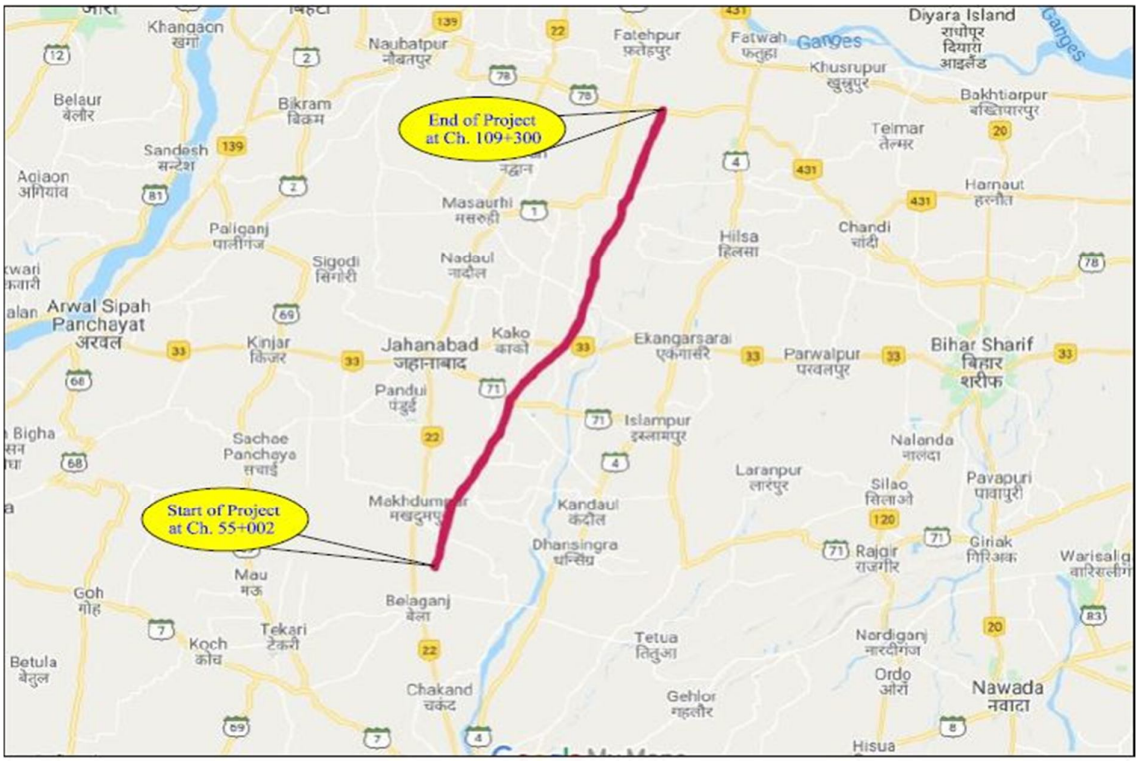
National Highways Authority of India

(Ministry of Road Transport & Highways, Government of India)

Consultancy services for preparation of Detailed Project Report of Economic corridors, Inter corridors and Feeder routes to improve the efficiency of freight movement in India under Bharatmala Pariyojana (Lot-5/Package-7) from **Shivrampur to Ramnagar** of Aurangabad to Anishabad Section.

MAIN REPORT

PKG-2: From Design Ch. 55+002 Km To Design Ch. 109+300 Km



Final Feasibility Report

JUNE-2020

SA Infrastructure Consultants Pvt. Ltd.

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Chapter-01

Executive Summary

1. General

The Ministry of Road Transport and Highways (MORTH), Government of India has proposed "BharatMala Pariyojana" an Umbrella scheme of road development project through National Highways Authority of India (NHAI), National Highway, Industrial Development Corporation Ltd (NHIDCL) and State Public Works Departments (PWD) at an estimated cost of INR 5,35,000crores. This is the second largest highways construction project in the country after NHDP, where in almost 50,000 km of roads are targeted across the country. This project aims to improve connectivity particularly on economic corridors, border areas and to remote areas with an aim of rapid and safe movement of cargo to boost exports. International trade considered as a key aspect in this scheme and North-eastern states have been given special focus.

The project was cleared by the Union Cabinet on October 25, 2017. The ambitious project expected to create nearly 100 million man days of jobs during the construction and subsequently to about 22million jobs of the increased economic activity across the country. The construction will be carried out through many means including debt funds, budgetary allocation, private investment, toll operator transfer etc. The total length of around 34,800 km considered in phase 1 including

- Economic corridors of around 9,000 km,
- Inter-corridor and feeder route of around 6,000 km,
- National Corridors Efficiency Program of about 5,000 km roads
- Border and international connectivity roads of around 2,000 km,
- Coastal and port connectivity roads of around 2,000 km,
- Expressways of around 800 km
- NHDP roads of 10,000 km.

SA Infrastructure Consultant Pvt. Ltd. 1101A, 11th floor, Tower A-II, Corporate park, Plot no. 7A/1, Sector-142, Noida, UP has been appointed as consultant to carry out Consultancy Services for Preparation of DPR for development of Economic Corridor, Inter Corridors and Feeder Routes to improve the efficiency of freight movement in India under Bharatmala Pariyojana (Lot-5/Package-7) from **Shivrampur to Ramnagar** of Aurangabad to Anishabad section, in the state of Bihar.

2. Introduction

The project is starting at Major T-Junction from "Amas" at Design Ch.0+000 Km to connect Ramnagar located at Design Ch. 109+300 Km on SH-78. The whole stretch is further divided into Two packages as stated below:

i. **Package -1** Amas to Shivrampur from Design Ch. 0+000 Km to Design Ch. 55+002 Km of length 55.002Km.

ii. **Package -2** Shivrampur to Ramnagar from Design Ch. 55+002 Km to Design Ch. 109+300 Km of length 54.298Km.

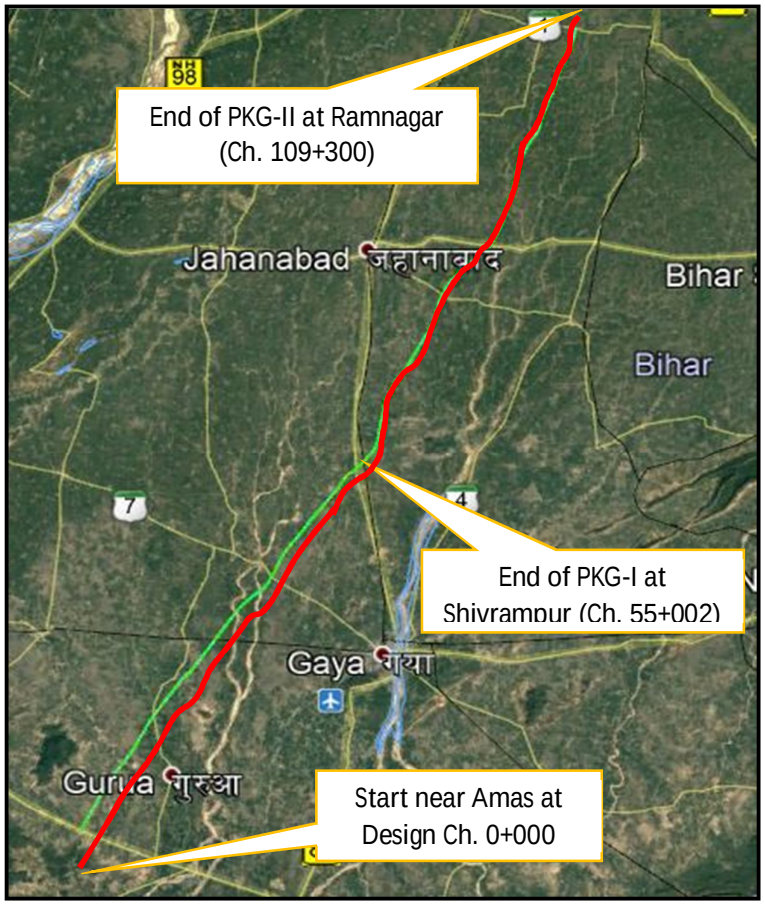
In this report we will discuss the project features of this new proposed green field alignment from "Shivrampur" to "Ramnagar" treated as **Package -2** as mentioned above.

The starting point of this project is near "Shivrampur" located at the District boundary of Gaya-Jahanabad, from Design Ch. 55+022 Km. The coordinates of the starting point is **Latitude 25.008958°and Longitude 84.990754°.**

The ending point of this project is near "Ramnagar" at Design Ch. 109+300 Km which is the connecting the SH-78 road. The coordinates of the ending point is **Latitude 25.446179° and Longitude 85.209871°.**

As this is a completely new Green Field Alignment, there are no existing structures in the project road. This alignment mainly passes through Plain terrain and shall be constructed as 4-Lane with Paved shoulder configuration in accordance to IRC: SP: 84-2014.

The Proposed ROW of this section is taken as **60m** in which all the configurations shall be fitted with. The key map of the proposed alignment is shown in **Fig. 1.0.**



3. Organization of this Report

This report is submitted against the deliverables described in clause 6.3 of the GCC at Stage 2: "Draft Feasibility Report".

This report consists of:

1. Main Report
2. Cost Estimate
3. Rate Analysis
4. Plan and Profile of Highway
5. General Arrangement Drawing of Structures.

4. Existing Carriageway and Pavement Details

This is a completely new proposed Green Field Alignment where there is no existing road. This road is proposed to connect from Amas to Ramnagar which will be a part of Bharatmala Pariyojana to improve the efficiency of the Freight movement in India. The whole section is proposed to be of Flexible Pavement type confirming to IRC:37-2018. Rigid pavement shall be constructed in the section(s) for Toll Plaza only. The configuration of the carriageway shall confirm to IRC:SP:84-2014 and the Structures shall be constructed as 4 lane configurations.

5. Settlements

As this is a green field alignment, there are many villages across the proposed road which are tried to retain by fixing the alignment in best method. The below listed settlements are given below in **Table 1.0.**

Table 1.0 Details of Settlements

S.No	Settlements	S.No	Settlements
1	Shiwrampur	17	Karhara
2	Berka	18	Gandhar
3	Damodarpur	19	Habalipur
4	Chandi	20	Charui
5	Chariyari	21	Dhobri
6	Mahewa	22	Deora
7	Kalanpur	23	Sadipur
8	Malathi	24	Jehanbad
9	Berthoo	25	Amarpura
10	Suppi	26	Manik Bigha
11	Kaji Sarai	27	Pabhera
12	Ibrahimpur	28	Tarwan
13	Golakpur	29	Abupur
14	Mohiuddinpur	30	Hulas Chak
15	Ahiasa	31	Andari
16	Mahammadpur	32	Ramnagar

Note: The alignment passes through these settlements which may or may not affect the structures. These names are for only for indicative purpose, actual R&R shall be provided separately.

6. Junction Details

There are 7 Major Junctions and 28 Minor Junctions in this project Stretch. The details of the Major Junctions are given in **Table 1.1** and details of Minor junctions are given in **Table 1.2.**

Table 1.1 Details of Major Junctions

S.No	Design Ch.	Junction Type	Classification	Leading To	Pavement Type	Remarks
1	58+270	+	Major	Barabar	Flexible	---
2	62+570	X	Major	Makhdumpur	Flexible	---
3	70+390	X	Major	Hati	Flexible	---
4	74+700	+	Major	Jahanabad-Ghosi	Flexible	SH-71
5	82+400	X	Major	Jahanabad	Flexible	NH-110
6	87+690	X	Major	Telhara	Flexible	
7	109+300	T	Major	Ramnagar	Flexible	SH-78

Table 1.2 Details of Minor Junctions

S.No	Design Ch.	Junction Type	Classification	Leading To	Pavement Type	Remarks
1	55+580	X	Minor	Berka	Earthen	Village Road
2	59+918	+	Minor	Chandai	Earthen	Village Road
3	65+640	X	Minor	Kurtha	Flexible	MDR
4	66+400	X	Minor	Jalalpur	Flexible	NH
5	66+900	X	Minor	Sumera	Flexible	Village Road
6	68+640	+	Minor	Chistipur Pakri	Flexible	Village Road
7	72+728	+	Minor	Lila Bigha	Earthen	Village Road
8	75+440	X	Minor	Ibrahimpur	Flexible	Village Road
9	76+200	X	Minor	Kaji Sarai	Flexible	MDR
10	77+768	X	Minor	Bishunpur	Cement Concrete	Village Road
11	79+468	X	Minor	Ahiasa	Flexible	Village Road
12	81+410	X	Minor	Dhamapur	Flexible	MDR
13	82+000	X	Minor	Daharpur	Flexible	MDR
14	86+450	X	Minor	Modanganj	Flexible	MDR
15	92+640	X	Minor	Sadipur	Flexible	Village Road
16	93+690	X	Minor	Bahrampur	Flexible	Village Road

S.No	Design Ch.	Junction Type	Classification	Leading To	Pavement Type	Remarks
17	94+878	X	Minor	Arampura	Flexible	Village Road
18	95+758	X	Minor	Dhamaul	Flexible	Village Road
19	96+265	X	Minor	Dhamaul	Flexible	Village Road
20	97+138	+	Minor	Rasalpur	Cement Concrete	Village Road
21	97+920	+	Minor	Chatti	Flexible	Village Road
22	98+578	X	Minor	Redbigha	Flexible	Village Road
23	99+520	X	Minor	Bigahapar	Flexible	Village Road
24	100+360	X	Minor	Pabhera	Flexible	Village Road
25	102+460	X	Minor	Abupur	Flexible	Village Road
26	103+218	X	Minor	Gauhar Chak	Earthen	Village Road
27	104+030	X	Minor	Hulas Chak	Flexible	Village Road
28	106+200	X	Minor	Nanda Chak	Flexible	Village Road

7. Typical Cross Sections

There are 6 nos. of TCS that have been used in this stretch. The details of the TCS schedule is provided in **Table 1.3** from Design Ch. 55+002 Km to Design Ch. 109+300 Km.

Table 1.2 Details of TCS Schedule

S.No.	Design Chainage		Descriptions	TCS	Length (m)
	From	To			
1	55+002	55+670	Typical Cross Section For 4 lane new construction without service road for embankment height >3m	TCS-II	668
2	55+670	55+870	Typical Cross Section For 4 lane new construction without service road for embankment height <3m	TCS-I	200
3	55+870	56+440	Typical Cross Section For 4 lane new construction without service road for embankment height >3m	TCS-II	570
4	56+440	56+900	Typical Cross Section For 4 lane new construction without service road for embankment height <3m	TCS-I	460

S.No.	Design Chainage		Descriptions	TCS	Length (m)
	From	To			
5	56+900	57+588	Typical Cross Section For 4 lane new construction without service road for embankment height >3m	TCS-II	688
6	57+588	57+618	Minor Bridge	TCS-IV	30
7	57+618	57+840	Typical Cross Section For 4 lane new construction without service road for embankment height >3m	TCS-II	222
8	57+840	58+270	Typical Cross Section For VUP/LVUP/Fly Over Approach with Slip Road	TCS-III	430
9	58+270	58+290	VUP Structure Part	RCC GIRDER	20
10	58+290	58+720	Typical Cross Section For VUP/LVUP/Fly Over Approach with Slip Road	TCS-III	430
11	58+720	59+130	Typical Cross Section For 4 lane new construction without service road for embankment height <3m	TCS-I	410
12	59+130	59+905	Typical Cross Section For 4 lane new construction without service road for embankment height >3m	TCS-II	775
13	59+905	59+912	MNB	RCC BOX	7
14	59+912	60+490	Typical Cross Section For 4 lane new construction without service road for embankment height >3m	TCS-II	578
15	60+490	60+940	Typical Cross Section For 4 lane new construction without service road for embankment height <3m	TCS-I	450
16	60+940	61+540	Typical Cross Section For 4 lane new construction without service road for embankment height >3m	TCS-II	600
17	61+540	61+816	Typical Cross Section For 4 lane new construction without service road for embankment height <3m	TCS-I	276
18	61+816	61+836	Minor Bridge	TCS-IV	20
19	61+836	62+120	Typical Cross Section For 4 lane new construction without service road for embankment height <3m	TCS-I	284
20	62+120	62+558	Typical Cross Section For VUP/LVUP/Fly Over Approach with Slip Road	TCS-III	438
21	62+558	62+578	VUP Structure Part	RCC GIRDER	20

S.No.	Design Chainage		Descriptions	TCS	Length (m)
	From	To			
22	62+578	62+920	Typical Cross Section For VUP/LVUP/Fly Over Approach with Slip Road	TCS-III	342
23	62+920	63+057	Typical Cross Section For 4 lane new construction without service road for embankment height >3m	TCS-II	137
24	63+057	63+067	Minor Bridge	RCC BOX	10
25	63+067	63+890	Typical Cross Section For 4 lane new construction without service road for embankment height >3m	TCS-II	823
26	63+890	64+240	Typical Cross Section For 4 lane new construction without service road for embankment height <3m	TCS-I	350
27	64+240	64+911	Typical Cross Section For 4 lane new construction without service road for embankment height >3m	TCS-II	671
28	64+911	64+921	Minor Bridge	RCC BOX	10
29	64+921	65+060	Typical Cross Section For 4 lane new construction without service road for embankment height >3m	TCS-II	139
30	65+060	65+160	Typical Cross Section For 4 lane new construction without service road for embankment height <3m	TCS-I	100
31	65+160	65+637	Typical Cross Section For VUP/LVUP/Fly Over Approach with Slip Road	TCS-III	477
32	65+637	65+649	LVUP Structure Part	RCC BOX	12
33	65+649	66+040	Typical Cross Section For VUP/LVUP/Fly Over Approach with Slip Road	TCS-III	391
34	66+040	66+240	Typical Cross Section For 4 lane new construction without service road for embankment height <3m	TCS-I	200
35	66+240	66+380	Typical Cross Section For 4 lane new construction without service road for embankment height >3m	TCS-II	140
36	66+380	66+410	Minor Bridge	TCS-IV	30
37	66+410	66+876	Typical Cross Section For 4 lane new construction without service road for embankment height >3m	TCS-II	466
38	66+876	66+906	Minor Bridge	TCS-IV	30

S.No.	Design Chainage		Descriptions	TCS	Length (m)
	From	To			
39	66+906	67+290	Typical Cross Section For 4 lane new construction without service road for embankment height >3m	TCS-II	384
40	67+290	67+670	Typical Cross Section For 4 lane new construction without service road for embankment height <3m	TCS-I	380
41	67+670	67+953	Typical Cross Section For 4 lane new construction without service road for embankment height >3m	TCS-II	283
42	67+953	67+963	Minor Bridge	RCC BOX	10
43	67+963	68+150	Typical Cross Section For 4 lane new construction without service road for embankment height >3m	TCS-II	187
44	68+150	68+280	Typical Cross Section For 4 lane new construction without service road for embankment height <3m	TCS-I	130
45	68+280	68+642	Typical Cross Section For 4 lane new construction without service road for embankment height >3m	TCS-II	362
46	68+642	68+654	Minor Bridge	RCC BOX	12
47	68+654	69+880	Typical Cross Section For 4 lane new construction without service road for embankment height >3m	TCS-II	1226
48	69+880	70+378	Typical Cross Section For VUP/LVUP/Fly Over Approach with Slip Road	TCS-III	498
49	70+378	70+398	VUP Structure Part	RCC Girder	20
50	70+398	70+700	Typical Cross Section For VUP/LVUP/Fly Over Approach with Slip Road	TCS-III	302
51	70+700	70+770	Typical Cross Section For 4 lane new construction without service road for embankment height >3m	TCS-II	70
52	70+770	71+840	Typical Cross Section For 4 lane new construction without service road for embankment height >3m	TCS-II	1070
53	71+840	72+180	Typical Cross Section For 4 lane new construction without service road for embankment height >3m	TCS-II	340

S.No.	Design Chainage		Descriptions	TCS	Length (m)
	From	To			
54	72+180	72+470	Typical Cross Section For 4 lane new construction without service road for embankment height <3m	TCS-I	290
55	72+470	73+800	Typical Cross Section For 4 lane new construction without service road for embankment height >3m	TCS-II	1330
56	73+800	74+140	Typical Cross Section For 4 lane new construction without service road for embankment height <3m	TCS-I	340
57	74+140	74+302	Typical Cross Section For VUP/LVUP/Fly Over Approach with Slip Road	TCS-III	162
58	74+302	74+317	Minor Bridge	TCS-IV	15
59	74+317	74+668	Typical Cross Section For VUP/LVUP/Fly Over Approach with Slip Road	TCS-III	351
60	74+668	74+728	Fly-Over Structure Part	RCC+PSC GIRDER	60
61	74+728	75+260	Typical Cross Section For VUP/LVUP/Fly Over Approach with Slip Road	TCS-III	532
62	75+260	75+650	Typical Cross Section For 4 lane new construction without service road for embankment height <3m	TCS-I	390
63	75+650	76+193	Typical Cross Section For 4 lane new construction without service road for embankment height >3m	TCS-II	543
64	76+193	76+213	Minor Bridge	TCS-IV	20
65	76+213	76+516	Typical Cross Section For 4 lane new construction without service road for embankment height >3m	TCS-II	303
66	76+516	76+541	Minor Bridge	TCS-IV	25
67	76+541	77+130	Typical Cross Section For 4 lane new construction without service road for embankment height >3m	TCS-II	589
68	77+130	77+370	Typical Cross Section For 4 lane new construction without service road for embankment height <3m	TCS-I	240
69	77+370	77+756	Typical Cross Section For 4 lane new construction without service road for embankment height >3m	TCS-II	386
70	77+756	77+776	Minor Bridge	TCS-IV	20

S.No.	Design Chainage		Descriptions	TCS	Length (m)
	From	To			
71	77+776	78+100	Typical Cross Section For 4 lane new construction without service road for embankment height >3m	TCS-II	324
72	78+100	79+160	Typical Cross Section For 4 lane new construction without service road for embankment height <3m	TCS-I	1060
73	79+160	80+483	Typical Cross Section For 4 lane new construction without service road for embankment height >3m	TCS-II	1323
74	80+483	80+498	Minor Bridge	TCS-IV	15
75	80+498	81+880	Typical Cross Section For 4 lane new construction without service road for embankment height >3m	TCS-II	1382
76	81+880	81+978	Typical Cross Section For VUP/LVUP/Fly Over Approach with Slip Road	TCS-III	98
77	81+978	82+028	Minor Bridge	TCS-IV	50
78	82+028	82+274	Typical Cross Section For VUP/LVUP/Fly Over Approach with Slip Road	TCS-III	246
79	82+274	82+389	Fly-Over Structure Part	RCC+PSC GIRDER	115
80	82+389	83+020	Typical Cross Section For VUP/LVUP/Fly Over Approach with Slip Road	TCS-III	631
81	83+020	83+450	Typical Cross Section For 4 lane new construction without service road for embankment height <3m	TCS-I	430
82	83+450	84+200	Typical Cross Section For 4 lane new construction without service road for embankment height >3m	TCS-II	750
83	84+200	84+730	Typical Cross Section For 4 lane new construction without service road for embankment height <3m	TCS-I	530
84	84+730	85+313	Typical Cross Section For 4 lane new construction without service road for embankment height >3m	TCS-II	583
85	85+313	85+333	Minor Bridge	TCS-IV	20
86	85+333	85+396	Typical Cross Section For 4 lane new construction without service road for embankment height >3m	TCS-II	63
87	85+396	85+411	Minor Bridge	TCS-IV	15

S.No.	Design Chainage		Descriptions	TCS	Length (m)
	From	To			
88	85+411	85+880	Typical Cross Section For 4 lane new construction without service road for embankment height >3m	TCS-II	469
89	85+880	86+447	Typical Cross Section For VUP/LVUP/Fly Over Approach with Slip Road	TCS-III	567
90	86+447	86+459	LVUP Structure Part	RCC BOX	12
91	86+459	86+820	Typical Cross Section For VUP/LVUP/Fly Over Approach with Slip Road	TCS-III	361
92	86+820	86+906	Typical Cross Section For 4 lane new construction without service road for embankment height <3m	TCS-I	86
93	86+906	86+914	Minor Bridge	RCC BOX	8
94	86+914	87+355	Typical Cross Section For 4 lane new construction without service road for embankment height >3m	TCS-II	441
95	87+355	87+520	Major Bridge	TCS-IV	165
96	87+520	87+680	Typical Cross Section For 4 lane new construction without service road for embankment height >3m	TCS-II	160
97	87+680	87+710	VUP Structure Part	PSC Girder	30
98	87+710	88+180	Typical Cross Section For VUP/LVUP/Fly Over Approach with Slip Road	TCS-III	470
99	88+180	88+500	Typical Cross Section For 4 lane new construction without service road for embankment height <3m	TCS-I	320
100	88+500	90+049	Typical Cross Section For 4 lane new construction without service road for embankment height >3m	TCS-II	1549
101	90+049	90+074	Minor Bridge	TCS-IV	25
102	90+074	90+520	Typical Cross Section For 4 lane new construction without service road for embankment height >3m	TCS-II	446
103	90+520	91+410	Typical Cross Section For 4 lane new construction without service road for embankment height <3m	TCS-I	890
104	91+410	91+903	Typical Cross Section For 4 lane new construction without service road for embankment height >3m	TCS-II	493
105	91+903	91+923	Minor Bridge	TCS-IV	20

S.No.	Design Chainage		Descriptions	TCS	Length (m)
	From	To			
106	91+923	92+623	Typical Cross Section For 4 lane new construction without service road for embankment height >3m	TCS-II	700
107	92+623	92+653	Minor Bridge	TCS-IV	30
108	92+653	93+020	Typical Cross Section For 4 lane new construction without service road for embankment height >3m	TCS-II	367
109	93+020	93+686	Typical Cross Section For 4 lane new construction without service road for embankment height <3m	TCS-I	666
110	93+686	93+706	Minor Bridge	TCS-IV	20
111	93+706	93+815	Typical Cross Section For 4 lane new construction without service road for embankment height >3m	TCS-II	109
112	93+815	93+825	Minor Bridge	RCC BOX	10
113	93+825	94+331	Typical Cross Section For 4 lane new construction without service road for embankment height >3m	TCS-II	506
114	94+331	94+341	Minor Bridge	RCC BOX	10
115	94+341	94+872	Typical Cross Section For 4 lane new construction without service road for embankment height >3m	TCS-II	531
116	94+872	94+888	Minor Bridge	TCS-IV	16
117	94+888	95+733	Typical Cross Section For 4 lane new construction without service road for embankment height >3m	TCS-II	845
118	95+733	95+753	Minor Bridge	TCS-IV	20
119	95+753	96+033	Typical Cross Section For 4 lane new construction without service road for embankment height >3m	TCS-II	280
120	96+033	96+043	Minor Bridge	RCC BOX	10
121	96+043	96+255	Typical Cross Section For 4 lane new construction without service road for embankment height >3m	TCS-II	212
122	96+255	96+285	Minor Bridge	TCS-IV	30
123	96+285	96+510	Typical Cross Section For 4 lane new construction without service road for embankment height >3m	TCS-II	225

S.No.	Design Chainage		Descriptions	TCS	Length (m)
	From	To			
124	96+510	96+990	Typical Cross Section For 4 lane new construction without service road for embankment height <3m	TCS-I	480
125	96+990	97+119	Typical Cross Section For 4 lane new construction without service road for embankment height >3m	TCS-II	129
126	97+119	97+149	Minor Bridge	TCS-IV	30
127	97+149	97+460	Typical Cross Section For 4 lane new construction without service road for embankment height >3m	TCS-II	311
128	97+460	97+670	Typical Cross Section For 4 lane new construction without service road for embankment height <3m	TCS-I	210
129	97+670	97+913	Typical Cross Section For 4 lane new construction without service road for embankment height >3m	TCS-II	243
130	97+913	97+933	Minor Bridge	TCS-IV	20
131	97+933	98+574	Typical Cross Section For 4 lane new construction without service road for embankment height >3m	TCS-II	641
132	98+574	98+607	Minor Bridge	TCS-IV	33
133	98+607	99+060	Typical Cross Section For 4 lane new construction without service road for embankment height >3m	TCS-II	453
134	99+060	99+340	Typical Cross Section For 4 lane new construction without service road for embankment height <3m	TCS-I	280
135	99+340	99+506	Typical Cross Section For 4 lane new construction without service road for embankment height >3m	TCS-II	166
136	99+506	99+531	Minor Bridge	TCS-IV	25
137	99+531	99+820	Typical Cross Section For 4 lane new construction without service road for embankment height >3m	TCS-II	289
138	99+820	100+090	Typical Cross Section For 4 lane new construction without service road for embankment height <3m	TCS-I	270
139	100+090	100+348	Typical Cross Section For VUP/LVUP/Fly Over Approach with Slip Road	TCS-III	258
140	100+348	100+360	LVUP Structure Part	RCC BOX	12

S.No.	Design Chainage		Descriptions	TCS	Length (m)
	From	To			
141	100+360	100+860	Typical Cross Section For VUP/LVUP/Fly Over Approach with Slip Road	TCS-III	500
142	100+860	101+093	Typical Cross Section For 4 lane new construction without service road for embankment height >3m	TCS-II	233
143	101+093	101+123	Minor Bridge	TCS-IV	30
144	101+123	101+240	Typical Cross Section For 4 lane new construction without service road for embankment height >3m	TCS-II	117
145	101+240	101+836	Toll Plaza	Toll Plaza	596
146	101+836	101+851	Minor Bridge	TCS-IV	15
147	101+851	101+947	Toll Plaza	Toll Plaza	96
148	101+947	102+100	Typical Cross Section For 4 lane new construction without service road for embankment height <3m	TCS-I	153
149	102+100	102+256	Typical Cross Section For 4 lane new construction without service road for embankment height >3m	TCS-II	156
150	102+256	102+281	Minor Bridge	TCS-IV	25
151	102+281	103+098	Typical Cross Section For 4 lane new construction without service road for embankment height >3m	TCS-II	817
152	103+098	103+230	Major Bridge	TCS-IV	132
153	103+230	103+977	Typical Cross Section For 4 lane new construction without service road for embankment height >3m	TCS-II	747
154	103+977	104+047	Major Bridge	TCS-IV	70
155	104+047	104+688	Typical Cross Section For 4 lane new construction without service road for embankment height >3m	TCS-II	641
156	104+688	104+708	Minor Bridge	TCS-IV	20
157	104+708	105+048	Typical Cross Section For 4 lane new construction without service road for embankment height >3m	TCS-II	340
158	105+048	105+063	Minor Bridge	TCS-IV	15
159	105+063	105+130	Typical Cross Section For 4 lane new construction without service road for embankment height >3m	TCS-II	67

S.No.	Design Chainage		Descriptions	TCS	Length (m)
	From	To			
160	105+130	106+000	Typical Cross Section For 4 lane new construction without service road for embankment height <3m	TCS-I	870
161	106+000	106+188	Typical Cross Section For 4 lane new construction without service road for embankment height >3m	TCS-II	188
162	106+188	106+213	Minor Bridge	TCS-IV	25
163	106+213	106+580	Typical Cross Section For 4 lane new construction without service road for embankment height >3m	TCS-II	367
164	106+580	107+051	Typical Cross Section for ROB approach with slip Road	TCS-V	471
165	107+051	107+081	Minor Bridge	TCS-IV	30
166	107+081	107+182	Typical Cross Section for ROB approach with slip Road	TCS-V	101
167	107+182	107+254	ROB Structure Part	TCS-VI	72
168	107+254	107+560	Typical Cross Section for ROB approach with slip Road	TCS-V	306
169	107+560	107+570	Minor Bridge	RCC BOX	10
170	107+570	107+920	Typical Cross Section for ROB approach with slip Road	TCS-V	350
171	107+920	108+060	Typical Cross Section For 4 lane new construction without service road for embankment height <3m	TCS-I	140
172	108+060	108+097	Typical Cross Section For 4 lane new construction without service road for embankment height >3m	TCS-II	37
173	108+097	108+109	Minor Bridge	RCC BOX	12
174	108+109	108+410	Typical Cross Section For 4 lane new construction without service road for embankment height >3m	TCS-II	301
175	108+410	109+300	Typical Cross Section For 4 lane new construction without service road for embankment height <3m	TCS-I	890
			Total Length		**54298**

NOTE: The Typical Cross Sections are attached at the end of this chapter.

8. Structure Details

The proposed alignment from Shivrampur to Ramnagar mainly traverses through Plain terrain. As this is a completely new proposed Green Field Alignment, it passes through many rivers and canals. Various structures have been proposed to facilitate the connectivity from other roads to maintain the traffic flow throughout. The details of the structures are summarised below in **Table 1.3**

Table 1.3 Summary of Structures

S.NO	Structure Type	Proposed Nos.
1	Major Bridges	03
2	Minor Bridges	44
3	Minor Bridge Cum LVUP	NIL
4	Vehicular Under Pass	04
5	Light Vehicular Under Pass	03
6	Small Vehicular Under Pass	02
7	Fly-Over	02
8	Viaduct	NIL
9	ROB	01
10	Culverts	88
11	Others	NIL

9. Major Bridges

There are 03 numbers of Major Bridges in this section which are to be constructed over various rivers. The details of the Major Bridges are given below in **Table 1.4.**

Table 1.4 Details of Major Bridges

S.No	Design Ch.	Structure Type	Proposed Span	Total Length(m)
1	87+437	PSC Girder	5x33	165
2	103+164	PSC Girder	4x33	132
3	104+012	PSC+RCC	25+20+25	70

10. Minor Bridges

There are 44 numbers of Minor Bridges in this section out of which 42 no. are on MCW and 2 no. are on Service/Slip road, which are to be constructed over various canals and rivers. The details of the Major Bridges are given below in **Table 1.5.**

a. Table 1.5 Details of Minor Bridges on MCW

S No	New Chainage	Structure	Size	Superstructure type
1	57+603	MNB	1X30	PSC Girder
2	59+908	MNB	1X7X3	RCC BOX
3	61+826	MNB	1X20	RCC Girder
4	63+062	MNB	1X10	RCC BOX
5	64+916	MNB	1X10	RCC BOX
6	66+395	MNB	1x30	PSC Girder
7	66+891	MNB	1x30	PSC Girder
8	68+648	MNB	2x6	RCC BOX
9	69+105	MNB	1X25	PSC Girder
10	74+309	MNB	1X15	RCC Girder
11	76+203	MNB	1X20	RCC BOX
12	76+528	MNB	1x25	PSC Girder
13	77+766	MNB	1X20	RCC Girder
14	80+490	MNB	1X15	RCC Girder
15	82+003	MNB	30+20	PSC+RCC
16	82+300	MNB	1X12	RCC BOX
17	85+323	MNB	1X20	RCC Girder
18	85+403	MNB	1X15	RCC Girder
19	86+910	MNB	1X8	RCC BOX
20	90+061	MNB	1X25	PSC Girder
21	91+913	MNB	1X20	PSC Girder
22	92+638	MNB	1X30	PSC Girder
23	93+696	MNB	1X20	RCC Girder
24	93+820	MNB	2x8	RCC BOX
25	94+336	MNB	1X10	RCC BOX
26	94+880	MNB	2x8	RCC BOX
27	95+743	MNB	1X20	RCC Girder
28	96+038	MNB	1X10	RCC BOX
29	96+270	MNB	1X30	PSC Girder
30	97+134	MNB	1X30	PSC Girder
31	97+923	MNB	1X20	RCC Girder
32	98+590	MNB	1X33	PSC Girder
33	99+518	MNB	1X25	PSC Girder
34	101+110	MNB	1X30	PSC Girder
35	101+843	MNB	1X15	RCC Girder
36	102+268	MNB	1X25	PSC Girder
37	104+698	MNB	1X20	RCC Girder
38	105+055	MNB	1X15	RCC Girder
39	106+200	MNB	1X25	PSC Girder
40	107+066	MNB	1X30	PSC Girder
41	107+565	MNB	1X10	RCC BOX
42	108+103	MNB	1X12	RCC BOX

b. Table 1.6 Details of Minor Bridges on Service/slip road

S.No	Design Ch.	Structure Type	Proposed Span(m)	Total Length(m)
1	82+300	PSC Girder	1x12	12
2	107+066	RCC Girder	1x12	12

11. VUP (Vehicular Under Pass)

There are 04 Vehicular Under Pass proposed in this stretch to allow the users to connect across the road. The details of the VUP's are summarised below in **Table 1.7.**

Table 1.7. Vehicular Under Pass

S.No	Design Ch.	Structure Type	Proposed Span	Total Length(m)	Passes Over
1	58+280	RCC Girder	1X20X5.5	20	Barabar Road
2	62+568	RCC Girder	1x20x5.5	20	Makhdumpur Road
3	70+388	RCC Box	1x12x5.5	12	Hati More-Korna Road
4	87+695	PSC Girder	1X30X5.5	30	Telhara-Imaniya Road

12. LVUP (Light Vehicular Under Pass)

There are 03 numbers of LVUP proposed across the Village/ODR roads to facilitate the movement of the users. The details of the LVUP are summarised below in **Table 1.8.**

Table 1.8. Details of Light Vehicular Under Pass

S.No	Design Ch.	Structure Type	Proposed Span	Total Length(m)	Passes Over
1	65+643	RCC Box	1x12x4	12	Kurtha Road
2	86+453	RCC Box	1x12x4	12	Modanganj Road
3	100+354	RCC Box	1x12x4	12	Pabhera road

13. Small Vehicular Under Pass

There are 02 SVUP's proposed in this section near the village roads to facilitate the movement of the road users. The details of the SVUP are summarised in **Table 1.9.**

Table 1.9. Details of Small Vehicular Under Pass

S.No	Design Ch.	Structure Type	Proposed Span	Total Length(m)
1	79+468	RCC Box	1x7	7
2	81+426	RCC Box	1x7	7

14. Fly-Over/Interchange

At the starting of the Project road, a Trumpet Interchange has been proposed followed with 2 Fly-Overs which are crossing the National/State Highways. The details of the Fly-Over and Interchange has been summarised in **Table 1.10.**

Table 1.10. Details of Fly-Over/Interchange

S.No	Design Ch.	Structure Type	Proposed Span	Total Length(m)	Passes Over
1	74+698	PSC+RCC Girder	15+30+15	60	SH-71
2	82+331	PSC+RCC Girder	30+35+30+20	115	NH-110

15. Road Over Bridge

There are 01 number of R.O.B Proposed in this section. The details of the ROB has been summarized below in **Table 1.11.**

Table 1.11. Details of R.O.B

S.No	Design Ch.	Structure Type	Proposed Span	Total Length(m)	Passes Over
1	107+218	RCC+Composite Girder	18+36+18	72	--

16. Viaduct

There is 0 number of Viaduct proposed in this section. The details of the Viaduct is summarised below in **Table 1.12.**

Table 1.12. Details of Viaduct

S.NO	Design Ch.		Proposed Span	Proposed Type	Structure Include
	From	To			
NIL					

17. Culverts

Box type culverts have been proposed in this alignment as cross drainage structures and at many places culverts are being proposed to serve a pathway to the village users in the dry seasons. There are 84 nos. of culverts proposed in this section. The details of the culverts are summarised below in **Table 1.13.**

Table 1.13. Details of the Culverts

S.No	Design Ch.	Proposed Span
		(Unit x Span x Height)m
1	55+278	1X3X3
2	55+578	1X5X3

S.No	Design Ch.	Proposed Span (Unit x Span x Height)m
3	56+031	1X3X3
4	56+368	1X3X3
5	56+953	1X3X3
6	57+088	1X6X3
7	57+298	1X4X3
8	58+374	1X4X3
9	58+394	1X3X3
10	58+638	1X3X3
11	59+218	1X3X3
12	59+508	1X4X3
13	60+278	1X3X3
14	60+899	1X3X3
15	61+208	1X3X3
16	61+223	1X3X3
17	61+463	1X3X3
18	62+493	1X5X3
19	63+376	1X3X3
20	63+666	1X3X3
21	64+256	1X3X3
22	64+471	1x3x3
23	65+456	1X3X3
24	65+568	1X5X3
25	67+156	1X3X3
26	67+338	1X6X3
27	67+958	1x6x3
28	68+278	1X3X3
29	68+648	1x6x3
30	69+108	1X5X3
31	69+698	1x6x3
32	70+108	1X4X3
33	70+590	1X3X3
34	70+983	1X3X3
35	71+115	1x3x3
36	71+565	1X3X3
37	72+108	1X3X3
38	72+720	1x4x3

S.No	Design Ch.	Proposed Span (Unit x Span x Height)m
39	73+096	1X3X3
40	73+536	1X3X3
41	75+449	1X4X3
42	75+848	1X4X3
43	76+818	1X4X3
44	77+323	1X3X3
45	78+073	1X3X3
46	78+448	1x6x3
47	78+678	1x6x3
48	79+045	1X3X3
49	79+625	1X6x3
50	80+160	1x6x3
51	80+946	1X3X3
52	81+061	1X3X3
53	81+208	1X3X3
54	81+821	1X3X3
55	83+028	1X3X3
56	83+410	1X4X3
57	84+428	1X3X3
58	84+829	1X3X3
59	86+036	1X3X3
60	88+177	1X3X3
61	88+587	1X3X3
62	88+983	1X3X3
63	89+657	1X4X3
64	90+367	1X3X3
65	90+844	1X3X3
66	91+266	1X3X3
67	91+637	1x6x3
68	92+344	1X3X3
69	93+040	1X3X3
70	95+508	1X6X3
71	96+453	1x5x3
72	96+639	1X3X3
73	97+538	1X3X3
74	98+118	1X5X3

S.No	Design Ch.	Proposed Span (Unit x Span x Height)m
75	98+358	1X6X3
76	99+738	1X3X3
77	100+587	1X3X3
78	100+795	1X3X3
79	102+684	1X3X3
80	103+609	1X4X3
81	104+394	1X3X3
82	105+563	1X3X3
83	105+594	1X3X3
84	105+814	1X3X3
85	106+415	1X3X3
86	106+423	1X3X3
87	106+705	1X3X3
88	109+028	1X3X3

18. Traffic Survey And Analysis

Count of traffic is the basic traffic study required in connection with many types of highway projects. Knowledge of the vehicular traffic using a road network is important for understanding the efficiency at which the system works at present and the general quality of service offered to the road users. The traffic using a road consists of a variety of vehicles ranging from the simple pedal cycles to the motor car and the heavy commercial vehicles, each type having an influence on the performance of the road on its own way. A simple volume count, without classifying the vehicles into distinct types, is of limited use. The normal practice is to take classified traffic volume count to evaluate the traffic plying on a road project.

Classified traffic counts were carried out for a period of 7 consecutive days at mid-block locations along 2 corridors. The locations selected were at the outskirts of city where the local traffic is low and regional traffic is high. The surveys were carried out mainly by trained enumerators. The data served as population base during base year and will be used to project traffic

Table 1.14: Survey Location and Periods

S.No.	Type of Survey	Location Code	Location Name	Road Name	Remark
1	**Traffic Volume Count**	TVC - 01	Sarwan	NH-83	7 Days
		TVC - 02	Sawkala Toll Plaza	NH-02	7 Days

19. Average Daily Traffic

The Analysis of traffic volumes over 7 days at each of the three locations show that the Average Day traffic. The details are presented in **Table -1.15**

Table 1.15: AVERAGE DAILY TRAFFIC

Mode	TVC – 01	TVC - 02
	Sarwan	Sawkala Toll Plaza
2-Wheeler	5000	4097
Car/ Van/ Jeep/ Taxi	6055	11239
Auto Rickshaw	623	141
Bus	410	1243
LCV	2482	2457
2 Axle Truck	452	1262
3 Axle Truck	424	2230
MAV	36	110
Agri. Tractor	203	25
Agri. Tractor + Trailer	53	482
Cycle	63	45
Cycle Rickshaw	0	0
Construction Vehicle	0	7
Total Vehicle	**15800**	**23339**
Total PCU	**17492**	**34077**

20. Annual Average Daily Traffic

To truly display the effect of different seasons and demand variations and reflect the true volumes on an average day, the consultants collected monthly sales of petrol and Diesel from representative fuel stations to identify the variation in sale of these fuels by month. The sale of these fuels in the month of November, when these surveys were carried out

was indexed with the sales during entire year and the estimated seasonal correction was applied separately for the vehicles propelled by petrol and diesel. The seasonal correction factor SCF is presented in **Table – 1.16**

Table 1.16: SEASONAL CORRECTION FACTOR (SCF) FOR DIFFERENT LOCATIONS

Location Code	Location Name	SCF	
		Petrol	Diesel
TVC - 01	Indian Oil	1.02	1.06
TVC - 02	HP Petrol Pump	1.02	1.06

The Annual Average Day Traffic AADT is estimated after applying the SCF. The mode wise traffic is presented is **Table – 1.17**

Table 1.17: ANNUAL AVERAGE DAILY TRAFFIC

Mode	TVC - 01	TVC - 02
	Sarwan	Sawkala Toll Plaza
2-Wheeler	5099	4179
Car/ Van/ Jeep/ Taxi	6176	11464
Auto Rickshaw	635	144
Bus	435	1318
LCV	2630	2604
2 Axle Truck	479	1338
3 Axle Truck	449	2364
MAV	38	116
Agri. Tractor	215	27
Agri. Tractor + Trailer	56	511
Cycle	63	45
Cycle Rickshaw	0	0
Construction Vehicle	0	8
Total Vehicle	**16277**	**24117**

Mode	TVC - 01	TVC - 02
	Sarwan	Sawkala Toll Plaza
Total PCU	18173	35583

21. Pavement Design

The entire Project shall be constructed with Flexible Pavement with a Design MSA of 90 for the Main Carriageway and 10 MSA for the service road. The details of the Thickness for different layers are given below:

Table 1.18: Proposed Flexible Pavement Design for MCW, Ramps, Loops & Approach Roads

Design period	Design Traffic	Va	Vb	Design CBR	BC (VG 40)	DBM (VG 40)	WMM	GSB	TOTAL
20 years	90 MSA	3.5%	12.5%	6%	50	135	250	250	**685**

Table 1.19: Proposed Design for Service Roads

Design Traffic	Bitumen Grade	Design CBR	BC	DBM	WMM	GSB	TOTAL
10 MSA	VG 30	7%	30	70	250	200	**550**

22. Soil Type

The black cotton soil is a type of problematic expansive soil which causes many problems in the construction of structures founded on them. In our case it is highway. It is having a swelling and impervious nature with poor geotechnical subgrade characteristics. As we know that Shivrampur to Ramnagar section is having black cotton soil. Black cotton soils normally have CBR around 3-4% but as per pavement design we have considered minimum effective CBR of 6%.

There are two options to solve black cotton soil problem. Firstly, we remove the black cotton soil with some another good quality soil or Secondly , improvement in the various geotechnical properties of black cotton soil such as index properties, swelling characteristics, consolidation characteristics, hydraulic conductivity characteristics and strength characteristics by blending it with materials such as river sand, fly ash and marble dust or Lime.

Lime stabilization is the most popular and useful method in Indian highways were existing soil is expansive. Lime helps to reduce the plasticity of soil. It is cost effective also in comparison of soil replacement if the soil is not available in nearby places. The

complete details of material, quantity, construction operation, equipment of construction used, and methodology, along with other parameters are given in MORTH clause no. 402 LIME TREATED SOIL FOR IMPROVED SUB-GRADE. It can be referred for the construction purpose.

23. Cost Estimate

The Cost Estimate has been prepared from the SOR of Bihar 2019-2020. The abstract of the cost estimate has been given in **Table 1.20.** For detail of Cost Estimate, separate volume is submitted along this submittals.

Table 1.20 Abstract of Cost Estimate

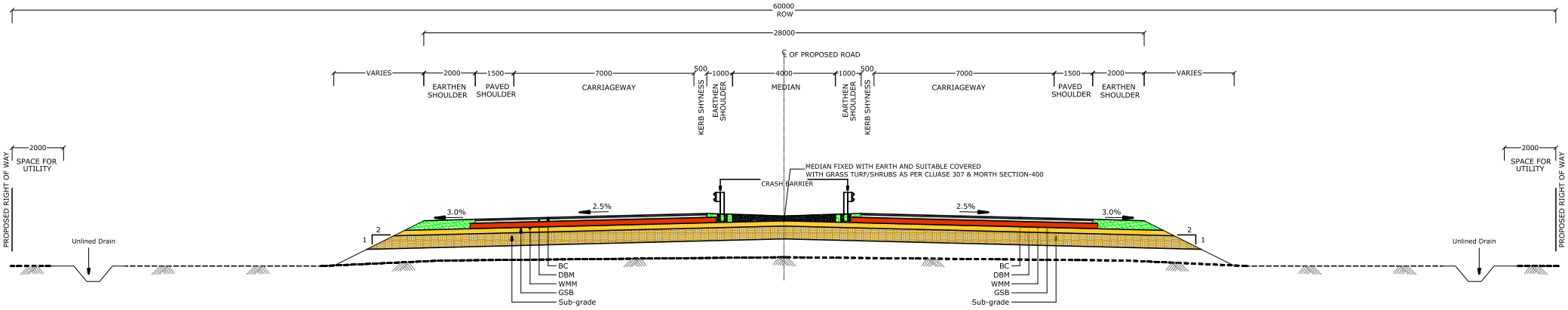
Sl. No.	Items	Unit	Length (in Km)	Rate (in Rs.)	Amount (in Rs.)	Amount (in Cr.)
A	**ROAD WORKS**					
1	Site Clearance				23,874,902.98	2.39
2	Earthwork Filling	Cum			993,081,937.50	99.31
3	Loosening & Recompacting	Cum			28,734,671.95	2.87
4	Sub Grade	Cum			283,235,912.46	28.32
5	GSB	Cum			628,596,388.86	62.86
6	WMM	Cum			520,623,236.98	52.06
7	Prime Coat	Sqm			33,522,253.00	3.35
8	Tack Coat	Sqm			25,952,712.00	2.60
9	DBM	Cum			998,874,380.16	99.89
10	BC	Cum			425,499,078.90	42.55
B	**BRIDGES and STRUCTURES**					
1	Major Bridges	No.	3.00		416,179,005.57	41.62
2	Minor Bridges	No.	44.00		1,493,689,312.87	149.37
3	VUP /LVUP /SVUP	No.	9.00		128,438,957.52	12.84
4	Flyovers	No.	2.00		139,679,482.77	13.97
5	Culverts	No.	88.00		315,312,762.87	31.53
6	ROB	No.	1		102,752,517.36	10.28
C	**SLOPE STRUCTURES**					
1	RE Wall	km	7.70		589,613,093.58	58.96
D	**JUNCTIONS**					
1	Major Junctions	No	7		83,817,521.13	8.38
2	Minor Junctions	No	28		203,013,272.00	20.30
3	Toll Plaza	No	1.00		248,804,365.58	24.88

Sl. No.	Items	Unit	Length (in Km)	Rate (in Rs.)	Amount (in Rs.)	Amount (in Cr.)
E	**DRAIN & PROTECTION WORK**					
1	Drainage Works	Km			413,766,175.77	41.38
2	RCC Crash Barrier with friction slab	Km	15.39		184,704,000.00	18.47
3	Metal Crash Barrier	Km	167.01		549,957,344.00	55.00
4	Other Protective Works (Fencing Wire & Steel Railing & Slope Protection)				203,392,829.08	20.34
F	**LAY BYES**					
1	Bus Bays	Nos	22.00	2,323,779.73	51,123,153.95	5.11
2	Truck Lay Bays	Nos	1.00	4,348,582.40	4,348,582.40	0.43
G	**OTHER MISCELLANEOUS ITEMS**					
1	Footpath and Separators				3,330,336.00	0.33
2	Rest Area Locations	Nos	1		57,623,811.00	5.76
3	Miscellaneous Items				23,836,000.00	2.38
4	Traffic Signs, Marking and Road Appurtenances				57,930,018.55	5.79
5	Reflective Road Studs	Nos	22470		4,808,580.00	0.48
6	Lighting Cost				82,150,000.00	8.22
	TOTAL CIVIL COST				**9,320,266,596.80**	**932.03**
	COST PER KM (LENGTH = 54.298 KM) IN CRORES ...					**17.17**
	GST (12%) on Civil Cost					**111.84**
	Labour Cess 1%					**9.32**
	TOTAL CIVIL COST					**1,053.19**
	COST PER KM (LENGTH = 54.298 KM) IN CRORES ...					**19.40**

24. Conclusion

From the above discussed project features, we conclude that the Project Stretch shall be constructed as 4 Lane with Paved Shoulder configuration as per the Standard and

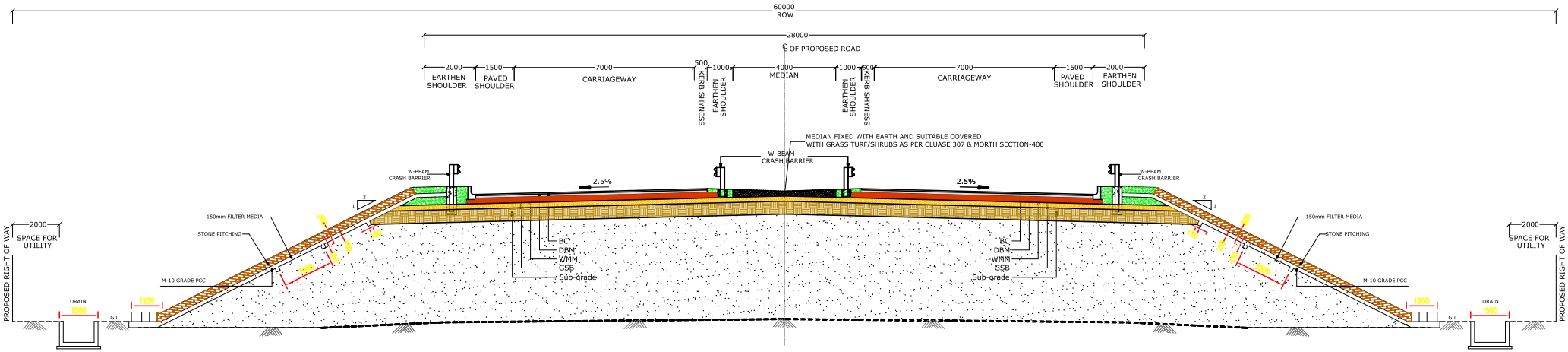
Specification of IRC:SP:84-2014 for the highway and the structures shall be constructed as per the Standard and Specifications of IRC:SP:73-2019. The ROW of adopted for this section is 60m. The Package-II shall be constructed from Design Ch. 55+002 Km to Design Ch. 109+300 Km. As this is a new proposed green field alignment, built up sections are avoided for construction purpose. This stretch starts from Shivrampur and ends near Ramnagar. The total project facilities and details are discussed in the forthcoming chapters in this report.



TCS-I TYPICAL CROSS SECTION
FOR 4-LANE DIVIDED HIGHWAY WITHOUT SERVICE ROAD WITH DEPRESSED MEDIAN

NOTES:-

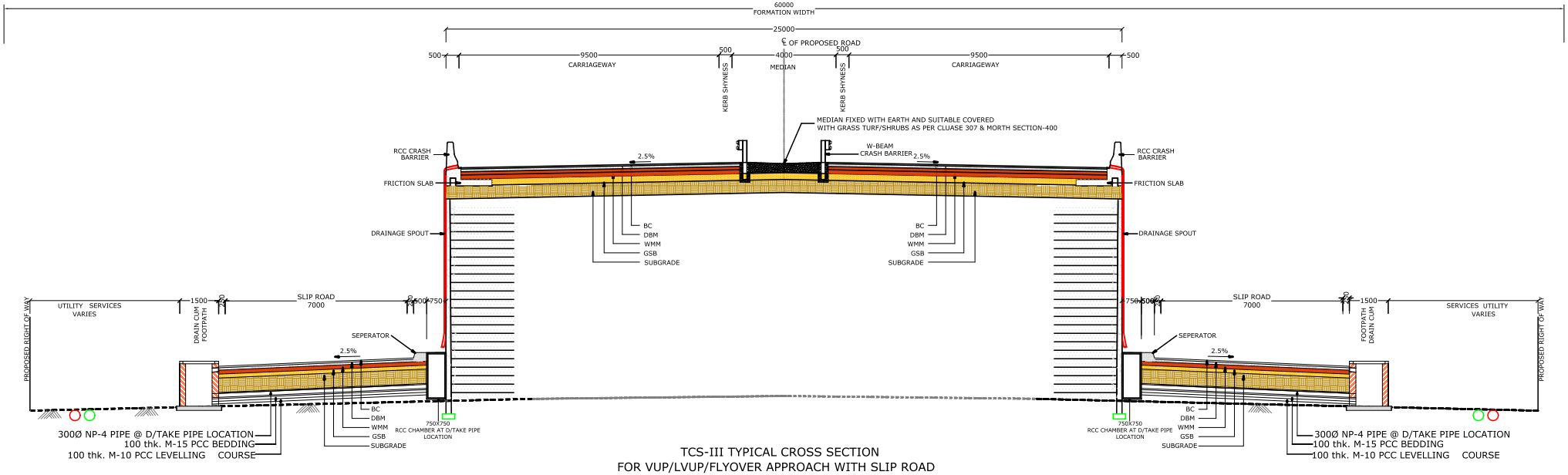
1. ALL DIMENSIONS ARE IN mm, UNLESS OTHERWISE MENTIONED.



