories of roads, improvements proposed is detailed in this section.

6.7.1 Major Intersections

72. Intersections with category of roads like NH/SH/MDR and having black top surface are presented in Table 6.2.

Table 6.2: Major Intersections/Junctions

Sr. No.	Intersection/ Junction	Type	Chainage (km)	Existing Width (m)	Improvement
SH-002 (Lunawada-Santrampur)					
1	Lunawada	3-Arm	130+010	22.5	As per IRC
2	Entry to Santrampur city	3-Arm	162+775	7+00	As per IRC
SH-152 (Santrampur-Khedapa)					
3	Santrampur	4-Arm	0+000	7.00/3.75	As per IRC
4	Khedapa-Fatepura	3-Legged	9+625	3.5	As per IRC standards

73. The start of the project corridor forms a junction with SH-5 near Lunawada, providing connectivity to Godhra and Rajasthan. The junction design is based on type designs for T junction on NH/SH as per MOST specifications. Another intersection is at entry to Santrampur, provides intersection point for traffic moving towards Santrampur bus terminal and direct access Khedapa road.

74. The staggered intersection at start point of Santrampur-Khedapa section providing connectivity to Zalod and Khedapa is also designed as per IRC standards. The detailed junction design is provided through Volume VIII.

6.7.2 Minor Junctions

75. The project section Lunawada Santrampur and Santrampur to Khedapa is having 68 and 25 minor junction respectively, with category of roads like MDR ODR and VR. Two typical designs (Type-I, Type-II) have been developed for these junctions types. Type-1 is for approach road having carriageway width greater than 5m. Type-2 is for approach road having carriageway width less than 5m. Two junctions are type-1 category in both Lunawada-Santrampur and Santrampur-Khedapa sections.

6.7.3 Access Road and Cart tracks

76. The access road leading to commercial establishments, public amenities and cart tracks leading to agricultural fields are 24 and 11 in number along the Lunawada-Santrampur and Santrampur-Khedapa sections respectively. For access road/carts tracks two types of typical designs are developed i.e. Type-I and Type-II. Type-1 is for access road having carriageway width greater than 5m. Type-2 is for access road having carriageway width less than 5m. Design details of these intersections are provided at Volume VIII- Drawings.

6.1 WAYSIDE AMENTITIES AND SAFETY ASPECTS

6.1.1 Pedestrian Safety

77. Pedestrian crossing across the roads is normally major cause for the accidents. iRAP study findings for Gujarat have highlighted such and other issues. To reduce the speed and subsequently to increase the pedestrian safety rumble strips are proposed at major intersections/junctions and at entry and exit of settlements.

78. **Rumble strips** are provided at 73 locations on Lunawada-Santrampur section and 29 locations Santrampur-Khedapa

79. **Pedestrian Crossings:** Raised pedestrians crossings are provided at 13 locations on Lunawada-Santrampur section and 8 locations Santrampur-Khedapa

6.1.2 Crash Barrier

80. The crash barriers are provided at sharp curves, approaches to canals and green tunnels along with signage's to provide safety for vehicles at such locations. The locations of guard rails are given in volume II Part-1 summing to a length of 9.0 km on both sides. The

crash barriers are provided with W-metal beam type barrier, the details of the same are provided in design drawings.

6.1.3 Signage

81. The detailed signage plan is provided in Volume VIII of this report. The same is checked for compliance to the safety audit report.

6.1.4 Bus Shelter

82. There are existing bus stops along the project corridor. Generally these stops are associated with a settlement area or an intersection with a crossroad. The details of bus shelter and bus bay locations along the project corridor are given Volume II Part 1.The typical design of bus shelter is provided in Figure 6.5. Bus Shelter with bus bay is provided at 50 locations and 33 existing bus shelters are retained.

