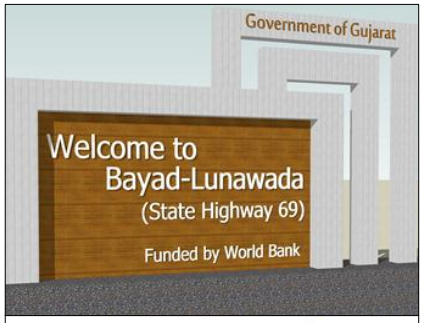

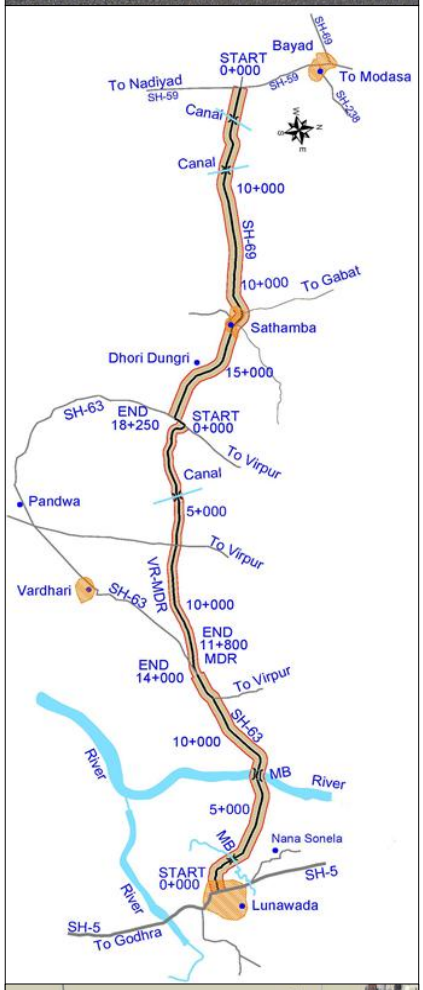

ROADS AND BUILDINGS DEPARTMENT

GOVERNMENT OF GUJARAT

GSHP-II

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

Detailed Project Report

Executive Summary

(BAYAD – LUNAWADA)

January 2013

LEA Associates South Asia Pvt. Ltd.

LEAdership in engineering & planning solutions

EXECUTIVE SUMMARY

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1 INTRODUCTION

1.1 PROJECT BACKGROUND

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-Himmatnagar	SH-55	66.15
Rehabilitation	9	Paliyad-Dhandhuka	SH-001	46.00

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

1.2 BROAD OBJECTIVES AND SCOPE

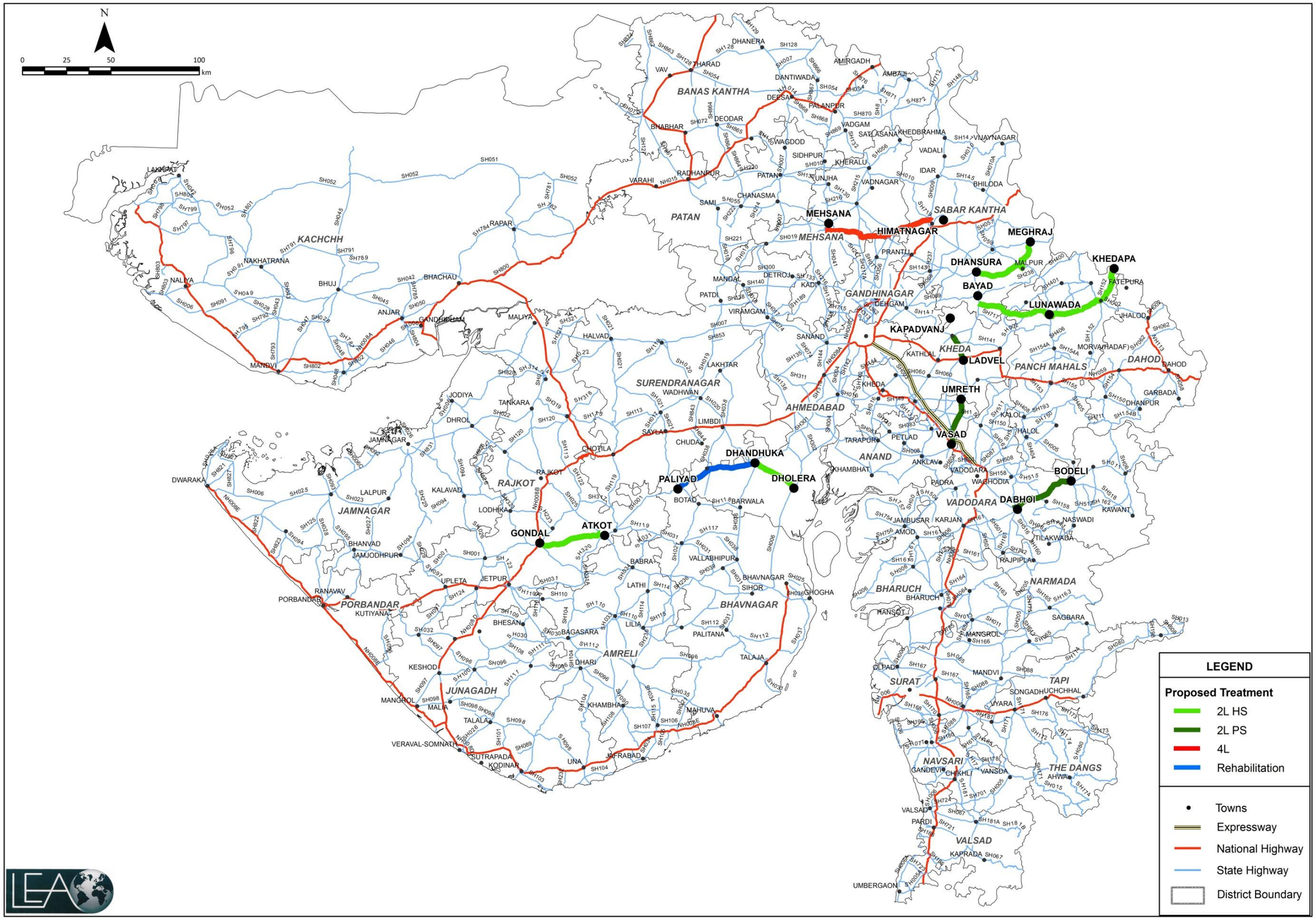
6. The broad objective of the assignment is to have detailed engineering project ready for bidding. It includes economic analysis for each section, integration of road safety audit in final design, implementation and O&M along with Environmental Impact Assessment, Environmental Management Action Plan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

