RAJASTHAN STATE ROAD DEVELOPMENT & CONSTRUCTION CORPORATION Ltd.

DETAIL PROJECT REPORT

B.O.T. WORK

Volume - I Main Report

NAME OF WORK	:	**STRENGTHING & WIDENING OF FATEHNAGAR DARIBA ROAD (MDR-33) KM 1/500 TO 19/500.**
LENGTH	:	18.00 Km
PROJECT COST	:	RS. 2844.76 Lacs
BLOCK	:	FATEHNAGAR, RAILMANGRA
DISTRICT	:	UDAIPUR & RAJSAMAND
STATE	:	RAJASTHAN

PREPARED BY

RESIDENT ENGINEER
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Index

ABBREVIATIONS AND ACRONYMS

BOQ	Bill of Quantity
BOT	Build Operate & Transfer
GAD	General Arrangement Drawing
ICB	International Competitive Bidding
IRC	Indian Roads Congress
Km	Kilometre
LA	Land Acquisition
m	Metre
MoSRT&H	Ministry of Shipping, Road Transport & Highways
NHAI	National Highways Authority of India
OFC	Optical Fibre Cable
PWD	Public Works Department
QAP	Quality Assurance Plan
RL	Reduced Level
ROW	Right of Way
TOR	Terms of Reference
VDF	Vehicle Damage Factor

1 EXECUTIVE SUMMARY

E 01. The Govt. of Rajasthan under Built Operate Transfer (BOT), is contemplating to enhance the traffic carrying capacity and safety for efficient transportation of goods as well as passenger traffic on the heavily trafficked National MDR and State Highways.

E 02. The project stipulates widening and strengthening of existing single lane carriageway to two lanes carriageway of the MDR-33 between Fatehnagar to Dariba. This MDR was earlier a Village road, and was declared as Major District Road in 1997. It starts from Fatehnagar and after connecting Dariba it goes up to Khendel where it joins with SH-12 which leads to Bhilwara NH-79 and Kankroli on NH-8.

E 03. The RSRDC has decided to prepare the DRP at his own level.

E 04. The project primarily stipulates widening of existing time single lane MDR-33 stretch to 2-lane carriageway configuration of MDR standards including widening of the existing structures. The Scope of Services shall cover to the following major tasks -

- Review of all available reports and published information about the project road and the project influence area.
- Identification of possible improvements in the existing alignment with alternatives; evaluation of different alternatives comparison on techno-economic and other considerations and recommendations regarding most appropriate option.
- Traffic studies including traffic surveys and Axle load survey and demand forecasting for next eighteen years;
- Inventory and condition surveys for road, Bridges, Cross-Drainage structures and Road side Drainage provisions;
- Detailed topographic surveys using Total Stations Auto level compass;
- Pavement & soil investigations;
- Identification of sources of construction materials;
- Detail Design of roads, its X-Section, Horizontal and vertical alignment.
- Preparation of GAD for Structures and approval of same with the respective authorities. Preparation of Construction Drawings and working drawings

- Identification of the type and the design of intersections;
- Design of complete drainage system.
- Value analysis / value engineering and project costing.
- Preparation of Detailed Project Report, cost estimate, rate analysis, detailed bill of quantities, bid documents for execution of civil works

E 05. The existing alignment of the package road portion of MDR-33 traverse - through two Districts of the State of Rajasthan namely Udaipur and Rajsamand passing mainly through plain rolling terrain. The road lies mostly in rural area, passing through few rural and quasi-urban settlements that causing mild hindrance to the uninterrupted flow of traffic.

E 06. Land use along the project road is predominantly agricultural. Scattered quasi-urban and rural settlements exist on both sides of the road with intervals. However, after Km 18/0 the urban area of Dariba starts and becomes thick after the bifurcation of Nathdwara road where the road is already have 5.50 mts. wide configuration with out developed junctions up to the end of Dariba Village Km 18/500.

E 07. The existing right of way is normally about 12m with the carriageway in the centre of it. The existing carriageway width for the entire project road is 3m with a varying earthen shoulder of 1.2 to 1.5m.

E 08. Pavement condition is varying from fair to poor. The condition of the pavement has been badly damaged in few stretches due to sub-grade defects. Almost the entire stretch is exhibiting the high level of undulation and cracking on the surface.

E 09. Traffic volume count on the corridor was undertaken in order to assess the level and characteristics of the present traffic on the road. The location was identified after the initial corridor appreciation to get a true representation of traffic on the corridor by avoiding significant local traffic while at same time keeping in mind the logistical requirements of conducting various surveys.

E 10. The average daily traffic is observed to be 1182 vehicles translating into 1932 PCUs. It is observed that passenger and goods vehicles are distributed in almost equal proportion. Three axle and multi axle trucks are a significant proportion of the total traffic contributing about 12% to the vehicle count. The present traffic volume is already beyond the design service volume for a single lane road and indicates congested traffic conditions.

E 11. The travel desire pattern indicates that a major chunk of the trips for both passenger and goods vehicles originate or are destined to Dariba. Of the

remaining traffic, again a major portion can be attributed to the rest of the areas of Udaipur and Rajsamand districts. A fairly small percentage of the trips originate or are destined to other areas in the state or outside of the state.

E 12. The traffic projections for the years up to 2030 have been worked out using the econometric method under three scenarios. The likely scenario has been adopted for planning and design purposes translating to about 3546 PCU's in the horizon year 2030.

E 13. Pavement Condition of the project road is in poor condition with 67% of the length is in poor condition, 11% length is in fair condition and 22% of the section is in good condition.

E 14. Various engineering survey and investigations were carried out to identify availability of construction material and estimates its quality and quantity in the project vicinity.

E 15. The present scope of work is to develop the existing single-lane carriageway configuration to two-lane carriageway configuration with the facility of partially access controlled road in order to ensure high speed of travel with comfort and safety. Minimum cutting of road side trees, relocation of temples and relocation of existing utility lines situated with in ROW have been taken in to consideration while finalizing widening proposal.

E 16. It is proposed to widen the road concentrically in order to avoid additional land acquisition, minimize resettlement and minimize adverse environmental impacts. At the same time the proposal is implement-able in shortest possible time compared to other alternatives considered.

E 17. The carriageway is proposed to be two- lane undivided along with 2.0m GSB shoulder on either side. The design speed is proposed to be 60Kmph except in built up areas where it would be 40Kmph.

E 18. The ADT for the project road is estimated to be about 1303 in the year 2012 under the likely scenario.

E 19. The pavement is proposed to be strengthen considering the poor condition of the existing pavement. Flexible pavement has been proposed for the project road after comparing the life cycle costs for rigid and flexible pavements.

E 20. Considering the Sub-grade CBR of 6 % and 3% and design traffic projected MSA, the total thickness of pavement according to IRC-37 works out as under:

Length		CBR (%)	Actual MSA	Design MSA	Pavement Design Thickness(MM)				
From	To				GSB	WMM	DBM	BC	Total
1/0 7/0 12/0	6/0 10/0 14/0	6%	11	11	200	250+ 150	65	40	705
6/0 10/0 14/0	7/0 12/0 18/0	3%	11	11	200	250+200	890	40	780

E 21. There is no minor bridges and major bridges in the stretch from km 0/0 to 18/0 (old Km 1/500 to 19/500) of MDR-33. Only CDworks having span up to 4.0m are to be constructed on the road. Some of the old CD works may be repaired including widening or redecking will be done as required.

E 22. About 37 existing culverts were observed and analyzed on the corridor and a majority would need to be reconstructed due to dimensional or structural constraints. The rest would be rehabilitated and widened as per requirement.

E 23. The environmental impact assessment and environmental management plan were prepared for the project as stipulated under the various environmental protection laws and rules of the country and as per international best practices. However, no prior environmental clearance is required from the ministry of environment and forests since the project does not meet the threshold criteria for the same.

E 24. The project is found to be environmentally and socially desirable due to the immense benefits derived out of increased transport efficiency in the post project scenario. There is minimal environmental and social impact of the project due to the fact that no additional land is being acquired. Mitigation measures have been suggested for the negative impacts during construction and operation phases of the project.

E 25. The cost estimate for Detail Engineering Report has been prepared based on the detail estimation of quantities and Rates for the individual Items. The Rates for most of the Items have been derived based on the standard Data Book of MoRTH using current market prices of Labour and Material. Rates for Other Items have been directly taken from latest available BSR of PWD Circle, Udaipur with suitable escalation factor to arrive at the prevailing rates. The approximate leads for various construction materials have been worked out for the respective sections based on the field survey.

E 26. Detail costs have been worked out for the different items of road works and structures. Estimated total cost of this package is **2844.76** Lacs. This works out the per kilometre cost of improvement as **158.04**Lacs including escalation, contingencies and- cost of land acquisition.

Section	Length (km)	Base Cost (Lacs)	Total Cost (Lacs)
MDR – 33 Fatehnagar To Dariba	18.00	2143.42	2844.76

2 INTRODUCTION

2.1 GENERAL

Rajasthan, a century State, came into being on 1 November 1956. It occupies 10.41 % of India's total land area with 3,42,239 sq. km, out of that it has got 3,24,000 sq. km i.e. 9.47% of the state as forest area. The State has a total population of 56473122 as per the 2001 Census. The decadal growth rate of population in the decade 1991- 2001 has been 28.33% (All India - 21.34), down from 24.23% during the previous decade. Rajasthan is bordered by 6 states. They are, clockwise from north, Punjab, Haryana, Delhi, Uttar Pradesh, Madhya Pradesh & Gujrat. The capital of Rajasthan is Jaipur and High Court of Rajasthan is situated at Jodhpur and Jaipur Bench.

Mining industry is a major contributor to the economy of Rajasthan. Rajasthan is the richest Indian state in terms of mineral wealth, with 28 varieties of major minerals, including Marble, Granite, Soapstone. Most of the zinc ore in India is in Rajasthan one of the best quality zinc ore deposits in the world is found in the in west Rajasthan the best quality of marble found in centre and west of Rajasthan, from where it is exported to Gulf countries. Rich deposits of limestone, are found in the State. The State is lucky to have large deposits of zinc, iron ore and limestone in close proximity, making it the ideal location for the low cost of production.

Jaipur, the state capital is connected to Delhi on one hand and Mumbai on other by National Highway 8. National Highways 11, 11A, 12 link the city with Sikar Dausa. Chakus, Niwai It is well connected by road to all important places of India. The state has a rapidly developing road network of State Highways, MDRs and ODRs with a present density of 411.40km per 100 sq-km.

2.2 PROJECT BACKGROUND

The Govt. of Rajasthan under Built Operate and Transfer is contemplating to enhance the traffic carrying capacity and safety for efficient transportation of goods as well as passenger traffic on the heavily trafficked State Highways and MDR'S

The project stipulates widening and strengthening of existing Single-lane carriageway to 2-lanes carriageway of the MDR-33 between Fatehnagar and Dariba. This MDR was earlier a village road and was declared as MDR in May 1997. It starts from Fatehnagar and after connecting Dariba it goes up to Khandel in Rajsamand Dist. where it meets with SH-12 which leads to Bhilwara and Kankroli.

2.3 SCOPE OF CONSULTING SERVICES

The corporation has decided to prepare DPR at Department level.

The project primarily stipulates widening of existing single lane MDR-33 stretch to 2-lane carriageway configuration of MDR standards including widening reconstruction of the existing structures. The Scope of Services shall cover to the following major tasks -

- Review of all available reports and published information about the project road and the project influence area.
- Detailed reconnaissance;
- Identification of possible improvements in the existing alignment with alternatives; evaluation of different alternatives comparison on techno-economic and other considerations and recommendations regarding most appropriate option.
- Traffic studies including traffic surveys and Axle load survey and demand forecasting for next twenty years;
- Inventory and condition surveys for road;
- Inventory and condition surveys for Bridges, Cross-Drainage structures and Road side Drainage provisions;
- Detailed topographic surveys using Total Stations Auto level Compass;
- Pavement investigations;
- Sub-grade characteristics and strength: investigation of required sub-grade and sub soil characteristics and strength for road and embankment design and sub soil investigation;
- Identification of sources of construction materials;
- Detail Design of roads, its X-Section, Horizontal and vertical alignment and Design of Embankment of height more than 6m and also in poor soil conditions.
- Preparation of GAD for Structures and approval of same with the respective authorities. Preparation of Construction Drawings and working drawings
- Identification of the type and the design of intersections;
- Design of complete drainage system and disposal point for storm water.
- Value analysis / value engineering and project costing.
- Contract packaging and implementation schedule.
- Strip plan indicating the scheme for carriageway widening, location of all existing utility services (both over- and underground), the scheme for their

relocation, trees to be felled and planted, estimates for cutting of trees and shifting of utilities from the concerned department.

- Preparation of Detailed Project Report, cost estimate, rate analysis, detailed bill of quantities, bid documents for execution of civil works
- Design of parking areas and rest areas, Bus Shelters or any other users facilities as per requirement
- Coordination with ongoing / sanctioned works of State Govt. / other agencies.

2.4 PROJECT DESCRIPTION

The project corridor is starting from Km 0/0(old Km. 1/500) (0 at Fatehnagar) after Fatehnagar village and passes mainly through rural and quasi-urban settlements before reaching Dariba. The villages en-route are Sanwad 1/400, Dhamerya (8/400), Gawadi (12/620), Anjna (15/00), Dariba (18/0). There after from Km 16/0 onward the Dariba starts. Udaipur & Rajsamand district maps which shows the project road is given below:

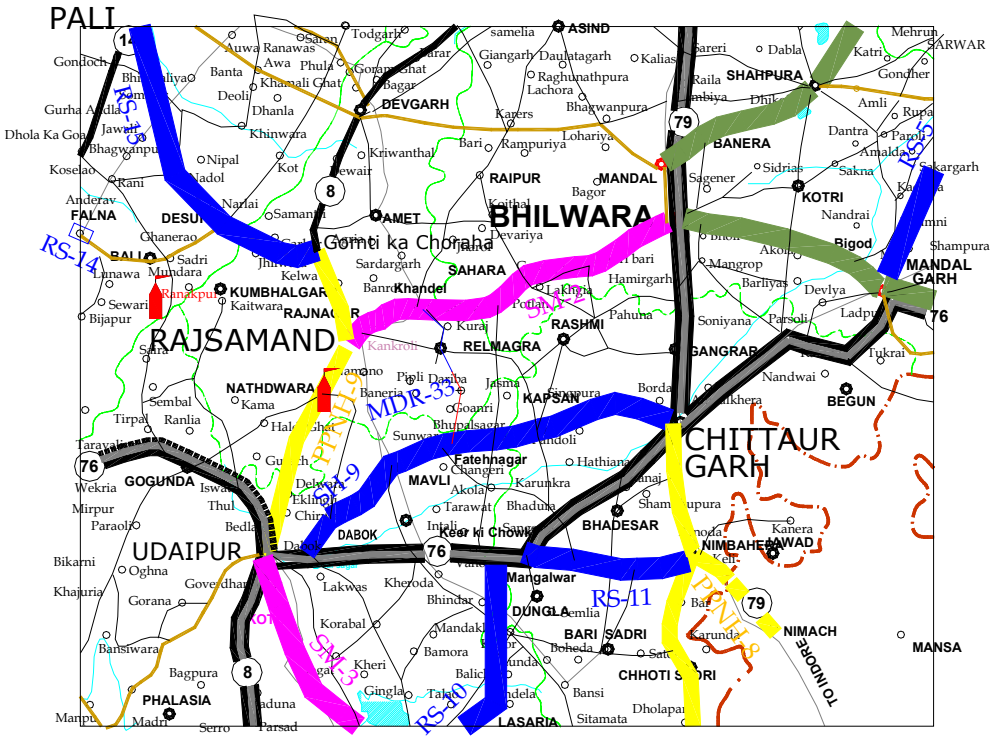

Figure 2-1: Location Map Project Road : Fatehnagar - Dariba

The carriageway width is almost constant (3.0 size single lane configuration) flanked with earthen/ hard shoulder with a varying width of 1.0m to 1.2m. As per the record the road is having a Right- of-Way (ROW) of about 12.0m where the existing carriageway is placed centrally.