TCS-II TYPICAL CROSS SECTION
FOR 4-LANE DIVIDED HIGHWAY WITHOUT SERVICE ROAD WITH DEPRESSED MEDIAN
(MORE THEN 3m HIGH EMBANKMENT)

NOTES:-

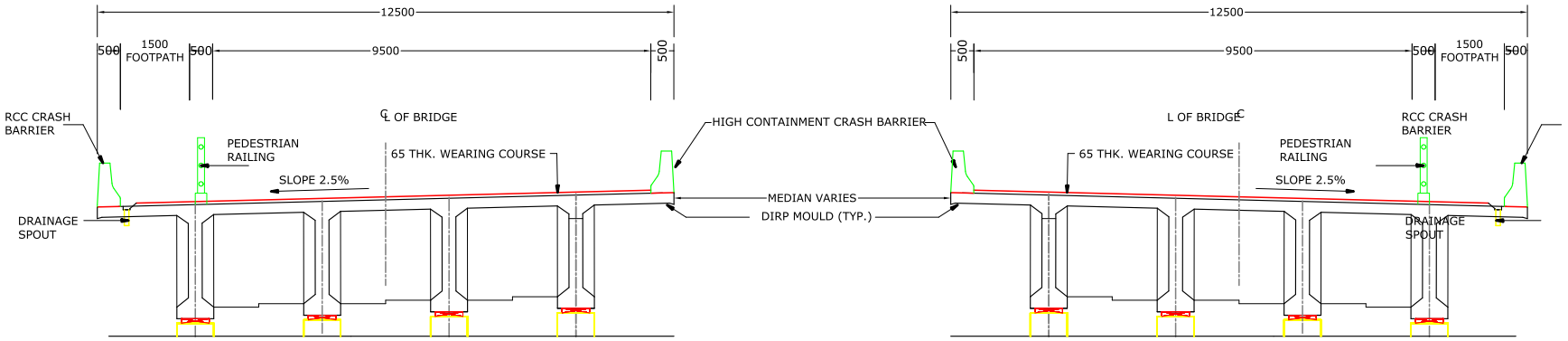
1. ALL DIMENSIONS ARE IN mm, UNLESS OTHERWISE MENTIONED.



TCS-III TYPICAL CROSS SECTION
FOR VUP/LVUP/FLYOVER APPROACH WITH SLIP ROAD

NOTES:-

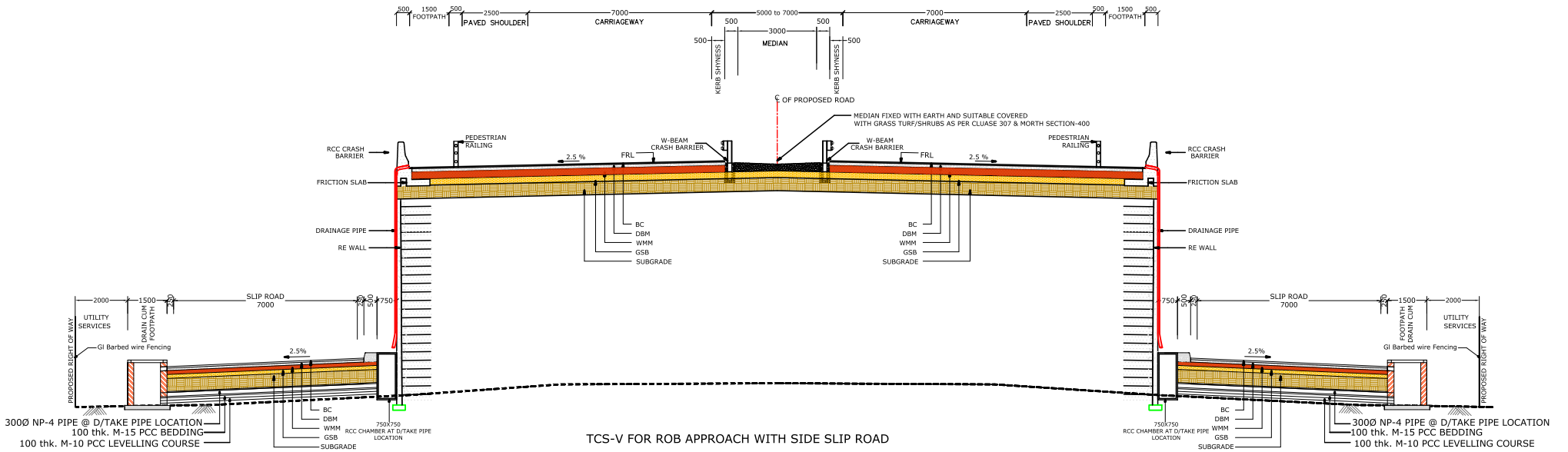
1. ALL DIMENSIONS ARE IN mm, UNLESS OTHERWISE MENTIONED.



TCS-IV TYPICAL CROSS SECTION
FOR NEW 4-LANE AT BRIDGE SECTION

NOTES:-

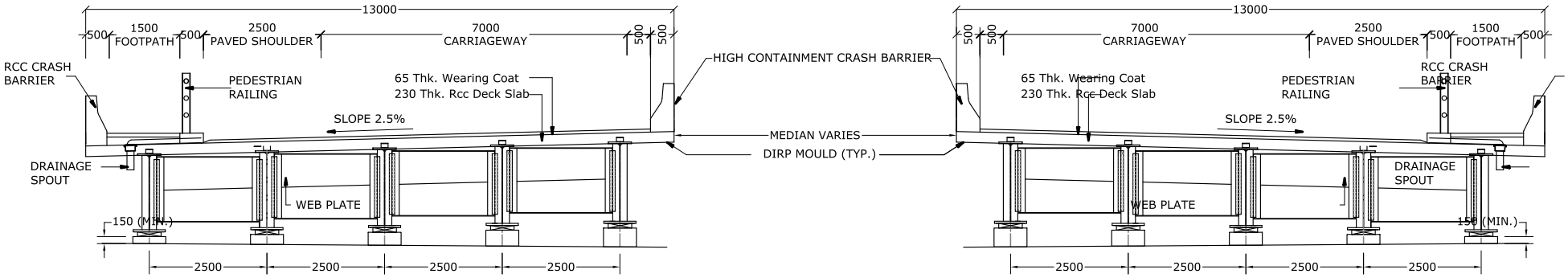
1. ALL DIMENSIONS ARE IN mm, UNLESS OTHERWISE MENTIONED.



TCS-V FOR ROB APPROACH WITH SIDE SLIP ROAD

NOTES:-

1. ALL DIMENSIONS ARE IN mm, UNLESS OTHERWISE MENTIONED.



TCS-VI TYPICAL CROSS SECTION
FOR NEW 4-LANE ROB

NOTES:-

1. ALL DIMENSIONS ARE IN mm, UNLESS OTHERWISE MENTIONED.

CHAPTER-2

OVERVIEW OF NHAI

2.1 GENERAL

The Government of India has decided to take up the development of various road stretches/Corridors in the Northern part of the country to upgrade the road network to meet the growing traffic requirement in this part of the country by augmenting the road capacity for safe and efficient movement of the traffic.

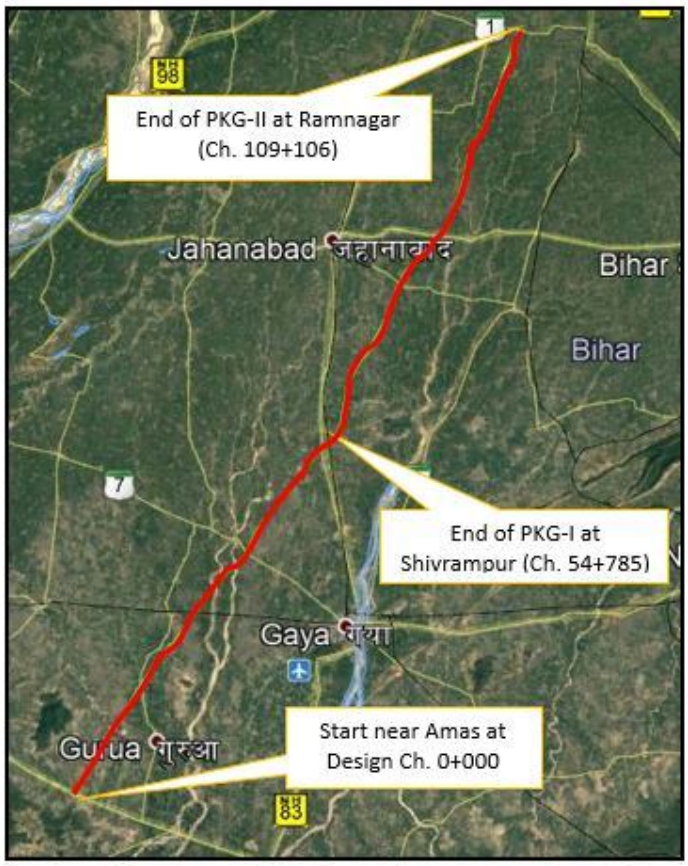
The National Highways Authority of India (NHAI) has been entrusted with the work of Preparation of DPR for development of Economic Corridors, Inter Corridors and Feeder Routes to improve the efficiency of freight movement in India under Bharatmala Pariyojana (Lot-5/Package-7) from **Shivrampur** t**o Ramnagar** of Aurangabad to Anishabad Section.

SA Infrastructure Consultant Pvt. Ltd. 1101 A, 11th floor, Tower A-2, Corporate Park, Plot No.7A/1,Sector -142,Noida ,(U.P) has been appointed as consultant to carry out Preparation of DPR for development of Economic Corridors, Inter Corridors and Feeder Routes to improve the efficiency of freight movement in India under Bharatmala Pariyojana (Lot-5/Package-7) from **Shivrampur to Ramnagar (Design Ch. 55+002 Km to Design Ch. 109+300 Km)** of Aurangabad to Anishabad Section.

Project stretch falls in the state of Bihar. It is an entirely land–locked state, in a subtropical region of the temperate zone. Bihar lies between the humid West Bengal in the east and the sub humid Uttar Pradesh in the west, which provides it with a transitional position in respect of climate, economy and culture. It is bounded by Nepal in the north and by Jharkhand in the south. Bihar plain is divided into two unequal halves (North Bihar and South Bihar) by the river Ganges which flows through the middle from west to east. The project stretch is located in southern Bihar. The total area of Bihar is 94163 sq. km. It mostly contains plain terrain. Forest area is approximately of 6.87%. The State has 26 nos. of National Highways with aggregate length 3526 kms.

The Project road starts at Design Ch. 55+002 Km at Shivrampur from Gaya-Jahanabad district boundary to connect Ramnagar at Design Ch. 109+300 Km. The total length is 54.322 Km which shall be constructed as per 4 lane configuration. This is a proposed Green field alignment which will connect from Amas to Ramnagar as a freight movement Economic corridor. The key map for the alignment is show below in **Fig.2.1**

FIGURE 2.1: PROJECT KEY PLAN



2.2 OVERVIEW OF NHAI'S ORGANIZATION AND PROGRAMME.

The National Highways Authority of India (NHAI) was created through the promulgation National Highway Authority Act, of Parliament in 1988 under the administrative control of the Ministry of Road Transport and Highways. NHAI has been set up as a Central Authority to develop, maintain and manage the National Highways entrusted to it by the Government of India. The Authority, however, became operational in February, 1995.

The Authority consists of a full time Chairman, and not more than five full time Members and four part time Members who are appointed by the Central Government. The part time Members are the Secretary (RT&H), Secretary (Expenditure), Secretary (Planning) and DG (RD) & SS. NHAI has Technical, Finance, Administrative and Vigilance Wings at its Headquarters. Project Implementation Units (PIUs) headed by a Project Director and supported by various technical and accounts officers have been set

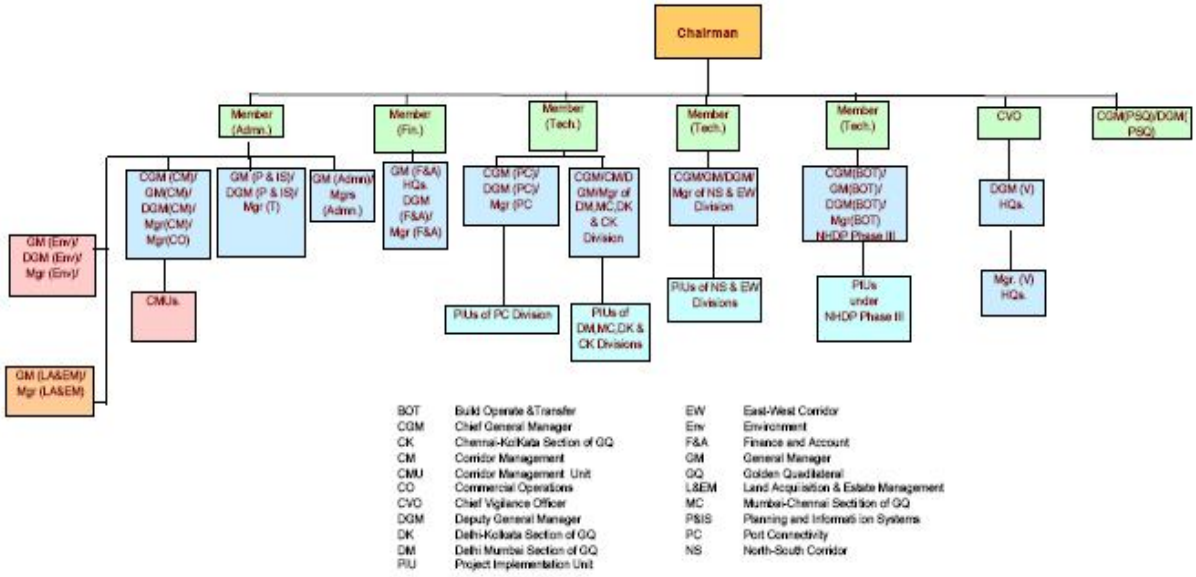
up at various sites to oversee timely completion of the projects. The indicative organization chart of NHAI is shown in **Figure 2.2.**

2.3 NHAI MANDATE

The National Highways have a total length of 66,590 km to serve as the arterial network of the country. The development of National Highways is the responsibility of the Government of India. The Government of India has launched major initiatives to upgrade and strengthen National Highways through various phases of National Highways Development project (NHDP). National Highway Development Program is envisaged to plan, design and construct a network of world class highways to support the economic growth of the country. Infrastructure in India has been found to be a bottleneck to speedier in economic development and the promotion of trade and business. Advantages of providing well developed network of highways are as below:

- Savings in vehicle operating costs by reduced fuel consumption and maintenance costs
- Travel time saving by faster and comfortable journeys
- Safer travel
- Benefits to trade especially in movement of perishable goods
- Reduce the demographic shift to urban areas
- Poverty alleviation and all round development of area

Figure 2.2: Indicative Organization Chart of NHAI



2.4 NATIONAL HIGHWAY DEVELOPMENT PROJECT

The task of its implementation under National Highway Development Project (NHDP) comprising of the Golden Quadrilateral and North-South & East-West Corridors was entrusted to the National Highway Authority of India (NHAI). NHDP has the following special features:

- ❖ India's largest ever highway project;
- ❖ International standard road with uninterrupted traffic flow;
- ❖ Major initiative for capacity enhancement of national highways ;
- ❖ Four / Six laning of around 13,146 Km; and
- ❖ Total cost Rs. 58,000 crores

NHDP's focus is on developing International standard roads with facilities for uninterrupted flow of traffic with:

- Enhanced safety features
- Better Riding Surface.
- Better Road Geometrics
- Better Traffic Management with improved Signage's
- Divided carriageways and Service roads
- Grade separators

- Over bridges and Underpasses
- Bypasses
- Wayside amenities

National Highways Development Project is being implemented in 7(seven) phases. The brief details are as under:

NHDP Phase I : NHDP Phase I was approved by Cabinet Committee on Economic Affairs (CCEA) in December 2000 at an estimated cost of Rs.30,000 crores comprising of GQ (5,846 km) and NS-EW Corridor (981km), port connectivity (356 km) and others (315 km).

NHDP Phase II: NHDP Phase II was approved by CCEA in December 2003 at an estimated cost of Rs.34,339 crores (2002 prices). It comprises of mostly NS-EW Corridor (6,161 km) and other National Highways of 486 km length. The total length of Phase II is 6,647 km.

NHDP Phase-III: Government approved on 5.3.2005 upgradation and 4 laning of 4,035 km of National Highways on BOT basis at an estimated cost of Rs. 22,207 crores (2004 prices). Subsequently government approved in April 2007 upgradation and 4 laning at 8074 km at an estimated cost of Rs. 54,339 crores.

NHDP Phase – IV: Two lane with paved shoulders being implemented by Ministry of Road Transport & Highways, jointly with State Public Works Department and NHAI.

NHDP Phase V: Under this Government has approved six laning of 6500 km of National Highways at a cost of Rs. 41,210 crore through PPP route on BOT (Toll) mode using Design Build Finance and Operate (DBFO) pattern with a maximum VGF of 10%. In DBFO private parties needs the upfront cost of design, construction and expenditure on annual maintenance and recovers the entire cost along with the interest from toll collection during the concession period. CCEA has approved on 5.10.2006 six laning of 6,500 km of existing 4 lane highways under NHDP Phase V (on DBFO basis). Six laning of 6,500 km includes 5,700 km of GQ and other stretches.

NHDP Phase VI: Under this Government on November 2006 has approved construction of 1000 km of expressways at an estimated cost of Rs. 16,680 crore through PPP route on BOT (Toll) mode following a DBFO pattern with a maximum VGF of 40%. Action is being taken for preparation of feasibility report. NHDP-VI is scheduled for completion by Dec. 2015.

NHDP Phase VII: Under this Government has approved construction of 700 km of stand alone ring roads/bypasses as well as grade separators, flyovers, elevated road, tunnels road over bridge, under passes etc at an estimated cost of Rs. 16,680 crore through PPP route on BOT (Toll) mode with a maximum VGF of 40% Action is being taken for preparation of feasibility study. NHDP-VII is scheduled for completion by Dec. 2014.

The main component of NHDP include following:

- Golden Quadrilateral (GQ) – Length 5846 Km
- North- South and East – West Corridor – Length 7300 Km

The over network of NHDP is shown in **Figure 2.3.**

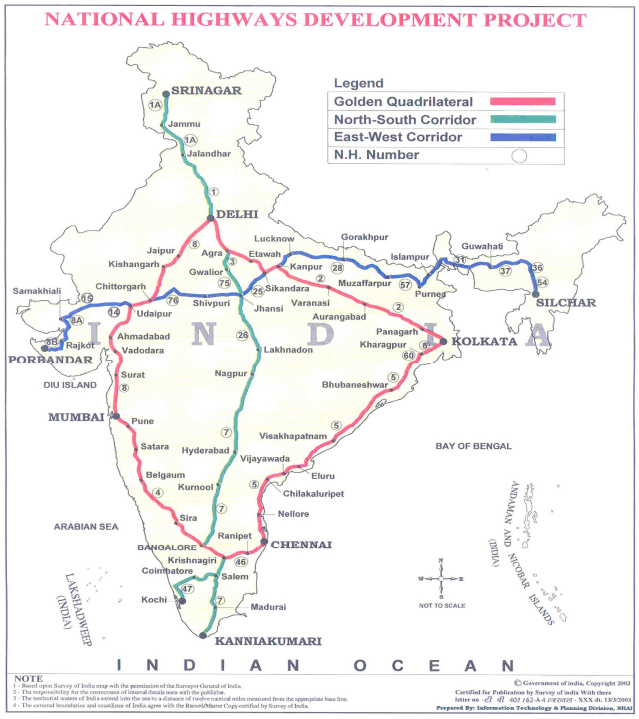


Figure 2.3: NHDP Road Network

2.5 NHAI MANDATE

Primary mandate of NHAI is to build world class highways with major initiatives for capacity enhancement of National Highways. To implement prestigious National Highway Projects in a timely and cost bound manner. Implementation of National Highways Development Project (NHDP) through host of funding options like PPP, EPC mode including external borrowings from multilateral agencies like World Bank, Asian Development Bank, JBIC etc. At present NHDP has 7 phases dealing with different aspects of National Highway Development as described before. NHDP IV deals with 2-lane with paved shoulders and is being implemented jointly by Ministry with PWD/ NHAI. The works in the remaining phases are being handled by NHAI directly. The figures below indicate the current status of these phases: -

Table 2.1: NHDP Program / Other Projects of NHAI Updated on 31st Dec-2012

DESCRIPTION	NHDP							Port Connectivity	SARDP -NE	NH-34	Others	Total by NHAI
	GQ	NS - EW Ph. I & II	NHDP Phase III	NHDP Phase IV	NHDP Phase V	NHDP Phase VII	NHDP Total					
Total Length (Km)	5,846	7,142	12,109	14,799	6,500	700	47,096	380	388	5.5	1390	49,260
Already 4/6Laned (Km)	5,846	6,053	4,602	62	1,276	19	17,858	368	49	-	964	19,239
Under Implementation (Km.)	0	722	5,734	3,928	2,804	22	13,210	12	63	5	406	13,696
Contracts Under Implementation (No.)	8	59	90	28	28	2	215	3	2	1	4	225
Balance length for award (Km)	-	367	1,773	10,809	2,420	659	16,028	0	276	-	20	16,324

Apart from developing national highways as per the 7 phases of NHDP as indicated above, NHAI has taken significant initiatives in areas of innovative financing, Operation & Maintenance activities as indicated below:

- Involving the private sector in financing the construction, maintenance and operation of National Highways and wayside amenities
- Improvement, maintenance and augmentation of the existing National Highways network.
- Implementation of road safety measures and environmental management.
- Introducing Information Technology in Construction, maintenance and all operation of NHAI.

2.6 FINANCING MECHANISM

NHAI proposes to finance its projects by a host of financing mechanisms. Some of them are as follows:

2.6.1 Enhanced Budgetary Allocation

This has become possible due to a historic decision by the Government of India to enhance the existing cess on both petrol and diesel along with a mechanism to distribute among different stake holding departments. This has enhanced the CRF fund. At the time of introduction of this bill the total amount accrued was about Rupees 2,000 crore per annum (at 1999 price). The Government has subsequently further enhanced the cess. The lion share of the CRF proceeds has been allocated for the construction of National Highways. As on today, the CRF contribution to NHAI is about 5 to 6 thousand crore per annum. This has given a big boost to the construction of National Highway projects by NHAI, by leveraging the budgetary allocations to meet the subsidy / grant to PPP Proposals.

2.6.2 Loan Assistance From International Funding Agencies

Loan assistance is available from multilateral development agencies like Asian Development Bank and World Bank and other overseas lending agencies like Japanese Bank of International Co – Operation.

2.6.3 Private Sector Participation

Major policy initiatives have been taken by the Government to attract domestic as well as foreign private investments. To promote involvement of the private sector in construction and maintenance of National Highways, Projects are offered on Build Operate and Transfer (BOT) basis to private agencies on concession basis. After the concession period, which normally ranges between 20 to 30 years, the concerned

project is transferred back to NHAI by the Concessionaires. NHAI funds are also leveraged by the setting up of Special Purpose Vehicles (SPVs). The SPVs borrow funds and repay these through toll revenues in the future. Some more models have emerged for better leveraging of funds available with NHAI such as Annuity, which is a variant of BOT model.

2.6.4 Market Borrowings

NHAI proposes to raise money from the domestic and foreign market by appropriately securitizing the cess money.

2.6.5 Special Purpose Vehicle

NHAI funds are also leveraged by the setting up of Special Purpose Vehicles (SPVs). The SPVs will be borrowing funds and repaying these through toll revenues in the future. This model will also be tried in some other projects. Some more models may emerge in the near future for better leveraging of funds available with NHAI such as Annuity.

2.7 GOVERNMENT POLICY INITIATIVE

- Government will carry out all preparatory work including land acquisition and utility shifting etc. Right of way (ROW) to be made available to concessionaires free from all encumbrances.
- NHAI / GOI to provide capital grant up to 40% of project cost by way of viability Gap Funding(VGF) to enhance viability on a case to case basis
- 100% tax exemption for 5 years and 30% relief for next 5 years, which may be availed of in 20 years.
- Concession period allowed up to 30 years
- Arbitration and Conciliation Act 1996 for domestic operators and UNICITRAL provisions for international operators.
- In BOT projects entrepreneur are allowed to collect and retain tolls
- Duty free import of specified modern high capacity equipment for highway construction.

2.8 COST RECOVERY MECHANISM

2.8.1 Toll Revenue

The National Highways Act empowers NHAI to charge users' fees on the sections of National
Highways, bridges on it. NHAI is charging users' fees on completed four/six lane sections of
National Highways. Part of this fund is being used for maintenance purpose. The surplus amount of user' fees are also a part of financing of NHDP and other projects.

2.8.2 Negative Grant

NHAI has received negative grant in few projects where the intensity of toll able traffic is very high. This amount is also a part of financing of these projects.

2.9 OBJECTIVE CONSULTING SERVICES

The main objectives of the consultancy services are:

- to establish the technical, economical, and financial viability of the project and prepare detailed project reports for rehabilitation and upgrading of the existing road to 2-lane with paved shoulders configuration with **provision of capacity augmentation**
- The viability of the project shall be established taking into account the requirements with regard to rehabilitation, upgrading and improvement based on highway design, pavement design, provision of service roads wherever necessary, type of intersections, rehabilitation and widening of existing and/or construction of new bridges and structures, road safety features, quantities of various items of works and cost estimates and economic analysis.
- The Detailed Project Report would inter-alia include detailed highway design, design of pavement and overlay with options for flexible or rigid pavements, design of bridges and cross drainage structures and grade separated structures, design of service roads, quantities of various items, detailed working drawings, detailed cost estimates, economic and financial viability analyses, environmental and social feasibility, social and environmental action plans as appropriate and documents required for tendering the project on commercial basis for international / local competitive bidding.
- The DPR consultant should ensure detailed project preparation incorporating aspects of value engineering, quality audit and safety audit requirement in design and implementation.
- The DPR should clearly bring out through financial analysis the mode [BOT / Government of India funding) on which the Civil Works for the stretches are to be taken up.

2.10 SCOPE OF CONSULTANCY SERVICES

The scope of consultancy services as per TOR is given below;

i. As far as possible, the widening/improvement work to 2 lane/4 lane with paved shoulder shall be within the existing right of way avoiding land acquisition, except for locations having inadequate width and where provisions of short bypasses, service roads, alignment corrections, improvement of intersections are considered necessary and practicable and cost effective. However bypasses proposals should also be considered, wherever in urban areas, improvement to 2 lane of the existing road is not possible. The Consultant shall furnish land acquisition details (i.e. all necessary schedules as per L.A. act) as per revenue records/maps.

ii. The Consultant shall study the possible locations and design of toll plaza. Wayside amenities required on tolled highway shall also be planned. The local and slow traffic may need segregation from the main traffic and provision of service roads and fencing may be considered, wherever necessary to improve efficiency and safety.

iii. The general scope of services is given in the sections that follow. However, the entire scope of services would, inter-alia, include the items mentioned in the Letter of Invitation and TOR. The Consultant will also make suitable proposals for widening/improvement of the existing road to 2 lane/2 lane with paved shoulder etc. and strengthening of the carriageways, as required at the appropriate time to maintain the level of service over the design period.

iv. All ready to implement 'good for construction' drawings shall be prepared.

v. Environmental Impact Assessment, Environmental Management Plan and Rehabilitation and Resettlement Studies shall be carried out by the Consultant meeting the requirements of the lending agencies like ADB/ World Bank/ JBIC etc

vi. Wherever required, consultant will liaise with concerned authorities and arrange all clarifications. Approval of all drawings including GAD and detail engineering drawings will be got done by the consultant from the Railways. However, if Railways require proof checking of the drawings prepared by the consultants, the same will be got done by NHAI and payment to the proof consultant shall be made by NHAI directly. Consultant will also obtain 'NO Objection Certificate' from Ministry of Environment and Forest and also incorporate the estimates for shifting of utilities of all types involved from concerned local authorities in the DPR. Consultant is also required to prepare all Land Acquisition papers (i.e. all

necessary schedules as per L.A. act) for acquisition of land either under NH Act or State Act.

vii. The DPR Consultant shall also assist the Authority on pre bid meetings and bidding process on Technical issues including preparation of answers to the bidders queries, preparation of pre-bid minutes & preparation of response to the concessionaire's/contractors queries after award of the work.

viii. Consultant shall obtain all types of necessary clearances required for implementation of the project on the ground from the concerned agencies. The client shall provide the necessary supporting letters and any official fees as per the demand note issued by such concerned agencies from whom the clearances are being sought to enable implementation. In case consultant does not obtain all the necessary clearances upto the completion of the assignment, deduction upto 5% amount will be made from the final payment. The amount thus deducted will be released after all necessary clearances have been obtained.

ix. Consultant shall examine suitability of all new materials / technologies accredited by IRC, approved/ accredited in the country of origin and those based on best global practices in the industry and their suitability with respect to Indian conditions, their initial cost and life cycle cost as well as lane closure time.

The Scope of consultancy services as set out in the TOR includes but not limited to the following major tasks:

i. Review of all available reports and published information about the project road and the project influence area;

ii. Environmental and social impact assessment, including such as related to cultural properties, natural habitats, involuntary resettlement etc.

(a). Public consultation, including consultation with Communities located along the road, NGOs working in the area, other stake-holders and relevant Govt. departments at all the different stages of assignment (such as inception stage, feasibility stage, and once final designs are concretized).

iii. Detailed reconnaissance;

iv. Identification of possible improvements in the existing alignment and bypassing congested locations with alternatives, evaluation of different alternatives comparison on techno-economic and other considerations and recommendations regarding most appropriate option;

v. Traffic studies including traffic surveys and Axle load survey and demand forecasting for next thirty years;

vi. Inventory and condition surveys for road;

vii. Inventory and condition surveys for bridges, cross-drainage structures and drainage provisions;

viii. Detailed topographic surveys using Total Stations and GPS;

ix. Pavement investigations;

x. Sub-grade characteristics and strength: investigation of required sub-grade and subsoil characteristics and strength for road and embankment design and sub- soil investigation;

xi. Identification of sources of construction materials;

xii. detailed design of road, its x-sections, horizontal and vertical alignment and design of embankment of height more than 6m and also in poor soil conditions and where density consideration require, even lesser height embankment.

xiii. Detailed design of structures preparation of GAD and construction drawings and cross-drainage structures and underpasses etc.

xiv. Identification of the type and the design of intersections;

xv. Design of complete drainage system and disposal point for storm water

xvi. Value analysis / value engineering and project costing;

xvii. Economic and financial analyses;

xviii. Contract packaging and implementation schedule.

xix. Strip plan indicating the scheme for carriageway widening, location of all existing utility services (both over- and underground) and the scheme for their relocation, trees to be felled and planted and land acquisition requirements including schedule for LA: reports documents and drawings arrangement of estimates for cutting of trees and shifting of utilities from the concerned department;

xx. To find out financial viability of project for implementation under BOT and suggest the mode on which the project is to be taken up i.e. either on BOT or under funding from Government of India.

xxi. Preparation of detailed project report, cost estimate, approved for construction drawings, rate analysis, detailed bill of quantities, bid documents for execution of civil works through budgeting resources.

xxii Design of toll plaza and identification of their numbers and location and office cum residential complex including working drawings

xxiii. Design of weighing stations, parking areas and rest areas.

xxiv. Any other user oriented facility en-route toll facility.

xxv. Tie-in of on-going/sanctioned works of MORT&H/ NHAI/ other agencies.

xxvi. Preparation of social plans for the project affected people as per policy of the World; Bank / Govt. of India R & R Policy.

2.11 STAGE OF SUBMISSION

As per TOR Project Preparation Activity are split in to three stages as brought out below:

Stage 1: Inception report and QAP

Stage 2: Feasibility Report

Stage 3: Detailed Project Report (DPR)

2.12 STRUCTURE OF THE REPORT

Volume I Main Report

Volume-1: Main Report is being submitted hereby with the following Chapters:-

Chapter 1	Executive Summary
Chapter 2	Overview of NHAI
Chapter 3	Project Description and Improvement Proposal
Chapter 4	Methodology Adopted
Chapter 5	Socio-Economic Profile

Chapter 6	Indicative Design Standards
Chapter 7	Traffic Survey and Analysis
Chapter 8	Environmental Screening Assessment Report
Chapter 9	Social Assessment and Land Acquisition Plan
Chapter 10	Cost Estimate
Chapter 11	Economic and Financial Analysis
Chapter 12	Conclusion and Recommendation

2.13 COMPLIANCE WITH TOR:

Table 2.2

Sl. No.	Description	Compliance with TOR
	Draft Feasibility Report	**10.4**
1	Executive Summary	10.4.I
2	Overview of NHAI organization and activities.	10.4.II
3	Project Description and Improvement Proposal	10.4.III
4	Methodology Adopted	10.4.IV
5	Socio-Economic Profile	10.4.V
6	Indicative Design Standards	10.4.VI
7	Traffic Survey and Analysis	10.4.VII
8	Environmental Screening and Assessment Report	10.4.VIII
9	Initial Social Assessment and Land Acquisition Plan	10.4.IX
10	Cost Estimate	10.4.X
11	Conclusion and Recommendation	10.4.XII

CHAPTER 3

PROJECT DESCRIPTION

3.1. Introduction

The **NATIONAL HIGHWAYS AUTHORITY OF INDIA (NHAI)** has been entrusted preparation of Detailed Project Report of selected stretches/corridors of National Highways for Four laning with paved shoulder configuration.

In pursuance of the above, SA Infrastructure Consultants Pvt. Ltd have been appointed as Consultants to carry out the Consultancy services for Preparation of DPR for development of Economic Corridors, Inter Corridors and Feeder Routes to improve the efficiency of freight movement in India under Bharatmala Pariyojana (Lot-5/Package-7) from Shivrampur to Ramnagar (Design Ch. 55+002 Km to Design Ch. 109+300 Km) of Aurangabad to Anishabad Section in the State of Bihar.

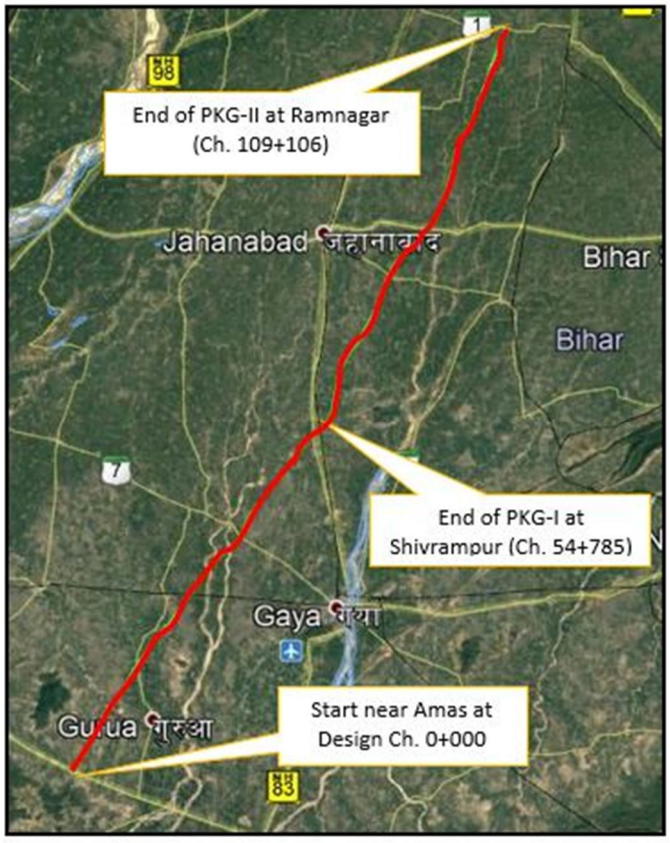


Fig. 3.1 - Key Plan.

3.2. The Consultants

The Consultancy Services for Preparation of DPR for development of Economic Corridors, Inter Corridors and Feeder Routes to improve the efficiency of freight movement in India under Bharatmala Pariyojana (Lot-5/Package-7) from Shivrampur to Ramnagar (Design Ch. 55+002 Km to Design Ch. 109+300 Km) of Aurangabad to Anishabad Section in the State of Bihar has been entrusted to SA Infrastructure Consultants Pvt. Ltd, The corporate office of the Consultants is located at the following address:

Head Office

SA INFRASTRUCTURE CONSULTANTS PRIVATE LIMITED
1101A,11th Floor, Tower A-II
Corporate Park, Plot No. 7A/1
Sector 142, Noida-201301
Uttar Pradesh
India
Phone: 0120 – 6148000

3.3. Objectives of Consultancy

The main objectives of the Consultancy services are:

3.3.1 To establish the technical, economical, and financial viability of the project and prepare detailed project reports for rehabilitation/upgrading/construction of the existing/missing road to 2/4 lane NH configuration.

3.3.2 The viability of the project shall be established taking into account the requirements with regard to rehabilitation, upgrading and improvement based on highway design, pavement design, provision of service roads wherever necessary, type of intersections, rehabilitation and widening of existing and/or construction of new bridges and structures, road safety features, quantities of various items of works and cost estimates and economic analysis.

3.3.3 The Final Feasibility Report would inter-alia include detailed highway design, design of pavement and overlay with options for flexible or rigid pavements, design of bridges and cross drainage structures and grade separated structures, design of service roads, quantities of various items, detailed working drawings, detailed cost estimates, economic and financial viability analyses, environmental and social feasibility, social

and environmental action plans as appropriate and documents required for tendering the project on commercial basis for international / local competitive bidding.

3.3.4 The consultant should ensure detailed project preparation incorporating aspects of value engineering, quality audit and safety audit requirement in design and implementation.

3.3.5 The consultant should, along with Feasibility Report, clearly bring out through financial analysis the preferred mode of implementation on which the Civil Works for the stretches are to be taken up. The consultant should also give cost estimates and tender documents along with feasibility report/ Detailed Project Report.

3.4. Scope of Services

The scope of service covers the following main activities:

3.4.1 As far as possible, the proposal work to 4 laning shall be within the proposed Right Of Way, except for locations having any other way side amenities or Project Facilities. The Consultant shall furnish land acquisition details as per revenue records/maps for further processing of land acquisition. Consultant shall also submit 3a, 3A and 3D draft notification for acquisition of land.

3.4.2 The Consultant shall study the possible locations and design of toll plaza. Wayside amenities required on tolled highway shall also be planned. The local and slow traffic may need segregation from the main traffic and provision of service roads and fencing.

3.4.3 All ready to implement 'good for construction' drawings shall be prepared.

3.4.4 Environmental Impact Assessment, Environmental Management Plan and Rehabilitation, and Resettlement Studies shall be carried out by the Consultant meeting the requirements of the lending agencies like ADB/ World Bank/JICA, etc.

3.4.5 Consultant shall obtain all types of necessary clearances required for implementation of the project on the ground from the concerned agencies. The client shall provide the necessary supporting letters and any official fees as per the demand note issued by such concerned agencies from whom the clearances are being sought to enable implementation.

3.4.6 The consultant shall prepare the bid documents including required schedules (as mentioned above) as per EPC/ PPP documents. For that it is suggested that consultant should also go through the EPC documents of ministry before bidding the project. The Consultant shall assist the NHAI and its Financial Consultant and the Legal Adviser by furnishing clarifications as required for the financial appraisal and legal scrutiny of the Project Highway and Bid Documents.

3.5 Project Stages

The Project has to be completed in stages as described herein below:

Stage-1: Quality Assurance Plan and Inception Report

Stage-2: Alignment options Report and Feasibility Report.

Stage-3: Strip Plan and Clearances, Land Acquisition Report, Utility Relocation Plan, Clearances Report.

Stage-4: Draft Detailed Project Report and Detailed Project Report.

3.6 The Final Feasibility Report (Stage 2)

The Final Feasibility Report consists of the listed volumes as described herein below:

Volume I : Main Report
Volume II : Design Report
(Highway, Pavement, Traffic, Bridges & Culverts)
Volume III : Materials Report
Volume IV : Environmental Assessment Report including Environmental Management plan (EMP) and Resettlement Action Plan (RAP)
Volume V : Technical Specifications
Volume VI : Rate Analysis
Volume VII : Cost Estimates
Volume VIII : Bill of Quantities
Volume IX : Drawing Volume

The Final Feasibility Report consists of the following chapters.

Chapter No	Name
1	Executive Summary
2	Overview of NHAI
3	Project Description
4	Methodology
5	Socio Economic Profile
6	Design Standards
7	Traffic Survey and Analysis
8	Environmental Screening
9	Resettlement action plan
10	Cost estimate
11	Economic and Financial Analysis
12	Conclusion and Recommendations

3.7.GENERAL

The Government of India has decided to take up the development of various road stretches/Corridors in the central part of the country to upgrade the road network to meet the growing traffic requirement in this part of the country by augmenting the road capacity for safe and efficient movement of the traffic.

National Highways Authority of India (NHAI) has been entrusted with the assignment of Project Management Consultancy including Preparation of Feasibility Study/ Detailed Project Report of selected road stretches for NH Connectivity to Backward Areas / Religious / Tourist Places (BRT) Scheme. NHAI now invites proposal from Technical consultants for carrying out Detailed Project Report and render consultancy services for proper structuring and implementation of projects on EPC/PPP mode

In pursuance of the above, SA Infrastructure Consultants Pvt. Ltd has been appointed as Consultants to carry out the Consultancy services for Preparation of DPR for development of Economic Corridors, Inter Corridors and Feeder Routes to improve the efficiency of freight movement in India under Bharatmala Pariyojana (Lot-5/Package-7) from Shivrampur to Ramnagar (Design Ch. 55+002 Km to Design Ch. 109+300 Km) of Aurangabad to Anishabad Section in the State of Bihar.

The Startting point of this project is near “Shivrampur” at Design Ch. 55+002 Km which is the District boundary of Gaya-Jahanabad. The coordinates of the starting point is **Latitude 25.008958° and Longitude 84.990754°.**

The ending point of this project is near “Ramnagar” at Design Ch. 109+300 Km which is the connecting the SH-78 road. The coordinates of the ending point is Latitude **25.446056° & Longitude 85.209556°.**

3.8. Existing Carriageway and Pavement

This is a completely new proposed Green Field Alignment where there is no existing road. This road is proposed to connect from Amas to Ramnagar which will be a part of Bharatmala Pariyojana to improve the efficiency of the Freight movement in India. The whole section is proposed to be of Flexible Pavement type confirming to IRC:37:2018. Rigid pavement shall be constructed in the section(s) for Toll Plaza only. The configuration of the carriageway shall confirm to IRC:SP:84-2014 and the Structures shall be constructed as 4 lane configurations.

3.9. Built up Areas and Settlements

As this is a green field alignment, there are many villages across the proposed road which are tried to retain by fixing the alignment in best method. The below listed settlements are given below in **Table 3.1.**

Table 3.1. Details of Settlements

S.No	Settlements	S.No	Settlements
1	Shiwrampur	17	Karhara
2	Berka	18	Gandhar
3	Damodarpur	19	Habalipur
4	Chandi	20	Charui
5	Chariyari	21	Dhobri
6	Mahewa	22	Deora
7	Kalanpur	23	Sadipur
8	Malathi	24	Jehanbad
9	Berthoo	25	Amarpura
10	Suppi	26	Manik Bigha
11	Kaji Sarai	27	Pabhera
12	Ibrahimpur	28	Tarwan
13	Golakpur	29	Abupur
14	Mohiuddinpur	30	Hulas Chak
15	Ahiasa	31	Andari
16	Mahammadpur	32	Ramnagar

3.10. ROW Details

The project stretch is completely new proposed Green Field Alignment which will Connect Ramnagar on SH-8 from Amas on NH-2. The ROW for this corridor is considered to 45m throughout except the locations of Project Facilities.

3.11. TCS Details

There are 6 nos. of TCS that have been used in this stretch. The details of the TCS schedule is provided in **Table 3.2** from Design Ch. 55+002 Km. to Design Ch. 109+300Km.

Table 3.2: TCS Schedule

S.No.	Design Chainage		Descriptions	TCS	Length (m)
	From	To			
1	55+002	55+670	Typical Cross Section For 4 lane new construction without service road for embankment height >3m	TCS-II	668
2	55+670	55+870	Typical Cross Section For 4 lane new construction without service road for embankment height <3m	TCS-I	200
3	55+870	56+440	Typical Cross Section For 4 lane new construction without service road for embankment height >3m	TCS-II	570
4	56+440	56+900	Typical Cross Section For 4 lane new construction without service road for embankment height <3m	TCS-I	460
5	56+900	57+588	Typical Cross Section For 4 lane new construction without service road for embankment height >3m	TCS-II	688
6	57+588	57+618	Minor Bridge	TCS-IV	30
7	57+618	57+840	Typical Cross Section For 4 lane new construction without service road for embankment height >3m	TCS-II	222
8	57+840	58+270	Typical Cross Section For VUP/LVUP/Fly Over Approach with Slip Road	TCS-III	430
9	58+270	58+290	VUP Structure Part	RCC GIRDER	20
10	58+290	58+720	Typical Cross Section For VUP/LVUP/Fly Over Approach with Slip Road	TCS-III	430
11	58+720	59+130	Typical Cross Section For 4 lane new construction without service road for embankment height <3m	TCS-I	410
12	59+130	59+905	Typical Cross Section For 4 lane new construction without service road for embankment height >3m	TCS-II	775
13	59+905	59+912	MNB	RCC BOX	7
14	59+912	60+490	Typical Cross Section For 4 lane new construction without service road for embankment height >3m	TCS-II	578

S.No.	Design Chainage		Descriptions	TCS	Length (m)
	From	To			
15	60+490	60+940	Typical Cross Section For 4 lane new construction without service road for embankment height <3m	TCS-I	450
16	60+940	61+540	Typical Cross Section For 4 lane new construction without service road for embankment height >3m	TCS-II	600
17	61+540	61+816	Typical Cross Section For 4 lane new construction without service road for embankment height <3m	TCS-I	276
18	61+816	61+836	Minor Bridge	TCS-IV	20
19	61+836	62+120	Typical Cross Section For 4 lane new construction without service road for embankment height <3m	TCS-I	284
20	62+120	62+558	Typical Cross Section For VUP/LVUP/Fly Over Approach with Slip Road	TCS-III	438
21	62+558	62+578	VUP Structure Part	RCC GIRDER	20
22	62+578	62+920	Typical Cross Section For VUP/LVUP/Fly Over Approach with Slip Road	TCS-III	342
23	62+920	63+057	Typical Cross Section For 4 lane new construction without service road for embankment height >3m	TCS-II	137
24	63+057	63+067	Minor Bridge	RCC BOX	10
25	63+067	63+890	Typical Cross Section For 4 lane new construction without service road for embankment height >3m	TCS-II	823
26	63+890	64+240	Typical Cross Section For 4 lane new construction without service road for embankment height <3m	TCS-I	350
27	64+240	64+911	Typical Cross Section For 4 lane new construction without service road for embankment height >3m	TCS-II	671
28	64+911	64+921	Minor Bridge	RCC BOX	10
29	64+921	65+060	Typical Cross Section For 4 lane new construction without service road for embankment height >3m	TCS-II	139

S.No.	Design Chainage		Descriptions	TCS	Length (m)
	From	To			
30	65+060	65+160	Typical Cross Section For 4 lane new construction without service road for embankment height <3m	TCS-I	100
31	65+160	65+637	Typical Cross Section For VUP/LVUP/Fly Over Approach with Slip Road	TCS-III	477
32	65+637	65+649	LVUP Strucutre Part	RCC BOX	12
33	65+649	66+040	Typical Cross Section For VUP/LVUP/Fly Over Approach with Slip Road	TCS-III	391
34	66+040	66+240	Typical Cross Section For 4 lane new construction without service road for embankment height <3m	TCS-I	200
35	66+240	66+380	Typical Cross Section For 4 lane new construction without service road for embankment height >3m	TCS-II	140
36	66+380	66+410	Minor Bridge	TCS-IV	30
37	66+410	66+876	Typical Cross Section For 4 lane new construction without service road for embankment height >3m	TCS-II	466
38	66+876	66+906	Minor Bridge	TCS-IV	30
39	66+906	67+290	Typical Cross Section For 4 lane new construction without service road for embankment height >3m	TCS-II	384
40	67+290	67+670	Typical Cross Section For 4 lane new construction without service road for embankment height <3m	TCS-I	380
41	67+670	67+953	Typical Cross Section For 4 lane new construction without service road for embankment height >3m	TCS-II	283
42	67+953	67+963	Minor Bridge	RCC BOX	10
43	67+963	68+150	Typical Cross Section For 4 lane new construction without service road for embankment height >3m	TCS-II	187
44	68+150	68+280	Typical Cross Section For 4 lane new construction without service road for embankment height <3m	TCS-I	130

S.No.	Design Chainage		Descriptions	TCS	Length (m)
	From	To			
45	68+280	68+642	Typical Cross Section For 4 lane new construction without service road for embankment height >3m	TCS-II	362
46	68+642	68+654	Minor Bridge	RCC BOX	12
47	68+654	69+880	Typical Cross Section For 4 lane new construction without service road for embankment height >3m	TCS-II	1226
48	69+880	70+378	Typical Cross Section For VUP/LVUP/Fly Over Approach with Slip Road	TCS-III	498
49	70+378	70+398	VUP Structure Part	RCC Girder	20
50	70+398	70+700	Typical Cross Section For VUP/LVUP/Fly Over Approach with Slip Road	TCS-III	302
51	70+700	70+770	Typical Cross Section For 4 lane new construction without service road for embankment height >3m	TCS-II	70
52	70+770	71+840	Typical Cross Section For 4 lane new construction without service road for embankment height >3m	TCS-II	1070
53	71+840	72+180	Typical Cross Section For 4 lane new construction without service road for embankment height >3m	TCS-II	340
54	72+180	72+470	Typical Cross Section For 4 lane new construction without service road for embankment height <3m	TCS-I	290
55	72+470	73+800	Typical Cross Section For 4 lane new construction without service road for embankment height >3m	TCS-II	1330
56	73+800	74+140	Typical Cross Section For 4 lane new construction without service road for embankment height <3m	TCS-I	340
57	74+140	74+302	Typical Cross Section For VUP/LVUP/Fly Over Approach with Slip Road	TCS-III	162
58	74+302	74+317	Minor Bridge	TCS-IV	15
59	74+317	74+668	Typical Cross Section For VUP/LVUP/Fly Over Approach with Slip Road	TCS-III	351

S.No.	Design Chainage		Descriptions	TCS	Length (m)
	From	To			
60	74+668	74+728	Fly-Over Structure Part	RCC+PSC GIRDER	60
61	74+728	75+260	Typical Cross Section For VUP/LVUP/Fly Over Approach with Slip Road	TCS-III	532
62	75+260	75+650	Typical Cross Section For 4 lane new construction without service road for embankment height <3m	TCS-I	390
63	75+650	76+193	Typical Cross Section For 4 lane new construction without service road for embankment height >3m	TCS-II	543
64	76+193	76+213	Minor Bridge	TCS-IV	20
65	76+213	76+516	Typical Cross Section For 4 lane new construction without service road for embankment height >3m	TCS-II	303
66	76+516	76+541	Minor Bridge	TCS-IV	25
67	76+541	77+130	Typical Cross Section For 4 lane new construction without service road for embankment height >3m	TCS-II	589
68	77+130	77+370	Typical Cross Section For 4 lane new construction without service road for embankment height <3m	TCS-I	240
69	77+370	77+756	Typical Cross Section For 4 lane new construction without service road for embankment height >3m	TCS-II	386
70	77+756	77+776	Minor Bridge	TCS-IV	20
71	77+776	78+100	Typical Cross Section For 4 lane new construction without service road for embankment height >3m	TCS-II	324
72	78+100	79+160	Typical Cross Section For 4 lane new construction without service road for embankment height <3m	TCS-I	1060
73	79+160	80+483	Typical Cross Section For 4 lane new construction without service road for embankment height >3m	TCS-II	1323
74	80+483	80+498	Minor Bridge	TCS-IV	15
75	80+498	81+880	Typical Cross Section For 4 lane new construction without service road for embankment height >3m	TCS-II	1382

S.No.	Design Chainage		Descriptions	TCS	Length (m)
	From	To			
76	81+880	81+978	Typical Cross Section For VUP/LVUP/Fly Over Approach with Slip Road	TCS-III	98
77	81+978	82+028	Minor Bridge	TCS-IV	50
78	82+028	82+274	Typical Cross Section For VUP/LVUP/Fly Over Approach with Slip Road	TCS-III	246
79	82+274	82+389	Fly-Over Structure Part	RCC+PSC GIRDER	115
80	82+389	83+020	Typical Cross Section For VUP/LVUP/Fly Over Approach with Slip Road	TCS-III	631
81	83+020	83+450	Typical Cross Section For 4 lane new construction without service road for embankment height <3m	TCS-I	430
82	83+450	84+200	Typical Cross Section For 4 lane new construction without service road for embankment height >3m	TCS-II	750
83	84+200	84+730	Typical Cross Section For 4 lane new construction without service road for embankment height <3m	TCS-I	530
84	84+730	85+313	Typical Cross Section For 4 lane new construction without service road for embankment height >3m	TCS-II	583
85	85+313	85+333	Minor Bridge	TCS-IV	20
86	85+333	85+396	Typical Cross Section For 4 lane new construction without service road for embankment height >3m	TCS-II	63
87	85+396	85+411	Minor Bridge	TCS-IV	15
88	85+411	85+880	Typical Cross Section For 4 lane new construction without service road for embankment height >3m	TCS-II	469
89	85+880	86+447	Typical Cross Section For VUP/LVUP/Fly Over Approach with Slip Road	TCS-III	567
90	86+447	86+459	LVUP Strucutre Part	RCC BOX	12
91	86+459	86+820	Typical Cross Section For VUP/LVUP/Fly Over Approach with Slip Road	TCS-III	361

S.No.	Design Chainage		Descriptions	TCS	Length (m)
	From	To			
92	86+820	86+906	Typical Cross Section For 4 lane new construction without service road for embankment height <3m	TCS-I	86
93	86+906	86+914	Minor Bridge	RCC BOX	8
94	86+914	87+355	Typical Cross Section For 4 lane new construction without service road for embankment height >3m	TCS-II	441
95	87+355	87+520	Major Bridge	TCS-IV	165
96	87+520	87+680	Typical Cross Section For 4 lane new construction without service road for embankment height >3m	TCS-II	160
97	87+680	87+710	VUP Structure Part	PSC Girder	30
98	87+710	88+180	Typical Cross Section For VUP/LVUP/Fly Over Approach with Slip Road	TCS-III	470
99	88+180	88+500	Typical Cross Section For 4 lane new construction without service road for embankment height <3m	TCS-I	320
100	88+500	90+049	Typical Cross Section For 4 lane new construction without service road for embankment height >3m	TCS-II	1549
101	90+049	90+074	Minor Bridge	TCS-IV	25
102	90+074	90+520	Typical Cross Section For 4 lane new construction without service road for embankment height >3m	TCS-II	446
103	90+520	91+410	Typical Cross Section For 4 lane new construction without service road for embankment height <3m	TCS-I	890
104	91+410	91+903	Typical Cross Section For 4 lane new construction without service road for embankment height >3m	TCS-II	493
105	91+903	91+923	Minor Bridge	TCS-IV	20
106	91+923	92+623	Typical Cross Section For 4 lane new construction without service road for embankment height >3m	TCS-II	700
107	92+623	92+653	Minor Bridge	TCS-IV	30
108	92+653	93+020	Typical Cross Section For 4 lane new construction without service road for embankment height >3m	TCS-II	367

S.No.	Design Chainage		Descriptions	TCS	Length (m)
	From	To			
109	93+020	93+686	Typical Cross Section For 4 lane new construction without service road for embankment height <3m	TCS-I	666
110	93+686	93+706	Minor Bridge	TCS-IV	20
111	93+706	93+815	Typical Cross Section For 4 lane new construction without service road for embankment height >3m	TCS-II	109
112	93+815	93+825	Minor Bridge	RCC BOX	10
113	93+825	94+331	Typical Cross Section For 4 lane new construction without service road for embankment height >3m	TCS-II	506
114	94+331	94+341	Minor Bridge	RCC BOX	10
115	94+341	94+872	Typical Cross Section For 4 lane new construction without service road for embankment height >3m	TCS-II	531
116	94+872	94+888	Minor Bridge	TCS-IV	16
117	94+888	95+733	Typical Cross Section For 4 lane new construction without service road for embankment height >3m	TCS-II	845
118	95+733	95+753	Minor Bridge	TCS-IV	20
119	95+753	96+033	Typical Cross Section For 4 lane new construction without service road for embankment height >3m	TCS-II	280
120	96+033	96+043	Minor Bridge	RCC BOX	10
121	96+043	96+255	Typical Cross Section For 4 lane new construction without service road for embankment height >3m	TCS-II	212
122	96+255	96+285	Minor Bridge	TCS-IV	30
123	96+285	96+510	Typical Cross Section For 4 lane new construction without service road for embankment height >3m	TCS-II	225
124	96+510	96+990	Typical Cross Section For 4 lane new construction without service road for embankment height <3m	TCS-I	480
125	96+990	97+119	Typical Cross Section For 4 lane new construction without service road for embankment height >3m	TCS-II	129
126	97+119	97+149	Minor Bridge	TCS-IV	30

S.No.	Design Chainage		Descriptions	TCS	Length (m)
	From	To			
127	97+149	97+460	Typical Cross Section For 4 lane new construction without service road for embankment height >3m	TCS-II	311
128	97+460	97+670	Typical Cross Section For 4 lane new construction without service road for embankment height <3m	TCS-I	210
129	97+670	97+913	Typical Cross Section For 4 lane new construction without service road for embankment height >3m	TCS-II	243
130	97+913	97+933	Minor Bridge	TCS-IV	20
131	97+933	98+574	Typical Cross Section For 4 lane new construction without service road for embankment height >3m	TCS-II	641
132	98+574	98+607	Minor Bridge	TCS-IV	33
133	98+607	99+060	Typical Cross Section For 4 lane new construction without service road for embankment height >3m	TCS-II	453
134	99+060	99+340	Typical Cross Section For 4 lane new construction without service road for embankment height <3m	TCS-I	280
135	99+340	99+506	Typical Cross Section For 4 lane new construction without service road for embankment height >3m	TCS-II	166
136	99+506	99+531	Minor Bridge	TCS-IV	25
137	99+531	99+820	Typical Cross Section For 4 lane new construction without service road for embankment height >3m	TCS-II	289
138	99+820	100+090	Typical Cross Section For 4 lane new construction without service road for embankment height <3m	TCS-I	270
139	100+090	100+348	Typical Cross Section For VUP/LVUP/Fly Over Approach with Slip Road	TCS-III	258
140	100+348	100+360	LVUP Strucutre Part	RCC BOX	12
141	100+360	100+860	Typical Cross Section For VUP/LVUP/Fly Over Approach with Slip Road	TCS-III	500

S.No.	Design Chainage		Descriptions	TCS	Length (m)
	From	To			
142	100+860	101+093	Typical Cross Section For 4 lane new construction without service road for embankment height >3m	TCS-II	233
143	101+093	101+123	Minor Bridge	TCS-IV	30
144	101+123	101+240	Typical Cross Section For 4 lane new construction without service road for embankment height >3m	TCS-II	117
145	101+240	101+836	Toll Plaza	Toll Plaza	596
146	101+836	101+851	Minor Bridge	TCS-IV	15
147	101+851	101+947	Toll Plaza	Toll Plaza	96
148	101+947	102+100	Typical Cross Section For 4 lane new construction without service road for embankment height <3m	TCS-I	153
149	102+100	102+256	Typical Cross Section For 4 lane new construction without service road for embankment height >3m	TCS-II	156
150	102+256	102+281	Minor Bridge	TCS-IV	25
151	102+281	103+098	Typical Cross Section For 4 lane new construction without service road for embankment height >3m	TCS-II	817
152	103+098	103+230	Major Bridge	TCS-IV	132
153	103+230	103+977	Typical Cross Section For 4 lane new construction without service road for embankment height >3m	TCS-II	747
154	103+977	104+047	Major Bridge	TCS-IV	70
155	104+047	104+688	Typical Cross Section For 4 lane new construction without service road for embankment height >3m	TCS-II	641
156	104+688	104+708	Minor Bridge	TCS-IV	20
157	104+708	105+048	Typical Cross Section For 4 lane new construction without service road for embankment height >3m	TCS-II	340
158	105+048	105+063	Minor Bridge	TCS-IV	15
159	105+063	105+130	Typical Cross Section For 4 lane new construction without service road for embankment height >3m	TCS-II	67
160	105+130	106+000	Typical Cross Section For 4 lane new construction without service road for embankment height <3m	TCS-I	870

S.No.	Design Chainage		Descriptions	TCS	Length (m)
	From	To			
161	106+000	106+188	Typical Cross Section For 4 lane new construction without service road for embankment height >3m	TCS-II	188
162	106+188	106+213	Minor Bridge	TCS-IV	25
163	106+213	106+580	Typical Cross Section For 4 lane new construction without service road for embankment height >3m	TCS-II	367
164	106+580	107+051	Typical Cross Section for ROB approach with slip Road	TCS-V	471
165	107+051	107+081	Minor Bridge	TCS-IV	30
166	107+081	107+182	Typical Cross Section for ROB approach with slip Road	TCS-V	101
167	107+182	107+254	ROB Structure Part	TCS-VI	72
168	107+254	107+560	Typical Cross Section for ROB approach with slip Road	TCS-V	306
169	107+560	107+570	Minor Bridge	RCC BOX	10
170	107+570	107+920	Typical Cross Section for ROB approach with slip Road	TCS-V	350
171	107+920	108+060	Typical Cross Section For 4 lane new construction without service road for embankment height <3m	TCS-I	140
172	108+060	108+097	Typical Cross Section For 4 lane new construction without service road for embankment height >3m	TCS-II	37
173	108+097	108+109	Minor Bridge	RCC BOX	12
174	108+109	108+410	Typical Cross Section For 4 lane new construction without service road for embankment height >3m	TCS-II	301
175	108+410	109+300	Typical Cross Section For 4 lane new construction without service road for embankment height <3m	TCS-I	890
			Total Length		**54298**

3.12. Structure Details

There are several structures along the project road. Various Structures have been proposed according to the settlements, hydrology data, and convenience of traffic movements. The summary of number of structures are given below and details are as follows-

Table- 3.3 Summary of Structures

S.NO	Structure Type	Proposed Nos.
1	Major Bridges	03
2	Minor Bridges	44
3	Minor Bridge Cum LVUP	NIL
4	Vehicular Under Pass	04
5	Light Vehicular Under Pass	03
6	Small Vehicular Under Pass	02
7	Fly-Over	02
8	Viaduct	NIL
9	ROB	01
10	Culverts	88
11	Others	NIL

3.12.1 Major Bridges

There are 3 numbers of Major Bridges in this section which are to be constructed over various rivers. The details of the Major Bridges are given below in **Table 3.4.**

Table 3.4: Details of Major Bridge.