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**

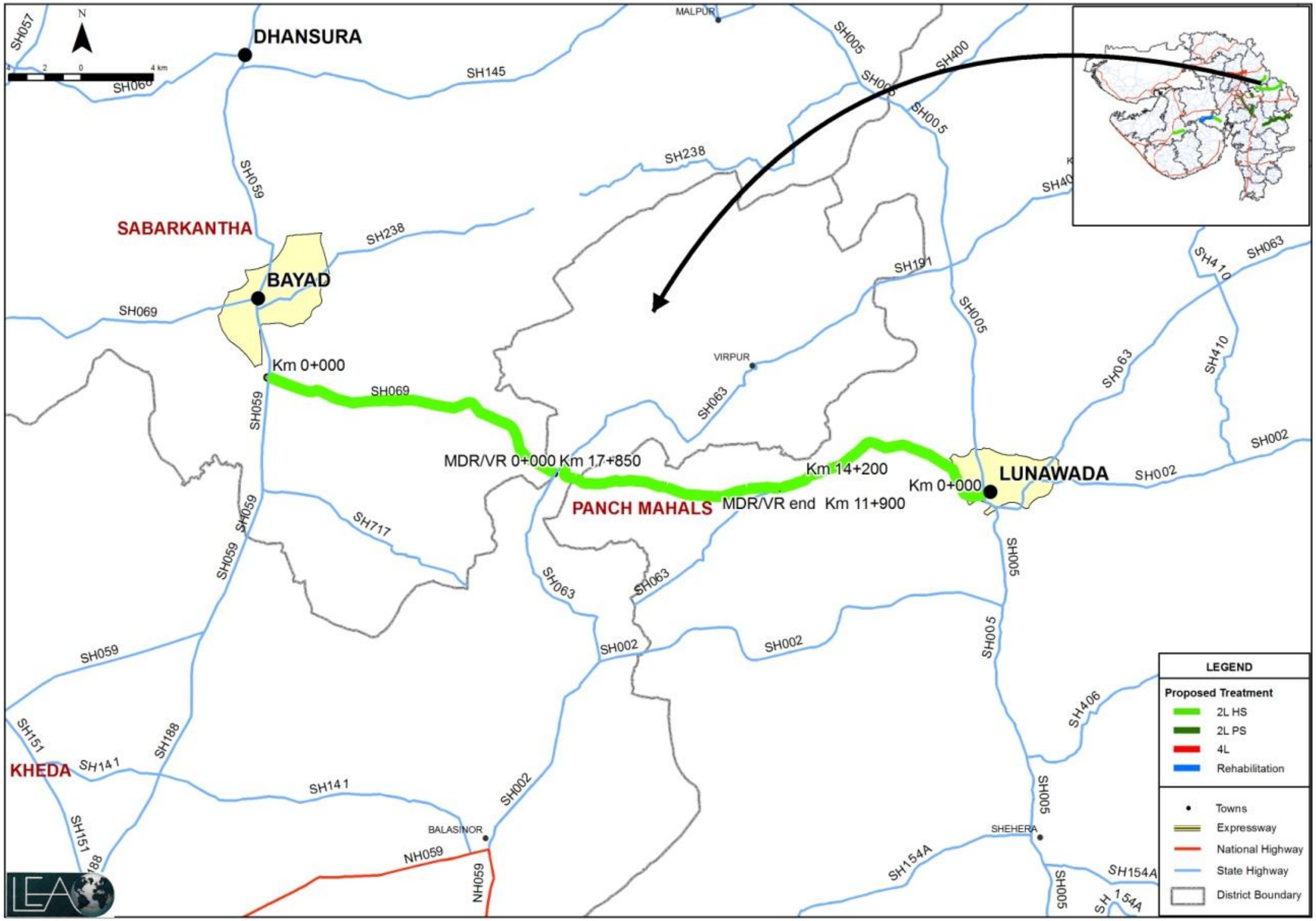
1.3 DETAILED PROJECT REPORT

7. This Executive Summary of DPR pertains to two laning with hard shoulder for the project corridor Bayad-Lunawada. 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

8. The corridor Bayad-Lunawada enroutes Bayad Taluka of Sabarkantha district, Virpur Taluka of Kheda and Lunawada taluka of Panchmahal district entailing a total length of nearly 44.5km. Project corridor adjoins 28 villages and 1 town with a population of 80,884 as per Census 2001.

2.1 PROJECT CORRIDOR PROFILE

9. **Population Distribution:** Project talukas through which the corridor passes comprises total population of 5.64 lakh in 2011 which was 5.03 lakh during 2001. Population of these talukas grew at an Average Annual Growth Rate (AAGR) of 1.2% during the year 2001 to 2011. Total 28 census villages and 1 town (Lunawada) abut the project corridor. Total population of villages and towns abutting corridor is 80,884 which is almost 16% to the Talukas population (Census 2001).

10. The total number of HH along project corridor is 15,695. Average Household (HH) size along the project corridor villages is 5.2.

11. **Population Composition:** The overall population below 6 years age in project corridor talukas is 13%. The average sex ratio for project corridor talukas during 2001 was 932 which increased to 939 during 2011. Sex ratio for project corridor villages during 2001 was 925. Similarly, looking into the Juvenile sex ratio[2] it was analysed that as against the juvenile sex ratio of 878 for project corridor Talukas, the project corridor villages had sex ratio of 864.

12. **Social Characteristics:** As per the Provisional Census 2011, project corridor talukas possess literacy rate of 77% which was 67% during 2001. Corresponding to this, average literacy rate in project corridor villages is 75%; constituting 86% male literates and 63% females.

13. As per Census 2001, total SC and ST population for settlements and villages along the corridor accounts for the figure of 7,985 which is nearly 10% of total population for settlements along the project corridor.

14. **Occupational Structure:** Total workers according to census 2001 in project corridor taluka were 2.50 lakh. Taking into account the composition of workers majority of workers are cultivators (49%) followed by workers engaged in other activities (26%).

15. The total workers in project corridor settlements are 33,561. Workers composition for the villages/settlements along the corridor shows highest share of workers engaged in others sector[3] (54%) followed by cultivators (27%).

[2]Juvenile Sex Ratio is the sex ratio of population in age-group 0-6 years

[3]Other Workers: all those workers other than cultivators or agricultural labourers or household industry workers are 'Other Workers'. The type of workers that come under this category of 'OW' include all

16. **Workforce Participation Ratio (WPR):** The WPR for project corridor taluka in 2001 was 50%. Comparing and analysing the male WPR and Female WPR, it was recorded that the female WPR is 31% as against male WPR of 51%. The average WPR for Project corridor settlements is 41% which is lower than the Talukas WPR.

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

17. Bayad-Lunawada road link is bridging corridor in continuity to Lunawada-Khedapa, another project section, establishing connectivity of tribal areas to mainstream; i.e. Lunawada, Santrampur and tribal areas till Rajasthan border with Gandhinagar, capital of the state. The corridor covers a length of 44.66 km. The corridor starts about 2.5 km down south of Bayad town while ends near Lunawada town. Lunawada town, which is taluka head quarter, is falling on north-south important state highway connectivity i.e. SH-005[4]. The project corridor falls under Central Region of Gujarat. The Chainages mentioned are existing Chainages.

Table 3.1: Existing Corridor Characteristics

Sr. No.	Components	Details			
1	Corridor Name and SH Number	Bayad-Lunawada (SH-063, VR/MDR, SH-069)			
2	District	Sabarkanta-Kheda-Panchamahal			
3	Sections	Bayad-Dhori Dungari (SH-069)	Dhori Dungari-Aaspur (VR)	Aaspur-Garasiyawada (VR)	Garasiyawada-Lunawada (SH-063)
4	Start Chainage (km)	0+000	0+000	0+000	0+000
5	End Chainage (km)	18+250	0+610	11+800	14+200
6	Total Length of Corridor (km)	44.86			
7	Right of Way (m)	18	24	12[5]	18
8	Carriageway width (m)	5.5	7	3.5/7	7
9	Intersection/Junction	6			
10	Traffic	SH-069: Km 14+100			SH-063: Km 10+500
		2,365 Vehicles (2,752 PCU)			2,363 Vehicles (2,726 PCU)
11	Terrain type	Plain	Plain	Rolling	Plain
12	Soil Classification	Clayey	Gravel	Gravel	Silty Clay
13	Pavement Condition	Fair to Poor	Fair	Widening Under Progress	Fair
14	CD Structures				
	Major Bridge	2			
	Minor Bridge	5			
	Pipe Culvert	55			
	Slab Culvert	2			
	Box Culvert	-			
	Total Number of Structures	64			
15	Riding Quality- IRI (m/km)	4.23-8.54	4.36	5.92-8.70	3.16-5.15
16	Existing Crust Thickness	370-630	300	220-500	410-750
17	Soaked CBR	1.30-15.80	6.70	3.10-16.10	3.20-6.90
18	Vehicle Damage Factor				

Vehicle Type	VDF
Mini Bus	0.1
LCV	0.3
BUS	0.5
2-Axle Truck	5.96
3-Axle Truck	6.8
M-Axle Truck	4.6

[4] SH-005 is Eastern State Highway, an alternative to NH8 within the state. Halol-Godhra-Shamlaji is four laned under PPP-VGF by GSRDC and GoG. SH5 and project corridors (Bayad-Lunawada-Khedapa) intersect each other in Lunawada.