Length of Project Road from Km 0/0 (old Km. 1/500) to Km 18/0 (old Km. 19/500) works out to be 18 Kms as per the Km stones fixed on the existing road. However, the section of the road falling within Dariba urban area is heavily built-up on either sides and is required four-lane configuration. The exact length of the package road thus works out to be 18.0Km from Fatehnagar Bypass Km 1/500 to Km 19/500.

The alignment is passing through plain/rolling terrain with sharp/flat horizontal curves, in which number of curve are sub standard curve. The vertical gradient of the road is gently varying with the terrain. The project road is passing its 7 km length through Black Cotton soil. Remaining in ordinary soil. Since the available Right-of-Way is only 12.0 m all along the existing road, for the widening work no additional land has to be acquired. But at some places for improvement of geometrics additional land will be required. If possible from social point of view the land acquisition would be tried with asymmetric pattern in a fashion to keep the future road centre line at the centre of the proposed land width in totality. This will help in future widening.

Figure 2-2: Widened portion in Dariba village

2.4.1 Terrain & Land Use

The project road connects Fatehnagar to Dariba passing through Udaipur and Rajasamand district distance 5 Km & 13 Km respectively. However the project section starts at Fatehnagar and passing through Udaipur and Rajasamand districts up to Dariba only. The following table gives a brief description of these districts.

Table 2-1: Area and Population of Districts on the Project Corridor

Districts	**Area (In Sq. km.)**	**Population (2001)**	**Headquarter**
Udaipur			Udaipur
Rajsamand			Rajsamand

The Project Road passes through plain/rolling terrain. The road predominantly passes through barren land, agricultural lands, and a few built up areas in the villages.

No.	Name	Description
1	**Introduction**	Introduces and provides the background to the Rajasthan Accelerated Road Development Programme (CARDP) and Project Description. The Brief description on report structure is also provided.
2	**Project Appreciation**	Project Appreciation
3	**Traffic Studies and Forecast**	Traffic Surveys and Analysis Outlines the various types of traffic surveys conducted and their analysis, findings, socio-economic profile of project influence area and Traffic Demand forecasting.
4	**Engineering Surveys & Investigations**	Engineering Surveys and Investigations describe the various field surveys and investigation their methodology, findings etc. The various field surveys includes, Topographical survey, and Material Investigations, Inventory and Condition Survey for Road, Bridges and Culverts, Pavement Investigations, etc.
5	**Improvement Proposals**	Improvement Proposals (proposed alignment, cross-section configuration, Widening scheme, utility relocation and tree felling requirements)
6	**Engineering Design**	Presents the various aspects of pavement design. The design methodology, calculation of MSA and CBR has been described. The detail designs of overlay and crust for new section has also been discussed in this chapter.
7	**Structures Inventory, Condition Survey & Design**	Presents the various aspects of Structures design. The design methodology, design standards adopted and details of structure design for the road.
8	**Environmental Impact Assessment**	Enumerates environmental and social impacts of the project and proposes mitigation measures for negative impacts.
9	**Cost Estimation**	Discuss cost estimates for each of the items included in the scope of work. It covers cost of basic inputs - materials, equipment, labor, including rate analysis, quantities, and total estimated cost. Preliminary rate analysis, quantity estimation and project cost.
10	**Annexure**	Gives the detailed data and information used in various analyses and recommendations.

3 PROJECT APPRECIATION

3.1 PROJECT ROAD

The Deptt. has decided to prepare the feasibility and preparation of Detailed Project Report for 2-lane of Fatehnagar – Dariba Road part of MDR-33.

3.2 SCOPE OF SERVICES

The detailed scope of work is as indicated in "Terms of Reference" and shall be followed meticulously while preparing the Detailed Project Report. Broadly the scope of work includes the following main aspects:

• Conduct traffic studies and assessing the growth of the same for the proposed widening.

• Conduct engineering surveys and prepare detailed designs for the highway and associated structures, quantity estimates and costing.

3.3 EXISTING SITUATION

3.3.1 Alignment / Geometrics

The existing alignment of the package road portion of MDR-33 traverses through two Districts of the State of Rajasthan as under:

• Udaipur District from Km 0/0 to Km 5/340

• Rajsamand District from Km (5/340) to Km (18/0)

Project road mainly passes through plain/rolling terrain. The road lies mostly in rural area, passing through few rural and quasi-urban settlements that causing mild hindrance to the uninterrupted flow of traffic. The settlement locations are listed below.

S No	***District***	***Tehsil***	***Village***	***Length (Meter)***
1	Udaipur	Mavli	Sanwad	500
2	Rajsamand	Railmagra	Dhaneriya	555
3	Rajsamand	Railmagra	Gawardi	540
4	Rajsamand	Railmagra	Anjna	300
5	Rajsamand	Railmagra	Dariba	750

Bottleneck due to existing structure in village portion Sanwad

Village portion Dhaneriya

Existing structure at bus stand Dhaneriya

Village portion of Gawardi

Bottleneck due to existing structure in village portion Anjana

Village portion Dariba

Bottleneck at Km 5/340 due to District Border gates

3.3.2 Climate

The climate of Rajasthan is characterized by its moderate humidity. Climatically the year may be divided into the hot season, cold season and the rainy. The rainy weather lasts from July to September and the rest of the year is warm to hot. The southwest monsoon begins from middle of June.

3.3.2.1 Temperature

The sub-tropical latitudinal and continental location of Rajasthan makes the variation of temperature that is not much. The highest daytime temperature is recorded during the months of May and June. It is ranging from 37°C to 45°C in this area. The minimum temperature is lowest from December to January. The lowest minimum temperature recorded in this region is 7° C.

3.3.2.2 Rainfall

Rajasthan normally has Indian hot, dry summer season. The atmosphere is normally hot all the times. Some rain occurs from March onwards in the afternoon, but the real force of the monsoon winds is faced from June onward. Rainfall in Rajasthan varies from 650 mm to 950 mm per year. Most of the rainfall occurs during the period July to September.

The major part of annual rainfall is experienced during the monsoon period, when the monsoon current in the Bay of Bengal enters from the southeast. The normal onset of the monsoon in Rajasthan is in the second week of June.

The relative humidity is high during monsoon season, generally exceeding 70% on the average. The driest part of the year is the pre monsoon period when the

humidity may drop to 35% during the afternoon. During the winter months, humidity increases toward the afternoon at certain high stations.

3.3.3 Land Use

Land use along the project road is predominantly agricultural. Scattered quasi-urban and rural settlements exist on both sides of the road with intervals. However, in some of village portion C.C. pavement constructed having width 5.50 M.

3.3.4 Right of Way

The existing right of way is normally about 12m with the carriageway in the centre of it. From the reconnaissance it is suggested to carry out eccentric widening. However, the alignment would be so designed as to keep the resulting carriage in the centre of the final right of way for the sake of ease of future widening. Additional Land Acquisition, may be a necessary and will essentially be to accommodate widening the road to 2-lane.

3.3.5 Roadway

The existing carriageway width for the entire project road is 3m with a varying earthen shoulder of 1.0 to 1.2m in Km 0/0 to 1/380. The carriage way width is 7.0 M with hard C.C. Interlocking Block having width 1.50 M.

3.3.6 Traffic Census data

Traffic Census data for the year 2009 has been collected from the divisions (Rajsamand) is given below. Though none of the census location actually lies on the project section the figures may be useful for sake of comparison.

Table 3-2: Traffic Census Data along the project road (Year 2009)

SN	*Location Name*	*Chainage (km)*	*CVPD*	*PCUs/day*	*Year*
1	Gawardi	14/0	764	4632	2009

Source : PWD, division, Rajsamand

3.3.7 Junctions/Intersections

A total of 37 roads meet the project road. Out of which 2 major junctions which are at crossing of SH-9 at Ch. 0/0 and at Dariba at Ch. 16/440 and rest of the junctions are all minor in nature which would need to be designed as per the typical requirements.

Table 3-3: List of Intersections

S. No.	Chainages	Type of Junction	Direction of Cross Road	Type of Cross Road	Width of Cross Road (m)	Leading To	
						Left	Right
1	0/0	+	Both	Paved	7.0	Udaipur	Chittorgarh
2	0/375	⊩	Right	Paved	3.0		Residential Colony
3	0/570	⊩	Right	Unpaved	3.0		Residential Colony
4	0/610	⊩	Right	Unpaved	3.0		Residential Colony
5	0/695	⊩	Right	Unpaved	3.0		Residential Colony
6	0/980	⊩	Right	Paved	3.0		To Heera Bada
7	1/080	⊣	Left	Paved	4.0		Residential Colony
8	1/230	⊩	Right	Paved	3.0		To Industrial Area
9	1/280	⊣	Left	Paved	3.3	Sanwar Village	-
10	1/390	⊣	Left	Paved	7.0	Sanwad	-
11	1/880	+	Both	Paved	4.0	Sanwad	Industrial Area
12	2/240	⊣	Left	Paved	3.1	Sanwad	-
13	2/260	⊣	Left	Paved	5.5	Phalisida	-
14	2/908	⊩	Right	Paved	3.0	-	Morat
15	3/150	⊣	Left	Unpaved	2.8	Field	-
16	5/340	+	Both	Unpaved	3.0	Charava	Morat
17	6/060	+	Right	Unpaved	3.0	-	Village Kheda
18	6/650	⊣	Left	Unpaved	3.1	Field	-
19	7/530	⊩	Right	Unpaved	2.9	-	Field
20	8/285	⊩	Right	Unpaved	3.0	-	Village

S. No.	Chainages	Type of Junction	Direction of Cross Road	Type of Cross Road	Width of Cross Road (m)	Leading To	
						Left	Right
21	8/410	+	Both	Paved	3.0	Medi Kheda	Dheniriyl
22	8/790	⊩	Right	Paved	3.75	-	Chanderiya
23	9/350	⊩	Right	Unpaved	3.0	-	Field
24	9/700	⊣	Right	Paved	3.75	-	Chapri
25	10/830	⊣	Left	Paved	3.00		-
26	11/790	⊩	Right	Unpaved	3.00	-	School
27	12/270	⊩	Right	Unpaved	3.00	-	Gawadi
28	12/620	⊣	Both	Paved	3.0		Gawadi
29	15/790	⊣	Right	Unpaved	3.0		Field
30	19/870	⊩	Right	Unpaved	3.0		Anjna
31	15/985	⊩	Right	Paved	6.0		Anjna
32	16/080	⊣	Left	Paved	3.0		-
33	16/440	⊩	Right	Paved	7.0		Dariba Factory
34	16/515	⊣	Left	Paved	3.0		-
35	17/175	⊣	Left	Paved	3.0		-
36	17/550	⊩	Right	Unpaved	3.0		Field
37	17/930	⊩	Right	Unpaved	3.7		Habitation

Summary

Left	*11*
Right	*21*
Both	*5*
Total	**37**

3.3.8 Pavement Condition

Pavement condition is varying from fair to poor. The condition of the pavement has been badly damaged in few stretches due to sub-grade defects. Almost the entire stretch is exhibiting the high level of undulation and cracking on the surface. It has been observed that in chainages between km 5/500 – Km 18/00. The riding quality

is very poor. Few sections of the road like at km 0/0 – 1/420, 2/0 – 5/0 show a good riding quality, this is mainly due to the overlay that has been applied recently.

3.3.9 Pavement Composition

Crust composition for the entire project road is varying from 200 mm to 370 mm. Actual crust composition is discussed in later sections of the report.

3.3.10 Submergence

The project road does not come under submergence at any location. However, during the rain it has been observed that the water comes to the brim of the roadway edge due to the lack of longitudinal drain and blockages and where the FRL is almost at the same level with the adjacent ground. The remedial measures shall be suggested during the improvement proposals.

3.3.11 Culverts

The culvert information has been recorded during reconnaissance survey and also collected separately at the time of detailed survey. The details of culverts available on the project road are given is Table 8.2.

3.3.12 Bridges

There are no bridges on the alignment.

3.3.13 Railway Crossings

There is No railway line crossing the project road.

3.3.14 Availability of construction Material

Quarries for stone aggregate and sand are available at locations as indicated below: Lead would depend upon the suitability and location of Quarries for the roadwork.

- Moorum - Dhaneriya, Singarsar
- Stone Quarries/ Aggregates - Sanwad, Dariba
- Sand Quarries - Kuraj
- Cement - Beawar, Nimbahera
- Steel - Jaipur
- Bitumen - Mumbai Baroda Refinery

Earth for road embankment would be available from borrow areas. The soil available close to the Project Road in 7 Km is generally Black Cotton soil. The chance of its suitability for road embankment is not possible. This can only be used in lower part

of embankment which is more than 500mm below the sub-grade and in remaining 11 Km the soil is ordinary soil which can be used for embankment purpose.

There is no coal based Thermal Power Station within 100 km of the project road, therefore fly ash is not being considered as a fill material.

3.3.15 Traffic

After the preliminary Reconnaissance and Survey following locations have been selected for conducting traffic surveys.

I. VOLUME COUNT SURVEYS

S.N.	Location	Chainage (km)	Remarks
i.	Near village Dariba	Km 17/0	To avoid the local influence of Dariba Sub-urban traffic

II. TURNING MOVEMENT SURVEYS

Since no major junction has been found along the project corridor, no turning movement survey has been conducted.

