



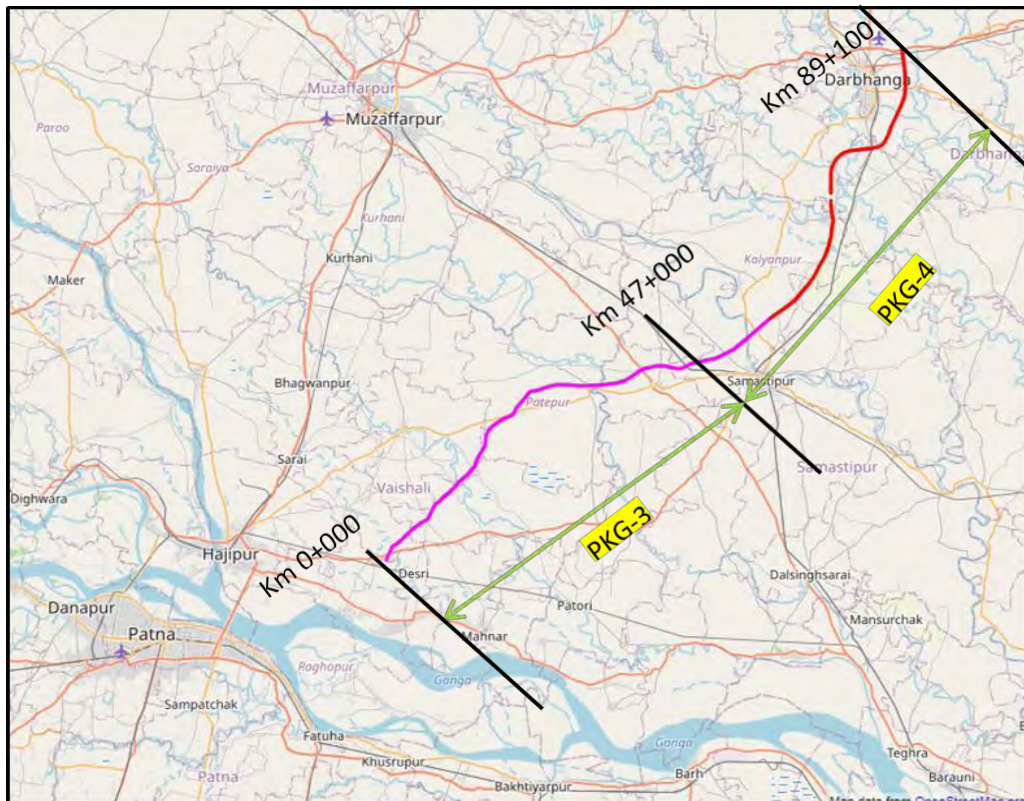
Ministry of Road Transport & Highways

MINISTRY OF ROAD TRANSPORT AND HIGHWAYS

Construction of Four lane access controlled Greenfield National Highway (NH-119D), starting from its junction with NH-19 (Old NH-02) near village Amas connecting Ramnagar, Kachhi Dargah, Kalyanpur (Hajipur), Tajpur and terminating at its junction with Nh-27 near village Bela Nawada (Darbhanga) under Bharatmala Pariyojna in the state of Bihar- Package-IV from village Balbhadarpur (Design Ch. 47+000) to village Bela Nawada (Darbhanga) (Design Ch. 89+210) Total Length – 42.210 Km.

MAIN REPORT

Package- IV (Design Ch. 47+000 Km To Design Ch. 89+210 Km)



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Detailed Project Report.

Table of Contents.

Chapter No.	Description	Page No.
1	Executive Summary	01-43
2	Overview of NHAI	44-59
3	Project Description	60-87
4	Methodology	88-113
5	Socio Economic Profile	114-123
6	Design Standards	124-131
7	Traffic Survey and Analysis	132-153
8	Environmental Screening	154-178
9	Resettlement Action Plan	179-179
10	Cost Estimate	180-182
11	Economic and Financial Analysis	183-186

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 22 million 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

- a. Economic corridors of around 9,000 km,
- b. Inter-corridor and feeder route of around 6,000 km,
- c. National Corridors Efficiency Program of about 5,000 km roads
- d. Border and international connectivity roads of around 2,000 km,
- e. Coastal and port connectivity roads of around 2,000 km,
- f. Expressways of around 800 km
- g. 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, InterCorridors and Feeder Routes to improve the efficiency of freight movement in India under Bharatmala Pariyojana (Lot-5/Package-7) from **Balbhadarpur to Bela Nawada (PKG-4) of Amas to Darbhanga Greenfield highway (NH-119D)** section, in the state of Bihar.

2. Introduction

Balbhadarpur to Bela Nawada (PKG-4) stretch is the of part of Amas to Darbhanga Greenfield highway project (New NH-119D) which is a part of Amas to Darbhanga Inter Corridor Route included in the list at Sr no- 3 of Annexure II(b) of SOP of the Bharatamala Pariyojna Issued on 21.12.2017.

Objective of this Project is to provide direct connectivity between two Economic Corridors (1) NH-02 (New NH-19) and (2) NH-57 (New NH-27) and also to improve the connectivity of inner parts of the State Bihar to the states of West Bengal, Jharkhand and North East states and ultimately this alignment will help to improve the efficiency of long route traffic and the Freight movement in India.

The connectivity of the Amas (at NH-02, New NH-19) with Darbhanga (at NH-27, East West Corridor) is via existing NH-139/NH-22, NH-322 and SH-50 where further improvement to four-six lane/access control facility is not viable due to limited ROW and heavy built-up areas. Accordingly, it is proposed to develop Amas-Darbhanga section 4-lane accessed controlled

Project: Construction of Four lane access controlled Greenfield National Highway (NH-119D), starting from its junction with NH-19 (Old NH-02) near village Amas connecting Ramnagar, Kachhi Dargah, Kalyanpur (Hajipur), Tajpur and terminating at its junction with Nh-27 near village Bela Nawada (Darbhanga) under Bharatmala Pariyojna in the state of Bihar- Package-IV from village Balbhadarpur (Design Ch. 47+000) to village Bela Nawada (Darbhanga) (Design Ch. 89+210) Total Length – 42.210 Km.



Detailed Project Report

Greenfield highway.

Vide SO 1043 (E) dated 04.03.2021, the highway starting from its junction with NH-19 near Amas connecting Ramnagar, Kacchi Dargah, Kalyanpur (Hajipur) , Tajpur and terminating at its junction with NH-27 near Bela Nawada (Darbhanga) in the state of Bihar is declared as New National highway no. 119D. the project will be developed in four packages.

Package I– Amas to Shivrampur - Length -55.002 Kms.

Package-II – Shivrampur to Ramnagar – Length- 54.322 kms.

Package III– Kalyanpur (near Hajipur) to Tal Dasraha (near Samastipur) - Length -47.00Kms.

Package-IV – Tal Dasraha (near Samastipur) To Bela Nawada (near Darbhanga) – Length- 42.21 kms.

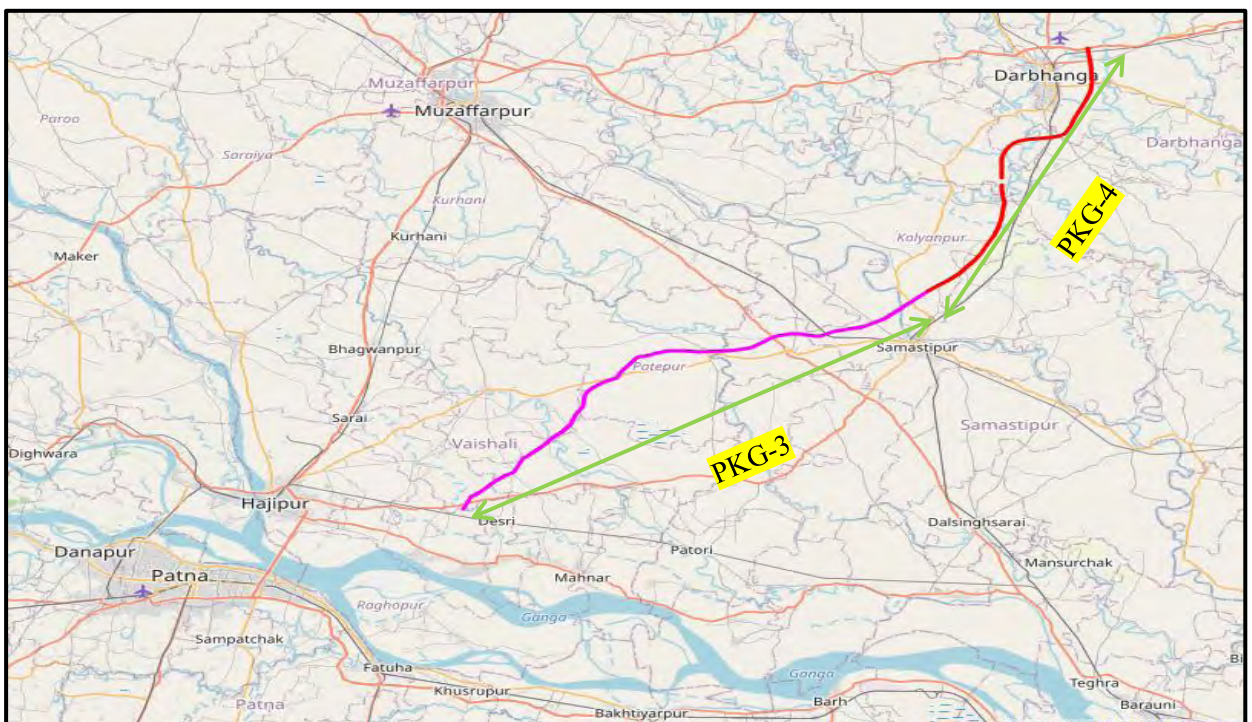
In this report we will discuss the project features of this new proposed green field alignment from “Balbhadarpur to Bela Nawada ” treated as **Package -4** as mentioned above.

The Project starting from its junction with NH-19 (Old NH-02) near village Amas connecting Ramnagar, Kachhi Dargah, Kalyanpur (Hajipur), Tajpur and terminating at its junction with Nh-27 near village Bela Nawada (Darbhanga) under Bharatmala Pariyojna in the state of Bihar- Package-IV from village Balbhadarpur (Design Ch. 47+000) to village Bela Nawada (Darbhanga) (Design Ch. 89+210) Total Length – 42.210 Km.

Latitude and longitude of this package of project corridor lies between 25.888289, 85.750183 and 26.186044°, 85.937056

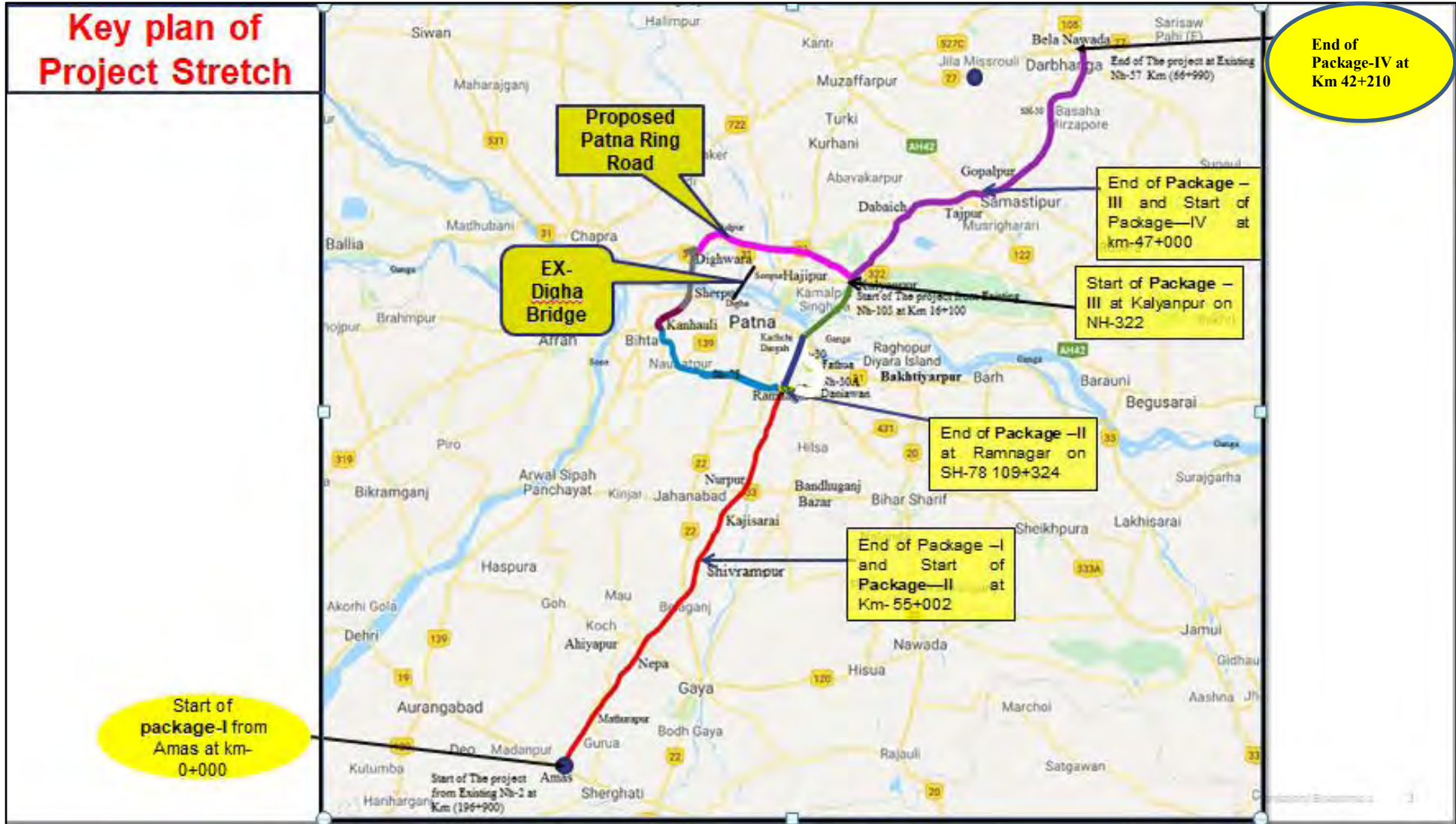
As this is a completely new Green Field Alignment, there are no existing structures in the project road. This alignment mainly passes through Plain terrain and shall be constructed as 4-Lane with Paved shoulder configuration in accordance to IRC: SP: 84:2019.

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



Project Construction of Four lane access controlled Greenfield National Highway (NH-119D), starting from its junction with NH-19 (Old NH-02) near village Amas connecting Ramnagar, Kachhi Dargah, Kalyanpur (Hajipur), Tajpur and terminating at its junction with Nh-27 near village Bela Nawada (Darbhanga) under Bharatmala Pariyojna in the state of Bihar- Package-IV from village Balbhadarpur (Design Ch. 47+000) to village Bela Nawada (Darbhanga) (Design Ch. 89+210) Total Length – 42.210 Km.

Detailed Project Report



3. Organization of this Report

This report is submitted against the deliverables described in clause 6.3 of the GCC at Stage2: “Final Feasibility Report”.

This report consists of:

1. Executive Summary
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 Kalyanpur to Bela Nawada 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:84:2019 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	Balbhadarapur	10	Manihas
2	Mathura Mandal	11	Bela Yakub
3	Harpur, Silaut	12	Mausimpur
4	Chal Rukum	13	Bela Nevada
5	Manjil	14	Simaria Bhindi
6	Mobarak	15	KoilaKund
7	Kharsand	16	Kolwara, Bihari
8	Mukund	17	Usma
9	Mirzapur	18	Asgaon

Note: The alignments 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 9 Major Junctions and 32 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	50+607	X	Major	Darbanga	Flexible	SH-50
2	66+154	X	Major	HATHURI Kothi	Flexible	(MDR)
3	77+765	X	Major	Baheri/Darbanga	Flexible	(MDR)
4	84+775	X	Major	Benipur/Darbanga	Flexible	SH-56
5	89+087	X	Major	Muzaffarpur/Jhanjharpur	Flexible	NH-27

Table 1.2 Details of Minor Junctions

S.No	Design Ch.	Junction Type	Classification	Pavement Type	Remarks
NIL					

7. Typical Cross Sections

There are 5 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. 0+000 Km to Design Ch. 47+000 Km.

Table 1.3 Typical Cross-sections for the Main Project Highway

S. No	Design CH.		DESCRIPTION	TCS TYPE	LENGTH (m)
	FROM	TO			
1	47+000	48+400	Typical Cross Section for 4-lane Divided Highway without Service Road (in Embankment)	TCS-I	1400
2	48+400	48+490	4- lane Divided Highway with RE Wall on both sides	TCS- III	90
3	48+490	48+634	4-lane Divided Highway with both sided RE Wall & one sided Service Road	TCS- II C	144
4	48+634	48+654	Typical Cross Section For Grade separated structures VUP and Elevated sections 4- lane Divided highway	TCS- IV	20
5	48+654	48+916	4- lane Divided Highway with RE Wall on both sides	TCS- III	262
6	48+916	49+873	Typical Cross Section For Grade separated structures VUP and Elevated sections 4- lane Divided highway	TCS- IV	957
7	49+873	50+100	4- lane Divided Highway with RE Wall on both sides	TCS- III	227
8	50+100	50+562	4 -Lane Divided Highway with Slip Road and RE wall on both sides	TCS- II	462
9	50+562	50+652	Typical Cross Section For Grade separated structures VUP and Elevated sections 4- lane Divided highway	TCS- IV	90
10	50+652	51+020	4 -Lane Divided Highway with Slip Road and RE wall on both sides	TCS- II	368
11	51+020	51+712	Typical Cross Section for 4-lane Divided Highway without Service Road (in Embankment)	TCS-I	692
12	51+712	51+724	Typical Cross Section For Grade separated structures VUP and Elevated sections 4- lane Divided highway	TCS- IV	12
13	51+724	52+159	Typical Cross Section for 4-lane Divided Highway without Service Road (in Embankment)	TCS-I	435
14	52+159	52+171	Typical Cross Section For Grade separated structures VUP and Elevated sections 4- lane Divided highway	TCS- IV	12
15	52+171	53+046	Typical Cross Section for 4-lane Divided Highway without Service Road (in Embankment)	TCS-I	875
16	53+046	53+053	Typical Cross Section For Grade separated structures VUP and Elevated sections 4- lane Divided highway	TCS- IV	7
17	53+053	53+320	Typical Cross Section for 4-lane Divided Highway without Service Road (in Embankment)	TCS-I	267
18	53+320	53+582	4- lane Divided Highway with RE Wall on both sides	TCS- III	262

Detailed Project Report

S. No	Design CH.		DESCRIPTION	TCS TYPE	LENGTH(m)
	FROM	TO			
19	53+582	53+602	Typical Cross Section For Grade separated structures VUP and Elevated sections 4- lane Divided highway	TCS- IV	20
20	53+602	53+860	4- lane Divided Highway with RE Wall on both sides	TCS- III	258
21	53+860	54+207	Typical Cross Section for 4-lane Divided Highway without Service Road (in Embankment)	TCS-I	347
22	54+207	54+214	Typical Cross Section For Grade separated structures VUP and Elevated sections 4- lane Divided highway	TCS- IV	7
23	54+214	54+794	Typical Cross Section for 4-lane Divided Highway without Service Road (in Embankment)	TCS-I	580
24	54+794	54+806	Typical Cross Section For Grade separated structures VUP and Elevated sections 4- lane Divided highway	TCS- IV	12
25	54+806	55+290	Typical Cross Section for 4-lane Divided Highway without Service Road (in Embankment)	TCS-I	484
26	55+290	55+310	Typical Cross Section of Bridge at Deck Level - with Footpath 4-lane Divided Highway	TCS- V	20
27	55+310	55+510	Typical Cross Section for 4-lane Divided Highway without Service Road (in Embankment)	TCS-I	200
28	55+510	55+640	4-lane Divided Highway with both sided RE Wall & one sided Service Road	TCS- IIC	130
29	55+640	55+780	4- lane Divided Highway with Service Road and RE wall on both sides	TCS- II A	140
30	55+780	55+800	Typical Cross Section For Grade separated structures VUP and Elevated sections 4- lane Divided highway	TCS- IV	20
31	55+800	56+740	4- lane Divided Highway with RE Wall on both sides	TCS- III	940
32	56+740	56+770	4-lane Divided Highway with both sided RE Wall & one sided Service Road	TCS- IIC	30
33	56+770	56+790	Typical Cross Section For Grade separated structures VUP and Elevated sections 4- lane Divided highway	TCS- IV	20
34	56+790	56+850	4-lane Divided Highway with both sided RE Wall & one sided Service Road	TCS- IIC	60
35	56+850	57+020	4- lane Divided Highway with RE Wall on both sides	TCS- III	170
36	57+020	57+789	Typical Cross Section for 4-lane Divided Highway without Service Road (in Embankment)	TCS-I	769
37	57+789	57+801	Typical Cross Section For Grade separated structures VUP and Elevated sections 4- lane Divided highway	TCS- IV	12
38	57+801	59+081	Typical Cross Section for 4-lane Divided Highway without Service Road (in Embankment)	TCS-I	1280
39	59+081	59+101	Typical Cross Section of Bridge at Deck Level - with Footpath 4-lane Divided Highway	TCS- V	20