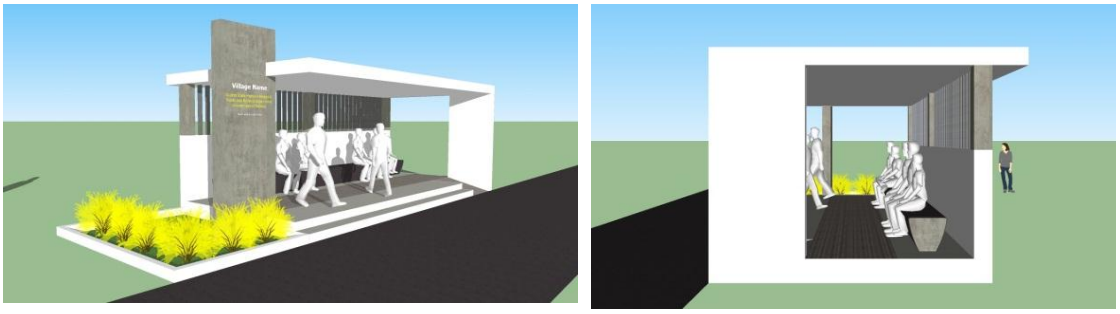


Figure 6-4: Typical Design of Bus-Shelter

6.1.5 Integration of Way Side Facilities

83. The integration of bus shelter, foot path and pedestrian crossing is done and the typical plan is depicted in Figure 6.5.

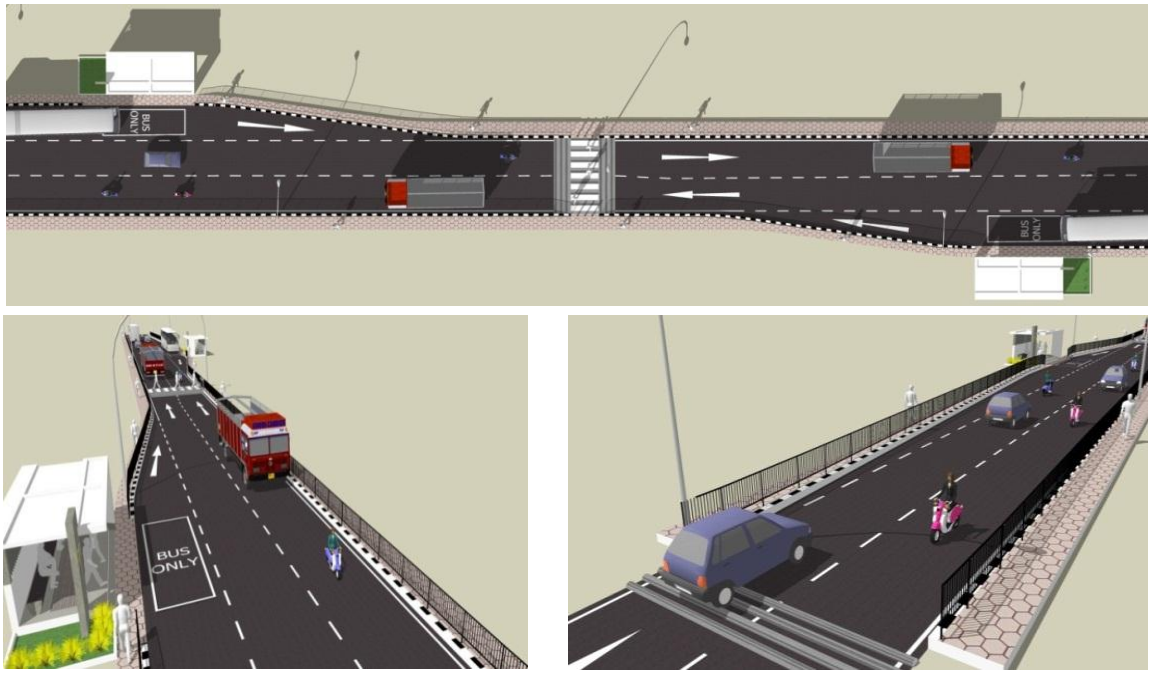


Figure 6.5: Integration of Wayside Facilities

6.1.6 Information on Infrastructure Development

84. The entry and exit point is treated with welcome signage's with due information regarding the project corridors. The same is shown up in Figure 6.6. The detailing is provided in Volume VIII of this report. These signs are provided at locations near exit and entry of project sections.

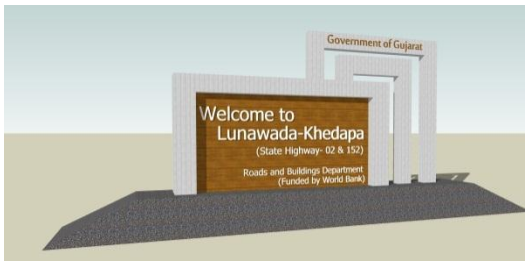


Figure 6.6: Typical View of Welcome Sign

6.1.7 Truck laybys

85. The truck laybys are provided at locations near newly acquired land for road geometry improvement i.e. km 132+425 and 133+200.