3.3.16 Trees in ROW

Common varieties of trees found along the existing road alignment mainly constitute of Neem, Bargad. Peepal, Kahua, Mahua, Parsa, Gulmohar, Mango, Babul, Imli, Jungle Imli, Eucalyptus etc. Widening scheme will be so evolved as to cause minimum damage to existing trees, wherever this damage becomes unavoidable, loss will be compensated by planting new tress in consultations with Social Forestry Department of the Government of Rajasthan. A separate plan for proposed tree cutting has been prepared to submit with this report.

3.3.17 Utilities

There are very few electric and one OFC lines within the proposed ROW which may not require re- location.

3.3.18 Religious/Community Property Structures

Places of religions congregation and worship are found to be there throughout the length of the road mostly encroaching on the Road Land at few places. These need to be relocated in consultation with local officials and community representatives.

Private property structure in village portion Anjana

3.3.19 Water Bodies

Number of ponds are available along and adjacent to the corridor. 17 numbers of village ponds are situated adjacent to the right of way. All efforts would be made to ensure that a minimal damage is caused to the water sources on which local people and their cattle are dependent. Some of the sources (like Hand Pumps) may have to be relocated in consultation with local officials and/or people affected in case these are falling within proposed ROW or these is a likelihood of their contamination during construction phase. Water sources developed during construction phase shall be left functional after construction.

Table 3-5: List of Ponds

S NO.	CHAINAGE	SIDE	Distance from Road Edge (in meter)	Affected by Widening
1	6/060	LHS	5.50	Yes
2	12/200	LHS	25.00	No
3	14/970	LHS	15.00	No

3.3.20 Interaction with other Departments

Following Departments /Agencies of Govt. Rajasthan and Govt. of India may need to be consulted and involved for evolving plans for widening scheme, cutting of trees, shifting of utilities etc. These agencies are:

Govt. of Rajasthan

- Revenue Department
- Environment / Forest Department
- Irrigation Department
- Rajasthan State Electricity Board
- Public Works Department

Govt. of India

- Telecom Department (BSNL)
- Ministry of Environment and Forests
- Survey of India
- Census of India
- Hindustan Zinc Limited

4 TRAFFIC STUDIES AND FORECAST

4.1 GENERAL

The project corridor extends from Km (0/0 old 1/500) to Km (18/0 Old 19/500) on MDR-33 and forms the link between the SH-9 to SH-12 and the second most important mines of HZL Dariba to Fatehnagar (largest food depot) of the area. The project corridor starts from Fatehnagar (SH-9 km 55/400) and ends at Dariba, where plant for the purity of Zinc started.This study currently aims at assessing the traffic flow and its likely growth over the next 15 years on the project corridor and to assess the feasibility for its widening to the two lane divided carriageway. The traffic studies are required to assess the existing traffic and travel characteristics on the project corridor and provide useful insights for demand forecasting.

4.2 TRAFFIC SURVEYS

It further outlines studies to be conducted. on the speed and delay characteristics, origin – destination and commodity movement characteristics, traffic volume and accident statistics along the corridor. The minimum number of survey locations identified as per the ToR is:

Table 4-1: Description of Surveys and Locations

S.No	Description	No. of locations
1	Classified Traffic Volume count	1
2	Origin-Destination and commodity movement characteristics	1
3	Axle load characteristics	1
4	Speed - Delay characteristics	Project corridor

4.3 FINDINGS FROM RECONNAISSANCE SURVEY

A reconnaissance survey of the project corridor was conducted in Dec 2009. The survey of the corridor revealed that there were no major intersections or settlements on the project corridor. Therefore, the project corridor is one homogeneous section. Though the volume of traffic on the single lane wide corridor is quite significant, there are very minor variations in traffic levels at different points.

Rich agricultural belt on both sides and some industrial areas flank the corridor. Major passenger and goods movement can be seen on the corridor signifying its importance as the major access road for the economic centres in the region. The traffic on the corridor exhibits a heterogeneous mix comprising slow moving traffic,

fast moving commercial vehicles and passenger vehicles. There are no major settlements along the corridor, only a few rural and quasi-urban settlements are present.

4.4 EXTENT AND LOCATION FOR PRIMARY SURVEYS

The data for this project has been collected from field surveys and from secondary sources. Establishing a sound database is a pre-requisite for appreciation of the ground realities. The primary surveys conducted include classified traffic volume for 7 day period, origin – destination survey for one day and speed delay survey on the entire corridor.

4.5 TRAFFIC SURVEYS

The significance of traffic database on study out come needs no elaboration. It is therefore essential to realistically and accurately assess the traffic and travel characteristics on the project road. The primary surveys were conducted for a period of 7days starting from 5.1.2010, to 12.1.2010. Brief description of different surveys is given in the following sections.

Table 4-2: Location of primary traffic surveys

S.No.	Section	Location Chainage (Km)	Type of Survey
1	Dariba Village (17/0)	17/0	VC and OD

VC = Volume Count, OD = Origin and Destination, WTP = Willingness To Pay

4.5.1 Classified Traffic Volume Counts

Traffic volume count on the corridor was undertaken in order to assess the level and characteristics of the present traffic on the road. The location was identified after the initial corridor appreciation to get a true representation of traffic on the corridor by avoiding significant local traffic while at same time keeping in mind the logistical requirements of conducting various surveys. This survey indicates the average daily traffic on the corridor, its composition of modes and the temporal variation along the corridor.

Table 4-3: Volume Counts, Locations and Duration

S.No	Location, Chainage (Km)	Duration	Date
1	Dariba Village (17/0)	7 days*	5.1.2010 to 12.1.2010

Round the Clock.

4.5.2 Origin and Destination Survey

Origin - Destination Survey was conducted at one location for 24 hrs. duration, to cover both goods as well as passenger traffic. The survey was done by roadside interview method through random sampling. The survey was conducted on a working day (Friday). This survey helps in assessing the interaction pattern between various zones and also their travel and trip characteristics.

Table 4-4: Location and Duration for Origin and Destination Survey

S.No	Location, Chainage (Km)	Duration	Date
1	Dariba Village (17/0)	24 Hrs	8.1.2010

4.6 TRAFFIC VOLUME CHARACTERISTICS

4.6.1 Introduction

The appreciation of traffic characteristics is essentially to identify the major issues and to evaluate the potential of the existing network so as to develop a rational policy for designing various components of the system. The classified traffic volume count data collected from the study corridor has been analyzed to include - Average daily traffic (ADT), hourly variation in total traffic, vehicular composition peak hour traffic etc.

The traffic data has been converted into passenger car units (PCU) to determine the relative effect of different types of vehicles on the traffic flow as compared to a standard vehicle. Table 3.7 lists the PCU factors adopted for different modes.

Table 4-5: PCU Factors Adopted For Different modes

Mode	PCU
Sc/MC/ Moped	0.5
Auto	1
Car / Govt Cars	1
Std. Bus	3
Mini Bus	1.5
Other Pass.	2

LCV	1.5
2 Axle / Govt Trucks	3
3 Axle Trucks	3
Multi Axle Trucks	4.5
Tractor	1.00
Other Goods	4.5
Cycle	0.5
Other NMT	3

4.6.2 Average Daily Traffic

Table 4-6 below gives the average daily traffic and peak hour traffic for each day of the week at the survey location. The average daily traffic is observed to be 1182 vehicles translating into 1932 PCUs.

Table 4-6: Daily Traffic Variation on Project Corridor

Date	**Daily Volume**		**Peak Hour Volume**		**Percentage Share**	
(Day)	**Vehicles**	**PCU**	**Vehicles**	**PCU**	**Vehicles**	**PCU**
5.01.2010 (Tuesday)	966	1609	140	237	6.9	6.8
6.01.2010 (Wednesday)	1319	2084	213	401	6.2	5.2
7.01.2010 (Thursday)	*1257*	*2102*	237	447	5.3	4.7
8.01.2010 (Friday)	1208	1992	208	321	5.8	6.2
9.01.2010 (Saturday)	1193	1937	*265*	372	4.5	5.2
10.01.2010 (Sunday)	1150	1886	169	290	6.8	6.5
11.01.2010 (Monday)	1174	1914	189	304	6.2	6.3
Weekly Total	8267	13521				
Average Daily	1182	1932	203	339	6.0	6.0

The analysis of the classified traffic volume data reveals an average daily volume of 1182 vehicles (1932 PCU) with the maximum traffic volume of 1319 vehicles (2084 PCU) on Tuesday and minimum volume of 966 vehicles (1609 PCU) on Monday. The average peak hour volume is a little below a thousand PCU, though the peak hour on the peak day (Wednesday) is observed to have 447 PCU.

Figure 4-1 below shows the average traffic composition. It is observed that passenger and goods vehicles are distributed in almost equal proportion. Three axle and multi axle trucks are a significant proportion of the total traffic contributing about 12% to the vehicle count. The detailed results of volume counts are given in Appendix 1.1.

4.6.3 Mode Wise Variation of Traffic with respect to Time

The number of the goods traffic in the day time is much less when compared with that of passenger traffic and the situation is just reversed during the night.

The goods traffic mainly constituted of heavy vehicles contributes more towards the traffic throughout the day but the major portion of goods flow happens during the evening and night hours. The passenger traffic is mostly limited to day hours.

Not much variation in terms of composition is observed during the week, though the proportion of passenger vehicles clearly goes up around the weekend.

4.6.4 Hourly variation:

The hourly fluctuation of total traffic (PCUs) at different locations is determinated and found that no major variations are observed.

4.6.5 Average Annual Daily Traffic (AADT)

The traffic data was collected from secondary sources namely PWD census for past years with a view to general comparison of figures and find out the seasonal correction factor for the traffic data. No PWD traffic census location was situated on the project corridor as such, however, two location on the MDR-33 were found closer to Fatehnagar. An attempt has been made to compare and extract some useful information from the data. Another major limitation of the PWD counts was that three axle trucks were not counted under a separate classification prior to June 2006 and therefore no real comparison can be made at a disaggregated level.

The primary objective of analyzing PWD census data was to try and figure out the seasonal variations in the traffic flow. The PWD counts are conducted twice every year in June and December respectively.

4.7 TRAVEL CHARACTERISTICS

4.7.1 Introduction

Travel characteristics reflect the nature and kind of traffic plying on the corridors. In this section an effort has been made to appreciate the travel characteristics in terms of distribution of trips by purpose, frequency of travel, average trip length, average trip time, trip length frequency distribution, travel time frequency distribution etc. The analysis performed shall help in predicting the nature of traffic in years to come and to support the changes in the existing traffic volume at different locations of the study corridor. Thus this survey forms an important input in the study out come.

As noted earlier, to elicit the present scenario of traffic movement and trip characteristics extensive roadside interviews were conducted on the study corridor locations. The description of the travel characteristics on the study corridor is presented in the ensuing sections.

4.7.2 Delineation of Traffic Zones

The zoning system has been designed with a view to understand the trip generation characteristics of traffic on the project corridor and to be able to use the same in estimating future demand. The project corridor mainly connects the two Industrial town of Rajasthan namely Fatehnagar and Dariba. Keeping in view of the length of the project corridor and absence of any major intersections between the beginning and the end, a two tier zoning system, has been adopted. The first tier consists of the immediate surroundings of the project corridor consisting of four zones, namely the urban areas of Fatehnagar, Sanwad & Dariba and the remaining areas of both the districts respectively. The second tier consists of the rest of the state of Rajasthan and all other states of the country.

4.7.3 Conclusions and Recommendations

The traffic projections for the years up to 2030 have been worked out using the econometric method under three scenarios. The over all traffic levels under the likely and pessimistic scenario are respectively 30% and 40% lower compared to the optimistic scenario in the horizon year.

For the purpose of highway design and project development, we need to adopt one scenario. The present, optimistic, economic outlook is based on the experience of

only past few years. Also, with structural changes in the economy the traffic elasticises with respect to economic growth may go down more than expected. High fuel costs may also affect traffic growth negatively. However, we understand that Rajasthan as a state has not yet reached its socioeconomic potential and would therefore register a higher growth impetus. Further, the project corridor connects two of the most important urban areas of the state, which in all likelihood would be the drivers of growth for the entire state and in process would grow fast themselves. Although, it is difficult to translate macro-economic indicators at a micro-economic regional level, we believe the growth of this region would be faster than the general growth rate of the state. Therefore, even if the growth scenario does not work out to be as optimistic, as the prevailing outlook, at the macro-economic scale, its impact on the regional economy may not be so drastic. In view of the above discussion we suggest that the likely scenario be considered for design and project development purpose.

5 ENGINEERING SURVEYS & INVESTIGATIONS

5.1 ROAD INVENTORY

The objective is to collect information on all physical and visible features of the road and the roadside features as existing at site to facilitate development of preliminary improvement proposals. All the details were recorded by actual measurements done at site, according to SP- 19 format duly modified as per the project requirements. The existing kilometre stones formed the reference marks for the survey team. The Road Inventory was recorded under the following sub-heads: -

- Type of Terrain- (Flat/ Rolling/ mountainous)
- Land use – (Agriculture /Commercial/Forest/ Residential/ Barren)
- Name of Village/Town
- Formation Width
- Carriageway- Type/ Width/ Condition
- Shoulder - Type/ Width/ Condition
- Embankment height
- Submergence area - location
- Details of Crossroads –Location/Road Name. /Carriageway Width
- Existence of Water bodies
- Road Side Drainage (Non Existing, Partially Functional, Functional)

5.2 PAVEMENT CONDITION SURVEY

The survey, in general pavement conditions was primarily a visual exercise undertaken by means of slow drive-over survey, and supplemented with measurements where necessary. Visual assessment was carried out from a vehicle, with speed not exceeding 20 - 30 km/hr and stopping at various locations at suitable intervals and wherever necessary, by variations in pavement conditions. At the points of stoppage, simple measurements using measuring tape; straight edge was carried out to quantify pavement deficiency on a representative basis. Aspects of pavement conditions assessed include surface defects, rut depth, cracking, potholes, patched areas, shoulder condition etc. An overall assessment of performance – serviceability of the road was also done to qualitatively rate the existing pavement and shoulder condition.

The pavement condition was measured under the following sub-heads:

• Shoulder-

- Composition/Condition/material Loss
- Riding Quality (Good/Fair/Poor/Very Poor)

• Pavement Condition-

- Cracking (%)
- Raveling (%)
- Potholes (%)
- Patching (%)
- Rut depth

All the distress conditions were estimated by carrying out visual condition survey and taking measurements wherever necessary after dividing each distress mode of the Pavement in categories By studying, the pavement condition of the project road.