[5] Proposed RoW is 24m.

4 TRAFFIC ANALYSIS AND FORECAST

4.1 INTRODUTION

18. 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

19. The analysis of traffic volume data indicates an ADT of 2,438 vehicles, equivalent to 2,837 PCU, at SH-069: km 14+100 (Bayad-Garasiyawada Jn) while 2,436 vehicles, equivalent to 2,811 PCU, are observed at SH-063: km 10+500 (Garasiyawada Jn to Lunawada). Two wheelers comprise the maximum share of vehicular traffic of about 46% at km 14+100, and about 41% at km 10+500. Around 6.9 to 6.8% of the total traffic is travelling within peak hour as observed at km 14+100 and km 10+500.

20. Travel desire pattern on the corridor indicates most of the traffic travelling within the state. Madhavamkampa near Bayad and Lunawada are identified as major intersection/junctions at which peak hour volume observed is 1,574 and 3,003 respectively. Speed and delay study indicates the existing average speed on the corridor as 33 kmph on Bayad-Garasiyawada Jn section and 40 kmph on Garasiyawada Jn to Lunawada section. The maximum VDF values are observed as 5.71 and 5.50 for 2-axle trucks and 3-axle trucks respectively.

21. 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 39% and 29% on km 14+100 and 30% and 34% on km 10+500 of the passenger and goods trips, respectively, to be made daily.

22. The major commodity being carried on the corridor is building materials. Lunawada-Balasinor (SH-063) is identified as influencing corridor on which an AADT of 2,143 vehicles (2,627 PCU) is observed.

23. 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	Proposed Chainage and Length			Section	Present Lane Configuration	Total	PCU
	Start	End	Length				
1	0	17.8	17.8	Junction	IL	2,365	2,752
	0	11.9	11.9	VR/MDR Section	2L	2,365	2,752
2	14	0	12	Rural	2L	2,363	2,726

4.3 TRAFFIC FORECAST

24. 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 14+100							km 10+500						
	2011	2015	2020	2025	2030	2035	2040	2011	2015	2020	2025	2030	2035	2040
Forecasted Traffic by Econometric Method														
Vehicle	2,365	3,005	4,087	5,367	6,921	8,814	11,285	2,364	2,994	4,057	5,305	6,796	8,595	10,915
PCU	2,753	3,497	4,805	6,473	8,646	11,489	15,386	2,727	3,403	4,579	6,039	7,880	10,238	13,409
Forecasted Traffic by Trend Based Method														
Vehicle	2,365	2,878	3,629	4,585	5,710	6,746	7,548	2,363	2,873	3,622	4,573	5,710	6,759	7,571
PCU	2,752	3,361	4,257	5,411	6,800	8,095	9,108	2,726	3,296	4,129	5,190	6,490	7,700	8,645
Forecasted Traffic by Flat 5% Growth Rate														
Vehicle	2,365	2,875	3,669	4,683	5,976	7,627	9,735	2,363	2,873	3,666	4,679	5,972	7,622	9,728
PCU	2,753	3,346	4,270	5,450	6,956	8,878	11,331	2,726	3,314	4,230	5,398	6,890	8,793	11,222

4.4 IMPROVEMENT OPTIONS

25. Improvement options are further reconfirmed with concerns related to geometry, safety, land acquisition, environmental and social aspects, before incorporation in the final design of the corridor. The proposed improvement option is presented in Table 4.3.

Table 4.3: Proposed Improvement Option

Sections	Proposed Chainage and Length			Present Lane Configuration	Proposed Improvement Option	Total	PCU
	Start	End	Length				
1	0	17.8	17.8	IL	2L+HS	2,365	2,752
	0	11.9	11.9	2L	2L+HS	2,365	2,752
2	14	0	12	2L	2L+HS	2,363	2,726

5 ROAD SAFETY AUDIT

5.1 PROJECT BRIEF

26. Bayad-Lunawada 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. 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

27. 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. 24 fatalities and 28 injuries reported in a span of 6 years (2006 – 2011). The data indicates most accidents concentrated at Savela Kampa, Talad and Sathmba.

5.3 SAFETY ISSUES FOR PROJECT CORRIDOR

5.3.1 Carriageway

28. It is observed that shoulders are inadequate in width for Lunawada to Garasiyawada 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.

29. For Bayad to Dhoridungri and VR/MDR, 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

30. 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

31. There are five major junctions 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 behavior 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

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

5.3.5 Traffic Management and Control Issues

33. It is identified that traffic signs needs to be provided at many places. Existing signage 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

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

35. For Bayad-Dhori Dungri section

a. Deficient 7 horizontal curves;
b. Identified 50 major/minor intersections (including access roads);
c. Identified 8 highway sections near habitations and;
d. Identified deficient 28 structures.

36. For VR/MDR section

a. Deficient 30 horizontal curves;
b. Identified 20 major/minor intersections (including access roads);
c. Identified 1 highway section near habitation and;
d. Identified deficient 36 structures.

37. For Lunawada-Garasiyawada section

a. Deficient 13 horizontal curves;
b. Identified 43 major/minor intersections (including access roads);
c. Identified 1 highway section near habitation and;
d. Identified deficient 24 structures.

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

6 DESIGN OF CORRIDOR

6.1 INTRODUCTION

39. 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

40. 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.

41. 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

42. 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

43. 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.

44. 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.

6.5 IMPROVEMENT OPTION

45. The project corridor is having the existing carriageway widths as 5.5m, 3.5m and 7.00m i.e. for Bayad-Dhoridungri, Dhoridungri-Garasiyawada (VR) and Garasiyawada-Lunawada (SH-63) sections respectively. Project scope is for widening of existing road from IL/Single lane to 2L+HS configuration. The width of hard shoulders is adopted as 1.0m[6] either sides.

46. The project corridor has right of way of 18m from for SH-69 and SH-63. While existing of Village Road section has 12 m as ROW, the same is proposed as 24 m RoW with additional Land Acquisition. The improvement option for project corridor is seen with respect to traffic, safety, speed and mobility. World Bank advises and shared iRAP**7** reports are also taken into consideration.

47. The projected traffic on any of the sections does not call for any higher order improvement which is IL/2L. This need to be seen beyond traffic numbers to bridging the tribal villages and talukas to mainstream. 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
Bayad to Garasiyawada	PCU	2,752	3,361	4,257	5,411	6,800	8,095	9,108
	V/C with 2LHS	0.09	0.11	0.14	0.18	0.23	0.27	0.30
Garasiyawada to Lunawada	PCU	2,726	3,296	4,129	5,190	6,490	7,700	8,645
	V/C with 2LHS	0.09	0.11	0.14	0.17	0.22	0.26	0.29

48. 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 6-1and Figure 6-2.