Detailed Project Report

S. No	Design CH.		DESCRIPTION	TCS TYPE	LENGTH(m)
	FROM	TO			
40	59+101	59+624	Typical Cross Section for 4-lane Divided Highway without Service Road (in Embankment)	TCS-I	523
41	59+624	59+636	Typical Cross Section For Grade separated structures VUP and Elevated sections 4- lane Divided highway	TCS- IV	12
42	59+636	60+003	Typical Cross Section for 4-lane Divided Highway without Service Road (in Embankment)	TCS-I	367
43	60+003	60+010	Typical Cross Section For Grade separated structures VUP and Elevated sections 4- lane Divided highway	TCS- IV	7
44	60+010	60+304	Typical Cross Section for 4-lane Divided Highway without Service Road (in Embankment)	TCS-I	294
45	60+304	60+316	Typical Cross Section For Grade separated structures VUP and Elevated sections 4- lane Divided highway	TCS- IV	12
46	60+316	61+093	Typical Cross Section for 4-lane Divided Highway without Service Road (in Embankment)	TCS-I	777
47	61+093	61+100	Typical Cross Section For Grade separated structures VUP and Elevated sections 4- lane Divided highway	TCS- IV	7
48	61+100	61+410	4- lane Divided Highway with RE Wall on both sides	TCS- III	310
49	61+410	61+430	Typical Cross Section For Grade separated structures VUP and Elevated sections 4- lane Divided highway	TCS- IV	20
50	61+430	61+640	4- lane Divided Highway with Service Road and RE wall on both sides	TCS- II A	210
51	61+640	61+740	4- lane Divided Highway with RE Wall on both sides	TCS- III	100
52	61+740	62+704	Typical Cross Section for 4-lane Divided Highway without Service Road (in Embankment)	TCS-I	964
53	62+704	62+711	Typical Cross Section For Grade separated structures VUP and Elevated sections 4- lane Divided highway	TCS- IV	7
54	62+711	63+424	Typical Cross Section for 4-lane Divided Highway without Service Road (in Embankment)	TCS-I	713
55	63+424	63+490	Typical Cross Section of Bridge at Deck Level - with Footpath 4-lane Divided Highway	TCS- V	66
56	63+490	64+246	Typical Cross Section for 4-lane Divided Highway without Service Road (in Embankment)	TCS-I	756
57	64+246	64+253	Typical Cross Section For Grade separated structures VUP and Elevated sections 4- lane Divided highway	TCS- IV	7
58	64+253	65+140	Typical Cross Section For 4 lane divided Carriageway without service road	TCS-I	887
59	65+140	65+295	4- lane Divided Highway with RE Wall on both sides	TCS- III	155
60	65+295	65+325	Typical Cross Section For Grade separated structures VUP and Elevated sections 4- lane Divided highway	TCS- IV	30



Detailed Project Report

S. No	Design CH.		DESCRIPTION	TCS TYPE	LENGTH(m)
	FROM	TO			
61	65+325	65+600	4 -Lane Divided Highway with Slip Road and RE wall on both sides and one side Service road	TCS- II D	275
62	65+600	65+740	4 -Lane Divided Highway with merging of Slip Roads/Ramps on both sides and one side Service road	TCS- II E	140
63	65+740	65+810	4 -Lane Divided Highway with merging of Slip Roads/Ramps on both sides and both side Service road	TCS- II F	70
64	65+810	65+960	4 -Lane Divided Highway with Slip Road, Service road and RE wall on both sides	TCS- II B	150
65	65+960	66+109	4 -Lane Divided Highway with Slip Road and RE wall on both sides	TCS- II	149
66	66+109	66+349	Typical Cross Section For Grade separated structures VUP and Elevated sections 4- lane Divided highway	TCS- IV	240
67	66+349	66+712	Typical Cross Section of Bridge at Deck Level - with Footpath 4-lane Divided Highway	TCS- V	363
68	66+712	66+900	4- lane Divided Highway(in Embankment Height more than 6m Restricted by Retaining wall	TCS- IIIA	188
69	66+900	67+545	Typical Cross Section for 4-lane Divided Highway without Service Road (in Embankment)	TCS-I	645
70	67+545	67575	Typical Cross Section of Bridge at Deck Level - with Footpath 4-lane Divided Highway	TCS- V	30
71	67+575	67+689	Typical Cross Section for 4-lane Divided Highway without Service Road (in Embankment)	TCS-I	114
72	67+689	67+701	Typical Cross Section For Grade separated structures VUP and Elevated sections 4- lane Divided highway	TCS- IV	12
73	67+701	67+910	Typical Cross Section for 4-lane Divided Highway without Service Road (in Embankment)	TCS-I	209
74	67+910	67+970	Typical Cross Section of Bridge at Deck Level - with Footpath 4-lane Divided Highway	TCS- V	60
75	67+970	69+080	Typical Cross Section for 4-lane Divided Highway without Service Road (in Embankment)	TCS-I	1110
76	69+080	69+087	Typical Cross Section For Grade separated structures VUP and Elevated sections 4- lane Divided highway	TCS- IV	7
77	69+087	69+460	Typical Cross Section for 4-lane Divided Highway without Service Road (in Embankment)	TCS-I	373
78	69+460	69+759	4- lane Divided Highway(in Embankment Height more than 6m Restricted by Retaining wall	TCS- IIIA	299
79	69+759	69+771	Typical Cross Section For Grade separated structures VUP and Elevated sections 4- lane Divided highway	TCS- IV	12
80	69+771	69+935	4- lane Divided Highway(in Embankment Height more than 6m Restricted by Retaining wall	TCS- IIIA	164
81	69+935	70+025	Typical Cross Section of Bridge at Deck Level - with Footpath 4-lane Divided Highway	TCS- V	90



Detailed Project Report

S. No	Design CH.		DESCRIPTION	TCS TYPE	LENGTH(m)
	FROM	TO			
82	70+025	70+634	Typical Cross Section for 4-lane Divided Highway without Service Road (in Embankment)	TCS-I	609
83	70+634	70+646	Typical Cross Section For Grade separated structures VUP and Elevated sections 4- lane Divided highway	TCS- IV	12
84	70+646	70+910	Typical Cross Section for 4-lane Divided Highway without Service Road (in Embankment)	TCS-I	264
85	70+910	70+970	Typical Cross Section of Bridge at Deck Level - with Footpath 4-lane Divided Highway	TCS- V	60
86	70+970	71+855	Typical Cross Section for 4-lane Divided Highway without Service Road (in Embankment)	TCS-I	885
87	71+855	72+005	Typical Cross Section of Bridge at Deck Level - with Footpath 4-lane Divided Highway	TCS- V	150
88	72+005	72+371	Typical Cross Section for 4-lane Divided Highway without Service Road (in Embankment)	TCS-I	366
89	72+371	72+401	Typical Cross Section of Bridge at Deck Level - with Footpath 4-lane Divided Highway	TCS- V	30
90	72+401	72+695	Typical Cross Section for 4-lane Divided Highway without Service Road (in Embankment)	TCS-I	294
91	72+695	72+755	Typical Cross Section of Bridge at Deck Level - with Footpath 4-lane Divided Highway	TCS- V	60
92	72+755	73+066	Typical Cross Section for 4-lane Divided Highway without Service Road (in Embankment)	TCS-I	311
93	73+066	73+078	Typical Cross Section For Grade separated structures VUP and Elevated sections 4- lane Divided highway	TCS- IV	12
94	73+078	73+470	Typical Cross Section for 4-lane Divided Highway without Service Road (in Embankment)	TCS-I	392
95	73+470	73+530	Typical Cross Section of Bridge at Deck Level - with Footpath 4-lane Divided Highway	TCS- V	60
96	73+530	73+955	Typical Cross Section for 4-lane Divided Highway without Service Road (in Embankment)	TCS-I	425
97	73+955	74+045	Typical Cross Section of Bridge at Deck Level - with Footpath 4-lane Divided Highway	TCS- V	90
98	74+045	74+520	Typical Cross Section for 4-lane Divided Highway without Service Road (in Embankment)	TCS-I	475
99	74+520	74+616	4- lane Divided Highway(in Embankment Height more than 6m Restricted by Retaining wall	TCS- IIIA	96
100	74+616	74+628	Typical Cross Section For Grade separated structures VUP and Elevated sections 4- lane Divided highway	TCS- IV	12
101	74+628	74+760	4- lane Divided Highway(in Embankment Height more than 6m Restricted by Retaining wall	TCS- IIIA	132
102	74+760	74+924	Typical Cross Section for 4-lane Divided Highway without Service Road (in Embankment)	TCS-I	164



Detailed Project Report

S. No	Design CH.		DESCRIPTION	TCS TYPE	LENGTH(m)
	FROM	TO			
103	74+924	74+931	Typical Cross Section For Grade separated structures VUP and Elevated sections 4- lane Divided highway	TCS- IV	7
104	74+931	75+494	Typical Cross Section for 4-lane Divided Highway without Service Road (in Embankment)	TCS-I	563
105	75+494	75+794	Typical Cross Section of Bridge at Deck Level - with Footpath 4-lane Divided Highway	TCS- V	300
106	75+794	75+940	4- lane Divided Highway(in Embankment Height more than 6m Restricted by Retaining wall	TCS- IIIA	146
107	75+940	76+094	4- lane Divided Highway with Service Road and RE wall on both sides	TCS- II A	154
108	76+094	76+106	Typical Cross Section For Grade separated structures VUP and Elevated sections 4-Divided highway	TCS- IV	012
109	76+106	76+440	Typical Cross Section for 4-lane Divided Highway without Service Road (in Embankment)	TCS-I	334
110	76+440	76+859	4- lane Divided Highway(in Embankment Height more than 6m Restricted by Retaining wall	TCS- IIIA	419
111	76+859	76+931	ROB	As per GAD	72
112	76+931	77+000	4- lane Divided Highway(in Embankment Height more than 6m Restricted by Retaining wall	TCS- IIIA	69
113	77+000	77+020	Typical Cross Section For Grade separated structures VUP and Elevated sections 4- lane Divided highway	TCS- IV	20
114	77+020	77+300	4- lane Divided Highway(in Embankment Height more than 6m Restricted by Retaining wall	TCS- IIIA	280
115	77+300	77+720	4 -Lane Divided Highway with Slip Road and RE wall on both sides	TCS- II	420
116	77+720	77+810	Typical Cross Section For Grade separated structures VUP and Elevated sections 4- lane Divided highway	TCS- IV	90
117	77+810	78+140	4 -Lane Divided Highway with Slip Road and RE wall on both sides	TCS- II	330
118	78+140	78+194	Typical Cross Section for 4-lane Divided Highway without Service Road (in Embankment)	TCS-I	54
119	78+194	78+206	Typical Cross Section For Grade separated structures VUP and Elevated sections 4- lane Divided highway	TCS- IV	12
120	78+206	79+249	Typical Cross Section for 4-lane Divided Highway without Service Road (in Embankment)	TCS-I	1043
121	79+249	79+261	Typical Cross Section For Grade separated structures VUP and Elevated sections 4- lane Divided highway	TCS- IV	12
122	79+261	79+827	Typical Cross Section for 4-lane Divided Highway without Service Road (in Embankment)	TCS-I	566
123	79+827	79+834	Typical Cross Section For Grade separated structures VUP and Elevated sections 4- lane Divided highway	TCS- IV	7



Detailed Project Report

S. No	Design CH.		DESCRIPTION	TCS TYPE	LENGTH(m)
	FROM	TO			
124	79+834	80+100	Typical Cross Section for 4-lane Divided Highway without Service Road (in Embankment)	TCS-I	266
125	80+100	80+256	Typical Cross Section for 4-lane Divided Highway with one side RE Wall & Service Road and other side Retaining wall	TCS- II G	156
126	80+256	80+276	Typical Cross Section For Grade separated structures VUP and Elevated sections 4- lane Divided highway	TCS- IV	20
127	80+276	80+560	4- lane Divided Highway(in Embankment Height more than 6m Restricted by Retaining wall	TCS- IIIA	284
128	80+560	81+156	Typical Cross Section for 4-lane Divided Highway without Service Road (in Embankment)	TCS-I	596
129	81+156	81+168	Typical Cross Section For Grade separated structures VUP and Elevated sections 4- lane Divided highway	TCS- IV	12
130	81+168	81+734	Typical Cross Section for 4-lane Divided Highway without Service Road (in Embankment)	TCS-I	566
131	81+734	81+746	Typical Cross Section For Grade separated structures VUP and Elevated sections 4- lane Divided highway	TCS- IV	12
132	81+746	81+840	Typical Cross Section for 4-lane Divided Highway with one side RE Wall & Service Road	TCS- IA	94
133	81+840	81+942	Typical Cross Section for 4-lane Divided Highway without Service Road (in Embankment)	TCS-I	102
134	81+942	81+958	Typical Cross Section of Bridge at Deck Level - with Footpath 4-lane Divided Highway	TCS- V	16
135	81+958	82+386	Typical Cross Section for 4-lane Divided Highway without Service Road (in Embankment)	TCS-I	428
136	82+386	82+393	Typical Cross Section For Grade separated structures VUP and Elevated sections 4- lane Divided highway	TCS- IV	7
137	82+393	82+934	Typical Cross Section for 4-lane Divided Highway without Service Road (in Embankment)	TCS-I	541
138	82+934	82+946	Typical Cross Section For Grade separated structures VUP and Elevated sections 4- lane Divided highway	TCS- IV	12
139	82+946	83+636	Typical Cross Section for 4-lane Divided Highway without Service Road (in Embankment)	TCS-I	690
140	83+636	83+643	Typical Cross Section For Grade separated structures VUP and Elevated sections 4- lane Divided highway	TCS- IV	7
141	83+643	84+159	Typical Cross Section for 4-lane Divided Highway without Service Road (in Embankment)	TCS-I	516
142	84+159	84+171	Typical Cross Section For Grade separated structures VUP and Elevated sections 4- lane Divided highway	TCS- IV	12
143	84+171	84+320	Typical Cross Section for 4-lane Divided Highway without Service Road (in Embankment)	TCS-I	149
144	84+320	84+730	4 -Lane Divided Highway with Slip Road and RE wall on both sides	TCS- II	410

S. No	Design CH.		DESCRIPTION	TCS TYPE	LENGTH(m)
	FROM	TO			
145	84+730	84+820	Typical Cross Section For Grade separated structures VUP and Elevated sections 4- lane Divided highway	TCS- IV	90
146	84+820	85+340	4 -Lane Divided Highway with Slip Road and RE wall on both sides	TCS- II	520
147	85+340	85+641	Typical Cross Section for 4-lane Divided Highway without Service Road (in Embankment)	TCS-I	301
148	85+641	85+659	Typical Cross Section of Bridge at Deck Level - with Footpath 4-lane Divided Highway	TCS- V	18
149	85+659	86+660	Typical Cross Section for 4-lane Divided Highway without Service Road (in Embankment)	TCS-I	1001
150	86+660	86+798	4- lane Divided Highway(in Embankment Height more than 6m Restricted by Retaining wall	TCS- IIIA	138
151	86+798	86+918	Typical Cross Section of Bridge at Deck Level - with Footpath 4-lane Divided Highway	TCS- V	120
152	86+918	87+073	4- lane Divided Highway(in Embankment Height more than 6m Restricted by Retaining wall	TCS- IIIA	155
153	87+073	87+127	Typical Cross Section of Bridge at Deck Level - with Footpath 4-lane Divided Highway	TCS- V	54
154	87+127	87+582	4- lane Divided Highway(in Embankment Height more than 6m Restricted by Retaining wall	TCS- IIIA	455
153	87+582	87+602	Typical Cross Section For Grade separated structures VUP and Elevated sections 4- lane Divided highway	TCS- IV	20
154	87+602	88+635	4- lane Divided Highway(in Embankment Height more than 6m Restricted by Retaining wall	TCS- IIIA	1033
155	88+635	88+725	ROB	As per GAD	90
156	88+725	88+780	Typical Cross Section For Grade separated structures VUP and Elevated sections 4- lane Divided highway	TCS- IV	55
157	88+780	89+210	INTERCHANGE	As per TCS of Interchange location	430

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

8. Structure Details

The proposed alignment from Kalyanpur to Balbhadarpur 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 summarized below in **Table 1.3**

Table 1.3 Summary of Structures

S.NO	Structure Type	Proposed Nos.
1	Major Bridges	08
2	Major Bridge Cum underpass	0
3	Minor Bridges	11
4	Vehicular Under Pass	8
5	Light Vehicular Under Pass	18
6	Small Vehicular Under Pass	11
7	Fly-Over including interchanging	5
8	Overpass	0
9	ROB	02
10	Culverts	89
11	Flyover Cum Viaduct	1

9. Major Bridges

There are 8 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

MAJOR BRIDGE (OVER RIVERS/STREAMS/ NALLAS)

Sl. No.	Chainage (Km)	Span Arrangement c/c Expansion joint in Square direction (m)	Skew angle	Structure Type	Deck Configuration (m)	Width of Open Median (m)
1	49+395	29x33	0	PSC I GIRDER	2x13.5	3
2	63+460	2x33	0	PSC I GIRDER	2x13.5	3
3	66+530	11x33	0	PSC I GIRDER	2x13.5	3
4	69+980	3x30	0	PSC I GIRDER	2x13.5	3
5	71+930	5x30	0	PSC I GIRDER	2x13.5	3
6	74+000	3x30	0	PSC I GIRDER	2x13.5	3
7	75+644	5x30	0	PSC I GIRDER	2x13.5	3
8	86+858	4x30	0	PSC I GIRDER	2x13.5	3

MAJOR BRIDGE CUM UNDERPASS

Sl. No.	Chainage (in Km)	Span Arrangement c/c Expansion joint in Square direction (m)	Skew angle	Type of Structure	Deck Configuration (m)	Width of Open Median (m)	Minimum vertical clearance from Cross road (m)
NIL							

10. Minor Bridges

There are 11 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 1.5.

Table 1.5 Details of Minor Bridges

Minor Bridges (OVER RIVERS, STREAMS, NALLAS)

Sl. No.	Chainage (Km)	Span Arrangement c/c Expansion joint in Square direction (m)	Skew Angle	Type of Structure	Deck Configuration (m)	Width of Open Median (m)
1	55+300	1x20	17	PSC I Girder	2x13.5	3
2	59+091	1x20	0	PSC I Girder	2x13.5	3
3	67+360	1x30	0	PSC I Girder	2x13.5	3
4	67+940	2x30	0	PSC I Girder	2x13.5	3
5	70+940	2x30	0	PSC I Girder	2x13.5	3
6	72+386	1x30	0	PSC I Girder	2x13.5	3
7	72+725	2x30	0	PSC I Girder	2x13.5	3
8	73+500	2x30	0	PSC I Girder	2x13.5	3
9	81+950	2x8	31	RCC BOX	2x13.5	3
10	85+650	1x18	0	PSC I Girder	2x13.5	3
11	87+100	3x18	0	PSC I Girder	2x13.5	3

MINOR BRIDGE CUM UNDERPASS

Sl. No.	Chainage (Km)	Span Arrangement c/c Expansion joint in Square direction (m)	Skew Angle	Type of Structure	Deck Configuration (m)	Width of Open Median (m)	Minimum vertical clearance from Cross road (m)
NIL							

11. VUP (Vehicular Under Pass)

There are 08 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 1.7**.

Table 1.7 Vehicular Under Pass

S. No.	Chainage (km)	Type of Crossing	Type of Structure	Clear Span in square direction (m)	Skew angle	Deck Configuration (m)	Width of Open Median (m)
1	48+644	MDR	PSC I GIRDER	1x20	30	2x11.6	3
2	53+592	MDR	PSC I GIRDER	1x20	22	2x11.6	3
3	55+790	MDR/Village Road	PSC I GIRDER	1x20	0	2x11.6	3
4	56+800	MDR	PSC I GIRDER	1x20	0	2x11.6	3
5	61+420	MDR	PSC I GIRDER	1x20	0	2x11.6	3
6	77+010	Village Road	PSC I GIRDER	1x20	35	2x11.6	3
7	80+266	Village Road	PSC I GIRDER	1x20	0	2x11.6	3
8	87+592	MDR	PSC I GIRDER	1x20	0	2x11.6	3

12. LVUP (Light Vehicular Under Pass)

There are 18 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.	Chainage (km)	Type of Crossing	Type of Structure	Clear Opening in square direction (m)	Skew angle	Deck Configuration (m)	Width of Open Median (m)
1	51+718	village road	RCC BOX	1X12	30	2x11.6	3
2	52+165	local connectivity Road	RCC BOX	1X12	28	2x11.6	3
3	54+800	local connectivity Road	RCC BOX	1X12	30	2x11.6	3
4	57+795	local connectivity Road	RCC BOX	1X12	21	2x11.6	3
5	59+630	local connectivity Road	RCC BOX	1X12	30	2x11.6	3
6	60+310	local connectivity Road	RCC BOX	1X12	28	2x11.6	3
7	67+695	local connectivity Road	RCC BOX	1X12	30	2x11.6	3



Detailed Project Report

S. No	Chainage (km)	Type of Crossing	Type of Structure	Clear Opening in square direction (m)	Skew angle	Deck Configuration (m)	Width of Open Median (m)
8	69+765	local connectivity Road	RCC BOX	1X12	30	2x11.6	3
9	70+640	local connectivity Road	RCC BOX	1X12	0	2x11.6	3
10	73+072	local connectivity Road	RCC BOX	1X12	30	2x11.6	3
11	74+621	local connectivity Road	RCC BOX	1X12	0	2x11.6	3
12	76+100	local connectivity Road	RCC BOX	1X12	0	2x11.6	3
13	78+200	local connectivity Road	RCC BOX	1X12	25	2x11.6	3
14	79+255	local connectivity Road	RCC BOX	1X12	21	2x11.6	3
15	81+162	local connectivity Road	RCC BOX	1X12	19	2x11.6	3
16	81+740	local connectivity Road	RCC BOX	1X12	0	2x11.6	3
17	82+940	local connectivity Road	RCC BOX	1X12	0	2x11.6	3
18	84+165	local connectivity Road	RCC BOX	1X12	0	2x11.6	3

13. Small Vehicular Under Pass

There are 11 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.	Chainage (km)	Type of Crossing	Type of Structure	Clear Opening in square direction (m)	Skew angle	Deck Configuration (m)	Width of Open Median (m)
1	53+050	village road	RCC BOX	1X7.0	30	2x11.6	3
2	54+210	village road	RCC BOX	1X7.0	30	2x11.6	3
3	60+007	village road	RCC BOX	1X7.0	23	2x11.6	3
4	61+096	village road	RCC BOX	1X7.0	0	2x11.6	3
5	62+707	village road	RCC BOX	1X7.0	0	2x11.6	3
6	64+250	village road	RCC BOX	1X7.0	0	2x11.6	3
7	69+084	village road	RCC BOX	1X7.0	18	2x11.6	3
8	74+928	village road	RCC BOX	1X7.0	30	2x11.6	3
9	79+830	village road	RCC BOX	1X7.0	17	2x11.6	3
10	82+390	village road	RCC BOX	1X7.0	17	2x11.6	3
11	83+640	village road	RCC BOX	1X7.0	16	2x11.6	3

14. Fly-Over/Interchange

There are 6 numbers of Fly-Over that have been proposed in this section which are crossing the National/State Highways. The details of the Fly-Over and Interchange have been summarized in **Table 1.10**

Table 1.10. Details of Fly-Over/Interchange

Sr. No	Design Chainage (Km)	Intersecting Road	Type of Structure	Span Arrangement c/c Expansion joint (nos. x length) in Square direction (m)	Ske w angle	Deck Configuration (m)	Width of Open Median (m)	Minimum Vertical Clearance (m)	Remarks
1	50+607	State Highway 50	PSC I Girder	3x30	0	2x11.6	3.0m	5.5m	At Grade junction shall be developed with provision of Roundabout as per layout given in Appendix: B-V.
2	65+310	For Junction U-turn	PSC I Girder	1x30	0	2x11.6	3.0m	5.5m	
3	66+154	MDR	PSC I Girder	8x30	0	2x11.6	3.0m	5.5m	
4	77+765	MDR	PSC I Girder	3x30	0	2x11.6	3.0m	5.5m	
5	84+775	SH-56	PSC I Girder	3x30	0	2x11.6	3.0m	5.5m	
6	89+087	NH-27	PSC I Girder	10x30+1x32.28+5x30	0	2x11.6	3.0m	5.5m	Flyover cum viaduct at trumpet Interchange location

DETAILS OF STRUCTURES ON INTERCHANGES at LOOP AND RAMP

Sl. No.	Interchange	Connecting Roads	Structure Details	Super structure	Span Arrangement c/c Expansion joint in Square direction (m)/Clear Opening Square direction (m)	Skew Angle	Deck Configuration (m)	Minimum Vertical Clearance (m)
1	Single trumpet Interchange at Km 89+087	NH-27	Viaduct structure for Exit Ramp	PSC I Girder	5x30	0	1x10.5	--
2	Single trumpet Interchange at Km 89+087	NH-27	Viaduct structure for Entry Ramp	PSC I Girder	5x30	0	1x10.5	--

15. Road Over Bridge

There is 02 number of R.O.B Proposed in this section. The details of the ROB have been summarized below in **Table 1.11**.