5.2.1 Results

It is seen from the results of the Table that the overall Pavement Condition of the project road is in poor condition. The summary of condition survey results is given in Table

Pavemant Condition	Percentage
Good	11
Fair	22
Poor	67

From the above table it can be seen that 67% of the length is in poor condition, 22% length is in fair condition and 11% of the section is in good condition.

However CBR results of Sub-grade below existing pavement has shown poor results in 7 km and reasonable in 11 Km of stretch which has been discussed in the chapter of Pavement design.

5.3 EXISTING CRUST COMPOSITION

Existing pavement crust thickness varies from 200mm to 370mm consisting of 40-120mm surface material, 100-150mm base material. 2 sub-base material in the form of GSB 100 to 150 mm thick were found, but they are almost mixed up with clay, tough to identify separately and exhibits very poor strength also. Most of the location Sub base is not present. Kilometer wise crust composition given in table given below:

Existing Crust composition for MDR-33 Km 0-Km18) Section

Km	BT	WBM	GSB
1	40	100	100
2	70	100	100
3	120	100	150
4	120	100	150
5	100	-	150
6	100	-	100
7	70	100	150
8	70	100	150
9	70	100	100
10	70	150	150
11	100	150	-
12	45	100	100
13	45	100	100
14	45	100	100
15	45	100	100
16	45	100	100
17	70	150	100
18	40	100	100

5.4 *BENKELMAN BEAM DEFLECTION SURVEY*

Benkelman Beam Deflection studies are carried out for evaluating the requirements of strengthening of pavements. Performance of flexible pavement is closely related to elastic deflection under the wheel loads. The deformation under a given load depends upon sub-grade soil type, its moisture content and compaction, pavement surface temperature, drainage condition etc.

Control Line Testing Scheme- The control line Testing involves carrying out deflection testing for each 100 m long section in each kilometer along the road. The selection such segment was kept normally in the middle of the kilometer staggering on either side of it. The deflection measurements for the control section testing were kept at an interval not more than 10 m (on same side).The points of record of deflection measurement were marked at 90 cm from pavement edge at an interval of 10 m as per Control Line Testing. The BBD survey was started as per Control Section Testing Scheme, however, the survey had to be discontinued in stretches

due to the very bad condition of the pavement.

The beam was calibrated using metallic pieces of known thickness to ensure that the beam and the dial gauge are working properly. The Standard 2-Axle truck having a rear axle weighing 8170 kg, fitted with dual tyres inflated to a pressure of 5.60 kg/cm2 (79.65 PSI) was used for loading the pavement.

The pavement surface temperature, seasonal variation in climate and average annual rainfall, influences the deflection measurement by Benkelman Beam. Pavement temperature was recorded once every hour by inserting a thermometer (Alcohol Medium) in a hole (45mm depth and 10mm dia) drilled in the pavement and filled with lube. The average rainfall of the study area has been noted which comes out to be less than 850 mm/year. The initial, intermediate and final deflections are recorded and Pavement deflection analysed as per IRC: 81–1997 “Guidelines for strengthening of Flexible pavements using Benkelman Beam Deflection Technique”.

Finally, the characteristic deflections have been determined to work out the thickness of overlay over the existing road crust. Results of BBD testing are given in Table 5.1. The results are as under

The correction factors have been applied for moisture content and Pavement Temperature as per the guidelines given in IRC: 81-1997. Deflection measurements

obtained from the field surveys have been used in the analysis to determine the mean deflection, standard deviation and characteristic defection. The details of field values are given in Annexure to this report.

Table 5-1: Km-wise Benkle Beam Deflection

Chainage	Characteristics Deflection	Rutting
1	3.58	225
2	2.01	170
3	2.71	200
4	1.75	145
5	2.34	182
6	1.78	144
7	2.08	170
8	2.51	192
9	2.51	192
10	3.58	225
11	3.10	212
12	2.69	198
13	2.71	200
14	3.39	220
15	4.02	238
16	4.19	242
17	2.80	205
18	3.15	217

5.5 TOPOGRAPHICAL SURVEY

Topographical survey is the backbone of detailed engineering design. Accuracy of the information collected during this survey has direct bearing on almost all the design activitiesinvolved in project preparation. The beginning of topographical surveys is made with collection of preliminary information of latitude and longitude of the region as well as approximate reduced level above mean sea from Survey of India

maps available in the region. For the purpose of detailed engineering design, topographical surveys were divided into following activities:

- Setting up permanent bench marks and control stations to be used during construction
- Establishment of horizontal control to have unique coordinate system of northings and eastings along the project corridor
- Establishment of vertical control to have the elevation coordinate hooked to nearest GTS stations along the project corridor
- Collection of Digital Terrain Model data containing the existing highway, rivers, streams and other topographical features to form the basis for the new designs;
- Preparation of base plans containing the entire natural and man made features like buildings, fences, walls, utilities, temples and other religious structures etc. that would govern the finalisation of horizontal alignment.

The following paragraphs describe the methodology adopted in carrying out the above said activities in details.

5.5.1 PERMANENT BENCH MARKS

Permanent benchmarks marked with fixed structure along the project corridors. Which will have least disturbance from the local villagers. Pillars were painted yellow and numbered with chainage is marked in red. The same pillars have been used for the purpose of establishing horizontal and vertical control with Total Station (Topcon GTS 701) and Digital Level (Topcon DL 101) respectively.

5.5.2 HORIZONTAL CONTROL

Horizontal control stations were established at every 200 m along the corridor using total Station.

Horizontal: 5mm plus 1ppm baseline length and

Vertical: 10mm plus 1ppm baseline length,

The benchmark pillars established along the project corridor were also connected during the closed loop traversing.

Since elevation data obtained by Total Station is not accurate enough to be used, this data was discarded and elevations obtained by Digital Level survey (discussed in next section) were used. The data covers information about the locations,

absolute horizontal coordinates and elevations. This established coordinates at site including the temporary stations are presented in the table at the end of this report.

5.5.3 VERTICAL CONTROL POINTS

The vertical control stations (Bench Marks) along the proposed corridor were established by closed loop leveling with Digital Levels. All the structures along the project road and the control stations set up for horizontal Control were used to serve as benchmarks.

5.5.4 DTM SURVEYS

Using the horizontal and vertical control points established, accurate data in the digital format in terms of Northing (Y), Easting (X) and Elevation (Z) co-ordinates for all breaks in terrain such as ridges and ditches was collected perpendicular to the centre line at 10m intervals in tangent sections using auto level. The minimum width of band was 7m-8m on either side of the centerline for MDR-33. However this bandwidth was increased to 12m on the inside of curves to account for minor adjustments required during design.

All natural and man made features such as buildings, drainage structures, temples, mosques, trees and utility installations etc if any were captured during the survey. Big trees with large girth were captured together with areas of plantation. Boundaries of Agricultural land area were also surveyed together with paddy field areas etc.

Where any existing cross road crosses the alignment, the survey was extended to a minimum of 50m on either side of the road centerline and was of sufficient width to allow improvements including at-grade intersections to be designed.

5.5.5 Quality Assurance

Every effort was made to minimize errors during the field survey. A system of checks was implemented to ensure the accuracy of all survey information to be gathered, particularly concerning the horizontal and vertical control points. As a part of quality assurance, primary and secondary responsibilities were established and instruments checked at regular intervals. DTM data collection was also based on the loop system with loop closures at every 200-500m. A precision of 1: 20000 was adopted in DTM collection. Suitable corrections were applied to coordinates wherever the error is out of the permissible limits and suitable adjustments were made. DTM survey was repeated wherever the requisite precision was not met.

5.5.6 Data Storage

A spatial co-ordinate system was followed for referencing all data points. Each data point was referenced by x, y and z co-ordinates, the first two representing the horizontal locations and the third elevation. The horizontal co-ordinates were with respect to absolute grid system of northing and easting established by Closed Loop Traversing. The elevation datum used was Bench Marks. at ch. 0/30 on centre median.

The survey information for DTM was as follows :

Point number T-1

Easting (x)

Northing (y)

Elevation (z)

Description.

All the data was stored in registrar.

5.5.7 BASE MAPS

Base Maps showing the alignment of existing roads and pertinent topographic features such as buildings, trees, rivers, fences, water-mains, underground and overhead telephone and electricity lines and OFC lines were prepared using the DTM data collected. The LDD program was then used to process the raw data and create co-ordinate files. Base plans were updated with walk over surveys on the corridors and wherever a feature was not captured, survey was again done at that location to prepare final base plans. The Base Plans are presented in the subsequent section of this report. However, the same base plan along with the optimized designed centerline has already been submitted.

5.5.8 RIVER BED PROFILES AND CROSS-SECTIONS

As all existing CD works widened to 12.00 M with span as per previous opening. some of them are dismantled as they are not safe to take projected traffic. Hence those structure are dismantled and reconstructed as per previous span.

5.6 SOIL AND MATERIAL INVESTIGATIONS AND ANALYSIS

5.6.1 INTRODUCTION

This chapter covers the soil and material investigations for the project corridor MDR-33, while also giving the list of quarries and borrow pit locations to be used as the sources of construction materials. The pavement and materials investigation were performed in accordance with the methodology described in the IRC: SP: 19-2001. The existing road level is slightly above natural ground level in maximum stretch of the project corridor. At urban locations it is at natural ground level. To determine the existing pavement thickness and its composition, trial pits were dug at the edge of the existing carriageway at every 1000 m interval left and right side staggered. Suitability of material is finally judged keeping in view the relevant MOST specifications and the different test results.

5.6.2 Components

The material investigation has the following components

- Soil sampling, field density tests and laboratory tests on existing sub-grade and sampling of the same soils.
- Investigating borrow materials for embankment, sub-grade and granular sub-base.
- Investigating metal and sand quarries.
- Locating water sources for construction work.
- Identifying sources for other construction material such as cement, bitumen and steel.

Samples of borrow soils, sand, crushed rock and moorum for use in embankment, pavement structure and concrete mix as applicable were collected from the existing as well as proposed borrow pit sources/quarries within reasonably short haulage distances from the Project corridor. Auger holes and test pits were also excavated wherever necessary to obtain samples for testing.

5.6.3 Investigations Accomplished

The following Table 5-2 summarizes the quantum of investigations and testing completed to achieve the desired objectives for material investigations for the feasibility report.

Table 5-2 : Quantum of Investigations

S. No.	Task Description	Avg. Interval	Number
1	Test pit excavation - penetrating the pavement structure down to sub-grade to • record pavement composition • perform field density test on sub-grade • collection of sub-grade samples	1000m -	18 18
2	Test pit excavation adjacent to toe on natural ground and collection of soil samples	-	12
4	Investigation of • quarry sources • sand sources	- 	 2 1
5	Investigation of soils from borrow sources	1.5 km	12
6	Investigation of water Samples	-	1
7	Investigation of GSB/moorum samples	-	2

5.6.4 Test Procedures

The test procedures followed for field-testing, soil sampling and laboratory testing are given in the Table 5-3. Majority of the laboratory tests were performed at and Rahul engineers Laboratory Udaipur.

Table 5-3: Testing Codes Adopted

Type of Test	Method
Field dry density using core cutter method	IS 2720 Part 29
Moisture content determination	IS 2720 Part 2 (section I)

Atterberg limits	IS 2720 Part 5
Sieve analysis • natural soils • rock aggregate	IS 2720 Part 4 IS 2386 Part 1
Compaction test (Heavy Compaction)	IS 2720 Part 8
CBR and Swell	IS 2720 Part 16
Free swell index	IS 2720 40
Aggregate impact value	IS 2386 Part 4
Coating and stripping of Bitumen aggregate mixtures	AASHTO T-182(as prescribed in MOST specifications)
Soundness of Aggregates	IS 2386 Part 5
Flakiness and Elongation Indices	IS 2386 Part 1
Water Absorption and Specific Gravity of aggregate	IS 2386 Part 3

Soil classification is done according to the Indian Soil Classification System (ISC) as detailed in IS 1498.

5.6.5 Existing Sub-grade and Embankment Soils

Test pits were excavated at selected locations with an interval of 1000m along MDR-33 to perform field density tests and to collect soil samples for laboratory tests. They were carefully dug from the pavement surface up to sub-grade level where these were manually leveled and prepared for field density tests. Field density tests on sub-grade soil were conducted at each test pit location and a small quantity of sample was collected in airtight container for determining field moisture content. Structural composition of existing pavement at the chain ages of test pit was also noted. Upon completion of the field density test, representative sample of sub-grade soil was collected in bulk, in gunny bag, from each test pit for laboratory testing.

Representative samples of soils and materials collected from the test pits were subjected to various laboratory tests listed below:

5.6.5.1 Sub-grade Soil Samples

Tests performed were

- Sieve analysis

- Atterberg limits
- Moisture density relationship (Heavy Compaction)
- Four days soaked CBR tests at optimum moisture content. These tests were initially planned to be conducted for each homogenous group of soils, which worked out to about one fifth of the total number of the samples, however, finally as much as 12 samples were tested irrespective of homogeneity. The grouping was established on the basis of similar soil index properties, Sieve analysis and moisture-density relationship. Four days soaked CBR at FDD and 97% of the MDD have been determined from the graphs plotted for CBR vs. Density.

5.7 CONSTRUCTION MATERIALS INVESTIGATION

The objectives of the material survey were to (i) locate potential sources of soil, sand, gravel, rock, water and other major construction materials within the project vicinity, (ii) examine the engineering properties of the materials relevant to the project as per MOST specifications. As a first step, material sources were identified with the help of existing data, local enquiry and field assessment. Thereafter soil, moorum and aggregate samples were collected from the sources for testing.

Since the good earth and moorum is not available within the vicinity of the corridor it has been considered to use local soil in embankment and GSB used as sub-grade. Potential such borrow sources are shown in Table 5.4. The tables also include information such as distance from the project road, location, village name etc. Borrowing GSB , moorum from these areas would require prior approval of the local authorities or negotiations with private owners as the case may be. Moorum samples from these borrow sources were collected in bulk quantities by excavating test pits up to 1.0 m depth from the existing ground surface. The Top layer is also the good quality of sub grade material.

Sampling and Laboratory Testing

Samples collected from the identified borrow pits/ moorum quarries have been tested for the following properties to assess the possibility of utilizing the local soil as embankment fill, sub grade or sub-base, material.

- Sieve analysis,
- Atterberg limits,
- Heavy compaction

- Four (4) days soaked CBR at 97% of MDD as applicable for sub-base (Heavy Compaction)

5.7.1 Quarries for Aggregates

Aggregates to be used for base and surface courses of pavements and concrete works were collected from the crushers under operation in the existing quarries. Most of these quarries are owned privately. The locations, estimated quantity and the approximate distance from each source to the nearest point on the Project Corridor are compiled in Table 5-4.