6.5.1 Widening Scheme

49. Existing road is placed concentrically within available ROW of 18m, in general. The condition of the existing pavement is poor in initial 10km in Bayad-Dhoridungri section, thereafter pavement condition is fair. The VR section of project road is having 12.00m existing ROW, which is insufficient to accommodate two lane facility with improvement option, so additional land acquisition 12.00m is proposed all along the project road. The part project section from Bayad- Dhoridungri and VR section of project road is proposed for reconstruction, remaining length is proposed with overlay and widening except at the locations of major curve improvement.

[6] The available RoW is 18m, the shoulder width is limited to 1.0m on either side, to accommodate with in RoW

[7] 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.

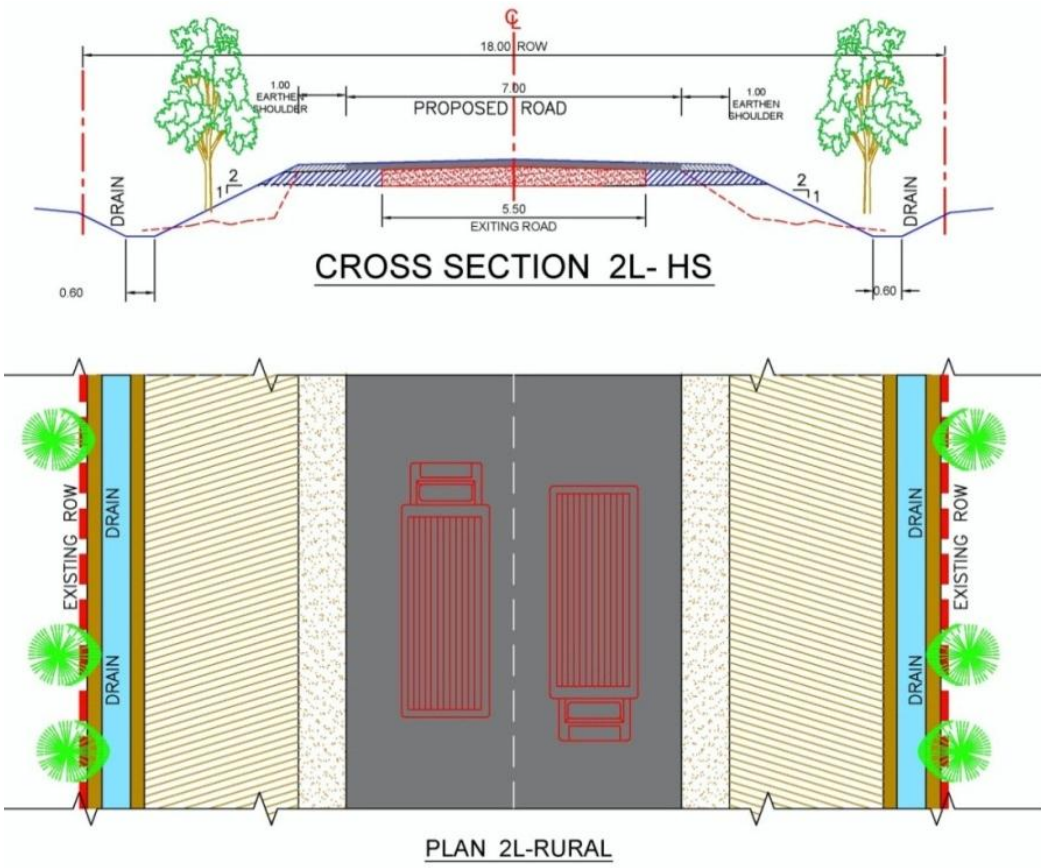


Figure 6-1: Proposed Improvement Option (IL to 2L+HS Bayad-Dhoridungri)

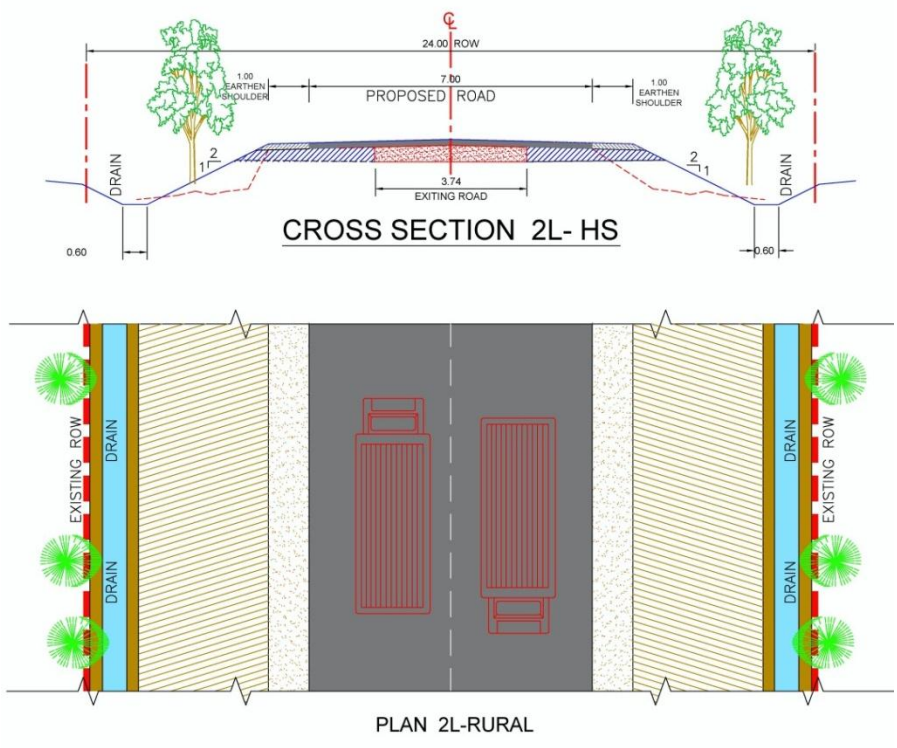


Figure 6-2: Proposed improvement option (SL to 2L+HS, Dhoridungri-Garasiyawada)

50. The settlement Sathambha along SH-69 is proposed for four lane and foot path, due to higher percentage of local traffic and mobility. The detailed type design and improvement scheme is provided in subsequent section on Pavement Design.

6.6 GEOMETRIC DESIGN

51. 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 Design interventions

6.6.1.1 Speed

52. 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.

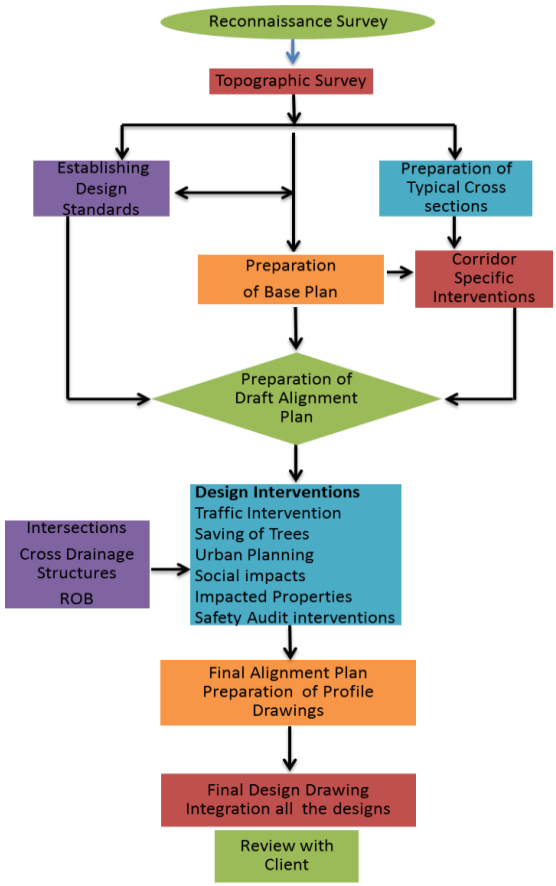


Figure 6-3: Design Interventions

6.6.1.2 Intervention on saving of Trees

53. The project corridor is considered mainly for strengthening and widening. The major plantations are observed along the SH-63, the trees adjoining to shoulder of carriageway is observed. Such sections are strengthened by overlay without widening; the trees adjoining to shoulder are safeguarded with crash barriers.