6.2 PAVEMENT DESIGN

86. This pavement design section for rehabilitation and upgrading of Lunawada Khedapa (SH No: 02 and 152) road covers the evaluation and detailed design of the pavements of the project corridor. The rehabilitation/upgrading works include pavement widening and strengthening along with new construction associated with shoulders. This report summarizes the findings of the investigations carried out during the course of the project preparation as well as detailing the proposed pavement requirements for Lunawada Khedapa Road. The findings and recommendations presented below are based on assessment of functional and structural evaluation of existing pavement. This coupled with material investigations enabled taking decisions on pavement strategies.

6.2.1 Pavement Thickness Requirements

6.2.1.1 Criteria for selection of pavement treatment option

87. The selection of treatment types is primarily governed by the structural need of the existing pavement and also influenced by pavement condition of the road.

88. The following criteria has been adopted for identification of failed section of bituminous surfacing for this project

- Cracking – sections with cracking exceeding 20% of the area, and/or
- Rutting greater than 20mm and/or
- Settlements of deformations in pavement section in area exceeding 10%
- Extensive ravelling

89. The failed sections as identified above will be considered as candidate sections for reconstruction /rehabilitation of the pavement. The pavements of road sections other than failed sections will be considered for strengthening of pavement by providing overlay.

6.2.2 Proposed road strengthening and Reconstruction needs

6.2.2.1 General

90. Based on Pavement condition survey km 130.010 to 153.00 of Lunawada-Santrampur section and km 0.00 to 2.00 of Santrampur to Khedapa section are considered as failed sections requiring reconstruction. All these sections have cracking more than 20%, ravelling more than 50%, exhibiting high deflection and IRI exceeding 3m/km (range 6.5 and 3) hence fulfils the criteria as detailed above for failed sections.

91. Distresses on pavement for rest of the sections of this corridor i.e. from km 153.00 to km 163.800 of Lunawada-Santrampur section and km 2.00 to 22.689 of Santrampur to Khedapa section are moderate but deflection is moderately high. The riding quality of road is not up to mark. However, to restore the structural and functional serviceability of the pavement it is necessary to strengthen this section of the corridor. The section of road from km 2.00 to 22.689 is considered most suitable candidate for strengthening of pavement by providing bituminous overlays on the existing pavement. The strengthening of pavement option envisages that the candidate preventive treatments will focus primarily on medium thick overlay, shape correction, pavement preparatory works, shoulder repairs and drainage.

92. Pavement design for full depth reconstruction and component for widening of Carriageway to standard two-lane is carried out as new pavement design based on concept of repetitions of million standard axles during the design life and design CBR of sub grade and in accordance with IRC Publication No.IRC:37-2001. The design life of new pavement is considered 10 years for bituminous courses and 15 years for granular base and sub base courses.

93. The road surfaces where the depth of depression is greater than 75mm and exceeding in an area 1 sq.m, will receive full depth repair treatments. The full depth repair treatment shall be carried out by dismantling the existing pavement and excavating the sub-base and sub-grade to a depth of 30 cm.

94. The proposed pavement treatment options are indicated in Table 6.3.

Table 6.3: Abstract of Treatment Option

From (km)	To (km)	Length (km)	Treatment Option	Remarks
Lunawada-Santrampur section SH-02				
130.000	153.000	23	Full depth Reconstruction	Cracking>20% and extensive ravelling, high IRI and high deflection
153.000	163.800	10.8	Strengthening by overlay	Moderate pavement distresses High deflection, IRI high
Santrampur-Khedapa section SH-152				
0.00	2.00	2	Widening to 7m and full depth reconstruction	Cracking>20% and extensive ravelling, high IRI and high deflection
2.00	22.689	20.689	Strengthening by overlay	Moderate pavement distresses High deflection & IRI

6.2.2.2 Pavement Strengthening (Overlay) Strategy

95. Pavement strengthening strategy adopted in this project envisages that after attending to the rectification of defects like cracking, potholes, deep depressions and rutting etc overlay

will be laid over the existing bituminous surface. The design of the overlay has been carried out to determine the strengthening requirement for a forecast period of 10-year's traffic demand.

96. The annual rainfall in project area is >2000 mm and the design traffic (msa) is less than 10, the proposed wearing course shall be SDBC and the binder course of required thickness.