Table 1.11. Details of R.O.B

Sl. No.	Chainage (Km)	Type of Structure	Span Arrangement c/c Expansion in square direction (m)	Skew Angle	Deck Configuration (m)	Median Width (m)
1	76+895	PSC I Girder	18+36+18	5	As per Approved GAD	3
2	88+680	PSC I Girder	15+60+15	0	As per Approved GAD	3

16. 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 89 nos. of culverts proposed in this section. The details of the culverts are summarized below in **Table 1.13**.

Table 1.13. Details of the Culverts

S.No	Design Chainage	Type Of Culvert	Size
			No x Width (m) x Height (m)
1	47+050	RCC Box	1x4x4
2	47+300	RCC Box	1x4x4
3	47+584	RCC Box	1x4x4
4	47+860	RCC Box	1x4x4
5	48+100	RCC Box	1x4x4
6	48+310	RCC Box	1x4x4
7	48+800	RCC Box	1x4x4
8	50+000	RCC Box	1x4x4
9	50+250	RCC Box	1x4x4
10	51+000	RCC Box	1x4x4
11	51+400	RCC Box	1x4x4
12	51+950	RCC Box	1x4x4
13	52+400	RCC Box	1x4x4
14	52+660	RCC Box	1x4x4
15	53+300	RCC Box	1x4x4
16	53+925	RCC Box	1x6x4
17	54+540	RCC Box	1x4x4
18	55+050	RCC Box	1x4x4
19	55+500	RCC Box	1x4x4
20	56+080	RCC Box	1x4x4
21	56+390	RCC Box	1x4x4
22	57+200	RCC Box	1x4x4
23	57+470	RCC Box	1x4x4
24	58+100	RCC Box	1x4x4
25	58+440	RCC Box	1x4x4
26	58+750	RCC Box	1x4x4
27	59+340	RCC Box	1x4x4
28	60+700	RCC Box	1x4x4
29	60+850	RCC Box	1x4x4
30	61+300	RCC Box	1x4x4
31	61+860	RCC Box	1x4x4
32	62+240	RCC Box	1x4x4

Detailed Project Report

S.No	Design Chainage	Type Of Culvert	Size
			No x Width (m) x Height (m)
33	62+450	RCC Box	1x4x4
34	62+920	RCC Box	1x4x4
35	63+200	RCC Box	1x4x4
36	63+710	RCC Box	1x4x4
37	63+950	RCC Box	1x4x4
38	64+500	RCC Box	1x4x4
39	64+900	RCC Box	1x4x4
40	65+667	RCC Box	1x3x3
41	66+900	RCC Box	1x4x4
42	67+200	RCC Box	1x4x4
43	67+560	RCC Box	1x4x4
44	68+360	RCC Box	1x4x4
45	68+850	RCC Box	1x4x4
46	69+350	RCC Box	1x4x4
47	69+550	RCC Box	1x4x4
48	70+200	RCC Box	1x4x4
49	70+400	RCC Box	1x4x4
50	70+760	RCC Box	1x4x4
51	71+100	RCC Box	1x4x4
52	71+325	RCC Box	1x4x4
53	71+600	RCC Box	1x4x4
54	72+200	RCC Box	1x4x4
55	72+560	RCC Box	1x4x4
56	72+900	RCC Box	1x4x4
57	73+330	RCC Box	1x4x4
58	73+700	RCC Box	1x4x4
59	74+300	RCC Box	1x4x4
60	75+065	RCC Box	1x4x4
61	75+300	RCC Box	1x4x4
62	76+250	RCC Box	1x4x4
63	76+550	RCC Box	1x4x4
64	77+240	RCC Box	1x4x4
65	78+360	RCC Box	1x4x4
66	78+600	RCC Box	1x4x4
67	78+900	RCC Box	1x4x4
68	79+540	RCC Box	1x4x4
69	80+050	RCC Box	1x4x4
70	80+500	RCC Box	1x4x4
71	80+780	RCC Box	1x6x4
72	81+450	RCC Box	1x4x4

S.No	Design Chainage	Type Of Culvert	Size
			No x Width (m) x Height (m)
73	82+100	RCC Box	1x4x4
74	82+680	RCC Box	1x4x4
75	83+250	RCC Box	1x4x4
76	83+500	RCC Box	1x4x4
77	83+950	RCC Box	1x4x4
78	84+350	RCC Box	1x4x4
79	85+120	RCC Box	1x4x4
80	85+380	RCC Box	1x4x4
81	85+700	RCC Box	1x4x4
82	86+000	RCC Box	1x4x4
83	86+260	RCC Box	1x4x4
84	86+520	RCC Box	1x4x4
85	86+940	RCC Box	1x4x4
86	87+400	RCC Box	1x4x4
87	87+910	RCC Box	1x6x4
88	88+140	RCC Box	1x4x4
89	88+400	RCC Box	1x4x4

17. Toll Plaza

The Toll Plazas on loops / ramps / main carriageway shall be provided as per Schedule D and minimum lane requirement in the opening year are as follows.

S. No.	Location	Chainage.	No of Toll lanes (ETC + Extra Wide)	Remarks
1	On Main Carriageway	86+140	(6+2)	-

Toll Plaza location and Minimum Lane Requirement in the Opening Year

Interchange No.	Toll Plaza	Location	Direction (Entry: to highway, Exit: from highway)	No. of toll lanes (ETC + Extra Wide)
Interchange 1 At km 50+607 (NH-50 crossing)	TP-1	On Slip road At km 50+300) & (50+400)	Exit (LHS)	(2+1)
			Entry (RHS)	(2+1)
	TP-2	On Slip road At km-(50+750) & (50+850)	Entry (LHS)	(2+1)
			Exit (RHS)	(2+1)
Interchange 2 At km 66+160 (MDR crossing)	TP-3	On Slip road At km- (65+900)& (65+950)	Exit (LHS)	(2+1)
			Entry (RHS)	(2+1)

Interchange No.	Toll Plaza	Location	Direction (Entry: to highway, Exit: from highway)	No. of toll lanes (ETC + Extra Wide)
Interchange 3 At km 77+765 (MDR crossing)	TP-5	On Slip road At km- 77+500 & 77+600	Exit (LHS)	(2+1)
			Entry (RHS)	(2+1)
	TP-6	On Slip road At km 77+950	Entry (LHS)	(2+1)
			Exit (RHS)	(2+1)
Interchange 4 At km 84+775 (MDR crossing)	TP-7	On Slip road At km84+450 & 85+550	Exit (LHS)	(2+1)
			Entry (RHS)	(2+1)
	TP-8	On Slip road At km(84+950)&(85+950)	Entry (LHS)	(2+1)
			Exit (RHS)	(2+1)

Toll plaza on the project highway shall be constructed at the location specified above and in accordance with the provisions specified in IRC SP – 84 -2019 and as per NHAI Policy Guidelines specified in Policy Circular No. 17.5.82 dated 24th May 2021.

18. Rest Area:-

Rest Area/Wayside amenities shall be developed at the following locations in accordance to **Schedule - D**.

S. No.	Start (Km)	End (Km)	Side	Type of facility	Area
1	60+460	60+660	LHS	Road user facility	2 Ha
2	68+353	68+845	RHS	Road user facility	2 Ha

19. 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	Location	Type of survey	Latitude	Longitude	Date
1	Sarai toll Plaza NH-77B	TVC, OD, Axle load Survey	25.802874	85.283396	May 2019
2	Uaghara SH-50	TVC, OD	26.042298	85.811019	

19.1 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 -1.15**

Table 1.15: AVERAGE DAILY TRAFFIC

Mode of Vehicle		Sarai Toll	Ughara
Tollable vehicles	Car	6023	2516
	Minibus	359	109
	Bus	1058	436
	LCV	2051	932
	2Axle Truck	1468	576
	3 Axle Truck	788	542
	MAV (4-6) Axle	512	250
Non-Tollable vehicles	2Wheeler	9878	3601
	3 Wheeler	1657	946
	Tractor	85	74
	Tractor with Trailer	55	25
Total	Grand Total (Nos.)	23934	10007
	Grand Total(PCU)	28855	12835

19.2 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 in **Table – 1.17**

Table 1.17: ANNUAL AVERAGE DAILY TRAFFIC

	Mode Type of Vehicle	Sarai Toll	Ughara
Toll able vehicles	Car	6143	2566
	Minibus	381	116
	Bus	1121	462
	LCV	2174	988
	2Axle Truck	1556	611
	3 Axle Truck	835	575
	MAV (4-6) Axle	543	265
Non-Toll able vehicles	2 Wheeler	10076	3673
	3 Wheeler	1756	1003
	Tractor	90	78
	Tractor with Trailer	58	27
Total	Grand Total (Nos.)	24734	10363
	Grand Total (PCU)	30148	13432

19.3 TOTAL TRAFFIC PROJECTION

The summary of projected total traffic is presented in **Table 1.18** below.

Table 1.18: Traffic Projection

Detailed Project Report

Year	2 Wheeler	3 Wheeler	Car	Mini bus	Bus	LC V	2-Axle	3-Axle	Multi Axle	Tractor With Trailer	TraCTOR	Total All Vehicles (Nos.)	Total All Vehicles (PCU)
2020	1900	280	3867	13	1063	1248	897	766	341	135	45	10555	17376
2021	2037	288	4155	13	1095	1324	926	790	352	139	46	11167	18181
2022	2184	297	4465	14	1128	1405	955	815	363	144	48	11818	19029
2023	2315	304	4741	14	1156	1473	979	836	372	147	49	12388	19759
2024	2453	312	5035	14	1185	1545	1004	857	382	151	50	12988	20522
2025	2600	320	5348	15	1214	1620	1029	879	391	155	52	13622	21319
2026	2756	328	5679	15	1244	1698	1055	901	401	159	53	14289	22153
2027	2921	336	6031	16	1275	1780	1081	924	411	163	54	14993	23026
2028	3072	343	6353	16	1303	1851	1104	943	420	166	55	15626	23800
2029	3230	350	6691	16	1330	1926	1127	962	428	170	57	16289	24605
2030	3397	358	7048	17	1359	2003	1150	982	437	173	58	16982	25443
2031	3572	366	7424	17	1388	2083	1174	1003	446	177	59	17709	26314
2032	3757	373	7819	17	1418	2167	1199	1024	456	180	60	18470	27221
2033	3927	380	8187	18	1445	2241	1220	1042	464	184	61	19168	28044
2034	4106	388	8572	18	1472	2318	1242	1060	472	187	62	19896	28896
2035	4292	395	8974	18	1500	2397	1264	1079	480	190	63	20654	29780
2036	4487	402	9396	19	1528	2479	1286	1099	489	194	65	21443	30696
2037	4690	410	9838	19	1557	2564	1309	1118	498	197	66	22266	31645
2038	4881	417	10252	19	1583	2640	1330	1135	505	200	67	23030	32518
2039	5080	424	10684	20	1610	2719	1350	1153	513	203	68	23824	33421
2040	5287	431	11133	20	1637	2800	1371	1171	521	206	69	24647	34353
2041	5502	439	11602	20	1665	2883	1392	1189	529	210	70	25501	35315
2042	5726	446	12091	21	1693	2969	1414	1207	538	213	71	26388	36310
2043	5937	453	12553	21	1719	3047	1433	1224	545	216	72	27220	37236
2044	6156	460	13032	21	1745	3128	1453	1241	552	219	73	28080	38189
2045	6383	467	13530	22	1772	3210	1473	1258	560	222	74	28970	39172
2046	6619	474	14047	22	1799	3295	1493	1275	568	225	75	29891	40185
2047	6863	481	14583	22	1826	3382	1514	1292	575	228	76	30844	41228
2048	7095	488	15094	23	1852	3462	1532	1308	582	231	77	31744	42209
2049	7335	495	15622	23	1878	3544	1551	1324	590	233	78	32674	43217
2050	7583	502	16169	23	1905	3628	1570	1341	597	236	79	33633	44254

20. Pavement Design

The entire Project shall be constructed with Rigid Pavement for the **Main Carriageway and Slip roads** and the service roads shall be constructed with flexible pavement for design traffic of 20 MSA. The details of the Thickness for different layers are given below:-

Table 1.18: Proposed Rigid Pavement Design for MCW, Ramps, Loops & Approach Roads and slip roads

Design period	Design CBR	PQC (mm)	DLC (mm)	GSB (mm)
30 years	6%	280	150	200

Table 1.19: Proposed Design for Service Roads

Design period	Design Traffic	Bitumen Grade	Design CBR	BC	DBM	WMM	CTS B
20 years	20MSA	VG 30	6%	30	50	150	200

21. Cost Estimate

The Cost Estimate has been prepared from the SOR of Bihar 2020-2021. The abstract of the cost estimate has been given in **Table 1.20**. For detail of Cost Estimate, separate volume is submitted along these submittals.

Table 1.20 Abstract of Cost Estimate

Sl. No.	Items	Unit	Length	Rate (in Rs.)	Amount (in Rs.)	Amount (in Cr.)
A	ROAD WORKS					
1	Site Clearance	Km	38.35	1,292,445	49,567,862.95	4.96
2	Excavation	Km	38.35	-	-	-
2	Earthwork Filling	Km	38.35	29,143,793	1,117,722,744.00	111.77
3	Loosening & Recompacting	Km	38.35	-	-	-
4	Sub Grade	Km	38.35	4,490,945	172,236,710.18	17.22
5	GSB	Km	38.35	20,953,896	803,623,803.54	80.36
7	DLC	Km	38.35	16,923,518	649,050,750.15	64.91
8	PQC	Km	38.35	43,347,756	1,662,473,155.74	166.25
9	WMM	Km	38.35	289,715	11,111,157.50	1.11
10	Prime Coat	Km				



Detailed Project Report

			2.59	307,125	796,068.00	0.08
11	Tack Coat	Km	2.59	113,700	294,710.40	0.03
12	DBM	Km	2.59	4,349,233	11,273,212.26	1.13
13	BC	Km	2.59	3,421,845	8,869,422.24	0.89

B	BRIDGES and STRUCTURES					
1	Major Bridges	No	8.00	368417201	2,947,337,607.36	294.73
2	Minor Bridges	No	11.00	60061748	660,679,228.68	66.07
3	VUP /LVUP /SVUP	No	39.00	20393591	795,350,050.92	79.54
4	Overpass	No	-		-	-
5	Flyovers	No	6.00	172773869	1,036,643,216.68	103.66
6	Culverts	No	90.00	3166342	284,970,798.46	28.50
7	ROB	No	1	324802776	324,802,775.76	32.48

C	SLOPE STRUCTURES					
1	RE Wall including Earthfilling	km	10.70		345,269,187.30	34.53
D	JUNCTIONS					
1	Major Junctions	No	6		242,777,302.38	24.28
2	Minor Junctions	No	28		46,185,213.06	4.62
3	Toll Plaza	No	1.00		256,978,901.89	25.70

E	DRAIN & PROTECTION WORK					
1	Drainage Works	Km			9,708,195.17	0.97
2	RCC Crash Barrier with friction slab	Km	21.41		119,650,500.00	11.97
3	Metal Crash Barrier	Km	102.82		288,912,960.00	28.89
4	Other Protective Works (Boundary Wall & Slope Protection)				599,296,920.36	59.93

F	OTHER MISCELLANEOUS ITEMS					
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Project Construction of Four lane access controlled Greenfield National Highway (NH-119D), starting from its junction with NH-19 (Old NH-02) near village Amas connecting Ramnagar, Kachhi Dargah, Kalyanpur (Hajipur), Tajpur and terminating at its junction with Nh-27 near village Bela Nawada (Darbhanga) under Bharatmala Pariyojna in the state of Bihar- Package-IV from village Balbhadarpur (Design Ch. 47+000) to village Bela Nawada (Darbhanga) (Design Ch. 89+210) Total Length – 42.210 Km.

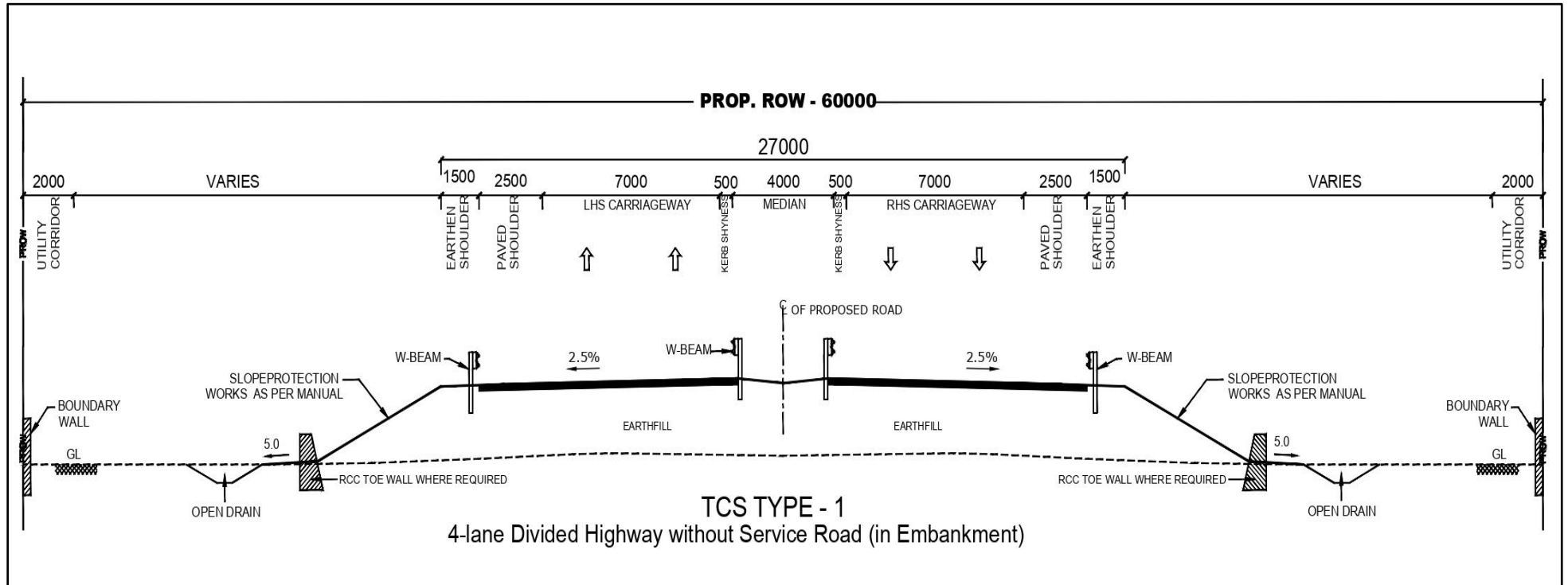


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1	Footpath and Separators				1,960,133.28	0.20
2	Rest Area Locations	No s	2		146,674,000.00	14.67
3	Miscellaneous Items				2,000,000.00	0.20
4	Traffic Signs, Marking and Road Appurtenances				81,759,476.12	8.18
5	Reflective Road Studs	No s	13360		3,046,080.00	0.30
6	Lighting Cost				25,350,000.00	2.54
	TOTAL CIVIL COST				12,706,372,144	1,270.64
	COST PER KM (LENGTH = 42.127 KM) IN CRORES ...					30.16
	GST (12%) on Civil Cost					152.48
	Labour Cess 1%					12.71
	Utility Cost					8.48
	TOTAL CIVIL COST					1,444.30
	COST PER KM (LENGTH = 42.127 KM) IN CRORES ...					34.28