S.No	Design Ch.	Structure Type	Proposed Span	Total Length(m)
1	87+437	PSC Girder	4x33	132
2	103+164	PSC Girder	4x33	132
3	104+012	PSC+RCC	25+20+25	70

3.12.2 Minor Bridges

There are 44 numbers of Minor Bridges in this section which are to be constructed over various canals and rivers. The details of the Major Bridges are given below in **Table 3.5**.

Table 3.5: Details of Minor Bridge.

S No	New Chainage	Structure	Size	Superstructure type
1	57+603	MNB	1X30	PSC Girder
2	59+908	MNB	1X7X3	RCC BOX
3	61+826	MNB	1X20	RCC Girder
4	63+062	MNB	1X10	RCC BOX
5	64+916	MNB	1X10	RCC BOX
6	66+395	MNB	1x30	PSC Girder

S No	New Chainage	Structure	Size	Superstructure type
7	66+891	MNB	1x30	PSC Girder
8	68+648	MNB	2x6	RCC BOX
9	69+105	MNB	1X25	PSC Girder
10	74+309	MNB	1X15	RCC Girder
11	76+203	MNB	1X20	RCC BOX
12	76+528	MNB	1x25	PSC Girder
13	77+766	MNB	1X20	RCC Girder
14	80+490	MNB	1X15	RCC Girder
15	82+003	MNB	30+20	PSC+RCC
16	82+300	MNB	1X12	RCC BOX
17	85+323	MNB	1X20	RCC Girder
18	85+403	MNB	1X15	RCC Girder
19	86+910	MNB	1X8	RCC BOX
20	90+061	MNB	1X25	PSC Girder
21	91+913	MNB	1X20	PSC Girder
22	92+638	MNB	1X30	PSC Girder
23	93+696	MNB	1X20	RCC Girder
24	93+820	MNB	2x8	RCC BOX
25	94+336	MNB	1X10	RCC BOX
26	94+880	MNB	2x8	RCC BOX
27	95+743	MNB	1X20	RCC Girder
28	96+038	MNB	1X10	RCC BOX
29	96+270	MNB	1X30	PSC Girder
30	97+134	MNB	1X30	PSC Girder
31	97+923	MNB	1X20	RCC Girder
32	98+590	MNB	1X33	PSC Girder
33	99+518	MNB	1X25	PSC Girder
34	101+110	MNB	1X30	PSC Girder
35	101+843	MNB	1X15	RCC Girder
36	102+268	MNB	1X25	PSC Girder
37	104+698	MNB	1X20	RCC Girder
38	105+055	MNB	1X15	RCC Girder
39	106+200	MNB	1X25	PSC Girder
40	107+066	MNB	1X30	PSC Girder
41	107+565	MNB	1X10	RCC BOX
42	108+103	MNB	1X12	RCC BOX

b. Table 1.6 Details of Minor Bridges on Service/slip road

S.No	Design Ch.	Structure Type	Proposed Span(m)	Total Length(m)
1	82+300	PSC Girder	1x12	12

S.No	Design Ch.	Structure Type	Proposed Span(m)	Total Length(m)
2	107+066	RCC Girder	1x12	12

3.12.3 Vehicular Under Pass

There are 04 Vehicular Under Pass proposed in this stretch to allow the users to connect across the road. The details of the VUP's are summarized below in **Table 3.7.**

Table 3.7: Details of VUP

S.No	Design Ch.	Structure Type	Proposed Span	Total Length(m)	Passes Over
1	58+280	RCC Girder	1X20X5.5	20	Barabar Road
2	62+568	RCC Girder	1x20x5.5	20	Makhdumpur Road
3	70+388	RCC Box	1x12x5.5	12	Hati More-Korna Road
4	87+695	PSC Girder	1X30X5.5	30	Telhara-Imaniya Road

3.12.4 Light Vehicular Under Pass

There are 03 numbers of LVUP proposed across the Village/ODR roads to facilitate the movement of the users. The details of the LVUP are summarised below in **Table 3.8**.

Table 3.8: Details of LVUP

S.No	Design Ch.	Structure Type	Proposed Span	Total Length(m)	Passes Over
1	65+643	RCC Box	1x12x4	12	Kurtha Road
2	86+453	RCC Box	1x12x4	12	Modanganj Road
3	100+354	RCC Box	1x12x4	12	Pabhera Road

3.12.5 Small Vehicular Under Pass

There are 02 SVUP's proposed in this section near the village roads to facilitate the movement of the road users. The details of the SVUP are summarized in **Table 3.9.**

Table 3.9: Details of SVUP

S.No	Design Ch.	Structure Type	Proposed Span	Total Length(m)	Passes Over
1	79+468	RCC Box	1x7	7	Ahiasa
2	81+426	RCC Box	1x7	7	Dhamapur

3.12.6 Fly-Over/Interchange

At the starting of the Project road, a Trumpet Interchange has been proposed followed with 2 Fly-Overs which are crossing the National/State Highways. The details of the Fly-Over and Interchange has been summarized in **Table 3.10**

Table 3.10- Details of Fly-Over/Interchange

S.No	Design Ch.	Structure Type	Proposed Span	Total Length(m)	Passes Over
1	74+480	PSC+RCC Girder	15+30+15	60	SH-71
2	82+113	PSC+RCC Girder	30+35+30+20	115	NH-110

3.12.7 Road Over Bridge

There are 01 numbers of R.O.B Proposed in this section. The details of the ROB has been summarized below in **Table 3.11.**

Table 3.11. Details of R.O.B

S.No	Design Ch.	Structure Type	Proposed Span	Total Length(m)	Passes Over
1	107+218	RCC+Composite Girder	18+36+18	72	

3.12.8 Viaduct

There is 0 number of Viaduct proposed in this section. The details of the Viaduct is summarised below in **Table 3.12.**

Table 3.12. Details of Viaduct

S.NO	Design Ch.		Proposed Span	Proposed Type	Structure Include
	From	To			
NIL					

3.12.9 Culverts

Box type culverts have been proposed in this alignment as cross drainage structures and at many places culverts are being proposed to serve a pathway to the village users in the dry seasons. There are 85 number of culverts proposed in this section. The details of the culverts are summarized below in **Table 3.13.**

Table 3.13- Details of Proposed Culverts

S.No	Design Ch.	Proposed Span

		(Unit x Span x Height)m
1	55+278	1X3X3
2	55+578	1X5X3
3	56+031	1X3X3
4	56+368	1X3X3
5	56+953	1X3X3
6	57+088	1X6X3
7	57+298	1X4X3
8	58+374	1X4X3
9	58+394	1X3X3
10	58+638	1X3X3
11	59+218	1X3X3
12	59+508	1X4X3
13	60+278	1X3X3
14	60+899	1X3X3
15	61+208	1X3X3
16	61+223	1X3X3
17	61+463	1X3X3
18	62+493	1X5X3
19	63+376	1X3X3
20	63+666	1X3X3
21	64+256	1X3X3
22	64+471	1x3x3
23	65+456	1X3X3
24	65+568	1X5X3
25	67+156	1X3X3
26	67+338	1X6X3
27	67+958	1x6x3
28	68+278	1X3X3
29	68+648	1x6x3
30	69+108	1X5X3
31	69+698	1x6x3
32	70+108	1X4X3
33	70+590	1X3X3
34	70+983	1X3X3
35	71+115	1x3x3
36	71+565	1X3X3

S.No	Design Ch.	Proposed Span (Unit x Span x Height)m
37	72+108	1X3X3
38	72+720	1x4x3
39	73+096	1X3X3
40	73+536	1X3X3
41	75+449	1X4X3
42	75+848	1X4X3
43	76+818	1X4X3
44	77+323	1X3X3
45	78+073	1X3X3
46	78+448	1x6x3
47	78+678	1x6x3
48	79+045	1X3X3
49	79+625	1X6x3
50	80+160	1x6x3
51	80+946	1X3X3
52	81+061	1X3X3
53	81+208	1X3X3
54	81+821	1X3X3
55	83+028	1X3X3
56	83+410	1X4X3
57	84+428	1X3X3
58	84+829	1X3X3
59	86+036	1X3X3
60	88+177	1X3X3
61	88+587	1X3X3
62	88+983	1X3X3
63	89+657	1X4X3
64	90+367	1X3X3
65	90+844	1X3X3
66	91+266	1X3X3
67	91+637	1x6x3
68	92+344	1X3X3
69	93+040	1X3X3
70	95+508	1X6X3
71	96+453	1x5x3

S.No	Design Ch.	Proposed Span (Unit x Span x Height)m
72	96+639	1X3X3
73	97+538	1X3X3
74	98+118	1X5X3
75	98+358	1X6X3
76	99+738	1X3X3
77	100+587	1X3X3
78	100+795	1X3X3
79	102+684	1X3X3
80	103+609	1X4X3
81	104+394	1X3X3
82	105+563	1X3X3
83	105+594	1X3X3
84	105+814	1X3X3
85	106+415	1X3X3
86	106+423	1X3X3
87	106+705	1X3X3
88	109+028	1X3X3

3.13. By-Passes

There are no By-Passes in this Section as this is a new proposed Green Field Alignment.

3.14. JUNCTIONS

There are 7 Major Junctions and 28 Minor Junctions in this project Stretch. The details of the Major Junctions are given in **Table 3.14** and details of Minor junctions are given in **Table 3.15**.

Table 3.14: List of Major Junctions

S.No	Design Ch.	Junction Type	Classification	Leading To	Pavement Type	Remarks
1	58+270	+	Major	Barabar	Flexible	---
2	62+570	X	Major	Makhdumpur	Flexible	---
3	70+390	X	Major	Hati	Flexible	---
4	74+700	+	Major	Jahanabad-Ghosi	Flexible	SH-71
5	82+400	X	Major	Jahanabad	Flexible	NH-110

S.No	Design Ch.	Junction Type	Classification	Leading To	Pavement Type	Remarks
6	87+690	X	Major	Telhara	Flexible	
7	109+300	T	Major	Ramnagar	Flexible	SH-78

Table 3.15: List of Minor Junctions

S.No	Design Ch.	Junction Type	Classification	Leading To	Pavement Type	Remarks
1	55+580	X	Minor	Berka	Earthen	Village Road
2	59+918	+	Minor	Chandai	Earthen	Village Road
3	65+640	X	Minor	Kurtha	Flexible	MDR
4	66+400	X	Minor	Jalalpur	Flexible	NH
5	66+900	X	Minor	Sumera	Flexible	Village Road
6	68+640	+	Minor	Chistipur Pakri	Flexible	Village Road
7	72+728	+	Minor	Lila Bigha	Earthen	Village Road
8	75+440	X	Minor	Ibrahimpur	Flexible	Village Road
9	76+200	X	Minor	Kaji Sarai	Flexible	MDR
10	77+768	X	Minor	Bishunpur	Cement Concrete	Village Road
11	79+468	X	Minor	Ahiasa	Flexible	Village Road
12	81+410	X	Minor	Dhamapur	Flexible	MDR
13	82+000	X	Minor	Daharpur	Flexible	MDR
14	86+450	X	Minor	Modanganj	Flexible	MDR
15	92+640	X	Minor	Sadipur	Flexible	Village Road
16	93+690	X	Minor	Bahrampur	Flexible	Village Road
17	94+878	X	Minor	Arampura	Flexible	Village Road
18	95+758	X	Minor	Dhamaul	Flexible	Village Road
19	96+265	X	Minor	Dhamaul	Flexible	Village Road
20	97+138	+	Minor	Rasalpur	Cement Concrete	Village Road
21	97+920	+	Minor	Chatti	Flexible	Village Road
22	98+578	X	Minor	Redbigha	Flexible	Village Road
23	99+520	X	Minor	Bigahapar	Flexible	Village Road
24	100+360	X	Minor	Pabhera	Flexible	Village Road
25	102+460	X	Minor	Abupur	Flexible	Village Road
26	103+218	X	Minor	Gauhar Chak	Earthen	Village Road

S.No	Design Ch.	Junction Type	Classification	Leading To	Pavement Type	Remarks
27	104+030	X	Minor	Hulas Chak	Flexible	Village Road
28	106+200	X	Minor	Nanda Chak	Flexible	Village Road

3.15. Truck Lay-Byes

There is 1 number of Truck lay Bye proposed in this section. The details are summarized in **Table 3.16.**

Table 3.16- Details of Truck Lay Byes

S.No	Design Ch.	Side
1	83+820	RHS

3.16. TOLL Plaza

There is 1 Toll Plaza of 16 lane configuration. All the lanes shall be equipped as ETC Lanes. The detail of Toll Plaza is summarized below in **Table 3.17.**

Table 3.17- Details of Toll Plazas

S.No	Design Ch.	Lanes
1	101+600	16

3.17. Bus Bay

There are 22 numbers of Bus Bay proposed in this section. The details of the Bus Bays are summarized below in **Table 3.18.**

Table 3.18. Details of Bus Bays

S.No	Design Ch.	Side
1	58+000	RHS
2	58+540	LHS
3	62+340	RHS
4	62+800	LHS
5	65+380	RHS
6	65+890	LHS
7	68+420	RHS
8	68+860	LHS
9	70+120	BHS
10	74+980	BHS
11	82+820	BHS

S.No	Design Ch.	Side
12	86+120	BHS
13	87+980	BHS
14	100+670	BHS
15	108+880	BHS

3.18. Way Side Amenity Center

There is 1 number of Way Side Amenity Center proposed in this project stretch which will allow users to take rest and other facility including Parking, Fooding and Fuel Station will be available. The details are given below in **Table 3.19.**

Table 3.19. Details of Way Side Amenity Center

S.No	Design Ch.	Lanes
1	91+020	RHS

3.19. Religious Structures

There are no religious structures along the project road.

3.20. School and Colleges.

There are no school or colleges in this project road.

3.21. Hospitals

There is no hospital in this project road.

3.22. POINTS OF CONSIDERATION

Keeping in view the length of the project, the design parameters and likely facilities to be provided in the project, the NH Division of PWD has submitted the estimate. It is proposed to have Flexible Pavement for 4 lane carriageway including paved shoulders for the project package. Based on engineering Surveys, Investigations, Traffic analysis and projections the following design standards have been adopted as per Manual of specifications and standards for 4 -laning of Highways with paved shoulder (IRC: SP: 84-2014) published by IRC.

Table 3.20: Design Standards

Sr. No.	Item	Standards for Plain / Rolling Terrain
1.	Design Speed	100 Kmph
2.	Land width in open	45m

Sr. No.	Item	Standards for Plain / Rolling Terrain
	/ Built-up Area	
3.	Width of Carriageway	14 m
4.	Paved Shoulder	2.5 m both side
5.	Unpaved shoulder	1.5 m both side
6.	Camber / Cross fall	
i.	Carriageway & Paved Shoulder (Flexible Pavement)	2.5 %
ii.	Earthen Shoulder	3 %

CHAPTER – 4

METHODOLOGY

4.1 INTRODUCTION

The Final Feasibility Report essentially aims at working out the best/optimum alignment and various technical improvements of the project stretch after considering relevant environmental and social impacts, cost-effectiveness and economic viability using international best practices including the use of state-of-art techniques within the limited time frame. This necessarily leads to inter-play of various competing demands and an inter disciplinary treatment. Thus, multi-discipline are approach was adopted involving:

- Traffic Study and survey
- Topographical Survey
- Highway Planning/Design
- Pavement Analysis & Design
- Bridge Condition Survey and Engineering
- Material Engineering & Geo-technical Investigation
- Environmental and Social Screening
- Economic and Financial Analysis

The broad methodology for the study has been outlined in the Inception Report. Further methodologies of these studies have been described in detail in their respective chapters of the feasibility Study Report.

4.2 REPORT PREPARATION

The Detailed Project Report will be prepared in the following volume as per CA:

Volume I :	Main Report
Volume II :	Design Report (Highway, Pavement, Traffic, Bridges & Culverts)
Volume III:	Materials Report
Volume IV :	Environmental Assessment Report including Environmental Management plan (EMP) and Resettlement Action Plan (RAP)
Volume V:	Technical Specifications
Volume VI:	Rate Analysis

Volume VII: Cost Estimates

Volume VIII: Bill of Quantities

Volume IX: Drawing Volume

4.3 HIGHWAY PLANNING / DESIGN

Strip Plan of each kilometer showing all the physical elements on the project stretch for 22.5 m width on either side has already been prepared. The available ROW, existing problems, constraints, the geometric deficiencies of the horizontal and vertical alignment have been analysed by the project experts in detail and based on that the alignment option & proposed improvement scheme has been finalized. While finalizing the scheme, the social impact due to acquisition and resettlement and environmental impact have been considered in consultation with Environmental & R&R Expert.

4.4 TRAFFIC STUDY

4.4.1 Background

Traffic is one of the key components of a Highway feasibility study. The study of the traffic & travel characteristics issued to assess the nature and magnitude of traffic problems on the project road. A correct assessment of the existing traffic condition along with past traffic flow trends forms a basis for further analysis of estimation of traffic flow for the horizon years. As the travel is the derived demand due to interaction of numerous socio economic activities, it is also imperative to study to study the growth of the socio-economic, demographic profiles in the project area influencing the travel demand.

Presently the project road experiences a wide variation in traffic flow characteristics in different sections. According to the study, the traffic on the project road at **Sarwan is 18173 PCU and at Sawkala Toll Plaza 35583 PCU** is observed and has an estimated annual growth of 5 % for different category of vehicles. Presently traffic facilities on the project road in terms of pedestrian sidewalk in urban area, access control, road signage's and marking are highly deficient.

Being flood prone area it has been observed road has been breached at number of location. Most of the bridges are in poor state. As a result heavy movement of goods traffic poses serious problems of traffic operation resulting in high degree of traffic congestion. Other problems along the highway are inadequate sight distance, poor road geometrics, kerb side parking, non-conforming activities along the roadside and other encroachments within the right of way.

Keeping these in view, utmost and judicious care has been taken to organize various logistics to study the traffic and travel characteristics on the project road. This would

enable the designer to plan and design the project road to meet future traffic requirements and ensure safe and efficient movement of traffic in horizon years.

4.4.2 Scope

The details scope of traffic studies for the project is as follows:

i) Reconnaissance Survey

ii) Planning, design of survey performa and conduct of various traffic studies along with coding and feeding of data

iii) Analysis of Traffic Flow

iv) Existing traffic flow analysis

v) Existing travel demand analysis

vi) Traffic flow forecasting of different sections of road

vii) Preparation of traffic flow diagrams at intersections

viii) Assessment of level of service of the existing road

ix) Analysis of movement of pedestrian traffic

x) Loading Pattern on Project road

xi) Preparation of report dealing with the analysis of traffic data

xii) Preparation of improvement plans for intersections including grade separators

xiii) Improvement measures for pedestrian safety

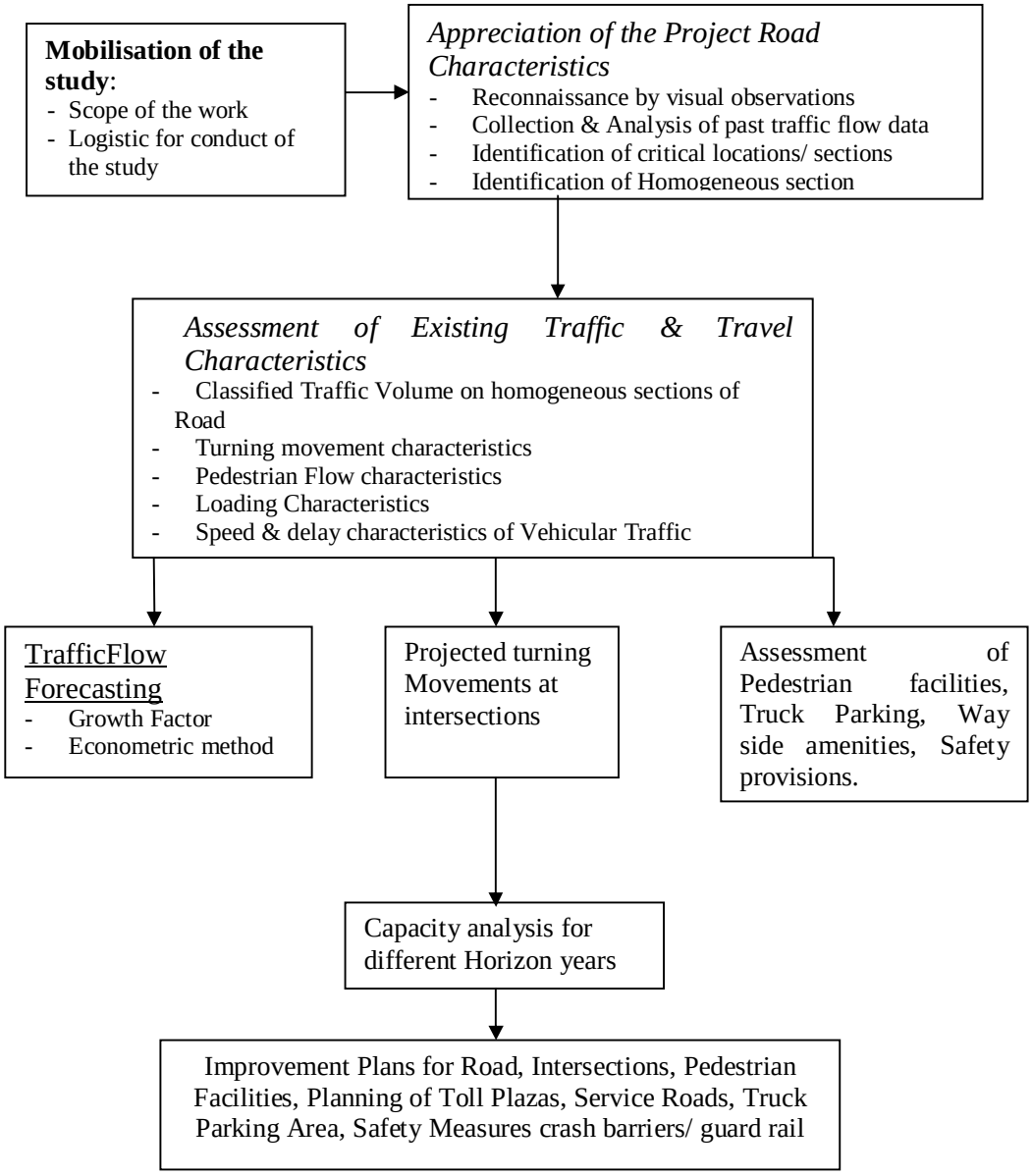
xiv) Preparation of technical report dealing with the traffic analysis and improvement plans

xv) Identification and planning of toll plazas at various entry and exit locations of the project road

xvi) Identification of location of service roads.

4.4.3 Methodology

A comprehensive methodology has been evolved to carry out the work as per the scope of traffic studies. A stepwise methodology is presented in the **Fig. 4.1**.



Methodology for Traffic Study

The Methodology flow chart presents six stages of work programme to be conducted.

In the first stage of the study, necessary data was collected from the secondary sources along with the field visit by the study team members. This have provided a detailed insight of the condition of the present road and enable study team members to

identify the critical areas of traffic operations in term of poor road geometric, inadequate sight distances, encroachments etc. The traffic homogenous sections and traffic survey locations were identified.

In the second stage of the study data collection through primary and secondary survey were collected. The traffic survey was conducted at identified locations on the designed formats as per scope of surveys already mentioned. The police help was sought to efficiently conduct the O-D Surveys, Willingness to pay and axle load surveys at identified locations. The secondary data pertaining to past trend on the road was collected from concerned PWDs offices and for estimation of seasonal factor data from Petrol Pumps was also collected.

In the third stage of the study, analysis of traffic survey data was undertaken to assess the existing traffic & travel characteristics of the project road. The data collected from the field was edited, coded and fed into the computer using the relevant software packages for quick analysis.

The fourth stage of the study was concerned with the forecasting of the traffic flows for different horizon periods up to 30 years as per TOR requirement. The forecasting of traffic flows for each homogeneous sections of the project road has been carried out based on the elasticity of transport demand. These growth rates vary for different time periods depending on the likely growth of economy of the country and state.

For design of intersections, forecast of turning movements was carried out using the growth rates which are same as the growth rates used to forecast the traffic in the various homogenous sections.

Based on the IRC guidelines and experience of the consultants, the traffic volumes which warrant signalization of intersection have been finalized. As a step further, the traffic levels which warrant the upgradation of signalized intersection to a grade separated facility have been identified along with the year in which the upgradation is justified (year of capping).

Besides these, demand analysis of parking has been carried out to estimate the future parking requirement at the selected parking places. Pedestrian movement analysis was also carried out based on the magnitude of vehicular & pedestrian conflicts.

In the fifth stage of the study, an attempt has been made to carry out the capacity analysis of the different sections of the project road for projected traffic in the horizon year so as to ensure that the project road would function smoothly and safely for the next 30 years period as contemplated in the design. Subsequently, planning for parking supply facilities will also be worked out at different places of the project road

bases on the future parking demand. As far as the safety for pedestrian traffic is concerned, the detailed strategies for provision of pedestrian facilities in terms of various control measures, subways, sidewalks etc. will be evolved at the critical locations generating high pedestrian flow. Finally the sixth stage of the study was directed towards identification and planning of Toll Plazas at various entry and exit locations of the project road. Besides this, improvement plans for major and minor inter sections, will be undertaken. Identification of location of service roads and concept plans for commercial areas / truck parking area and other wayside amenities will also be carried out.

4.5 PAVEMENT DESIGN

4.5.1 Pavement Condition Assessment Survey

4.5.1.1 Visual Inspection Survey

Visual Inspection Survey was carried out. The parameters observed in this Survey were:

a) Types of surface
b) Types of cracks (alligator/block/transverse/longitudinal) and its area;
c) Pot holes, raveling and patching areas;
d) Shoulder defect;
e) Rutting (measured with a 3 meter long straight edge.)

All the above defects were calculated in terms of percentage of carriageway area of length 1000 meters and width of 7 meters. This was done to consider the results of Pavement Condition Survey against those of Bump Integrator or Roughness Survey.

4.5.1.2 Roughness Survey

For assessment of roughness (reported in terms of unevenness index) the locations identified on the carriageway were left and right wheel paths. Since it was difficult to maintain the standard test speed of Bump Integrator Unit on account of heavy commercial vehicles, measurements along the central wheel path could not be done. Average of the values along left and right wheel paths were taken as the measure of unevenness index for the carriageway. Based on the MoRT&H & IRC recommendations or roughness, the riding quality of the pavement has been determined in terms of Pavement Serviceability Rating (PSR) also. The survey was carried out through Central Road Research Institute, New Delhi.

4.5.1.3 Benkleman Beam Deflection Survey

The methodology was adopted as prescribed in IRC: 81- 1997. Deflection measurements were done using Benkleman Beam at twenty members of points staggered along the length per 1 km. of road. The temperature of pavement was also noted down at regular intervals so that temperature correction could be applied subsequently. The correction for seasonal variation was not needed, as the deflection measurements were not taken during dry months, but "during the monsoon or soon after" it. The data was analyzed and duly considered in the design of overlay (thickness).

4.5.1.4 CBR along with allied tests and DCP Tests

CBR along with allied tests and DCP tests below the existing pavement were carried out as described under Para 4.5.Crust thickness of the existing pavement and shoulders were also determined.

4.5.2 Pavement Design

4.5.2.1 General

Pavement design has been done for three scenarios:

4.5.2.2 Design of overlay over existing Pavement

a) Flexible Overlay:

For the overlay design of flexible type, Benkelman Beam Deflection survey data was used. The data of the survey was corrected for temperature variation and correction was applied for seasonal variation, wherever required, although the survey was conducted soon after monsoon, which is the period when the pavement is in its weakest condition as per Para 4.5.1 of IRC-8-1980.IRC; 81-1997 was followed for the design of overlay thickness.

For use in the design of overlay thickness, VDF was calculated from the data of Axle Load Survey, conducted at suitable locations on the road. The commercial vehicles using the road were a mix of two axle and multi axle. All the load values were classified in a class interval of 2 and their mid-value used for calculating their equivalence factor or damaging effect. Average vehicle damage factors were calculated for each class interval and average vehicle damage factor for commercial vehicles was computed.

The VDF thus calculated was used in the relevant formula to calculate MSA over the design period. The projected MSA took account of growth rate, determined again from detailed traffic survey and study of past trend.

b) Rigid Overlay:

Rigid overlays over flexible pavements have been designed as plain cement concrete with joints. The thickness has been computed using Portland Cement Association method. Rigid overlay has been considered only in those stretches where the existing pavement is in a distressed condition. In view of the high temperature prevalent, the thin bituminous layer will be scarified and the thickness designed as for a new pavement. The 'k' value has been assessed on the basis of CBR value of the sub grade below the pavement and the presence of granular layers in the existing crust.

4.5.2.3 Design of flexible pavement for new Formation

The flexible pavement design was done as per IRC: 37-2012.The methods prescribed in IRC: 37-2012(Draft) and AASHTO were also considered. The CBR value of the sub grade soil was determined in the laboratory. Traffic growth rate was arrived at after conducting appropriate study. The vehicle damage factor was also calculated from the data of axle load survey conducted on the existing SH-248 at different locations.

4.5.2.4 Design of Rigid Pavement for new Formation

For the design of rigid pavements over new formation methods suggested in IRC: 58-2011, Portland Cement Association (PCA) and AASHTO Design Guide were considered. Considering the relative merits and demerits of these principal methods, the method recommended by PCA has been adopted. Traffic census was actually recommended by PCA has been adopted. Traffic census was actually carried out for the assessment of the design traffic intensity. The foundation strength 'k', in case of rigid pavement design has been determined by its correlation with CBR value. The effective sub grade reaction 'k' has been estimated with reference to CBR value of sub grade soil and layer of dry lean cement concrete sub base. A design thickness for flexural strength of 45 kg/cm^2 at 28 days in the field (M-40 grade concrete) concrete pavement slab has been assumed for the purpose of design and has been tested for its safety. However, thickness adjustment of 2 cm has been done over the assumed thickness based on projected traffic intensity. A drainage layer in full formation width has been provided. All the data collected through surveys/laboratory results were used for designing the pavement making use of design charts formulae given in the relevant codes. The performance period has been taken as 30 years. The justification for following PCA standards as compared to IRC/AASHTO Guidelines has been discussed in detail in Chapter 12 – Pavement Type (Option) Study.

4.5.3 Selection of Option

The selection of option is based on the life cycle costing of flexible type vis-à-vis rigid type of pavement. The life cycle cost of each type of pavement has been estimated with due consideration to the following factors.

1. Cost of initial construction
2. Cost of maintenance
3. Cost of rehabilitation during the design life period

The design life of Rigid Pavement has been taken as 30 years after the period of construction. For Flexible Pavement the life cycle cost has been compared by taking the initial cost of construction. Routine maintenance, periodical renewals and overlay after every 10 years.

4.6 BRIDGES & CULVERTS

4.6.1 Introduction

For evaluation of existing and proposed Bridges and CD Structures, the methodology discussed hereunder has been adopted in accordance with the terms of reference.

a) The appreciation of the hydrological problem of the project stretch;

b) The determination of the adequacy/inadequacy of the existing drainage structure based on local enquiry, past flood patterns including the floods this year;

c) Preparation of the condition survey report of the existing structures and formulation of the plan for upgrading or replacement of the existing structures, if found deficient;

d) Identification of new structures in addition to existing structures, considering the problems of drainage/floods in the project stretch.

e) Preparation of conceptual plans for the new structures on the proposed two/four lane;

f) Preparation of General Arrangement Drawings for new rail over Bridges/under Bridges, proposed;

g) The estimation of the approximate cost of repairs and/or of construction according to alternative options;

4.6.2 As a first step towards collecting data for the existing bridges, 'Preliminary Inspection and Condition Assessment Survey of Bridges and CD Structures' was conducted in accordance with IRC: SP-13. The adequacy of water way of existing cross drainage structures will be checked as follows:

a) For culverts the maximum flood discharge was estimated by catchment area method:

Using the popular Dicken's formula as given below:

$$Q = C \times M^{3/4}$$

Where, Q = peak run-of in cm/sec
M = catchment area in sq. km
C = a constant, taken as 14 for this region

The discharging capacity of the culverts was calculated by assuming them to be flowing full. The following formula was used.

$$Q = A \times 4.43 \times \left(\frac{H}{1 + K_e + K_f} \right)^{1/}$$

Where, A= area of flow and K_e & K_f are entry and friction co-efficient and were calculated from Table 5 of SP 13 of IRC.

The adequacy of waterway for culverts will be checked by the above method and will be corroborated from visual observations details collected immediately after monsoon/floods. New culverts for extra waterway will be provided, where ever needed.

4.6.3 The data collected from the field and obtained from the department will be analyzed for each structure to determine, if it was deficient in any way, and if so, how best to upgrade it. If upgradation is not found feasible, it will be considered for replacement.

4.6.4 For the estimation of cost, the rates for materials and items of work were obtained from the PWD and the market. For arriving at a reasonable rate per meter of a structure, the analyzed rate was compared with recently tendered rates and a suitable value adopted.

4.6.5 Analysis of rates for different items of repair or new construction was prepared. For new construction rates per meter length were calculated on the basis of preliminary design and estimate for different types of structures. These were compared with those obtained from different sources and suitable values were adopted. These were used for arriving at costs of different structures.

4.6.6 On the basis of the above, cost of different options and other technical considerations, the most suitable options have been considered and recommended for consideration of the client.

4.7 MATERIALS & GEO-TECHNICAL INVESTIGATION

Material and geo technical investigation for existing pavement and related structure have been done by adopting the following methodology.

The soil samples collected below the pavement sub-grade and borrow areas were tasted as per MORT&H specification and IRC codes to determine the required parameters related with the existing road pavement construction, and of new pavement for four laning and bypasses.

Assessing – availability of material for embankment and materials for pavement and other structures with due consideration to lead distance and cost procurement. Investigations of borrow areas and quarries have been done as per MORT&H specifications.

4.7.1 Investigation of Existing Pavement and Sub-grade

Maximum Dry Density (MDD) and corresponding Optimum moisture content were (OMC) determined using standard method in accordance with IS: 100074-1982. After calculating the bulk density and dray density – for different moisture content and dry density graphs were plotted. The moisture content corresponding and MDD was taken as optimum moisture mix content.

4.7.1.1 CBR

Samples were collected from the pits at the location of test pits used for D.C.P. test. The CBR moulds were prepared by using Dynamic Standard Compaction method in accordance with IS: 9669-1980, IS: 2720 (Part-16) 1979 and IRC-37. Moulds were prepared for samples before the pavement at FMC if the O.M.C. was less than F.M.C. and at O.M.C. if the F.M.C. was less than O.M.C. For samples at toe, the moulds were prepared at O.M.C.; C.B.R. values were determined after evaluating the results at 2.5 mm. and 5.00 mm.

4.7.1.2 Crust

The sub grade below the pavement and pavement (existing) structures were investigated by excavating pits of 1m x 1m size and up to a depth of 1m below the pavement surface. The thickness of different layers was noted.

4.7.1.3 Field Dry Density

The field density of sub grade was found by core-cutter method.

4.7.1.4 DCP

DCP test was performed below the sub grade up to a depth of 3000 mm by Dynamic Cone Penetration method (DCP) using 60˚ and 50 mm dia cone. The hammer used for giving blows is of 65 Kg. Weight and its dropping height is 750 mm (fixed).

4.7.1.5 Soil Classification

(a) Atterberg's Limit

Tests were conducted in accordance with SP 36 (part I & II); Liquid limit was determined by cone penetration method and the penetration in 5 seconds was recorded. The graph between water content and penetration was recorded as Liquid limit.

Plastic Limit was found out according to IS: 2720 (part V) – 1985 and then plasticity index was found out by getting the difference between the above two.

(b) Sieve Analysis

The procedure followed was in accordance with IS: 2720 (part-$) 1985. The soil sample was taken and kept in a series of sieves i.e. 4.75m, 3.35m, 2.36mm, 1.18mm, 0.6mm, 0.3mm, 0.15mm and 0.75mm. The whole arrangement was mounted on a sieve-vibrating machine. The percentage of material passing each sieve by weight and percentage retained on each sieve were noted. The sieving was done by wet sieving method.

(c) Moisture Content

Moisture Content was determined in accordance with IS: 2720 (part-2) 1973, IS: 2720 (part-18) – 1964, IS: 2720 (part-19) 1964. Using the above data, the soils were classified as per BIS – 1498 and also as per AASHTO classification system.

4.7.2 Investigation of Borrow Areas

The borrow areas were first identified by visual inspection and enquiries along the project road and adjacent areas. The soil samples from these borrow areas were collected, and the required tests as per MoRT&H specification & IRC/BIS codes were done. Grain size analysis was done for particles smaller than 4.75 microns, sieve analysis was done (wet sieving) and for particles smaller than 75 microns, Hydrometer analysis was done. CBR test, Atterberg's Limit and moisture contents were also determined.

4.7.3 Investigation of Quarries

The investigation of different quarries was done from different places were stone aggregates and sand are available. Samples were collected and following tests were conducted:

(i) LA Value/AIV
(ii) Water absorption
(iii) Flakiness index
(iv) Coating and stripping value
(v) Soundness

These tests were performed in accordance with IS: 2386 (part III), IS: 120 (Part I), ASSHTO – T182, IS: 624-19711, IS: 2380 (Part V)

4.7.4 Investigation of Fly Ash

We are not using fly ash in through out of stretch.

4.7.5 Investigations of other Construction Materials

Availability and suitability of other construction materials like coarse sand, local sand and bricks were investigated. Cement and Steel and Bitumen and manufactured items are readily available.

The details on Materials & Geo-technical Investigation have been discussed in chapter – 11.

4.8 PRELIMINARY COST ESTIMATE

As required by the NHAI, for Feasibility stage, Approximate Cost Estimate has been prepared & Quantity has been worked out on taking into consideration the proposed development plan, design features of various road components, preliminary design of Pavement, bridges & structures, the environmental and Social cost involved in the project. Cost Estimate for Flexible Pavement in both two lanes has been prepared for based on the proposed development plan for the project stretch.

Unit rates for different items of works have been analyzed on the basis of the formats given in the standard Data Book for analysis of rates published in the year 2007 by Indian Roads Congress on behalf of Ministry of Road Transport & Highways, Road Wing, Govt. of India, New Delhi.

Current Schedule of Rates of PWD, Bihar has been taken under consideration for analysis of finished carriage cost of construction Materials. Further Market survey has been carried out in details for finished rate of these materials at site. The Market rates found to be nearer and less than the cost evaluated based on the PWD, Bihar, and Schedules of rates. Finally, finished carriage cost of construction Materials based on Current Schedule of Rates of PWD, Bihar has been adopted ensuring that analysed rates are as per Latest data book.

4.9 ENVIRONMENTAL AND SOCIAL SCREENING

A clear definition of the Corridor of Impact (COI) and identification of the Right of Way (ROW) are prerequisite for establishing the extent of social and environmental impact in any Highway project. This needs detailed data and involves the following steps:

a) Establishing the width that may include carriageway, shoulder, and safety zone, borrows areas, etc. for required widening such as 2, 4 or 6 lane road.

b) Collection of data from different agencies and sources which already exists and documented by then including existing Row from Local NH division and PWD.

c) Both primary and secondary data are required for establishing the extent of environmental and social impact. This process will involve:
- Administering the pilot questionnaire for collecting information on structures, agriculture land and type of ownership and social groups, trees, etc.
- Establish baseline conditions to define characteristics of the existing environment and provide the basis from which project impact comparisons.
- Rough identification of stretches requiring land acquisition and special R&R measures.

d) Analysis of potential impacts, their magnitude and duration on physical (Air, Water, Noise), natural, social and the environmental impacts duly taking into account the public opinion.

e) Assessment of legal and administrative framework and identification of group or agency like local administration, Non Governmental Organizations, Community Based Organizations etc.

f) Developing database with rough estimates of different categories of project affected people irrespective of their legal holding, which will get updated after the census at further stages of project preparation.

4.10 GUIDELINES AND TOOLS FOR INITIAL ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT

The on site experiences and observation, discussions with the client and other related officials were the main source for guiding and collecting the data from the field. Secondary information and statistical data were collected from Census of India, district level offices, and state statistical abstract of Bihar.

Primary environmental and social screening of the project road was carried out using semi structured questionnaires during site visit where individuals and groups were also consulted at various places of importance.

4.10.1 Questionnaire for Data Collection and Field Testing of Questionnaire

To assess the potential social impacts Pilot Questionnaires (see Appendix-I) were administered and a rough database developed out of it. For detailed Social assessment structured Census and Socio-Economic questionnaires will be pre-tested in the field during the screening and necessary modifications be incorporated. Sample questionnaires used are given as Appendix-II, Appendix-III and a checklist for Focus Group Discussions (see Appendix-IV).

4.10.2 Field Work and Data Collections

The data collection was done with the help of enumerators/ investigators. The professionals have mapped the social features sheets to prepare the strip map. The interviewers were trained and they practiced for two days for filling up the Questionnaire at the site. The emphasis was laid on quality of data so that the conclusions arrived at are authentic and reliable.

4.11 TESTING AND MONITORING

In order to assess the situation in different sections of the highway during the screening and site visit of the area, tentatively, different locations will be identified for testing & monitoring the air ambient quality, noise level and water quality.
An approved laboratory by the Bihar State Pollution Control Board will be commissioned for conducting environmental monitoring tests under the supervision of an Environmental Engineer of the project. Necessary methodologies for conducting these tests are given below:

i) Air Sampling and Measurement

In order to evaluate air quality and to design appropriate air pollution control measures, it is necessary to quantify the pollutants in the ambient air. Ambient air quality monitoring will provide the background of air quality data in urban or rural areas and gives a scope for future predictions. The guidelines issued by Central Pollution Control Board, New Delhi have laid down guidelines for ambient air quality standards, which is reproduced in the **Table: 4.1.**

Table 4.1 : National Ambient Air Quality Standards

Pollutant	Time weighted average	Concentration of Ambient Air		
		Industrial area	Residential rural & other area	Sensitive area
Sulphur dioxide (SO_2)	Annual[a]	80 µg/m^3	60 µg/m^3	15 µg/m^3
	24 h[b]	120 µg/m^3	80 µg/m^3	30 µg/m^3
Oxides of nitrogen (NO_2)	Annual[a]	80 µg/m^3	60 µg/m^3	15 µg/m^3
	24 h[b]	120 µg/m^3	80 µg/m^3	30 µg/m^3
Suspended Particulate Matter (SPM)	Annual[a]	360 µg/m^3	140 µg/m^3	70 µg/m^3
	24 h[b]	500 µg/m^3	200 µg/m^3	100 µg/m^3
Respirable Particulate Matter (size Less than 10 µm) RPM	Annual[a]	120 µg/m^3	60 µg/m^3	50 µg/m^3
	24 h[b]	150 µg/m^3	100 µg/m^3	75 µg/m^3
Lead as Pb	Annual[a]	1.0 µg/m^3	0.75 µg/m^3	0.50 µg/m^3
	24 h[b]	1.5 µg/m^3	1.0 µg/m^3	0.75 µg/m^3
Carbon monoxide	8 h[b]	5.0 mg/m^3	2.0 mg/m^3	1.0 mg/m^3
	1 h	10.0 mg/m^3	4.0 mg/m^3	2.0 mg/m^3

The data from secondary sources has also been collected to represent the situation in the coverage area. Micro level data will be compared at the time of final Environment Assessment (E.A.) with the secondary data.

ii) Monitoring of Noise Level

Noise monitoring will be carried out by integrated noise monitor. Generally for road study case dB scale is used for monitoring noise level in existing environment at particular place and time. The noise standards are given in the **Table: 4.2**

Table: 4.2 Standards for monitoring noise level

S. No.	Area	Leq dB (A)	
		Day time*	Night time**
1	Industrial	75	70
2	Commercial Area	65	55
3	Residential Area	55	45
4	Silence Zone	50	40

** Day time – 6.00 AM to 9.00 PM (15 hours)*

*** Night Time – 9.00 AM to 6.00 AM (09 hours)*

iii) Physio-Chemical & Biological quality of water ecosystems

For physio-chemical analysis, the water samples were collected in clean plastic containers.

Samples collected and analyzed for various physical, chemical and biological parameters like temperature, BOD, DO, COD, NH3N, hardness and silicate will be determined by using the methods as described in standard methods for the examination of water and waste water (APHA, 1991). By this methodology the surface and ground water will be tested.

4.11.1 Secondary Data from Different Sources

Table 4.3: The details of the source and the data collected are given below:

Sl No.	Data for Social & Environment Screening	Sources
1.	Census Reports	Government of India
2.	Primary census Abstracts	Registrar General-Directorate of Bihar
3.	The District Gazetteers Bihar State	Department of Statistics, Bihar State
4.	District Profile	
5.	Census of India	
6.	Statistical abstract of India	Central Statistical organization, Planning Min.
7.	Economic Review	State Planning Board
8.	SC, ST approved list of the Govt. of Bihar	District Tribal Welfare Office, Nagpur
9.	Tourism Statistics	Tourism Office, Govt. of India
10.	Environment, Effluent, Emission and Noise Standard and Guidelines	Pollution Control Board, Bihar
11.	Ground water Tables	Central Ground Water Authority
12.	Data on rain, humidity, wind direction and speed	Indian Metrological Department
13.	Forestry in Bihar, procedures	Forestry Department of the State of Bihar obtaining the permission from Forest

Sl No.	Data for Social & Environment Screening	Sources
		Department for cutting the affected trees.

4.11.2 Compilation of Data

Data collected and recorded by the enumerators on questionnaires has been compiled on
Computers through Excel (Office Version 2000) and prepared tables.

4.11.3 Analysis & Reporting

The tabulated data was summarized in tables and analyzed so that social & environmental situation prevailing is visualized and potential environmental & social issues are estimated.

The analysis will prove the feasibility of the project and will help in suggesting various socially viable alignment options for engineering design and also come out with the mitigation measures to make the project socio-economically acceptable. A strip plan indicating R&R features is also prepared and attached as Appendix.

4.11.4 Analytical Techniques for Identifying Critical Impacts / Areas

In order to identify the critical areas on the stretch the data was analyzed by using the Delphi Technique1. The following process was followed:

A list of relevant participant was complied. Those participants were representatives from various professions such as ecology, forestry, environmental planning, transportation economics, transport planning, regional planning, environmental analysis, socio-economic, architecture, urban planning, hydrology, structural engineering, highway engineering and biology. There were representatives from NGOs, and also engineers from the relevant agency.

A questionnaire was designed asking participants to fill in “indicator importance weightages”; in the project office the data were analyzed to help in Delphi process.
Background information regarding project characteristics and some relevant information about the project corridors and their heterogeneity in land use was supplied to individual participants to develop understanding for necessary professional judgment.

We consolidated the results of the first round of questions and designed a follow up questionnaire to second review. This consisted of providing each person with consolidated results of first round, along with the new questionnaire. In this way everyone knew the aggregate of first round responses and then they used this as new information upon which to re-evaluate their agreement on a rating scale. Also they were asked to express their opinions again, and to explain reasons underlying any change in first attitude.

4.12 ECONOMIC ANALYSIS

The economic indicator of any investment in highway improvement is the net benefit resulting from the investment, over a given period express in net present value or rate of return. The benefit from a road investment is the difference in the transportation costs on the improvement with do-nothing (i.e., without project) scenario. Economic evaluation of a project attempts to take in to account all the costs and benefits to the society irrespective of who pay the costs and who receives the benefits. In the case of a road project, the benefits accrue mainly to the road users (society in general) in the from of vehicle operating cost savings and time savings.

Transportation costs over the period of analysis, in case of "with project" alternative consists of cost of construction of the facility (initial investment on improvement), cost of maintenance of facility in the future (maintenance cost plus cost of major repairs/rehabilitation) and road user costs incurred in the future (vehicle operating costs and time related costs). In the "without project" alternative, the transportation cost will include the cost of maintenance of the facility and road user costs incurred in the future.

The road user cost will increase due to the deterioration of pavement (not withstanding routine maintenance) and the increase congestion due to the traffic growth over a period in the "without project" alternative. Whereas, in the "with project" 'alternative the road user cost will be reduced significantly due to improved riding surface, and less or no congestion. Thus the road user cost will be much lower for the improvement alternative as compared to "without project."
The rate of pavement deterioration is directly affected by the standards of maintenance applied to repair defects on the pavement surfaces such as cracking, raveling, potholes, etc. or to preserve the structural integrity of the pavement (for example, surface treatments, overlays, etc.), there by permitting the road pavements directly depends on the maintenance or improvement standards applied to the road. **Figure 3.2** illustrates the predicted trend in pavement performance represented by the riding quality that is often measured in terms of the international roughness index (IRI).