6.2.2.3 Pavement Composition

97. The designed new pavement and overlay thickness for various sections for reconstruction, widening and strengthening is given in Table 6.4.

Table 6.4: Pavement Composition

Section	Overlay		New Pavement/ Reconstruction				
	Wearing course	Strengthening course	Wearing course	Binder course	Granular base course	Granular sub base course	Subgrade CBR & thickness
Lunawada Santrampur section							
km 130 to 153 (Reconstruction) No widening			25 mm SDBC	55 DBM	250 mm WMM	300 mm GSBC	500 mm CBR-5
km 153 to 163.800 (Strengthening) No widening	25 mm SDBC	55 DBM					
Santrampur to Khedapa section							
km 0.00 to 2.00 Reconstruction & widening			25 mm SDBC	55 DBM	250 mm WMM	250 mm GSBC	500 mm CBR-5
km 2.00 to 14.00 Strengthening and widening	25mm SDBC	*	25 mm SDBC	55mm DBM	250 mm WMM	250 mm GSBC	500 mm CBR-5
km 14.00 to 22.00 Strengthening and widening	25mm SDBC	55 mm DBM	25 mm SDBC	55mm DBM	250 mm WMM	250 mm GSBC	500 mm CBR-5

*PCC with DBM

6.3 WIDENING SCHEME

98. The pavement widening scheme is provided in Table 6-15 to Table 6-16. Pavement sections are prepared with respect to type of treatment, varying widths, improvement options and road furniture in line with existing site condition on situation to situation;

Table 6.5:Treatment Option

Type	Treatment Option
Type A:	Reconstruction; 7.0m carriageway+2.5m Hard Shoulder
Type B:	Overlay and Shoulder Widening; 7.0m carriageway +2.5 Hard Shoulder
Type B1:	Overlay and Shoulder Widening; 7.0m carriageway +1.0 Hard Shoulder
Type C:	Eccentric Widening with 3m Extra width (total 10m B.C)+1.0 m Hard Shoulder
Type D:	Overlay over the Existing Pavement + Addition of Closed Drains
Type E:	Reconstruction; 7.0m carriageway+1.0m Hard Shoulder
Type F:	Overlay and Widening to 7.0m carriageway +1.0 Hard Shoulder
Type G:	Eccentric Widening with 1m Extra width (total 8m B.C)+1.0m Hard Shoulder
Type H:	New Construction, Divided Four lane

Table 6.6:Widening Schedule

From (km)	To (km)	Length (m)	Type	Existing CW width (m)	Existing Shoulder (m)	Proposed CW (m)	Proposed HS (m)
SH-2: Lunawada-Santrampur							
130+010	130+400	0.390	Type H	7	1.000	7+2+7	2.5
130+400	153+000	22.600	Type A	7	1.000	7	2.5
153+000	154+850	1.850	Type B	7	1.000	7	2.5

From (km)	To (km)	Length (m)	Type	Existing CW width (m)	Existing Shoulder (m)	Proposed CW (m)	Proposed HS (m)
154+850	154+970	0.120	Type C	7	1.000	10	1
154+970	155+400	0.430	Type B	7	1.000	7	2.5
155+400	155+575	0.175	Type C	7	1.000	10	1
155+575	155+900	0.325	Type B	7	1.000	7	2.5
155+900	156+000	0.100	Type C	7	1.000	10	1
156+000	158+850	2.850	Type B	7	1.000	7	2.5
158+850	158+925	0.075	Type C	7	1.000	10	1
158+925	160+660	1.735	Type B1	7	1.000	7	1
160+660	160+725	0.065	Type C	7	1.000	10	1
160+725	161+330	0.605	Type B1	7	1.000	7	1
161+330	161+400	0.070	Type C	7	1.000	10	1
161+400	162+800	1.400	Type B1	7	1.000	7	1
162+800	163+800	1.000	Type D	7/10	1.000	10	1.5/With Footpath
SH-152: Santrampur-Khedapa							
0+000	0+065	0.065	Type H	3.75	1.000	7+2+7	2.5
0+065	2+000	1.350	Type E	3.75	1.000	7	1
2+000	3+050	1.050	Type F	3.75	1.000	7	1
3+050	3+400	0.350	Type E	3.75	1.000	7	1
3+400	10+700	7.300	Type F	3.75	1.000	7	1
10+700	10+800	0.100	Type E	3.75	1.000	7	1
10+800	12+600	1.800	Type F	3.75	1.000	7	1
12+600	12+800	0.200	Type G	3.75	1.000	8	1
12+800	13+750	0.950	Type F	3.75	1.000	7	1
13+750	14+000	0.250	Type G	3.75	1.000	8	1
14+000	15+150	1.150	Type F	3.75	1.000	7	1
15+150	15+425	0.275	Type G	3.75	1.000	8	1
15+425	15+650	0.225	Type F	3.75	1.000	7	1
15+650	16+175	0.525	Type G	3.75	1.000	8	1
16+175	16+325	0.150	Type F	3.75	1.000	7	1
16+325	16+450	0.125	Type E	3.75	1.000	7	1
16+450	16+950	0.500	Type F	3.75	1.000	7	1
16+950	17+500	0.550	Type E	3.75	1.000	7	1
17+500	17+600	0.100	Type F	3.75	1.000	7	1
17+600	17+975	0.375	Type G	3.75	1.000	8	1
17+975	18+650	0.675	Type F	3.75	1.000	7	1
18+650	19+050	0.400	Type E	3.75	1.000	7	1
19+050	19+775	0.725	Type F	3.75	1.000	7	1
19+775	20+050	0.275	Type G	3.75	1.000	8	1
20+050	20+650	0.600	Type F	3.75	1.000	7	1
20+650	21+100	0.450	Type E	3.75	1.000	7	1
21+100	22+100	1.000	Type F	3.75	1.000	7	1
22+100	22+690	0.590	Type G	3.75	1.000	8	1