The following tests were conducted on rock aggregates from the quarries

- Sieve Analysis (in case of samples collected from crusher)
- Specific Gravity
- Water Absorption
- Flakiness and Elongation indices (in case of samples collected from crusher)
- Aggregate Impact Value
- Soundness

Samples were collected from 1 identified quarries based on local inquiry where private crushers are already under operation. Each quarry is rock outcrops with a little overburden of earth/weathered rock.

5.7.2 Quarries for Sand

Sand samples were collected from one source and tested. Table 5-4 shows the location of these quarries along with lead distance to the project corridor. The following tests were conducted on sand samples collected so far

- Sieve analyses and calculation of fineness modulus

Table 5-4: Quarry locations of Aggregate, Moorum and Sand

S.No.	Chainage	Location	Distance (Km)	Quarry
1	1/900	Sanwad	2.0	Aggregate / Stone
2	2/900	Morat	4.0	Aggregate/ Moorum
3	5/340	Morat	4.0	Aggregate/ Moorum
4	8/410	Dheneriya	2.0	Aggregate / GSB
5	9/690	Chapri	0.5	GSB / Moorum / Aggregate / Stone
6	18/0	Singesar	5.0	Aggregate / GSB / Moorum / Stone
7	28/500	Kuraj	20	Sand

5.7.3 Source for Water

There are a number of natural storage/ ponds of water adjacent to the project corridor. There are also a number of open wells along the corridor and water from these wells is used for drinking. The discharge in the river/nala near by the project corridor is maximum during the rainy season with visible impurities such as clay and discharge reduces to minimum in the dry season.

Two samples of ground water were collected from the bore well at chainage 9 / 020 along MDR-33 and tested. Test result is satisfactory.

5.7.4 Sources for Other Construction Materials

Cement Grade33, Grade 43 and Grade 53 are available at Nimbaheda (J.K.) Pindwara & Beawar (Shree Cement) and steel of various grades including HYSD steel as per IS: 432 are available in to Udaipur, Rajsamand and local areas and can be procured either from there or directly from any manufacturer of repute. Bitumen is available at Mumbai and Baroda refinery. Manufacturer's test/ quality certificate is needed for each consignment of all such materials.

5.8 EVALUATION OF TEST RESULTS

5.8.1 Existing Sub-Grade Soils

Test Results summarized in Table 5.4 indicate that the soils used in the sub-grade construction belong primarily to the SM, SC and CI category. Liquid limit and plasticity index of the SM, SC type soils varies from 23% to 41% and 0% to 17% respectively. The soaked CBR value of sample varies from 2.5 % to 6.50%.

5.8.2 Toe Soil Samples

Soil samples from the toe of the embankment were collected at an average interval of 1.5 km to investigate the engineering properties of the soils in the area adjoining to corridor. Test Results show that the 90% of the soils all along the corridor belong to the SM category. The soaked CBR of the soil samples is found to be as low as 2.50% and varying up to 6.50% with an average value of 4.5%. Exceptionally one sample has shown the maximum value of soaked CBR as 6.50%. This shows that local soils from neighboring fields are suitable for embankment construction.

5.8.3 Borrow Pit Soils

Severe scarcity of good quality material prevails along the corridor. However, plenty of ordinary soil is available in couple of locations. Having same characteristics as soil used in embankment previously. hence it is recommended to use locally available normal soil in embankment as well as select sub-grade.

Chainage	Sample No.	Grain Size Analysis	Atterberg's Limits		Remarks	Soil Classification
			LL (%)	PI (%)		
1/0	10/009/02	V	24	NP	Sub-grade Sample	SM
2/0	10/010/02	V	23	NP	Sub-grade Sample	SM
3/0	10/011/02	V	24	NP	Sub-grade Sample	SM
4/0	10/012/02	V	23	NP	Sub-grade Sample	SM
5/0	10/013/02	V	30	11	Sub-grade Sample	SC

6/0	10/014/02	V	41	17	Sub-grade Sample	CI
7/0	10/015/02	V	25	NP	Sub-grade Sample	SM
8/0	10/016/02	V	26	NP	Sub-grade Sample	SM
9/0	10/017/02	V	23	NP	Sub-grade Sample	SM
10/0	10/018/02	V	24	NP	Sub-grade SampleSM	SM
11/0	10/019/02	V	24	NP	Sub-gradeSM Sample	SM
12/0	10/020/02	V	23	NP	Sub-grade Sample	SM
13/0	10/021/02	V	37	14	Sub-grade Sample	SC
14/0	10/022/02	V	23	NP	Sub-grade Sample	SM
15/0	10/023/02	V	25	NP	Sub-grade Sample	SM
16/0	10/024/02	V	23	NP	Sub-grade Sample	SM
17/0	10/025/02	V	23	NP	Sub-grade Sample	SM
18/0	10/026/02	V	23	NP	Sub-grade Sample	SM

Summary results of laboratory test for Toe soil

Chainage	Sample No.	Grain Size Analysis	Modified proctor test		CBR at 97% of MDD	Soil Classification
			MDD (g/cc)	OMC %		
3/200	09/692/09	V	1.99	10.00	6.1	SM
5/200	09/692/08	V	2.04	8.50	6.20	CI
6/200	09/493/07	V	1.89	12.0	2.90	CI
7/200	09/692/07	V	2.00	9.50	6.30	CI
9/200	09/692/06	V	1.95	11.0	6.50	CI
10/100	09/692/05	V	1.75	11.0	2.50	CI
11/300	09/692/04	V	1.97	9.5	4.00	CI
12/600	09/692/03	V	1.97	11.0	6.40	CI
14/200	09/493/06	V	1.83	9.5	3.90	CI
14/800	09/692/02	V	1.84	12.0	4.10	CI
16/200	09/692/01	V	1.90	12.0	4.70	CI
16/800	09/493/01	V	1.92	12.0	3.30	CI

6 IMPROVEMENT PROPOSAL

6.1 INTRODUCTION

Improvement Proposal is a prerogative for development of any asset. Highway Improvement Proposals are technically sound, environmental friendly and economically feasible highway improvement options for widening and strengthening of the project corridors. These improvements not only include the formulation of suitable cross-sections and horizontal alignments for widening of road sections, but also include finalization of CD alignments and provision of roadside facilities like bus bays, laybys etc. This chapter deals with the approach adopted in proposing the improvement options to both the project corridors in rural and urban areas.

6.2 Major District Road - 33

6.2.1 General

The project corridor is entirely passing through the plain/ Rolling terrain with a very mild cross slope. Mainly the adjacent land-use is dominated by the agriculture. However, apart from the settlements enroute the last two kilometer is increasingly commercial. Generally the corridor is having small embankment. Before the approach of CD work the embankment gains some height.

6.2.2 Availability of ROW

As per the available record and discussion with various PWD officers it has been revealed that the available Right of Way is not les than 12.0m all along the project stretch. The existing road is placed concentrically within the Row.

6.2.3 Widening Proposal

The present scope of work is to develop the existing single-lane carriageway configuration to 2-lane dual carriageway configuration with the facility of partially access controlled road in order to ensure high speed of travel with comfort and safety. Minimum cutting of road side trees, relocation of temples and relocation of existing utility lines situated with in ROW has been taken in to consideration while finalizing widening proposals. Existing road has 1-lane carriageway. Base open (2009) AADT on the project road is observed in the order of about 1932 PCU. Thus the proposed cross sections for improvement of existing road is worked out in accordance with the design standards and the Major features are given here:

- Carriageway 1 X 7.00 m
- Median 1.50m Built up
- 4-Lane at dariba village portion
- Verge / GSB Shoulder 2.00 m (on either side in rural areas only)

Widening in form of concentric widening is proposed. Design of widening scheme is governed by the roadside constraints and availabilities of right of way. The design centerline has been shown along with the Base Plan submitted as a part of survey report the corridor is designed for the 60kmph. Last 2 km of urban area has been designed for 40kmph. The horizontal curve details designed for the proposed alignment is shown below.

Summary of Horizontal Curves

Curve	chain	Delta	Ts	Ls	Es	Rc	V	e	Extra Widening
Km 1 C1	0/920	18˚	61.773	60.00	3.252	200.00	65.00	7.00%	0.60
Km 2 C2	1/400	5˚	-	-	-	-	-	-	-
C3	1/530	12˚	-	-	-	-	-	-	-
C4	1/555	38˚	40.967	40.00	4.628	60.00	30.00	7.00%	0.60
C5	1/600	6˚	-	-	-	-	-	-	-
C6	1/630	22˚	37.019	35.00	2.391	100.00	35.00	5.00%	0.60
C7	1/670	9˚	-	-	-	-	-	-	-
C8	1/750	12˚	51.077	60.00	1.855	200.00	65.00	7.00%	0.60
C9	1/880	18˚	-	-	-	-	-	-	-
Km 3 C2	2/010	21˚	67.184	60.00	4.168	200.00	65.00	7.00%	0.60
C3	2/160	6˚	-	-	-	-	-	-	-
C4	2/260	60˚	74.123	65.00	13.711	70.00	40.00	7.00%	0.60
C5	2/300	9˚	-	-	-	-	-	-	-
C6	2/450	22˚	68.999	60.00	4.507	200.00	65.00	7.00%	0.60
C7	2/530	12˚	-	-	-	-	-	-	-
C8	2/580	14˚	40.912	4.00	1.672	170.00	50.00	6.53%	0.60
C9	2/600	12˚	-	-	-	-	-	-	-
C10	2/645	11˚	-	-	-	-	-	-	-
C11	2/750	7˚	-	-	-	-	-	-	-
C12	2/900	29˚	-	-	-	-	-	-	-
C13	2/930	48˚	-	-	-	-	-	-	-
C13	2/930	77˚	87.807	75.00	21.589	60.00	40.00	7.00%	0.60
Km 4 C2	3/030	15˚	35.114	35.00	1.641	125.00	40.00	5.70%	0.60
C3	3/070	8˚	-	-	-	-	-	-	-
C4	3/120	7˚	-	-	-	-	-	-	-
C5	3/250	29˚	48.542	45.00	4.16	100.00	40.00	7.00%	0.60
C6	3/345	11˚	36.778	35.00	1.181	200.00	50.00	5.56%	0.60
C7	3/550	7˚	38.914	35.00	0.8	350.00	65.00	5.36%	0.60
C8	3/990	5˚	-	-	-	-	-	-	-

Km 5 C2	4/150	2˚	-	-	-	-	-	-	-
C3	4/780	11˚	36.778	35.00	1.181	200.00	50.00	5.56%	0.60
C4	4/980	8˚	32.49	30.00	0.761	250.00	50.00	4.50%	0.60
Km 6 C2	5/060	7˚	30.298	30.00	0.618	250.00	50.00	4.50%	0.60
C3	5/340	2˚	-	-	-	-	-	-	-
C4	5/570	6˚	30.728	30.00	0.537	300.00	50.00	4.50%	0.60
C5	5/910	30˚	49.483	45.00	4.4	10.00	40.00	7.00%	0.60
Km 7 C2	6/040	23˚	31.354	30.00	2.117	80.00	30.00	5.00%	0.60
C3	6/100	12˚	31.312	30.00	1.097	155.00	40.00	4.60%	0.60
C4	6/440	4˚	-	-	-	-	-	-	-
C5	6/710	8˚	40.991	40.00	0.955	300.00	65.00	6.25%	0.60
C6	6/920	16˚	60.185	50.00	2.878	250.00	65.00	7.00%	0.60
Km 8 C2	7/180	7˚	30.298	30.00	0.618	250.00	50.00	4.45%	0.60
C3	7/390	9˚	34.685	30.00	0.923	250.00	50.00	4.45%	0.60
C4	7/480	4˚	-	-	-	-	-	-	-
C5	7/700	14˚	55.739	50.00	2.297	250.00	65.00	7.00%	0.60
C6	7/850	22˚	68.999	60.00	4.507	200.00	65.00	7.00%	0.60
Km 9 C2	8260	3˚	-	-	-	-	-	-	-
C3	8340	19˚	48.513	45.00	2.707	155.00	50.00	7.00%	0.60
C4	8420	6˚	35.849	35.00	0.626	350.00	65.00	5.40%	0.60
C5	8640	15˚	43.938	40.00	2.067	170.00	50.00	6.50%	0.60
C6	8880	2˚	-	-	-	-	-	-	-
Km 10 C2	9070	6˚	35.849	35.00	0.626	350.00	65.00	5.40%	0.60
C3	9550	12˚	38.543	35.00	1.358	200.00	50.00	5.60%	0.60
C4	9700	15˚	43.938	40.00	2.067	170.00	5.00	6.50%	0.60
Km 11 C2	10230	16˚	62.695	55.00	2.966	250.00	65.00	7.00%	0.60
C3	10430	9˚	34.685	30.00	0.923	250.00	65.00	7.00%	0.60
C4	10470	3˚	-	-	-	-	-	-	-
C5	10530	7˚	30.298	30.00	0.618	250.00	50.00	4.45%	0.60
C6	10830	4˚	-	-	-	-	-	-	-
Km 12 C2	11200	3˚	-	-	-	-	-	-	-
C3	11300	13˚	40.313	35.00	1.551	200.00	50.00	5.50%	0.60
C4	11370	10˚	35.016	35.00	1.02	200.00	50.00	5.50%	0.60
C5	1175	16˚	35.114	35.00	1.641	125.00	40.00	5.70%	0.60
C6	11820	6˚	28.345	20.00	0.528	350.00	50.00	3.20%	0.60
C7	11880	17˚	36.231	35.00	1.801	125.00	40.00	5.70%	0.60
Km 13 C2	12190	21˚	31.076	25.00	1.968	100.00	30.00	4.00%	0.60
C3	12240	26˚	31.034	25.00	2.438	80.00	30.00	5.00%	0.60
C4	12310	23˚	32.892	25.00	2.314	100.00	30.00	4.00%	0.60
C5	12360	10˚	27.384	25.00	0.803	170.00	40.00	7.00%	0.60
C6	12430	15˚	43.938	40.00	2.067	170.00	50.00	6.50%	0.60
C7	12620	7˚	30.298	30.00	0.618	250.00	50.00	4.50%	0.60
C8	12780	32˚	67.086	45.00	6.812	155.00	5.00	7.00%	0.60
C9	12860	47˚	59.422	40.00	8.946	90.00	35.00	6.00%	0.60
C10	12970	18˚	28.373	25.00	1.51	100.00	30.00	4.00%	0.60
Km 14 C2	13020	33˚	42.192	25.00	4.566	100.00	30.00	4.00%	0.60
C3	13220	12˚	51.311	50.00	1.796	250.00	65.00	7.00%	0.60
C4	13370	27˚	57.707	55.00	4.587	125.00	50.00	7.00%	0.60
C5	13520	13˚	40.312	35.00	1.551	200.00	50.00	5.50%	0.60
C6	13590	5˚	-	-	-	-	-	-	
Km 15 C2	14090	3˚	-	-	-	-	-	-	
C3	14290	8˚	32.49	30.00	0.761	250.00	50.00	4.50%	0.60