54. Efforts have been made to minimize impacts on structures, trees and other assets located within RoW.

6.6.2 Horizontal Alignment Design

55. 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.

56. The project road design chainage are given herewith:

Project Section	Start Chainage(km)	End Chainage(km)	Length (km)
Bayad-Dhori Dungri	0+000	17+961	17.961
Dhoridungri-Garasiyawada	0+000	12+338	12.338
Lunawada -Garasiyawada	0+006	13+937.17	13.937

57. 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. The project corridor has fair horizontal geometrics but several locations of horizontal curves, low degree of curvature are identified. The Village road section of the project road is having poor geometrics, so complete realignment is proposed along the same. The detail of such locations having geometric deficiency is given in Figure 6-2.

58. 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.

Table 6.2: Locations of Geometric Deficiency

Chainage		Old Radius	New Radius	New Speed	Old Speed	Remarks
From (km)	To (km)					
Bayad-Dhori Dungri (SH-69)						
2+200	2+400	290	360	80	65	
2+775	2+950	125	360	80	65	
4+800	4+975	340	500	80	65	
10+400	10+600	310	360	80	65	
VR/MDR		**Complete Realignment**				
Lunawada-Garasiyawada (SH-63)						
2+700	2+950	160	700	100	50	LAQ
6+850	6+950	120	500	100	50	LAQ
7+600	8+000	125	650	100	50	LAQ
9+700	9+850	210	600	50	40	
11+510	11+610	150	200	60	40	

6.6.3 Vertical Alignment Design

59. 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.

60. The design Finished Road Levels (FRL) at the centerline 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.

61. The FRL of the carriageway is finalized, by rising minimum height of overlay thickness over the existing carriageway, this can achieved by providing PCC over the existing pavement to correct longitudinal geometry and local depressions.

62. The SH-63 of the project highway crosses the Mahi River at chainage of 7+300, which is a low level bridge, with some record of over topping during floods. The new high level bridge is proposed with FRL above the H.F.L. The new bridge alignment is about 100m downstream of the existing bridge; the banks of the river also further on higher level, necessitates cutting in approaches of the proposed bridge.

6.6.4 Side slopes

63. 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 Utility Crossings

64. Utility crossing are proposed at following locations given in the Table 6.3 to avoid frequent digging of carriageway.

Table 6.3: Utility Crossing Locations

Sr. No.	Station	Location
Bayad To Dhori Dungri		
1	STA: 0+025	Bayad
2	STA: 11+025	Sathamba
3	STA: 11+550	
4	STA: 12+083	
5	STA: 17+925	Dhoridungri
Dhori dungri To Garasiyawada		
1	STA:0+050	Dhoridungri
2	STA: 3+600	Dhamnod
3	STA: 4+100	
4	STA: 12+225	Garasiyawada
5	STA: 12+325	
Lunawada To Garasiyawada		
1	STA:0+050	Lunawada
2	STA: 0+575	
3	STA: 1+100	

6.7 INTERSECTION/JUNCTION DESIGN

65. 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.

66. The project corridor is having five major junctions, 66 minor junctions/intersections and 69 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

67. Intersections with category of roads like NH/SH/MDR and having black top surface are presented in Table 6.4.

Table 6.4: Major Intersections/Junctions

Sr. No.	Intersection/ Junction	Type	Chainage (km)	Existing Width (m)	Improvement
SH-69 (Bayad-Dhori Dungri)					
1	Bayad	3-Arm	0+000	5.5	As per IRC standards
2	Dhoridungri	3-Arm	17+961	5.5	As IRC
VR (Dhori Dungri-Garasiyawada)					
3	Lalsar	4-Arm	6+450	7.00	As per IRC standards
4	Garasiyawada	Y-Jun	9+625	7.00	As per IRC standards
SH-63 (Lunawada-Garasiyawada)					
5	Lunawada	3-Arm	0+006	7.00	As per IRC standards

68. The start of the project corridor forms a junction with SH-59 near Bayad, providing connectivity to Kapadvanj, Dakor and Subsequently to Godhra and Anand. The junction design is based on type designs for T junction as per IRC standards. Another four legged

intersection is designed on VR for Virpur and Balasinor cross road. The intersection at end point of project road provides connectivity to Rajasthan and South Gujarat and is treated accordingly.

6.7.2 Minor Junctions

69. The project sections SH-69, VR and SH-63 is having 22, 19 and 25 minor junctions 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. One junction of type-1 category is observed on SH-69. Design details of these intersections are provided at Volume VIII-Drawings.

6.8 WAYSIDE AMENTITIES AND SAFETY ASPECTS

6.8.1 Pedestrian Safety

70. 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.

71. **Rumble strips** are provided at 72 locations on project corridor

72. **Pedestrian Crossings:** Raised pedestrians crossings are provided at 10 locations on project corridor

73. **Foot Path:** is provided at 19 locations summing upto a length of 3.56 km alongside the project corridor on both sides

6.8.2 Crash Barrier

74. 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 4.0 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.

6.8.3 Bus Shelter

75. There are existing bus stops along project corridor. Generally these stops are associated with a settlement area or an intersection/junction with a crossroad. It is proposed to provide bus stops and bus bays in both directions at these locations. The details of bus shelter and bus bay locations along the project corridor are given in Volume II Part-1. The typical design of bus shelter is provided in Figure 6.4. New Bus Shelters and bus bays are provided at 39 locations and 12 existing bus shelters are retained.

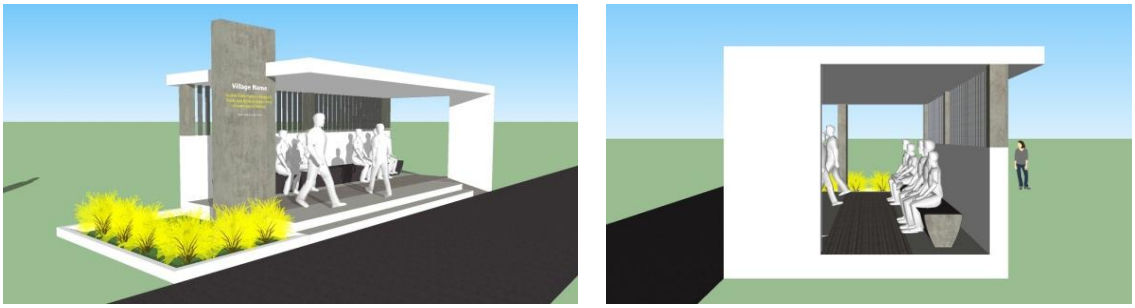


Figure 6.4: Typical Design of Bus-Shelter

6.8.4 Integration of Way Side Facilities

76. The integration of bus shelter, foot path and pedestrian crossing is done and the typical plan is depicted in Figure 6-5.