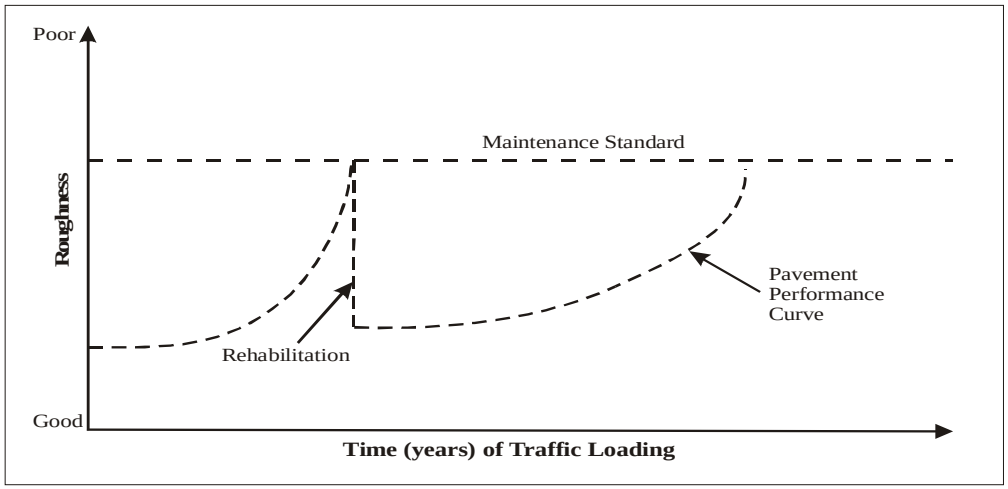


Figure 4.2: Concept of Life-cycle analysis in HDM-4

The savings in transportation costs through improvement vis-à-vis "without project" are the benefits to the society from such improvement. The benefits over the analysis period is discounted to the base year to obtain the Net Present Value (NPV) of the investment or to estimate the Internal Rate of Return (IRR), which is the discount rate at which the costs and benefits over the analysis period are equal.

Basic Data Inputs

The economic analysis will be carried out with the HDM 4 (Highway Development and Management) Model. The following inputs will be considered for the application of HDM 4 Model.

- Pavement Option :
- Analysis Period :
- Design Life :
- Construction Period :
- Investment Schedule :

YEAR 1 :

YEAR 2 :

- Discount rate :
- Salvage Value :
- Project Cost :
- Maintenance Cost :

Periodic :

Routine :

Vehicle Characteristics

Vehicle Characteristics such as Vehicle Damage Factor (VDF) gross vehicle weight, number of axles and number of passengers and number of tyres and vehicle utilization data such as service life, hours driven per year Kilometer driven per year, and annual interest rate etc. will be considered for analysis.

Existing Road Characteristics

The following project road characteristics collected through field surveys will be input for the analysis:

- Road Length (section wise)
- Road Width
- Rise & Fall
- Super-elevation
- Effective Number of Lanes
- Curvature
- Sub-grade CBR
- BBD
- Roughness (IRI)
- Percentage of Cracks
- Potholes

Traffic Volume and Composition

Base year traffic data collected from the field surveys will be used for analysis.

Economic analysis

Base on the above inputs the economic analysis for the project road will be carried out to determine the IRR (Internal Rate of Return) and NPV (Net Present Value).

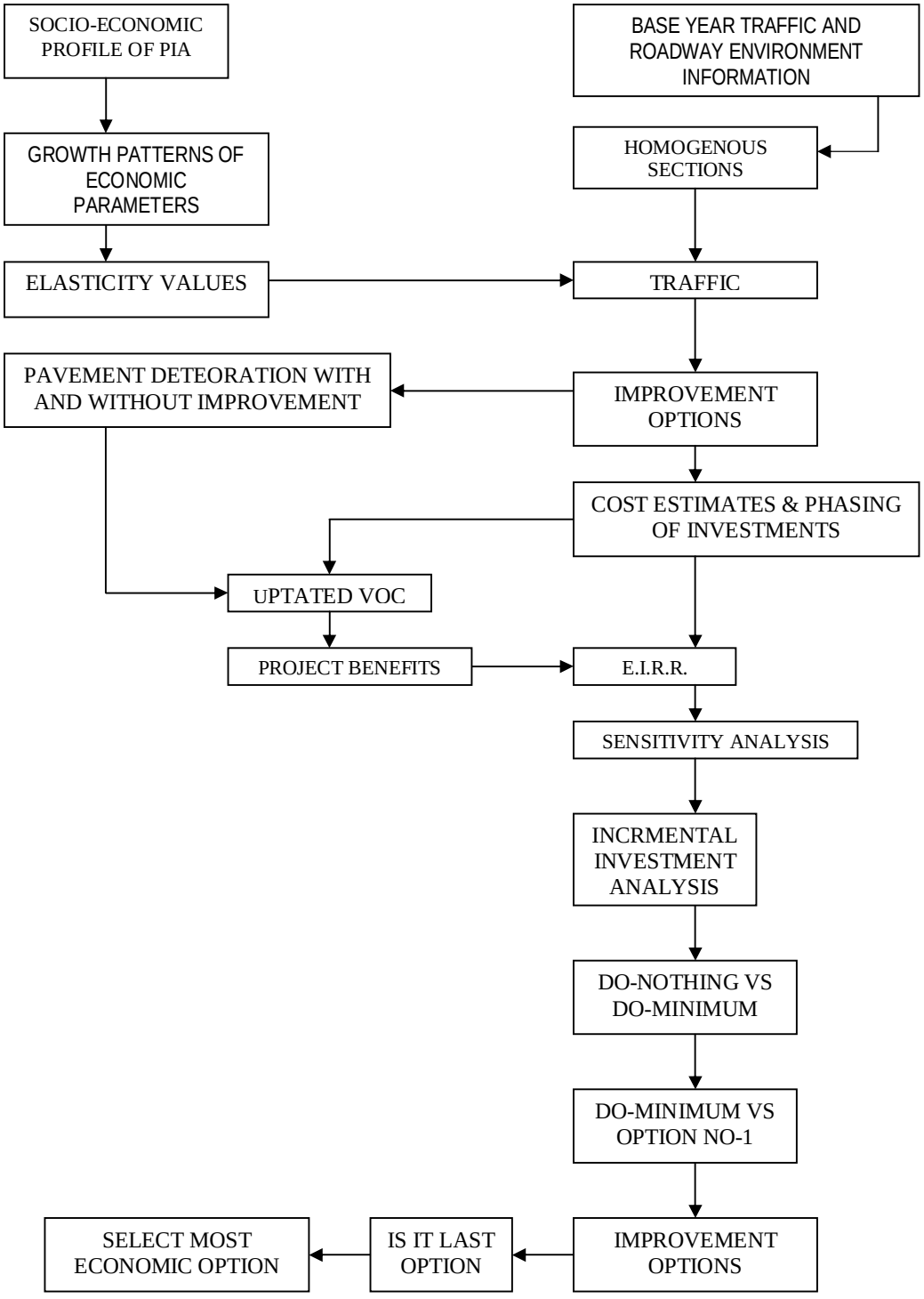
Sensitivity Analysis

Sensitivity Analysis will also be carried out to examine the effect on economic viability of the project due to increase in cost and decrease in benefits. The sensitivity analysis under following condition will be analyzed:

- Increase in cost by 15 %
- Decrease in benefits by 15 %
- Increase in cost by 15 % and decrease in benefits by 15

The stepwise methodology is presented in the following **Figure 4.3**

Figure 4.3: Economic Analysis Methodology



Stepwise Study Methodology for Economic Evaluation

STEP ONE: Estimate the traffic growth rates for different modes

STEP TWO: Divide the entire stretch into homogenous sections based on traffic and Roadway characteristics

STEP THREE: Study the alternative improvement option and implementation schedule of each option.

STEP FOUR: Use the improvement costs of each option and the phase wise deployment of these funds as the basis input for carrying out the study.

STEP FIVE: Estimate traffic levels for each option based on traffic growth rates.

STEP SIX: Estimate the operating speeds of different modes based on traffic flow conditions.

STEP SEVEN: Estimate the value of travel time for passengers (mode wise) and the commodities in transit.

STEP EIGHT: Estimate the congestion factors, which is the function of V/C ratio for traffic scenario under each option.

STEP TEN: Estimate of VOC based on the inputs to updated Road User Costs-92 Model and the deterioration of road surface by traffic load

STEP ELEVEN: Modify the VOC equations after incorporating the congestion factors (Step Nine).

STEP TWELVE: Estimate the benefits due to savings in accidents.

STEP THIRTEEN: Estimate the net benefits under each option by subtracting the costs from benefits.

STEP FOURTEEN: Estimate the EIRR for each option.

STEP FIFTEEN: Sensitivity analysis by making suitable assumptions.

STEP SIXTEEN: Finalize EIRR.

STEP SEVENTEEN: Carry out incremental investment analysis for options to justify Investments.

4.13 FINANCIAL ANALYSIS

The basic objectives of the financial analysis is to determine whether the build, operate, transfer (BOT) model is workable for the project road, and if so, under what conditions.

The Return of Equity (ROE) representing the return to the BOT operator has been calculated from the projected cash flows as the internal rate of return (IRR) of the investments made by the private investor and the free cash flows accruing to the investor over the concession period. A minimum return of 20% can be considered the cut off for considering the project viable for BOT, though this is a subjective assessment. Also, return for over 20% is likely to be demanded by the private investor after considering risks such as a short fall in revenue due to lower than projected traffic.

Analysis has been carried out by projecting the profit and loss statement and cash flow statement over the concession period of 20/30 years. The approach is to examine the viability of the project on a stand-alone basis without considering any grant from NHAI. If that is not viable the various options for the grant will be considered.

Project road will be analyzed for the following scenarios:

- Base case with no NHAI grant.
- With NHAI grant of maximum 15% (considering at NPV @10%) of project capital (Disbursement of grant up to 60% during construction period and 40% during O &M period).
- With NHAI grant of maximum 25% (considering at NPV @10%) of project capital (Disbursement of grant up to 60% during construction period and 40% during O &M period).

Basic Data Inputs

The following inputs will be considered for the financial analysis:

- Project Capital Cost
- Construction Schedule
- Operation & Maintenance Cost
- Funding Options-Debt-Equity
- Tolls Rates
- Income Tax Rate and tax Holiday
- Depreciation rate
- Traffic Volume and Growth

Financial Analysis

Base on the above inputs the economic analysis for the project road will be carried out to determine the ROE, IRR, Pay Back period, NPV and DSCR will be for the various scenarios of the project road.

Sensitivity Analysis

Sensitivity Analysis will also be carried out to examine the effect on financial viability of the project due to increase in cost and decrease in traffic. The sensitivity analysis under following condition will be analyzed:

- Increase in cost by 10 %
- Traffic Decrease by 10 %
- Increase in cost by 10 % and decrease in traffic by 10 %

CHAPTER 5

SOCIO ECONOMIC PROFILE OF THE PROJECT AREA

5.1 Socio Economic Profile State

5.1.1 General

Social Studies were carried out in order to understand socio-economic features along the project road. The purpose of social studies carried out is to identify structures falling in proposed ROW and to assess the physical and social and cultural impacts. In this regard, the relevant information was gathered by interview with peoples and the self- assessment of the issues involved, socio economic conditions, such as, household, population growth, population density, sex ratio, occupational pattern, amenities available in the settlement located along the project road have been compiled from census records.

5.1.2 Bihar - Project Influence State

Bihar is located in the eastern part of the country (between 83°-30' to 88°-00' longitude) in the lower and middle Gangetic region extending 483 Km from west to east. This state embraces some of the most fertile lands of India with a total area of 94,163 km. Bihar is bounded on the north by Nepal, on the south by Jharkhand, on the east by West Bengal and on the west by Uttar Pradesh. The Bihar plain is divided into two unequal halves by the river Ganga which flows through the middle from west to east. The State is divided into 9 divisions viz. Bhagalpur, Darbhanga, Kosi, Magadh, Munger, Patna, Purnia, Saran and Tirhut.

The State of Bihar is one of the poorest states of India in terms of the gross state domestic product per capita and the poverty incidence. The Indian government has taken initiatives, to improve the overall socio-economic environment in the country. The project road will definitely boost up the untapped agriculture activities, flooding disparities, setting up of industries, carrying of agriculture based products to the larger towns and cities of the region. Better road will attract more tourists which will add on to the economic growth. More Employment generation and poor farmers will not depend on the middlemen to sell their crops they can directly go to the cities to bargain. Schools, colleges can be developed which will lead to increased literacy rates boosting up the standards of the people.

5.1.3 Demography

Bihar has a population of 104,099,452, consisting of 54,278,157 males and 49,821,295 females. Percentage of Total Population is 17.90%, which consist of 17.75% of male population and 18.07% of female population. Literacy rate is about 63.82% of which 73.39% are males and 53.33% are females. Decadal population growth is about 25.07% since 2001. Average population density is 1,102 per sqkms. Average sex ratio of the State is 916 females per 1000 males.

5.1.4 Economy and Infrastructure

Bihar has a number of major public sector projects like the Oil refinery of Indian Oil Corporation and Fertilizer manufacturing plant of Hindustan Fertilizer Corporation Ltd (HPCL) at Barauni, Pyrites, Phosphates and Chemicals Ltd (PPCL) at Amjhor; Cotton spinning mills at Siwan, Pandaul, Bhagalpur, Mokamah and Gaya; 13 sugar mills in private sector and 15 in public section located in South and North Bihar. In addition distilleries at Gopalganj, West Champaran, Bhagalpur and Riga (Sitamarhi District); finish leather industry in West Champaran, Muzaffarpur and Barauni; Jute mills at Katihar and Samastipur; Medicine manufacturing unit at Hajipur; Food processing units and Vanaspati manufacturing units at Aurangabad and Patna; Kalyanpur Cement Ltd at Banjari are some of the notable industries in Bihar. Recently, the dairy industry has picked up very well in Bihar. Sugar industry is another one which has started to show up with 25 new sugar factories committed in Bihar. Proposed Atomic Energy Plant in Rajauli, Nawada will solve the scarcity of electricity in the state.

Bihar was the main scene of activities of the Buddha and the 24 Jain Tirthankaras. It is also one of the important places in the annals of Indian history which has seen the rise and fall of major empires. With its historical past, there are many tourist destinations especially pilgrim centers in the state like Patna, Bodhgaya, Rajgir, Vaishali and ruins of the world famous, ancient university of Nalanda, etc. Bihar's Buddhist circuit to places includes Bodhgaya, Gaya, Vaishali, etc. Apart from that, it has places of historical and national parks.

5.1.5 Religion

Gautam Buddha attained Enlightenment at Bodh Gaya, a town located in the modern day district of Gaya in Bihar. Vardhamana Mahavira, the 24th and the last Tirthankara of Jainism, was born in Vaishali around 6th century BC. In Ancient Era, Bihar was the centre of Buddhist and Jainism but in Vedic Era it was the centre of Hindu Religion.

The holy 'Ramayana' tells that Sita, wife of God Ram took birth in Bihar and behind her name the place is called Sitamarhi.

In rural Bihar, religion is the main component of popular culture. Shrines are located everywhere – even at the foot of trees, roadsides, etc., religious symbols or images of deities can be found in the most obscure or the most public places.

There are many variations on the festival theme. While some are celebrated all over the state, others are observed only in certain areas. However, Bihar is so diverse that different regions and religions have something to celebrate at some time or the other during the year. So festivals take place round the year. Many of these are officially recognized by the days on which they take place being proclaimed as government holidays.

5.1.6 Culture

Hindi and Urdu are the official languages of the state (recently Maithili is also included as one of the official languages of the state. Presently Bihari languages are considered one of the five subgroups of Hindi; however, Maithili was declared a separate language. Mithila painting is a style of Indian painting practiced in the Mithila Darbhanga, Madhubani region of Bihar.

Traditional festivals are celebrated with happiness. Some important festivals celebrated are Chatth Puja, Sama-Chakeva, Ram Navami, Makar-Sankranti, Bihula, Madhushravani, Teej, PitrapakshaMela at Gaya, Sonepur Fair.

5.1.7 Health

Improved health status is an important indicator of human development and it is important to organise an efficient health service system to attain it. Most of the people of Bihar, as elsewhere in India, depend on public health facilities. In recent years, Bihar has made significant progress in meeting some of these challenges. This may be attributed to increased expenditure on health, expansion of public health infrastructure, as well as constant and effective monitoring of the health services.

Selected Health Indicators of Bihar

One of the sensitive indicators of the health status of population is Life Expectancy at Birth (LEB). The relevant data on this indicator, both for Bihar and India, has been presented in Table 5.1. It emerges from the table that LEB in Bihar was much less than that of India during 2001-05; during 2006-2010, though LEB in Bihar is still less than that in India, the gap has been considerably reduced. During 2001-05, the LEB in Bihar was 61.0 years, compared to 63.1 years in India, implying a gap of 2.1 years.

This difference was narrowed to only 0.3 year in 2006-10 — 65.8 years for Bihar and 66.1 years for India.

Table 5.1: Life Expectancy at Birth of Bihar and India

State/India	2001-2005			2006-2010		
	Male	Female	Total	Male	Female	Total
Bihar	62.0	60.1	61.0	65.5	66.2	65.8
India	62.3	63.9	63.1	64.6	67.7	66.1

Source: Sample Registration System (SRS), Office of the Registrar General, India, Ministry of Home Affairs, GOI

Health Infrastructure

Because of limited income of the majority of the population in Bihar, their dependence on public health services is very high. In recent years, the state government has taken a number of steps to improve the functioning of the public health institutions and, consequently the number of patients visiting government hospitals has increased significantly (Table 5.2). The average number of patients visiting government hospitals per month was 3077 in 2007, which has become more than three times (9317) in 2011.

Table 5.2: Monthly Average Number of Patients Visiting Government Hospitals

(2007-2011)

Year	2007	2008	2009	2010	2011
No. of patients visiting the hospital	3077	3855	3826	4675	9317

5.1.8 Transportation in Bihar

The aspects of transportation play a vital role in the economic growth process of the area. This is particularly so from the point of view of investors to invest and support development initiatives as well as from the point of view of locals for meeting their requirements of goods and services. Hence good connectivity with rail and road is very important. Market expansion and penetration are the two major pillars for sustainable socio-economic development and both these require quality physical infrastructure support.

5.1.8.1 Road Network

The state has a vast network of National and State highways. National highways like 2, 31, 28, 23, 30, and 33 connect the state from places all over India.

5.1.8.2 Railway Network

Bihar is well-connected by railway lines to the rest of India. Most of the towns are interconnected among themselves, and they also are directly connected to Kolkata, Delhi, and Mumbai. Patna, Bhagalpur, Muzaffarpur and Gaya are Bihar's best-connected railway stations.

5.1.8.3 Airways

Bihar has three airports - Patna, Bhagalpur Airport and Gaya. Patna airport is connected to Delhi, Mumbai, Kolkata, Lucknow and Ranchi. It is categorized as a restricted international airport, with customs facilities to receive international chartered flights. Gaya airport is a small international airport connected to Colombo and Bangkok.

5.2 Nawada- Project Influence District

Nawada district is one of the thirty-eight districts of the Indian state of Bihar. Nawada is its administrative headquarters. The district is the easternmost district of the Magadh Division, one of the nine administrative division of Bihar. The area of the modern district was historically part of the Magadha, Shunga and Gupta empires. Koderma and Giridih districts of the state of Jharkhand lie on the southern border of the district; it also shares borders with the Gaya, Nalanda, Sheikhpura, and Jamui districts of Bihar. The district occupies an area of 2,494 km2 (963 sq mi)

5.2.1 Demography

Nawada has a population of 2,216,653 (as of 2011).

Table 5.3 Demography of Nawada

Demography	Nawada	Bihar
Population (2011)	2,216,653	103804637
Decadal Population Growth Rate(2001-11)	22.49%	25.07
Population Density per Sq. Km.(2011)	(2,300/sq mi)	1102

Demography	Nawada	Bihar
Sex Ratio(2011)	936	916

5.2.2 Education

The average literacy rate of the district is 75.05 %. While male literacy rate is 80.79 and female literacy rate is 68.71% according to the 2011 census data.

5.2.3 Employment Profile

The total working population is 37.70% of the total population. The main working population is 23% of the total population while the marginal working population is 14.70% .The total non working population is 62.30% of the total population.

Table 5.4 Employment profile in Nawada

Employment Profile(In lakhs)	2011
Total Population	2,003,567
Total Working Population	755,371
Main workers	460,770
Marginal Workers	294,601
Non workers	1,248,196

5.2.4 Land Use

The project road starts from Amas and terminated at Ramnagar at SH-78. As far as the land use pattern is concerned, paddy, wheat, gram, peanut, mustard are the main crops grew in the project area.

5.3 Gaya- Project Influence District

Gaya is one of the thirty-eight districts of Bihar state, India. It was officially established on 3 October 1865. The district has a common boundary with the state of Jharkhand to the south. Gaya city is both the district headquarters and the second-largest city in Bihar.

Gaya district occupies an area of 4,976 square kilometres (1,921 sq mi),comparatively equivalent to the island of Trinidad.

5.3.1 Demography

According to the 2011 census Gaya district has a population of 4,391,418, roughly equal to the nation of Moldova or the US state of Kentucky. This gives it a ranking of 42nd in India (out of a total of 640).The district has a population density of 880 inhabitants per square kilometre (2,300/sq mi) . Its population growth rate over the decade 2001-2011 was 26.08%. Gaya has a sex ratio of 932 females for every 1,000 males and a literacy rate of 66.35%.

At the time of the 2011 Census of India, 92.80% of the population in the district spoke Hindi and 7.04% Urdu as their first language.

5.3.2 Education

Schools in Gaya are either government run schools or private schools. Schools mainly use Hindi or English as the medium of instruction. The schools are affiliated with the Bihar School Examination Board, the Central Board of Secondary Education (CBSE) or the National Institute of Open Schooling (NIOS). Under the 10+2+3/4 plan, after completing their secondary education, students typically enroll in a school with a higher secondary facility affiliated with the BSEB, the NIOS or the CBSE. Students usually choose from one of three streams — liberal arts, commerce, or science, though vocational streams are also available. Upon completing the required coursework, students may enroll in general or professional degree programmed.

5.3.3 Employment Profile

The total working population is 37.07% of the total population. The main working population is 25.56% of the total population. While the marginal working population is 11.51% .The total non working population is 54.62% of the total population.

Table 5.6 Employment profile in Gaya

Employment Profile(In lakhs)	2011
Total Population	2877653
Total Working Population	1045420
Main workers	740949
Marginal Workers	304471
Non workers	1832233

5.3.4 Agriculture:

Agriculture is the main source of occupation. The farmers mainly grow paddy, apart from it they grow Potato, and Onion. Few people of the district are also involved in

handloom weaving. Since the district is a famous tourist destination, tourism plays a vital role in the economy of Gaya

5.4 Patna – Capital of Bihar

Patna is one of the oldest continuously inhabited places in the world. Patna was founded in 490 BCE by the king of Magadha. Ancient Patna, known as Pataliputra, was the capital of the Magadh Empire under the Ancient Patba, known as Pataliputra, was the capital of the Magadh Empire under the Haryanka, Nanda, Maurya, Shunga, Gupta and Pala empires. Chakravarti Ashoka Samrat, the greatest king of Ancient India and Magadh Empire was born in Pataliputra.

5.4.1 Demography

The district is home to about 58.4 lakh people, among them about 30.8 lakh (53%) are male and about 27.6 lakh (47%) are female. 84% of the whole population are from general caste, 16% are from schedule caste and 0% are schedule tribes. Child (aged under 6 years) population of Patna district is 16%, among them 52% are boys and 48% are girls. There are about 9.8 lakh households in the district and an average 6 persons live in every family.

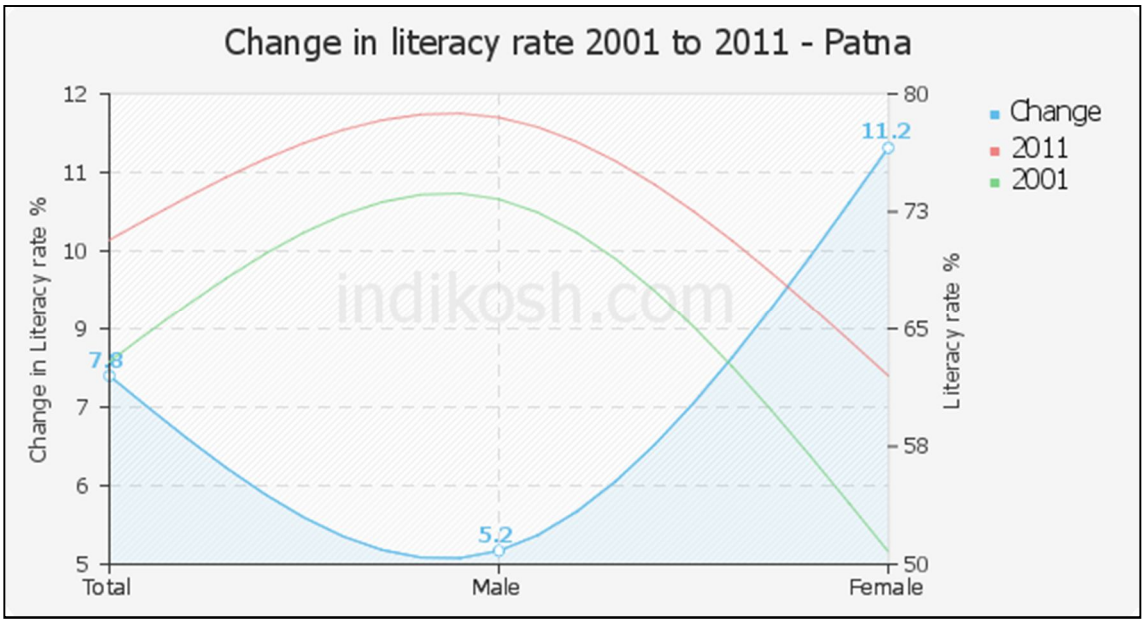
The majority of the population, nearly 57% (about 33.2 lakh) live in Patna District rural part and 43% (about 25.1 lakh) population live in the Patna District urban part. Rural population density of Patna district is 1134 and urban population density is 9321 persons per km2.

Table 5.8 Demography of Patna

Demography	Patna	Bihar
Population (2011)	5838465	103804637
Decadal Population Growth Rate(2001-11)	22.34	25.07
Population Density per Sq. Km.(2011)	1823	1102
Sex Ratio(2011)	897	916

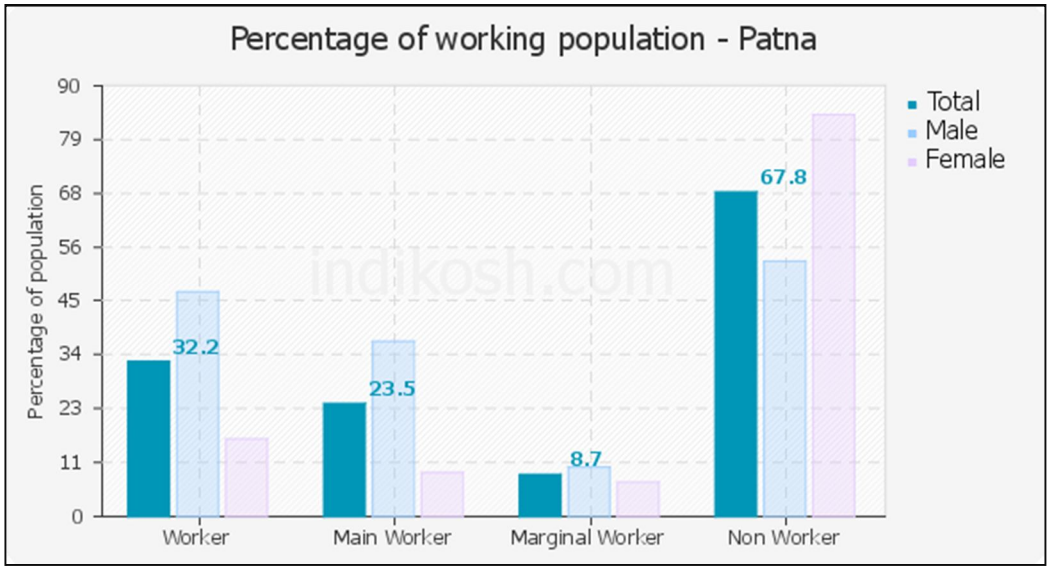
5.4.2 Education

Total about 34.6 lakh people in the district are literate, among them about 20.3 lakh are male and about 14.3 lakh are female. Literacy rate (children under 6 are excluded) of Patna is 71%. 78% of male and 62% of female population are literate here. Overall literacy rate in the district has increased by 8%. Male literacy has gone up by 5% and female literacy rate has gone up by 11%.



5.4.3 Employment Profile

Patna has 32% (about 18.8 lakh) population engaged in either main or marginal works. 47% male and 16% female population are working population. 36% of total male population are main (full time) workers and 10% are marginal (part time) workers. For women 9% of total female population are main and 7% are marginal workers.



5.4.4 Agriculture:

Three Rivers Ganga, Son and Punpun pass through Patna District and these three rivers cause flood in the district. These rivers also affect the agriculture and its products.

Paddy, wheat and pulses like gram, lentil are the major crops of the district, Onion and potato are also grown here.

5.7 Habitation/towns/villages

As part of project preparation, it is found that the project road traverses through many urban and sub-urban area of

S.No	Settlements	S.No	Settlements
1	Shiwrampur	17	Karhara
2	Berka	18	Gandhar
3	Damodarpur	19	Habalipur
4	Chandi	20	Charui
5	Chariyari	21	Dhobri
6	Mahewa	22	Deora
7	Kalanpur	23	Sadipur
8	Malathi	24	Jehanbad
9	Berthoo	25	Amarpura
10	Suppi	26	Manik Bigha
11	Kaji Sarai	27	Pabhera
12	Ibrahimpur	28	Tarwan
13	Golakpur	29	Abupur
14	Mohiuddinpur	30	Hulas Chak
15	Ahiasa	31	Andari
16	Mahammadpur	32	Ramnagar

5.9 Cultural and Religious properties

Under the project impact zone, there is no cultural or religious property protected by the Archeological Survey of India. However, the famous ancient Nalanda and Rajgir, the capital of Gupta Dynasty is about 20 - 30 kilometer far from the project stretch.

Land Acquisition

Land Acquisition will be done as per NH Act 1956 and the details of land acquisition will be finalized after the acquisition.

CHAPTER – 6

DESIGN STANDARDS

6.1 GENERAL

The project road is construction of New Green Filed Alignment from Shivrampur to Ramnagar in the state of Bihar. The major portion of the road has agricultural land with a number of villages on either side of the road. This is a complete new alignment with 45m ROW.

Considering the physical constraints and high costs likely to be involved in the widening of the highway, it is considered desirable that a new green field alignment shall be proposed for the inter corridor route and developed under two sets of standards, namely:

The desirable standards, which could be adopted as a rule.

The minimum standards, which could be accepted for difficult stretches where application of the desirable standards, would lead to exorbitant costs.

Accordingly design standards for geometric elements have been proposed under "desirable" and "minimum" categories. These proposed standards are consistent with and fall within the parameters recommended in the related standards of the Indian Roads Congress (IRC).

6.2 TERRAIN CLASSIFICATION

The following terrain classification recommended by IRC SP-84 2014 is proposed to be adopted:

Terrain Classification country	Percentage cross slope of the
Plain	0-10
Rolling	>10-25

As the percentage cross slope is less than 10%, the project road lies in plain terrain.

6.3 DESIGN SPEED

Design speed is the basic parameter, which determines geometric features of the road. The proposed design speeds for different terrain categories are as follows:

Terrain Classification	Design Speed (Km/hr)	
	Desirable	Minimum
Plain	100	80
Rolling	100	80

As the road lies in the plain terrain, the corresponding design speed of 100 kmph will be used for 4-lane carriageway and is recommended for the stretches passing through rural area. However, road stretches passing through built-up areas, the lower speeds corresponding to rolling terrain are proposed to be adopted.

6.4 CROSS - SECTIONAL ELEMENTS

6.4.1 Lane Width

The width of basic traffic lane is taken to be 3.5 m. Thus for 2-lane carriageway, the carriageway widths will be 7.0 m. For the 4- lane divided carriageway cross-section, 0.5 wide edge strip as compensation for kerb shyness is proposed.

6.4.2 Paved Shoulders

As per IRC:SP:84-2014, the configuration of the paved shoulder shall be of 2.5m on either side of the carriageway for Open Country with Isolated Built Up areas. As our project stretch lies in Green Field, here 2.5m width paved shoulder is applicable.

6.4.3 Earthen Shoulders

As per IRC:SP:84-2014, the configuration of the earthen shoulder shall be of 1.5m on either side of the carriageway Open Country with Isolated Built Up areas. As our project stretch lies in Green Field, here 1.5m width earthen shoulder is applicable. The earthen shoulder shall be filled with suitable granular material to avoid the soil erosion.

6.4.4 Median

The highway will be developed with depressed median of width 7m for open country sections in which concrete drain shall be constructed in the median gap to avoid water logging.

For the structure locations along with the approaches, the median width is taken as 5m including the kerb shyness and the crash barrier. The kerb shyness shall be adopted as 500mm.

6.4.5 Side Slopes

For fill sections, the following side slopes are proposed:

Fill height up to 3.0 m	-	1H: 1V
Fill height from 3.0 m to 6.0 m	-	1.5H: 1V

Fill height exceeding 6.0 m	-	2H: 1V

Cut Slopes will be as follows:

Soil and phyllite material	-	1H: 1V

6.5 SIGHT DISTANCE

Safe stopping sight distance, both in the vertical and horizontal directions will apply in design. The sight distance values as per IRC-73-2018 recommendations are as follows:

Design Speed (km/hr)	Safe stopping sight distance (m)
100	180
80	120
60-65	90

6.6 HORIZONTAL ALIGNMENT

The proposed widening will be parallel and in line with the existing highway after the later has been corrected for any geometric deficiency minimizing the land acquisition to the maximum extent. The new alignment in the bypass stretch has been designed as per IRC standards along the approved alignment.

Adopting a maximum value of 7% for super elevation and 15% for side friction factor, the minimum radius for horizontal curves works out to be as follows:

Terrain Classification	Absolute Desirable	Minimum
Plain / Rolling	250	400

6.7 VERTICAL ALIGNMENT

The vertical alignment of the widening carriageway will generally be compatible with that of the existing carriageway, except for cases where alignment of the new carriageway deviates from the existing one. The following criteria shall in general be followed while designing vertical curves:

At locations of grade break of 0.5% or more, suitably designed vertical curves will be provided. For other cases, short length curves will be provided for smoothening the profile.

The length of designed vertical curve will be not less than 0.6V (kmph)

6.7.1 Gradient

The gradients recommended by IRC-73-2018 for the different terrain classes are as follows :

Terrain Catégories	Gradient (%)	
	Ruling	Limiting
Plain and Rolling	2.5	3.3

The gradient for the widening carriageway will be compatible with that of the existing carriageway after making necessary flattening as considered necessary and feasible. Where the new carriageway is not parallel to existing road, its grade line will be designed independently adopting the ruling gradient for design control.

6.7.2 Vertical Curves

Vertical curves will be designed to provide for visibility at least corresponding to the safe stopping sight distance. More liberal values will be adopted wherever this is economically feasible. Valley curves will be designed for headlight sight distance. The 'K' values for design control and the minimum length of vertical curves will be as follows.

Terrain categories	'K' value for summit curves		'K' value for valley curves		Minimum length of curve (m)
	Desirable	Minimum	Desirable	Minimum	
Plain	74	38	42	28	60

6.8 CROSSFALL

Each carriageway will have unidirectional crossfall. Each carriageway will have unidirectional crossfall. The crossfall for the pavement and paved shoulders will be 2.0%. For earthen shoulders, the corresponding value will be 2.5% in case of Rigid Pavement.

6.9 GEOMETRIC DESIGN CONTROL

Widening to 2-lane:

One of the important aspect of the widening works to 2-lane lies in the art of widening to one side only to the maximum extent possible. This will facilitate construction as well as traffic management during construction. However widening in built-up area may call for concentric widening for requirement of higher formation width (for including paves shoulders for parking, footpath, drains etc) till property line.

Widening to 4-lane:

One of the important aspect of the widening works to 4- lane lies in the art of accommodating the new carriageway within the existing ROW to the maximum extent possible. This will call for positioning the new carriageway by the side of the existing one, or to carry out concentric widening in difficult situations, and also by reducing the median width.

For the divided carriageway in rural stretches, the median width of 5.0m will be reduced to 1.2m depending on the intensity of constraining features.

For ensuring consistent, compatible and aesthetically acceptable geometries for the upgraded highway, the following step-by-step procedure has been adopted.

a. All the horizontal curves on the existing highway have been examined for radius. All the curves having radius less than desirable standards have been examined for
Feasibility of flattening with reference to land availability, connectivity to adjoining
curves, affected length and other related factors.

b. For eccentric widening cases in 4-lane cases, with a view to eliminating kinks in the alignment, the kerb line have been fixed by cutting into the existing pavement edge to the extent upto 300 mm. The other kerb line is fixed parallel to this.

c. The profile along the existing highway has been similarly examined for gradient,
Stretches having gradient exceeding ruling standards examined for flattening and
Geometric improvements worked out accordingly.

d. Once the geometric improvements as at (a), (b) and (c) above for the existing highway are decided, the widening carriageway more or less follows the corrected geometries of the existing highway.

Transition between sections with different median widths has been considered as part of horizontal design and all transitions are covered through horizontal design standards. The approach has been adopted to have better driving / geometric consistency.

6.10 ROADWAY WIDTH AT CROSS-DRAINAGE STRUCTURES

6.10.1 Culverts

The culverts have been proposed of 14.0 m Carriageway in 2 Lane and 19.5 in 4 Lane. For four- lane where required median width varies according to the proposed TCS as per the availability of Existing ROW at that place. All Culverts proposed are either pipe or box or solid slab type depending upon discharge and fill condition.

6.10.2 Minor Bridges (Length up to 60 m)

The minor bridges will have 11.0 m Carriageway width. For 4-lane carriageways median varies in built up section. Superstructure proposed with RCC solid slab or with RCC T-beam and deck slab, sub-structure with RCC wall type piers and abutments. As general nature of soil for foundation is Sandy silty or rocky, open foundation, pile or box type structure are proposed depending on load conditions and soil characteristics.

6.10.3 Major Bridges (Length > 60 m)

Major bridges along the new carriageway are proposed to be built with roadway width of 11.0 m. For major bridges superstructure with RCC T-beam or PSC box or PSC T-beam composite structure proposed. As soil strata is mainly Sandy silty or rocky pile or open foundation proposed depending up on load and soil characteristics.

6.10.4 Public Underpasses

Underpasses along the new carriageway are proposed to be built to a roadway width of 11.0 m. Underpass are with 3.5 mt clear height. Underpasses are RCC box type proposed for this corridor.

Loading Standards for Bridge Structures

The following are normal loading standars to be follwed for the design of bridges.

a) Dead Load

The Dead load carried by girder or slab shall consist of the prtion of the weight of the
superstructre which is supportd wholly by the member as specified in clause 205 of
IRC:6-2017

b) Live Load

i) Live Load –for 3-Lane carriageway

IRC class A three lane or
IRC Class A single Lane + 70R (wheel) single lane
IRC Class A single Lane + 70R (track) single lane
at different span positions whichever gives maximum effect to be considered.

ii) Live Load –for 2-Lane carriageway

IRC class A two lane or
70R (wheel) single lane
70R (track) single lane
at different span positions whichever gives maximum effect to be considered.

c) Footpath Live Load

For Footpath Live Load clause. 209.3 of IRC:6-2017 is followed.

d) Wind Load

The wind forces shall be considered to act horizontally and in such a direction that the resultant stresses in the member under consideration are maximum following clause 212 of IRC:6-2017.

e) Water Current Forces

Any part of the bridge which may be submerged in running water shall be designed to sustain safely the horizontal pressure due to the water current force and as mentioned in clause 213 of IRC: 6-2017.

f) Longitudinal Forces

Longitudinal forces due to Braking effect and due to reaction at bearings considered as mentioned in clause 214 of IRC: 6-2017.

g) Seismic Forces

As corridor comes in Zone V, seismic forces both longitudinal and transverse direction as specified in Clause 222 of IRC: 6-2015 will be followed.

6.11 STANDARDS FOR JUNCTIONS

Grade separated junctions at major intersections have been proposed as found necessary. The design standards adopted are as follows:

a) Design Speed

The proposed design standards for this element are as under:

For turning movements, the minimum radius of 30 m for major roads and 15 m for minor roads is recommended.

b) Radius / Design Speed

Sl. No.	Design Speed	Radius (m)
1	20	27
2	30	32
3	40	37
4	50	41

c) Gradient

Maximum gradients proposed are:

Desirable = 2%
Absolute = 5%

d) Summit and Valley Curves for Interchanges

Both summit and valley curves would be designed for stopping sight distance subject to a minimum length equal to 0.6 V, where V = Design Speed in Km/h.

e) Cross-Sectional Elements

The desirable carriageway width for two lanes is 7.0 m. The width of paved shoulders would be 1.5m on either side. The recommended cross falls are 2.0% and 2.5% for carriageway and untreated shoulder portions respectively.

6.12 STANDARDS FOR AT-GRADE INTERSECTIONS

The standards proposed in IRC SP: 41 "Guidelines for the Design of At-Grade Intersection in Rural and Urban Areas" have been applied.

6.13 DRAINAGE

Trapezoidal shaped open drains connected to natural outfall have been proposed for drainage of roadside land. Two types of drains are proposed. These are:

- *Rectangular drain with road side protected by masonry/concrete slab wall:* This has been applied in the urban sections.

- *Trapezoidal lined drain :* This will apply to drains with erodible bed and carrying
  medium to high discharge.

At high embankments (height exceeding 6 m) a system of kerbing at edge of paved shoulders and chuting at 25 m intervals is proposed to safely dispose off surface water without erosion.

Chapter-7

Traffic Survey and Analysis

7.0 GENERAL

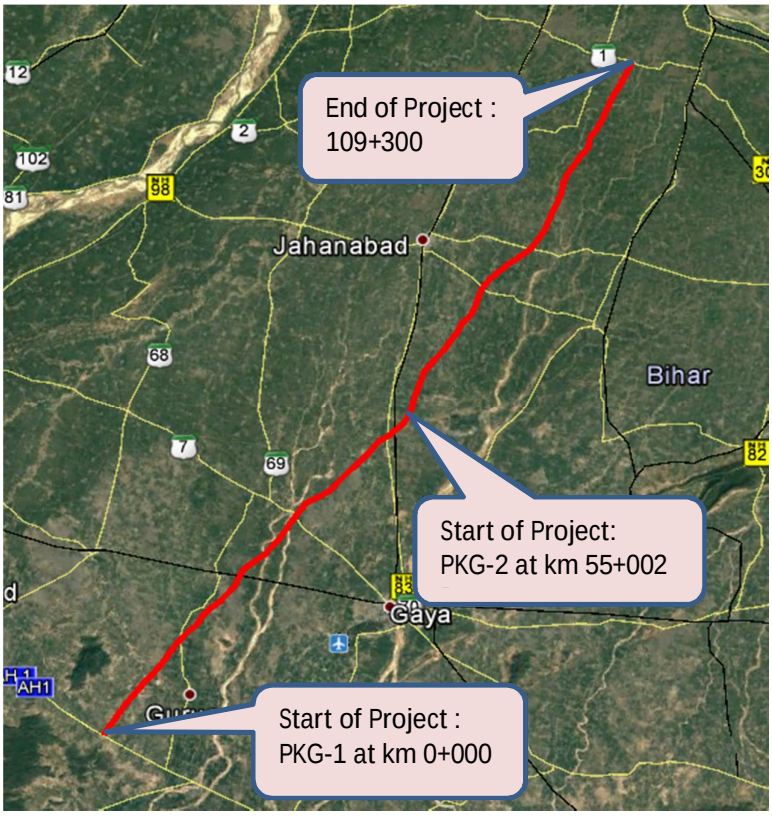
There is a requirement to conduct the traffic survey for Preparation of DPR for development of Economic Corridors, Inter Corridors and Feeder Routes to improve the efficiency of freight movement in India under Bharatmala Pariyojana (Lot-5/Package-7) from Shivrampur to Ramnagar of Aurangabad to Anishabad Section. The classified traffic volume count and origin-destination survey is conducted to find out the trend of the traffic near the project influence area (PIA). Traffic zones are created to find out the normal, induced and diverted traffic on our project stretch.

7.1 REQUIREMENT OF CLASSIFIED TRAFFIC VOLUME

Count of traffic is the basic traffic study required in connection with many types of highway projects. Knowledge of the vehicular traffic using a road network is important for understanding the efficiency at which the system works at present and the general quality of service offered to the road users. The traffic using a road consists of a variety of vehicles ranging from the simple pedal cycles to the motor car and the heavy commercial vehicles, each type having an influence on the performance of the road on its own way. A simple volume count, without classifying the vehicles into distinct types, is of limited use. The normal practice is to take classified traffic volume count to evaluate the traffic plying on a road project.

Classified traffic counts were carried out for a period of 7 consecutive days at mid-block locations along 2 corridors. The locations selected were at the outskirts of city where the local traffic is low and regional traffic is high. The surveys were carried out mainly by trained enumerators. The data served as population base during base year and will be used to project traffic The Survey locations are presented in Figure 1.

Figure: 1 Key Plan



7.2 TRAFFIC SURVEY LOCATIONS

Following are the traffic survey locations given in **Table 7.1**

Table 7.1: Survey Location and Periods

S.No.	Type of Survey	Location Code	Location Name	Road Name	Remark
1	Traffic Volume Count	TVC - 01	Sarwan	NH-83	7 Days
		TVC - 02	Sawkala Toll Plaza	NH-02	7 Days

7.3 PCU

The Passenger Car Unit (PCU) recommended by IRC: 64-1990 and adopted values have been used for analysis. These values are given in **Table 7.2**

Table 7.2: PCU Factors

Type of Vehicle	PCU Factor	Type of Vehicle	PCU Factor
Two Wheeler/ Class 0	0.5	**LCV/Tempo**	1.5
Three Wheeler/ Auto Rickshaw	1	**Tractor With Trailer**	4.5
Car / Jeep / Van	1	**Tractor Without Trailer**	1.5
LMV	1	**Class 15**	0.5
Bus	3	**Cycle**	0.5
2- Axle	3	**Cycle Rickshaw**	1.5
3-Axle	3	**Bullock Cart**	6
Multi- Axle	4.5	**Other**	3

7.4 ANALYSIS OF TRAFFIC DATA

7.4.1 Average Daily Traffic

The Analysis of traffic volumes over 7 days at each of the three locations show that the Average Day traffic. The details are presented in **Table -7.3**

Table 7.3: AVERAGE DAILY TRAFFIC

Mode	**TVC – 01**	**TVC - 02**
	Sarwan	**Sawkala Toll Plaza**
2-Wheeler	5000	4097
Car/ Van/ Jeep/ Taxi	6055	11239
Auto Rickshaw	623	141
Bus	410	1243
LCV	2482	2457
2 Axle Truck	452	1262

Mode	TVC – 01	TVC - 02
	Sarwan	Sawkala Toll Plaza
3 Axle Truck	424	2230
MAV	36	110
Agri. Tractor	203	25
Agri. Tractor + Trailer	53	482
Cycle	63	45
Cycle Rickshaw	0	0
Construction Vehicle	0	7
Total Vehicle	**15800**	**23339**
Total PCU	**17492**	**34077**

7.4.2 Annual Average Daily Traffic

The ADT described in Table 3 does not describe the true volume of traffic on an average day. To truly display the effect of different seasons and demand variations and reflect the true volumes on an average day, the consultants collected monthly sales of petrol and Diesel from representative fuel stations to identify the variation in sale of these fuels by month. The sale of these fuels in the month of November, when these surveys were carried out was indexed with the sales during entire year and the estimated seasonal correction was applied separately for the vehicles propelled by petrol and diesel. The seasonal correction factor SCF is presented in **Table – 7.4**

Table 7.4: SEASONAL CORRECTION FACTOR (SCF) FOR DIFFERENT LOCATIONS

Location Code	Location Name	SCF	
		Petrol	Diesel
TVC - 01	Indian Oil	1.02	1.06
TVC - 02	HP Petrol Pump	1.02	1.06

The Annual Average Day Traffic AADT is estimated after applying the SCF. The mode wise traffic is presented is **Table – 7.5**

Table 7.5: ANNUAL AVERAGE DAILY TRAFFIC

Mode	TVC - 01	TVC - 02
	Sarwan	Sawkala Toll Plaza
2-Wheeler	5099	4179
Car/ Van/ Jeep/ Taxi	6176	11464
Auto Rickshaw	635	144
Bus	435	1318
LCV	2630	2604
2 Axle Truck	479	1338
3 Axle Truck	449	2364
MAV	38	116
Agri. Tractor	215	27
Agri. Tractor + Trailer	56	511
Cycle	63	45
Cycle Rickshaw	0	0
Construction Vehicle	0	8
Total Vehicle	**16277**	**24117**
Total PCU	**18173**	**35583**

7.4.3 Directional Distribution of Traffic

The directional distribution of CVC data for Sarwan & Sawkala Toll Plaza is shown in the table. The details are presented in **Table – 7.6.**

Table 7.6: DIRECTIONAL DISTRIBUTION OF AVERAGE DAY TRAFFIC

Mode	TVC - 01		TVC – 02	
	Sarwan		Sawkala Toll Plaza	
	Patna to Gaya	Gaya to Patna	Aurangabad to Dhobhi	Dhobhi to Aurangabad
2-Wheeler	2600	2400	2130	1966
Car/ Van/ Jeep/ Taxi	3149	2906	5844	5395
Auto Rickshaw	324	299	73	68
Bus	213	197	646	597
LCV	1117	1365	1278	1179
2 Axle Truck	203	249	656	606
3 Axle Truck	191	233	1160	1070
MAV	16	20	57	53
Agri. Tractor	106	97	13	12
Agri. Tractor + Trailer	27	25	251	232
Cycle	33	30	23	22
Cycle Rickshaw	0	0	0	0
Construction Vehicle	0	0	4	3
Total Vehicle	**7978**	**7821**	**12136**	**11203**
Total PCU	**8640**	**8852**	**17720**	**16357**

7.4.4 Traffic Composition

The traffic has been analysis in term of two broad categories namely fast vehicles and slow vehicles. It could be observed that the share of light fast traffic is highest followed by heavy fast vehicles and show traffic. The details are presented in **Table 7.7.**

Table 7.7: TRAFFIC COMPOSITION

Mode	TVC – 01	TVC - 02
	Sarwan	Sawkala Toll Plaza
Fast Traffic	15737	23294
Slow Traffic	63	45
Total Vehicle	**15800**	**23339**
Total PCU	**17492**	**34077**

7.4.5 Day wise Variation of Traffic

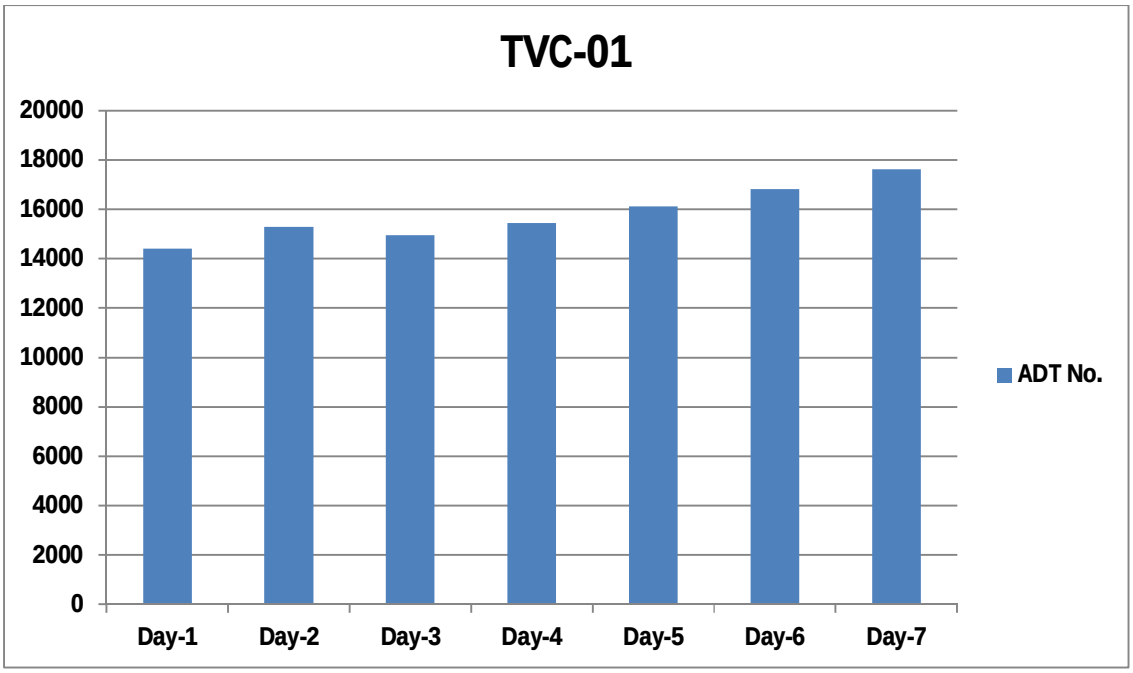
The traffic along the regional routes varies by day on account of the local factors like weekly markets, land use, traffic regulations etc. or due to regional factors like industries or any other factors. Traffic demand on a peak day may lead to excessive congestion and delays as the road infrastructure is unable to cope with the demand. This trend is witnessed at the project along which traffic counts were carried for this project too. The details are presented in **Table – 7.8**

Table 7.8: DAY WISE VARIATION OF TRAFFIC

TVC – 01		TVC – 02	
Sarwan		Sawkala Toll Plaza	
Day	**Vehicles**	**Day**	**Vehicles**
18-Oct 2019	14399	**18-Oct2019**	23174
19-Oct2019	15273	**19-Oct2019**	22560
20-Oct2019	14937	**20-Oct2019**	22613
21-Oct2019	15428	**21-Oct2019**	23258
22-Oct2019	16124	**22-Oct2019**	23428
23-Oct2019	16817	**23-Oct2019**	23951

24-Oct2019	17620	**24-Oct2019**	24388

7.4.6 Variation of Traffic, Day wise Variation of Traffic and Composition of Traffic of ADT graphically presented in Figure 2 to 5.