C4	14440	21˚	51.131	45.00	3.197	155.00	50.00	7.00%	0.60
C5	14610	31˚	50.215	50.00	4.595	90.00	40.00	7.00%	0.60
C6	14680	13˚	40.312	35.00	1.551	170.00	50.00	6.50%	0.60
C7	14810	38˚	55.478	55.00	6.269	80.00	40.00	7.00%	0.60
C8	14920	32˚	51.074	52.00	4.828	90.00	40.00	7.00%	0.60
C9	14940	18˚	-	-	-	-	-	-	-
Km 16 C2	15060	36˚	54.554	52.00	5.845	90.00	40.00	7.00%	0.60
C3	15160	6˚	23.105	20.00	0.41	250.00	40.00	3.00%	0.60
C4	15380	12˚	31.312	30.00	1.097	155.00	40.00	4.60%	0.60
C5	15480	32˚	51.074	50.00	4.828	90.00	40.00	7.00%	0.60
C6	15520	7˚	25.294	20.00	0.534	250.00	40.00	3.00%	0.60
Km 17 C2	16140	3˚	-	-	-	-		-	-
C3	16410	17˚	36.231	35.00	1.801	125.00	40.00	5.70%	0.60
C4	16470	6˚	23.105	20.00	0.41	250.00	40.00	3.00%	0.60
C5	16680	27˚	46.672	45.00	3.708	100.00	40.00	7.00%	0.60
C6	16780	21˚	43.249	40.00	2.671	125.00	40.00	5.70%	0.60
Km 18 C2	17120	46˚	62.016	55.00	8.613	80.00	40.00	7.00%	0.60
C3	17350	3˚	-	-	-	-	-	-	-

6.2.4 Longitudinal Profile Improvement

Based on the approved geometric standards and formulated horizontal plan of the proposed two lane road, it is essential to provide improvement proposals to the existing sub-standard vertical profile at various locations on the project roads. Since the road is running through a absolutely plain / Rolling terrain no such geometric deficient vertical alignment has been observed. However, due to the proposed raising along the corridor the new profile would be designed according to the standard specifications. While designing the vertical profile the following aspects were considered:

- Cost effectiveness by designing the facility as at-grade sections with gentle gradients to minimize construction of elevated structures;
- CD work
- Existing levels of at-grade junctions;
- Method of pavement rehabilitation- overlay or reconstruction; and
- Extent of submergence zone;

Firstly, to minimize the additional load on structures the deck level would remain unchanged (barring a thin layer of bituminous wearing course) in case of existing carriageway. No consideration about the existing level has been given for the alignment over culverts and bridges under reconstruction.

Secondly, the influence of the pavement rehabilitation method on vertical alignment design has been most significant. The modus operandi of pavement strengthening by

overlay determines the vertical profile of the finished road. However, more liberties have been taken while designing the profile for reconstruction stretches.

The horizontal and vertical alignments at and near super elevated sections require special attention to comply with the standards of transition curve, tangent run-off and the method of attainment of super-elevation.

6.2.5 Longitudinal Gradient

The longitudinal gradient of road has taken improved by providing additional layer of earth/GSB/WMM in the stretches where hump/local depression found. The accumulated water tries to seep through the sub-grade which becomes very week in wet conditions and leads to regular failure of the road in rainy seasons. So proper drainage is provided.

To overcome this, following remedial measures are proposed.

- Raise the Road Level to comply with IRC requirements i.e. sub-grade to be 600mm above the general ground level, subject to practical considerations.
- Sub-grade material to confirm to IRC and MoRTH specifications. Black Cotton Soil as sub-grade can not to be allowed.
- Top 500mm of embankment below the sub-grade to be non expansive i.e. local B C Soil can not be used there as well.
- Additional 3 no. of RCC home pipe culverts well integrated with longitudinal drains, are proposed to improve the cross drainage and minimize the seepage below the roads.

Longitudinal gradients vary depending upon the topography of the land. The longitudinal gradient has been standardized such that there is no difficulty for vehicles and surface drainage of the pavement.

a) Longitudinal gradient in rural stretch- ruling maximum 2.5%, absolute maximum 3.3%

b) Longitudinal gradient in urban stretch- It is not always possible to provide adequate gradient however, it has been overcome by proposing adequate (0.3%) gradient in kerb channel as well as in lined drain.

6.2.6 Junctions

Road intersections are critical element of a road section. Intersections create conflict points in a road network due to crossing and turning traffic flows and the mix of pedestrians, cyclists and vehicular traffic.

All intersections have been designed / improved as per IRC: SP-41, "Guidelines for the design of Grade intersections in rural and urban areas" & Type Design for Intersections, MoRTH. All intersections have been designed to minimize the number and severity of potential conflicts between cars, buses, trucks, bicycles and pedestrians by access control islands through channelizing & by providing acceleration & deceleration lanes. Raised channelizing islands have been provided to accommodate traffic control devices. Refuge islands have been provided for the safe manoeuvres of pedestrians. Separate left / right turn lanes are provided to reduce conflict in the intersection area. Provision of acceleration lane on the major road, for the left turning traffic flow from the minor road on to the major road and deceleration lane on the major road, for left turning traffic flow from the major road on to the minor road has been made to minimize hazard and inconvenience as also to increase capacity, and to promote operating efficiency. The junction improvements take into account the future traffic demands, so that the improvements made are adequate throughout the expected life of the intersection.

6.2.7 Typical Cross-Sections

Based on foregoing considerations typical cross-sections proposed to be adopted for various situations are given at fig 5.1 to fig 5.2:

6.3 FUTURE IMPROVEMENT PROPOSAL

6.3.1 Capacity Analysis

The IRC (Indian Roads Congress) code 64-1990 is the standard guideline for assessing capacity of rural highways in India. For rural roads the design service volume is taken to be the traffic volume at Level of Service (LOS) "B" which is about half of the ultimate capacity. The design service volume for a two lane rural road in level terrain is 15000 PCU/day provided road curvature is not high.

6.3.2 Future upgrade

No up gradient is required up to year 2030.

7 ENGINEERING DESIGN

7.1 METHODOLOGY - FLEXIBLE PAVEMENT

The project involves widening of existing 1-lane bituminous road to 2-lane carriageway with earthen /GSB shoulders on either side. The pavement option study shows that flexible pavement is going to be more economical in this case. Besides the widening scheme as per site conditions shifting often from central to right side to left side renders flexible pavement as a preferred option. Therefore flexible pavement has been adopted for the complete reach. For design of flexible pavement IRC: 37-2001 has been adopted for widening/new pavement construction and IRC: 81-1997 for design of overlay over existing pavement.

The design process therefore includes design of:

i. New flexible pavement

ii. Strengthening overlays over existing pavement

The principal method of pavement design for new carriageway is based on IRC: 37-2001. For the strengthening of the pavement overlay IRC-81-1997 has been followed. The analysis and design of the pavements have been done using MS-Excel spread sheets.

While designing of the pavement following factors have been considered:

- New Flexible pavement using granular sub base course (GSB), Wet Mix Macadam (WMM) and bituminous surfacing (DBM & BC);
- Overlay on existing road with Wet Mix Macadam, Dense Bituminous Macadam and Bituminous Concrete shall be done after scarification of the existing bituminous surfacing.

7.1.1 Pavement Design Methods

The following method has been adopted for design of pavements for different components:

New Flexible Pavement:

- IRC-37 - Guidelines for Design of Flexible Pavement.

Strengthening Overlay:

- IRC-81 - Guidelines for Strengthening of Flexible Pavement - Benkelman Beam Deflection Technique.

7.2 PAVEMENT INVESTIGATION

Design inputs required to the pavement design are established based on the pavement investigations. Summaries of results of pavement investigations carried out are explained in section 5.3.

7.2.1 Traffic Forecast, Growth Rates & Axle Load Survey

7.2.1.1 Traffic Forecast

The Classified Traffic Count Survey was carried out for 7 Consecutive days in both directions. The traffic survey was carried out by manual count technique. The data as collected was analysed and Average Daily Traffic (ADT) was computed for the base year and projected for future years in the design period under different growth scenarios as shown in Table 7-1 below.

Table 7-1: Summary of base year and Projected ADT

Scenario	Optimistic		Likely		Pessimistic	
	Total Vehicles	Total PCU	Total Vehicles	Total PCU	Total Vehicles	Total PCU
2010 (Base Year)	1182	1932	1182	1932	1182	1932

The yearwise Growth rate assumed as 5.00%

7.2.1.2 Axle Load Survey

According to the Axle Load Survey carried out for different modes of transport using the project road, the VDF widely varies with the type of the vehicle and the average VDF for the major transport modes is taken as 3.50 for CV 150-1500 Two axle and three axle trucks are carrying loads much beyond the legal axle loads. Due the very low sample of standard buses could capture during the survey a value below 1 i.e. 0.9 has been considered to evaluate the mSA projections. The detailed calculation sheets are given in Annexure to this report.

7.2.1.3 Traffic in CMSA (Cumulative Million Standard Axles)

The design traffic has been computed following the VDF as stated above and the relationship stated in para 3.3.6.1 of IRC-37-2001. The traffic for 17-year viz. 2025 (15 years design life including 2 year of Project Development and Construction) according to the computation works out to CMSA for the design period. MSA has been worked out based on the 2-lane carriageway. The MSA projections are 10.99 MSA.

The projected MSA under the most likely scenario of traffic comes out to be 10.99 for 15 years. For the deign purpose MSA value of 11 has been adopted for the entire stretch (from Km 00 to 18/0). If in case the optimistic case hold good in future then a strengthening course could be laid along with the periodic overlay at that time based on the residual strength of the pavement.

7.3 DESIGN OF NEW FLEXIBLE PAVEMENT

7.3.1 IRC: 37-2001

Considering the Sub-grade CBR of 3% & 6% and design traffic projected MSA, the total thickness of pavement according to IRC-37 works out as under:

Length		CBR (%)	Actual MSA	Design MSA	Pavement Design Thickness(MM)				
From	To				GSB	WMM	DBM	BC	Total
1/0 7/0 12/0	6/0 10/0 14/0	6%	11	11	200	250	65	40	705
6/0 10/0 14/0	7/0 12/0 18/0	3%	11	11	200	250	95	40	780

7.4 RIGID PAVEMENT STRUCTURAL DESIGN

The rigid pavements on this project are designed for a life of 30 years and for the projected traffic loadings over the next 30 years. The primary tool used for design on this project, are IRC: 58- 2002, because this take into account combined edge loading and temperature stresses. As the Tandem axle forms small part in India, erosion analysis has not been carried out. The parameters used for the design of rigid pavement method are as follows:

Concrete

Flexural modulus, fek	=	45 kg/cm2
Elastic modulus	=	3 x 105kg/cm2
Coefficient of expansion	=	10 x 10-6 per 0C
Poisson's ratio, μ	=	0.15

Other

Modulus of sub-grade reaction		
Corresponding to Sub-grade CBR of 6%	=	5.003 kg/cm2/cm
Load safety factor	=	1.2
Tyre pressure	=	8 kg/cm2
Spacing of contraction joint	=	3.5 m
Width of slab	=	3.5 m

Joint Design

Design wheel load 98% load	=	5,100 kg
Load transfer	=	40%
Joint width	=	2 cm
Permissible flexural stress in dowel bar	=	1400 kg/cm2
Permissible shear stress in dowel bar	=	1000 kg/cm2
Permissible bearing stress in concrete	=	100 kg/cm2
Diameter of dowel bar	=	32 mm
Coefficient of friction	=	1.5
Density of Concrete	=	2400 kg/cm2
Allowable tensile stress in steel	=	2000 kg/cm2
Permissible bond stress in plain tie bar	=	17.5 kg/cm2
Permissible bond stress in deformed tie bar	=	24.6 kg/cm

Since the soaked CBR value of the sub-grade borrow material is taken as 3%to 6% it has a 'k' value of 5.033 kg/cm2/cm, which is required for placing the slab directly over WMM.

The IRC Guidelines suggest 25% of traffic in one direction as sufficient for design against fatigue failure, but the Portland Cement Association suggests up to that 100% of trucks in truck lane be considered in their design procedure.

IRC Design Thickness

Continuous traffic counts have been conducted at km 17/00 near Dariba and the same is provided in Main Report I B. The design based on the data is given below:

IRC Design Thickness

Continuous traffic counts have been conducted at km 17/000 near Dariba village, and the same is provided in Main Report I B. The design based on the data is given below:

Present traffic = 483 CVD

Design life = 30 years

Growth rate = 5.0 %

Present traffic in one direction = 483/2

= 242 CVD

Rigid Pavement based on procedure laid down in "Design of Rigid Pavement as per IRC: 58- 2002 and the data indicated are done by providing the CC thickness as shown below:

Trial one : 10 cm DLC + 30 cm PQC

Layer	Thickness (mm.)
CC	200
WMM	250
GSB	200

FLEXIBLE OVERLAY DESIGN

7.5.1 IRC-81 - Benkelman Beam Deflection Technique:

The actual deflection data as measured on the road for the various stretches have been summarized in the table 4.1. Since the overall condition is not good where value of rutting is above 20mm in maximum cases and the cracking is also observed in all along the sections, the BBD has been used to evaluate the overlay thicknesses. Looking at other points like sub grade condition, embankment height etc., a complete reconstruction is being recommended.

7.6 SHOULDERS

7.6.1 GSB Shoulder

For the movement of 2-Wheelers and slow moving traffic the GSB shoulders provided along the road. Generally the shoulder is structurally designed to carry 10 to 20% of the traffic load, the design lane is expected to carry. However the structural drainage system of the shoulder is required to be integrated with that of the carriageway pavement. The latter condition thus requires the thickness of pavement structure to be the same as that for the traffic lanes since the lower layer of the sub-base for the carriageway is extended to the full width of formation for the lateral drainage of any water percolating into the pavement. Therefore the drainage

requirements demand that each carriageway pavement layer be extended to shoulder as this ensures constructional ease, quality and speed.

7.6.2 Earthen Shoulders

To allow proper drainage, layer of granular sub-base from the carriageway will be extended up to the embankment slope. The earthen shoulder will have sub-grade soil characteristics and compacted thickness of 150 mm of the GSB.

7.7 LIFE CYCLE COST ANALYSIS

The objective here is to identify the best economical option for pavement type to be considered for pavement design. In this regard, following options were considered:

- Flexible pavement
- Rigid pavement

The option selected is based on the principle of maximizing the net present value of net benefits, estimated by adopting life cycle cost analysis method. Hence the procedure involves estimating the benefits, costs and net benefit.