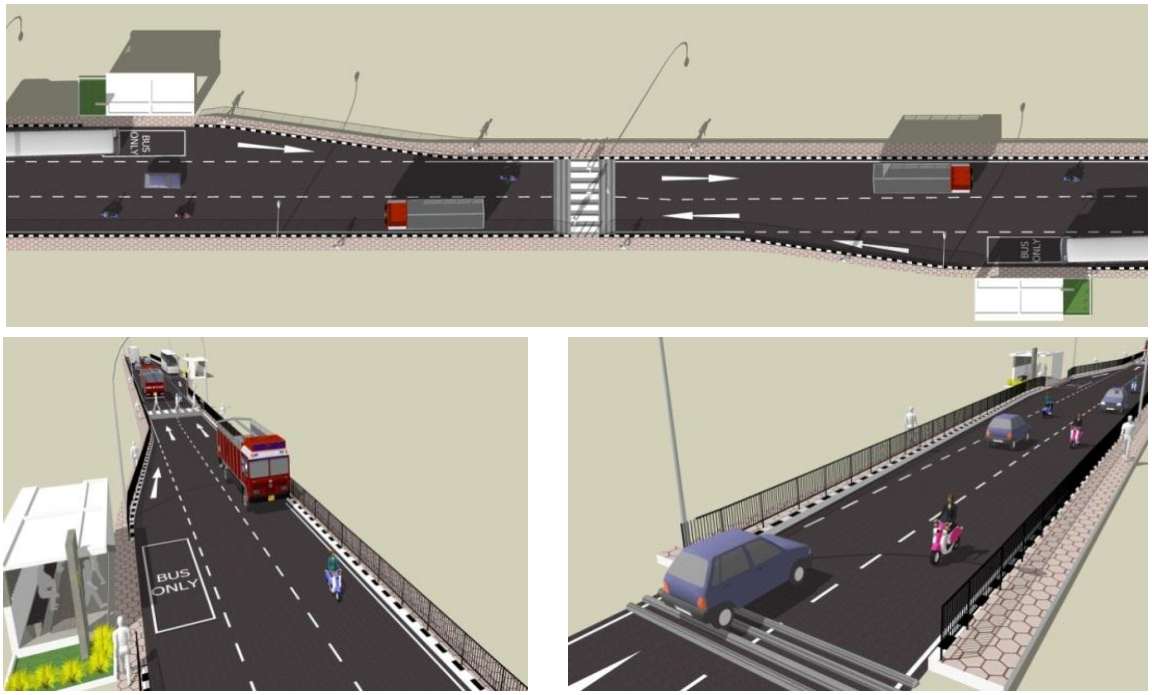


Figure 6.5: Integration of Wayside Facilities

6.8.5 Information on Infrastructure Development

77. 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.

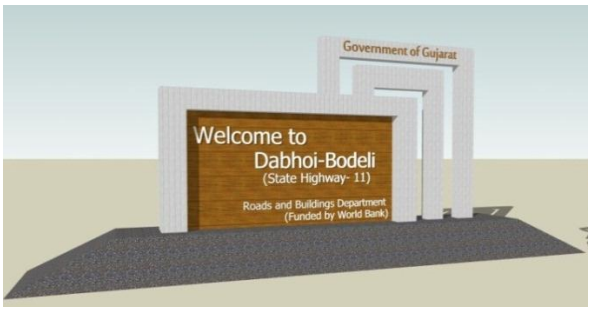


Figure 6.6: Typical View of Welcome Sign

6.8.6 Truck laybys

78. The truck laybys are provided at locations near newly acquired land for road geometry improvement i.e. km 6+200 on VR section and 2+800 on SH-63.

6.9 PAVEMENT DESIGN

79. This pavement design section for rehabilitation and up gradation of Bayad-Lunawada (State Highway No 69, 63 and VR/MDR) 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 shoulder paving. This summarizes the findings of the investigations carried out during the course of the project preparation as well as detailing the proposed pavement requirements for Bayad-Lunawada 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.

6.9.1 Pavement Thickness Requirements

6.9.1.1 Criteria for selection of pavement treatment option

80. 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.

81. 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

82. 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.

6.9.2 Proposed Road Strengthening and Reconstruction Needs

83. Based on pavement condition survey; sections from km 00.000 to 10.00 and Km 16.00 to 17+961 of Bayad- Dhori Dungri SH 69 section and km 0.00 to 2.00 are considered as failed sections requiring reconstruction. All these sections have cracking more than 20%, ravelling more than 50%, patching in 60% area, exhibiting high deflection and IRI exceeding 3m/km (range 8.54 and 5.24) hence fulfills the criteria as detailed above for failed sections.

84. Distresses on pavement for rest of the sections from km 10.00 to km 16.00 of Bayad – Dhori Dungri and KM 0.000 to 13+937 of SH63 Garasiyawada to Lunawada are moderate but deflection is moderately high. The riding quality of road is not up to mark. However, in order to control further deterioration of pavement and improve the riding quality strengthening of pavement is necessary. These sections of road are 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.

6.9.2.1 Dhori Dungri to Garasiyawada MDR/VR (Km 00.00 to 11.800)

85. The Dhoridungri to Garasiyawada section MDR, VR of project corridor is 12.338 kilometre single lane/two lane. The pavement of this section is highly distressed. The geometrics of this section is deficient and poor, which impacts adversely on the speed of vehicles and comfort of road users. Looking to the geometric deficiencies it is proposed to realign the quite a few stretches of this section of project corridor.

86. The proposed pavement treatment options are indicated in Table 6.5.

Table 6.5: Abstract of Treatment Option

From (km)	To (km)	Length (km)	Treatment Option	Remarks
SH 69 Bayad to Dhori dungri section Km 00.00 to 17+961				
00.000 16.000	10.000 17+961 SH63	11.80	Full depth Reconstruction and widening to 7m	Cracking>20% and extensive ravelling, high IRI and high deflection
10.000	16.00	6.0	Strengthening by overlay and widening to 7m	Moderate pavement distresses High deflection, IRI high
MDR, VR Dhori Dungri to Garasiyawada section Km 00.00 to 12+338				
0.000	12+338	11.8	New construction of pavement with CW- 7 m	Realignment
SH 63 Garasiywada to Lunawada section Km 0.00 to13+937.12				
00.000	14+200	14.2	Strengthening by overlay	Moderate pavement distresses High deflection, IRI high

6.9.2.2 Pavement Strengthening (Overlay) Strategy

87. 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.

6.9.2.3 Pavement Composition

88. The designed new pavement and overlay thickness for various sections for reconstruction, widening and strengthening is given in Table 6.6.

Table 6.6: 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
Km 00 to 10.00 Km 16.00 to 17.961 (Reconstruction) in 7m width of SH63			30 mm SDBC	60 DBM	250 mm WMM	260 mm GSBC	500 mm CBR-6
Km 10.00 to 14.00 Km 14.00 to 16.00 (Strengthening) and widening	30mm SDBC	60 DBM	30 mm SDBC	60 DBM	250 mm WMM	260 mm GSBC	500 mm CBR-6
MDR,VR Km 00.00 to 12.338 Reconstruction in 7 m width			30 mm SDBC	60 DBM	250 mm WMM	260 mm GSBC	500 mm CBR-6
SH 63 Strengthening in 7.0 m width	30mm SDBC	60 DBM	30 mm SDBC	60 DBM	250 mm WMM	260 mm GSBC	500 mm CBR-6

Note: The quantity of overlay layer of DBM is suitably increased to account for PCC requirement.