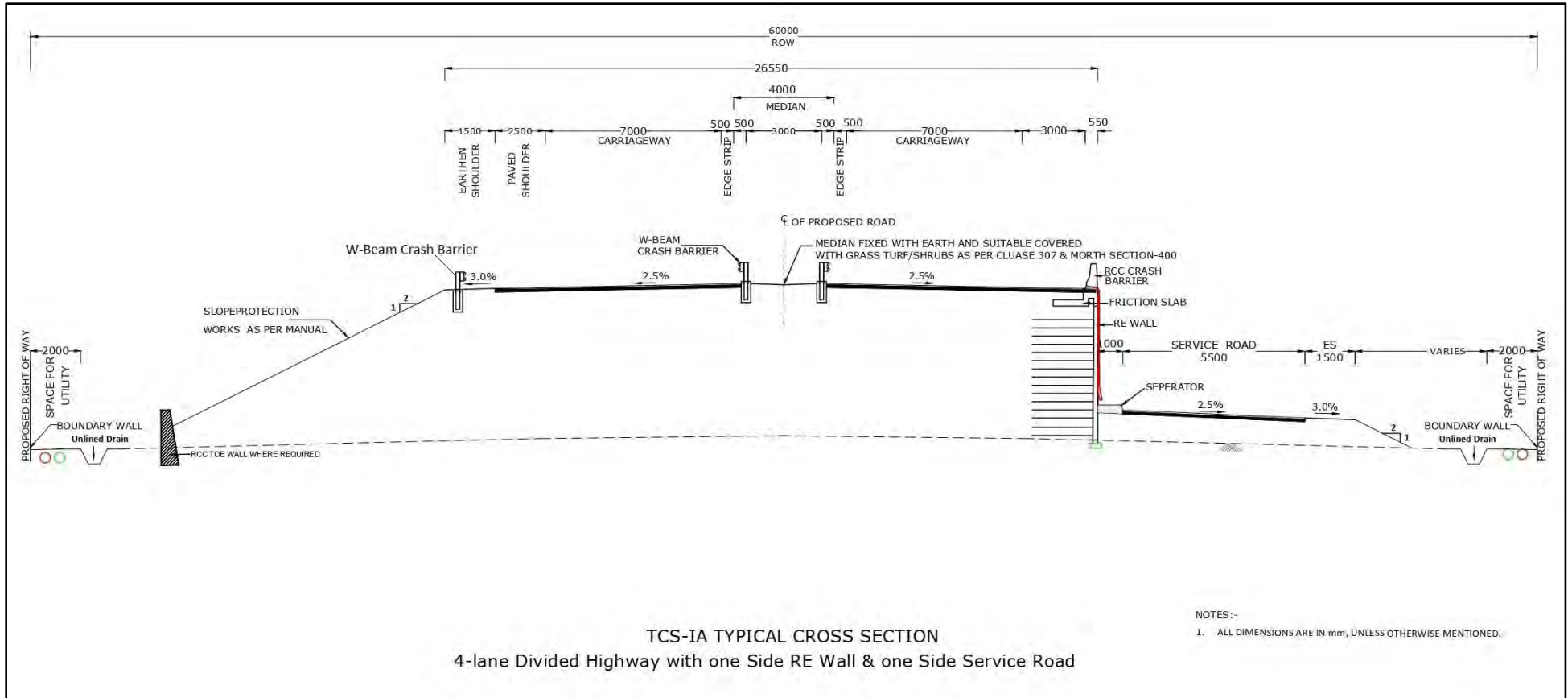
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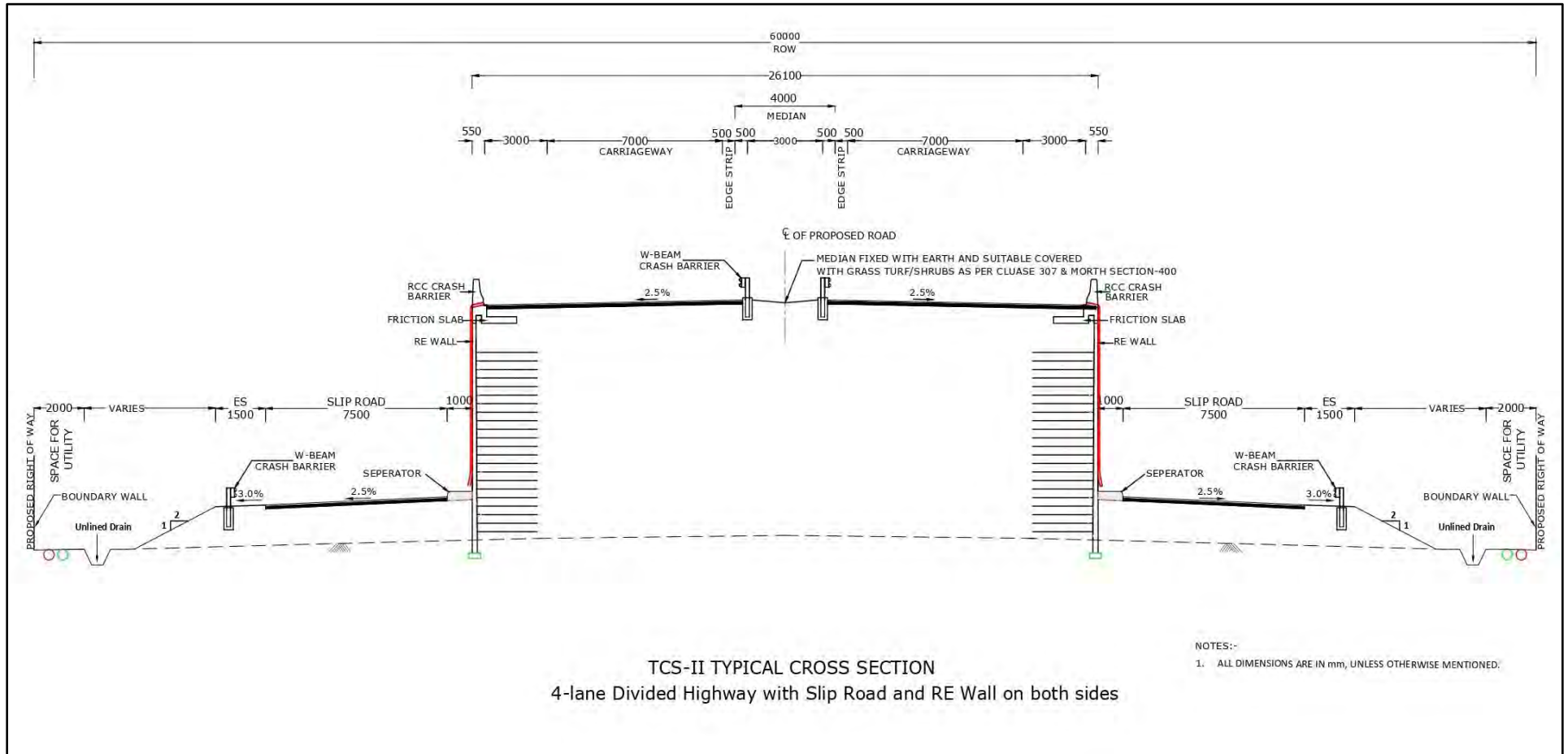
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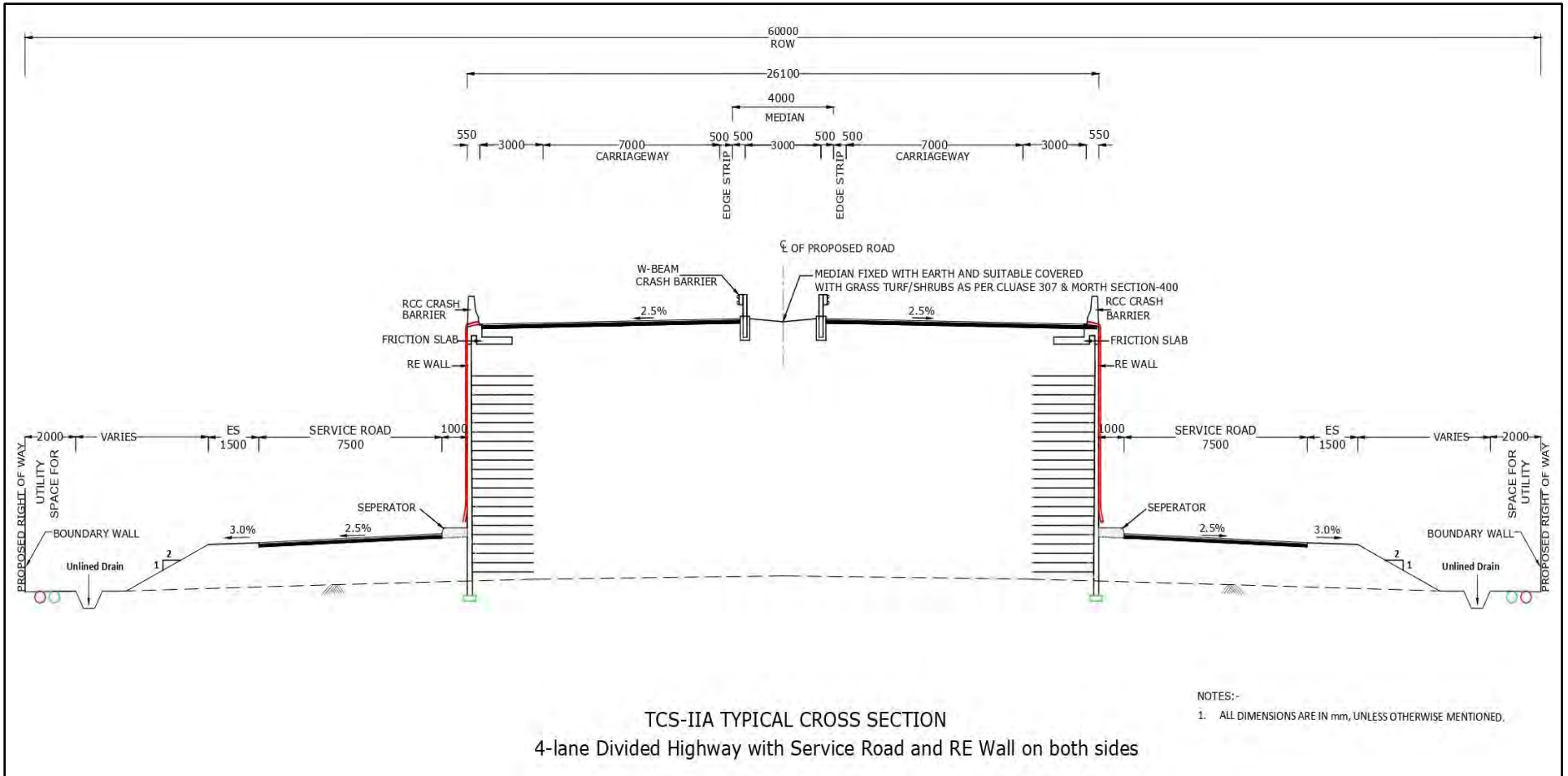


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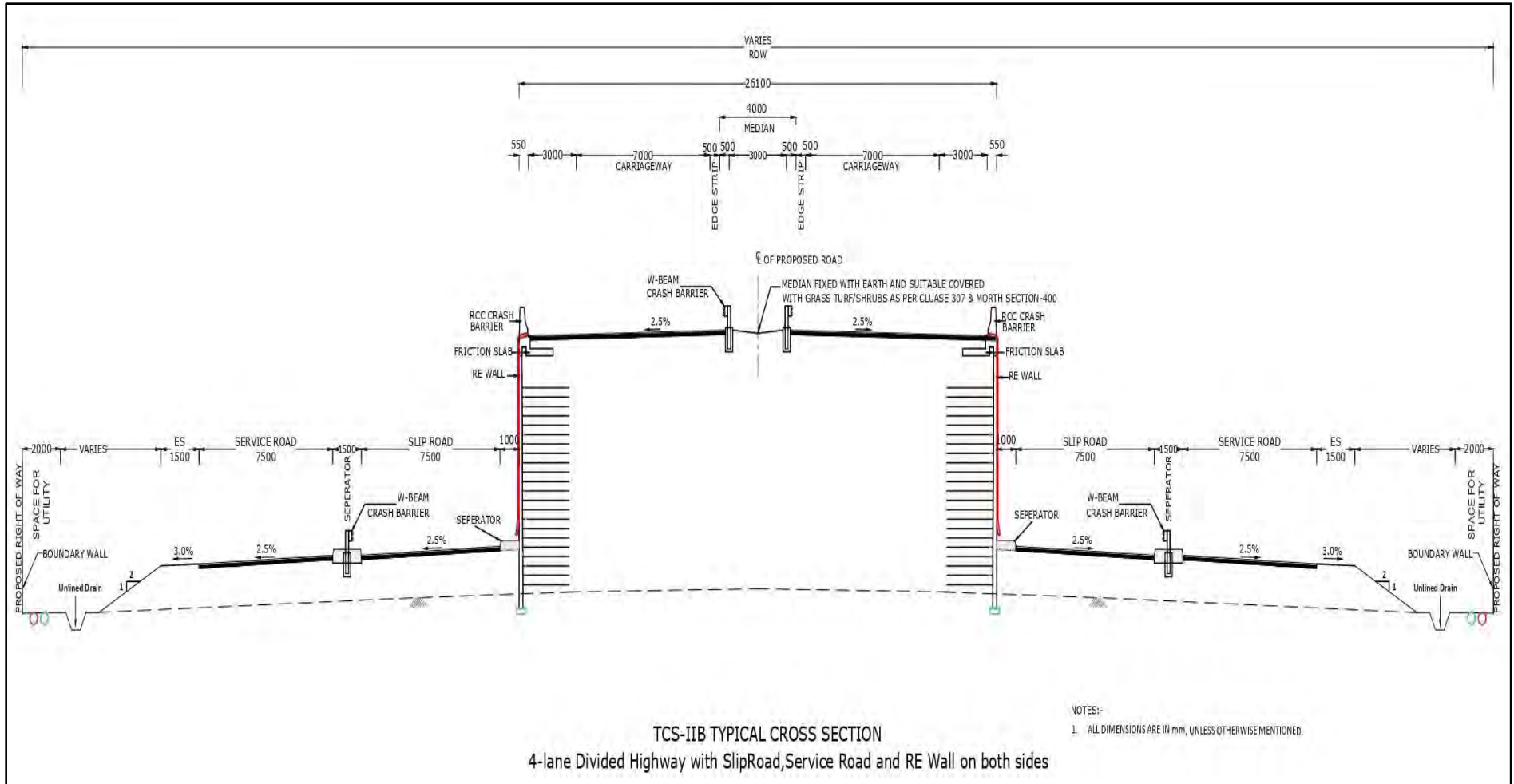


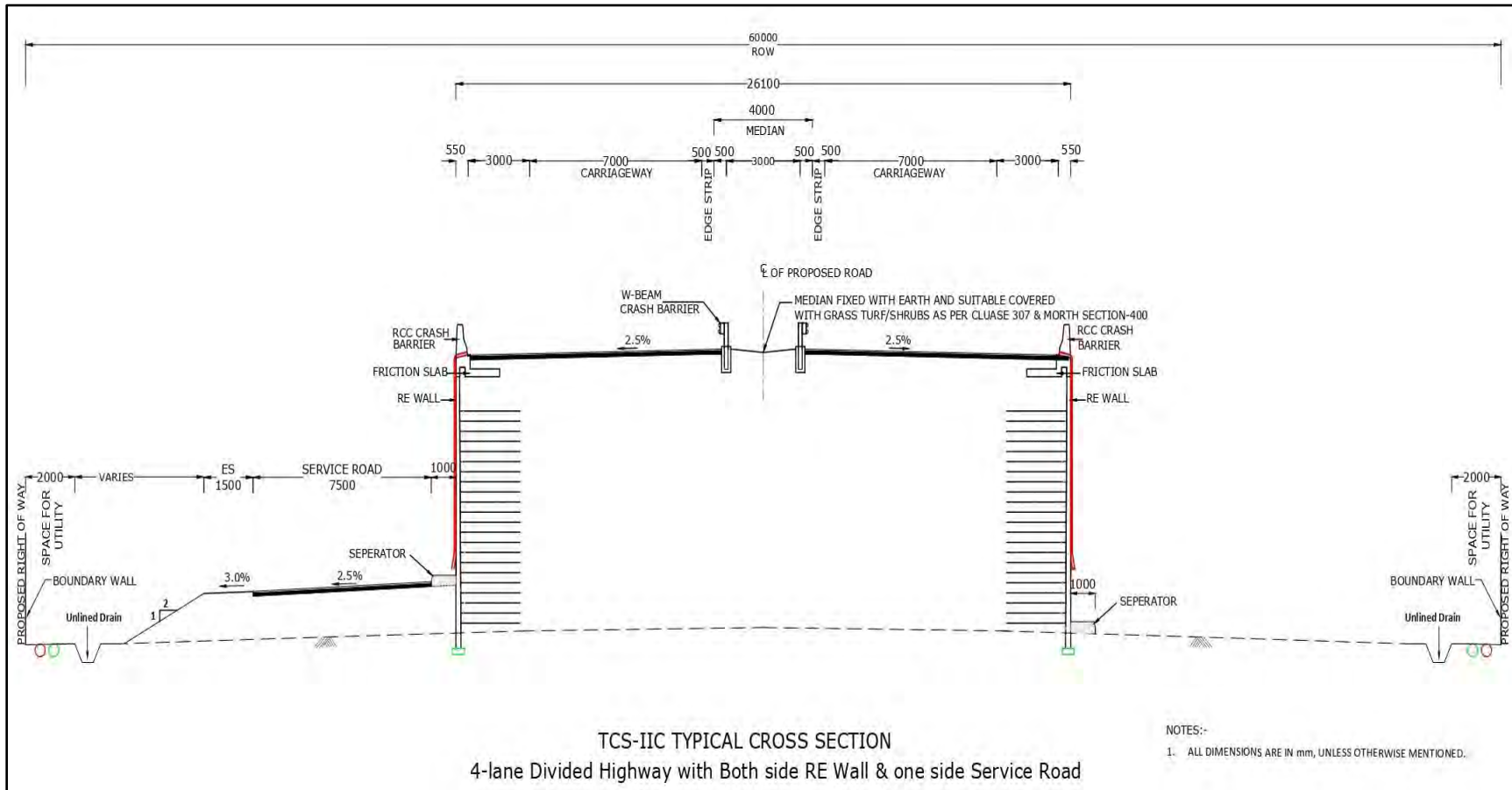




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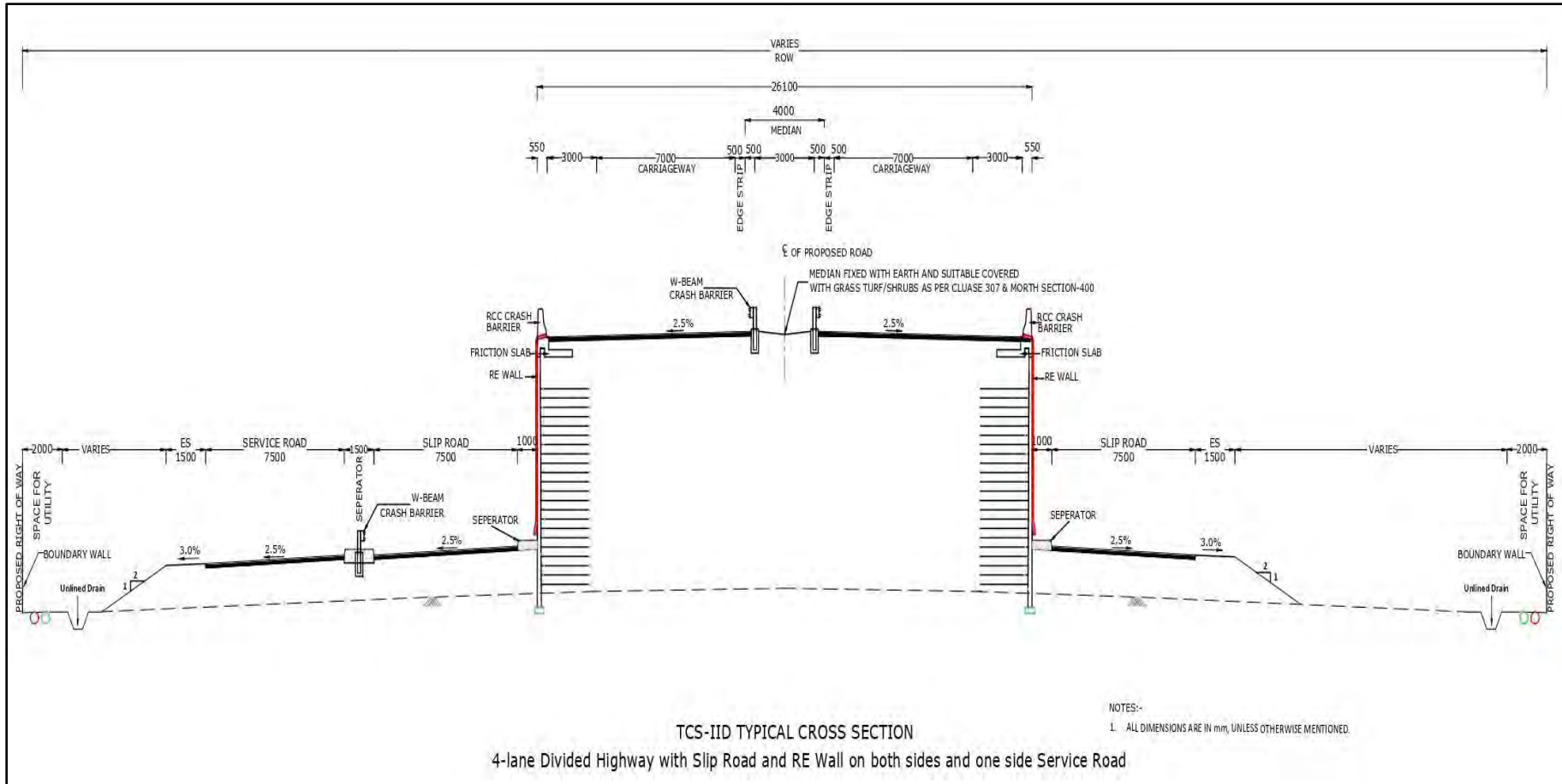
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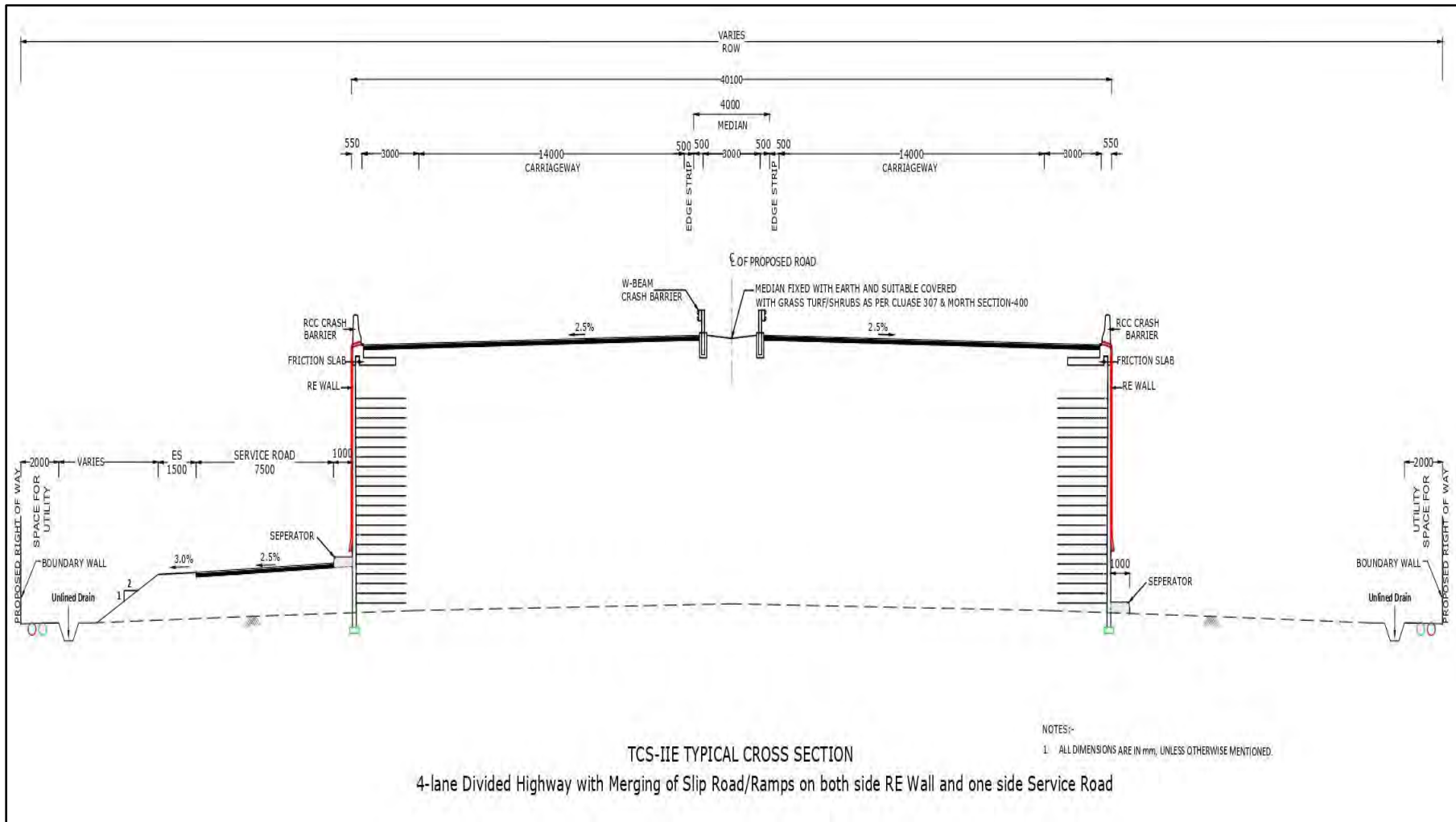