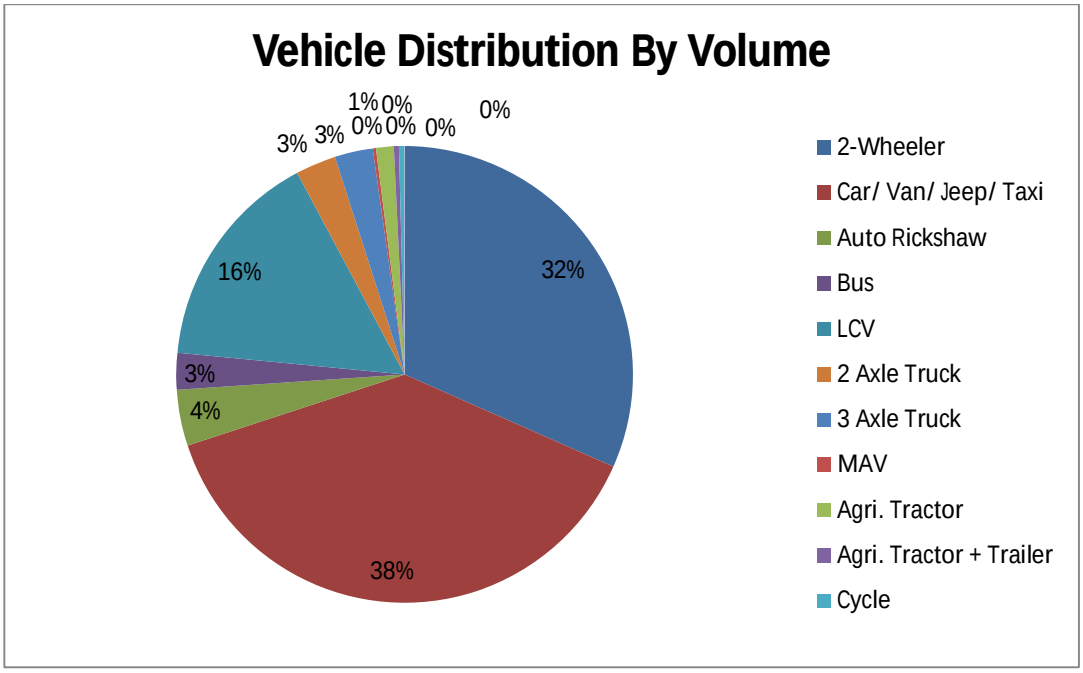
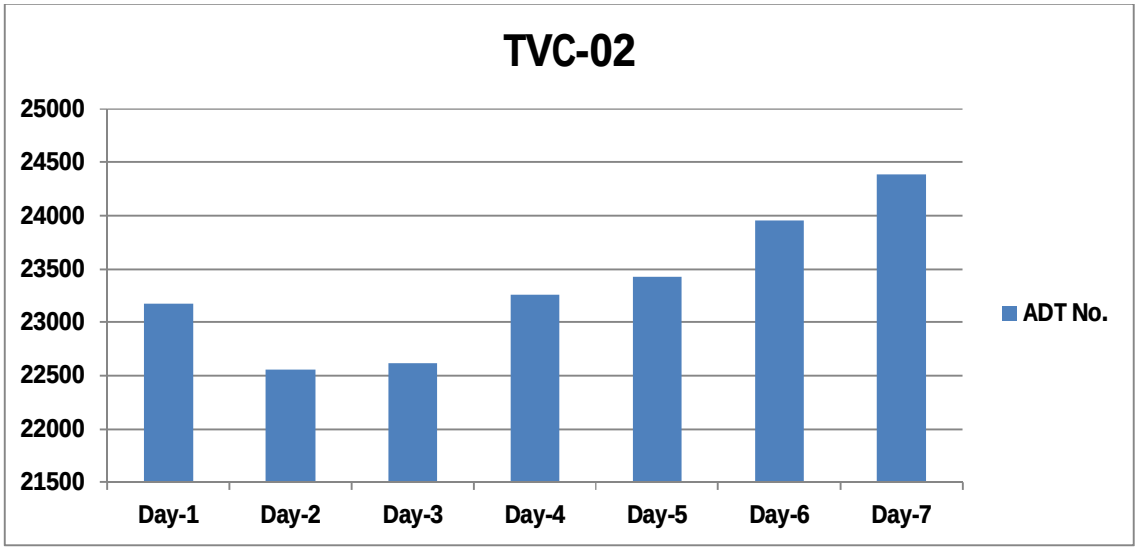


Figure :- 2,3(1st TVC Data)



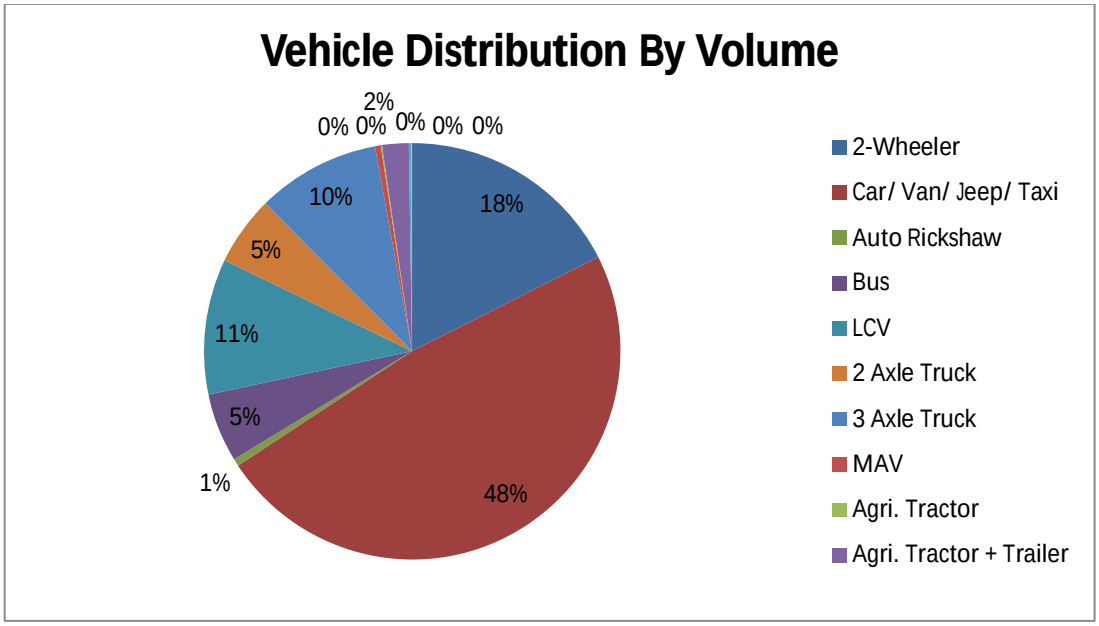


Figure :-4,5(2nd TVC Data)

7.5 TRAFFIC GROWTH RATE AS PER ECONOMETRIC METHOD IRC-108

Traffic growth on a road facility is generally estimated on the basis of historical trends, in the present case traffic growth rates are estimated using econometric methods. Demand changes are usually because of shifts in the pattern of economic activities in the surrounding regions.

7.5.1 METHODOLOGY FOR TRAFFIC GROWTH RATE ESTIMATION

The exercise of traffic growth rate estimation has been carried out by us using the elasticity approach. The elasticity method relates traffic growth to changes in the related economic parameters. According to IRC: 108 – 2015, elasticity based econometric model for highway projects could be derived in the following form:

$$\text{Loge}(P) = A0 + A1\ \text{Loge}(EI)$$

Where;

P = Traffic volume (of any vehicle type)

EI =Economic Indicator (GDP/NSDP/Population/PCI) A_0 = Regression constant

A_1 = Regression co-efficient (Elasticity Index)

The main steps followed are:

- Defining the project influence area from OD analysis of travel pattern.
- Estimating the past elasticity of traffic growth from time series of registered vehicles of influencing state(s).
- Assessment of future elasticity values for major vehicle groups, namely, car, bus and truck.
- Study of past performance and assessment of perspective growth rates of state economies of influence area.

The elasticity values will be obtained by fitting log-log regression between the registered vehicle types (car, bus and commercial vehicles) and NSDP, Population and Per-capita income of influencing states and GDP of India. The influencing states obtained from the Origin-Destination survey include Rajasthan, Haryana, Punjab, Gujarat and Rest of India. The regression analysis will be carried out using various combinations of economic indicators and population of registered vehicles and the elasticity values resulted from the best fit equations will be used in estimating growth rates.

7.5.2 PAST VEHICLE REGISTRATION DETAILS

In order to analyses the vehicle growth in the states, the vehicle registration data of Bihar and India have been collected and presented in **Table 7-9** below.

Table 7-9 REGISTERED VEHICLES DATA

Registered Vehicles						
Registered Vehicles of BIHAR						
Year	**Two Wheeler**	**Cars**	**LCV**	**Buses**	**Trucks**	**Total Vehicles**
2004-05	903261	133647	42050	16158	49437	**1351938**
2005-06	964594	141457	45365	16271	50016	**1432343**
2006-07	1077579	154622	48123	17192	52005	**1577383**
2007-08	1197875	170116	54153	18533	54414	**1739140**
2008-09	1364757	190204	62576	19654	58012	**1959553**
2009-10	1606613	292367	74968	21209	66485	**2356986**
2010-11	1899017	256346	92390	22703	73472	**2673209**
Registered Vehicles of INDIA						
Year	**Two Wheeler**	**Cars**	**LCV**	**Buses**	**Trucks**	**Total Vehicles**
2004-05	58799702	10320314	3753603	892787	2718597	**81501719**
2005-06	64743126	11526444	4084529	992084	2951779	**89618267**
2006-07	69128762	12649179	4871283	1350255	2945046	**96707260**
2007-08	75336026	13949829	5338206	1427221	3166553	**105352854**
2008-09	82402105	15312586	5839985	1485605	3347558	**114951033**
2009-10	91597791	17109410	6542521	1527101	3504491	**127745972**
2010-11	101864582	19231143	7320519	1603826	3760864	**141865607**

7.5.3 PAST GROWTH OF ECONOMY

Growth of traffic on the project road is influenced by existing development and future growth prospects of the connecting regions. The time series data of states income NSDP at constant (2004-05) prices, state population, per-capita Income of PIA states and GDP as published by Central Statistical Organization have been collected and studied to assess the past performance of influencing state economies. Table 7-10 depicts the growth of economic indicators (The datum for GDP and other income levels have been modified to 2004-05prices).

Table 7-10: ECONOMIC INDICES OF STATES AND INDIA AT CONSTANT PRICES (2004 - 05)

Year	*NSDP (Corers.)*	*PCI (Rs)*	*Populations*
Bihar			
2004-05	70167	7914	89264
2005-06	70447	7813	90752
2006-07	83846	9150	92208
2007-08	90133	9685	93633
2008-09	103867	10994	95026
2009-10	115131	12012	96389
2010-11	132488	13632	97720
2011-12	150398	15268	99020
India			
2004-05	2971464	24143	1095722
2005-06	3253073	26015	1112186
2006-07	3564364	28067	1128521
2007-08	3896636	30332	1144734
2008-09	4158676	31754	1160813
2009-10	4507637	33843	1176742
2010-11	4885954	35993	1192506
2011-12	5202514	37851	1192506

Source: Central Statistical Organization (CSO), Govt. of India

7.5.4 TRANSPORT DEMAND ELASTICITY

The elasticity approach was used for determining growth rates of future traffic. Since time series traffic data on project road is not available, traffic growth rates and elasticity values are established by using registered vehicles as dependent variable.

Regression analysis was carried out on the database to arrive at the transport demand elasticity and growth rates using each category of vehicle with various combinations of economic parameter and population. The resultant elasticity values, growth rates, R^2 values and t-statistic are presented in Table 7-11 based on best fit.

Table 7-11: OBSERVED TRANSPORT DEMAND ELASTICITY VALUES AND TRAFFIC GROWTH

Vehicle Type	Parameter	Elasticity	R-square
Bihar			
Two wheeler	PCI	1.13	0.98
Car	PCI	1.2	0.84

Vehicle Type	Parameter	Elasticity	R-square
Bihar			
LCV	NSDP	1.2	0.97
Bus	Population	0.5	0.98
Trucks	NSDP	0.6	0.94
India			
Two wheeler	PCI	1.14	0.98
Car	PCI	1.32	0.99
LCV	NSDP	1.36	1
Bus	Population	1.29	0.84
Trucks	NSDP	0.63	0.97

7.5.5 PROJECTED TRANSPORT DEMAND ELASTICITY

In order to arrive at realistic future elasticity values for the project road, various factors relating to vehicle technology changes besides character of traffic and travel pattern on the project road have been considered.

High elasticity of cars being witnessed now is because of large demand facilitated by financing schemes and loans. Factors like growth of house hold incomes (particularly in urban areas), reduction in the prices of entry-level cars, growth of the used car market, changes in life style, growing personal incomes, desire to own a vehicle facilitated by availability of loans/financing schemes on easy terms, etc. have all contributed to the rapid growth in ownership of cars. However, such trend would slow down and elasticity can be expected to decline.

Over the years there is a change in passenger movement with more and more people shifting towards personalized modes. Moreover, the buses are usually plying on fixed pre-decided routes and thus elasticity values for buses have been considered accordingly.

Presently, the trend of gradual replacement of three axle trucks by MAVs also observed in many areas, leading to reduction in numbers of 3 axle trucks. This shift has already been observed in various areas of the country.

The transport demand elasticity by vehicle type, over a period of time, tends to decline and approach unity or even less. As the economy and its various sectors grow, every region tends to become self- sufficient. Moreover, much of the past growth has been associated with the country's transition from a largely rural subsistence economy to cash-based urban economy, dominated by regional and national linkages. As the transition proceeds, its impact on transport pattern can be expected to become less dominant. Therefore, the demand for different type of vehicles falls, over time, despite greater economic development. In other words the values of elasticity tend to decrease with economic development in future years due to changes in the structure of economy, with higher contribution from service sector and higher value of industrial outputs. The same is also clear from

the relationships of the economy and transport demand elasticity over time nationally and internationally.

7.5.6 PERSPECTIVE GROWTH: STATES& NATIONAL ECONOMIES

Against this background, any agenda for future growth of the state economies has to take into account past trends, future prospects, and the emerging challenges. The growth prospects for the subject states have been developed taking into consideration the past performance of the state economies and the economic growth envisaged for the future. The pace with which the regional economies grow with the envisaged growth of the state is a major contributing factor in growth of traffic.

Based on the present composition of goods vehicles, overall growth of goods vehicles and average load carried by each vehicle type, tonnage has been calculated for 5 year blocks for the present and future composition of traffic. The difference in the present and future tonnage gives the additional traffic due to change in modal share which has been converted into vehicles. On this basis the growth rates of the commercial vehicles have been moderated keeping the overall growth of trucks constant.

Normally, the growth potential of passenger traffic depends on the population, per capita income and economic growth rates. As discussed above, the population is used to project these modes due to its good correlation with their respective growth.

Considering all the above discussed points, the growth rates were conceived using method discussed earlier and are modified accordingly given in table 7-12.

Table 7-12: Estimated Traffic growth rates (%)

Years	Two Wheeler	Cars	LCV	Buses	Trucks
2018-2022	7.21%	7.45%	6.12%	3.00%	3.18%
2023-2027	5.99%	6.20%	4.84%	2.49%	2.52%
2028-2032	5.16%	5.33%	4.01%	2.14%	2.08%
2033-2037	4.54%	4.70%	3.42%	1.89%	1.78%
2038-2042	4.07%	4.21%	2.98%	1.69%	1.55%
2043-2047	3.69%	3.82%	2.64%	1.53%	1.37%
2048-2052	3.38%	3.50%	2.37%	1.41%	1.23%

As per IRC-108: 2015 traffic growth rate should not be less than 5%. The final adopted growth rates are given in **Table 7-13**.

Table 7-13: ADOPTED TRAFFIC GROWTH RATES (%)

Years	Two Wheeler	Cars	LCV	Buses	Trucks
2018-2022	7%	7%	6%	5%	5%
2023-2027	6%	6%	5%	5%	5%
2028-2032	5%	5%	5%	5%	5%
2033-2037	5%	5%	5%	5%	5%
2038-2042	5%	5%	5%	5%	5%
2043-2047	5%	5%	5%	5%	5%
2048-2052	5%	5%	5%	5%	5%

7.5.7 PROJECTION OF TRAFFIC DATA

Table 7.14: PROJECTION OF CLASSIFIED TRAFFIC AT SARWAN

Pcu Factor	0.5	1	1	3	1.5	3	3	4.5	4.5	1.5	0.5				
Year	Fast Moving Vehicles										Slow Moving Vehicles				
	2 Wheeler	3 Wheeler	Passenger Car	Bus	LCV 6 Tyre	2-Axle	3-Axle	Multi Axle	Agricultural Tractor With Trailer	Agricultural Tractor Without Trailer	Bicycle	Total Fast Moving Vehicles	Total Slow Vehicles	Total All Vehicles (Nos.)	Total All Vehicles (PCU)
2019	5099	635	6176	435	2630	479	449	38	56	215	63	16212	63	16275	18172
2020	5456	667	6608	457	2788	503	471	40	59	226	66	17274	66	17341	19294
2021	5838	700	7071	480	2955	528	495	42	62	237	69	18407	69	18477	20487
2022	6246	735	7566	504	3132	555	520	44	65	249	73	19615	73	19688	21756
2023	6621	772	8020	529	3320	582	546	46	68	261	77	20766	77	20842	22997
2024	7019	810	8501	555	3520	611	573	48	71	274	80	21983	80	22064	24310
2025	7440	851	9011	583	3731	642	602	51	75	288	84	23273	84	23357	25699
2026	7886	894	9552	612	3955	674	632	53	79	303	89	24639	89	24727	27167
2027	8359	938	10125	643	4192	708	663	56	83	318	93	26084	93	26177	28720
2028	8777	985	10631	675	4401	743	697	59	87	334	98	27389	98	27486	28131
2029	9216	1034	11163	709	4621	780	731	62	91	350	103	28758	103	28861	31663
2030	9677	1086	11721	744	4853	819	768	65	96	368	108	30196	108	30304	33247
2031	10161	1140	12307	781	5095	860	806	68	101	386	113	31706	113	31819	34909

Pcu Factor	0.5	1	1	3	1.5	3	3	4.5	4.5	1.5	0.5				
Year	Fast Moving Vehicles										Slow Moving Vehicles				
	2 Wheeler	3 Wheeler	Passenger Car	Bus	LCV 6 Tyre	2-Axle	3-Axle	Multi Axle	Agricultural Tractor With Trailer	Agricultural Tractor Without Trailer	Bicycle	Total Fast Moving Vehicles	Total Slow Vehicles	Total All Vehicles (Nos.)	Total All Vehicles (PCU)
2032	10669	1197	12922	820	5350	903	847	72	106	405	119	33291	119	33410	36654
2033	11202	1257	13568	861	5617	948	889	75	111	426	125	34956	125	35080	38487
2034	11762	1320	14247	904	5898	996	933	79	116	447	131	36703	131	36834	40411
2035	12350	1386	14959	950	6193	1046	980	83	122	469	138	38538	138	38676	42432
2036	12968	1455	15707	997	6503	1098	1029	87	128	493	144	40465	144	40610	44554
2037	13616	1528	16492	1047	6828	1153	1081	91	135	517	152	42489	152	42640	46781
2038	14297	1528	17317	1099	7169	1210	1135	91	142	543	159	44532	159	44691	49023
2039	15012	1528	18183	1154	7528	1271	1191	91	149	570	167	46678	167	46845	51378
2040	15763	1528	19092	1212	7904	1334	1251	91	156	599	176	48931	176	49106	53849
2041	16551	1528	20046	1272	8300	1401	1313	91	164	629	184	51296	184	51481	56445
2042	17378	1528	21049	1336	8714	1471	1379	91	172	660	194	53780	194	53974	59170
2043	18247	1528	22101	1403	9150	1545	1448	91	181	693	203	56388	203	56591	62032
2044	19159	1528	23206	1473	9608	1622	1520	91	190	728	213	59126	213	59340	65036
2045	20117	1528	24367	1547	10088	1703	1596	91	199	764	224	62002	224	62226	68191
2046	21123	1528	25585	1624	10593	1788	1676	91	209	803	235	65021	235	65256	71504
2047	22179	1528	26864	1705	11122	1878	1760	91	220	843	247	68191	247	68438	74982
2048	23288	1528	28207	1791	11678	1972	1848	91	231	885	259	71520	259	71779	78634
2049	24453	1528	29618	1880	12262	2070	1941	91	242	929	272	75015	272	75287	82469

Table 7.15: PROJECTION OF CLASSIFIED TRAFFIC AT SAWKALA TOLL PLAZA

Pcu Factor	0.5	1	1	3	1.5	3	3	4.5	4.5	1.5	0.5				
Year	Fast Moving Vehicles										Slow Moving Vehicles				
	2 Wheeler	3 Wheeler	Passenger Car	Bus	LCV 6 Tyre	2-Axle	3-Axle	Multi Axle	Agricultural Tractor With Trailer	Agricultural Tractor Without Trailer	Bicycle	Total Fast Moving Vehicles	Total Slow Vehicles	Total All Vehicles (Nos.)	Total All Vehicles (PCU)
2019	4179	144	11464	1318	2604	1338	2364	116	511	27	45	24073	45	24118	35584
2020	4472	151	12266	1384	2760	1405	2482	122	537	28	47	25616	47	25663	37673
2021	4785	159	13125	1453	2926	1475	2606	128	563	30	50	27259	50	27308	39888
2022	5119	167	14044	1526	3101	1549	2737	134	592	31	52	29009	52	29061	42237
2023	5427	175	14887	1602	3287	1626	2873	141	621	33	55	30682	55	30737	44562
2024	5752	184	15780	1682	3485	1708	3017	148	652	34	57	32452	57	32510	47015
2025	6097	193	16727	1766	3694	1793	3168	155	685	36	60	34325	60	34385	49604
2026	6463	203	17730	1855	3915	1883	3326	163	719	38	63	36307	63	36370	52338
2027	6851	213	18794	1947	4150	1977	3493	171	755	40	66	38403	66	38469	55223
2028	7194	223	19734	2045	4358	2076	3667	180	793	42	70	40323	70	40393	51850
2029	7553	235	20720	2147	4576	2179	3851	189	832	44	73	42339	73	42413	60883
2030	7931	246	21756	2254	4805	2288	4043	198	874	46	77	44456	77	44533	63928
2031	8327	259	22844	2367	5045	2403	4245	208	918	48	81	46679	81	46760	67124
2032	8744	272	23986	2485	5297	2523	4458	219	964	51	85	49013	85	49098	70480
2033	9181	285	25186	2610	5562	2649	4681	230	1012	53	89	51464	89	51553	74004
2034	9640	299	26445	2740	5840	2782	4915	241	1062	56	94	54037	94	54130	77704
2035	10122	314	27767	2877	6132	2921	5160	253	1115	59	98	56739	98	56837	81590

Pcu Factor	0.5	1	1	3	1.5	3	3	4.5	4.5	1.5	0.5				
Year	Fast Moving Vehicles										Slow Moving Vehicles				
	2 Wheeler	3 Wheeler	Passenger Car	Bus	LCV 6 Tyre	2-Axle	3-Axle	Multi Axle	Agricultural Tractor With Trailer	Agricultural Tractor Without Trailer	Bicycle	Total Fast Moving Vehicles	Total Slow Vehicles	Total All Vehicles (Nos.)	Total All Vehicles (PCU)
2036	10628	330	29156	3021	6439	3067	5418	266	1171	62	103	59576	103	59679	85669
2037	11160	347	30613	3172	6761	3220	5689	279	1230	65	108	62554	108	62663	89953
2038	11718	347	32144	3331	7099	3381	5974	279	1291	68	114	65650	114	65763	94366
2039	12303	347	33751	3497	7453	3550	6272	279	1356	72	119	68900	119	69019	99000
2040	12919	347	35439	3672	7826	3728	6586	279	1424	75	125	72313	125	72438	103865
2041	13564	347	37211	3855	8217	3914	6915	279	1495	79	132	75896	132	76028	108974
2042	14243	347	39071	4048	8628	4110	7261	279	1570	83	138	79659	138	79797	114338
2043	14955	347	41025	4251	9060	4315	7624	279	1648	87	145	83609	145	83755	119971
2044	15703	347	43076	4463	9513	4531	8005	279	1730	91	152	87758	152	87910	125885
2045	16488	347	45230	4686	9988	4757	8406	279	1817	96	160	92113	160	92273	132094
2046	17312	347	47491	4921	10488	4995	8826	279	1908	101	168	96687	168	96855	138615
2047	18178	347	49866	5167	11012	5245	9267	279	2003	106	176	101489	176	101665	145461
2048	19087	347	52359	5425	11563	5507	9731	279	2103	111	185	106531	185	106716	152649
2049	20041	347	54977	5696	12141	5783	10217	279	2209	117	194	111825	194	112020	160197

7.5 ROADSIDE ORIGIN-DESTINATION (O-D) SURVEYS

The Origin destination survey is conducted to find out the trend of the commercial and noncommercial vehicles from one traffic zone to another traffic zone.

Following are the Origin destination survey locations given in **Table 7.16**

Table 7.16: Survey Location and Periods

S. No.	Type of Survey	Location Code	Location Name	Road Name	Remark
1	Origin destination Survey	OD - 01	Sarwan	NH-83	1 Day
		OD - 02	Sawkala Toll Plaza	NH-02	1 Day

7.5.1 Traffic Zones

Traffic Zones as per the standard methods has been decided and made to find out the flow of traffic are given in table 7.17.

Table 7.17: OD CODE FOR GOODS/PASSENGER

Sr.No.	Name of Place / Region
1	PATNA
2	NALANDA , BIHAR SHARIF
3	ARWAL, JEHANABAD
4	GAYA
5	NAWADA
6	AURANGABAD
7	SHEIKHPURA
8	LAKHISARAI
9	BEGUSARAI , Barauni
10	SAMASTIPUR
11	VAISHALI
12	SARAN, CHHAPRA
13	SAHARSA
14	JAMUI
15	MUNGER
16	BANKA

Sr.No.	Name of Place / Region
17	BHAGALPUR
18	PURNIA , KATIHAR
19	SUPAUL , ARARIA
20	Madhepura
21	Khagaria
22	DARBHANGA
23	Muzaffarpur , Dumri
24	SIWAN , GOPALGANJ
25	ARRAH , BUXER , BHOJPUR
26	ROHTAS , BHABUA, SASARAM , Kaimur
27	MADHUBANI
28	SITAMARHI , SHEOHAR
29	CHAMPARAN, Motihari , Raxaul
30	Rest of BIHAR
31	GARHWA, PALAMU, LATEHAR, CHATRA
32	HAZARIBAGH, KODERMA, GIRIDIH
33	DEOGHAR, GODDA, SAHEBGANJ, PAKUR, DUMKA, JAMTARA
34	DHANBAD, BOKARO
35	RANCHI, KHUNTI, LOHARDAGA, GUMLA, SIMDEGA,
36	Rest of Jharkhand
37	WEST SINGHBHUM, EAST SINGHBHUM, SERAIKELA
38	Bankura, Birbhum,Cooch Behar, DakshinDinajpur
39	Darjeeling, Hooghly, Howrah, Jalpaiguri,
40	Jhargram, Kalimpong, Kolkata, Malda, Murshidabad
41	Nadia, North 24 Parganas, PaschimBardhaman, PaschimMedinipur
42	PurbaBardhaman, PurbaMedinipur, Purulia, South 24 Parganas, Uttar Dinajpu
43	Rest of West Bangal
44	Lucknow, Gorakhpur, Jaunpur, Varanasi, Allahabad, Bareilly , Kanpur, Jalaun
45	Noida, Ghaziabad, Aligarh, Bulandshahr
46	Meerut, Hapur, Bhagpat
47	Muzaffarnagar, Saharanpur, Shamli, Bijnor, Amroha, Moradabad, Rampur, Sambhal
48	Agra, Firozabad, Mainpuri, Mathura
49	Jhansi, Latipur

Sr.No.	Name of Place / Region
50	Rest of Uttar Pradesh
51	Delhi , Haryana State, Rajasthan
52	Maharashtra, Gujarat, Madhya Pradesh,
53	Jammu & Kashmir, Himachal Pradesh, Punjab, Uttarakhand
54	Goa, Kerala, Tamil Nadu, Karnataka, Andhra Pradesh, Telengana
55	Bihar, Jharkhand, Orissa, Chhattisgarh, West Bengal
56	Sikkim, Arunachal Pradesh, Nagaland, Manipur, Mizoram, Tripura, Assam, Meghalaya
57	NEPAL, BHUTAN

7.5.8 Sarwan NH-83 OD Production and Attraction for Passenger vehicle

Table 7.18: OD Production and Attraction for Passenger vehicle

Zone Number	Zone Name	Production	Attraction	Total	Production	Attraction	%age Share
1	PATNA	183	167	350	32	29	62
2	NALANDA , BIHAR SHARIF	0	0	0	0	0	0
3	ARWAL, JEHANABAD	55	58	113	10	10	20
4	GAYA	33	50	83	6	9	15
5	NAWADA	1	0	1	0	0	0
6	AURANGABAD	3	3	6	1	1	1
7	SHEIKHPURA	0	0	0	0	0	0
8	LAKHISARAI	0	0	0	0	0	0
9	BEGUSARAI , Barauni	3	0	3	1	0	1
10	SAMASTIPUR	0	0	0	0	0	0
11	VAISHALI	2	3	5	0	1	1
12	SARAN, CHHAPRA	0	0	0	0	0	0

Zone Number	Zone Name	Production	Attraction	Total	Production	Attraction	%age Share
13	SAHARSA	0	0	0	0	0	0
14	JAMUI	0	0	0	0	0	0
15	MUNGER	0	0	0	0	0	0
16	BANKA	0	0	0	0	0	0
17	BHAGALPUR	0	0	0	0	0	0
18	PURNIA , KATIHAR	0	0	0	0	0	0
19	SUPAUL , ARARIA	0	0	0	0	0	0
20	Madhepura	0	0	0	0	0	0
21	Khagaria	0	0	0	0	0	0
22	DARBHANGA	0	0	0	0	0	0
23	Muzaffarpur , Dumri	2	0	2	0	0	0
24	SIWAN , GOPALGANJ	0	0	0	0	0	0
25	ARRAH , BUXER , BHOJPUR	0	0	0	0	0	0
26	ROHTAS , BHABUA, SASARAM , Kaimur	0	0	0	0	0	0
27	MADHUBANI	0	0	0	0	0	0
28	SITAMARHI , SHEOHAR	0	0	0	0	0	0
29	CHAMPARAN, Motihari , Raxaul	2	2	4	0	0	1
30	Rest of BIHAR	0	0	0	0	0	0
31	GARHWA, PALAMU, LATEHAR, CHATRA	0	0	0	0	0	0
32	HAZARIBAGH, KODERMA,	0	0	0	0	0	0

Zone Number	Zone Name	Production	Attraction	Total	Production	Attraction	%age Share
	GIRIDIH						
33	DEOGHAR, GODDA, SAHEBGANJ, PAKUR, DUMKA, JAMTARA	0	0	0	0	0	0
34	DHANBAD, BOKARO	0	0	0	0	0	0
35	RANCHI, KHUNTI, LOHARDAGA, GUMLA, SIMDEGA,	0	0	0	0	0	0
36	Rest of Jharkhand	0	0	0	0	0	0
37	WEST SINGHBHUM, EAST SINGHBHUM, SERAIKELA	0	1	1	0	0	0
38	Bankura, Birbhum,Cooch Behar, DakshinDinajpur	0	0	0	0	0	0
39	Darjeeling, Hooghly, Howrah, Jalpaiguri,	0	0	0	0	0	0
40	Jhargram, Kalimpong, Kolkata, Malda, Murshidabad	0	0	0	0	0	0
41	Nadia, North 24 Parganas, PaschimBardhaman, PaschimMedinipur	0	0	0	0	0	0
42	PurbaBardhaman, PurbaMedinipur, Purulia, South 24 Parganas, Uttar Dinajpu	0	0	0	0	0	0
43	Rest of West Bangal	0	0	0	0	0	0
44	Lucknow, Gorakhpur, Jaunpur, Varanasi, Allahabad, Bareilly , Kanpur, Jalaun	0	0	0	0	0	0
45	Noida, Ghaziabad, Aligarh, Bulandshahr	0	0	0	0	0	0

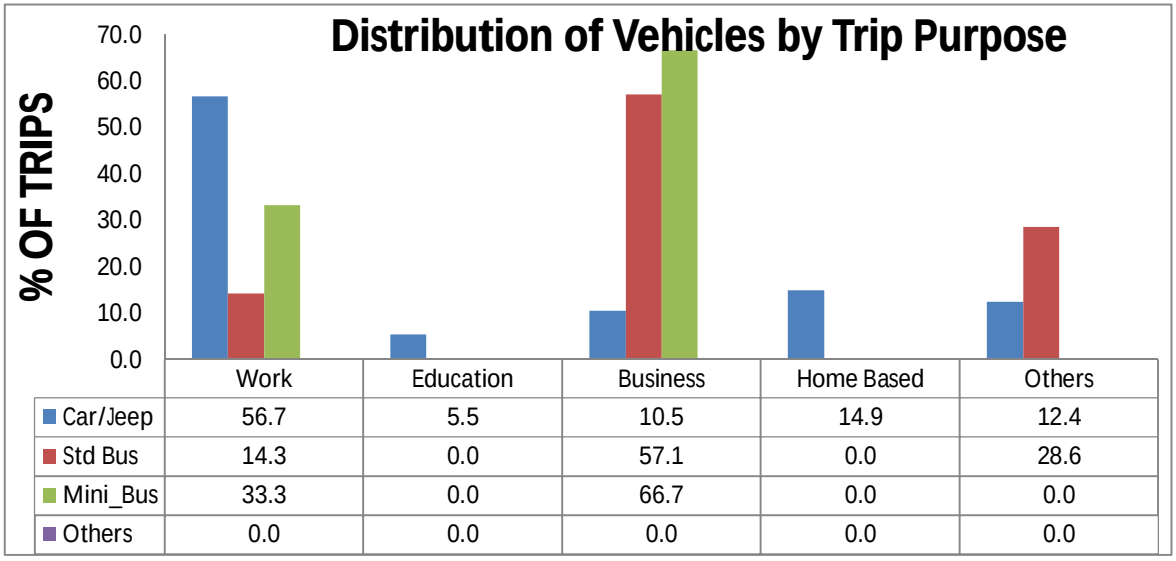
Zone Number	Zone Name	Production	Attraction	Total	Production	Attraction	%age Share
46	Meerut, Hapur, Bhagpat	0	0	0	0	0	0
47	Muzaffarnagar, Saharanpur, Shamli, Bijnor, Amroha, Moradabad, Rampur, Sambhal	0	0	0	0	0	0
48	Agra, Firozabad, Mainpuri, Mathura	0	0	0	0	0	0
49	Jhansi, Latipur	0	0	0	0	0	0
50	Rest of Uttar Pradesh	0	0	0	0	0	0
51	Delhi , Haryana State, Rajasthan	0	0	0	0	0	0
52	Maharashtra, Gujarat, Madhya Pradesh,	0	0	0	0	0	0
53	Jammu & Kashmir, Himachal Pradesh, Punjab, Uttarakhand	0	0	0	0	0	0
54	Goa, Kerala, Tamil Nadu, Karnataka, Andhra Pradesh, Telengana	0	0	0	0	0	0
55	Bihar, Jharkhand, Orissa, Chhattisgarh, West Bengal	0	0	0	0	0	0
56	Sikkim, Arunachal Pradesh, Nagaland, Manipur, Mizoram, Tripura, Assam, Meghalaya	0	0	0	0	0	0
57	NEPAL, BHUTAN	0	0	0	0	0	0
		284	**284**	**568**	**50**	**50**	**100**

7.5.9 Purpose of work (Passenger vehicles)

The work trips and religious tourist trips are the major purposes of passenger trips. The details are presented in Table 7.19.

Table 7.19: Purpose of Work of Passenger Vehicles (Sarwan)

Purpose	Car/Jeep	Std Bus	Mini_Bus	Total
Work	56.7	14.3	33.3	55.4
Education	5.5	0.0	0.0	5.3
Business	10.5	57.1	66.7	12.3
Home Based	14.9	0.0	0.0	14.4
Others	12.4	28.6	0.0	12.6
Total	100.0	100.0	100.0	100.0

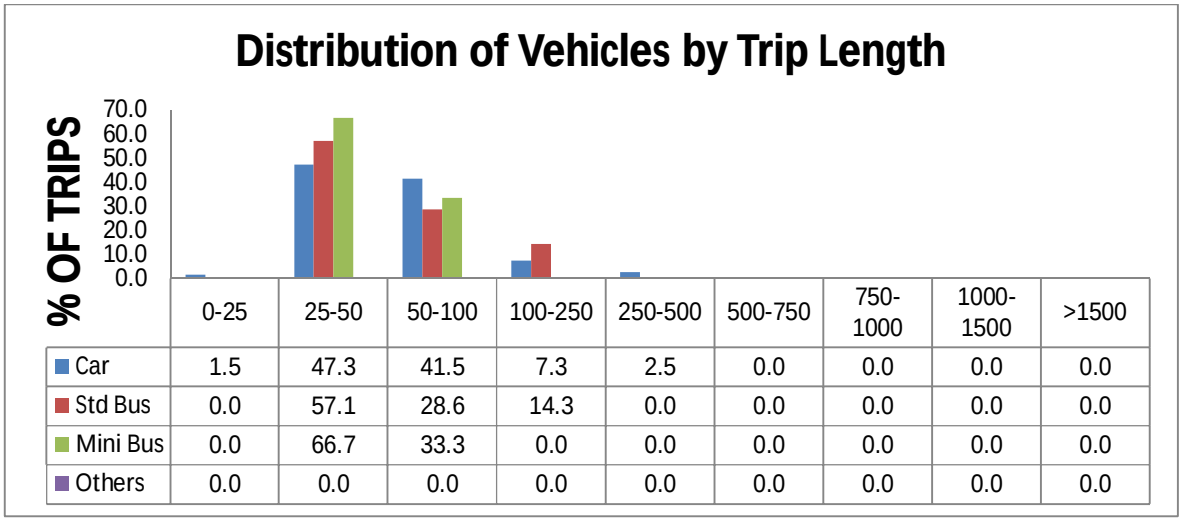


7.5.10 Trip Length

Trip length is given in table below:

Table7-20: Trip Length Frequency Distribution for Passenger Vehicles (Sarwan)

Distribution of Vehicles by Trip Length				
Trip Length	**Car**	**Std Bus**	**Mini Bus**	**Others**
0-25	1.5	0.0	0.0	0.0
25-50	47.3	57.1	66.7	100.0
50-100	41.5	28.6	33.3	0.0
100-250	7.3	14.3	0.0	0.0
250-500	2.5	0.0	0.0	0.0
500-750	0.0	0.0	0.0	0.0
750-1000	0.0	0.0	0.0	0.0
1000-1500	0.0	0.0	0.0	0.0
>1500	0.0	0.0	0.0	0.0
	100.0	**100.0**	**100.0**	**100.0**

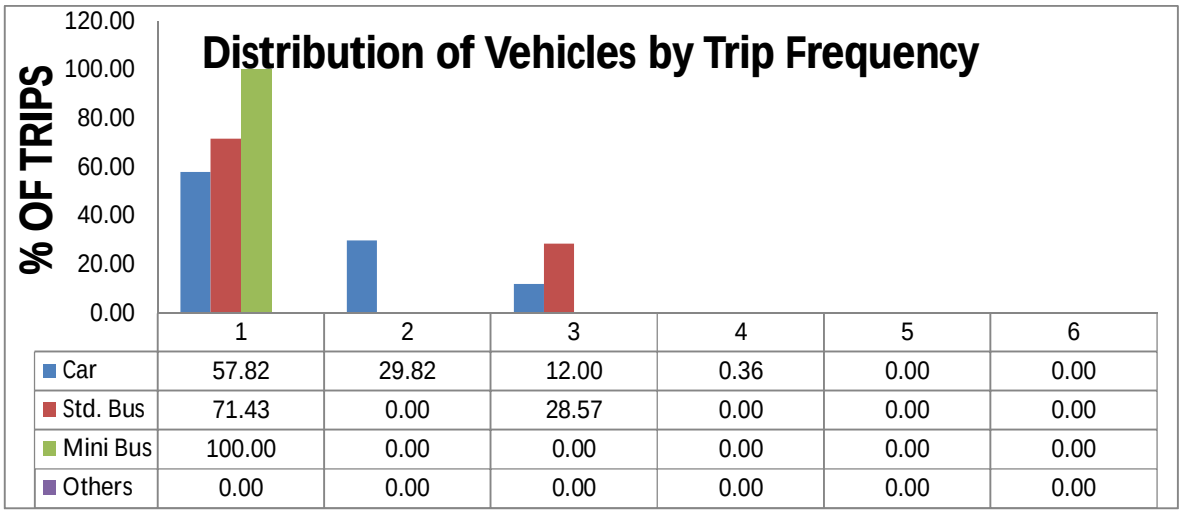


	0-25	25-50	50-100	100-250	250-500	500-750	750-1000	1000-1500	>1500
Car	1.5	47.3	41.5	7.3	2.5	0.0	0.0	0.0	0.0
Std Bus	0.0	57.1	28.6	14.3	0.0	0.0	0.0	0.0	0.0
Mini Bus	0.0	66.7	33.3	0.0	0.0	0.0	0.0	0.0	0.0
Others	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

7.5.11 Trip Frequency

Table 7-21: Distribution of Vehicles by Trip Frequency (Sarwan)

			(In Percentage)	
Frequency	**Car**	**Std. Bus**	**Mini Bus**	**Others**
1	57.82	71.43	100.00	100.00
2	29.82	0.00	0.00	0.00
3	12.00	28.57	0.00	0.00
4	0.36	0.00	0.00	0.00
6	0.00	0.00	0.00	0.00
8	0.00	0.00	0.00	0.00
Total	100.00	100.00	100.00	100.00



	1	2	3	4	5	6
Car	57.82	29.82	12.00	0.36	0.00	0.00
Std. Bus	71.43	0.00	28.57	0.00	0.00	0.00
Mini Bus	100.00	0.00	0.00	0.00	0.00	0.00
Others	0.00	0.00	0.00	0.00	0.00	0.00

7.5.12 Sarwan OD Production and Attraction for Goods vehicle

Table 7.17: OD Production and Attraction for Goods vehicle

BAKHTIYARPUR-PATNA									
Goods									
Zone Code	Zone	Production	Attraction	Total	%age	Production	Attraction	Total	%age Share
1	PATNA	1000	1119	2119	68	31	37	68	68
2	NALANDA , BIHAR SHARIF	0	10	10	3	0	3	3	3
3	ARWAL, JEHANABAD	27	13	40	13	8	4	13	13
4	GAYA	20	9	29	9	6	3	9	9
5	NAWADA	0	0	0	0	0	0	0	0
6	AURANGABAD	1	2	3	1	0	1	1	1
7	SHEIKHPURA	0	0	0	0	0	0	0	0
8	LAKHISARAI	0	0	0	0	0	0	0	0
9	BEGUSARAI , Barauni	0	0	0	0	0	0	0	0
10	SAMASTIPUR	0	0	0	0	0	0	0	0
11	VAISHALI	0	4	4	1	0	1	1	1
12	SARAN, CHHAPRA	0	0	0	0	0	0	0	0
13	SAHARSA	0	0	0	0	0	0	0	0
14	JAMUI	0	1	1	0	0	0	0	0
15	MUNGER	0	0	0	0	0	0	0	0
16	BANKA	0	0	0	0	0	0	0	0

BAKHTIYARPUR-PATNA									
Goods									
Zone Code	Zone	Production	Attraction	Total	%age	Production	Attraction	Total	%age Share
17	BHAGALPUR	0	0	0	0	0	0	0	0
18	PURNIA , KATIHAR	0	0	0	0	0	0	0	0
19	SUPAUL , ARARIA	0	0	0	0	0	0	0	0
20	Madhepura	0	0	0	0	0	0	0	0
21	Khagaria	0	0	0	0	0	0	0	0
22	DARBHANGA	0	0	0	0	0	0	0	0
23	Muzaffarpur , Dumri	1	0	1	0	0	0	0	0
24	SIWAN , GOPALGANJ	0	0	0	0	0	0	0	0
25	ARRAH , BUXER , BHOJPUR	0	0	0	0	0	0	0	0
26	ROHTAS , BHABUA, SASARAM , Kaimur	0	0	0	0	0	0	0	0
27	MADHUBANI	0	0	0	0	0	0	0	0
28	SITAMARHI , SHEOHAR	2	0	2	1	1	0	1	1
29	CHAMPARAN, Motihari , Raxaul	0	0	0	0	0	0	0	0
30	Rest of BIHAR	0	0	0	0	0	0	0	0
31	GARHWA, PALAMU, LATEHAR, CHATRA	0	0	0	0	0	0	0	0
32	HAZARIBAGH, KODERMA, GIRIDIH	7	0	7	2	2	0	2	2
33	DEOGHAR, GODDA, SAHEBGANJ, PAKUR, DUMKA, JAMTARA	0	0	0	0	0	0	0	0
34	DHANBAD, BOKARO	0	0	0	0	0	0	0	0
35	RANCHI, KHUNTI, LOHARDAGA,	1	1	2	1	0	0	1	1

BAKHTIYARPUR-PATNA									
Goods									
Zone Code	Zone	Production	Attraction	Total	%age	Production	Attraction	Total	%age Share
	GUMLA, SIMDEGA,								
36	Rest of Jharkhand	0	0	0	0	0	0	0	0
37	WEST SINGHBHUM, EAST SINGHBHUM, SERAIKELA	0	0	0	0	0	0	0	0
38	Bankura, Birbhum,Cooch Behar, DakshinDinajpur	0	0	0	0	0	0	0	0
39	Darjeeling, Hooghly, Howrah, Jalpaiguri,	0	0	0	0	0	0	0	0
40	Jhargram, Kalimpong, Kolkata, Malda, Murshidabad	0	0	0	0	0	0	0	0
41	Nadia, North 24 Parganas, PaschimBardhaman, PaschimMedinipur	0	0	0	0	0	0	0	0
42	PurbaBardhaman, PurbaMedinipur, Purulia, South 24 Parganas, Uttar Dinajpu	0	0	0	0	0	0	0	0
43	Rest of West Bangal	0	0	0	0	0	0	0	0
44	Lucknow, Gorakhpur, Jaunpur, Varanasi, Allahabad, Bareilly , Kanpur, Jalaun	0	0	0	0	0	0	0	0
45	Noida, Ghaziabad, Aligarh, Bulandshahr	0	0	0	0	0	0	0	0
46	Meerut, Hapur, Bhagpat	0	0	0	0	0	0	0	0
47	Muzaffarnagar, Saharanpur, Shamli, Bijnor, Amroha, Moradabad, Rampur, Sambhal	0	0	0	0	0	0	0	0
48	Agra, Firozabad, Mainpuri, Mathura	0	0	0	0	0	0	0	0
49	Jhansi, Latipur	1	0	1	0	0	0	0	0
50	Rest of Uttar Pradesh	0	0	0	0	0	0	0	0

BAKHTIYARPUR-PATNA									
Goods									
Zone Code	Zone	Production	Attraction	Total	%age	Production	Attraction	Total	%age Share
51	Delhi , Haryana State, Rajasthan	0	1	1	0	0	0	0	0
52	Maharashtra, Gujarat, Madhya Pradesh,	0	0	0	0	0	0	0	0
53	Jammu & Kashmir, Himachal Pradesh, Punjab, Uttarakhand	0	0	0	0	0	0	0	0
54	Goa, Kerala, Tamil Nadu, Karnataka, Andhra Pradesh, Telengana	0	0	0	0	0	0	0	0
55	Bihar, Jharkhand, Orissa, Chhattisgarh, West Bengal	0	0	0	0	0	0	0	0
56	Sikkim, Arunachal Pradesh, Nagaland, Manipur, Mizoram, Tripura, Assam, Meghalaya	0	0	0	0	0	0	0	0
57	NEPAL, BHUTAN	0	0	0	0	0	0	0	0
Total		160	160	320	100	50	50	100	100

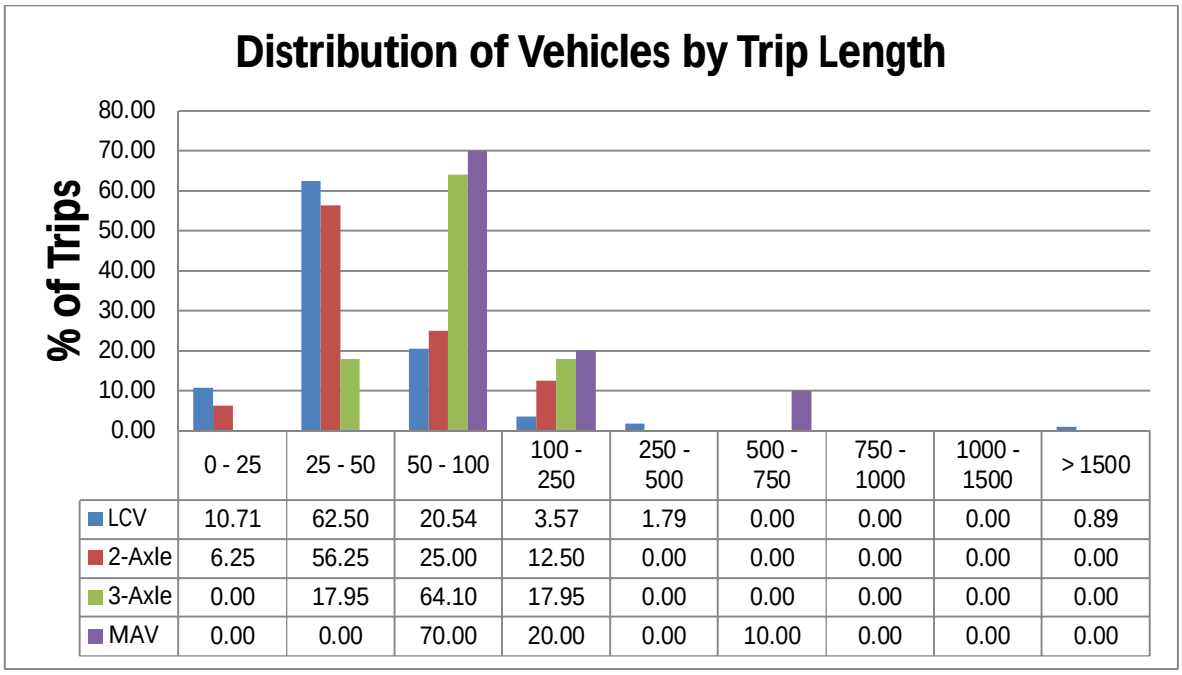
7.5.13 Trip Length

Trip length are given in table below:

Table 7-22: Distribution of Vehicles by Trip Length

				(In Percentage)
Trip Length	**LCV**	**2-Axle**	**3-Axle**	**MAV**
0 - 25	10.71	6.25	0.00	0.00
25 - 50	62.50	56.25	17.95	0.00
50 - 100	20.54	25.00	64.10	70.00

				(In Percentage)
Trip Length	**LCV**	**2-Axle**	**3-Axle**	**MAV**
100 - 250	3.57	12.50	17.95	20.00
250 - 500	1.79	0.00	0.00	0.00
500 - 750	0.00	0.00	0.00	10.00
750 - 1000	0.00	0.00	0.00	0.00
1000 - 1500	0.00	0.00	0.00	0.00
> 1500	0.89	0.00	0.00	0.00
Total	**100.00**	**100.00**	**100.00**	**100.00**



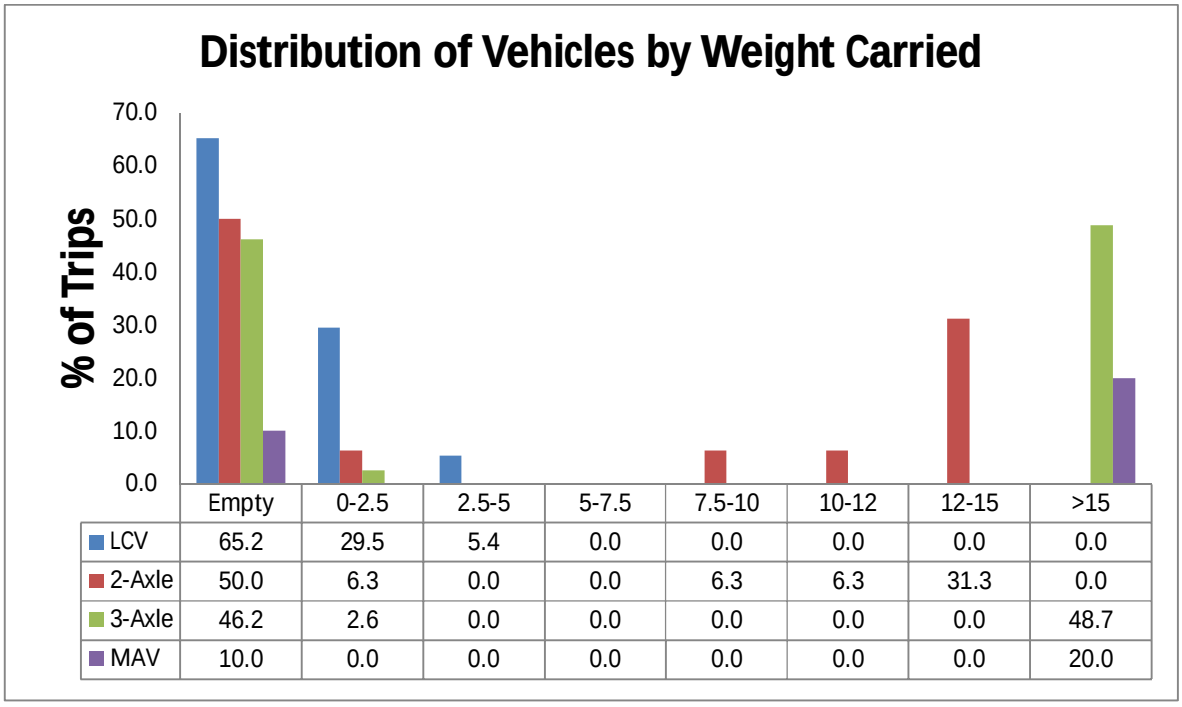
	0 - 25	25 - 50	50 - 100	100 - 250	250 - 500	500 - 750	750 - 1000	1000 - 1500	> 1500
LCV	10.71	62.50	20.54	3.57	1.79	0.00	0.00	0.00	0.89
2-Axle	6.25	56.25	25.00	12.50	0.00	0.00	0.00	0.00	0.00
3-Axle	0.00	17.95	64.10	17.95	0.00	0.00	0.00	0.00	0.00
MAV	0.00	0.00	70.00	20.00	0.00	10.00	0.00	0.00	0.00

7.5.14 Weight Carried

Weight carried are given in table below:

Table 7-23 : Distribution of Vehicles by Weight Carried

				(In Percentage)
Weights(Tonnes)	**LCV**	**2-Axle**	**3-Axle**	**MAV**
Empty	**65.2**	**50.0**	**46.2**	**10.0**
0-2.5	**29.5**	**6.3**	**2.6**	**0.0**
2.5-5	**5.4**	**0.0**	**0.0**	**0.0**
5-7.5	**0.0**	**0.0**	**0.0**	**0.0**
7.5-10	**0.0**	**6.3**	**0.0**	**0.0**
10-12	**0.0**	**6.3**	**0.0**	**0.0**
12-15	**0.0**	**31.3**	**0.0**	**0.0**
>15	**0.0**	**0.0**	**48.7**	**20.0**
Total	**100.0**	**100.0**	**97.4**	**100.0**



7.5.15 Commodity Distribution

Weight carried is given in table below:

Table7.24 :Distribution of Vehicles by Commodity Distribution

Sr. No.	Commodity	LCV	2 Axle	3 Axle	MAV
1	Food Grains	13.4	12.5	0.0	0.0
2	Fruits and Vegetables	8.9	6.3	0.0	0.0
3	Irons	0.0	0.0	0.0	0.0
4	Petroleum	4.5	6.3	5.1	0.0
5	Building material (Hardware,paint, tanker water)	0.0	6.3	0.0	0.0
6	Tyres	0.0	0.0	0.0	0.0
7	Household Goods	5.4	0.0	0.0	0.0
8	Minerals Oil	0.0	0.0	0.0	0.0
9	Heavy Machinery	0.0	0.0	0.0	0.0
10	Empty	0.9	0.0	0.0	0.0
11	Construction material	0.0	12.5	48.7	90.0
TOTAL		24.242	100.0	100.0	100.0

7.5.16 Sawkala Toll Plaza OD Production and Attraction for Passenger vehicle

Table 7.25 : OD Production and Attraction for Passenger vehicle

Zone Number	Zone Name	Production	Attraction	Total	Production	Attraction	%age Share
1	PATNA	9	5	14	1	0	1
2	NALANDA , BIHAR SHARIF	0	5	5	0	0	0
3	ARWAL, JEHANABAD	5	0	5	0	0	0
4	GAYA	302	213	515	19	13	32
5	NAWADA	1	0	1	0	0	0
6	AURANGABAD	133	178	311	8	11	20
7	SHEIKHPURA	0	0	0	0	0	0
8	LAKHISARAI	1	0	1	0	0	0
9	BEGUSARAI , Barauni	0	0	0	0	0	0
10	SAMASTIPUR	2	0	2	0	0	0
11	VAISHALI	0	0	0	0	0	0
12	SARAN, CHHAPRA	0	0	0	0	0	0
13	SAHARSA	0	0	0	0	0	0
14	JAMUI	0	0	0	0	0	0
15	MUNGER	1	5	6	0	0	0
16	BANKA	0	0	0	0	0	0
17	BHAGALPUR	0	0	0	0	0	0
18	PURNIA , KATIHAR	0	0	0	0	0	0
19	SUPAUL , ARARIA	0	0	0	0	0	0
20	Madhepura	0	0	0	0	0	0