6.10 WIDENING SCHEME

89. The pavement widening scheme is provided in Table 6-16 to Table 6-18. Pavement sections are prepared with respect to type of treatment, varying widths, improvement options and road furniture in line with existing site condition; the same is given Volume-II: Design Report.

Table 6.7: Treatment Option

Type	Treatment Option
Type A:	Reconstruction; 7.0m carriageway+1.0m Hard Shoulder
Type B:	Overlay and Widening; 7.0m carriageway +1.0 Hard Shoulder
Type C:	Eccentric Widening , 7.00m Carriageway+1.0 m Hard Shoulder
Type D:	Overlay over the Existing Pavement + Addition of Closed Drains and Footpath
Type E:	Divided Four lane with Footpath for Junction Improvement
Type F:	Overlay and Shoulder Strengthening to 7.0m carriageway +1.0 Hard Shoulder
Type G:	Divided Four lanes with footpath in Settlement areas.

Table 6.8: Widening Schedule

From (km)	To (km)	Length (m)	Type	Existing CW width (m)	Existing Shoulder (m)	Proposed CW (m)	Proposed Hard Shoulder	Remarks
SH-69								
0.000	0.100	0.100	Type E	5.5	1.000	15.5	1.25	Divided Four lane/Close Drain and Foot Path
0.100	10.000	9.900	Type A	5.5	1.000	7	1	
10.000	11.000	1.000	Type B	5.5	1.000	7	1	
11.000	12.400	1.400	Type G	5.5	1.000	15.5	1.25	Divided Four lane/Closed Drain and Foot Path
12.400	13.950	1.550	Type B	5.5	1.000	7	1	
13.950	14.225	0.275	Type C	5.5	1.000	7	1	
14.225	14.900	0.675	Type B	5.5	1.000	7	1	
14.900	15.175	0.275	Type C	5.5	1.000	7	1	
15.175	15.450	0.275	Type B	5.5	1.000	7	1	
15.450	15.650	0.200	Type C	5.5	1.000	7	1	
15.650	16.000	0.350	Type B	5.5	1.000	7	1	
16.000	17.861	1.861	Type A	5.5	1.000	7	1	
17.861	17.961	0.100	Type E	5.5	1.000	15.5	1.25	Divided Four lane/Close Drain and Foot Path
VR/MDR								
0.000	0.100	0.100	Type E	7.000	1.000	15.500	1.250	Divided Four lane/Close Drain and Foot Path
0.100	6.400	6.300	Type A	5.5	1.000	7	1	
6.400	6.650	0.250	Type E	7.000	1.000	15.500	1.250	Divided Four lane/Close Drain and Foot Path
6.650	12.239	5.589	Type A	5.5	1.000	7	1	
12.239	12.339	0.100	Type E	7	1.000	15.5	1.25	Divided Four lane/Close Drain and Foot Path
SH-63								
13.937	13.787	0.150	Type E	7.000	1.000	15.500	1.250	Divided Four lane/Close Drain and Foot Path
13.787	8.400	5.387	Type F	7.00	1.000	7	1	
8.400	7.400	1.000	Type A	7.00	1.000	7	1	
7.400	7.250	0.150	Mahi River	7.00	1.000	7	1	
7.250	6.600	0.650	Type A	7.00	1.000	7	1	
6.600	6.000	0.600	Type F	7.00	1.000	7	1	
6.000	5.750	0.250	Type A	7.00	1.000	7	1	
5.750	3.050	2.700	Type F	7.00	1.000	7	1	
3.050	2.600	0.450	Type A	7.00	1.000	7	1	
2.600	2.400	0.200	Type F	7.00	1.000	7	1	
2.400	1.900	0.500	Type A	7.00	1.000	7	1	
1.900	1.200	0.700	Type F	7.00	1.000	7	1	
1.200	0.106	1.094	Type D	7.00	1.000	7	1	
0.106	0.006	0.100	Type E	7.00	1.000	15.5	1.25	Divided Four lane/Close Drain and Foot Path

Table 6.9: Type Design in Widening Scheme

Type of Cross Section	Section	Length	Overlay		Reconstruction/Widening				
			SDBC	DBM	SDBC	DBM	WMM	GSB	Subgrade CBR 6%
Bayad Dhori Dungri (SH 69)									
A,D,E	Km 0.00 to 10.00	10.0			30	60	250	260	500
B,C,D	Km 10.00 to 16.00	6.0	30	60	30	60	250	260	500
A	Kn16.00 to 17.961	1.8			30	60	250	260	500
Dhori Dungri to Garasiyawada (VR)									
A	Km 0.00 to 12+338	11.8			30	60	250	260	500
Garasiyawada to Lunawada (SH 63)									
F,G	13.931 to 0.006	14.2	30	60					

6.11 IMPROVEMENT PROPOSAL FOR STRUCTURES

90. **Major and Minor Bridges:** There are 2 major bridges on this corridor on SH-063. As condition of these bridges is good it is proposed to be retained. One submersible bridge on river Mahi is to be repaired and new high-level bridge is to be constructed on downstream side. Out of 8 minor bridges 7 are retained as it is and 1 minor bridge needs replacement with new structure. The details of proposed treatments for bridges are provided in Table 6.10.

Table 6.10: Proposed Treatment

Sr. No	Design Chainage (km)	Type of Bridge	Nos. of span	Span length (m)	Total Length of Bridge (m)	Total Width of bridge (m)	Carriage way Width (m)	Proposal
1	SH-069 1+550	Canal Minor	2	17.80	35.60	8.40	7.00	Retain
2	SH-069 4+150	Canal Minor	2	7.00	14.00	8.25	6.00	Retain
3	SH-069 9+070	Minor	2	5.00	10.00	8.00	5.70	Repair
4	SH-069 15+400	Minor	2	5.00	10.00	7.30	5.50	Replace with BC 2/5.0x2.0/0
5	MDR 3+235	Canal Minor	2	16.00	32.00	8.40	8.30	Retain
6	MDR 3+990	Box Minor	7	3.40	23.80	8.40	7.00	Retain
7	MDR 10+775	Minor	1	6.10	6.10	8.00	6.80	Repair
8	SH-063 7+300	Major-low level/ submerge	25	12.20	305.00	7.90	6.50	Repair and Provide New High level bridge
9	SH-063 1+600	Major	5	3 x 22 mt. Inter. + 2 x 10 mt. end	86.00	8.30	7.50	Repair
10	SH-063 1+450	Under Pass	1	7.30	7.30	10.70	7.50	Repair

91. **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.

92. The summary of proposed treatment for culverts is presented in Table 6.11.

Table 6.11: Summary of Proposed Treatment

Treatment	Numbers			
	SH-069	MDR	SH-063	**Total**
Repair	10	2	15	27
Repair and Widen	2	1	1	4
Replace with new	10	2	4	16
New on New Alignment	-	2	-	2
Retain	-	23	1	24
Total	**22**	**30**	**21**	**73**

7 ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT

7.1 ENVIRONMENTAL IMPACT ASSESSMENT

93. The proposed upgradation (strengthening and widening) 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 with no wildlife, that is scattered along the project corridor. 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.

94. There are 1324 avenue trees[8] 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 and a Village Road viz, SH-69, SH-63 and VR/MDR. As per the Government of Gujarat Gazette dated 5th July, 1973, both the State Highways (Bayad-Dhori Dungri section (SH-69) and Untadi-Lunawada (SH-63) sections are notified under protected forest, and require forest clearance for diversion of 24.42 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 to be 5.37 ha. For obtaining forest clearances as well as permission for tree felling, proposals have been submitted to the forest department for necessary action.