Note: Section from km 2+000 to km 14+000, Provide overlay of 25 mm SDBC on existing pavement

6.4 IMPROVEMENT PROPOSAL FOR STRUCTURES

99. **Major and Minor Bridges:** There are 2 major bridges on this corridor i.e. one on Lunawada – Santrampur stretch (SH-002) and other on Santrampur – Khedapa stretch (SH-152). As condition of these bridges is good it is proposed to be retained. Out of 16 minor bridges 11 newly constructed are retained as it is and among rest of 5 minor bridges 2 needs repair and the other 3 needs widening and repair. The details of proposed treatments for bridges are provided in Table 6.7.

Table 6.7: Proposed Treatment: Lunawada – Khedapa (SH-002 & SH-152)

Sr. No.	Design Chainage (km)	Type of Bridge	Nos. of Span	Span length (m).	Total Length of Bridge	Total Width of Bridge	Carriageway Width (m)	Proposal
Lunawada – Santrampur (SH-002)								
1	133+965	Box Minor	2	3.5	7	12	7	Retain new structure
2	136+318	Box Minor	2	3.5	7	12	7	Retain new structure
3	136+500	Box Minor	2	3.5	7	12	7	Retain new structure

Sr. No.	Design Chainage (km)	Type of Bridge	Nos. of Span	Span length (m).	Total Length of Bridge	Total Width of Bridge	Carriageway Width (m)	Proposal
4	137+600	Box Minor	2	3.5	7	12	7	Retain new structure
5	140+678	Box Minor	2	3.5	7	12	7	Retain new structure
6	141+062	Minor	1	7	7	8.4	7	Repair
7	144+090	Minor	2	7.3	14.6	9.8	7	Retain new structure
8	151+015	Minor	2	8.2	16.4	7.7	6.5	Repair and widening
9	157+700	Minor	3	10.7	32.1	7.5	6.7	Repair and widening with footpath
10	161+960	Minor	3	4.2	12.6	8	6.8	Repair and widening
11	162+750	Major BM Arch	9	7.9	71.1	8.5	7.4	Repair
Santrampur – Khedapa (SH-152)								
12	0+410	Box Minor	2	3.3	6.6	12	5.4	Retain new structure
13	1+645	Box Minor	4	3.5	14	22	3.6	Retain new structure
14	5+230	Major	6	16	96	8.2	7.2	Repair
15	9+365	Box Minor	2	3.5	7	12	3.5	Retain new structure
16	10+155	Minor Submersible	5	10	50	8.3	7	Repair
17	14+433	Box Minor	2	3.5	7	12	3.5	Retain new structure
18	19+170	Box Minor	2	3.5	7	12	3.5	Retain new structure

100. **Culverts:** The condition of some culverts along this corridor are bad, more over these are very old structures with loose joints, blockage of pipes, scour and growth of vegetation. Head walls of some culverts are damaged. Hence reconstruction is suggested of such highly damaged culverts.