Zone Number	Zone Name	Production	Attraction	Total	Production	Attraction	%age Share
21	Khagaria	0	0	0	0	0	0
22	DARBHANGA	2	0	2	0	0	0
23	Muzaffarpur , Dumri	0	0	0	0	0	0
24	SIWAN , GOPALGANJ	3	0	3	0	0	0
25	ARRAH , BUXER , BHOJPUR	25	2	27	2	0	2
26	ROHTAS , BHABUA, SASARAM , Kaimur	14	127	141	1	8	9
27	MADHUBANI	2	0	2	0	0	0
28	SITAMARHI , SHEOHAR	0	0	0	0	0	0
29	CHAMPARAN, Motihari , Raxaul	0	3	3	0	0	0
30	Rest of BIHAR	0	0	0	0	0	0
31	GARHWA, PALAMU, LATEHAR, CHATRA	0	0	0	0	0	0
32	HAZARIBAGH, KODERMA, GIRIDIH	50	7	57	3	0	4
33	DEOGHAR, GODDA, SAHEBGANJ, PAKUR, DUMKA, JAMTARA	0	0	0	0	0	0
34	DHANBAD, BOKARO	44	0	44	3	0	3
35	RANCHI, KHUNTI, LOHARDAGA, GUMLA, SIMDEGA,	39	17	56	2	1	4
36	Rest of Jharkhand	26	22	48	2	1	3
37	WEST SINGHBHUM, EAST SINGHBHUM, SERAIKELA	0	25	25	0	2	2
38	Bankura, Birbhum,Cooch Behar, DakshinDinajpur	0	44	44	0	3	3
39	Darjeeling, Hooghly, Howrah, Jalpaiguri,	0	1	1	0	0	0
40	Jhargram, Kalimpong, Kolkata, Malda, Murshidabad	36	0	36	2	0	2
41	Nadia, North 24 Parganas, PaschimBardhaman,	3	37	40	0	2	3

Zone Number	Zone Name	Production	Attraction	Total	Production	Attraction	%age Share
	PaschimMedinipur						
42	PurbaBardhaman, PurbaMedinipur, Purulia, South 24 Parganas, Uttar Dinajpu	0	0	0	0	0	0
43	Rest of West Bangal	1	0	1	0	0	0
44	Lucknow, Gorakhpur, Jaunpur, Varanasi, Prayagraj, Bareilly , Kanpur, Jalaun	60	2	62	4	0	4
45	Noida, Ghaziabad, Aligarh, Bulandshahr	1	40	41	0	3	3
46	Meerut, Hapur, Bhagpat	0	0	0	0	0	0
47	Muzaffarnagar, Saharanpur, Shamli, Bijnor, Amroha, Moradabad, Rampur, Sambhal	0	0	0	0	0	0
48	Agra, Firozabad, Mainpuri, Mathura	0	0	0	0	0	0
49	Jhansi, Latipur	0	0	0	0	0	0
50	Rest of Uttar Pradesh	15	0	15	1	0	1
51	Delhi , Haryana State, Rajasthan	4	1	5	0	0	0
52	Maharashtra, Gujarat, Madhya Pradesh,	14	7	21	1	0	1
53	Jammu & Kashmir, Himachal Pradesh, Punjab, Uttarakhand	0	51	51	0	3	3
54	Goa, Kerala, Tamil Nadu, Karnataka, Andhra Pradesh, Telengana	0	2	2	0	0	0
55	Bihar, Jharkhand, Orissa, Chhattisgarh, West Bengal	2	0	2	0	0	0
56	Sikkim, Arunachal Pradesh, Nagaland, Manipur, Mizoram, Tripura, Assam, Meghalaya	0	1	1	0	0	0
57	NEPAL, BHUTAN	795	795	1590	50	50	100
58		9	5	14	1	0	1

Table 7-26 : Combined Zones

Zone Number	Zone Name	Production	Attraction	Total	Production	Attraction	%age Share
1 TO 17	PATNA	9	5	14	1	0	1
	GAYA	302	213	515	19	13	32
	AURANGABAD	133	178	311	8	11	20
	MUNGER	1	5	6	0	0	0
18 TO 27	ARRAH , BUXER , BHOJPUR	25	2	27	2	0	2
	ROHTAS , BHABUA, SASARAM , Kaimur	14	127	141	1	8	9
28 TO 37	HAZARIBAGH, KODERMA, GIRIDIH	50	7	57	3	0	4
	DHANBAD, BOKARO	44	0	44	3	0	3
	RANCHI, KHUNTI, LOHARDAGA, GUMLA, SIMDEGA,	39	17	56	2	1	4
	Rest of Jharkhand	26	22	48	2	1	3
	WEST SINGHBHUM, EAST SINGHBHUM, SERAIKELA	0	25	25	0	2	2
38 TO 57	Bankura, Birbhum,Cooch Behar, DakshinDinajpur	0	44	44	0	3	3
	Jhargram, Kalimpong, Kolkata, Malda, Murshidabad	36	0	36	2	0	2
	Nadia, North 24 Parganas, PaschimBardhaman, PaschimMedinipur	3	37	40	0	2	3
	Lucknow, Gorakhpur, Jaunpur, Varanasi, Prayagraj, Bareilly , Kanpur, Jalaun	60	2	62	4	0	4
	Rest of Uttar Pradesh	15	0	15	1	0	1

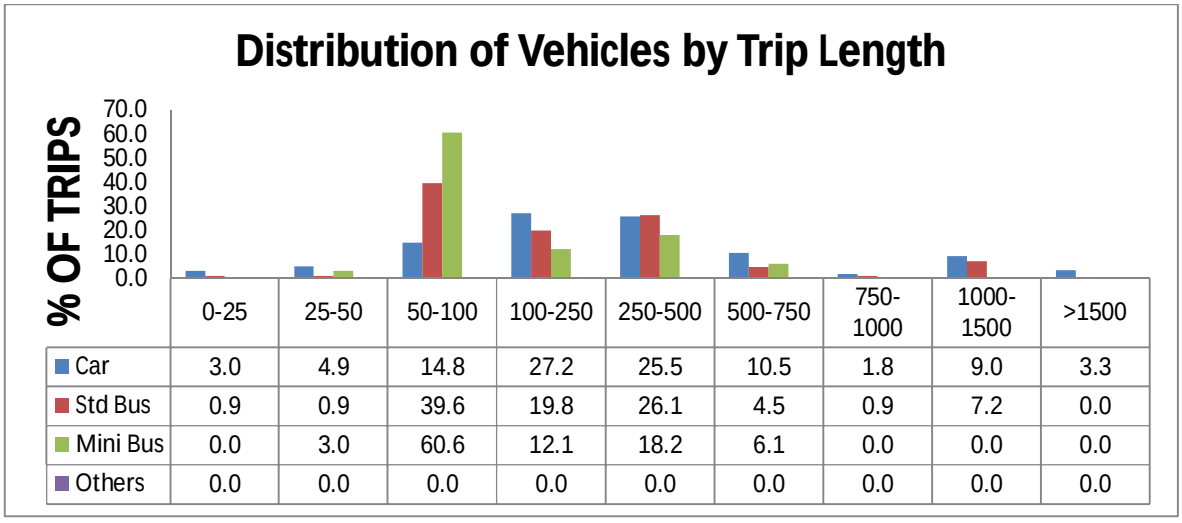
Zone Number	Zone Name	Production	Attraction	Total	Production	Attraction	%age Share
	Maharashtra, Gujarat, Madhya Pradesh,	14	7	21	1	0	1
	Jammu & Kashmir, Himachal Pradesh, Punjab, Uttarakhand	0	51	51	0	3	3

7.5.17 Purpose for Work of Passenger Vehicles

The work trips and religious tourist trips are the major purposes of passenger trips. The details are presented in **Table 7.27**

Table 7-27 : Purpose for Work of Passenger Vehicles

Distribution of Vehicles by Trip Length			
Trip Length	**Car**	**Std Bus**	**Mini Bus**
0-25	3.0	0.9	0.0
25-50	4.9	0.9	3.0
50-100	14.8	39.6	60.6
100-250	27.2	19.8	12.1
250-500	25.5	26.1	18.2
500-750	10.5	4.5	6.1
750-1000	1.8	0.9	0.0
1000-1500	9.0	7.2	0.0
>1500	3.3	0.0	0.0
Total	**100.0**	**100.0**	**100.0**

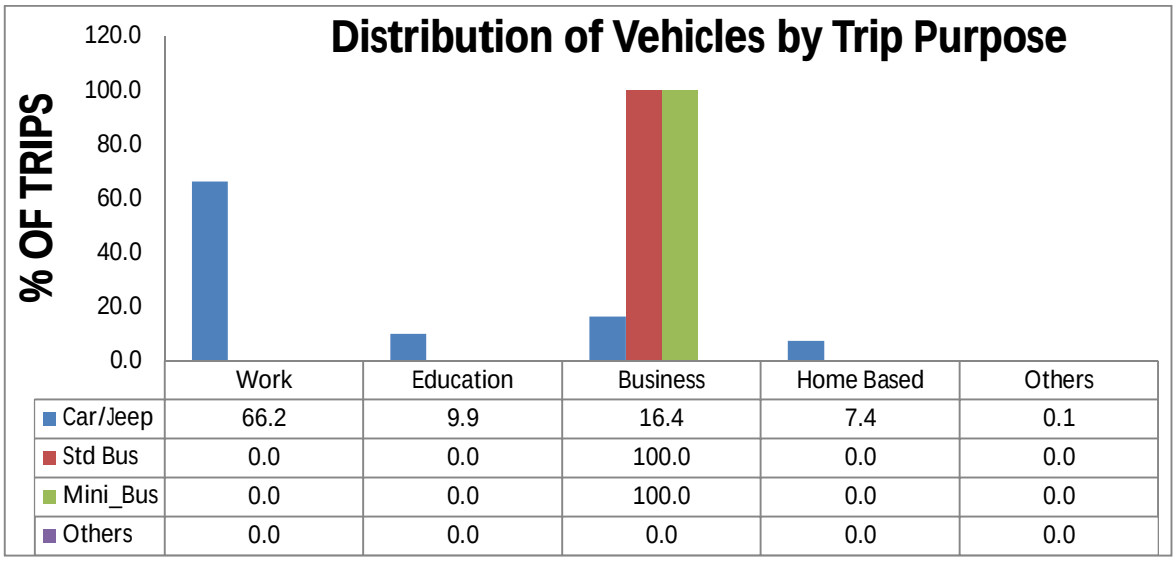


	0-25	25-50	50-100	100-250	250-500	500-750	750-1000	1000-1500	>1500
Car	3.0	4.9	14.8	27.2	25.5	10.5	1.8	9.0	3.3
Std Bus	0.9	0.9	39.6	19.8	26.1	4.5	0.9	7.2	0.0
Mini Bus	0.0	3.0	60.6	12.1	18.2	6.1	0.0	0.0	0.0
Others	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

7.5.18 Distribution of Vehicles by Purpose

Table 7-28 :Distribution of Vehicles by Purpose

Distribution of Vehicles by Purpose				
Purpose	**Car/Jeep**	**Std Bus**	**Mini_Bus**	**Total*(In Percentage)***
Work	66.2	0.0	0.0	55.4
Education	9.9	0.0	0.0	8.3
Business	16.4	100.0	100.0	30.0
Home Based	7.4	0.0	0.0	6.2
Others	0.1	0.0	0.0	0.1
Total	**100.0**	**100.0**	**100.0**	**100.0**

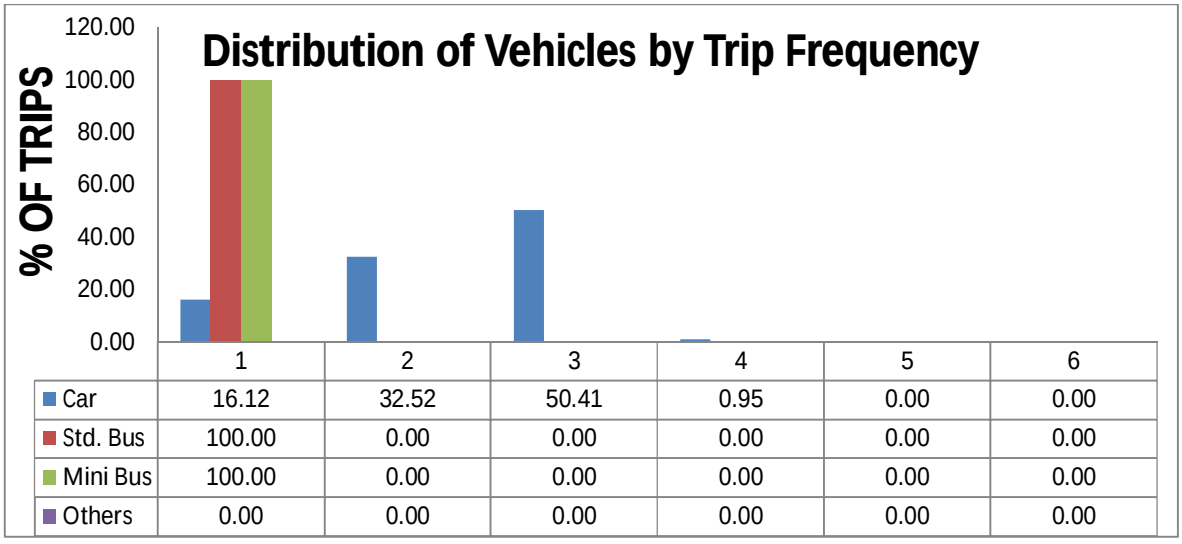


	Work	Education	Business	Home Based	Others
Car/Jeep	66.2	9.9	16.4	7.4	0.1
Std Bus	0.0	0.0	100.0	0.0	0.0
Mini_Bus	0.0	0.0	100.0	0.0	0.0
Others	0.0	0.0	0.0	0.0	0.0

7.5.19 Distribution of Vehicles by Trip Frequency

Table7-29 :Distribution of Vehicles by Trip Frequency

			(In Percentage)
Frequency	**Car**	**Std. Bus**	**Mini Bus**
1	16.12	100.00	100.00
2	32.52	0.00	0.00
3	50.41	0.00	0.00
4	0.95	0.00	0.00
6	0.00	0.00	0.00
8	0.00	0.00	0.00
Total	100.00	100.00	100.00



7.5.20 Sawkala Toll Plaza OD Production and Attraction for Goods vehicle

Table 7-30 :Sawkala Toll Plaza OD Production and Attraction for Goods vehicle

Zone Code	Zone	Production	Attraction	Total	%age	Production	Attraction	Total	%age Share
1	**PATNA**	6	9	15	1	0	1	1	1
2	**NALANDA , BIHAR SHARIF**	2	1	3	0	0	0	0	0
3	**ARWAL, JEHANABAD**	0	1	1	0	0	0	0	0
4	**GAYA**	44	6	50	4	3	0	4	4
5	**NAWADA**	1	3	4	0	0	0	0	0
6	**AURANGABAD**	8	17	25	2	1	1	2	2
7	**SHEIKHPURA**	0	0	0	0	0	0	0	0
8	**LAKHISARAI**	0	2	2	0	0	0	0	0
9	**BEGUSARAI , Barauni**	0	0	0	0	0	0	0	0
10	**SAMASTIPUR**	0	4	4	0	0	0	0	0
11	**VAISHALI**	0	0	0	0	0	0	0	0
12	**SARAN, CHHAPRA**	0	5	5	0	0	0	0	0
13	**SAHARSA**	0	0	0	0	0	0	0	0
14	**JAMUI**	1	0	1	0	0	0	0	0
15	**MUNGER**	0	0	0	0	0	0	0	0
16	**BANKA**	0	0	0	0	0	0	0	0
17	**BHAGALPUR**	0	0	0	0	0	0	0	0
18	**PURNIA , KATIHAR**	0	0	0	0	0	0	0	0
19	**SUPAUL , ARARIA**	3	0	3	0	0	0	0	0
20	**Madhepura**	0	0	0	0	0	0	0	0

Zone Code	Zone	Production	Attraction	Total	%age	Production	Attraction	Total	%age Share
21	**Khagaria**	0	0	0	0	0	0	0	0
22	**DARBHANGA**	0	2	2	0	0	0	0	0
23	**Muzaffarpur , Dumri**	1	0	1	0	0	0	0	0
24	**SIWAN , GOPALGANJ**	0	2	2	0	0	0	0	0
25	**ARRAH , BUXER , BHOJPUR**	0	13	13	1	0	1	1	1
26	**ROHTAS , BHABUA, SASARAM , Kaimur**	100	23	123	9	7	2	9	9
27	**MADHUBANI**	0	0	0	0	0	0	0	0
28	**SITAMARHI , SHEOHAR**	0	0	0	0	0	0	0	0
29	**CHAMPARAN, Motihari , Raxaul**	0	0	0	0	0	0	0	0
30	**Rest of BIHAR**	0	0	0	0	0	0	0	0
31	**GARHWA, PALAMU, LATEHAR, CHATRA**	0	0	0	0	0	0	0	0
32	**HAZARIBAGH, KODERMA, GIRIDIH**	3	2	5	0	0	0	0	0
33	**DEOGHAR, GODDA, SAHEBGANJ, PAKUR, DUMKA, JAMTARA**	0	0	0	0	0	0	0	0
34	**DHANBAD, BOKARO**	24	37	61	4	2	3	4	4
35	**RANCHI, KHUNTI, LOHARDAGA, GUMLA, SIMDEGA,**	19	103	122	9	1	7	9	9
36	**Rest of Jharkhand**	83	23	106	7	6	2	7	7
37	**WEST SINGHBHUM, EAST SINGHBHUM, SERAIKELA**	0	0	0	0	0	0	0	0
38	**Bankura, Birbhum,Cooch Behar, DakshinDinajpur**	0	0	0	0	0	0	0	0
39	**Darjeeling, Hooghly, Howrah, Jalpaiguri,**	0	0	0	0	0	0	0	0

Zone Code	Zone	Production	Attraction	Total	%age	Production	Attraction	Total	%age Share
40	**Jhargram, Kalimpong, Kolkata, Malda, Murshidabad**	151	214	365	26	11	15	26	26
41	**Nadia, North 24 Parganas, PaschimBardhaman, PaschimMedinipur**	0	0	0	0	0	0	0	0
42	**PurbaBardhaman, PurbaMedinipur, Purulia, South 24 Parganas, Uttar Dinajpu**	0	0	0	0	0	0	0	0
43	**Rest of West Bangal**	61	2	63	4	4	0	4	4
44	**Lucknow, Gorakhpur, Jaunpur, Varanasi, Prayagraj, Bareilly , Kanpur, Jalaun**	80	83	163	11	6	6	11	11
45	**Noida, Ghaziabad, Aligarh, Bulandshahr**	1	6	7	0	0	0	0	0
46	**Meerut, Hapur, Bhagpat**	0	6	6	0	0	0	0	0
47	**Muzaffarnagar, Saharanpur, Shamli, Bijnor, Amroha, Moradabad, Rampur, Sambhal**	0	1	1	0	0	0	0	0
48	**Agra, Firozabad, Mainpuri, Mathura**	0	0	0	0	0	0	0	0
49	**Jhansi, Latipur**	0	0	0	0	0	0	0	0
50	**Rest of Uttar Pradesh**	4	26	30	2	0	2	2	2
51	**Delhi , Haryana State, Rajasthan**	110	131	241	17	8	9	17	17
52	**Maharashtra, Gujarat, Madhya Pradesh,**	24	61	85	6	2	4	6	6
53	**Jammu & Kashmir, Himachal Pradesh, Punjab, Uttarakhand**	145	55	200	14	10	4	14	14
54	**Goa, Kerala, Tamil Nadu, Karnataka, Andhra Pradesh, Telengana**	0	0	0	0	0	0	0	0

Zone Code	Zone	Production	Attraction	Total	%age	Production	Attraction	Total	%age Share
55	**Bihar, Jharkhand, Orissa, Chhattisgarh, West Bengal**	13	47	60	4	1	3	4	4
56	**Sikkim, Arunachal Pradesh, Nagaland, Manipur, Mizoram, Tripura, Assam, Meghalaya**	4	1	5	0	0	0	0	0
57	**NEPAL, BHUTAN**	2	4	6	0	0	0	0	0
Total		**890**	**890**	**1424**	**100**	**49**	**51**	**100**	**100**

Table 7-31 : Combined Zones

Zone Code	Zone	Production	Attraction	Total	%age	Production	Attraction	Total	%age Share
1 to 17	**PATNA**	6	9	15	1	0	1	1	1
	GAYA	44	6	50	4	3	0	4	4
	AURANGABAD	8	17	25	2	1	1	2	2
18 to 27	**SUPAUL , ARARIA**	3	0	3	0	0	0	0	0
	ROHTAS , BHABUA, SASARAM , Kaimur	100	23	123	9	7	2	9	9
28 to 37	**DHANBAD, BOKARO**	24	37	61	4	2	3	4	4
	RANCHI, KHUNTI, LOHARDAGA, GUMLA, SIMDEGA,	19	103	122	9	1	7	9	9
	Rest of Jharkhand	83	23	106	7	6	2	7	7
38 to 57	**Jhargram, Kalimpong, Kolkata, Malda, Murshidabad**	151	214	365	26	11	15	26	26

Zone Code	Zone	Production	Attraction	Total	%age	Production	Attraction	Total	%age Share
	Rest of West Bangal	61	2	63	4	4	0	4	4
	Lucknow, Gorakhpur, Jaunpur, Varanasi, Prayagraj, Bareilly , Kanpur, Jalaun	80	83	163	11	6	6	11	11
	Rest of Uttar Pradesh	4	26	30	2	0	2	2	2
	Delhi , Haryana State, Rajasthan	110	131	241	17	8	9	17	17
	Maharashtra, Gujarat, Madhya Pradesh,	24	61	85	6	2	4	6	6
	Jammu & Kashmir, Himachal Pradesh, Punjab, Uttarakhand	145	55	200	14	10	4	14	14
	Bihar, Jharkhand, Orissa, Chhattisgarh, West Bengal	13	47	60	4	1	3	4	4
	Sikkim, Arunachal Pradesh, Nagaland, Manipur, Mizoram, Tripura, Assam, Meghalaya	4	1	5	0	0	0	0	0

7.5.21 Distribution of Vehicles by Commodity Carried with empty vehicles

Table 7.32: Distribution of Vehicles by Commodity Carried with empty vehicles

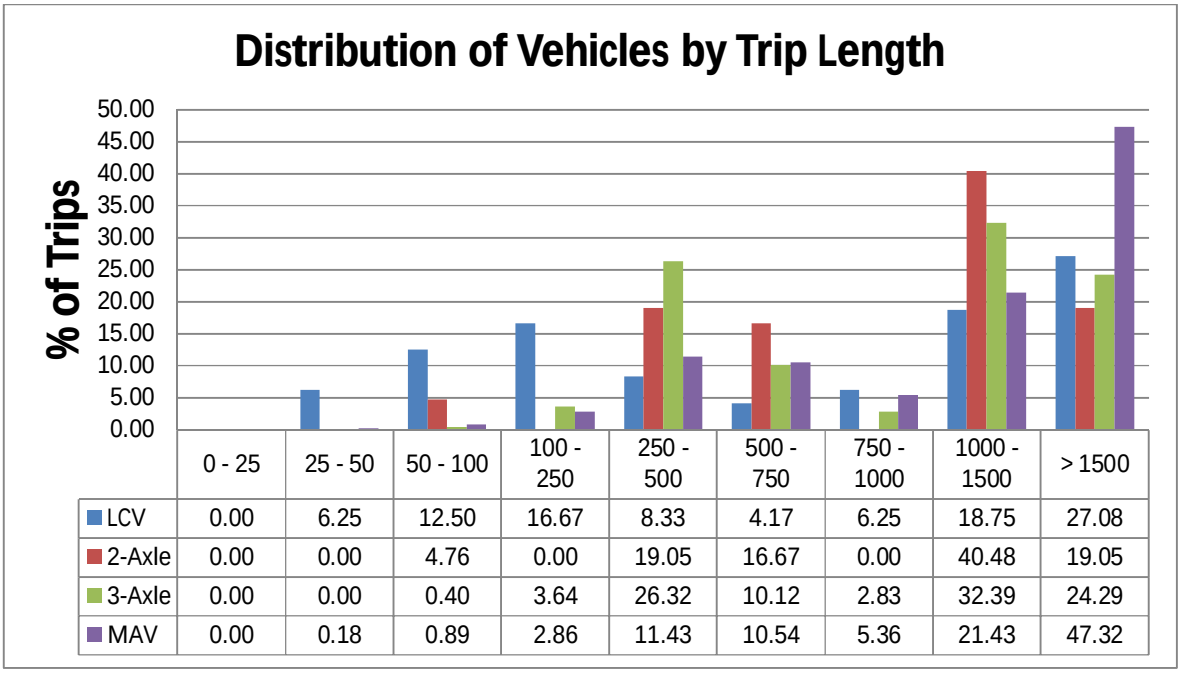
							(In Percentage)
	Commodity	**LCV**	**2 Axle**	**3 Axle**	**MAV**	**Total**	**Average**

							(In Percentage)
	Commodity	**LCV**	**2 Axle**	**3 Axle**	**MAV**	**Total**	**Average**
1	Food Grains	2.1	19.0	37.2	21.7	25.3	20.0
2	Fruits and Vegetables	4.2	11.9	22.7	24.2	21.8	15.7
3	Iron	4.2	0.0	0.4	0.2	0.5	1.2
4	Petroleum	0.0	0.0	2.8	8.1	5.5	2.7
5	Building material (Hardware,paint, tanker water)	0.0	4.8	3.2	0.2	1.4	2.1
6	Tyres	4.2	2.4	3.2	15.4	10.2	6.3
7	Household Goods	41.7	50.0	17.4	14.3	18.9	30.8
8	Mineral Oils	6.3	2.4	2.4	0.2	1.4	2.8
9	Heavy Machinery	2.1	2.4	0.0	0.0	0.3	1.1
10	Empty	0.0	0.0	0.0	4.9	2.8	1.2
11	New Vehicle	0.0	0.0	0.8	3.8	2.4	1.2
	TOTAL	100.0	100.0	100.0	100.0	100.0	100.0

7.5.22 Distribution of Vehicles by Trip Length

Table 7-33 : Distribution of Vehicles by Trip Length

				(In Percentage)
Trip Length	**LCV**	**2-Axle**	**3-Axle**	**MAV**
0 - 25	0.00	0.00	0.00	0.00
25 - 50	6.25	0.00	0.00	0.18
50 - 100	12.50	4.76	0.40	0.89
100 - 250	16.67	0.00	3.64	2.86
250 - 500	8.33	19.05	26.32	11.43
500 - 750	4.17	16.67	10.12	10.54
750 - 1000	6.25	0.00	2.83	5.36
1000 - 1500	18.75	40.48	32.39	21.43
> 1500	27.08	19.05	24.29	47.32
Total	**100.00**	**100.00**	**100.00**	**100.00**

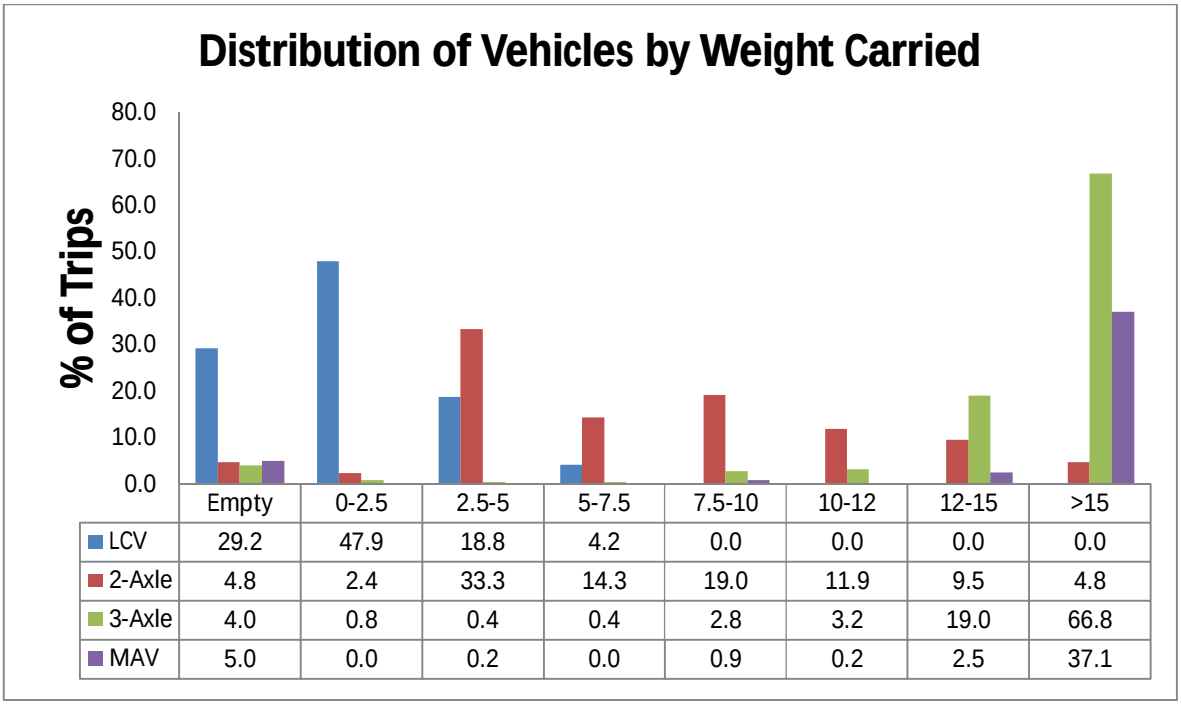


	0 - 25	25 - 50	50 - 100	100 - 250	250 - 500	500 - 750	750 - 1000	1000 - 1500	> 1500
LCV	0.00	6.25	12.50	16.67	8.33	4.17	6.25	18.75	27.08
2-Axle	0.00	0.00	4.76	0.00	19.05	16.67	0.00	40.48	19.05
3-Axle	0.00	0.00	0.40	3.64	26.32	10.12	2.83	32.39	24.29
MAV	0.00	0.18	0.89	2.86	11.43	10.54	5.36	21.43	47.32

7.5.23 Distribution of Vehicles by Weight carried

Table 7-34 : Distribution of Vehicles by Weight Carried

				(In Percentage)
Weights(Tonnes)	**LCV**	**2-Axle**	**3-Axle**	**MAV**
Empty	29.2	4.8	4.0	5.0
0-2.5	47.9	2.4	0.8	0.0
2.5-5	18.8	33.3	0.4	0.2
5-7.5	4.2	14.3	0.4	0.0
7.5-10	0.0	19.0	2.8	0.9
10-12	0.0	11.9	3.2	0.2
12-15	0.0	9.5	19.0	2.5
>15	0.0	4.8	66.8	37.1
Total	**100.0**	**100.0**	**97.6**	**100.0**



	Empty	0-2.5	2.5-5	5-7.5	7.5-10	10-12	12-15	>15
LCV	29.2	47.9	18.8	4.2	0.0	0.0	0.0	0.0
2-Axle	4.8	2.4	33.3	14.3	19.0	11.9	9.5	4.8
3-Axle	4.0	0.8	0.4	0.4	2.8	3.2	19.0	66.8
MAV	5.0	0.0	0.2	0.0	0.9	0.2	2.5	37.1

7.5.24 Distribution of Vehicles by Commodity Carried with empty vehicles

Table 7-35: Distribution of Vehicles by Commodity Carried with empty vehicles

Sr. No.	Commodity	LCV	2 Axle	3 Axle	MAV
1	Food Grains	2.1	19.0	37.2	21.7
2	Fruits and Vegetables	4.2	11.9	22.7	24.2
3	Irons	4.2	0.0	0.4	0.2
4	Petroleum	0.0	0.0	2.8	8.1
5	Building material (Hardware,paint, tanker water)	0.0	4.8	3.2	0.2
6	Tyres	4.2	2.4	3.2	15.4
7	Household Goods	41.7	50.0	17.4	14.3

Sr. No.	Commodity	LCV	2 Axle	3 Axle	MAV
8	Minerals Oil	6.3	2.4	2.4	0.2
9	Heavy Machinery	2.1	2.4	0.0	0.0
10	Empty	0.0	0.0	0.0	4.9
11	Construction material	0.0	0.0	0.8	3.8
TOTAL		100.000	100.0	100.0	100.0

7.5.25 OD Production and Attraction for Passenger vehicle

Table 7-36 : OD Production and Attraction for Passenger vehicle

Zone Number	Zone Name	Production	Attraction	Total	Production	Attraction	%age Share
1	PATNA	175	243	418	17	24	41
2	NALANDA , BIHAR SHARIF	0	4	4	0	0	0
3	ARWAL, JEHANABAD	101	103	204	10	10	20
4	GAYA	5	16	21	0	2	2
5	NAWADA	0	0	0	0	0	0
6	AURANGABAD	135	74	209	13	7	21
7	SHEIKHPURA	0	0	0	0	0	0
8	LAKHISARAI	0	0	0	0	0	0
9	BEGUSARAI , Barauni	0	4	4	0	0	0
10	SAMASTIPUR	0	1	1	0	0	0
11	VAISHALI	31	3	34	3	0	3
12	SARAN, CHHAPRA	5	1	6	0	0	1
13	SAHARSA	0	5	5	0	0	0
14	JAMUI	0	0	0	0	0	0
15	MUNGER	0	0	0	0	0	0
16	BANKA	1	0	1	0	0	0

Zone Number	Zone Name	Production	Attraction	Total	Production	Attraction	%age Share
17	BHAGALPUR	0	0	0	0	0	0
18	PURNIA , KATIHAR	0	0	0	0	0	0
19	SUPAUL , ARARIA	16	2	18	2	0	2
20	Madhepura	0	0	0	0	0	0
21	Khagaria	0	0	0	0	0	0
22	DARBHANGA	0	0	0	0	0	0
23	Muzaffarpur , Dumri	1	0	1	0	0	0
24	SIWAN , GOPALGANJ	5	1	6	0	0	1
25	ARRAH , BUXER , BHOJPUR	10	1	11	1	0	1
26	ROHTAS , BHABUA, SASARAM , Kaimur	13	14	27	1	1	3
27	MADHUBANI	0	0	0	0	0	0
28	SITAMARHI , SHEOHAR	0	1	1	0	0	0
29	CHAMPARAN, Motihari , Raxaul	2	0	2	0	0	0
30	Rest of BIHAR	0	0	0	0	0	0
31	GARHWA, PALAMU, LATEHAR, CHATRA	2	0	2	0	0	0
32	HAZARIBAGH, KODERMA, GIRIDIH	0	0	0	0	0	0
33	DEOGHAR, GODDA, SAHEBGANJ, PAKUR, DUMKA, JAMTARA	0	0	0	0	0	0
34	DHANBAD, BOKARO	0	0	0	0	0	0
35	RANCHI, KHUNTI, LOHARDAGA, GUMLA, SIMDEGA,	0	1	1	0	0	0
36	Rest of Jharkhand	2	10	12	0	1	1

Zone Number	Zone Name	Production	Attraction	Total	Production	Attraction	%age Share
37	WEST SINGHBHUM, EAST SINGHBHUM, SERAIKELA	0	5	5	0	0	0
38	Bankura, Birbhum,Cooch Behar, DakshinDinajpur	0	0	0	0	0	0
39	Darjeeling, Hooghly, Howrah, Jalpaiguri,	0	0	0	0	0	0
40	Jhargram, Kalimpong, Kolkata, Malda, Murshidabad	1	0	1	0	0	0
41	Nadia, North 24 Parganas, PaschimBardhaman, PaschimMedinipur	0	1	1	0	0	0
42	PurbaBardhaman, PurbaMedinipur, Purulia, South 24 Parganas, Uttar Dinajpu	0	0	0	0	0	0
43	Rest of West Bangal	0	0	0	0	0	0
44	Lucknow, Gorakhpur, Jaunpur, Varanasi, Allahabad, Bareilly , Kanpur, Jalaun	0	1	1	0	0	0
45	Noida, Ghaziabad, Aligarh, Bulandshahr	0	0	0	0	0	0
46	Meerut, Hapur, Bhagpat	0	0	0	0	0	0
47	Muzaffarnagar, Saharanpur, Shamli, Bijnor, Amroha, Moradabad, Rampur, Sambhal	0	0	0	0	0	0
48	Agra, Firozabad, Mainpuri, Mathura	0	0	0	0	0	0
49	Jhansi, Latipur	0	0	0	0	0	0
50	Rest of Uttar Pradesh	0	0	0	0	0	0

Zone Number	Zone Name	Production	Attraction	Total	Production	Attraction	%age Share
51	Delhi , Haryana State, Rajasthan	0	1	1	0	0	0
52	Maharashtra, Gujarat, Madhya Pradesh,	0	9	9	0	1	1
53	Jammu & Kashmir, Himachal Pradesh, Punjab, Uttarakhand	0	0	0	0	0	0
54	Goa, Kerala, Tamil Nadu, Karnataka, Andhra Pradesh, Telengana	0	4	4	0	0	0
55	Bihar, Jharkhand, Orissa, Chhattisgarh, West Bengal	0	0	0	0	0	0
56	Sikkim, Arunachal Pradesh, Nagaland, Manipur, Mizoram, Tripura, Assam, Meghalaya	0	0	0	0	0	0
57	NEPAL, BHUTAN						
		505	505	1010	50	50	100

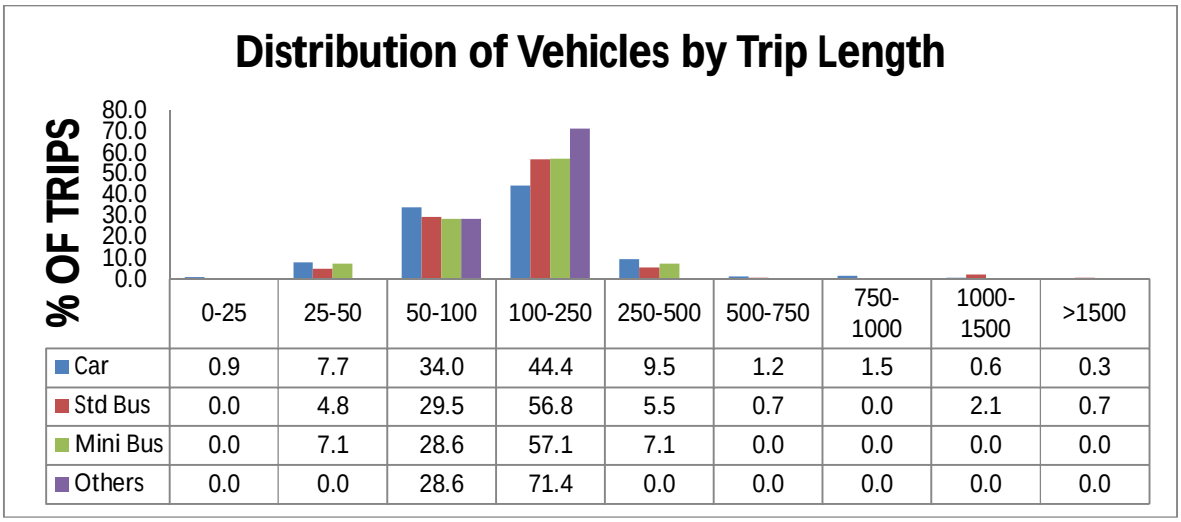
Table7-37 : Combined Zones

Zone Number	Zone Name	Production	Attraction	Total	Production	Attraction	%age Share
1 to 17	PATNA	175	243	418	17	24	41
	ARWAL, JEHANABAD	101	103	204	10	10	20
	AURANGABAD	135	74	209	13	7	21
	VAISHALI	31	3	34	3	0	3
18 to 27	SUPAUL , ARARIA	16	2	18	2	0	2
	ARRAH , BUXER , BHOJPUR	10	1	11	1	0	1
	ROHTAS , BHABUA, SASARAM , Kaimur	13	14	27	1	1	3
28 to 37	Rest of Jharkhand						

7.5.26 Distribution of Vehicles by Trip Length

Table7.38 :Rashidpur Distribution of Vehicles by Trip Length

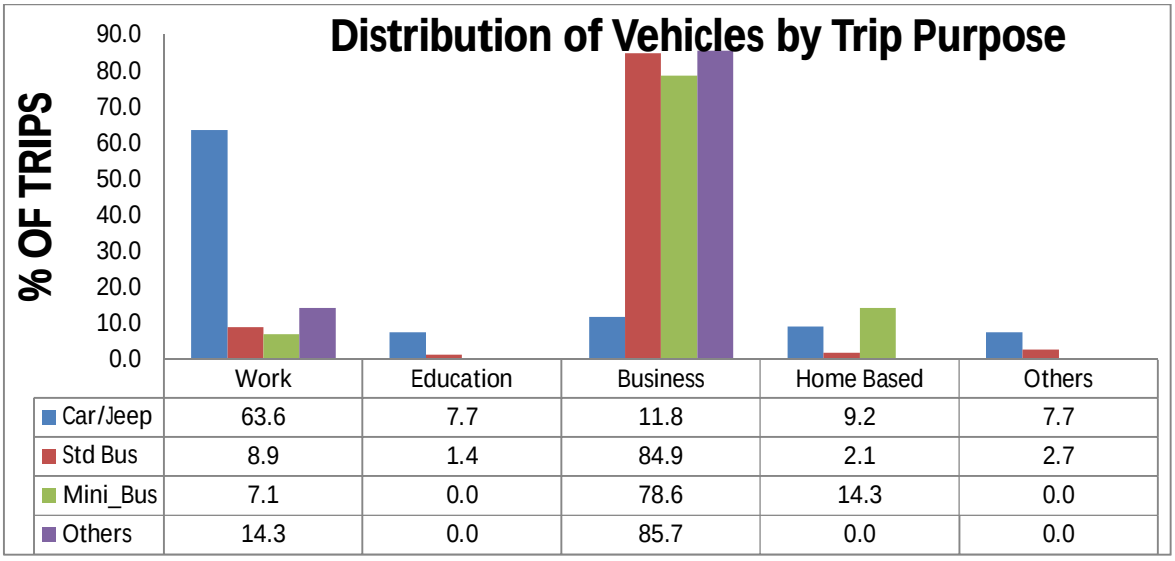
Trip Length	Car	Std Bus	Mini Bus	Others
0-25	0.9	0.0	0.0	0.0
25-50	7.7	4.8	7.1	0.0
50-100	34.0	29.5	28.6	28.6
100-250	44.4	56.8	57.1	71.4
250-500	9.5	5.5	7.1	0.0
500-750	1.2	0.7	0.0	0.0
750-1000	1.5	0.0	0.0	0.0
1000-1500	0.6	2.1	0.0	0.0
>1500	0.3	0.7	0.0	0.0
Total	**100.0**	**100.0**	**100.0**	**100.0**



7.5.27 Distribution of Vehicles by Trip Purpose

Table 7-39: Distribution of Vehicles by Trip Purpose

					(In Percentage)
Purpose	**Car/Jeep**	**Std Bus**	**Mini_Bus**	**Others**	**Total**
Work	63.6	8.9	7.1	14.3	45.5
Education	7.7	1.4	0.0	0.0	5.5
Business	11.8	84.9	78.6	85.7	35.8
Home Based	9.2	2.1	14.3	0.0	7.1
Others	7.7	2.7	0.0	0.0	5.9
Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

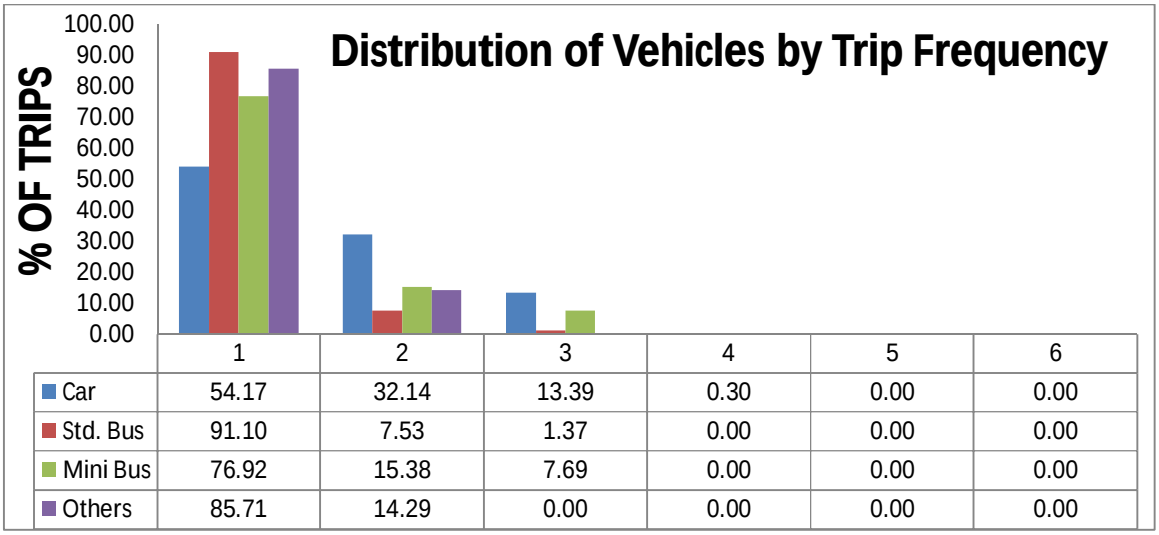


	Work	Education	Business	Home Based	Others
Car/Jeep	63.6	7.7	11.8	9.2	7.7
Std Bus	8.9	1.4	84.9	2.1	2.7
Mini_Bus	7.1	0.0	78.6	14.3	0.0
Others	14.3	0.0	85.7	0.0	0.0

7.5.28 Distribution of Vehicles by Trip Frequency

Table 7-40 : Distribution of Vehicles by Trip Frequency

			(In Percentage)	
Frequency	**Car**	**Std. Bus**	**Mini Bus**	**Others**
1	54.17	91.10	76.92	85.71
2	32.14	7.53	15.38	14.29
3	13.39	1.37	7.69	0.00
4	0.30	0.00	0.00	0.00
6	0.00	0.00	0.00	0.00
8	0.00	0.00	0.00	0.00
Total	100.00	100.00	100.00	100.00



	1	2	3	4	5	6
Car	54.17	32.14	13.39	0.30	0.00	0.00
Std. Bus	91.10	7.53	1.37	0.00	0.00	0.00
Mini Bus	76.92	15.38	7.69	0.00	0.00	0.00
Others	85.71	14.29	0.00	0.00	0.00	0.00

7.6 SPEED AND DELAY SURVEY

As we know that our entire project stretch is Greenfield alignment, it is not possible to conduct speed and delay survey.

7.7 AXLE LOAD SURVEY

Axle load survey is very important for design of the pavement. We have conducted axle load survey on Sarwan NH83 which is parallel to our stretch. As per our survey studies we have calculated following Vehicle damage factors for pavement design. Raw data is also given below in table 7-41 ,7-42 and 7-43.

Table 7-41 : VDF Factors

VDF (CV Wise) on LHS C/Way		VDF (CV Wise) on RHS C/Way	
Commercial Vehicle Type	**VDF CV Wise (on LHS C/way)**	**Commercial Vehicle Type**	**VDF CV Wise (on RHS C/way)**
LCV	1.41	**LCV**	0.46
M.Bus	0.00	**M.Bus**	0.00
Bus	2.10	**Bus**	1.04
2AT	7.60	**2AT**	0.64
3AT	9.80	**3AT**	6.04
MAV	13.80	**MAV**	9.70

Table 7-42 : Axle Load data LHS Side

Direction	Vehicle type	1st Axle	2nd Axle	3rd Axle	4th Axle	5th Axle
LHS	2AT	10.29	10.64	0	0	0
LHS	2AT	9.82	11.25	0	0	0
LHS	2AT	8.84	10.44	0	0	0
LHS	LCV	5.59	6.76	0	0	0
LHS	2AT	8.22	9.36	0	0	0
LHS	2AT	9.44	11.43	0	0	0
LHS	2AT	9.28	11.94	0	0	0
LHS	3AT	7.12	10.76	13.08	0	0
LHS	2AT	9.03	9.8	0	0	0
LHS	2AT	8.95	9.1	0	0	0
LHS	2AT	8.38	9.38	0	0	0
LHS	2AT	8.89	9.74	0	0	0
LHS	2AT	8.1	9.87	0	0	0
LHS	LCV	6.37	8.37	0	0	0
LHS	BUS	6.56	7.37	0	0	0

Direction	Vehicle type	1st Axle	2nd Axle	3rd Axle	4th Axle	5th Axle
LHS	MAV	11.97	12.11	12.37	13.09	13.95
LHS	MAV	10.32	10.928	11.44	12.92	12.36
LHS	2AT	10.16	11.88	0	0	0
LHS	LCV	5.76	5.96	0	0	0
LHS	LCV	4.25	4.8	0	0	0
LHS	3AT	10.2	11.4	14.84	0	0
LHS	2AT	11.69	12.75	0	0	0
LHS	LCV	5.26	6.58	0	0	0
LHS	BUS	7.57	8.17	0	0	0
LHS	BUS	5.65	6.38	0	0	0
LHS	BUS	4.4	4.96	0	0	0
LHS	3AT	8.17	9.08	10.62	0	0
LHS	MAV	8.4	9.74	11	13.25	0
LHS	LCV	4.36	5.5	0	0	0
LHS	2AT	10.38	12.78	0	0	0
LHS	LCV	4.8	4.96	0	0	0
LHS	2AT	8.83	9.56	0	0	0
LHS	2AT	8.97	9.51	0	0	0
LHS	2AT	9.17	10.56	0	0	0
LHS	3AT	8.37	10.36	12.16	0	0
LHS	MAV	7.4	5.01	12.2	12.3	0
LHS	3AT	10.56	14.51	14.17	0	0
LHS	LCV	6.6	7.36	0	0	0
LHS	LCV	4.2	4.35	0	0	0
LHS	2AT	8.36	10.96	0	0	0
LHS	2AT	12.56	13.58	0	0	0
LHS	3AT	7.98	8.68	9.21		0
LHS	2AT	11.68	12.96	0	0	0
LHS	2AT	11.16	11.58	0	0	0
LHS	LCV	5.2	5.48	0	0	0
LHS	2AT	6.16	6.58	0	0	0
LHS	MAV	3.36	5.7	12.1	12.25	0
LHS	MAV	5.56	7.8	11.25	13.6	0
LHS	2AT	8.96	9.12	0	0	0
LHS	MAV	4.58	6.62	10.4	11.38	0
LHS	LCV	6.68	7.26	0	0	0
LHS	2AT	8.96	9.52	0	0	0

Direction	Vehicle type	1st Axle	2nd Axle	3rd Axle	4th Axle	5th Axle
LHS	2AT	9.96	10.56	0	0	0
LHS	MAV	12.36	13.87	16.25	16.62	0
LHS	MAV	10.38	12	12.51	12.56	13.06
LHS	2AT	8.02	8.57	0	0	0
LHS	2AT	8.96	9.38	0	0	0
LHS	3AT	7.96	8.12	9.98		0
LHS	2AT	6.45	7.5	0	0	0
LHS	2AT	7.2	7.96	0	0	0
LHS	2AT	7.98	8.16	0	0	0
LHS	2AT	7.88	8.32	0	0	0
LHS	LCV	5.56	7.8	0	0	0
LHS	2AT	8.17	9.18	0	0	0
LHS	2AT	11.78	12.58	0	0	0
LHS	3AT	7.58	8.36	10.52	0	0
LHS	2AT	7.18	8.56	0	0	0
LHS	2AT	7.38	8.25	0	0	0
LHS	2AT	10.72	11.78	0	0	0
LHS	2AT	11.1	12.36	0	0	0
LHS	2AT	12.58	12.76	0	0	0
LHS	LCV	5.45	5.9	0	0	0
LHS	3AT	8.38	9.76	11.36	0	0
LHS	2AT	6.56	7.56		0	0
LHS	2AT	7.36	8.76	0	0	0
LHS	MAV	10.16	12.96	13.54	13.3	12.56
LHS	3AT	10.92	12.3	13.22	0	0
LHS	3AT	7.17	8.18	10.36		0
LHS	3AT	10.88	11.12	11.78	0	0
LHS	3AT	8.79	10.08	12.32		0
LHS	3AT	8.16	10.11	12.78	0	0
LHS	3AT	9.77	11.16	10.56	0	0
LHS	3AT	10.95	11.36	12.04	0	0
LHS	2AT	7.54	7.72	0	0	0
LHS	3AT	8.21	10.12	11.76	0	0
LHS	3AT	9.36	11.16	12.49		0
LHS	MAV	10.6	13.5	13.05	14.3	0
LHS	3AT	10.73	11.12	11.38	0	0
LHS	2AT	7.84	8.42	0	0	0

Direction	Vehicle type	1st Axle	2nd Axle	3rd Axle	4th Axle	5th Axle
LHS	2AT	7.81	8.36	0	0	0
LHS	3AT	8.74	8.81	9.56	0	0
LHS	2AT	11.3	12.34	0	0	0
LHS	3AT	9.78	10.68	11.12	0	0
LHS	3AT	10.73	12.08	12.36	0	0
LHS	2AT	13.81	14.39	0	0	0
LHS	LCV	5.93	6.2	0	0	0
LHS	3AT	8.63	10.36	11.72	0	0
LHS	MAV	10.36	12.21	12.74	12.8	0
LHS	3AT	9.58	9.16	11.97	0	0
LHS	3AT	8.78	9.76	11.98	0	0
LHS	3AT	11.56	12.36	12.58	0	0
LHS	3AT	11.39	12.76	13.37	0	0
LHS	3AT	9.96	10.12	11.98	0	0
LHS	3AT	10.36	12.74	14.93	0	0
LHS	2AT	10.75	11.89	0	0	0

Table 7-43 : Axle Load data RHS Side

Direction	Vehicle type	1st Axle	2nd Axle	3rd Axle	4th Axle	5th Axle
RHS	2AT	**5.56**	**5.36**			
RHS	3AT	**7.08**	**9.16**	**9.58**		
RHS	3AT	**6.16**	**5.9**	**7.06**		
RHS	LCV	**3.96**	**4.36**			
RHS	LCV	**4.96**	**5.73**			
RHS	2AT	**5.96**	**5.29**			
RHS	3AT	**7.17**	**6.02**	**8.19**		
RHS	2AT	**4.64**	**7.1**			
RHS	2AT	**6.36**	**5.72**			
RHS	MAV	**10.76**	**10.06**	**11.44**	**13.25**	**13.55**
RHS	2AT	**7.56**	**11.35**			
RHS	2AT	**6.9**	**11.06**			
RHS	3AT	**7.76**	**9.16**	**11.88**		