95. 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 3.04 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 Siva Temple (Ch 4+200), Public well (Ch 9+200), and Sanskar Education Trust Primary School (Ch 11+650).

7.2 LAND ACQUISITION AND RESETTLEMENT IMPACTS

96. A total of 18.2 ha of private agricultural and vacant land will be affected due to curve improvement in 10 villages. Land acquisition along the corridor is envisaged at Tajpur

[8] As per estimated by Forest department, GoG

(0+000 km to 0+825 km), Dhamod (0+825 km to 4+650 km), Sadhakpur (4+550 km to 5+300 km), Lalsar(5+300 km to 7+900 km), Vakhatpur(7+900 to 8+600 km), Ucharpi (8+600 km to 10+775 km), Undra(10+775 km to 12+400 km) Hadod(8+400 km to 7+400 km), Khantana Bhensavada (7+400 km to 6+570 km), and Madia (3+083 km to 2+581 km). Other than these 10 village locations, the proposed improvement will be carried out within the existing RoW throughout the corridor.

97. According to the census survey the proposed road improvement will impact 33 commercial structures (kiosks), which are of non-titleholders. One mixed property (residential-cum-commercial), 1 fencing of a vacant land will be affected. Boundary wall of a school will also be affected. There will not be any impact on religious structures.

98. Five 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, shifting of alignment to protect mainly structures of religious importance, provision of road safety measures such as pedestrian crossings, warning signs, markings, etc has been carried out.

99. A resettlement budget of INR 17.2 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

8.1 INTRODUCTION

100. 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 99 villages located within 2 km bandwidth of the proposed corridor, of which 50 villages are chosen for the survey. Altogether 250 households (includes 1181individuals) are surveyed.

8.2 PROFILE OF SAMPLE POPULATION

101. **Gender and Age Distribution:** Age distribution shows that 53 percent of the population belongs to the age group of 26-60 and 12 percent of the population is in the age group of 6-14.

102. **Education profile:** Female population has a lower level of education compared to male population.

103. **Income Profile and Dependency Ratio:** 48 percent of the sample households have a monthly income of less than Rs.3000, of which 32 percent have a monthly income less than Rs.2000. The dependency ratio is 2.4:1.

104. **Occupation Profile:** major percentage of sample population is engaged in agriculture.

8.3 MAJOR FINDINGS

105. **Trip Information:** Analysis of trip information of villagers is based on 909 cases of usual trip information of 250 surveyed households. Analysis based on chi-square test shows that trip information does not vary significantly between income-groups.

106. **Mode of Travel**: Amongst the 909 usual trip information, 323 (36 percent) travel on foot and 511 trips (56 percent) are by bicycle, auto-rickshaw, bus or *chakda*.

107. **Frequency of Travel:** 41 percent of the 909 usual trips are on daily basis, 31 percent of the trips are for 3-4 times in a week and 5 percent trips are on monthly basis. Among all vehicles, bus and *chakda* are the most used modes for usual trip. Bus is used for 52 percent of usual trips. Of the total trips using vehicles, 22 percent trips are on daily basis and 39 percent are for 3-4 times a week.

108. **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

109. 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 95.23 crore. The total cost is presented in three subheads as Civil Construction Cost EMP related cost and Social Cost. 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	93,50,08,279
2	Social Cost	1,72,53,434
Grand Total		**95,22,61,713**

10 ECONOMIC ANALYSIS

10.1 RESULTS OF ECONOMIC ANALYSIS

10.1.1 Base Analysis

110. 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	4.18%	7.74%	15.68%	17.11%	16.99%	18.28%
		NPV (in million Rupees)					
I	Base Costs + Base Benefits	-335	-258	202	373	281	469

111. The project is economically viable only with VOT and accident cost savings.

10.1.2 Sensitivity Analysis

112. 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).

113. 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)	2.68%	6.58%	13.51%	15.22%	14.73%	16.29%
II	Base Costs and Base Benefits minus 15% (15% reduction in benefits)	2.57%	6.53%	13.37%	15.10%	14.58%	16.16%
III	Base Costs plus 15% and Base Benefits minus 15% (15% Increase in costs and 15% reduction in benefits)	1.13%	5.43%	11.35%	13.37%	12.48%	14.34%
		NPV (in million Rupees)					
I	Base Costs + 15% and Base Benefits	-444	-368	93	263	171	359
II	Base Costs and Base Benefits minus 15%	-385	-319	72	218	139	299
III	Base Costs + 15% and Base Benefits minus 15 %	-495	-429	-38	108	29	189

114. 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

115. 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 68.7 million in 2015 to about Rs 3174.1 million in the year 2040. Therefore, the state should get the project initiated soon. (Refer Figure 10.1).

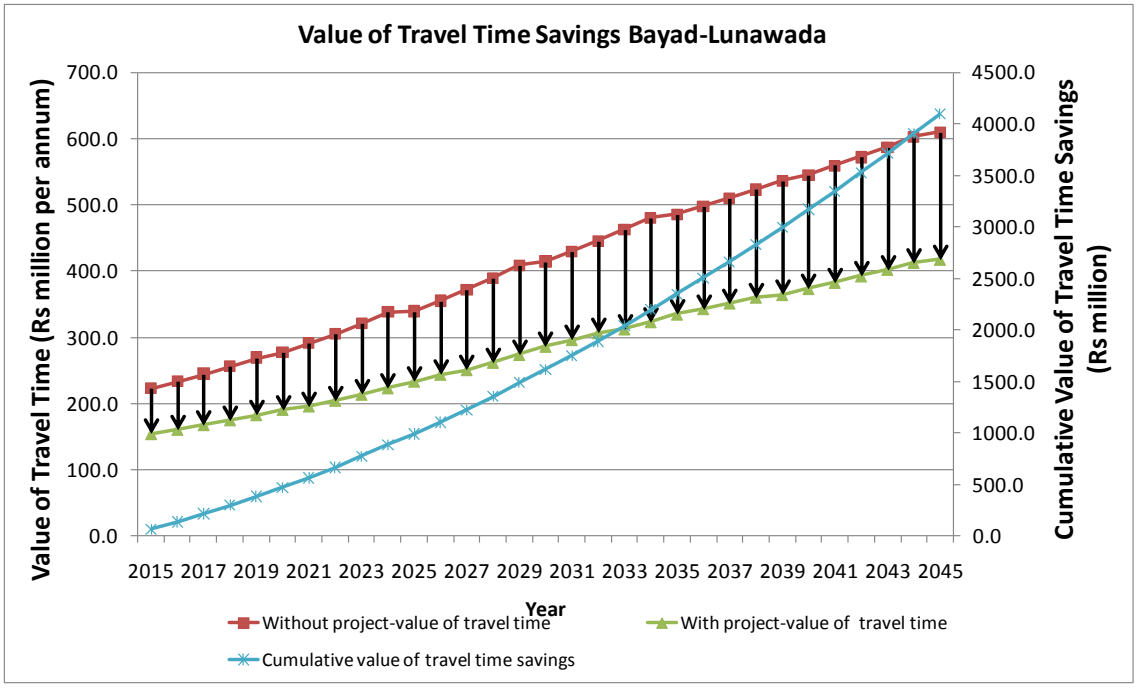


Figure 10.1: Value of Travel Time Savings

10.3 CONCLUSION

116. 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.