101. The summary of proposed treatment for culverts is presented in Table 6.8.

Table 6.8: Summary of Proposed Treatment

Treatment	Numbers		
	Lumawada-Santrampur (SH-002)	Santrampur-Khedapa (SH-152)	Total
Repair	25	11	36
Repair and Widen	2	7	9
Replace with new	18	21	39
Retain new structure	3	5	8
Headwall Reconstruction	-	1	1
Total	**48**	**45**	**93**

7 ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT

7.1 ENVIRONMENTAL IMPACT ASSESSMENT

102. The proposed upgradation (strengthening and widening) of Lunawada-Khedapa (SH-02 and 152) are designed within the available RoW. The environment and social screening and the subsequent consultations with the stakeholders confirms that there are no sensitive environmental features that are identified along the corridor except for the reserved forest patches which has no wildlife. In addition to the construction related impacts, the key issues raised were (i) Safety issues with respect to geometric / curve improvement and provision of road safety furniture at settlement / urban areas and temples, schools and cultural properties, and (ii) improvement and provision of road safety furniture at settlement / urban areas, temples and schools (iii) Provision for sufficient drain facility including upgrading the bridges and culverts and provision of additional culverts at various locations.

103. There are 1885 avenue trees that are to be felled as part of the proposed upgradation. As discussed earlier, the said project corridor is a combination of two State highways viz, SH-2 and SH-152. As per the Government of Gujarat Gazette dated 5th July, 1973, Lunawada-Santrampur section (SH-02) is notified under protected forest, and requires forest clearance for diversion of 18.33 ha of forest area for non-forest purpose. Apart from the protected forest, the project corridor requires diversion of parcels of reserve forest area within the CoI at various stretches. After a joint inspection with the forest officials, the RF area that needs diversion is estimated as 19.61 ha. For obtaining forest clearances as well as permission for tree felling, proposals have been submitted to the forest department for necessary action.

104. The environmental impacts associated with the proposed upgradation are construction related impacts associated with road widening projects. These are proposed to be addressed through good engineering practices and adoption of environmental management measures proposed in the Environmental Management Plan (EMP) of the corridor. The EMP budget of INR 2.56 million encompasses the management measures that needs to be implemented, for carrying out the environmental monitoring, HIV/ AIDS prevention measures as well as provision of enhancement measures at Chavdi Mata Temple (134+900), Simaliya Primary School (13+850) and tree plantation at Malanpur Primary School (1+050) and Harigarna Primary School (145+200).

7.2 LAND ACQUISITION AND RESETTLEMENT IMPACTS

1. A total of 0.48 ha of private land belonging to 4 households will be affected due to curve improvement at Lunawada village (km 132+290 to km 132+525 on RHS and km 133+035 to km 133+312 on LHS), Ukedi village (km 135+934 to 136+172 on LHS), and at Godna Muvada village (km 139+528 to 139+789 on LHS) in Lunawada Taluka. Other than these four locations, the proposed improvement will be carried out within the existing RoW of 24 m throughout the corridor. Other than the agricultural land, 9 commercial structures will

be affected due to the proposed improvement which are kiosks and are of non-titleholders. Land acquisition and resettlement of the affected persons shall be carried out in accordance with the provisions of the RPF of the project.

2. The proposed road improvement will not affect any cultural properties or community assets. The structures of Chavadi Mata temple (km 134+890) and a Dargah (at km 161+450) has been protected with appropriate mitigation measures by way of shifting alignment within the RoW and removing/limiting hard shoulders.

3. Seven public consultation meetings were held along the project corridor with road side communities to obtain their views and suggestions regarding the proposed project interventions. The consultations have provided inputs towards mitigation of impacts, improvement in designs, and preparation of resettlement plan and its implementation. Based on the suggestions design modifications including curve improvement, provision of road safety measures such as pedestrian crossings, warning signs, markings, etc., has been carried out.

105. A resettlement budget of INR 20.68 million including compensation for the affected land & structures, assets within the affected properties and rehabilitation and resettlement assistance has been estimated. Any unforeseen impacts on resettlement during implementation will be taken up in accordance with the Resettlement Policy Framework (RPF) of the project.