7.7.1 Methodology

The life cycle cost of the project is also estimated considering only the costs that vary due to pavement type. In other words, costs of all works have not been considered to account for the total construction costs. While estimating the economic costs of the project under with and without project conditions, routine maintenance and periodical maintenance costs have been included in the analysis. The economic life of the rigid pavement is considered to be 30 years as against 15 years for the flexible pavement as per cost companions the flexible pavements is recommended for execution.

8 STRUCTURES INVENTORY, CONDITION SURVEY AND DESIGN

8.1 INVENTORY BRIDGES AND CULVERTS

The project road has to be widened or reconstructed to two lane carriageway configuration.. The CD work have to be widened to match the formation width including service road. The proposed new CD will be of 12mt total width with 7.00m carriageway on the following pages.

List of CD work

1-Row 1000	**2.0m RCC Slab**	**3.0m RCC Slab**	**4.0m RCC Slab**	**Widening of Existing CD (slab)**	**Widening of Existing CD (pipe)**
1/525	3/344	10/664	12/820	4/070	6/310
13/590	7/173	18/500		4/750	15/000
14/700	8/147			5/925	16/600
	13/700			7/850	
	14/552			8/850	
	15/260			8/993	
	15/770			9/200	
	15/940			9/305	
	16/000			10/524	
	16/100			11/880	
	16/200			15/540	
				16/775	
				16/900	
				18/200	
				18/990	
				19/420	
				19/500	

8.2 Existing condition of structure

8.2.1 *There is no bridges in the proposed alignment.*

8.2.2 Culverts

Inventory and condition survey of culverts has been given in annexure 2 to this report. It may be observed that most of the culverts are constructed using either stone masonry abutment and RCC slab and subsequently widened with Masonry abutment and RCC Slab. In one case the old damaged slab has also been reconstructions.

It has been observed that there are no signs of any scouring or undermining of foundation of any culverts which implies that water way available for all the culverts is sufficient. Thus we may infer that the vent size of the culverts does not require any widening from hydraulic point of view.

As per typical cross section proposed and discussed earlier, length of all the culverts in the project corridor shall be at least 75.5 meter sections.

Following CD works constructed as new CD

1. 1000mm dia pipe culverts 3 no. 1/525, 13/525, 14/700

2. contruction of 2 m span new RCC culverts 11 no. Ch. 3/344,7/173,

8/147,13/700,14/552,15/260,15/770,15/940,16/00,16/100,16/200,

3. widening of existing 17 nos. CD works.

8.4 ROB, UNDERPASSES AND OVERPASSES

No ROBs, underpasses and overpasses are proposed in this stretch of the highway.

9 ENVIRONMENTAL IMPACT ASSESSMENT

Rajasthan, a 21st century State, came into being on 30 March 1956. It occupies 10.41 % of India's total land area with 3,42,239 sq. km, out of that it has got 32400 sq. km i.e. 9.47% of the state as forest area. The State has a total population of 5,64,73,122 as per the 2001 Census. The decadal growth rate of population in the decade 1991-2001 has been 28.33% (All India - 21.34), down from 24.23% during the previous decade. Rajasthan is bordered by 6 states. They are, clockwise from north, Panjab, Haryana, Madhya Pradesh, Uttar Pradesh, Gujrat. The capital of Rajasthan is Jaipur and High Court of Rajasthan is situated in the district of Jodhpur and Jaipur.

9.1 THE PROJECT

This major district road "MDR-33" was earlier a village road. It has been declared as MDR -33.It starts from Fatehnagar and after connecting Dariba it goes up to Khaendel in Bhilwara District Where it meets with SH-12 which leads to Kankroli and Bhilwara.

The project corridor is starting from Km 0/0 after Fatehnagar Chouraha. The villages are Sanwad, Dhaneriya, Gawardi, Anjana. There after from Km 16/0 onward the urban area of dariba starts. The carriageway width is almost constant (3m single lane configuration) flanked with earthen/ hard shoulder with a varying width of 1.2m to 1.7m. As per the record the road is having a Right-of-Way (ROW) of about 12.0 m where the existing carriageway is placed centrally.

The mining industry is major contributor to thr economy of Rajasthan. Rajasthan is the richest Indian state in terms of mineral wealth. Lime stone, soapstone , marble, zinc and iron ore are product in large quantity, In Dariba there is a large deposite of Zinc, Iron , Cadmium. The HZL has established a new plant for purification of ore, After developing of this road the transportation of purified ore and acid is easy.

9.2 THE EXISTING SCENARIO

MDR-33 is an old road, following the alignments existing for more than 38years. This road has been periodically maintained and improved in the last 8 years. Although the MDR-33 is an important link to major urban centers of Dariba & Fatehnager. The existing RoW is limited (varies between 10 to 12m). The existing ROW is barely sufficient for accommodating the proposed improvement/widening.

The annual average daily traffic (during Jan. 20010) on the project stretch 1932 PCUs. Share of goods traffic was found to be very high. The traffic volume on the project road section is projected to grow up to 3546 PCUs by 2030AD.

The bituminous carriageway on the existing road is generally 3.0m to 3.20m wide with completely absent or narrow GSB shoulder (width varying from 0.5 to 1.5m). The riding quality of the existing road is poor. There is no access control, and there are minor and major intersections.

9.3 IMPROVEMENT PROPOSALS

The objective of the project is to widen to 2 lanes the existing road to meet the traffic needs for the next 15 years. A conscious effort was made to minimize displacement of people and properties, and loss of roadside trees, along the project corridor, as much as possible. As a result the widening / improvement proposal was completely fit into the existing RoW to completely avoid land acquisition.

The proposed improvements include widening to 1-lane carriageways by addition of a new 2.0mNew carriageway on both side of existing carriageway. There would be no paved shoulders to avoid land acquisition. However, 1m earthen shoulders on either side of the highway will be provided. The new carriageways will have bituminous flexible pavement. The existing 2-lane carriageway will be strengthened by overlays/rehabilitation/ reconstruction. The existing cross-drainage structures (major/minor bridges and culverts) on the highway will be repaired/ rehabilitated, including widening to standard width, if required. Existing cross-drainage structures would be duplicated for the 2-lane carriageway. Geometric improvements will be made to the horizontal and vertical profile of the highway. Other measures include footpaths in the built-up stretches; crash barriers, safety guards, etc. Roadside drains will be provided for the entire stretch, including covered drains in the built-up areas.

9.4 SOCIAL & ENVIRONMENTAL BENEFITS FROM THE PROJECT

The project is seen as a major generator of economic momentum, since it connects the two most important cities in the state along with a number of industry locations, and will benefit the Rajasthan State in a very significant way. The project is expected to remove the industrial development bottlenecks, bring the cost of transportation down, for both goods and personnel, and thereby benefit all sections of the society.

The foremost benefit for the local communities would be the increased level of road safety through removal of bottlenecks and segregation of opposing traffic streams. Large employment opportunities will be directly and indirectly created by the project for construction and related activities. A large share of this would be available to the local communities.

The project would result in significantly better riding quality, reduction in traffic congestion and removal of bottlenecks. Environmental benefits will be accrued due to in terms of reduction of air and noise pollution due to increased road capacity and speedier traffic, lessened congestion, traffic segregation; increased overall safety levels and mitigation of existing accident black-spots; better visual environment; improved local and roadside drainage; introduction of low-pollution construction techniques, scheduling, plants and machinery, etc.

9.5 INSTITUTIONAL AND LEGAL FRAMEWORK

At present the project does not require any land acquisition, and it does not pass through (or is close to) any environmentally and ecologically sensitive area. It may be seen that in light of the 2006 amendment to the Environment (Protection) Act, 1986, the project does not require prior environmental clearance from the MoEF or the State Environment Impact Assessment Authority (SEIAA). Consequently, it does not require any "Public Hearing".

However, the installations (of the project) during construction, such as the hot-mix plants, the batching plants, etc., would require approval from the CGSPCB with respect to the Air Act, 1981 and the Water Act, 1974.

As the project does not include any land acquisition, neither a land acquisition plan, nor a resettlement action plan (consequent to the EIA notification) is required. The project does not come within 300m of any protected monument or site, and therefore a clearance from the ASI is not required.

9.6 COMMUNITY CONSULTATION

Public participation and community consultation has been taken up proactively as an integral part of social and environmental assessment process of the project. It assisted in the identification of the problems associated with the project as well as the needs of the population likely to be impacted.

9.6.1 ISSUES RAISED BY THE COMMUNITY

The focus of the community consultation sessions was in developing solutions to the issues raised. Though presently no land acquisition is involved, likely resettlement and compensation was a major issue in all the consultation sessions or the public meetings. However, safety was also a very predominant issue.

The roadside communities were very concerned about the potential loss of property (particularly agricultural land) and property-based livelihood. Safety, especially of children and cattle is of great concern to the communities. Speed breakers, widening and median were suggested as general solutions to these. There was also a general concern about vehicular pollution at all congested locations along the project corridor. Local people as well as the government officials were concerned about the trees to be cut along the MDR-33. During consultations, water logging was raised as a major concern.

9.6.2 ADDRESSING THE ISSUES

The recommendations of the state/ district or local/village level consultations have been carefully considered in the design and "no land acquisition" has been proposed. The issue of 'livelihood support' to the commercial (encroaching or squatting) settlements being evicted has been resolved in discussion with the District Administration.

In the project, service roads, distinct parking spaces/bays have been proposed to avoid accidents. The median divided carriageways will certainly help in reducing the propensity of accidents. Other safety measures, such as signage have been proposed all along.

The project has considered each of the cases of bypasses very carefully, and proposed that no bypass be built. As discussed with the people, the project investigated and incorporated, wherever feasible, the means of reducing the ambient pollution occurring due to vehicular emissions and noise/vibration. The number of trees to be cut has been minimized. About two-thirds of the existing trees (within the RoW) will be left unaffected. At several locations, including all such places where such demands were raised, drainage schemes have been prepared and feasible elements incorporated.

9.7 PROJECT CORRIDOR ALIGNMENT

The major difficulty with the proposal to develop access controlled new expressway was land acquisition, lack of funds, and lack of viability for private financing. However, capacity augmentation is an immediate necessity. Therefore, the proposal for improving the existing alignments, including the present project stretch on the MDR-33, with minimum (if not absolutely zero) land acquisition, service roads, and short sections of (limited or partial) access control. The pre-feasibility studies confirmed that this approach is economically sound, socially and environmentally more viable, and could be implemented in a considerably shorter period of time.

9.7.1 ALTERNATIVES CONSIDERED IN THE PROJECT

9.7.1.1 'With' & 'Without' Project Alternatives

The "no-action" alternative is neither a reasonable nor a prudent course of action for the proposed project, as it would amount to failure to initiate any further improvements, Impede economic development, and will worsen the quality of environmental close to the road.

9.7.1.2 Alignment Alternatives within the Existing RoW

Three alignment alternatives have been considered, analysed and examined for each subsection of the Road (length of the sub-sections was as small as 100m). The 3 options available were (i) eccentric widening towards east, (ii) eccentric widening towards west, and (iii) concentric widening.

Each alternative was carefully examined with respect to the inventory of environmental/cultural resources and the footprint of the residential/ agricultural/ commercial properties. The final road alignment has been finalised to be concentric. This has reduced impact on private properties, and absolutely avoided land acquisition, among others.

9.7.1.3 Road configuration alternatives

The lane configuration, raising of carriageways, narrow medians, intermediate lane service roads, drains underneath the footpath, etc., are some of the options considered. A combination of various options was selected for each of these locations to minimize impacts (impacts have been minimized and land acquisition has been totally avoided).

9.8 IMPACTS, AVOIDANCE AND MITIGATION

The focus in project has been on the positive and negative impacts associated with the improvement/rehabilitation of the project corridor. The impacts on the various environmental components have been evaluated for both the construction and the operation stages.

Avoidance and mitigation measures involve decisions and strategies taken during the entire study and project period to minimise the negative impacts and enhance the positive impacts of the project on the surrounding environment.

9.8.1 STANDARD AVOIDANCE

Certain impacts have been actually avoided (or minimised) during project preparation. Examples of total avoidance include avoiding land acquisition. Examples of minimising impacts include minimising felling of roadside tree plantation, and impacts on people and properties. Such minimisation has been possible by earmarking a corridor of impact (CoI), and restric ting all proposed project activity within such CoI.

9.8.2 NATURAL AND BIO PHYSICAL ENVIRONMENT

9.8.2.1 Meteorological Climate

By and large, though no change in the macro-climatic setting is envisaged. The project has proposed replacement of trees as per the compensatory forestation norms. Impacting surface water bodies have been avoided totally.

9.8.2.2 Air

During the construction stage, increase in the concentration of air pollutants is likely during the construction stage, especially from the hot-mix plants and the batching plants. To assess the likely impacts on the Ambient Air Quality in the operation stage due to the project, the prediction of pollutant concentrations along the corridor has been carried out using CALINE-4.

SPM concentration already exceeds the permissible limit at the start of the project corridor (with respect to the norms for rural areas) and at Bilaspur Town (with respect to the norms for industrial areas). Even at the end section of the project stretch, SPM concentration will cross the applicable (rural areas) limit by 2023AD. The concentration NOx, at Dariba Town will exceed the applicable limits (for

industrial areas) by 2015AD. At the start of the project stretch, the concentration of NOx though remaining much lower than that at Dariba Town, will exceed the applicable limit (for rural areas) in 2023AD. Lead, carbon monoxide and hydrocarbon concentrations in the ambient air are expected to remain within the permissible standards (both for rural/residential and industrial areas) throughout the project's economic life (till 2023AD).

At critical sections especially along the congested stretches of the existing highway, removal of bottlenecks and relieving congestion in built-up stretches were incorporated and will ensure smooth flow of traffic and reduce emission of pollutants.

Water will be sprayed in the lime/cement and earth mixing sites, asphalt mixing site and temporary service and access roads. After compacting the earthwork, water will be sprayed on regularly to prevent dust. To avoid dust emissions likely to result from transporting crushed rock and earth, the vehicles delivering construction material will be covered.

Apart from the GoI pollution control initiatives, the roadside and median landscape (as per the NHAI Roadside Plantation Strategy) will help in mitigating air pollution in the operation phase.

9.8.2.3 Water

The short-term increase in runoff during the construction stage may occur due to the removal of trees, vegetative cover and compaction of the surrounding soil. The additional two lanes, which is essentially a paved impervious surface, will cause increased surface runoff.