Direction	Vehicle type	1st Axle	2nd Axle	3rd Axle	4th Axle	5th Axle
RHS	2AT	**4.26**	**4.56**			
RHS	BUS	**5.56**	**6.96**			
RHS	2AT	**4.56**	**5.3**			
RHS	LCV	**3.36**	**3.18**			
RHS	LCV	**4.36**	**4.2**			
RHS	LCV	**3.16**	**3.38**			
RHS	3AT	**6.56**	**5.78**	**7.08**		
RHS	2AT	**4.4**	**5.56**			
RHS	LCV	**4.03**	**4.56**			
RHS	MAV	**10.74**	**11.6**	**12.29**	**13.6**	
RHS	BUS	**4.46**	**6.43**			
RHS	BUS	**8.1**	**9.2**			
RHS	BUS	**6.98**	**8.96**			
RHS	MAV	**5.5**	**5.78**	**8.4**	**12**	
RHS	3AT	**6.42**	**6.14**	**7.93**		
RHS	2AT	**4.24**	**4.89**			
RHS	LCV	**4.32**	**4.96**			
RHS	LCV	**3.96**	**4.56**			
RHS	3AT	**5.98**	**6.06**	**8.4**		
RHS	2AT	**4.36**	**5.09**			
RHS	3AT	**6.82**	**6.16**	**7.76**		
RHS	LCV	**4.64**	**4.5**			
RHS	MAV	**5.75**	**6.56**	**7.92**	**10.3**	
RHS	2AT	**5.56**	**7.91**			
RHS	MAV	**8.08**	**6.67**	**10.58**	**12.5**	
RHS	MAV	**7.58**	**5.86**	**8.56**	**10.8**	
RHS	2AT	**6.96**	**7.29**			
RHS	2AT	**4.38**	**4.92**			
RHS	3AT	**6.38**	**6.74**	**10.08**		
RHS	3AT	**6.56**	**6.69**	**8.03**		
RHS	2AT	**5.16**	**5.34**			
RHS	3AT	**4.96**	**4.69**	**6.38**		
RHS	LCV	**4.49**	**5.36**			
RHS	2AT	**5**	**5.12**			
RHS	2AT	**5.36**	**5.95**			
RHS	LCV	**4.26**	**5.18**			
RHS	2AT	**3.9**	**4.3**			
RHS	3AT	**5.28**	**5.8**	**10.34**		
RHS	LCV	**3.16**	**3.52**			
RHS	2AT	**5.78**	**8.64**			

Direction	Vehicle type	1st Axle	2nd Axle	3rd Axle	4th Axle	5th Axle
RHS	2AT	**3.96**	**4.48**			
RHS	2AT	**4.2**	**4.04**			
RHS	LCV	**3.96**	**4.2**			
RHS	2AT	**4.36**	**4.58**			
RHS	MAV	**6.24**	**6.56**	**9.44**	**13.38**	
RHS	2AT	**4.56**	**5.8**			
RHS	2AT	**5.05**	**5.29**			
RHS	2AT	**5.96**	**5**			
RHS	2AT	**4.36**	**3.16**			
RHS	3AT	**6.62**	**10.56**	**14.96**		
RHS	3AT	**6.38**	**6.18**	**10.98**		
RHS	LCV	**3.89**	**4.2**			
RHS	3AT	**6.96**	**9.38**	**11.74**		
RHS	3AT	**6.95**	**7.78**	**10.76**		
RHS	3AT	**10.53**	**13.07**	**14.55**		
RHS	3AT	**6.32**	**13.24**	**11.96**		
RHS	3AT	**6.96**	**10.41**	**13.01**		
RHS	3AT	**7.96**	**13.53**	**14.09**		
RHS	3AT	**7.79**	**9.38**	**11.61**		
RHS	3AT	**6.38**	**8.16**	**9.88**		
RHS	2AT	**6.37**	**6.69**			
RHS	2AT	**7.81**	**9.96**			
RHS	3AT	**7.96**	**9.12**	**14.33**		
RHS	2AT	**7.56**	**9.96**			
RHS	2AT	**6.36**	**7.78**			
RHS	3AT	**6.16**	**8.16**	**13.37**		
RHS	3AT	**7.99**	**9.08**	**14.38**		
RHS	3AT	**7.6**	**9.96**	**15.3**		
RHS	LCV	**3.76**	**4.18**			
RHS	3AT	**6.71**	**10.36**	**12.51**		
RHS	3AT	**7.66**	**9.75**	**11.93**		
RHS	2AT	**6.36**	**7.98**			
RHS	3AT	**7.8**	**8.38**	**10.67**		
RHS	3AT	**6.76**	**8.56**	**10.78**		
RHS	3AT	**7.76**	**9.8**	**11.96**		
RHS	3AT	**7.99**	**10.36**	**13.12**		
RHS	3AT	**6.36**	**2.596**	**9.99**		
RHS	3AT	**7.47**	**14.79**	**17.07**		
RHS	2AT	**6.61**	**10.41**			
RHS	LCV	**4.47**	**4.21**			

Direction	Vehicle type	1st Axle	2nd Axle	3rd Axle	4th Axle	5th Axle
RHS	3AT	**9.82**	**14.98**	**18.42**		
RHS	2AT	**4.42**	**4.44**			
RHS	3AT	**5.82**	**6.96**	**9.02**		
RHS	3AT	**5.81**	**5.93**	**7.95**		
RHS	3AT	**6.68**	**7.11**	**8.61**		
RHS	3AT	**8.15**	**8.48**	**14.63**		
RHS	3AT	**8.01**	**8.28**	**14.64**		
RHS	3AT	**8.9**	**10.51**	**13.12**		
RHS	LCV	**3.81**	**4.15**			
RHS	LCV	**4.21**	**7.804**			
RHS	3AT	**8.73**	**9.75**	**12.75**		
RHS	3AT	**5.95**	**8.51**	**11.61**		

7.8 NORMAL AND DIVERTED AND INDUCED TRAFFIC ON OUR STRETCH

Based on Traffic volume count and Origin Destination Survey conducted on the nearby stretches, the analysis has been done and the final Annual Average daily Traffic in 2020 can be predicted on our stretch has been found out as below in Table 7.44:

Table 7-44: ANNUAL AVERAGE DAILY TRAFFIC AT OUR PROJECT STRETCH

Mode	TVC
	Project Stretch
2-Wheeler	860
Car/ Van/ Jeep/ Taxi	8055
Auto Rickshaw	84
Bus	617
LCV	2692
2 Axle Truck	749
3 Axle Truck	513
MAV	52
Agri. Tractor	69
Agri. Tractor + Trailer	14
Cycle	24
Cycle Rickshaw	0
Construction Vehicle	0

Total Vehicle	**13729**
Total PCU	**18657**

7.5.29 COMMERCIAL AND NON COMMERCIAL TRAFFIC

Table 7-45: COMMERCIAL AND NON COMMERCIAL TRAFFIC

Mode	**Diverted & Induced Traffic**	
	Project Stretch	
Non Commercial Vehicle	**AADT**	**PCU**
2-Wheeler	860	430
Car/ Van/ Jeep/ Taxi	8055	8055
Auto Rickshaw	84	84
Cycle	24	12
Cycle Rickshaw	0	0
Total Vehicle	**9023**	**8581**
Commercial Vehicle	**AADT**	**PCU**
Bus	617	1851
LCV	2692	4038
2 Axle Truck	749	2247
3 Axle Truck	513	1539
MAV	52	234
Agri. Tractor	69	103.5
Agri. Tractor + Trailer	14	63
Construction Vehicle	0	0
Total Vehicle	**4706**	**10076**

7.5.30 TOLLABLE AND NON TOLLABLE TRAFFIC ON OUR STRETCH

Table 7-46: TOLLABLE AND NON TOLLABLE TRAFFIC ON OUR STRETCH

Mode	**Diverted & Induced Traffic**	
	Project Stretch	
Non Tollable Traffic	**AADT**	**PCU**
2-Wheeler	861	431
Auto Rickshaw	84	84
Cycle	24	12

Cycle Rickshaw	0	0
Total Vehicle	**969**	**527**

Mode	**Diverted & Induced Traffic**	
	Project Stretch	
Tollable Traffic	**AADT**	**PCU**
Car/ Van/ Jeep/ Taxi	8055	8055
Bus	617	1851
LCV	2692	4038
2 Axle Truck	749	2247
3 Axle Truck	513	1539
MAV	52	234
Agri. Tractor	69	104
Agri. Tractor + Trailer	14	63
Construction Vehicle	0	0
Total Vehicle	**12761**	**18131**

7.5.31 FUTURE TRAFFIC PROJECTION ON OUR STRETCH

Table 7-47: FUTURE TRAFFIC PROJECTION ON OUR STRETCH

PCU Factor	0.5	1	1	3	1.5	3	3	4.5	4.5	1.5	0.5	3				
Year	Fast Moving Vehicles										Slow Moving Vehicles					
	2 Wheeler	3 Wheeler	Passenger Car	Bus	LCV 6 Tyre	2-Axle	3-Axle	Multi Axle	Agricultural Tractor With Trailer	Agricultural Tractor Without Trailer	Bicycle	Others	Total Fast Moving Vehicles	Total Slow Vehicles	Total All Vehicles (Nos.)	Total All Vehicles (PCU)
2020	860	84	8055	617	2692	749	513	52	14	69	24	0	13705	24	13729	18657
2021	922	87	8655	636	2857	773	529	54	14	71	25	0	14597	25	14623	19727
2022	988	89	9300	655	3032	797	546	55	15	73	26	0	15551	26	15577	20865
2023	1048	91	9876	671	3178	817	560	57	15	75	28	0	16389	28	16417	21855
2024	1110	94	10489	688	3332	838	574	58	16	77	29	0	17276	29	17305	22898
2025	1177	96	11139	705	3493	859	588	60	16	79	31	0	18213	31	18243	23996
2026	1247	98	11830	722	3662	881	603	61	16	81	32	0	19203	32	19235	25152
2027	1322	101	12563	740	3840	903	619	63	17	83	34	0	20251	34	20284	26370
2028	1390	103	13233	756	3994	922	631	64	17	85	35	0	21195	35	21231	27460
2029	1462	105	13938	772	4154	941	645	65	18	87	37	0	22187	37	22224	26284
2030	1538	107	14681	789	4320	961	658	67	18	88	39	0	23227	39	23266	29793
2031	1617	110	15464	806	4494	981	672	68	18	90	41	0	24318	41	24360	31041
2032	1700	112	16288	823	4674	1001	686	69	19	92	43	0	25464	43	25507	32346
2033	1778	114	17053	838	4834	1019	698	71	19	94	45	0	26517	45	26563	33539
2034	1858	116	17855	854	4999	1037	710	72	19	96	48	0	27617	48	27664	34781
2035	1943	119	18694	870	5170	1055	723	73	20	97	50	0	28764	50	28814	36074
2036	2031	121	19573	887	5347	1074	736	75	20	99	52	0	29961	52	30014	37420

PCU Factor	0.5	1	1	3	1.5	3	3	4.5	4.5	1.5	0.5	3				
Year	Fast Moving Vehicles										Slow Moving Vehicles					
	2 Wheeler	3 Wheeler	Passenger Car	Bus	LCV 6 Tyre	2-Axle	3-Axle	Multi Axle	Agricultural Tractor With Trailer	Agricultural Tractor Without Trailer	Bicycle	Others	Total Fast Moving Vehicles	Total Slow Vehicles	Total All Vehicles (Nos.)	Total All Vehicles (PCU)
2037	2123	123	20492	904	5530	1093	749	76	20	101	55	0	31211	55	31266	38821
2038	2209	125	21355	919	5695	1110	760	77	21	102	58	0	32374	58	32432	40118
2039	2299	127	22254	934	5864	1127	772	78	21	104	61	0	33582	61	33643	41463
2040	2393	129	23191	950	6039	1145	784	79	21	105	64	0	34838	64	34902	42857
2041	2490	132	24168	966	6219	1163	796	81	22	107	67	0	36143	67	36210	44304
2042	2592	134	25185	983	6404	1181	809	82	22	109	70	0	37500	70	37570	45803
2043	2687	136	26147	998	6573	1197	820	83	22	110	74	0	38774	74	38847	47206
2044	2787	138	27146	1013	6747	1213	831	84	23	112	77	0	40093	77	40170	48656
2045	2889	140	28183	1028	6925	1230	842	85	23	113	81	0	41459	81	41541	50155
2046	2996	142	29259	1044	7108	1247	854	87	23	115	85	0	42875	85	42960	51705
2047	3106	144	30377	1060	7295	1264	866	88	24	116	90	0	44341	90	44430	53307
2048	3211	146	31440	1075	7468	1279	876	89	24	118	94	0	45728	94	45822	54818
2049	3320	148	32541	1090	7645	1295	887	90	24	119	99	0	47160	99	47259	56376
2050	3432	151	33680	1106	7827	1311	898	91	25	121	104	0	48640	104	48744	57983

7.6 Pavement Design

FLEXIBLE PAVEMENT DESIGN

Flexible Pavement is designed for MCW including Loops, Ramps and Approach roads for access to wayside amenities. Main Carriage way is designed for 20 years**.**

Table 7.48 : Design Traffic

Flexible Pavement in MCW	Length in km	Design Traffic
For entire project stretch	54.785	90 MSA

7.7 Proposed Flexible Pavement Design for MCW, Ramps and Loops

Table 7.49: Pavement Thickness

Design period	Design Traffic	Va	Vb	Design CBR	BC (VG 40)	DBM (VG 40)	WMM	GSB	TOTAL
20 years	90 MSA	3.5%	12.5%	6%	50	135	250	250	**685**

7.8 FLEXIBLE PAVEMENT DESIGN FOR SERVICE ROADS

Service roads are designed for 10 MSA. Design CBR of minimum of 6% is recommended. The design crust composition is given in the table below.

Table7.50: Proposed Design for Service Roads

Design period	Design Traffic	Bitumen Grade	Design CBR	BC	DBM	WMM	GSB	TOTAL
20 years	10 MSA	VG 30	6%	30	70	250	200	550

Chapter- 8

Environmental Screening Assessment Report

8.1 Introduction

Environmental screening study has been carried out to identify critical Environmental issues and areas that would be explained in detail for impact assessment, mitigation measures and management plan. Findings of the screening and environmental assessment are presented in this chapter. Further details will be taken up during subsequent stages of the project preparation. This chapter has been prepared mainly based on the field survey and collection of secondary data from government database.

In the screening stage, existing environmental set-up of the study corridor in general i.e., the corridor of impact, and proposed Right of Way (RoW) in particular were studied and described in subsequent sections. The entire environmental impact due to project was assessed within existing policy, legal and administrative framework considering the applicable environmental legislation, regulations and guidelines. The environmental screening report covers the following:

a) Baseline Environmental Scenario
b) Probable Environmental Impacts
c) Applicable Environmental Laws and Regulations
d) Various clearances /NOC
e) Mitigation measures

8.2 General

Road projects are meant for improving the quality of life of people and developing the country's economy. Considering all the positive impacts of the road projects, there may also be some significant detrimental impacts on nearby communities and local environment. The impact due to proposed project may be on properties of people, their livelihood and other social components, similarly there can be direct or indirect impact on flora, fauna, water resources, land use etc. To account all of these issues, environmental and social impact assessment is utmost necessary. These concerns for environmental and social issues in road projects have also become a part of legal requirements and necessary for obtaining financial support. Environmental assessment is therefore of prime importance in road projects.

8.3 Scope of Work

The main objective of the consultancy service is to prepare detailed project report for development of Economic Corridors, Inter Corridors and Feeder Routes to improve the efficiency of freight movement in India under Bharatmala Pariyojana (Lot-5/Package-7) from Shivrampur to Ramnagar of Aurangabad to Anishabad Section.

Environmental impact assessment, Environmental Management Plan and Rehabilitation and Resettlement shall be carried out by consultant meeting the requirement of the lending

agencies like ADB/World Bank etc. Whenever required, consultant will liaise with concerned authorities and arrange all clearances.

The preliminary environmental examination has been done to streamline environmental issues in project design, constructional and operational stages. This chapter deals with environmental screening and preliminary environmental assessment for the feasibility report for the project. The baseline data has been obtained from secondary sources.

8.4 Purpose / Objective of the Environmental Screening exercise

Environmental assessment is a detailed process, which starts from the conception of the project and continues till the operation phases. The steps for Environmental Assessment are therefore different at different phases. The first step for Environmental Assessment is known as screening & scoping. It is a preliminary study for identifying major environmental issue and their mitigation to be included in the design of the project.

8.5 Project Road

The project is starting at Major T-Junction from Amas (Gaya District) at Design Ch.0+000 Km to connect Ramnagar (Patna District) located at Design Ch. 109+106 Km on SH-78. The whole stretch is further divided into two packages as stated below:

i. **Package -1** Amas to Shivrampur from Design Ch. 0+000 Km to Design Ch. 55+002 Km of length 54.785 Km.
ii. **Package -2** Shivrampur to Ramnagar from Design Ch. 55+002 Km to Design Ch. 109+300 Km of length 54.298 Km.

In this report we will discuss the project features of this new proposed green field alignment from “Shivrampur” to “Ramnagar” treated as Package -2 as mentioned above.

The starting point of this project is near “Shivrampur” located at the District boundary of Gaya-Jehanabad, from Design Ch. 55+002 Km. The coordinates of the starting point is **Latitude 25.008958° and Longitude 84.990754°.** The ending point of this project is near “Ramnagar” at Design Ch. 109+300 Km which is the connecting the SH-78 road. The coordinates of the ending point is Latitude **25.446056° & Longitude 85.209556°.**

The project road passes through the following three districts:

1) Jehanabad (Design Ch. 55+002 Km - Design Ch. 92+717 Km)
2) Nalanda (Design Ch. 101+717 Km - Design Ch. 103+517)
3) Patna (Design Ch. 92+717 Km - Design Ch. 101+717 and Design Ch. 103+517 Km - Design Ch. 109+300)

As this is a completely new Green Field Alignment, there are no existing structures in the project road. This alignment mainly passes through Plain terrain and shall be constructed as 4-Lane with Paved shoulder configuration in accordance to IRC: SP: 84:2014.

The Proposed ROW of this section is taken as 60 m in which all the configurations shall be fitted with. The key map of the proposed alignment is shown in Fig. 8.1.

8.6 Settlements

As this is a green field alignment, there are many villages across the proposed road which are tried to retain by fixing the alignment in best method. The below listed settlements are given below in Table 8.1.

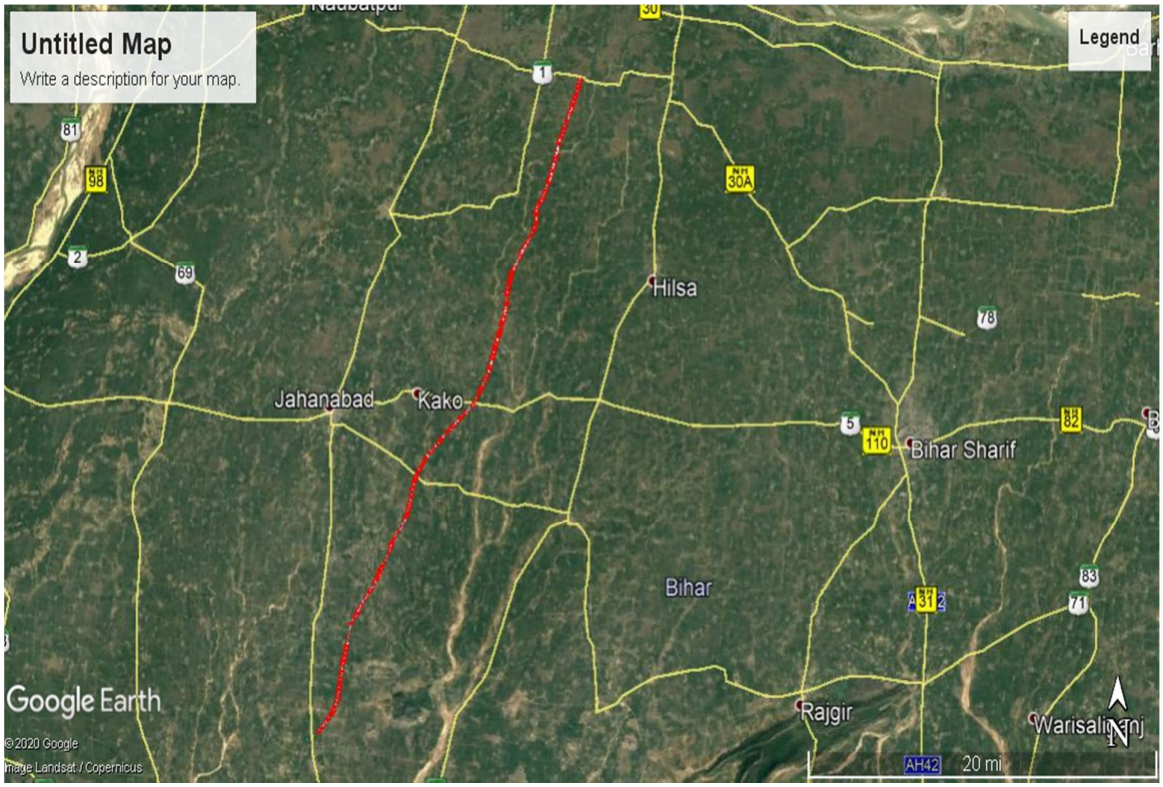


Figure 8.1: Index Map

Table 8.1: Detail of Settlements

S. No	Settlements	S. No	Settlements
1	Shiwrampur	17	Karhara
2	Berka	18	Gandhar
3	Damodarpur	19	Habalipur
4	Chandi	20	Charui
5	Chariyari	21	Dhobri
6	Mahewa	22	Deora
7	Kalanpur	23	Sadipur
8	Malathi	24	Jehanbad
9	Berthoo	25	Amarpura
10	Suppi	26	ManikBigha
11	KajiSarai	27	Pabhera
12	Ibrahimpur	28	Tarwan
13	Golakpur	29	Abupur

S. No	Settlements	S. No	Settlements
14	Mohiuddinpur	30	Hulas Chak
15	Ahiasa	31	Andari
16	Mahammadpur	32	Ramnagar

Note: The alignments pass through these settlements which may or may not affect the structures. These names are for only for indicative purpose, actual R&R shall be provided separately.

8.7 Traffic Survey and Analysis

Count of traffic is the basic traffic study required in connection with many types of highway projects. Knowledge of the vehicular traffic using a road network is important for understanding the efficiency at which the system works at present and the general quality of service offered to the road users. The traffic using a road consists of a variety of vehicles ranging from the simple pedal cycles to the motor car and the heavy commercial vehicles, each type having an influence on the performance of the road on its own way. A simple volume count, without classifying the vehicles into distinct types, is of limited use. The normal practice is to take classified traffic volume count to evaluate the traffic plying on a road project.

Classified traffic counts were carried out for a period of 7 consecutive days at mid-block locations along 2 corridors. The locations selected were at the outskirts of city where the local traffic is low and regional traffic is high. The surveys were carried out mainly by trained enumerators. The data served as population base during base year and will be used to project traffic

Table 8.2: Survey Location and Periods

S. No.	Type of Survey	Location Code	Location Name	Road Name	Remark
1	Traffic Volume Count	TVC - 01	Sarwan	NH-83	7 Days
		TVC - 02	Sawkala Toll Plaza	NH-02	7 Days

8.8 Expected Benefits from Proposed Project

The Major Benefits of the Project are:

1) Project Road would release the traffic stress and smoothen the traffic. Fast and safe connectivity resulting in saving in fuel, travel time and total transportation cost to society.
2) Employment opportunity to people.
3) Development of local industry like agriculture and handicrafts etc.
4) Development of Tourism and pilgrimage.
5) Transportation, processing and marketing of Agricultural products.
6) Better approach to medical and educational services and quick transportation of perishable goods like fruits, vegetables and Dairy products.
7) Improved quality of people lives.

8) Aggressive Afforestation policy leading to development of avenue plantation and thus overall green area.

8.9 Methodology

The major issues identified in this scope are:

i. Baseline scenario;
ii. Co-ordination of environmental screening with the feasibility study;
iii. legal and policy framework
iv. important environmental features along the road alignment
v. Assessment of potential impacts; and
vi. Mitigation measures

Study of Project Documents: the project documents have been studied to have the understanding of the project objectives, its main components, boundaries etc.

Study of Laws and Regulations: Laws and regulations enacted by Government of India and Bihar state relevant to road construction and environmental were studied.

Study of Guidelines and Standards: Various documents and publications of the Ministry of Environment, Forest and Climate Change (MoEF&CC) and Indian Road Congress were studied for screening exercise.

Analysis of data and screening exercise: The data collection through the above steps will be compiled to develop the environmental scenario of the project area and the sensitive components within the project area. The full road length including Right of Way (RoW) and Corridor of impact (COI) will be put under screening to identify the hot spot zones. The identification of hot spots in project area would help in further detailed study and preparation of Environmental Impact Assessment report and Environmental Management Plan for the project at later stage.

8.10 Reconnaissance Survey

A team of environmental and social expert will carry out reconnaissance survey of the project road. Important environmental components including water bodies, forests, public utilities, community resources, cultural sites, high pollution zone, accident prone area etc. along the corridor will be identified. On the basis of background information, legal and policy positions etc. a checklist was prepared to conduct screening exercise. Discussion with local people and administrators were also conducted to obtain their opinion about the project.

8.11 Types and source of data collection

The environmental data was collected from secondary sources. The objective is to gather information for assessment of regional environmental status all along the stretch in respect to physical and biological environment, secondary data on geology & topography, soil & agriculture, land use, hydrology and water use, meteorology, and socio-economy and inventory of flora & fauna and also occurrence of any endangered species from authentic and

published sources. Following are some important information available from secondary sources.

Demography - Census of India and Government of Bihar

Land Use - Survey of India Toposheet and Government of Bihar website

Metrology - Primary surveys, Meteorology Department and Government of Bihar Website.

Forest - Department of Forest, Government of Bihar Website

District Profile- Government of Bihar Website

Geological Data - Government of Bihar Website

Field Study / Monitoring / Laboratory Analysis for generation of Primary data in the study corridor will involve following:

a) Water quality monitoring at identified ground water and surface water locations
b) Air quality monitoring at identified locations
c) Ambient noise level monitoring at identified locations
d) Enumeration of roadside trees

8.12 Environmental Impact Assessment

The environmental assessment will be conducted in accordance with the norms and guidelines of the Government of India. Wherever possible and practicable, a quantitative analysis would be performed. Following aspects will be given due importance during assessment of impact and recommending remedial measures:

i. Alignment of the project road and topographical changes
ii. Nature and quantum of automobile emissions
iii. Water requirement during construction and sources
iv. Noise level during operation and noise control measures
v. Loss of trees and compensatory plantation & Afforestation
vi. Noise level, dust concentration and water logging near construction sites
vii. Nature quantity and disposal of construction spoils
viii. Public health and sanitation and occupational health & safety of construction workers
ix. Population effected including weaker sections

8.13 Environmental legislations and their implications/application

The government of India has formulated various policy guidelines; acts and regulations aimed to protection and enhancement of environmental resources. The following table surmises the existing legislations pertaining to the project, the various clearances required for the project and the status as on date.

Table 8.3: Summary of Relevant Environmental Acts and Guidelines

S. No.	Act/Rules	Year	Objective	Applicable Yes/No	Reason for applicability	Authority
1.	Environmental (Protection) Act	1986	To protect and improve overall environment	Yes	As all environmental notifications, rules and schedules are issued under this act	MoEF&CC GoI, Forests & Env. Dept., GoB, CPCB, BSPCB
2.	Environmental Impact Assessment (EIA) Notification	2006	To provide environmental clearance to new development activities following environmental impact assessment	No	The project does not attracts the conditions of EIA Notification 2006 and further amendments	MoEF&CC
3.	Forest (Conservation) Act	1980	To check deforestation by restricting conversion of forested areas into non-forested areas	No	There is no notified forest area	Forest Department GoB
4.	Water (Prevention and Control of Pollution) Act and Cess Act of 1977 as amended in 1988	1974	To control water pollution by controlling emission & Water pollutants as per the prescribed standards	Yes	This act will be applicable during construction, for establishments of hot mix plant, stone crusher, construction camp, workers' camp, etc.	BSPCB
5.	Air (Prevention and Control of Pollution) Act as amended in 1987	1981	To control air pollution by controlling emission and air pollutants according to prescribed standards	Yes	This act will be applicable during construction; for obtaining NOC for establishment of hot mix plant, workers' camp, stone crusher, construction camp, etc.	BSPCB

S. No.	Act/Rules	Year	Objective	Applicable Yes/No	Reason for applicability	Authority
6.	Noise Pollution (Regulation and Control) rules	2000	Noise pollution regulation and controls	Yes	This act will be applicable as vehicular noise on project routes required to assess for future years and necessary protection measure need to be considered in design.	BSPCB
7.	Ancient Monuments and Archaeological. Sites and Remains (Amendment and Validation) Act, 2010	2010	Conservation of Cultural and Historical remains found in India	No	The project route is not close to any Ancient Monument, declared protected under the act.	Archaeological Dept. Gol, Dept. of Archaeolog, GoB,
8.	Notification for use of fly ash	2016	Promoting the utilization of fly ash in the manufacture of building materials and in construction activity within a specified radius of 300 kilometers from coal or lignite based thermal power plants	Yes	Thermal power plant located within 300 km from project site	MoEF&CC
9.	The Explosives Act (& Rules)	1884	An Act to regulate the manufacture, possession, use, sale, transport, import and export of Explosives	Yes	For transporting and storing diesel, bitumen etc.	BSPCB
10.	Public Liability Insurance Act	1991	Insurance for the purpose of providing immediate relief to the	Yes	Contractor need to stock hazardous material like diesel,	BSPCB

S. No.	Act/Rules	Year	Objective	Applicable Yes/No	Reason for applicability	Authority
			persons affected by accident occurring while handling any hazardous substance and for matters connected therewith or incidental thereto		Bitumen, Emulsions etc. safely	
11.	Coastal Regulation Zone	2011	To regulate activities in the coastal zone to protect ecologically sensitive areas	No	The proposed highway does not pass through CRZ	HCZMA, MoEF&CC
12.	Hazardous and Other Wastes (Management and Transboundary Movement) Rules	2016	Storage, handling, transportation and disposal of hazardous waste	Yes	Storage and handling of hazardous waste during construction	BSPCB
13.	Solid Waste Management Rules	2016	Management and handling of solid waste	Yes	For disposal of solid waste generated during construction	BSPCB
14.	Construction and Demolition Waste Management Rules	2016	Management of construction and demolition waste	Yes	For disposal of solid waste generated due to construction and demolition	BSPCB
15.	Batteries (Management & Handling) Amendment Rules	2010	Management and handling of used lead batteries	Yes	Safe disposal of used lead batteries	BSPCB
16.	E-Waste (Management) Rules	2016	Effective mechanism to regulate generation, collection, storage, transport, import, export, recycling, treatment and disposal of e-wastes	Yes	Handling of e-waste	BSPCB

S. No.	Act/Rules	Year	Objective	Applicable Yes/No	Reason for applicability	Authority
16.	Central Motor Vehicles Act	1988	To control vehicular air and noise pollution.	Yes	This rule will be applicable to road users and construction machinery	Motor Vehicle Department
17.	Minor Mineral and concession Rules	1960	For opening new quarry	Yes	Regulate use of minor minerals like stone, soil, river, sand etc.	District Collector
18.	The Mining Act	1952	The mining act has been notified for safe and sound mining activity	Yes	The construction of proposed highway will require aggregates. These will be procured through mining from quarries	Department of mining, GoB
19.	National Forest Policy (Revised)	1988	To maintain ecological stability through preservation and restoration of biological diversity	Yes	This policy will not be applicable.	Forest Department Gol and GoB
20.	The Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act	2013	Set out rules for fair compensation and acquisition of land	Yes	This act will be applicable as there will be acquisition of land for widening, geometric improvements and bypasses	Revenue Department State Government
21.	The National Highway Act	1956	For Land Acquisition	Yes	This act will be applicable as there will be acquisition of land for widening, geometric improvements and bypasses	NHAI Revenue Department, GoB

8.14 Environmental Permits / Approvals required

The summary table showing time requirements for agency responsible for obtaining clearance, and a stage at which clearance will be required is given below:

Table 8.4: Summary of Clearances & NOCs Applicable

S. No.	Type of Clearance	Statutory Authority	Applicability	Project stage	Time required	Responsibility
1	Forest Clearance	State Department of Environment, Forest and Climate Change and MoEF&CC	Diversion of Forest land for non forest purpose	Pre-construction	6-9 Months	DPR Consultants
2	Tree felling permission	State Department of Environment and Forest	Felling of trees	Pre-construction	30 Days	Concessionaire / Contractor
3	NOC And Consents Under Air, Water, EP Acts & Noise rules of SPCB	State Pollution Control Board	For establishing plants	Construction (Prior to work initiation)	2-3 Months	Concessionaire / Contractor
4	NOC And Consents Under Air, Water, EP Acts & Noise rules of SPCB	State Pollution Control Board	For operating Hot mix plants, Crushers and batching plants	Construction (Prior to work initiation)	1-2 Months	Concessionaire / Contractor
5	Permission to store Hazardous Materials	State Pollution Control Board	Storage and Transportation of Hazardous Materials and Explosives	Construction (Prior to work initiation)	2-3 Months	Concessionaire / Contractor

S. No.	Type of Clearance	Statutory Authority	Applicability	Project stage	Time required	Responsibility
6	Explosive license	Chief controller of explosives	Storage of explosive materials	Construction (Prior to work initiation)	2-3 Months	Concessionaire / Contractor
7	NOC under Hazardous Waste (Management And Handling) Rules, 1989	State Pollution Control Board	Disposal of bituminous wastes	Construction (Prior to work initiation)	2-3 Months	Concessionaire / Contractor
8	PUC certificate for use of vehicles for construction	Department of Transport	For all construction vehicles	Construction (Prior to work initiation)	1-2 Months	Concessionaire / Contractor
9	Quarry lease deeds and license	Dept. of Geology and Mines	Quarrying and borrowing operations	Construction (Prior to work initiation)	2-3 Months	Concessionaire / Contractor
10	NOC for water extraction For construction and allied works	Ground Water Authority	Ground water extraction	Construction (Prior to work initiation)	2-3 Months	Concessionaire / Contractor

Table 8.5: Summary of Clearances & NOCs Not Applicable

S. No.	Type of Clearance	Statutory Authority	Reason
1	Prior Environmental Clearance	SEIAA and EAC MoEF&CC	As per Notification issued on 22nd Aug 2013 S.O. 2559 (E) expansion road projects involved acquisition up to 40 meters and 60 meters on realignment/ bypasses are

S. No.	Type of Clearance	Statutory Authority	Reason
			exempted
2	Diversion of Sanctuary land / Permission for road construction	Chief Wild Life Warden, NBWL	Project road not passing through any protected area and not falling in EIA Notification 2006 for 10 km radius from protected area clearance from NBWL applicability
3	Permission for Activities near archaeological protected area	Archaeological survey of India / the state department of Archaeology	No Archaeological structures within 300 meter of project road

8.15 Baseline Environmental Conditions

A brief description of key environmental features of project districts i.e. Nalanda, Jehanabad and Patna (Figure 8.2) is discussed in the following sub-sections. This over-view would help in understanding the over-all setting within which the proposed project interventions would be implemented.

8.15.1 Location & Topography

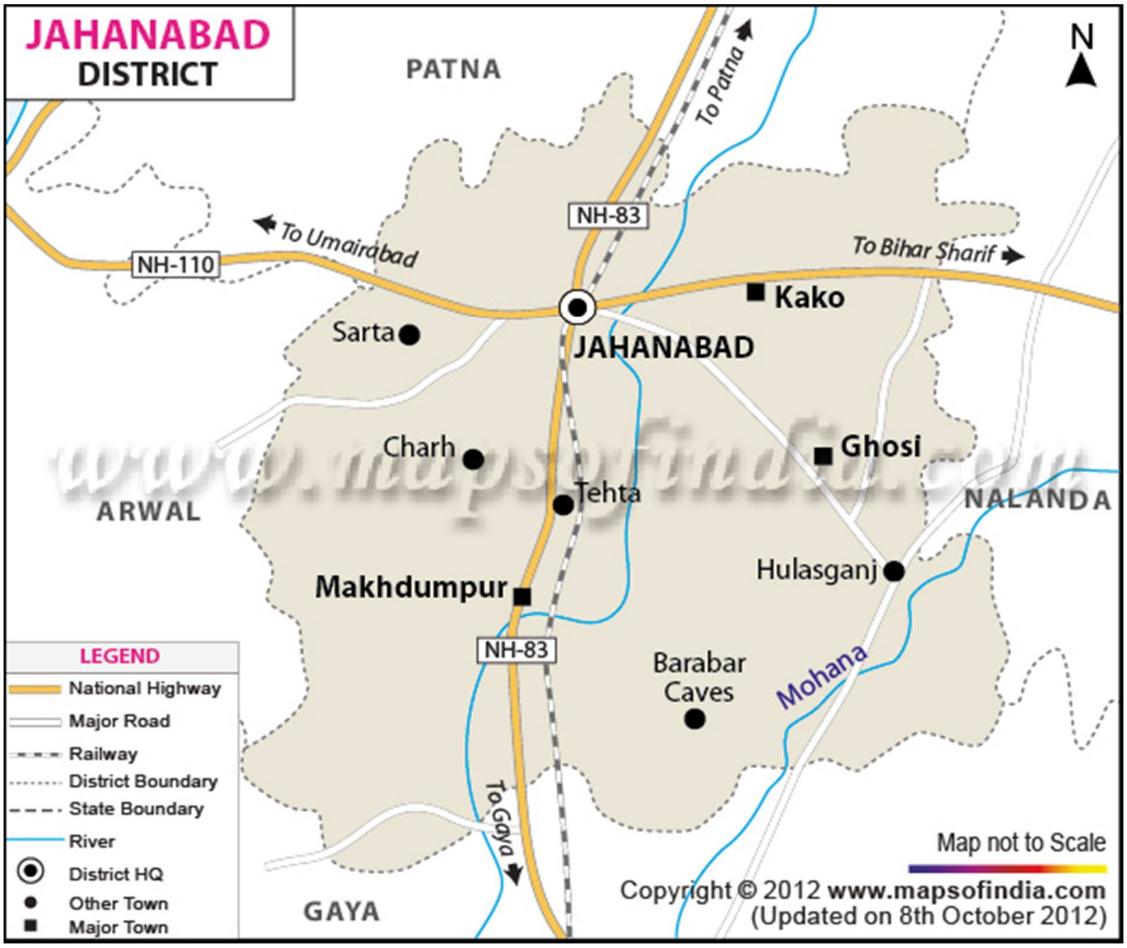
The project is located in the state of Bihar in Northern India. The starting point of this project is near "Shivrampur" located at the District boundary of Gaya-Jehanabad, from Design Ch. 54+785 Km. The coordinates of the starting point is 25° 0'32.16"N, 84°59'25.87"E. The ending point of this project is near "Ramnagar" at Design Ch. 109+106 Km which is the connecting the SH-78 road. The coordinates of the ending point is 25.445905° N, 85.210199° E.

The project road passes through the following three districts:

1) Jehanabad (Design Ch. 55+002 Km - Design Ch. 92+717 Km)
2) Nalanda (Design Ch. 101+717 Km - Design Ch. 103+517)
3) Patna (Design Ch. 92+717 Km - Design Ch. 101+717 and Design Ch. 103+517 Km - Design Ch. 109+300)

The topography of project districts is plain. Hillocks are rare in the project districts. The land in the project area is highly fertile. The district is devoid of any forest wealth of consequence. The alluvial text of land yields rice, sugarcane and other food grains.


NALANDA
DISTRICT
N
PATNA
Harnaut
Hilsa
Chandi
Nursarai
Sarmera
Ekangar Sarai
JEHANABAD
BIHAR SHARIF
Ashabanan
Islampur
Nalanda
Pavapuri
SHEKHPURA
Silao
Rajgir
Giriak
NAWADA
GAYA
Mohana
LEGEND
National Highway
Major Road
Railway
District Boundary
State Boundary
River
District HQ
Other Town
Major Town


JAHANABAD
DISTRICT
PATNA
N
To Patna
NH-83
NH-110
To Umairabad
To Bihar Sharif
Kako
Sarta
JAHANABAD
Charh
Ghosi
Tehta
ARWAL
NALANDA
Hulasganj
Makhdumpur
NH-83
Barabar Caves
Mohana
To Gaya
GAYA
LEGEND
National Highway
Major Road
Railway
District Boundary
State Boundary
River
District HQ
Other Town
Major Town
Map not to Scale
Copyright © 2012 www.mapsofindia.com
(Updated on 8th October 2012)

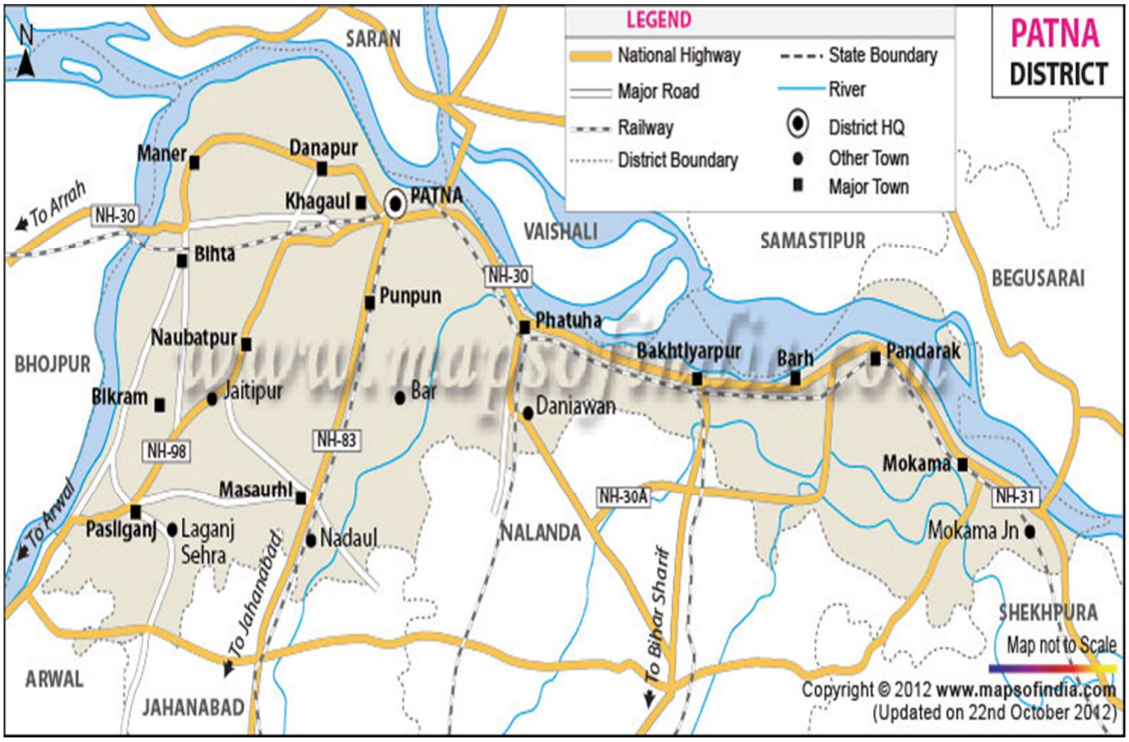


Figure 8.2: Map of 3 Project Districts

8.15.2 Climate and Meteorology

Seasons and Temperature Range: The project area has humid subtropical climate with extremely hot summers from March to mid-June, monsoons from mid-July to late September and chilly winter nights, foggy or sunny days from November to February. The highest recorded temperature is 46.6 degree celsius (°C) and the lowest is 2.3°C. The temperature during the summer season ranges between 18°C and 32°C and between 9°C and 29°C during the winter season. The average annual rainfall is 1130 mm. There is heavy rainfall in the months of July, August and September. During the other months of the year there is little or no rainfall. (Source: Indian Meteorology Department, Patna).

Relative Humidity: The minimum average relative humidity recorded was 84% and the maximum was 100%. The overall average relative humidity was 83%.

Rainfall: The recorded annual average rainfall in the Patna district during 2009 – 2013 was 922 ± 150 mm. Most of the rainfall was observed in August-September and least in November-December. During the last five years, the highest rainfall recorded was 1162 mm in 2011.

Atmospheric Pressure: The daily averaged atmospheric pressure level was 1016 hPa ± 3 hPa.

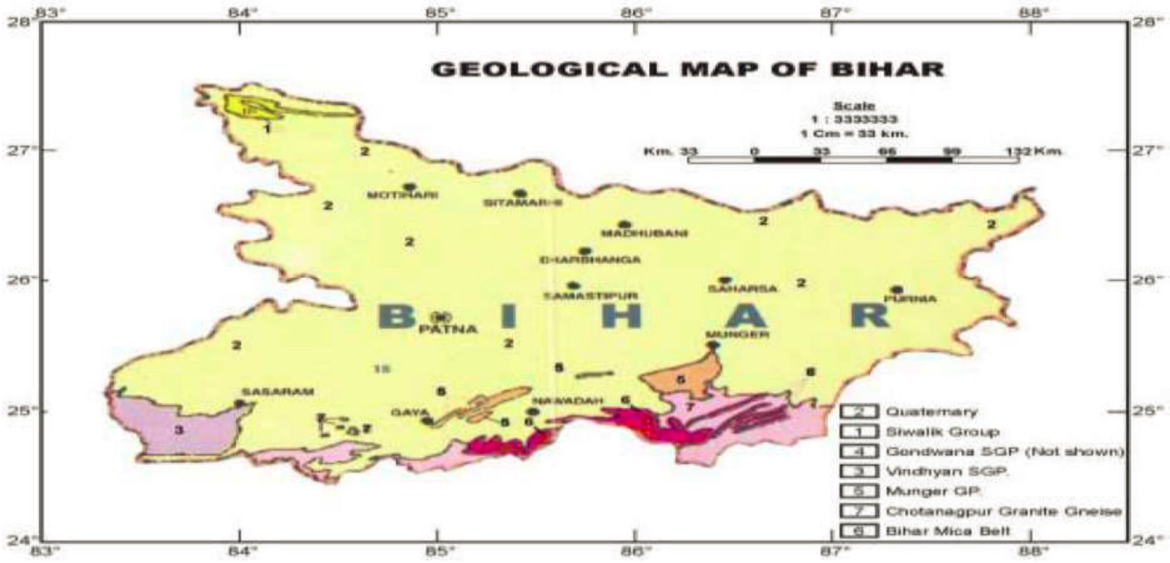
Wind Speed and Pattern: The daily averaged wind speed was 5 km/hr ± 3 km/hr. The winds were predominantly observed blowing from W followed by WNE and NW. The calm hours observed were 35%.

8.15.3 Geology

The project area is underlain by unconsolidated formation, which is quarternary to upper quarternary of age group. (Figure 8.3). Lithologically, the project area is made up of recent alluvium, clay, silt, sand, and gravel pebbles with concentration of calcareous materials.

The project area is part of the Indo-Gangetic alluvium, one of the three main physiographic divisions of India, which separates Extra-Peninsular regions on the north from the peninsular region on the south. The level plain is known to be the outcome of a granular filling of a great depression with alluvial sediments since Middle Pleistocene times. This forming a part of the flood plains of the Ganga has a monotonously flat relief. The transmissivity of the aquifer varies from 1000 to 5000 m^2/day. The specific yield varies between 8-12%. The movement of ground water is in south-east direction towards the river Ganga. The aquifer is highly potential with an estimated yield of 50- 100 m^3.

Seismicity: The seismic zonation map of India (Bureau of Indian Standards map) is shown in Figure 8.4. It can be seen from the map that the entire Bihar state falls in Zones III, IV and V. The project site of proposed 6-lane Ganga Bridge is situated in moderately stable zone which falls under seismic zone IV (as per IS 1893 (Part-I): 2002) category.



(Source: State of Environment Report for Bihar, 2007)

Figure 8.3: Geological Map of Bihar and Project Area

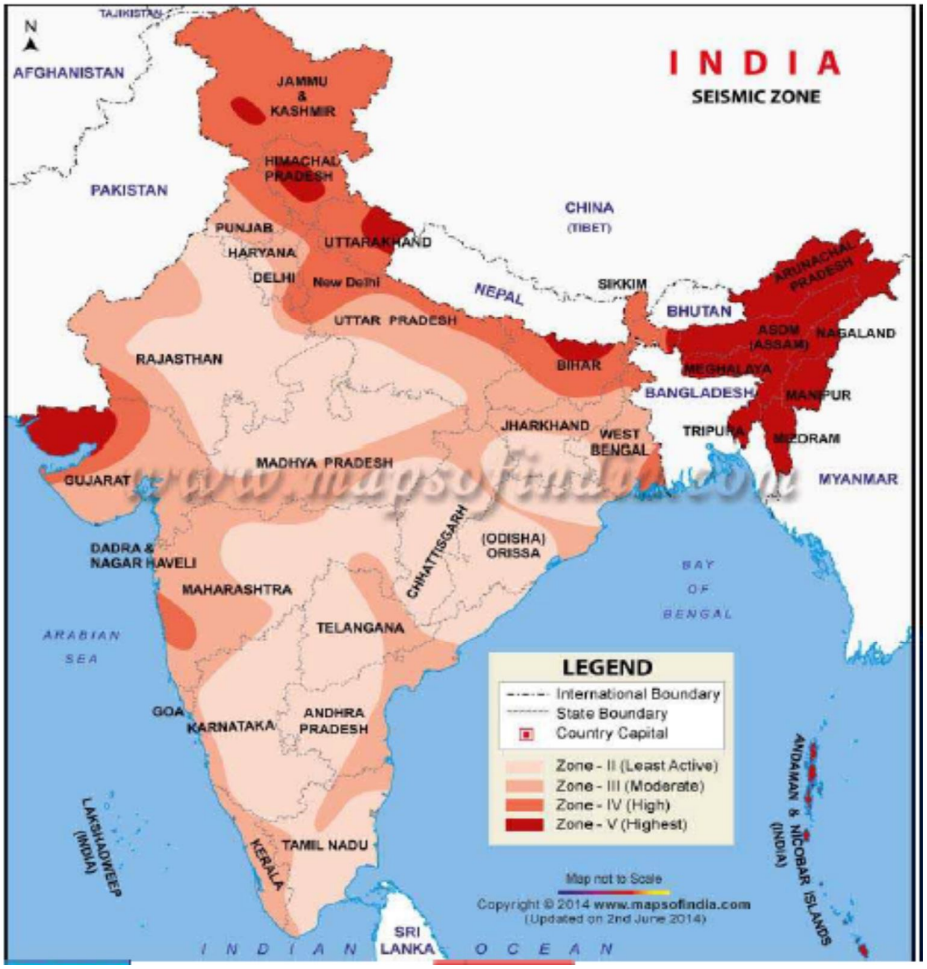


Figure 8.4: Seismic Zonation Map of India and Project Region

Hydrology and Drainage: The project area falls under the Ganga river basin. Figure 8.5 present the drainage pattern and river basin map of river Ganges and the project area.

The major tributaries of Ganga in India include Yamuna, Ghaghara, Gandak and Kosi. Chambal is one of the major tributaries of Yamua, which merges with Ganga at Prayag (Allahabad). These tributaries and their watershed form the 16 major sub-basins of the Ganga basin. Hoogly diverts from Ganga before Ganga enters Bangladesh.

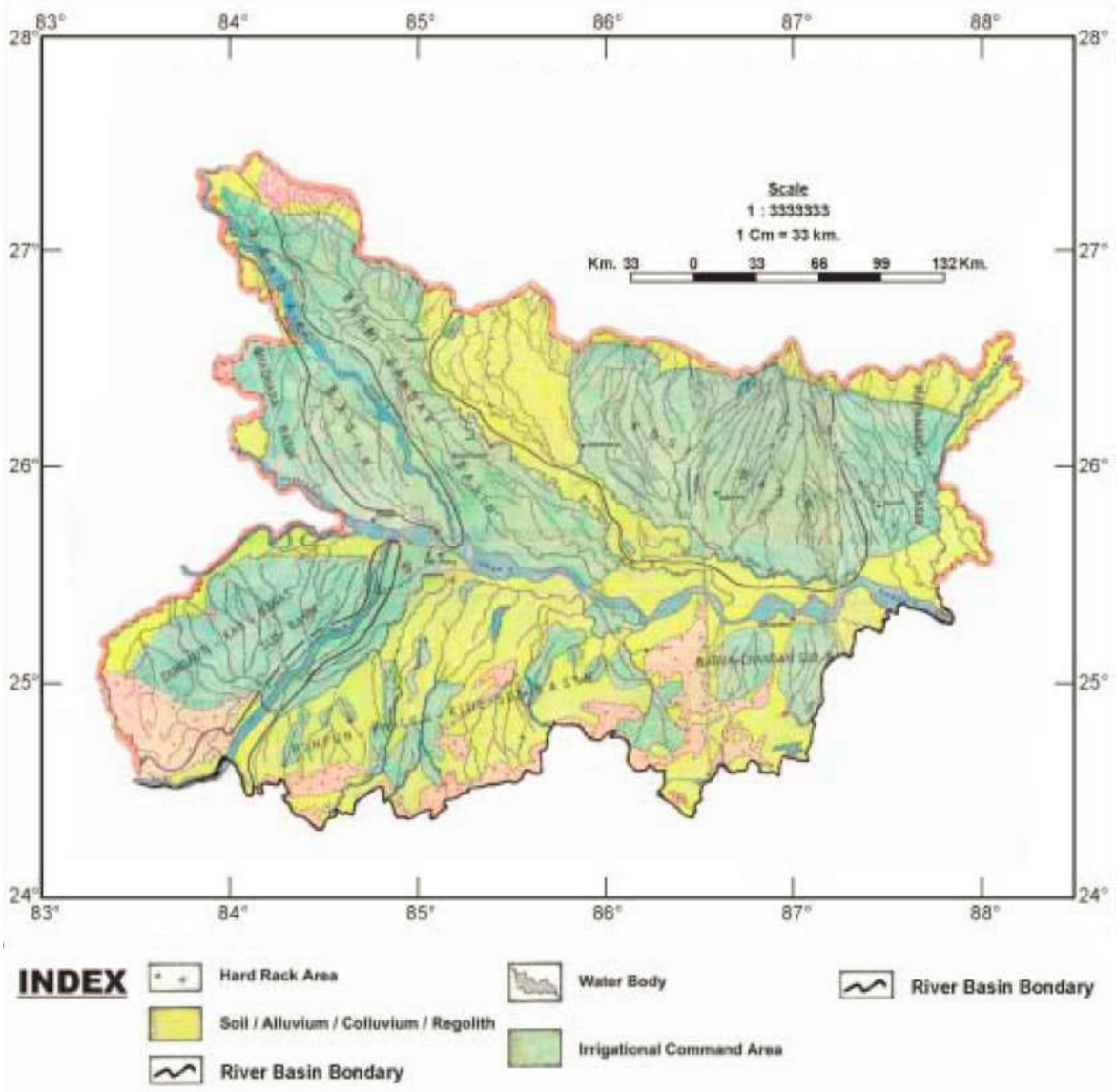


Figure 8.5: Drainage Pattern and River Basin Map of Bihar and Project Region

8.15.4 Ambient Air Quality

Ambient air quality in the project area is quite pure compared to Patna main city where emission level is reported higher side. There are no major industrial activities in the project area however operation of brick kilns near proposed sites is leading to higher level of SPM. These brick kilns, vehicular pollution and dust arising from unpaved surfaces are main sources of pollution in the project area.

There is no secondary data available in the project area. Therefore in order to establish the baseline for ambient air quality in the project area. Ambient air quality for the project is presently being monitored to assess the background levels and characterize the air quality in

the study corridor and will be presented in detail along with the Environmental Impact Assessment (EIA) report.

8.15.5 Noise Quality Data

Noise pollution is not a current problem in the region except in commercial location in urban areas where major settlements are, and high traffic flow. During construction period, temporary increase in the noise levels are expected from the movement of construction machineries and construction activities. Suitable barriers and timely scheduling of construction activities will minimize these impacts.

No secondary information was available on noise level in the project area. In order to establish the baseline noise quality in the project area, a reconnaissance survey was therefore undertaken to identify noise generating sources and sensitive receptor such as school, hospitals, temples, built-up areas.

Ambient Noise level monitoring using suitable sound level meter is presently being monitored to assess the background noise levels and characterize the Noise environment in the study and will be presented in detail along with the Environmental Impact Assessment (EIA) report.

8.15.6 Water Resources and Water Quality

Surface Water Resources:

The project districts Patna and Nalanda are mainly drained by the Ganga River, Son River, Punpun River, Phalgu River and Mohane River. Jehanabad is located on the confluence of two small rivers called Dardha and Yamunaiya.

Ground Water Resources: The groundwater resources of the state are broadly divided into two hydrological units, i) fissured formations, and ii) porous formations. Ground water is widely used by the communities in the project area. It is the main source of water for household use including drinking and water is mainly drowns through hand pumps. Therefore availability of ground water is very important for the local communities in the project area. There are also few wells and small ponds in the project area.