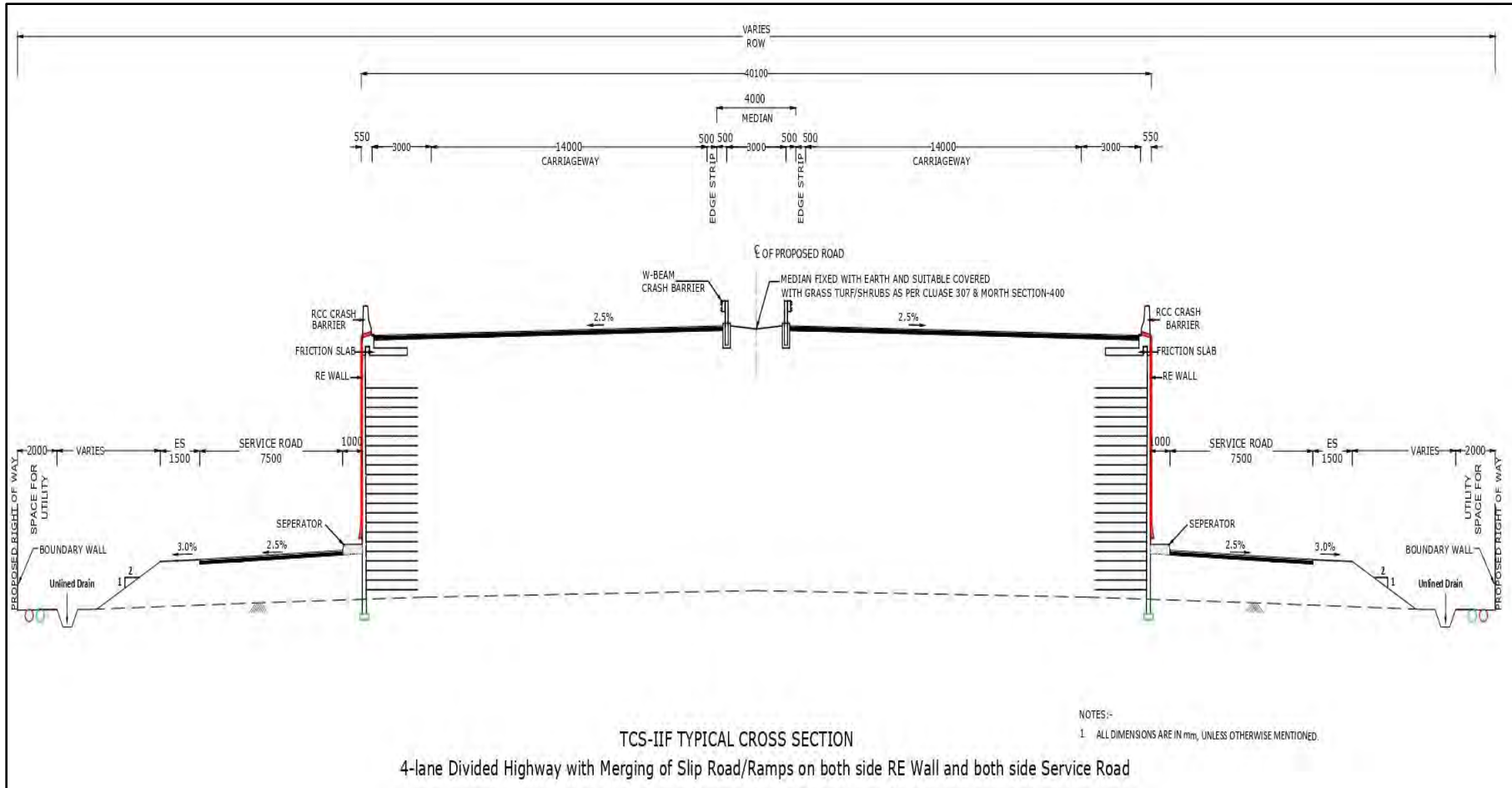


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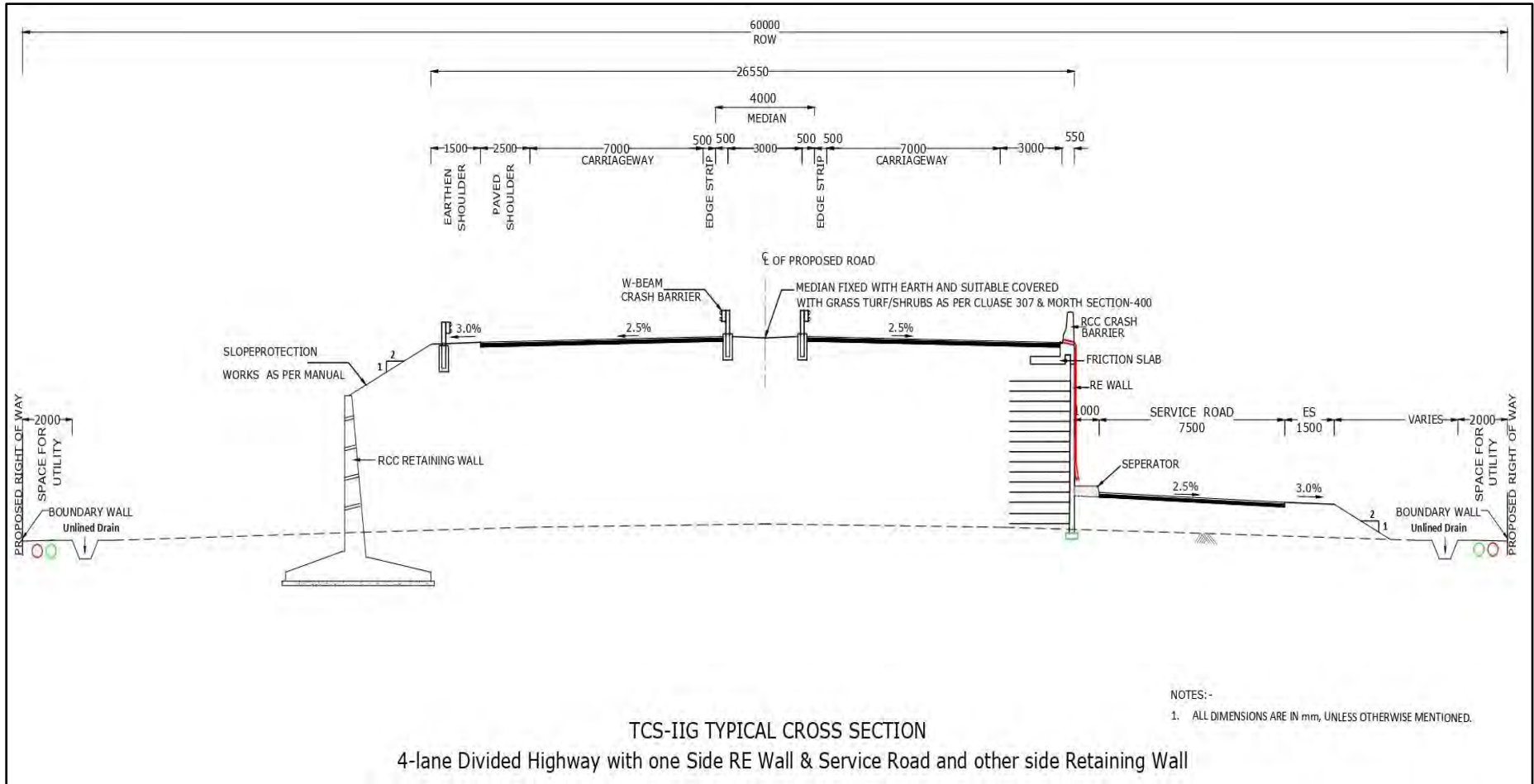


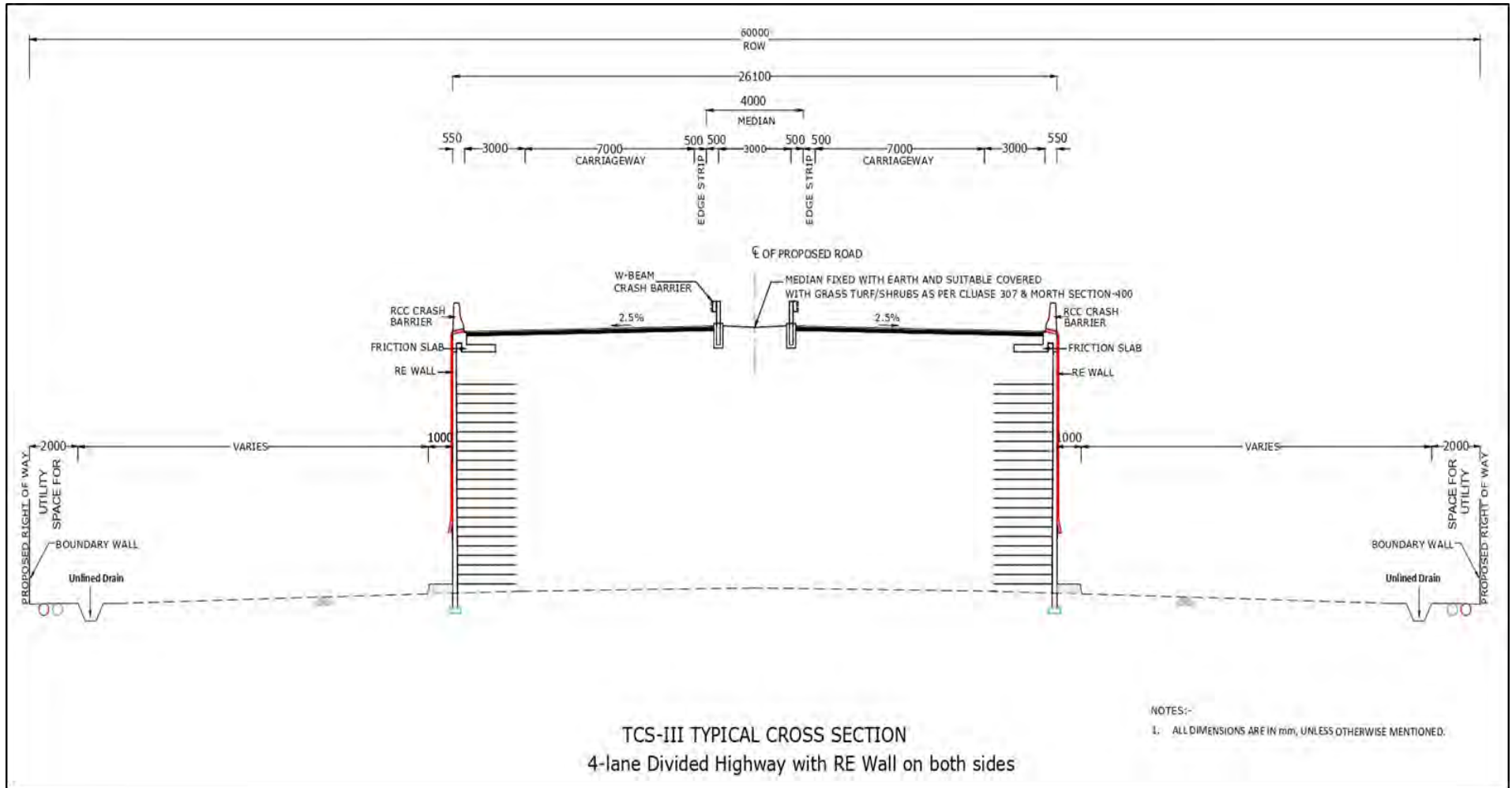




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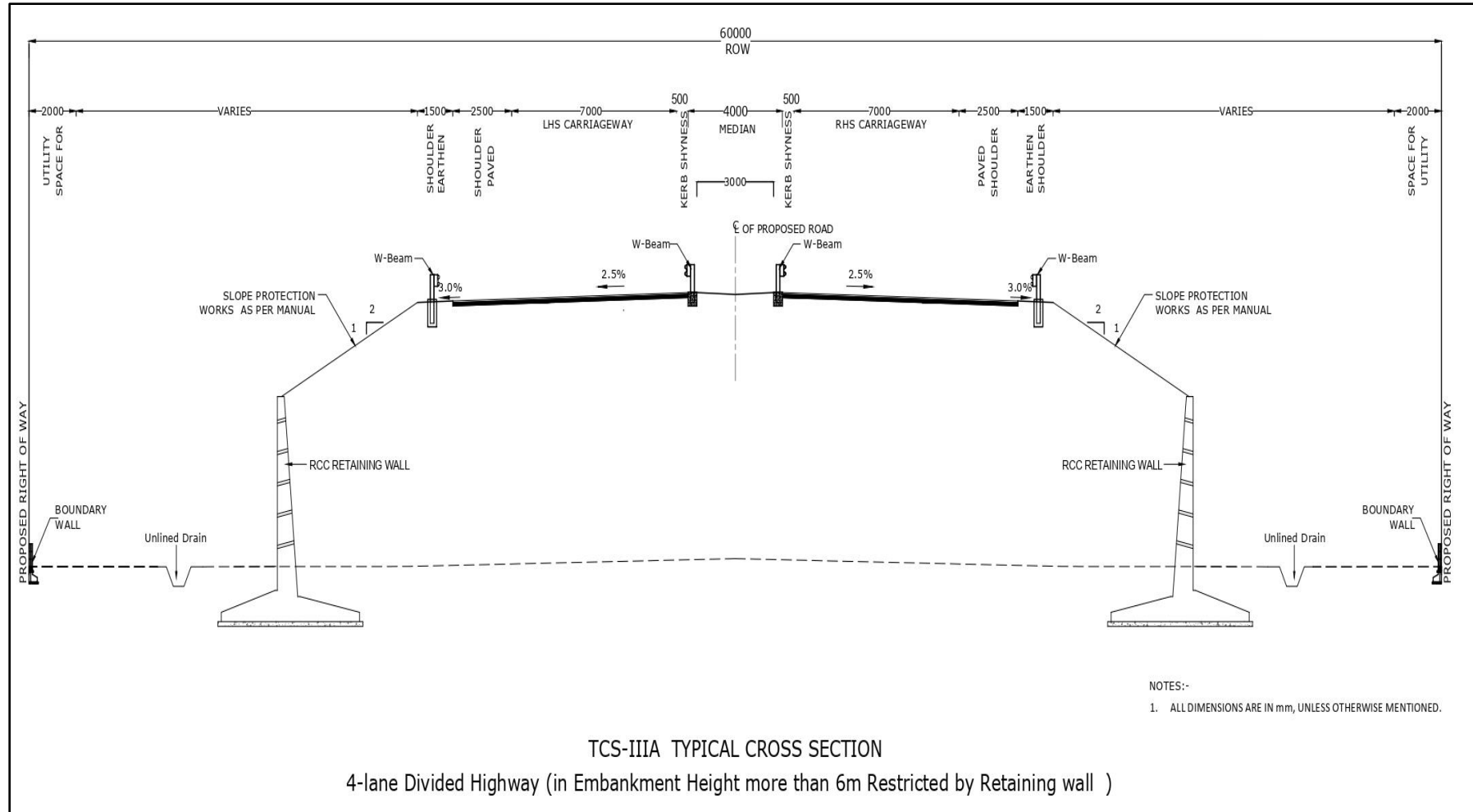
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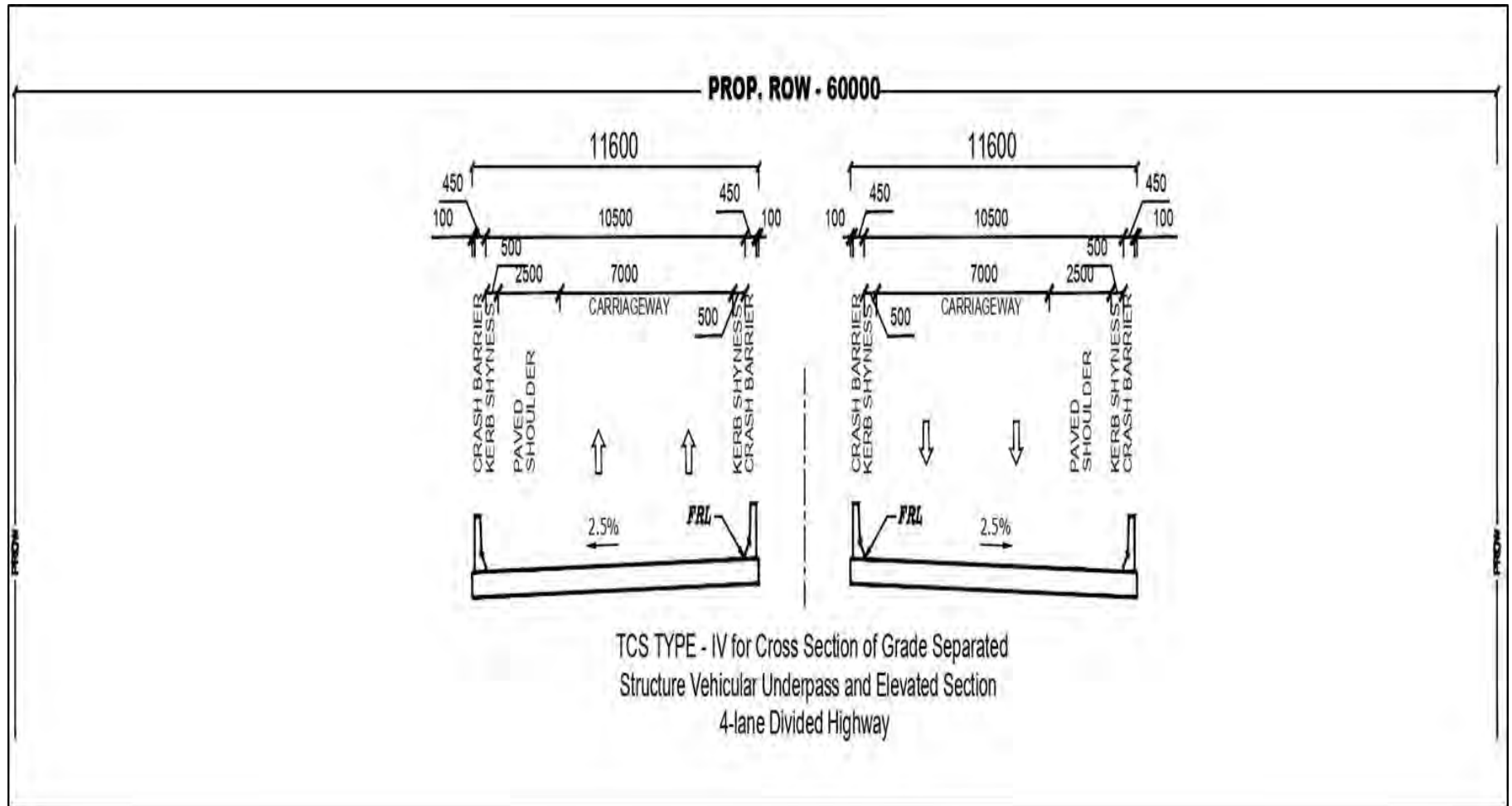