The project requirement of 127m3/d water is only 1.1% of the total flow in the major rivers in the area. Thus, the water requirement for the project will not be a major impact on the environment. However, not all the water requirement for the project would be met by the river and tube well could be used during the lean season and location far from the river. Three hand pumps will be relocated due to the project. Flood hazards are not very common in the project area, except in the peak precipitation days. Man-made inundation problems occur mostly at the built-up, stretches due to rising of shoulders/kerbs by the local residents, and earlier borrowing within the RoW.

Measures incorporated in the project to constitute of the following:

- Protection of Banks and edges
- Cascade for Scour Protection
- Oil interceptor
- The location of all fuel storage and vehicle cleaning area will be at least 300m from the nearest river or water channel
- The slopes of embankments leading to water bodies will be modified and re channelised to prevent entry of contaminants into the water body
- Drainage structures and raising to prevent inundation
- All sources of community water supply, incidentally damaged during construction will be replaced by the contractor
- Conservation of the local water supply.

Ground water is available in abundance at a fairly reasonable depth of 7-10 m in the project vicinity areas. However, if groundwater is used for the project, the contractors will be using deep (bore) wells only. Such wells will only be dug with explicit permission of the CSPCB and the State Ground Water Board.

9.8.2.4 Land

The proposed project would have no measurable impact on the topography of the project region. No significant cutting has been designed in this project, and impact on topography has been absolutely minimized. Moreover, the waste material from the existing pavement will be mostly used in the filling to raise the proposed road level.

Land acquisition has been taken in the proposed project where geometrical improvement is needed, but there is no impact will result to the productive soil in the region. Erosion potential exists mostly at high embankment areas of the road, especially at bridge-approaches. Contamination of soil can take place in sites wherein construction vehicles are parked and serviced due to leakage or spillage of fuel and lubricants.

Though the quarry materials are to be transported over substantial distances to the construction sites, all the quarries identified have proper access roads; therefore, no major impact is envisaged during the haulage of materials. Again, as no new quarry needs to be opened for this project, no new impacts are likely to arise due to quarrying operations.

As the borrowing is to be carried out in accordance to the guidelines laid out in IRC-10-1961, no major adverse impacts are anticipated. Also, productive agricultural areas have been and will be avoided for borrowing.

The slope protection measures undertaken by the project include turfing of slopes, reinforced earth walls and stone pitching. Moreover, all borrow pits will be redeveloped by filling and providing 150mm thick layer of preserved top-soil; by creating a pond for fisheries, etc; or by levelling an elevated, raised earth mound and covering it with 150mm thick preserved top-soil. Some borrow areas may be redeveloped as covered construction waste disposal sites or sanitary landfill sites, provided that the other redevelopment measures are taken.

9.8.2.5 Noise

Due to the various construction activities, there will be temporary noise impacts in the immediate vicinity of the project corridor. The noise levels (close to the highway) are already higher than the permissible levels, and are predicted to remain high during the operation period. At both locations, the noise level is likely to increase by as much as 5 to 10dB(A) by 2023AD.

In the project, noise standards will be strictly enforced for all vehicles, plants, equipment, and construction machinery. All construction equipment used for an 8-hour shift will conform to a standard of less that 90dB(A). If required, machinery producing high noise as concrete mixers, generators etc, will be provided with noise shields. Workers will wear earplugs, helmets and be engaged in diversified activities to prevent prolonged exposure to noise levels of more than 90dB(A) per '8 hour' shift. Construction sites will not be located 300 m from settlement areas. No hot mix, batching and aggregate crushing plants will be located within 200m of sensitive land uses such as schools, hospitals, etc.

Based on the predicted noise levels, no noise barrier is deemed to be required in the first few years of the project. However, in the operational phase, land use close to the road may change, and noise attenuation might be required. The location of such noise barriers will be determined by the Deptt, if such need arises.

9.8.2.6 Flora

The cutting of trees may have manifold impact. Most visible impact is the loss of shade. Also, there is a possibility of the local people being deprived of tree products, such as wood, fruits, and leaves.

No trees are to be felled due to the project. Removal of roadside tress will reduce comfort levels for slow moving traffic and pedestrians. The felling of these roadside trees may lead to temporary increase in erosion. Marginal impact would also arise with respect to air quality and ambient noise, as trees attenuate air pollutants and noise at varying degrees.

There is no acquisition of forestland in the project. As a consequence of the project, no adverse impact on the reserved forests is anticipated. The project, on its part will discourage use of the quarries located within any forest areas. No quarries or crushers located within any reserved forest areas (even those who operate with licenses from appropriate authorities) will be used for any purpose of the project whatsoever.

A road landscape (as per the NHAI Roadside Plantation Strategy) will be implemented during the operation period of the road maintaining visual characteristics and uniformity for all the stretch.

9.8.2.7 Fauna

The envisaged impacts during construction and operation stage are disturbance or accident to local fauna and cattle of the surrounding areas due to noise generated by vehicles. No rare or endangered fauna is found in the vicinity of the project highway, and therefore, no impact on this account is envisaged.

General measures such as prevention of hunting have been recommended and enforcement of regular patrolling during construction and operation stage (as part of corridor management plan during operation stage) has been proposed. The environmental management plan for the project also includes a provision for protection of chance-found fauna.

9.8.3 SOCIAL ENVIRONMENT

General impacts would include fear regarding uncertainties among project-affected persons/families; inducement of land prices; inducement of ribbon development; public health and safety impacts during construction phase; and resettlement.

No property will be affected by the widening proposal. There are no individual properties getting affected as the entire improvement is being limited within the existing right of way. Certain encroachments or squatters that may be getting affected are being identified. The final report would provide for distinct entitlements and assistance for each of the affected persons thus identified.

9.8.4 AVOIDANCE/MITIGATION

Debris generated from the demolition of properties will be properly disposed of to avoid the health problems. Roadside plantations will be maintained to reduce dust generation and air pollution. In highly developed residential areas, at hospitals and schools where high noise levels are absolutely undesirable will be marked as “silence zone”.

In the labour camps, all temporary accommodation must be constructed and maintained in such a fashion that potable water is available for drinking, cooking and washing. The sewage system for the camp will be properly designed built and operated so that no health hazard occurs. Garbage bins will be provided in the camp and regularly emptied. The collected garbage will be disposed off in a hygienic and approved manner.

Detailed recommendations have been made in the contract document (for the civil works) about health and hygiene of the construction workers, particularly the women and children. This includes regular medical facilities and check-up. A set of awareness generation and preventive measures with regard to the sexually transmitted diseases (including HIV/AIDS) will also be implemented in the operation phase of the project.

The contractor will provide, erect and maintain barricades, including signage, marking flags, lights and flagmen, as required, to prevent accidents. A construction period safety plan will be implemented during the construction phase.

9.8.5 CULTURAL PROPERTIES

As no protected monument or site is located in the project area, there will be no impact. However, which would be taken up as per the findings of community consultation.

9.9 ENVIRONMENTAL MANAGEMENT PLAN

9.9.1 ENVIRONMENTAL MANAGEMENT PLAN

The EMP is a phase-wise plan of action for mitigation/ management/ avoidance of the negative impacts of the project and enhancement of the project corridor during the pre-construction, construction and operational phases of the project. For each

measure to be taken, its location, timeframe, implementation and overseeing/supervision responsibilities have been specified.

9.9.2 INSTITUTIONAL ARRANGEMENTS

RSRDC is the nodal agency responsible for implementation of all the mitigation and management measures suggested in EMP. The RSRDC is also responsible for implementation the complete resettlement and rehabilitation of all those affected by the project.

The RSRDC already has the organisational and institutional capacity to be able to satisfactorily complete the implementation of the EMP. The Social/Environmental Cell at the RSRDC Corporate, as well as the PIU have responsibilities for implementing both the EMP and resettlement. A separate training programme will not be required as part of the project. The RSRDC already has a pool of trained professionals working for their various projects.

9.9.3 MONITORING AND REPORTING

To ensure the effective implementation of the EMP, an effective monitoring plan will be implemented with the following objectives:

- To evaluate the performance of mitigation measures proposed in the EMP;
- To evaluate the adequacy of Environmental Impact Assessment and identify any unforeseen impacts during the project implementation or operation
- To suggest improvements in management plan, if required;
- To enhance environmental quality; and,
- To satisfy the legal and community obligations.

The physical, biological and social components identified as of particular significance in affecting the environment at critical locations will be examined on the basis of identified performance Indicators.

9.9.3.1 Reporting System

No consultant is engaged in this project so the reporting system is only to Department officer.

9.9.4 BUDGET FOR THE ENVIRONMENTAL COMPONENTS

No provision of plantation is including this project.

10 COST ESTIMATION

10.1 GENERAL

The cost estimate for Detail Engineering Report has been prepared based on the detail estimation of quantities and Rates for the individual Items. The Rates for most of the Items have been derived based on the latest available BSR of PWD Udaipur, Rajasthan with suitable escalation factor to arrive at the prevailing rates. The approximate leads for various construction materials have been worked out for the respective sections based on the field survey.

10.2 METHODOLOGY

Estimation of the detailed quantity of each item of works is the important input required for the Cost Estimate. The quantities of the items under Site Clearance, Earth Works, Sub-base and Base Courses, Bituminous/Cement Concrete Courses, Road Junctions, Drainage and Protective Works, Bridges, Culverts and Rehabilitation etc. have been computed based on the requirement and Design and Drawings.

After the quantities are computed for each of the work items the amount of each item is evaluated by multiplying the respective quantities with the relevant unit rates and finally the total estimated cost is arrived accordingly.

10.3 BILL OF QUANTITIES

The Bill of Quantities for the various Items have been prepared under different heads like Earth Work, Non Bituminous and Bituminous Works, Culverts, Major & Other structures, Road Furniture, Protective works and other miscellaneous activities etc. Total of Individual Bill has been worked out separately and then summarized to work out the Cost for the Package. Contingencies @ 5% have been added for the normal quantity variation during actual execution of work.

For rate analysis, leads for various materials from different quarry locations were collected, which serves the basic guidelines for preparation of the rate analysis and tentative cost for all sections.

10.4 UNIT RATES

The Unit Rate for the various Items have been worked out either based on the latest available BSR for PWD or otherwise based on the Standard data Book of MoRT&H. Following methodology has been adopted to work out the unit rates for different Items:

1. Considering that PWD BSR for roadwork/ structural work was revised during the year 2009 the rate of the items which has been directly taken from BSR have been escalated @10% per annum for a period of 2 years to arrive for the working rate during the period 2010-2011.
2. Considering the unprecedented and abnormal hike in the prices of major construction material like aggregate, Steel, Cement, Bitumen etc. during the last 2-3 year period rates of PWD BSR for most of the items especially for concrete and Bituminous/Non Bituminous works are not at all workable even by adding normal escalation and hence the rates for such items have been worked out for addition of Tender premium on work.
3. Labour rate has been adopted based on the minimum wages as fixed by Govt. of Rajasthan.
4. Prevailing market rate for various construction material i.e. Steel, cement Bitumen and aggregate has been considered for rate analysis
5. Hire Charges of major equipment and plant has been derived from MoRTH Data Book for the year 2010-2011 and suitably escalated (@10% to arrive at the rate for the year 2011based on BSR of PWD Udaipur Rajasthan and then further escalation @ 10% per Annum) to arrive at the prevailing rate.

10.4.1 Basic Rates of Material

Market Rates of material have been considered for the rate Analysis. The stone aggregate has been evaluated by way of installing crusher plant and production of the required quantities of the different sizes of aggregate exclusively for use in the project work.

This would ensure considerable overall economy when compared with direct purchase of the finished products from the private crusher owners of the area. At the same time no available crusher is having the production capacity to match with our requirement of Aggregate.

For HYSD Bar, information on rates has been collected from the market at Jaipur.

With regard to Bitumen, 60/70 grade is proposed for DBM works while for Bituminous concrete 60/70 has been proposed and the rates of 60/70 grade of bitumen is collected from the offices of the HPC/ IOC at Mumbai / Vizag.

Bitumen emulsion shall be used for prime coat and tack coat. The rate was also collected by inquiry from the offices of the Petroleum Companies at Baroda.

10.4.2 Lead of Material

Shortest average leads have been adopted in respect of stone aggregate, Moorum, sand etc from the quarries/ sources up to the proposed location of the Hot Mix plant, Pug Mill, Concrete Batching Plant as the Case may be. For Bitumen and Bitumen Emulsion the leads are from Baroda and taken up to the center point of stretch.

Extra lead for the mixed materials from the Hot Mix Plant/ Pug Mill/ Concrete Batching Plant to the work site has been adopted as per MoRTH Data Book.

10.4.3 Provision of Royalty

Royalty has been added to the basic rates of the materials in the Rate Analysis as per prevailing Government Norms.

10.4.4 Carriage Rates of finished Materials

The carriage rates of materials, as stipulated in the State Schedule of Rates have been allowed in the analysis. However, in case of the mixed materials from the respective plants to the workplace overall rate has been considered.

10.5 COST ESTIMATES

Detail costs have been worked out for the different items of road works and structures. Estimated total cost of this package is 28.45 crore. This works out the per kilometre cost of improvement as 1.58 crore including escalation, contingencies and cost of land acquisition.

Table 10-1: Abstract of Cost Estimation

Project Cost for the Fatehnager - Dariba (MDR-33, from Km 0/0 - Km 18/0)

GENERAL ABSTRACT

PART	PARTICULARS	AMOUNT (Rs.)
Part “A”	Road Work	142381916.00
Part “B”	C.C. Pavement	8423453.00
Part "C"	C.D.Works - I	5342293.00
Part "D"	C.D. Works Maintenance- II	5476237.00
Part "E"	C.D. Works - III	7681131.00
Part ”F”	Retaining Wall	8025835.00
Part “G”	Road Furniture	1589027.00
Part "H"	Toll Plaza & Foot path	7290304.00
	Total	**186210196.00**
	Say	**1862.10**

Project Cost for the Fatehnager - Dariba (MDR-33), from Km 0/0 - Km 18/0)

ABSRACT OF PROJECT COST

	Particulars	**Amount (in lacs)**
A	Land Acquisition/ Shifting of Services	281.32
B	Land Development	
C	(i) Item Wise Cost	
	Fatehnagar-Dariba Road (MDR-33) KM 1/500 TO 19/500	1862.10
	Base cost	**2143.42**
	Escalation for the 2nd year @ 10% Of 40% of Base Cost	74.48
	TP @ 5%	93.11
	Contingency @ 5%	93.11
	Quality control @ 1%	18.62
	Guarantee Commission to State Govt.	18.62
	Sub Total	**2441.36**
	A&S Charges	216.00
	Application fee and front end fee	9.31
	Sub Total	**2666.67**
	IDCP	80.17
	Intrest payable to HZL	97.92
	Total Cost of Project	**2844.76**