Water Quality: The Public Health Engineering Department, Government of Bihar has also reported that nine north eastern districts viz; Kishanganj, Purnea, Katihar, Madhepura, Araria, Saharsa, Supaul, Khagaria & Begusarai are affected by excessive Iron while some of the districts namely Gaya, Nawada, Jamui & Munger are affected by excessive fluoride. The eleven districts bordering Ganga (including Patna) are affected by excess arsenic content in drinking water sources. Excess nitrate in few habitations has also been noticed.

8.15.7 Physiography & Soil

Physiography: Physiographically, India is divided into seven major divisions: (1) Northern Mountains, (2) Great Plains (3) Central Highlands (4) Peninsular Plateaus, (5) East Coast, (6) West Coast and (7) Islands.

The Ganga basin falls entirely within the first three divisions (Figure 8.6). Northern Mountains comprises the Himalayan ranges including their foothills. The Gangetic plains, situated between the Himalayas and the Deccan plateau, constitute the most fertile plains of the sub-basin ideally suited for intensive cultivation. The Central highlands lying to the south of the Great plains consists of mountains, hills and plateaus intersected by valleys and river plains. They are largely covered by forests. Aravali uplands, Bundelkhand upland, Malwa plateau, Vindhyan ranges and Narmada valley lie in this region.

The project area for proposed 6-lane bridge near Patna falls under active alluvial plain i.e. landform created by deposition of sediment over a long period of time by river coming from highland regions.

Soils: Predominant soil types found in the gangatic sub-basin are sandy, loamy, clay and their combinations such as sandy loam, loam, silty clay loam and loamy sand soils. Soils in the project area are mostly active alluvial plain i.e. landform created by deposition of sediment over a long period of time by river coming from highland regions. Among the soil types within Ganga basin, the alluvial soil covers more than 52 per cent of the basin. Figure 8.7 present the soil profile of the region and project area in particular.

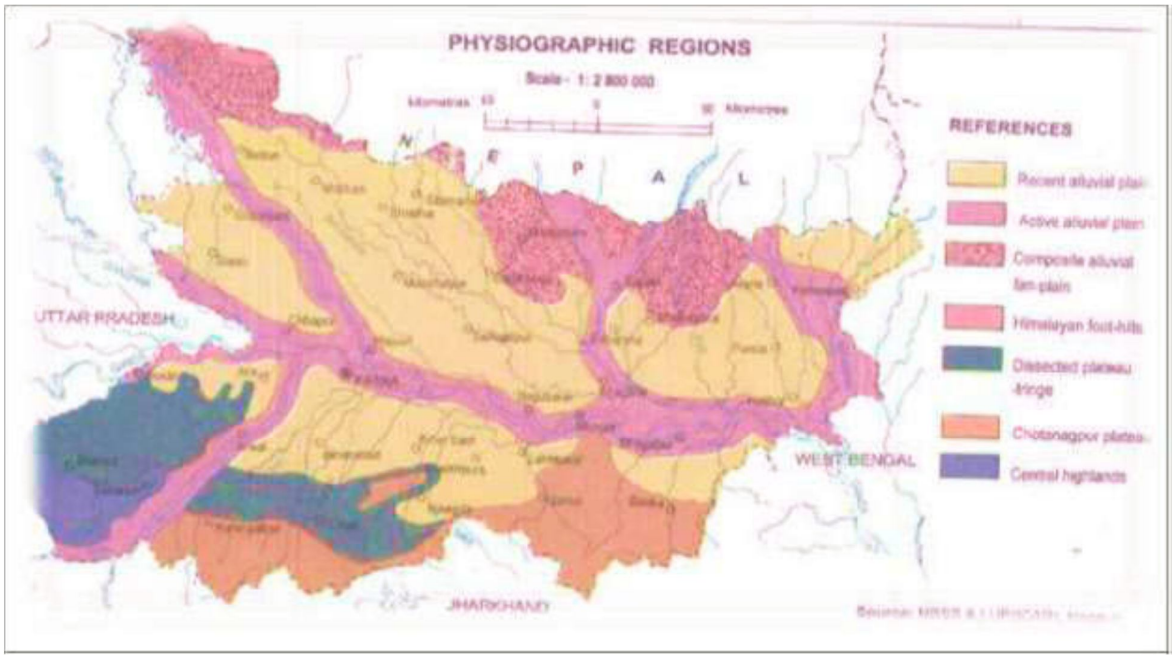


Figure 8.6: Physiographic Map of Project Area

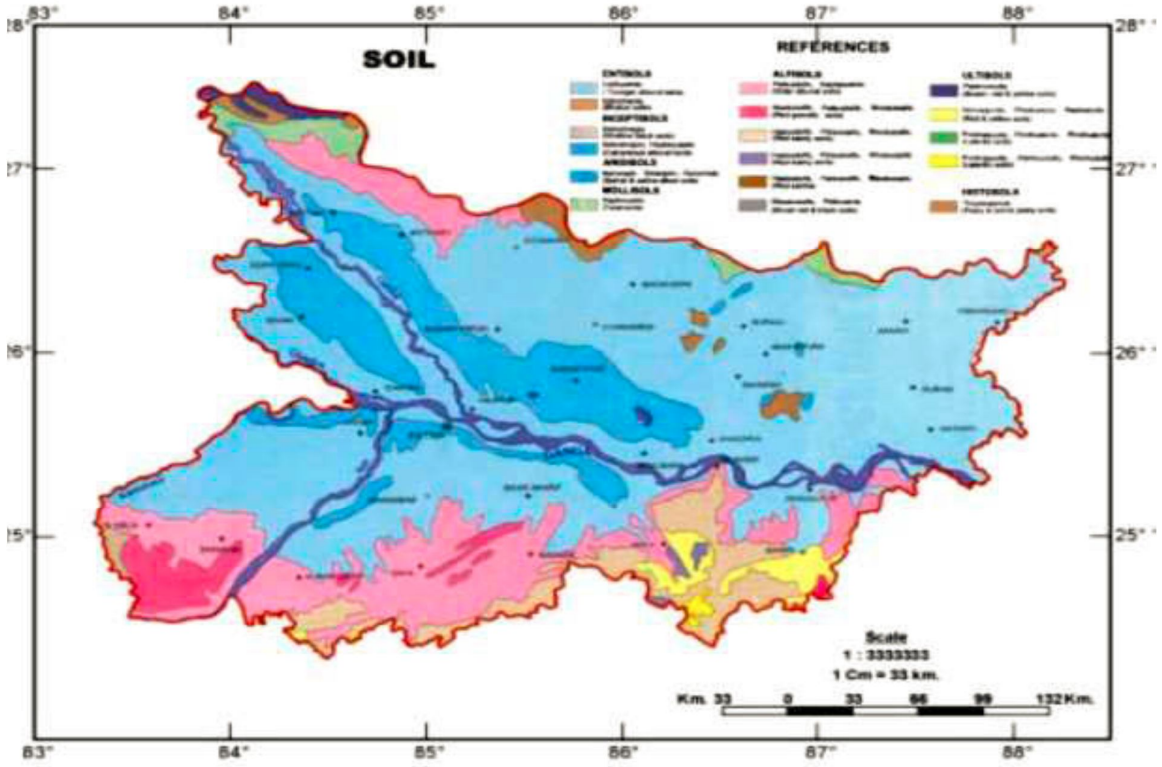


Figure 8.7: Soil Map of the State and Project Area

8.15.8 Ecological Environment

The coverage of the ecological study for the project included a core zone comprising the immediate project area covering the proposed road and a 10 km radius project influence area surrounding the immediate project area including. Secondary data was collected for information in both the immediate project area as well as the surrounding influence area of 10 km.

8.15.8.1 Forests and Vegetation

Forest Cover: With a geographical area of 94,163 sq. km Bihar is located in eastern part of India bordering Nepal. The forest cover in the state is 6473 sq. km which is about 6.87 percent of the state's geographical area. In terms of forest canopy density classes, the state has 231 sq. km very dense, 3280 sq. km moderately dense forest, and 3334 sq. km open forest. The forest cover distribution of state is shown in Figure 8.8 and forest cover map is shown in Figure 8.9.

Forest Classification: Of the total forest area in Bihar state, Reserved Forests constitute 10.70%, Protected Forests 89.28% and Unclassed Forests 0.02% of the total forest area.
No Forest area identified along the alignment, however at some locations (crossings point of roads/railway/canal), the proposed project falls in notified protected forest areas declared for

management purposes and diversion of protected forest land is unavoidable. Thus Forest clearance is required from competent authority.

Landuse and Habitat Type: Majority of the land use in the project area of influence is agricultural land.

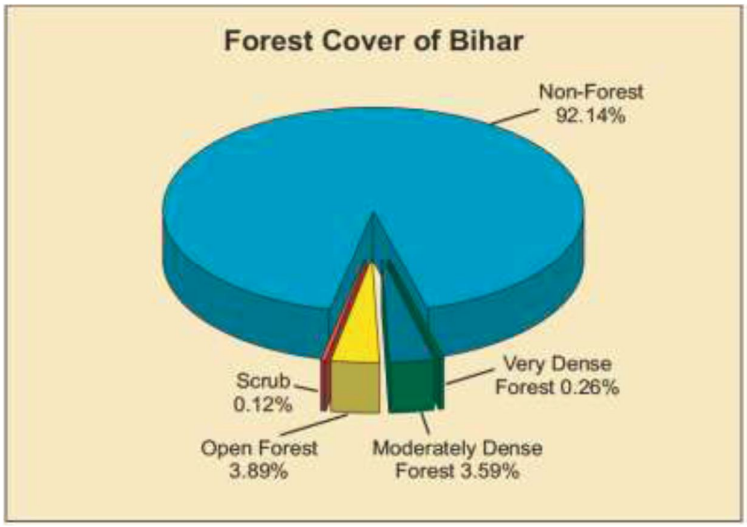


Figure 8.8: Forest Cover Distribution of Bihar

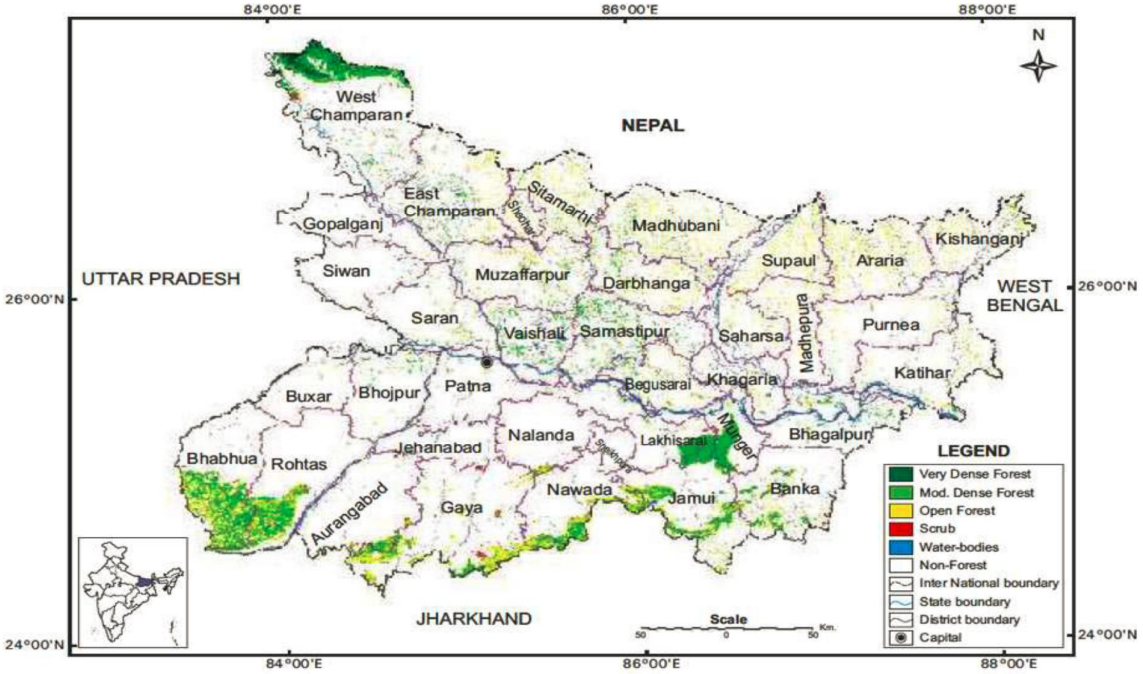


Figure 8.19: Forest Cover Map of Bihar and Project Area

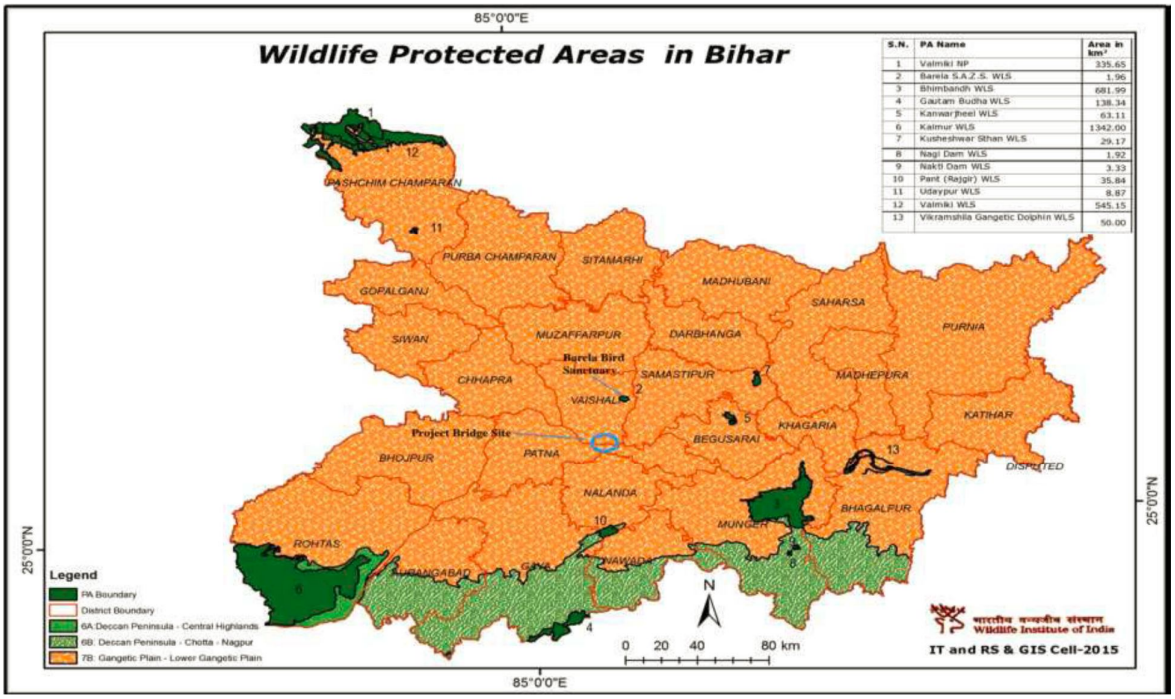
Flora

Common trees include *Shorea robusta* (sal), *Toona ciliate* (toon), *Diospyros melanoxylon* (Kendu), *Boswellia serrata* (Salai), *Terminalia tomentosa* (Asan), *Terminalia bellayoica* (Bahera), *Terminalia arjuna* (Arjun), *Pterocarpus marsupium* (Paisar), *Madhuca indica* (Mahua), *Dalbergia sissoo* (Shisham), *Gmelina arborea* (Gamhar), *Neolamarckia cadamba* (Kadamb), *Bombax ceiba* (Semal), *Azadirachta indica* (Neem), *Ficus religiosa* (Peepal), *Ficus benghalensis* (Bargad), *Haldina cordifolia* (Haldu). Other plants of Bihar include, *Holarrhena antidysenterica, Flemengia chappar, Zizyphus xylopyra, Bauhinia vahlii, Smilex protifrera, Butea superba, Butea parviflora*.

8.15.8.2 Wildlife and Protected Area

Protected Area Network: The protected area network of Bihar consists of wildlife sanctuaries and national parks. There is one national park and twelve wildlife sanctuaries covering an area of 0.32 million hectares, which constitutes 3.38% of the total geographical area of the state. The lone tiger reserve of the state i.e. Valmiki Tiger Reserve covers an area of 84,000 hectares. Kabar, situated in Begusarai district with an area of 6,738 hectares, is a wetland of national importance. Details of these protected areas are given in figure 8.10 show the protected area map of the Bihar.

As evident in figure 8.10 none of the protected areas are located within 10 km of the project bridge location. Of the 13 protected areas the Vikramashila Gangetic Dolphin Sanctuary is the only Dolphin sanctuary in India. The Project influence area is located over 100 km upstream from this dolphin sanctuary.



(Source: Wildlife Institute of India, Dehradun)

Figure 8.10: Protected Area Map of Bihar and Project Area

Mammals: Local people also reported the presence of the Indian mongoose (*Herpestes edwardsii*) and five stripped squirrel (*F. p. chhattisgarhi*). Other than these wild animals, domesticated mammals like goat, sheep, dog, cow, ox, donkey etc. are also present in the project influence area.

Reptiles: Rat Snakes (*Ptyas mucosus*), Common Krait (*Bungarus caerulens*) and Indian cobra (*Naja Naja*) have also been reported to be seen in the project area. Many house geikos and garden lizards were sighted during field surveys.

Avian Fauna: Through field surveys the following birds were sighted in the project influence area: Common crow, Myna, Eagle, Sparrow, Babbler, Pigeon, Cattle Egrets, Red Vented bulbul, Drongo, Sparrow and Indian Roller.

Fishes: The species of fishes noticed from study are Rohu, Catla, Hilsa, Mystus sp, Cirrhinus Sp, etc. The species of fishes commonly reported in the fresh water bodies like river, streams, lakes, pond and estuaries. They are cosmopolitan in distribution and are reported all over India and Indian Sub continents. These species of fishes are commonly used in aqua culture practice and had good commercial importance.

8.16 Socio-Economic Environment

1) **Land Use:** Major portion of the land use is under agriculture.

2) **Demographic Features:** Bihar is a land-locked state in the Eastern part of the country with a population of about 82.9 million with more than 90 percent of the population living in the rural areas. The human population density is 880 persons/km^2 compared to 325 persons/km^2 for the entire country. Sex ratio is 921 against the 933 in the country. The demographic feature of Bihar is unique in that there are many recognized tribes, which inhabit mostly the remote areas and each with distinct culture, ethos, and traditional knowledge systems. The minority groups in the state namely Bathudi, Binjhia, Binjhal, Birhor, Birjia, Chik Baraik, Paharia Korwa, and Santal. The majority of the people survive on subsistence economy based mainly on the agriculture, supplemented with forest produces, animal husbandry, crafts/handloom, etc.
   According to the 2011 census Jehanabad district has a population of 1,125,313. This gives it a ranking of 412th in India (out of a total of 640). The district has a population density of 1,206 inhabitants per square kilometer. Its population growth rate over the decade 2001-2011 was 21.34%. Jehanabad has a sex ratio of 918 females for every 1000 males, and a literacy rate of 78.27%. At the time of the 2011 Census of India,

95.08% of the population in the district spoke Hindi and 4.83% Urdu as their first language

According to the 2011 census Nalanda district has a population of 2,877,653. This gives it a ranking of 98th in India (out of a total of 640). The district has a population density of 1,220 inhabitants per square kilometer. Its population growth rate over the decade 2001-2011 was 21.18%. Nalanda has a sex ratio of 921 females for every 1000 males, and a literacy rate of 66.41%. At the time of the 2011 Census of India, 93.59% of the population in the district spoke Hindi and 5.69% Urdu as their first language.

According to the 2011 census Patna district has a population of 5,838,465. This gives it a ranking of 15th in India (out of a total of 640). The district has a population density of 1,823 inhabitants per square kilometer. Its population growth rate over the decade 2001-2011 was 22.34%. Patna has a sex ratio of 897 females for every 1,000 males, and a literacy rate of 72.47%. At the time of the 2011 Census of India, 93.18% of the population in the district spoke Hindi, 5.19% Urdu and 1.24% Maithili as their first language.

Agriculture and livestock rearing is the mainstay of the local people in the project area. It plays a significant role with respect to both generation of employment and share in the GDP. In addition the local communities in the project area also rely on allied agriculture, small scale businesses and small scale industries for employment as laborers.

3) **Agriculture and Forestry:** Agriculture forms the backbone of the national economy and despite resolute industrialization in the last five decades; agriculture holds a place of pride in Bihar state. About half the area is under cultivation, but pressure of population has pushed cultivation to the furthest limits, and little remains to be developed. The transitional nature of the climatic zone is reflected in the cropping pattern, which shows a mixture of wet and dry crops. Rice is everywhere the dominant crop, but corn (maize), wheat, barley, gram, oilseeds, and pulses (legumes) are important supplementary crops. Sugarcane is grown in a fairly well-defined belt in the northwest. Jute, a crop of the hot, moist lowlands, is found only in the easternmost plain districts. There are three harvests in a year: bhadai, dominated by corn that is sown from May to June and gathered in Bhado (August to September).Second is aghani, consisting primarily of rice sown in mid-June and gathered in the month of Aghan (December).Third is rabi made up largely of wheat that ripens in the plains in spring.

In 2005-06 the State is at present producing about 8.59 million tones of food grains (comprising Cereals 1.41 million tones and 0.45 million tones of Pulses) and about 0.14 million tones of total Oilseed. In the production level the State was contributing (about 4.12% food grains in 2005-06, 4.14 % Cereals and 3.36 % Pulses) in National Kitty. The Contribution in national oilseed Production is about 0.5%. As far as Jute &

Mesta is concerned Bihar stands second after West Bengal producing 1.39 million tonnes. Fruits and vegetables are extensively grown. Muzaffarpur and Darbhanga are particularly noted for mangoes, bananas, and litchi fruits. The potato-growing area near Bihar Sharif, in Patna district, produces the best variety of seed potato in India. The forest occupies 0.6 million hectares of the geographical area of the state whereas the cultivated area is about 6.2 million ha.

4) **Fisheries:** The state has potential for fisheries by enhancement of ponds, irrigation reservoirs, other water resources, the rivers. The fish production for the year 2004-2005 was 267510 tonnes. The important fishes commonly found in the region's plain and river basins are Catla catla, Labeo rohita, Labeio calbase, Cirrihinus mirigale, L. Bata, M.aor, W.attu, B. bagrius, Heteropneuptus fonilis, Notopterus nontopterus, C. gaehua, and C. striatus, etc. Fishing in the project influence area takes place on an ad hoc basis with no specific regular fishing locations. Amongst the 20 communities that live 10 km upstream and downstream of the bridge location, it is estimated there are approximately 200 fishermen.

5) **Transportation:** Transportation system is a key factor in the socio-economic development of any state. In comparison with other Indian states, Bihar is poorly served with transport and communications facilities. State has about 21.77 km of roads per 100 sq. km, as against the national average of 38.33 km per 100 sq. km. The road network is seriously deficient both in the quantum network connectivity as well as in riding quality of the roads, mainly the state highways, district roads and village roads. Important railway junctions include Patna, Gaya, Mugalsarai, Muzaffarpur, Bhagalpur, Samastipur, Katihar, and Barauni. Also connecting the state with other parts of India are airports at Patna, Gaya and Bhagalpur as well as several national highways.

6) **Mineral Resources:** The most of mineral belt i.e. about 90% of the important minerals was taken away by Jharkhand from Bihar after its separation. Still some more important minerals are located in the state which are not only useful for the state but also has become important source of revenue for the state. There are reserves of important deposits of Limestone, Purite, Magnetite, Mica, Chinaclay, Soapstone, Gold, Slate, Felspar, Galena, Sandstone, Saltpetre, etc.

7) **Industrial Situation:** Bihar is not so enriched with the resources for the industries and with a few scanty industries is located in the state. Some of the industries of the state are of sponge iron, oil refinery, forging, fertilizers, jelly filled communication cables, watch factory, fruit processing, bulk drugs, etc. One factory to be mentioned which is old and renowned rail wagon manufacturing plant, the Arthur Butler & Co, at

Muzaffarpur. The major industrial units in the state are of sugar mills which are scattered throughout Bihar. Other types of mills are of rice and edible oil.

8) **Aesthetic and Tourism:** The state having the vast historical background is one of the hot tourist destinations of country. Bodhgaya is one of the ancient places in Bihar having a status of World Heritage Site and an important place of pilgrimage, has a number of monasteries, some of them established by Buddhists of Japan, Thailand, Myanmar, Sri Lanka etc. Vaishali was one of the earliest republics in the world (6th century BC).It was here that Buddha preached his last sermon. Vaishali, birthplace of Lord Mahavira is also Sacred to Jains. Rajgir, 19 kms from Nalanda, was the ancient capital of Magadha Empire and is one of the important tourist centres in India.

9) **Energy and Electric Power Potential:** The state is well endowed with potential hydroelectric power. Main hydroelectric projects are Kosi Hydel Power Station, Eastern Gandak Canal, Sone Eastern Link Canal and Sone Western Link Canal. The other small hydel projects in the state are Agnoor and Delabagh and Nasirganj. Installed power capacity of Bihar is 540 MW, of which 320 MW is produced from Barauni Thermal Power Station and 220 MW from Muzaffarpur Thermal Power Station. As on today, the installed generating capacity of Bihar State Electricity Board in terms of its Thermal and Hydro- Electrical plants exceeds 559.2 MW. Per capita electricity consumption in the state is 141 Kwh.

8.17 Assessment of Potential Environmental Issues & Impacts

The key environmental health safety and social issues that were identified to have a major impact due to various proposed interventions are as below;

- Dumping of construction waste
- Air quality
- Water pollution, drinking water sources, water scarcity in non-monsoon months and construction
- water requirements
- Roadside trees, tree plantation
- Employment opportunity during civil works
- Location of labour camp and hot mix plant sites
- Impact on property and land acquisition
- Resettlement options

Possible Environmental Impacts: The primary purpose of the environmental impact assessment (EIA) study is to identify significant environmental impacts of reversible and irreversible nature that may be caused due to implementation of the proposed project. As a result of various development interventions and improvement works, there are several benefits to human being and natural environment. The probable positive and negative impacts under proposed project are summarized below.

Positive Impacts: As a result of development and improvement, there are several benefits to human being and natural environment. Some among them are described below.

- Improvement of existing road sections and construction of new bridges will provide safe and the better connectivity to the local communities inhabiting along the proposed project corridors.
- After its successful implementation, it will also satisfy social demands and economic needs of the local communities in immediate future.
- Besides the above there are several unforeseen positive impacts after implementation of the proposed project.

Negative Impacts: The project implementation has also some adverse impacts on the environments. Adequate mitigation measures should be planned and it is required to be taken to minimize the degree of negative impacts. Impacts subjected to construction and improvement of existing roads and bridges are broadly related to:

(I) Pre-construction Phase (i.e. Planning & Design of the Work along with obtaining relevant clearances for the effective execution of project).

(II) Construction Phase.

- Construction of Roads.
- Establishment of Hot and Batch Mixing Plants, Heavy Machineries, Site Offices, Construction and labour camps.
- Quarry and Borrows areas etc.

(III) Operation Phase.

The type and magnitude of impact depends upon the features of existing sites of the environment. There is no scale for quantitative measurements of magnitude of impacts. A qualitative scale has been devised such it can be used as a method to denote the order of impacts and to take affective remedies in order to reduce them. Each of the negative impact requires consideration of mitigation measures. Few among them require judicious applications of engineering design in construction methodology, while others require special techniques.

To identify these impacts, broadly on physical, ecological and social environment, an Impact Identification Matrix has been developed (Table - 8.6).

Table 8.6: Environmental Impact Matrix

Activities under Project	**Planning & Design Phase**	**Construction Phase**						**Operation Phase**	**Indirect effect of operation**
Environmental Component Affected	Acquisition of Land	Pile Foundation/ Dredging/ Excavation	Site clearance/ removal of Vegetation &\ Trees	Vehicle & machine operation & maintenance	Disposal of wastes & Sanitation	Establishment of hot & batch mixing plants, machineries *etc.*	Laying of pavement	Vehicle operation induced development	Induced development
Water Resources as ponds, rivers & streams	Loss of water bodies	Alteration of Topography	-	Contamination by fuel & lubricants	Contamination from wastes	Contamination by leakages of fuel	-	Contamination by fuel & lubricants Impact on flora, fauna & wetlands	Increased pollution with developmental interventions
Soils erosion potential	-	Erosion & loss of top soils	Erosion and loss of topsoil	Contamination by fuel & lubricants	Contamination from wastes	-	-	-	-
Flora	Impact on flora	-	Loss of trees & vegetation	Denudation of vegetation	-	Dis-balance in	-	-	-

Activities under Project	**Planning & Design Phase**	**Construction Phase**						**Operation Phase**	**Indirect effect of operation**
						Ecosystems or Habitat Loss			
Fauna	-	Disturbance of ecosystem Due to loss of habitats	Habitat loss	Disturbance to wildlife	-	-	-	Disturbances and accident with wildlife	-
Land as Forest, Agricultural and private	Loss of land as RoW	-	-	-	-		-	-	Diversion of forest and agricultural land
Health & Safety	-	-	-	-	Increase in communicable diseases	Dust fumes	Accidental risks	Accidental risks	-
Cultural Heritage Structures	Removal of structures from RoW	-	Loss of religious properties and trees	-	-		-	-	-

Activities under Project	**Planning & Design Phase**	**Construction Phase**						**Operation Phase**	**Indirect effect of operation**
Pollution to nearest settlements/ habitats	-	-	-	Air, Water and Noise Pollution	-	Dust fumes, smoke, noise pollution to Habitats	-	-	-
Wetland/ Water bodies	-	Obstruction in water flow / water clogging	-	Contamination and Siltation	-	-	-	-	-

8.18 Mitigation and Enhancement measures

The negative impacts of road projects can be reduced or minimized only if proper safeguards are put in place during the design and construction stage itself. These can include reducing pollutant discharge from the harmful activities at source or protecting the sensitive receptor. An effective mitigation strategy will utilize a combination of both options to arrive at practically implementable measures. Conscious efforts shall be worked out to minimize any adverse impacts on the various environmental and social components. Where the impacts on various environmental components shall be unavoidable, suitable mitigation designs are adopted as has been summarized inTable 10.7.

Table 10.7: Summary of Mitigation measures

S. No.	Potential Impact	Mitigation Measures / Enhancement
1	Change in Geology	Quarry Development Plan shall be enforced.
2	Change in Seismology	All structures to be checked and complied with the seismological settings of the region (Zone)
3	Loss of land	Alignment selected to have maximum exposure of Government & barren land
4	Generation of Debris	Disposed properly to avoid contamination
5	Soil Erosion	• Embankment protection through stone pitching & Turfing • Residual spoil need to be disposed properly • Silt Fencing need to be provided • Quarries need to be reclaimed
6	Contamination of Soil	• Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016 to be enforced. • Oil Interceptor will be provided for accidental spill of oil and diesel • Rejected material will be laid as directed by engineer. • Septic tank will be constructed for waste disposal.
7	Soil quality monitoring	Measures will be revised & improved to mitigate / enhance environment due to any unforeseen impact.
8	Scarified Bituminous Wastes	• Scarification involved. • In case concessionaire decides to scarify then the material to be reused in the GSB layer. • Non reusable Bituminous wastes to be dumped in 30 cm thick clay lined pits with the top 30cm layer covered with good earth for supporting vegetation growth over a period only after obtaining permission of Independent Consultant.
9	Scarified Non Bituminous	Used in the normal GSB layer (not the drainage

S. No.	Potential Impact	Mitigation Measures / Enhancement
	Material	layer)
10	Cut material	• Reused as embankment, median & shoulder fill materials • Excess material to be used for filling up of borrow areas identified by the concessionaire and approved by the Independent Consultant
11	Construction debris generated from dismantling of structures	Guidelines for Identification of Debris Disposal Sites & Precautions and Guidelines for Rehabilitation of Dumpsites, Quarries and Borrow Areas shall be framed
12	Soil Contamination due to accident spills	• An emergency response team to be created. The team shall contain members of the district and police administration and also have specialist in remediation. Responsibility of Concessionaire to inform the team to take actions. The roles and responsibility of the members of the ram shall be framed in conjunction with all the parties to address the situation arising out of the accidental spills resulting in situation like water and soil contamination, health hazards in the vicinity of the accident spot, fire and explosions etc. • During construction, the contractor and the concessionaire's described previously. Fuel storage will be in proper bounded areas. • All spills and collected petroleum products to be disposed off in accordance with MoEF&CC and SPCB guidelines and as per the directions of the Emergency Response team. • Fuel storage and fuelling areas will be located at least 300 m from all cross drainage structures and significant water bodies.
13	Runoff and drainage	• Improvements of design shall lead to less accidents and hence less spillage of oil and grease • Silt fencing to be provided • Recharge well to be provided to compensate the loss of pervious surface
14	Operation of residential facilities for labour camps, Vehicle parking areas	Vehicle parking area will be made impervious using 75 mm thick P.C.C. bed over 150 mm thick rammed brick bats. The ground will be uniformly sloped towards to adjacent edges towards the road. A drain will take allthe spilled material to the oil interceptor.
15	Meteorological factors and climate	• Comprehensive Afforestation • Avenue plantation

S. No.	Potential Impact	Mitigation Measures / Enhancement
		• Shrub plantation in the median / island
16	Dust generation	• Sprinkling of Water • Fine materials to be completely covered, during transport and stocking. • Plant to be installed in down wind direction from nearby settlement.
17	Gaseous pollutants	• Air pollution Norms will be enforced. • Labourers will be provided mask. • Local people will be educated on safety and precaution on access roads, newly constructed embankment etc.
18	Air quality emissions	Compliance with future statuary regulatory requirements
19	Air quality monitoring	Measures will be revised & improved to mitigate enhance
20	Alteration of Cross Drainage	Widening & construction of bridges, there will be an improvement in the drainage characteristics of the project area.
21	Water requirement for project	• Contractor needs to obtain approvals for taking adequate quantities of water from surface and ground water sources. • This is required to avoid depletion of water sources. • Water harvesting structures to be provided.
22	Increased sedimentation	• Silt fencing to be provided • Guidelines for Sediment Control to be framed
23	Contamination of Water	• Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016 to be enforced. • Oil Interceptor will be provided for accidental spill of oil and diesel. • Rejected material will be laid as directed by IC. • Septic tank will be construction for waste disposal.
24	Water quality monitoring	Measures will be revised and improved to mitigate /enhance environment due to any unforeseen impact.
25	Noise mitigation for Sensitive receptors	• Options for Noise barriers to be analysed • No Horn Zone sign Post.
26	Noise Pollution (Pre-Construction Stage)	• Machinery to be checked and complied with noise pollution regulations. • Camps to be setup away from the settlements, in the down wind direction
27	Noise Pollution (Construction	• Camps to be setup away from the settlements, in the down wind direction.

S. No.	Potential Impact	Mitigation Measures / Enhancement
	Stage)	• Noise pollution regulation to be monitored and enforced. • Temporary as the work zones will be changing with completion of construction.
28	Noise Pollution (Operation Stage)	Will be compensated with the uninterrupted movement of vehicles
29	Noise Pollution Monitoring	Measures will be revised and improved to mitigate /enhance environment due to any unforeseen impact.
30	Forest area	• Minimum acquisition of land • Permission for acquisition from forest department as per Forest Act • Plantation of trees as per Forest Department
31	Trees Cutting	• Compulsory tree plantation in the ratio of 1:3. • Option of compensatory Afforestation through Forest Department. • Identification of incidental spaces for plantation along corridor, where ever possible
32	Vegetation	• Clearing and grubbing will be minimised • Exposed surface like embankment slopes will be protected with stone pitching and turfing. • Open land in and around plant will be vegetated.

8.19 Land Acquisition - Mitigation Measures

Based on the preliminary survey conducted and information on RoW obtained so far, the land required for construction of proposed road and acquisition to provide a 60 m wide RoW for the project shall include agricultural, barren / fallow lands & governmental lands. Care shall be taken to minimize land acquisition. In order to mitigate the ensuing negative impacts of the land acquisition a resettlement and rehabilitation (R&R) policy shall be prepared based on the National Policy of R&R. The salient features of the mitigation measures are:

- Wherever possible, displacement shall be reduced or avoided altogether by sensitive design of civil works (e.g. alternative designs or modification to the design).
- Where displacement is unavoidable, those displaced will have their living standard improved.
- PAPs will be compensated, at replacement cost, for assets lost. Adequate social and physical infrastructure will be provided.
- PAPs and lost community would be encouraged to participate in the implementation of RAP.
- An entitlement policy shall be worked out as part of the RAP and will deliver a comprehensive package of compensation and assistance to entitled persons, families groups suffering losses as a result of the project.

8.20 Safety

The project design shall take care of safety measures for road users. Safety of pedestrians as well as of the vehicles plying on the road shall be given highest importance and adequate measures shall be incorporated in the design of the alignment. Beside the divided carriage way designed for the project, service roads are also proposed. Signboards indicating construction sites on the road and flags shall be erected. All the signboards giving caution and barricades for diverting the traffic shall be as per MoSRT&H / IRC specifications.

8.21 Environment Safety Measures

- The following mitigation measures shall be considered at the detailed design stage:
- Up gradation of existing approach roads to the highway
- Adequate drainage facilities along the road
- Provision of service roads
- Appropriate noise barriers at sensitive locations
- Development of strip plantation on both sides and median shrubs
- Regular monitoring of ambient air quality, noise level and water quality during construction
- Grade separation at interchanges

8.22 Enhancement Opportunities

Enhancements specifically refer to these positive actions to be taken up during the implementation of the project for the benefit of the road users and the communities living close to project road alignment. The following enhancement opportunities shall be explored as part of the detailed project report:

- Day-tourism potential along roadsides
- Water storage capacity for settlements
- Bus bay and Truck lay bye
- Wayside amenities
- Road signs, illuminations and pavement markings
- Introduction of ambulance services to transport serious accident cases

The enhancements have been carried out with the following objectives:

- To enhance the appeal and environmental quality of the project road to the users;
- To enhance visual quality along the highway; and
- To generate goodwill amongst the local community towards the project, by the enhancement of common property resources.

8.23 Landscaping and Arboriculture

A proper landscape shall be provided along the highway alignment to fit in with the surroundings for pleasing appearance reduce headlight glare and adverse environmental effects such as air pollution, noise pollution and visual intrusion. The proposal for future landscaping shall include the following:

- Treatment of embankment slopes as per IRC: 56 – 1974, depending upon soil type involved
- Turfing of slopes of high embankment for controlling rain and wind erosion
- Planting of low height shrubs on medians for reducing glare effect and visual intrusion
- Planting of trees along ROW as part of compensatory Afforestation
- Grading of ground between the embankment toe and ROW and provision of surface drain along the ROW. This will help in physical delineation of the ROW and avoid encroachment at later date
- Unlined drain shall be provided taking in to account the ground water recharging arrangement at required locations
- Water harvesting structures shall be provided

8.24 Environmental Budget

The Environmental budget for the various environmental management measures proposed in the Environmental Management Plan (EMP) will be provided in detail in later stages. The rates for the budget will be worked out on the basis of market rates and the Schedule of rates.

8.25 Environmental Management Plan

Environmental Management Plan for various Environmental Anticipated impacts will be provided in detailed Environmental Impact Assessment report in later stages.

8.26 Recommendations & Conclusion

The feasibility report is a step towards preparation of environmental impact assessment report. The screening process as described in previous sections has primarily tried to focus on the potential impacts due to the proposed project, identification of the hotspots and to propose mitigation measures at different phases of the project. Based on the findings during the screening study some measures have to be considered from the inception of the project, which will reduce the detrimental effects of project appreciably. These are:

- The project road does not fall under the conditions of EIA notification 2006 as per latest notification 2013 of MoEF&CC hence no Environmental Clearance is required.
- Trees will be fell due to the project activity and Compensatory Afforestation will be done along the road side in strip plantation
- No Forest area identified along the alignment, however at some locations (crossings point of roads/railway/canal), the proposed project falls in notified protected forest areas declared for management purposes and diversion of protected forest land is unavoidable. Thus Forest clearance is required from competent authority.
- None of the wildlife or protected areas are located within 10 km of the project bridge location hence wildlife clearance is not required from competent authority.
- There shall be displacement of the local population as land has to be acquired.
- Some structures like houses and shops shall be affected due to the project.
- Environmental consideration shall be included in the project activities from the design stage

- The proposed alignment has been designed considering the design criteria laid in IRC 38, 1988 & IRC SP 23,1983
- Arrangement for alternative public utilities would be done before impacting them during construction or operation and this shall be part of project planning.
- Attempt shall be made to keep removal of trees to minimum. Re-plantation programme shall be designed beforehand and compensatory Afforestation would be simultaneously carried out.
- Construction worker camp utilities would be provided to avoid impact on local environment.
- With the above approaches to design, construction and operation the project will be environmentally feasible.

CHAPTER 9

Initial social assessment and preliminary LA/Resettlement action plans

=➔ This is Independent Report and submitted separately.

CHAPTER-10

PROJECT COST ESTIMATE

10.1 GENERAL

The cost estimates for the project are extremely important as its entire viability and implementation depends on the project cost. Therefore, cost estimates and rate analysis of the items have been carried out with due care. The project cost estimates have been prepared considering various items of works and based on the rates calculated as per SOR of Bihar, and prevailing market rates in the project vicinity.

10.2 ESTIMATION OF QUANTITIES

The quantities of major items of work for the Project road have been estimated on the basis of Pavement design, geometric design and structural design as presented in Cost Estimate.

The quantities of the following major items of works has been estimated separately.

a. Site Clearance
b. Earth Works
c. Granular Sub-base and Base Courses
d. Bituminous Courses
e. Bridges, Culverts and Retaining Walls etc.
f. Kerbs, Drainage and Protective Works
g. Road Furniture and Safety Works
h. Traffic Management and Miscellaneous.

10.3 SITE CLEARANCE

Site clearance quantity is estimated, as overall area requires clearance for construction of road. It includes the cutting of trees etc and reuse/re-fixing of usable material.

10.4 EARTH WORKS

Earthwork quantities are calculated using the "MX Roads" software package. The earthwork is calculated based on the amount of cut or fill with respect to the datum line defined in the template and the existing ground profile, which in turn is obtained from the DTM surface developed by the software. The volumes of earthwork as well as materials have been calculated with the areas obtained at 10m intervals.

10.5 PAVEMENT MATERIAL (FLEXIBLE)

The pavement work includes construction of proposed carriageway. The flexible pavement includes Bituminous Concrete (BC), Dense Bituminous Macadam (DBM), Wet Mix Macadam (WMM), Granular Sub-base (GSB), Subgrade and other related items like prime coat and tack coat etc. over road formation. The quantities of bituminous course are calculated for full width of carriageway.

10.6 CROSS DRAINAGE STRUCTURES

The construction of bridges and culverts are assessed on proposed length and the earthwork, pavement and shoulders for bridge approaches have been included as appropriate roadwork items. The other items like RCC and PCC work of culverts are calculated as per design and drawings.

10.7 DRAINAGE AND PROTECTIVE WORKS

Drainage and protective works provides for the roadside drains in the plain.

10.8 ROAD FURNITURE AND SAFETY WORKS

Provisions for road safety measures road signs, markings, road appurtenant have been made.

10.9 CONTINGENCIES & ESCALATION CHARGES

The following percentage had been considered in costing;

Contingency charges (1%)
IC/Preoperative Expences @1% of Total EPC Cost (C)
Financing Charges
@2% of Debt amount upto EPC Cost Rs. 500 Cr.
@1.5% of Debt amount upto EPC Cost more than 500 Cr and lessthan 1000cr
@1% of Debt amount more than EPC Cost Rs. 1000 Cr.
Interest during construction **10.1 % per annum on debt**
Centages over EPC

The cost estimate for works item is presented in **Table 10.1 in which SOR, Bihar, 2019-2020 has been used.**

Table 10.1 Abstract of Cost Estimate

Sl. No.	Items	Unit	Length (in Km)	Rate (in Rs.)	Amount (in Rs.)	Amount (in Cr.)
A	**ROAD WORKS**					
1	Site Clearance				1,96,52,908.29	1.97
2	Earthwork Filling	Cum			1,07,10,35,625.00	107.10
3	Loosening & Recompacting	Cum			2,96,99,800.03	2.97
4	Sub Grade	Cum			30,31,87,098.51	30.32
5	GSB	Cum			63,63,99,729.80	63.64
6	WMM	Cum			57,60,86,439.26	57.61
7	Prime Coat	Sqm			3,72,78,616.00	3.73

Sl. No.	Items	Unit	Length (in Km)	Rate (in Rs.)	Amount (in Rs.)	Amount (in Cr.)
8	Tack Coat	Sqm			2,88,60,864.00	2.89
9	DBM	Cum			1,10,65,56,140.97	110.66
10	BC	Cum			47,24,52,791.70	47.25
B	**BRIDGES and STRUCTURES**					
1	Major Bridges	No.	3.00		44,61,20,560.65	44.61
2	Minor Bridges	No.	43.00		1,49,94,39,608.03	149.94
3	VUP /LVUP /SVUP	No.	10.00		13,81,07,232.41	13.81
4	Flyovers	No.	2.00		13,96,79,482.77	13.97
5	Culverts	No.	85.00		31,07,27,795.19	31.07
6	ROB	No.	1		10,27,52,517.36	10.28
C	**SLOPE STRUCTURES**					
1	RE Wall	km	9.94		72,92,66,608.28	72.93
2	Toe Wall	Km	64.322		28,24,35,523.37	28.24
D	**JUNCTIONS**					
1	Major Junctions	No	7		8,38,17,521.13	8.38
2	Minor Junctions	No	29		10,51,31,873.00	10.51
3	Toll Plaza	No	1.00		24,88,04,365.58	24.88
E	**DRAIN & PROTECTION WORK**					
1	Drainage Works	Km			15,34,13,101.35	15.34
2	RCC Crash Barrier with friction slab	Km	19.87		23,84,40,000.00	23.84
3	Metal Crash Barrier	Km	104.20		34,31,30,600.00	34.31
4	Other Protective Works (Fencing Wire & RCC Crash barrier & Slope Protection)				17,78,85,161.75	17.79
F	**LAY BYES**					
1	Bus Bays	Nos	22.00	23,23,779.73	5,11,23,153.95	5.11
2	Truck Lay Bays	Nos	1.00	43,48,582	43,48,582.40	0.43

Sl. No.	Items	Unit	Length (in Km)	Rate (in Rs.)	Amount (in Rs.)	Amount (in Cr.)
				.40		
G	**OTHER MISCELLANEOUS ITEMS**					
1	Footpath and Separators				31,02,528.00	0.31
2	Miscellaneous Items				2,65,03,000.00	2.65
3	Traffic Signs, Marking and Road Appurtenances				6,13,40,481.68	6.13
4	Reflective Road Studs	Nos	23400		50,07,600.00	0.50
5	Lighting Cost				8,51,50,000.00	8.52
	TOTAL CIVIL COST				**9,51,69,37,310.45**	**951.69**
	COST PER KM (LENGTH = 54.321 KM) IN CRORES ...					**17.52**
	GST (12%) on Civil Cost					**114.20**
	Labour Cess 1%					**9.52**
	TOTAL CIVIL COST					**1,075.41**
	COST PER KM (LENGTH = 54.321 KM) IN CRORES ...					**19.80**

Chapter- 11

Economic Analysis and Financial Analysis

11.0 Economic Analysis

An infrastructure project is subjected to economic appraisal to ensure that the investment proposed would yield appropriate return to the national economy. It is therefore important that decisions about investments in roads are made on objective judgments and therefore, Economic appraisal has been carried out for each traffic homogenous section of entire Project road.

The basic purpose of the economic analysis is to enable the decision-makers in the Government to decide whether the project is worthy of investment keeping in view the benefits to the society. In order to assess the benefits accrued to the society; both the options of 'Existing' and 'Proposed' have to be compared. For this purpose, the entire existing Road has been considered along with its proposed maintenance and improvement proposals.

11.1 Economic Analysis Approach

The economic evaluation has been carried out within the broad framework of social cost benefit analysis. The objective is to determine the best improvement scheme out of several proposals, which will lead to minimizing total transport costs and maximizing benefits to the road users.

The benefits accruing to society from the proposed improvement are mainly reduced vehicle operating cost, reduced travel time cost and reduced accident costs. Total transport costs comprise of two basic components as shown in **Table 1 1 .1**.

Table 11.1: Total Transport Costs

Road Supplier Costs	Road User Costs
Construction Costs	Vehicle Operating Costs (VOC) both MT & NMT
Maintenance Costs	Travel Time Costs
Replacement Costs: Costs of Environmental Impact Mitigation Measures, Costs of Rehabilitation and Resettlement (R&R) measures	

These costs are generated using HDM – IV for every year of the analysis period (cost-benefit stream) from which economic indicator parameters that essential for viability of project namely Net Present Value (NPV), Economic Rate of Return (EIRR) and Benefit Cost Ratio (B/C) are the final economic outputs.

NPV is the present value of Net Benefits (NB) during the project period. EIRR is the discount rate at which the NPV of the Net Benefit (NB) is zero. Net Benefit is the cumulative sum of the difference between yearly benefit and yearly costs incurred after discounting.

$$NB = \sum_{n=1}^{M} (Benefit(n) - Cost\ (n))$$

Savings from vehicle emission reduction and less energy consumption due to improved facility are also important economic savings which are possible to calculate but these quantities are not converted to economic cost inside the software. So these benefits are not included.

The appraisal period (including the construction period) has been taken as 30 years after which a residual value of investment is assumed as 10%.

11.2 Economics Internal Rate of Return

Economic Analysis has been carried out for construction option discussed above. Variables considered in for economic analysis of the project are volatile and depend on various factors. In general, in case of economic analysis is also recommended that analysis period should not be long as it may lead to erroneous results.

However, in order to be able to draw the conclusions on common platform Economic Analysis have also been carried out for 15 years of analysis period. The summary of Economic internal rate of return (EIRR) worked out, for construction option based on life cycle cost analysis is presented below.

Economic Analysis will be carried out following the methodology and input data discussed in the preceding paragraphs of this chapter using HDM-4 software.

HDM-4 outputs on Annual Discounted Net Benefit Streams with time savings is presented vide.

HDM-4 output on Benefit Cost Ratios is presented vide.

HDM4 results shall be provided in Final Feasibility Report.

11.3 Financial Analysis:

Financial analysis is necessary for selection of the mode on which a project to be implemented. There are three types of modes for project implementation:-

1- **BOT (Toll)**
2- **EPC (Engineering Procurement & Construction)**
3- **HAM (Hybrid Annuity Mode)**

BOT (Toll)- Under the BOT model though, private players have an active role — they build, operate and maintain the road for a specified number of years — say 10-15 years — before transferring the asset back to the government. Under BOT, the private player arranged all the finances for the project, while collecting toll fee as revenue.

EPC - Under the EPC model, NHAI pays private players to lay roads. The private player has no role in the road's ownership, toll collection or maintenance (it is taken care of by the government).

HAM (Hybrid Annuity Mode) –As the name suggests, HAM's a hybrid — a mix of the EPC (engineering, procurement and construction) and BOT (build, operate, transfer) models**.** Under HAM, on behalf of the government, NHAI releases 40 per cent of the total project cost as "Grant", such that the Equity IRR for contractor will be 15%. It is given in five tranches linked to milestones. The balance 60

H D M - 4 Economic Analysis Summary

Alternative: Project stretch vs Alternative: Base
Sensitivity Scenario: 15% Decrease in traffic

	Increase in Road Agency Costs			Savings in MT VOC	Savings in MT Travel Time Costs	Savings in NMT Travel & Operating Costs	Reduction in Accident Costs	Net Social / Exogenous Benefits	Net Economic Benefits (NPV)
	Capital	Recurrent	Special						
Undiscounted	39.92	-0.06	0.00	589.79	-420.47	3.98	0.00	0.00	133.44
Discounted	54.46	-0.01	0.00	-78.84	-20.67	1.83	0.00	0.00	-152.13

Economic Internal Rate of Return (EIRR) = 1.8% (No. of solutions = 3)

Alternative: Project stretch vs Alternative: Base
Sensitivity Scenario: 15% increase in cost

	Increase in Road Agency Costs			Savings in MT VOC	Savings in MT Travel Time Costs	Savings in NMT Travel & Operating Costs	Reduction in Accident Costs	Net Social / Exogenous Benefits	Net Economic Benefits (NPV)
	Capital	Recurrent	Special						
Undiscounted	45.90	-0.06	0.00	1,454.89	-436.59	3.77	0.00	0.00	976.24
Discounted	62.63	-0.02	0.00	94.67	-20.91	1.79	0.00	0.00	12.93

Economic Internal Rate of Return (EIRR) = 13.1% (No. of solutions = 3)

per cent is arranged by the developer. Here, the developer usually invests not more than 20-25 per cent of the project cost (as against 40 percent or more before), while the remaining is raised as debt.

Financial analysis is done for Shivrampur to Ramnagar project to find the how much VGF (Viability Gap

Funding) or Grant is required to be paid by NHAI to contractor, so that the Equity IRR is to be maintained equal to 15%. Following results are obtained after analysis:-

Sr.No	VGF (%)	PIRR(%)	EIRR (%)	Concession Period
1	43	7.70	15.00	22 Years

Based on the above results, it is found that VGF is greater than 30%, for concession period of 22 years, so this project is not viable in BOT (Toll) model therefore it is suggested to implement this project in HAM model in which 40 % Grant will be paid by NHAI.

So it is suggested to implement Shivrampur to Ramnagar project in HAM model.

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CHAPTER 12

CONCLUSIONS AND RECOMMENDATIONS

12.1 BRIEF PROJECT DESCRIPTION

The project road starts from Design Ch. 55+002 Km and ends at Design Ch. 109+300 Km The total length of the road is 54.298 Km. The alignment passes through the plain section and through agricultural land.

The Final Feasibility study of the project road comprised inter-alia the assessment of deficiencies formulation of design proposals, estimation of the costs and benefits for carrying out the economic and financial analysis for examining the viability of the project to cater for traffic demand during 20/30 year horizon period.

12.2 Road Work

The proposed project shall be constructed with the following structures and the project facilities which is a completely new green field alignment. The summarized structure details are as below:

a) Major Bridges
There are 03 new proposed Major Bridge.

b) Minor Bridges
There are 46 nos. proposed Minor bridge.

c) Minor Bridge cum LVUP
There are 00 nos. proposed Minor bridge cum LVUP.

d) VUP
There is 04 number of VUP proposed in the project section.

e) LVUP
There are 03 nos of LVUP that have been proposed in the project corridor according to the traffic and built-up scenario.

f) SVUP
There are 02 nos proposed SVUP

g) Fly-Over
There are 02 no.of proposed Fly-Over in the project section.

h) Viaduct
There is 00 no of Viaduct in this project Section.

i) ROB
There is 01 no of ROB in this project Section.

12.3 Culverts

There are total number of 88 culverts in this package proposed for new construction.

12.4 TOLL Plaza

There is 01 no.of Toll Plaza Proposed in Main Carriageway which shall be of 16 lane ETC configuration.

12.5 Miscellaneous Facilities

a) Truck Lay Byes

There are 1 nos Truck Lay-Byes in the project Corridor.

b) Bus Bays

There are 22 numbers of Bus bays in this section.

c) Way Side Amenity Center

There is 01 number of Way side amenity center in this corridor.

12.6 CONCLUSIONS AND RECOMMENDATIONS

From the above discussed project features, we conclude that the Project Stretch shall be constructed as 4 Lane with Paved Shoulder configuration as per the Standard and Specification of IRC: SP:84:2014 for the highway and the structures shall be constructed as per the Standard and Specifications of IRC:SP:73:2019. Th Design Ch. 55+002 Km to Design Ch. 109+300 Km. As this is a new proposed green field alignment, built up sections are avoided for construction purpose. This stretch starts from Shivrampur and ends near Ramnagar. The total project facilities and details are discussed in the forthcoming chapters in this report.

1. The New Green Field alignment has been proposed to improve the geometry of road.
2. Due to damaged bridges and poor geometry of road, motorized traffic is using alternative Routes induced and diverted to this road.
3. The road is proposed to be constructed in such a way to minimize the land acquisition and R&R effect.
4. Project road is economically viable and it may be taken for implementation.