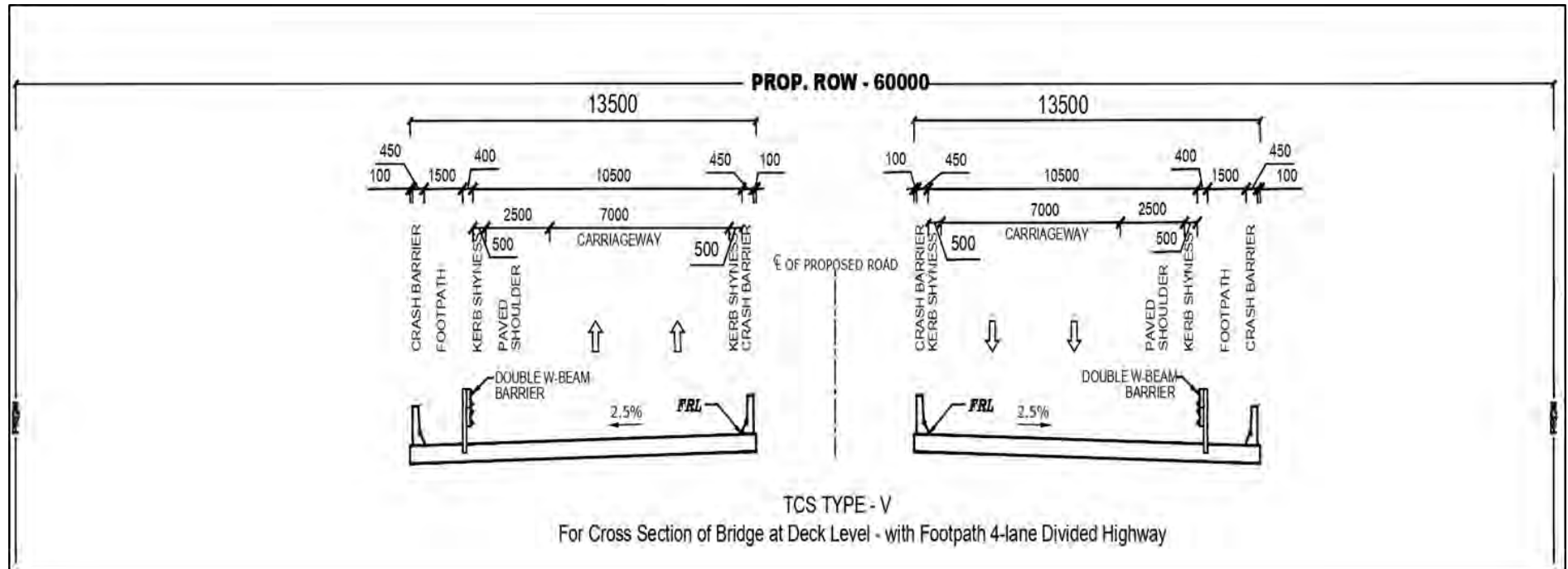


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Detailed Project Report

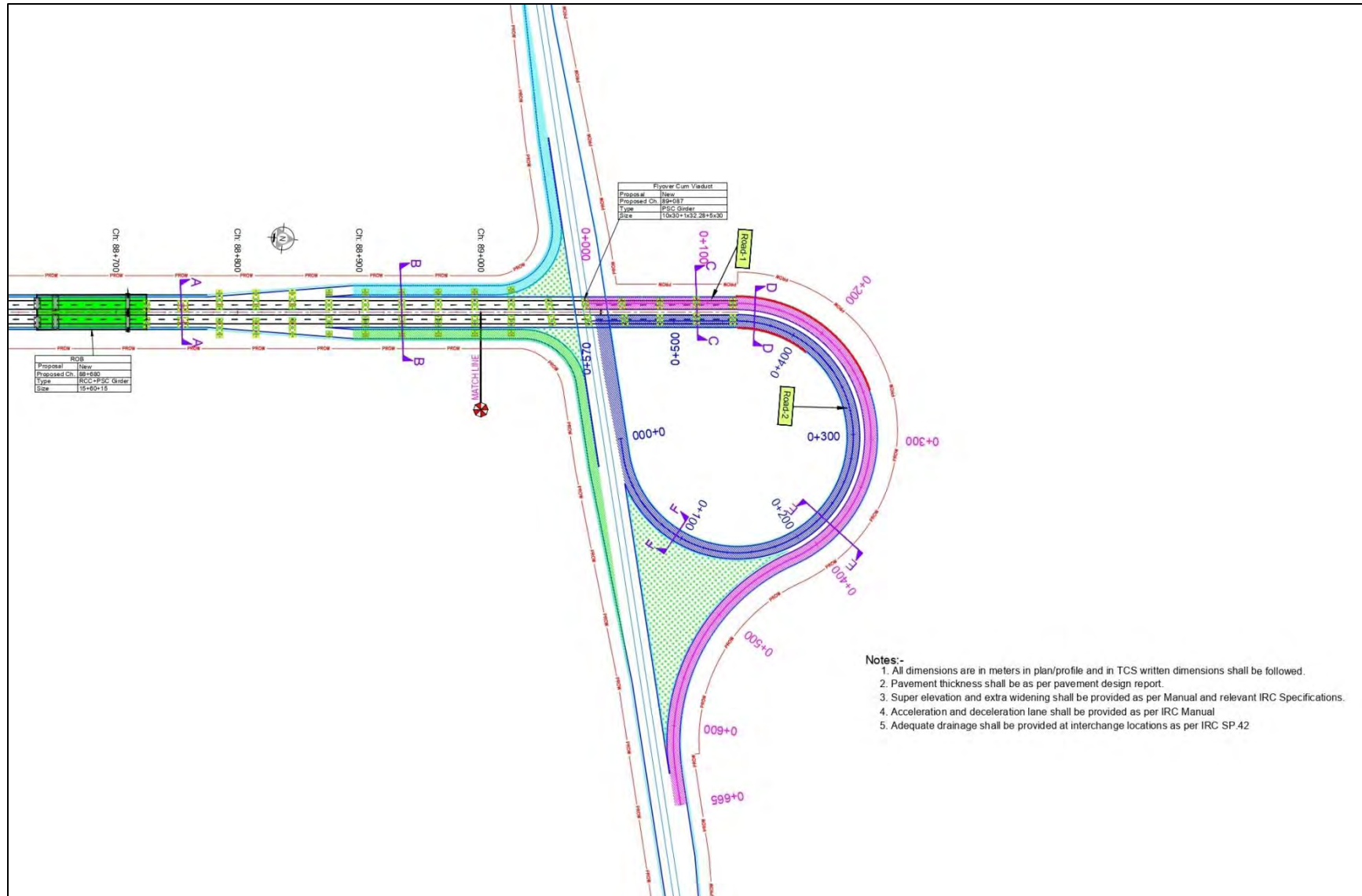


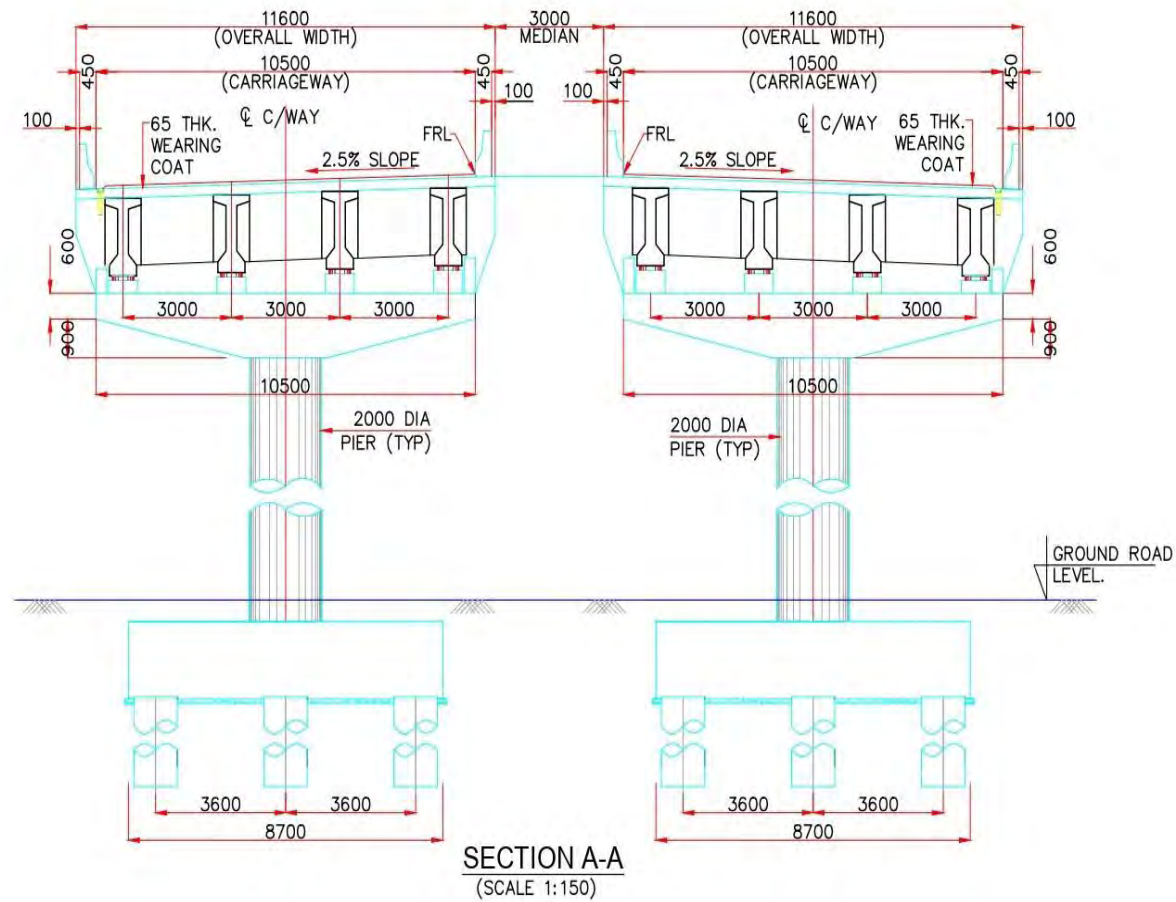


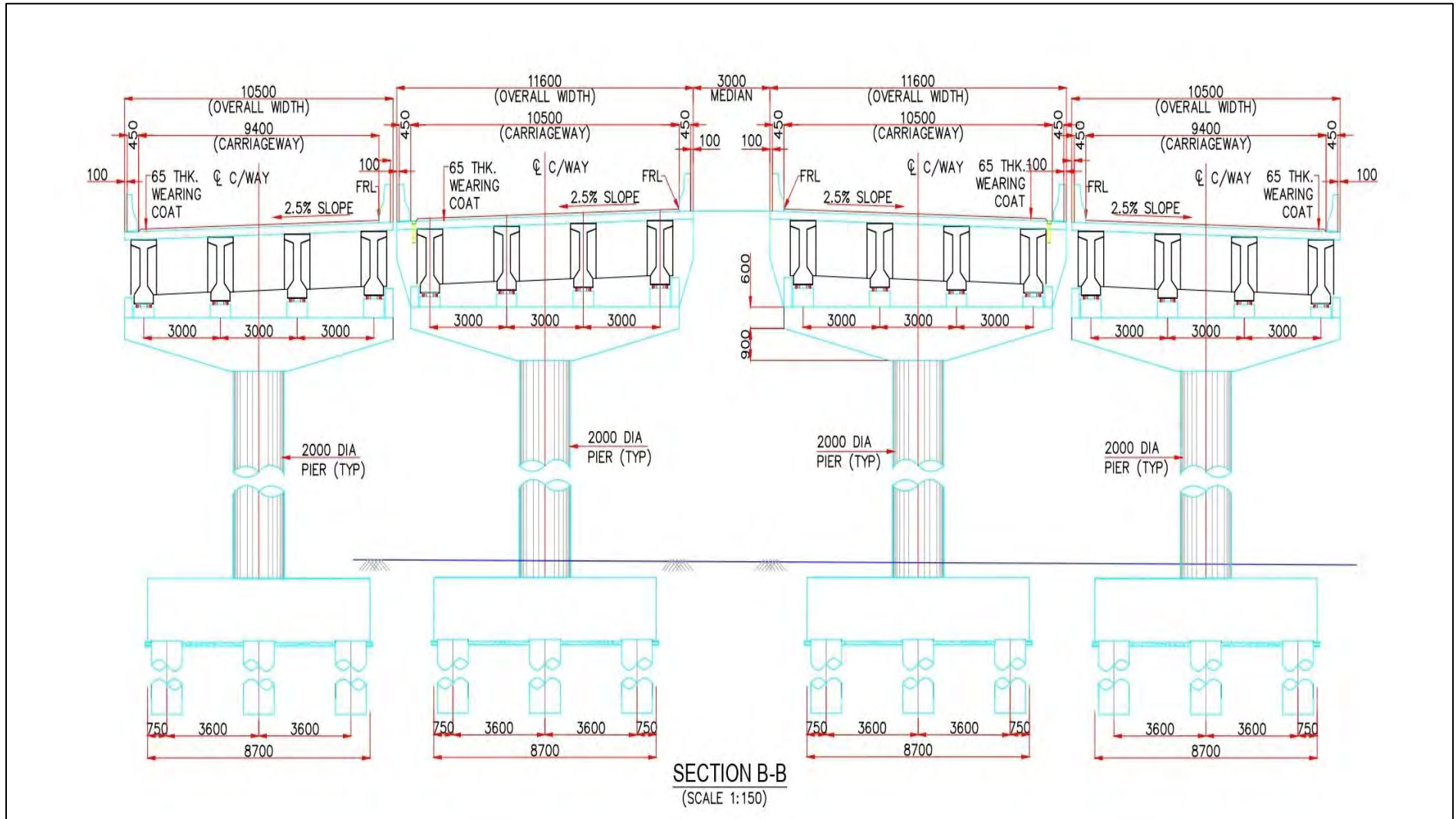


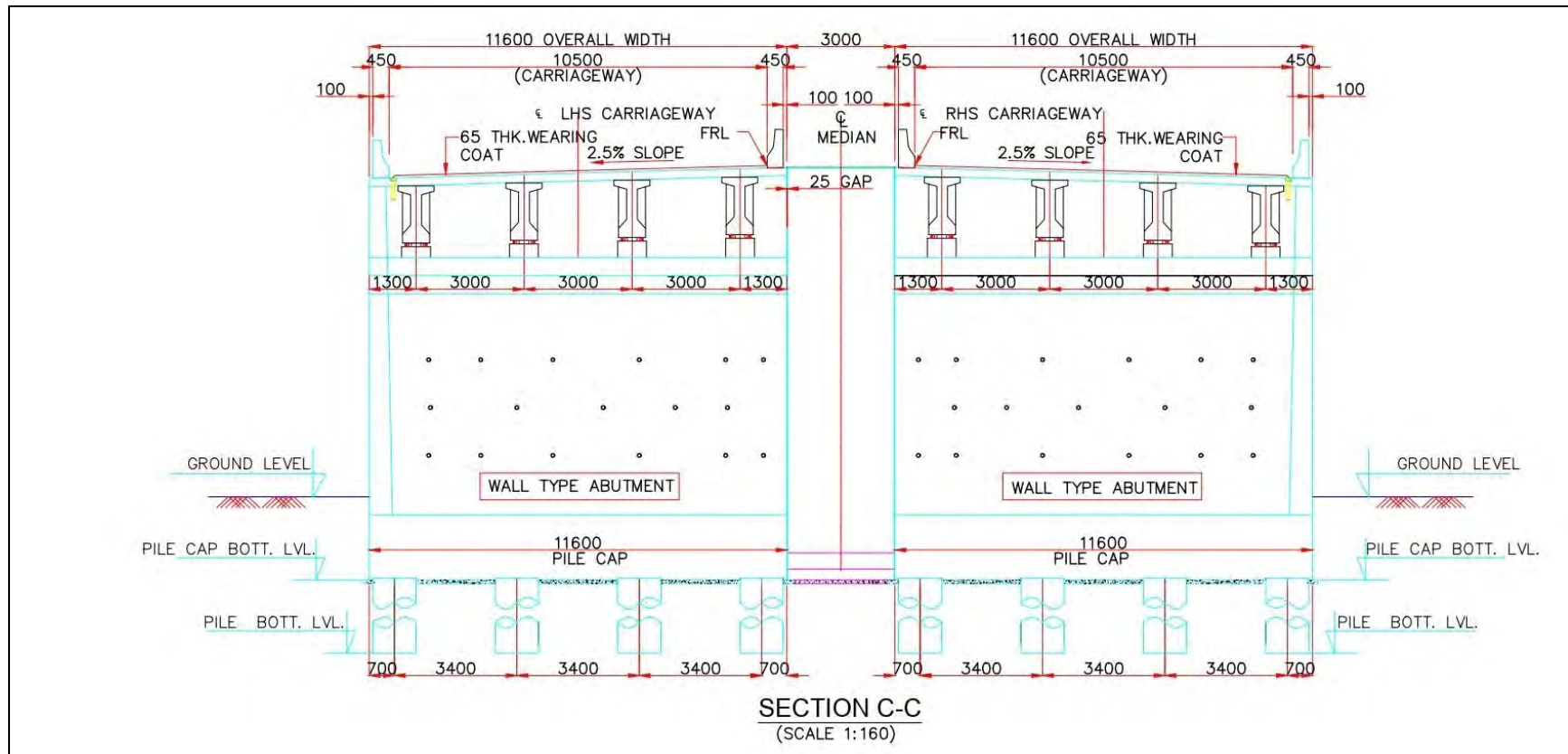
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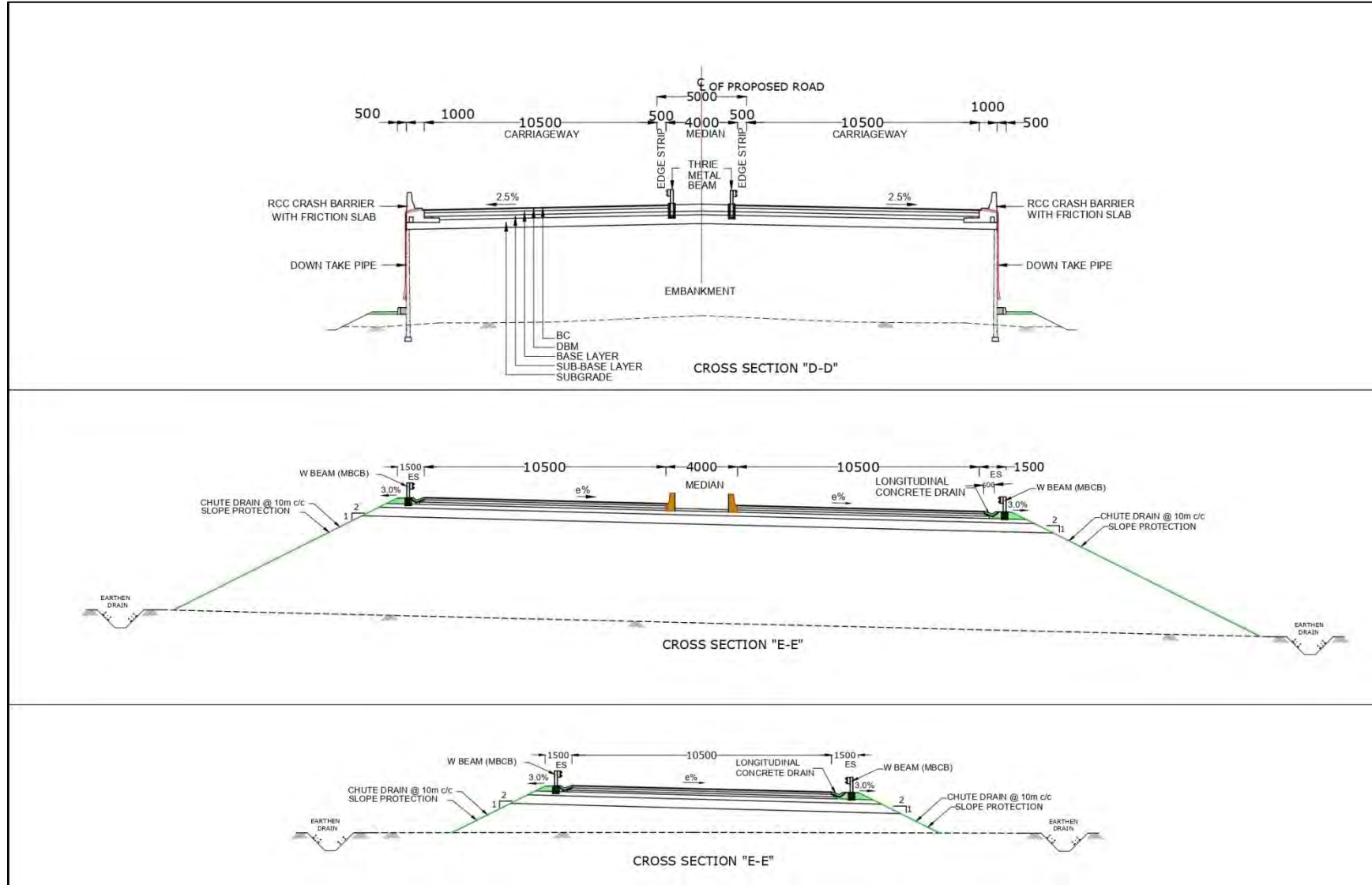
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CHAPTER-2

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 **Balbhadarpur to Bela Nawada of Amas to Darbhanga** Section of NH-119D.

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 **Balbhadarpur to Bela Nawada (Design Ch. 47+000 Km to Design Ch. 89+210 Km)** of Hajipur to Darbhanga 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.