8 ACCESSIBILITY AND MOBILITY TO TRANSPORT FACILITIES IN VILLAGES: SUMMARY

8.1 INTRODUCTION

17. Baseline socio-economic information related to accessibility and mobility to transport facilities in the villages along the proposed corridor has been collected and analyzed. The study intended to assess the travel pattern of villagers, which includes, travel time to major markets, educational and health institutions, frequency of trips to nearby places, perception of villagers on travel situation, etc. The findings of the present study shall form basis for measuring impacts after the proposed roads are improved. There are 106 villages located within 2 km bandwidth of the proposed corridor, of which 53 villages are chosen for the survey. Altogether 265 households (includes 1080 individuals) are surveyed.

8.2 PROFILE OF SAMPLE POPULATION

18. **Gender and Age Distribution:** Age distribution shows that 52 percent of the population belongs to the age group of 26-60 and 14 percent of the population is in the age group of 6-14.

19. **Education profile:** 38% of the population has secondary level of education and 16 percent are having graduation level of qualification.

20. **Income Profile and Dependency Ratio:** 84 percent of the sample households have a monthly income of less than Rs.3000, of which 63 percent have a monthly income less than Rs.2000. The dependency ratio is 2.8:1.

21. **Occupation Profile:** 79 percent of sample population is engaged in agriculture.

8.3 MAJOR FINDINGS

22. **Trip Information:** analysis of trip information of villagers is based on 706 cases of usual trip information of 265 surveyed households. Analysis based on chi-square test shows that trip information does not vary significantly between income-groups.

23. **Mode of Travel**: Amongst the 706 usual trip information, 306 (43 percent) travel on foot and 379 trips (54 percent) are by bicycle, auto-rickshaw, bus or *chakda*.

24. **Frequency of Travel:** 36 percent of the 706 usual trips are on daily basis, only 1 percent of the trips are for 3-4 times in a week and 23 percent trips are on monthly basis. Among all vehicles, bus and *chakda* are the most used modes for usual trip. Bus is used for 63.8 percent of usual trips. Of the total trips using vehicles, 5 percent trips are on daily basis and 32 percent are for monthly basis.

106. **Perception about Present Transport Situation:** Villagers opined about the requirement of good quality roads, more number of buses, improved access to health centres, etc.

9 PROJECT COSTING

9.1 PROJECT COST

107. The project corridor is designed involving widening, reconstruction and maintenance of both pavement and cross-drainage structures. Based on the estimated quantities and extensive rate analysis, combined project cost including environmental and social cost is Rs Rs 117.22 crore. The total cost is presented in two subheads as Civil Construction Cost and Social Cost. Environmental Management Plan (EMP) related cost is factored in construction cost itself. The total cost under two sub heads is given in Table 9.1.

Table 9.1: Project Cost

Sr. No.	Description	Amount (INR)
1	Civil Construction Cost	1,15,15,39,864
2	Social Cost	2,06,82,070
Grand Total		**1,17,22,21,934**

10 ECONOMIC ANALYSIS

10.1 RESULTS OF ECONOMIC ANALYSIS

10.1.1 Base Analysis

108. The economic analysis has been undertaken for the project road by using RUCS equations. The results obtained are in terms of the Economic Internal Rate of Return (EIRR), Net Present Value (NPV), as presented below for project corridor as a whole.

Table 10.1: Result of Economic Analysis

Scenarios	Description	EIRR					
		Without Time		With Time		With Accidents	
		20 years	30 years	20 years	30 years	20 years	30 years
I	Base Costs + Base Benefits	4.82%	8.03%	29.15%	29.52%	29.93%	30.28%
		NPV (in million Rupees)					
I	Base Costs + Base Benefits	-373	-285	1,328	1,680	1,402	1,772

109. The project is economically viable only with VOT and accident cost savings. Since in total traffic, the component of passenger vehicles is very high, substantial increase is observed in the EIRR when savings in value of travel time is considered.

10.1.2 Sensitivity Analysis

110. Any investment is subject to risks and uncertainties. All risks culminate into either increase in project cost, reduction in benefits or both put together. In order to cover the above stated risks, a detailed sensitivity analysis, with respect to the sensitive parameters, has been undertaken. The various sensitivity scenarios considered are as follows:

- Sensitivity 1: Base Costs plus 15% and Base Benefits (15% Increase in cost);
- Sensitivity 2: Base Costs and Base Benefits minus15% (15% reduction in benefits); and
- Sensitivity 3: Base Costs plus 15% and Base Benefits minus 15% (15% Increase in costs and 15% reduction in benefits).