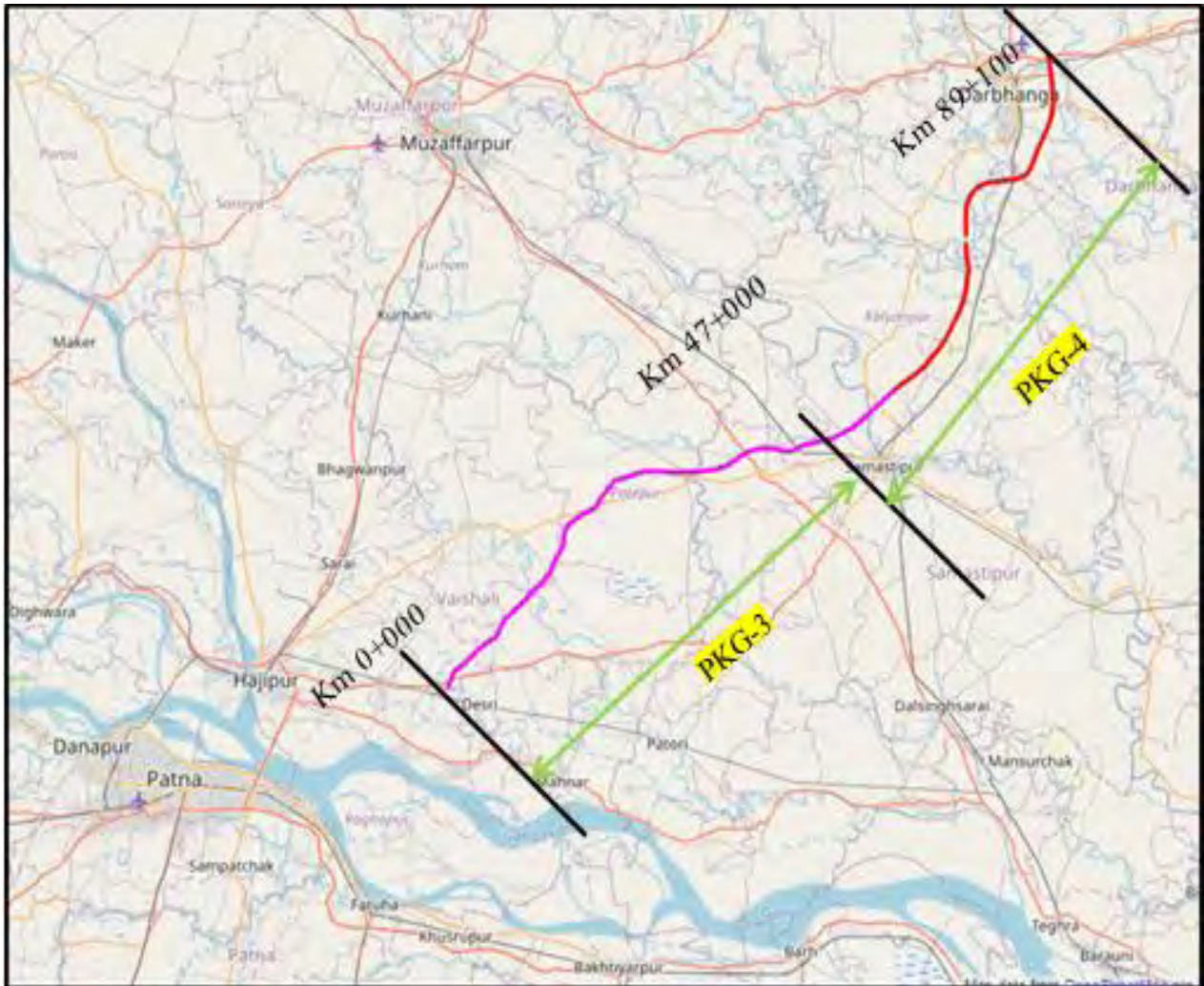
The Project road starts at Design Ch. 47+000 Km at Balbhadarpur to connect Bela Nawada Design Ch. 89+21 0Km. The total length is 42.210Km which shall be constructed as per 4 lane configuration. This is a proposed Green field alignment which will connect from Kalyanpur to Bela Nawada as a freight movement Inter corridor. The key map for the alignment is show below in **Fig.2.1**

PROJECT- Construction of Four lane access controlled Greenfield National Highway (NH-119D), starting from its junction with NH-19 (Old NH-02) near village Amas connecting Ramnagar, Kachhi Dargah, Kalyanpur (Hajipur), Tajpur and terminating at its junction with Nh-27 near village Bela Nawada (Darbhanga) under Bharatmala Pariyojna in the state of Bihar- Package-IV from village Balbhaddarpur (Design Ch. 47+000) to village Bela Nawada (Darbhanga) (Design Ch. 89+210) Total Length – 42.210 Km.



Detailed Project Report.

FIGURE 2.1: PROJECT KEY PLAN



2.2 OVERVIEW OF NHA'S ORGANIZATION AND PROGRAMME.

The National Highways Authority of India (NHA) 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. NHA 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.

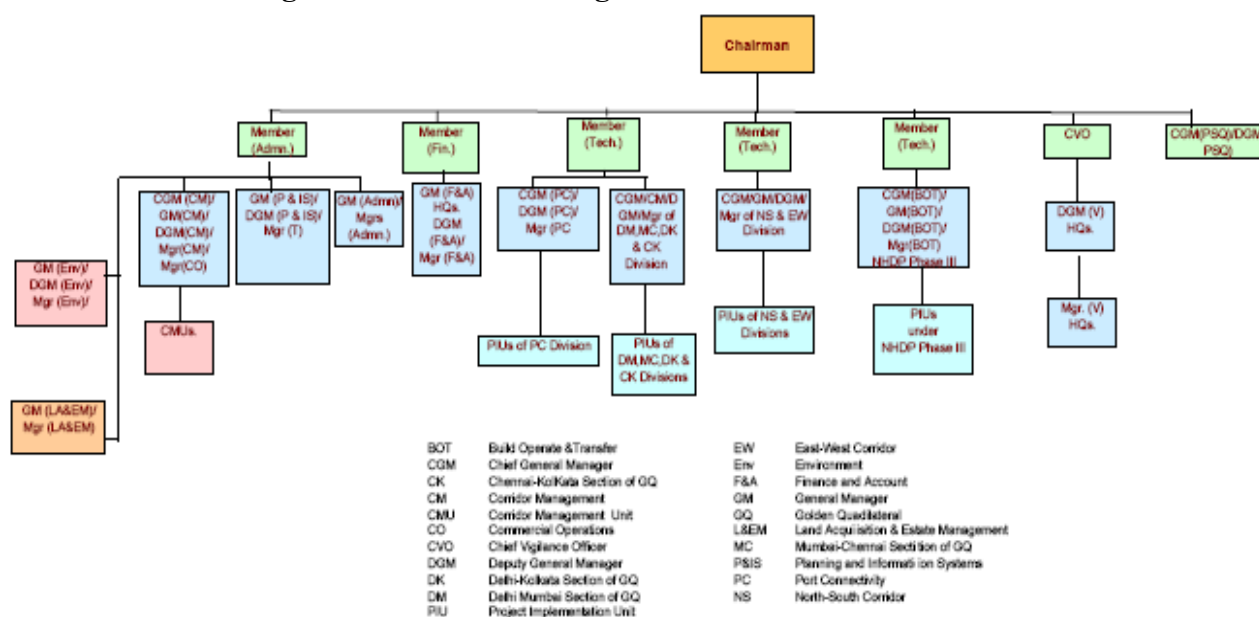
The Authority consists of a full time Chairman, and not more than five full time Members and four part time Members who are appointed by the Central Government. The part time Members are the Secretary (RT&H), Secretary (Expenditure), Secretary (Planning) and DG (RD) & SS. NHA has Technical, Finance, 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 NHA is shown in **Figure 2.2**.

2.3 NHA 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

PROJECT- Construction of Four lane access controlled Greenfield National Highway (NH-119D), starting from its junction with NH-19 (Old NH-02) near village Amas connecting Ramnagar, Kachhi Dargah, Kalyanpur (Hajipur), Tajpur and terminating at its junction with Nh-27 near village Bela Nawada (Darbhanga) under Bharatmala Pariyojna in the state of Bihar- Package-IV from village Balbhadarpur (Design Ch. 47+000) to village Bela Nawada (Darbhanga) (Design Ch. 89+210) Total Length – 42.210 Km.



Detailed Project Report.

- 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

PROJECT- Construction of Four lane access controlled Greenfield National Highway (NH-119D), starting from its junction with NH-19 (Old NH-02) near village Amas connecting Ramnagar, Kachhi Dargah, Kalyanpur (Hajipur), Tajpur and terminating at its junction with Nh-27 near village Bela Nawada (Darbhanga) under Bharatmala Pariyojna in the state of Bihar- Package-IV from village Balbhadarpur (Design Ch. 47+000) to village Bela Nawada (Darbhanga) (Design Ch. 89+210) Total Length – 42.210 Km.



Detailed Project Report.

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**.

PROJECT- Construction of Four lane access controlled Greenfield National Highway (NH-119D), starting from its junction with NH-19 (Old NH-02) near village Amas connecting Ramnagar, Kachhi Dargah, Kalyanpur (Hajipur), Tajpur and terminating at its junction with Nh-27 near village Bela Nawada (Darbhanga) under Bharatmala Pariyojna in the state of Bihar- Package-IV from village Balbhadarpur (Design Ch. 47+000) to village Bela Nawada (Darbhanga) (Design Ch. 89+210) Total Length – 42.210 Km.



Detailed Project Report.



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: -

PROJECT- Construction of Four lane access controlled Greenfield National Highway (NH-119D), starting from its junction with NH-19 (Old NH-02) near village Amas connecting Ramnagar, Kachhi Dargah, Kalyanpur (Hajipur), Tajpur and terminating at its junction with Nh-27 near village Bela Nawada (Darbhanga) under Bharatmala Pariyojna in the state of Bihar- Package-IV from village Balbhadarpur (Design Ch. 47+000) to village Bela Nawada (Darbhanga) (Design Ch. 89+210) Total Length – 42.210 Km.



Detailed Project Report.

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.

Detailed Project Report.

- 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.

PROJECT- Construction of Four lane access controlled Greenfield National Highway (NH-119D), starting from its junction with NH-19 (Old NH-02) near village Amas connecting Ramnagar, Kachhi Dargah, Kalyanpur (Hajipur), Tajpur and terminating at its junction with Nh-27 near village Bela Nawada (Darbhanga) under Bharatmala Pariyojna in the state of Bihar- Package-IV from village Balbhadarpur (Design Ch. 47+000) to village Bela Nawada (Darbhanga) (Design Ch. 89+210) Total Length – 42.210 Km.



Detailed Project Report.

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

PROJECT- Construction of Four lane access controlled Greenfield National Highway (NH-119D), starting from its junction with NH-19 (Old NH-02) near village Amas connecting Ramnagar, Kachhi Dargah, Kalyanpur (Hajipur), Tajpur and terminating at its junction with Nh-27 near village Bela Nawada (Darbhanga) under Bharatmala Pariyojna in the state of Bihar- Package-IV from village Balbhadarpur (Design Ch. 47+000) to village Bela Nawada (Darbhanga) (Design Ch. 89+210) Total Length – 42.210 Km.



Detailed Project Report.

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

Detailed Project Report.

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 NHA and payment to the proof consultant shall be made by NHA 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.

Detailed Project Report.

- 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;

Detailed Project Report.

- 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

PROJECT- Construction of Four lane access controlled Greenfield National Highway (NH-119D), starting from its junction with NH-19 (Old NH-02) near village Amas connecting Ramnagar, Kachhi Dargah, Kalyanpur (Hajipur), Tajpur and terminating at its junction with Nh-27 near village Bela Nawada (Darbhanga) under Bharatmala Pariyojna in the state of Bihar- Package-IV from village Balbhadarapur (Design Ch. 47+000) to village Bela Nawada (Darbhanga) (Design Ch. 89+210) Total Length – 42.210 Km.



Detailed Project Report.

- 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

PROJECT- Construction of Four lane access controlled Greenfield National Highway (NH-119D), starting from its junction with NH-19 (Old NH-02) near village Amas connecting Ramnagar, Kachhi Dargah, Kalyanpur (Hajipur), Tajpur and terminating at its junction with Nh-27 near village Bela Nawada (Darbhanga) under Bharatmala Pariyojna in the state of Bihar- Package-IV from village Balbhadarpur (Design Ch. 47+000) to village Bela Nawada (Darbhanga) (Design Ch. 89+210) Total Length – 42.210 Km.



Detailed Project Report.

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

Project:- Construction of Four lane access controlled Greenfield National Highway (NH-119D), starting from its junction with NH-19 (Old NH-02) near village Amas connecting Ramnagar, Kachhi Dargah, Kalyanpur (Hajipur), Tajpur and terminating at its junction with Nh-27 near village Bela Nawada (Darbhanga) under Bharatmala Pariyojna in the state of Bihar- Package-IV from village Balbhadarpur (Design Ch. 47+000) to village Bela Nawada (Darbhanga) (Design Ch. 89+210) Total Length – 42.210 Km.



Detailed Project Report.

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 Balbhadarpur to Bela Nawada (Design Ch. 47+000 Km from Design Ch. 89+210 Km) **PKG -4** of Amas to Darbhanga Section of NH-119D in the State of Bihar.

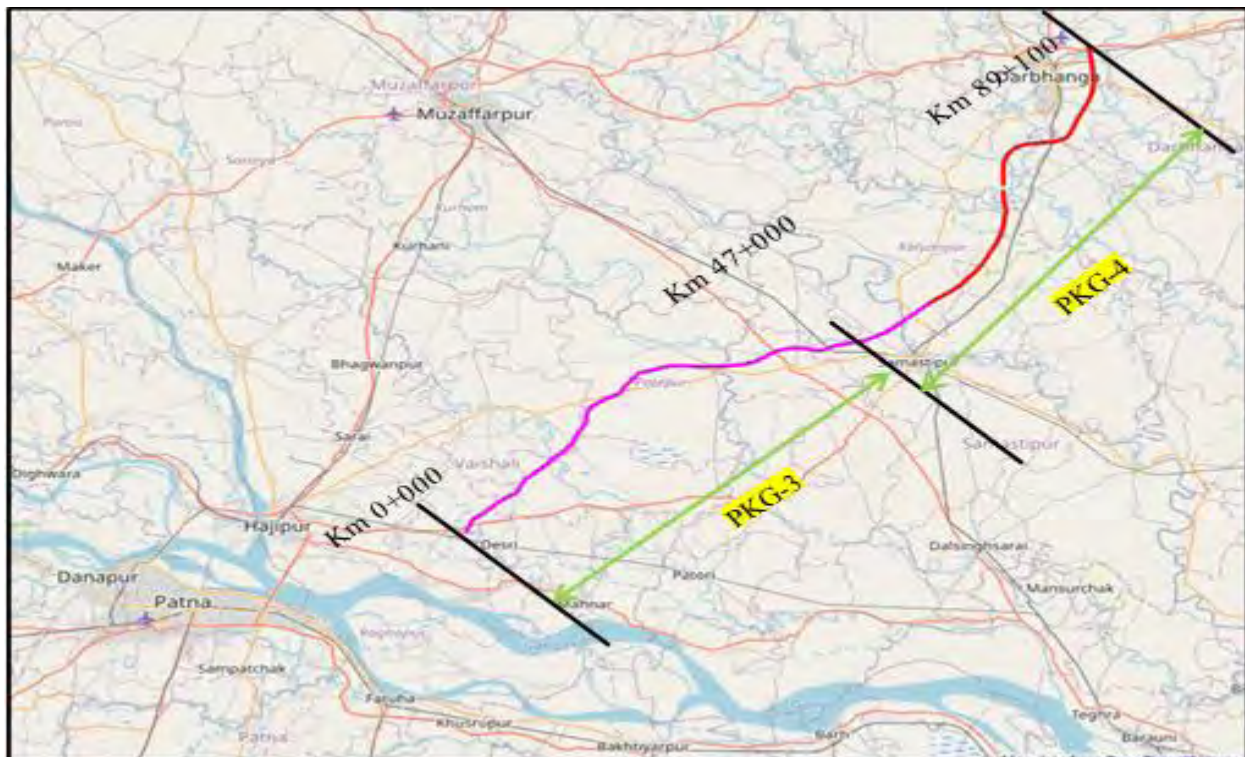


Fig. 3.1 - Key Plan.

Project:- Construction of Four lane access controlled Greenfield National Highway (NH-119D), starting from its junction with NH-19 (Old NH-02) near village Amas connecting Ramnagar, Kachhi Dargah, Kalyanpur (Hajipur), Tajpur and terminating at its junction with Nh-27 near village Bela Nawada (Darbhanga) under Bharatmala Pariyojna in the state of Bihar- Package-IV from village Balbhadarpur (Design Ch. 47+000) to village Bela Nawada (Darbhanga) (Design Ch. 89+210) Total Length – 42.210 Km.



Detailed Project Report.

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 from Balbhadarpur to Bela nawada (Design Ch. 47+000 Km from Design Ch. 89+210 Km) **PKG -4** of Amas to Darbhanga 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 Draft 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,

Project:- Construction of Four lane access controlled Greenfield National Highway (NH-119D), starting from its junction with NH-19 (Old NH-02) near village Amas connecting Ramnagar, Kachhi Dargah, Kalyanpur (Hajipur), Tajpur and terminating at its junction with Nh-27 near village Bela Nawada (Darbhanga) under Bharatmala Pariyojna in the state of Bihar- Package-IV from village Balbhadarpur (Design Ch. 47+000) to village Bela Nawada (Darbhanga) (Design Ch. 89+210) Total Length – 42.210 Km.



Detailed Project Report.

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.

Project:- Construction of Four lane access controlled Greenfield National Highway (NH-119D), starting from its junction with NH-19 (Old NH-02) near village Amas connecting Ramnagar, Kachhi Dargah, Kalyanpur (Hajipur), Tajpur and terminating at its junction with Nh-27 near village Bela Nawada (Darbhanga) under Bharatmala Pariyojna in the state of Bihar- Package-IV from village Balhadarpur (Design Ch. 47+000) to village Bela Nawada (Darbhanga) (Design Ch. 89+210) Total Length – 42.210 Km.



Detailed Project Report.

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 Draft Feasibility Report (Stage 2)

The Draft 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 Draft 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

Project:- Construction of Four lane access controlled Greenfield National Highway (NH-119D), starting from its junction with NH-19 (Old NH-02) near village Amas connecting Ramnagar, Kachhi Dargah, Kalyanpur (Hajipur), Tajpur and terminating at its junction with Nh-27 near village Bela Nawada (Darbhanga) under Bharatmala Pariyojna in the state of Bihar- Package-IV from village Balbhadarapur (Design Ch. 47+000) to village Bela Nawada (Darbhanga) (Design Ch. 89+210) Total Length – 42.210 Km.



Detailed Project Report.

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 (NHA) 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. NHA 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 Kalyanpur to Balbhadarapur(Design Ch. 0+000 Km to Design Ch. 47+000Km) of Hajipur to Darbhanga Section in the State of Bihar.

The starting point of this project is near “Balbhadarapur” located at the NH-19 from Design Ch. 47+000 Km. The coordinates of the starting point is **25.888289°N, 85.750183°E.**

The ending point of this project is near “Bela Nawada” at Design Ch. 89+210 Km which is divided as half of the project length. The coordinates of the ending point is **26.186044° N, 85.937056° E.**

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 Kalyanpur to Bela Nawada 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 Rigid Pavement type confirming to IRC: 58. Flexible pavement shall be constructed in the section(s) for Service road only. The configuration of the carriageway shall confirm to IRC: SP: 84:2019 and the Structures shall be constructed as 4 lane configurations.

3.9. Built up Areas and Settlements

Project:- Construction of Four lane access controlled Greenfield National Highway (NH-119D), starting from its junction with NH-19 (Old NH-02) near village Amas connecting Ramnagar, Kachhi Dargah, Kalyanpur (Hajipur), Tajpur and terminating at its junction with Nh-27 near village Bela Nawada (Darbhanga) under Bharatmala Pariyojna in the state of Bihar- Package-IV from village Balbhaddarpur (Design Ch. 47+000) to village Bela Nawada (Darbhanga) (Design Ch. 89+210) Total Length – 42.210 Km.



Detailed Project Report.

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	Balbhaddarpur	10	Manihas
2	Mathura Mandal	11	Bela Yakub
3	Harpur, Silaut	12	Mausimpur
4	Chal Rukum	13	Bela Nevada
5	Manjil	14	Simaria Bhindi
6	Mobarak	15	KoilaKund
7	Kharsand	16	Kolwara,Bihari
8	Mukund	17	Usma
9	Mirzapur	18	Asgaon

3.10. ROW Details

The project stretch is completely new proposed Green Field Alignment which will Connect Bela Nawada on East West Expressway from Kalyanpur on NH-322. The ROW for this corridor is considered to **60 m** throughout except the locations of Project Facilities.

3.11. TCS Details

There are 5 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. 47+000 Km. to Design Ch. 89+210 Km.

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Detailed Project Report.