111. The results of the sensitivity analysis have been presented in Table 10.2.

Table 10.2: Results of Sensitivity Analysis

Scenarios	Description	EIRR					
		Without Time		With Time		With Accidents	
		20 years	30 years	20 years	30 years	20 years	30 years
I	Base Costs plus 15% and Base Benefits (15% Increase in cost)	3.23%	6.78%	25.78%	26.29%	26.50%	26.98%
II	Base Costs and Base Benefits minus 15% (15% reduction in benefits)	3.20%	6.78%	25.59%	26.11%	26.30%	26.79%
III	Base Costs plus 15% and Base Benefits minus 15% (15% Increase in costs and 15% reduction in benefits)	1.69%	5.61%	22.53%	23.23%	23.18%	23.84%
		NPV (in million Rupees)					
I	Base Costs + 15% and Base Benefits	-508	-420	1,192	1,545	1,267	1,636
II	Base Costs and Base Benefits minus 15%	-437	-361	1,009	1,310	1,072	1,387
III	Base Costs + 15% and Base Benefits minus 15 %	-572	-496	873	1,174	937	1,252

112. The sensitivity analysis reflects project viability in the worst scenario when savings from VOT is also considered. However, with additional benefits like accident cost savings, the project attractiveness gets better.

10.2 IMPACT OF PROJECT DELAY ON ECONOMY

113. The project needs to be planned and implemented soon. The savings in travel time is precious for the economy. In case, the project implementation is delayed, the cumulative loss in value of travel time is likely to go up from Rs 234.3million in 2015 to about Rs 9448.9 million in the year 2040. Therefore, the state should get the project initiated soon. (Refer Figure 10.1).

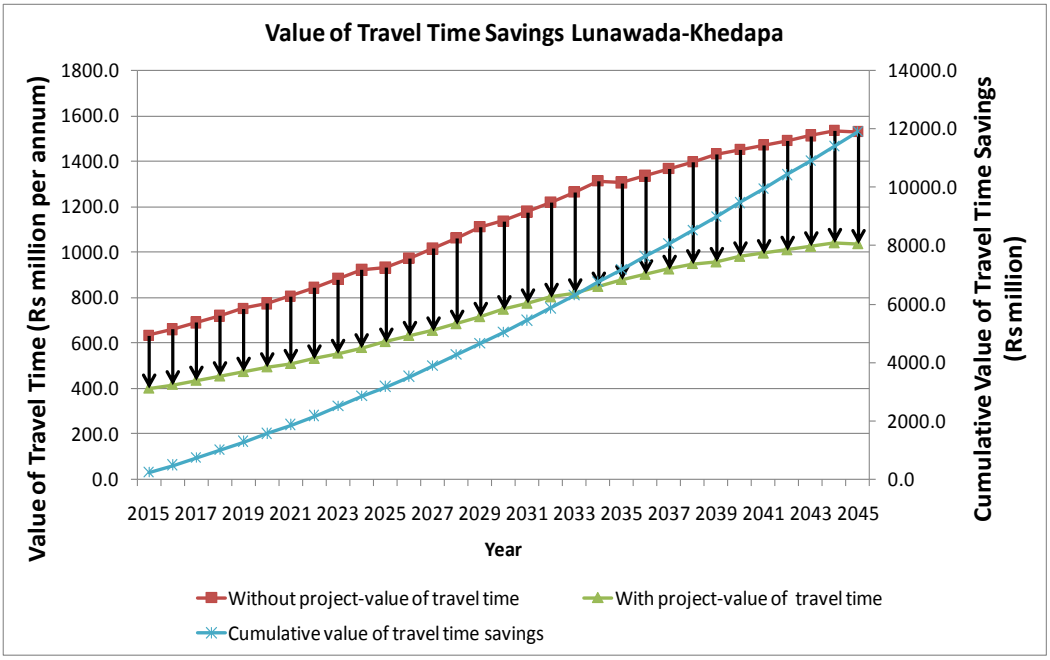


Figure 10.1: Value of Travel Time Savings – Lunawada-Khedapa

10.3 CONCLUSION

114. The road project ***is desirable from the society's point of view.*** The project corridor as a whole is found to be economically viable with positive net present values and EIRR greater than 12%, even in the worst scenario of drop in benefits coupled with increase in cost. Hence, based on the above results, the project is recommended for implementation.