Table 3.2: TCS Schedule

S. No	Design CH.		DESCRIPTION	TCS TYPE	LENGTH (m)
	FROM	TO			
1	47+000	48+400	Typical Cross Section for 4-lane Divided Highway without Service Road (in Embankment)	TCS-I	1400
2	48+400	48+490	4- lane Divided Highway with RE Wall on both sides	TCS- III	90
3	48+490	48+634	4-lane Divided Highway with both sided RE Wall & one sided Service Road	TCS- II C	144
4	48+634	48+654	Typical Cross Section For Grade separated structures VUP and Elevated sections 4- lane Divided highway	TCS- IV	20
5	48+654	48+916	4- lane Divided Highway with RE Wall on both sides	TCS- III	262
6	48+916	49+873	Typical Cross Section For Grade separated structures VUP and Elevated sections 4- lane Divided highway	TCS- IV	957
7	49+873	50+100	4- lane Divided Highway with RE Wall on both sides	TCS- III	227
8	50+100	50+562	4 -Lane Divided Highway with Slip Road and RE wall on both sides	TCS- II	462
9	50+562	50+652	Typical Cross Section For Grade separated structures VUP and Elevated sections 4- lane Divided highway	TCS- IV	90
10	50+652	51+020	4 -Lane Divided Highway with Slip Road and RE wall on both sides	TCS- II	368
11	51+020	51+712	Typical Cross Section for 4-lane Divided Highway without Service Road (in Embankment)	TCS-I	692
12	51+712	51+724	Typical Cross Section For Grade separated structures VUP and Elevated sections 4- lane Divided highway	TCS- IV	12
13	51+724	52+159	Typical Cross Section for 4-lane Divided Highway without Service Road (in Embankment)	TCS-I	435
14	52+159	52+171	Typical Cross Section For Grade separated structures VUP and Elevated sections 4- lane Divided highway	TCS- IV	12
15	52+171	53+046	Typical Cross Section for 4-lane Divided Highway without Service Road (in Embankment)	TCS-I	875

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Detailed Project Report.

S. No	Design CH.		DESCRIPTION	TCS TYPE	LENGTH (m)
	FROM	TO			
16	53+046	53+053	Typical Cross Section For Grade separated structures VUP and Elevated sections 4- lane Divided highway	TCS- IV	7
17	53+053	53+320	Typical Cross Section for 4-lane Divided Highway without Service Road (in Embankment)	TCS-I	267
18	53+320	53+582	4- lane Divided Highway with RE Wall on both sides	TCS- III	262
19	53+582	53+602	Typical Cross Section For Grade separated structures VUP and Elevated sections 4- lane Divided highway	TCS- IV	20
20	53+602	53+860	4- lane Divided Highway with RE Wall on both sides	TCS- III	258
21	53+860	54+207	Typical Cross Section for 4-lane Divided Highway without Service Road (in Embankment)	TCS-I	347
22	54+207	54+214	Typical Cross Section For Grade separated structures VUP and Elevated sections 4- lane Divided highway	TCS- IV	7
23	54+214	54+794	Typical Cross Section for 4-lane Divided Highway without Service Road (in Embankment)	TCS-I	580
24	54+794	54+806	Typical Cross Section For Grade separated structures VUP and Elevated sections 4- lane Divided highway	TCS- IV	12
25	54+806	55+290	Typical Cross Section for 4-lane Divided Highway without Service Road (in Embankment)	TCS-I	484
26	55+290	55+310	Typical Cross Section of Bridge at Deck Level - with Footpath 4-lane Divided Highway	TCS- V	20
27	55+310	55+510	Typical Cross Section for 4-lane Divided Highway without Service Road (in Embankment)	TCS-I	200
28	55+510	55+640	4-lane Divided Highway with both sided RE Wall & one sided Service Road	TCS- IIC	130
29	55+640	55+780	4- lane Divided Highway with Service Road and RE wall on both sides	TCS- II A	140
30	55+780	55+800	Typical Cross Section For Grade separated structures VUP and Elevated sections 4- lane Divided highway	TCS- IV	20
31	55+800	56+740	4- lane Divided Highway with RE Wall on both sides	TCS- III	940

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Detailed Project Report.

S. No	Design CH.		DESCRIPTION	TCS TYPE	LENGTH (m)
	FROM	TO			
32	56+740	56+770	4-lane Divided Highway with both sided RE Wall & one sided Service Road	TCS- IIC	30
33	56+770	56+790	Typical Cross Section For Grade separated structures VUP and Elevated sections 4- lane Divided highway	TCS- IV	20
34	56+790	56+850	4-lane Divided Highway with both sided RE Wall & one sided Service Road	TCS- IIC	60
35	56+850	57+020	4- lane Divided Highway with RE Wall on both sides	TCS- III	170
36	57+020	57+789	Typical Cross Section for 4-lane Divided Highway without Service Road (in Embankment)	TCS-I	769
37	57+789	57+801	Typical Cross Section For Grade separated structures VUP and Elevated sections 4- lane Divided highway	TCS- IV	12
38	57+801	59+081	Typical Cross Section for 4-lane Divided Highway without Service Road (in Embankment)	TCS-I	1280
39	59+081	59+101	Typical Cross Section of Bridge at Deck Level - with Footpath 4-lane Divided Highway	TCS- V	20
40	59+101	59+624	Typical Cross Section for 4-lane Divided Highway without Service Road (in Embankment)	TCS-I	523
41	59+624	59+636	Typical Cross Section For Grade separated structures VUP and Elevated sections 4- lane Divided highway	TCS- IV	12
42	59+636	60+003	Typical Cross Section for 4-lane Divided Highway without Service Road (in Embankment)	TCS-I	367
43	60+003	60+010	Typical Cross Section For Grade separated structures VUP and Elevated sections 4- lane Divided highway	TCS- IV	7
44	60+010	60+304	Typical Cross Section for 4-lane Divided Highway without Service Road (in Embankment)	TCS-I	294
45	60+304	60+316	Typical Cross Section For Grade separated structures VUP and Elevated sections 4- lane Divided highway	TCS- IV	12
46	60+316	61+093	Typical Cross Section for 4-lane Divided Highway without Service Road (in Embankment)	TCS-I	777
47	61+093	61+100	Typical Cross Section For Grade separated structures VUP and Elevated sections 4- lane Divided highway	TCS- IV	7

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Detailed Project Report.

S. No	Design CH.		DESCRIPTION	TCS TYPE	LENGTH (m)
	FROM	TO			
48	61+100	61+410	4- lane Divided Highway with RE Wall on both sides	TCS- III	310
49	61+410	61+430	Typical Cross Section For Grade separated structures VUP and Elevated sections 4- lane Divided highway	TCS- IV	20
50	61+430	61+640	4- lane Divided Highway with Service Road and RE wall on both sides	TCS- II A	210
51	61+640	61+740	4- lane Divided Highway with RE Wall on both sides	TCS- III	100
52	61+740	62+704	Typical Cross Section for 4-lane Divided Highway without Service Road (in Embankment)	TCS-I	964
53	62+704	62+711	Typical Cross Section For Grade separated structures VUP and Elevated sections 4- lane Divided highway	TCS- IV	7
54	62+711	63+424	Typical Cross Section for 4-lane Divided Highway without Service Road (in Embankment)	TCS-I	713
55	63+424	63+490	Typical Cross Section of Bridge at Deck Level - with Footpath 4-lane Divided Highway	TCS- V	66
56	63+490	64+246	Typical Cross Section for 4-lane Divided Highway without Service Road (in Embankment)	TCS-I	756
57	64+246	64+253	Typical Cross Section For Grade separated structures VUP and Elevated sections 4- lane Divided highway	TCS- IV	7
58	64+253	65+140	Typical Cross Section For 4 lane divided Carriageway without service road	TCS-I	887
59	65+140	65+295	4- lane Divided Highway with RE Wall on both sides	TCS- III	155
60	65+295	65+325	Typical Cross Section For Grade separated structures VUP and Elevated sections 4- lane Divided highway	TCS- IV	30
61	65+325	65+600	4 -Lane Divided Highway with Slip Road and RE wall on both sides and one side Service road	TCS- II D	275
62	65+600	65+740	4 -Lane Divided Highway with merging of Slip Roads/Ramps on both sides and one side Service road	TCS- II E	140
63	65+740	65+810	4 -Lane Divided Highway with merging of Slip Roads/Ramps on both sides and both side Service road	TCS- II F	70

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Detailed Project Report.

S. No	Design CH.		DESCRIPTION	TCS TYPE	LENGTH (m)
	FROM	TO			
64	65+810	65+960	4 -Lane Divided Highway with Slip Road, Service road and RE wall on both sides	TCS- II B	150
65	65+960	66+109	4 -Lane Divided Highway with Slip Road and RE wall on both sides	TCS- II	149
66	66+109	66+349	Typical Cross Section For Grade separated structures VUP and Elevated sections 4- lane Divided highway	TCS- IV	240
67	66+349	66+712	Typical Cross Section of Bridge at Deck Level - with Footpath 4-lane Divided Highway	TCS- V	363
68	66+712	66+900	4- lane Divided Highway(in Embankment Height more than 6m Restricted by Retaining wall	TCS- IIIA	188
69	66+900	67+545	Typical Cross Section for 4-lane Divided Highway without Service Road (in Embankment)	TCS-I	645
70	67+545	67+575	Typical Cross Section of Bridge at Deck Level - with Footpath 4-lane Divided Highway	TCS- V	30
71	67+575	67+689	Typical Cross Section for 4-lane Divided Highway without Service Road (in Embankment)	TCS-I	114
72	67+689	67+701	Typical Cross Section For Grade separated structures VUP and Elevated sections 4- lane Divided highway	TCS- IV	12
73	67+701	67+910	Typical Cross Section for 4-lane Divided Highway without Service Road (in Embankment)	TCS-I	209
74	67+910	67+970	Typical Cross Section of Bridge at Deck Level - with Footpath 4-lane Divided Highway	TCS- V	60
75	67+970	69+080	Typical Cross Section for 4-lane Divided Highway without Service Road (in Embankment)	TCS-I	1110
76	69+080	69+087	Typical Cross Section For Grade separated structures VUP and Elevated sections 4- lane Divided highway	TCS- IV	7
77	69+087	69+460	Typical Cross Section for 4-lane Divided Highway without Service Road (in Embankment)	TCS-I	373
78	69+460	69+759	4- lane Divided Highway(in Embankment Height more than 6m Restricted by Retaining wall	TCS- IIIA	299
79	69+759	69+771	Typical Cross Section For Grade separated structures VUP and Elevated sections 4- lane Divided highway	TCS- IV	12

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Detailed Project Report.

S. No	Design CH.		DESCRIPTION	TCS TYPE	LENGTH (m)
	FROM	TO			
80	69+771	69+935	4- lane Divided Highway(in Embankment Height more than 6m Restricted by Retaining wall	TCS- IIIA	164
81	69+935	70+025	Typical Cross Section of Bridge at Deck Level - with Footpath 4-lane Divided Highway	TCS- V	90
82	70+025	70+634	Typical Cross Section for 4-lane Divided Highway without Service Road (in Embankment)	TCS-I	609
83	70+634	70+646	Typical Cross Section For Grade separated structures VUP and Elevated sections 4- lane Divided highway	TCS- IV	12
84	70+646	70+910	Typical Cross Section for 4-lane Divided Highway without Service Road (in Embankment)	TCS-I	264
85	70+910	70+970	Typical Cross Section of Bridge at Deck Level - with Footpath 4-lane Divided Highway	TCS- V	60
86	70+970	71+855	Typical Cross Section for 4-lane Divided Highway without Service Road (in Embankment)	TCS-I	885
87	71+855	72+005	Typical Cross Section of Bridge at Deck Level - with Footpath 4-lane Divided Highway	TCS- V	150
88	72+005	72+371	Typical Cross Section for 4-lane Divided Highway without Service Road (in Embankment)	TCS-I	366
89	72+371	72+401	Typical Cross Section of Bridge at Deck Level - with Footpath 4-lane Divided Highway	TCS- V	30
90	72+401	72+695	Typical Cross Section for 4-lane Divided Highway without Service Road (in Embankment)	TCS-I	294
91	72+695	72+755	Typical Cross Section of Bridge at Deck Level - with Footpath 4-lane Divided Highway	TCS- V	60
92	72+755	73+066	Typical Cross Section for 4-lane Divided Highway without Service Road (in Embankment)	TCS-I	311
93	73+066	73+078	Typical Cross Section For Grade separated structures VUP and Elevated sections 4- lane Divided highway	TCS- IV	12
94	73+078	73+470	Typical Cross Section for 4-lane Divided Highway without Service Road (in Embankment)	TCS-I	392
95	73+470	73+530	Typical Cross Section of Bridge at Deck Level - with Footpath 4-lane Divided Highway	TCS- V	60

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Detailed Project Report.

S. No	Design CH.		DESCRIPTION	TCS TYPE	LENGTH (m)
	FROM	TO			
96	73+530	73+955	Typical Cross Section for 4-lane Divided Highway without Service Road (in Embankment)	TCS-I	425
97	73+955	74+045	Typical Cross Section of Bridge at Deck Level - with Footpath 4-lane Divided Highway	TCS- V	90
98	74+045	74+520	Typical Cross Section for 4-lane Divided Highway without Service Road (in Embankment)	TCS-I	475
99	74+520	74+616	4- lane Divided Highway(in Embankment Height more than 6m Restricted by Retaining wall	TCS- IIIA	96
100	74+616	74+628	Typical Cross Section For Grade separated structures VUP and Elevated sections 4- lane Divided highway	TCS- IV	12
101	74+628	74+760	4- lane Divided Highway(in Embankment Height more than 6m Restricted by Retaining wall	TCS- IIIA	132
102	74+760	74+924	Typical Cross Section for 4-lane Divided Highway without Service Road (in Embankment)	TCS-I	164
103	74+924	74+931	Typical Cross Section For Grade separated structures VUP and Elevated sections 4- lane Divided highway	TCS- IV	7
104	74+931	75+494	Typical Cross Section for 4-lane Divided Highway without Service Road (in Embankment)	TCS-I	563
105	75+494	75+794	Typical Cross Section of Bridge at Deck Level - with Footpath 4-lane Divided Highway	TCS- V	300
106	75+794	75+940	4- lane Divided Highway(in Embankment Height more than 6m Restricted by Retaining wall	TCS- IIIA	146
107	75+940	76+094	4- lane Divided Highway with Service Road and RE wall on both sides	TCS- II A	154
108	76+094	76+106	Typical Cross Section For Grade separated structures VUP and Elevated sections 4- Divided highway	TCS- IV	012
109	76+106	76+440	Typical Cross Section for 4-lane Divided Highway without Service Road (in Embankment)	TCS-I	334
110	76+440	76+859	4- lane Divided Highway(in Embankment Height more than 6m Restricted by Retaining wall	TCS- IIIA	419
111	76+859	76+931	ROB	As per GAD	72

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Detailed Project Report.

S. No	Design CH.		DESCRIPTION	TCS TYPE	LENGTH (m)
	FROM	TO			
112	76+931	77+000	4- lane Divided Highway(in Embankment Height more than 6m Restricted by Retaining wall	TCS- IIIA	69
113	77+000	77+020	Typical Cross Section For Grade separated structures VUP and Elevated sections 4- lane Divided highway	TCS- IV	20
114	77+020	77+300	4- lane Divided Highway(in Embankment Height more than 6m Restricted by Retaining wall	TCS- IIIA	280
115	77+300	77+720	4 -Lane Divided Highway with Slip Road and RE wall on both sides	TCS- II	420
116	77+720	77+810	Typical Cross Section For Grade separated structures VUP and Elevated sections 4- lane Divided highway	TCS- IV	90
117	77+810	78+140	4 -Lane Divided Highway with Slip Road and RE wall on both sides	TCS- II	330
118	78+140	78+194	Typical Cross Section for 4-lane Divided Highway without Service Road (in Embankment)	TCS-I	54
119	78+194	78+206	Typical Cross Section For Grade separated structures VUP and Elevated sections 4- lane Divided highway	TCS- IV	12
120	78+206	79+249	Typical Cross Section for 4-lane Divided Highway without Service Road (in Embankment)	TCS-I	1043
121	79+249	79+261	Typical Cross Section For Grade separated structures VUP and Elevated sections 4- lane Divided highway	TCS- IV	12
122	79+261	79+827	Typical Cross Section for 4-lane Divided Highway without Service Road (in Embankment)	TCS-I	566
123	79+827	79+834	Typical Cross Section For Grade separated structures VUP and Elevated sections 4- lane Divided highway	TCS- IV	7
124	79+834	80+100	Typical Cross Section for 4-lane Divided Highway without Service Road (in Embankment)	TCS-I	266
125	80+100	80+256	Typical Cross Section for 4-lane Divided Highway with one side RE Wall & Service Road and other side Retaining wall	TCS- II G	156
126	80+256	80+276	Typical Cross Section For Grade separated structures VUP and Elevated sections 4- lane Divided highway	TCS- IV	20

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Detailed Project Report.

S. No	Design CH.		DESCRIPTION	TCS TYPE	LENGTH (m)
	FROM	TO			
127	80+276	80+560	4- lane Divided Highway(in Embankment Height more than 6m Restricted by Retaining wall	TCS- IIIA	284
128	80+560	81+156	Typical Cross Section for 4-lane Divided Highway without Service Road (in Embankment)	TCS-I	596
129	81+156	81+168	Typical Cross Section For Grade separated structures VUP and Elevated sections 4- lane Divided highway	TCS- IV	12
130	81+168	81+734	Typical Cross Section for 4-lane Divided Highway without Service Road (in Embankment)	TCS-I	566
131	81+734	81+746	Typical Cross Section For Grade separated structures VUP and Elevated sections 4- lane Divided highway	TCS- IV	12
132	81+746	81+840	Typical Cross Section for 4-lane Divided Highway with one side RE Wall & Service Road	TCS- IA	94
133	81+840	81+942	Typical Cross Section for 4-lane Divided Highway without Service Road (in Embankment)	TCS-I	102
134	81+942	81+958	Typical Cross Section of Bridge at Deck Level - with Footpath 4-lane Divided Highway	TCS- V	16
135	81+958	82+386	Typical Cross Section for 4-lane Divided Highway without Service Road (in Embankment)	TCS-I	428
136	82+386	82+393	Typical Cross Section For Grade separated structures VUP and Elevated sections 4- lane Divided highway	TCS- IV	7
137	82+393	82+934	Typical Cross Section for 4-lane Divided Highway without Service Road (in Embankment)	TCS-I	541
138	82+934	82+946	Typical Cross Section For Grade separated structures VUP and Elevated sections 4- lane Divided highway	TCS- IV	12
139	82+946	83+636	Typical Cross Section for 4-lane Divided Highway without Service Road (in Embankment)	TCS-I	690
140	83+636	83+643	Typical Cross Section For Grade separated structures VUP and Elevated sections 4- lane Divided highway	TCS- IV	7
141	83+643	84+159	Typical Cross Section for 4-lane Divided Highway without Service Road (in Embankment)	TCS-I	516

Project:- Construction of Four lane access controlled Greenfield National Highway (NH-119D), starting from its junction with NH-19 (Old NH-02) near village Amas connecting Ramnagar, Kachhi Dargah, Kalyanpur (Hajipur), Tajpur and terminating at its junction with Nh-27 near village Bela Nawada (Darbhanga) under Bharatmala Pariyojna in the state of Bihar- Package-IV from village Balhadarpur (Design Ch. 47+000) to village Bela Nawada (Darbhanga) (Design Ch. 89+210) Total Length – 42.210 Km.



Detailed Project Report.

S. No	Design CH.		DESCRIPTION	TCS TYPE	LENGTH (m)
	FROM	TO			
142	84+159	84+171	Typical Cross Section For Grade separated structures VUP and Elevated sections 4- lane Divided highway	TCS- IV	12
143	84+171	84+320	Typical Cross Section for 4-lane Divided Highway without Service Road (in Embankment)	TCS-I	149
144	84+320	84+730	4 -Lane Divided Highway with Slip Road and RE wall on both sides	TCS- II	410
145	84+730	84+820	Typical Cross Section For Grade separated structures VUP and Elevated sections 4- lane Divided highway	TCS- IV	90
146	84+820	85+340	4 -Lane Divided Highway with Slip Road and RE wall on both sides	TCS- II	520
147	85+340	85+641	Typical Cross Section for 4-lane Divided Highway without Service Road (in Embankment)	TCS-I	301
148	85+641	85+659	Typical Cross Section of Bridge at Deck Level - with Footpath 4-lane Divided Highway	TCS- V	18
149	85+659	86+660	Typical Cross Section for 4-lane Divided Highway without Service Road (in Embankment)	TCS-I	1001
150	86+660	86+798	4- lane Divided Highway(in Embankment Height more than 6m Restricted by Retaining wall	TCS- IIIA	138
151	86+798	86+918	Typical Cross Section of Bridge at Deck Level - with Footpath 4-lane Divided Highway	TCS- V	120
152	86+918	87+073	4- lane Divided Highway(in Embankment Height more than 6m Restricted by Retaining wall	TCS- IIIA	155
153	87+073	87+127	Typical Cross Section of Bridge at Deck Level - with Footpath 4-lane Divided Highway	TCS- V	54
154	87+127	87+582	4- lane Divided Highway(in Embankment Height more than 6m Restricted by Retaining wall	TCS- IIIA	455
153	87+582	87+602	Typical Cross Section For Grade separated structures VUP and Elevated sections 4- lane Divided highway	TCS- IV	20
154	87+602	88+635	4- lane Divided Highway(in Embankment Height more than 6m Restricted by Retaining wall	TCS- IIIA	1033
155	88+635	88+725	ROB	As per GAD	90

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Detailed Project Report.

S. No	Design CH.		DESCRIPTION	TCS TYPE	LENGTH (m)
	FROM	TO			
156	88+725	88+780	Typical Cross Section For Grade separated structures VUP and Elevated sections 4- lane Divided highway	TCS- IV	55
157	88+780	89+210	INTERCHANGE	As per TCS of Interchange location	430

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	08
2	Major Bridge Cum underpass	0
3	Minor Bridges	11
4	Vehicular Under Pass	8
5	Light Vehicular Under Pass	18
6	Small Vehicular Under Pass	11
7	Fly-Over including interchanging	5
8	Overpass	0
9	ROB	02
10	Culverts	89
11	Flyover Cum Viaduct	1

3.12.1 Major Bridges

There are 8 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**.

Project:- Construction of Four lane access controlled Greenfield National Highway (NH-119D), starting from its junction with NH-19 (Old NH-02) near village Amas connecting Ramnagar, Kachhi Dargah, Kalyanpur (Hajipur), Tajpur and terminating at its junction with Nh-27 near village Bela Nawada (Darbhanga) under Bharatmala Pariyojna in the state of Bihar- Package-IV from village Balbhadarpur (Design Ch. 47+000) to village Bela Nawada (Darbhanga) (Design Ch. 89+210) Total Length – 42.210 Km.



Detailed Project Report.

Table 3.4: Details of Major Bridge.
MAJOR BRIDGE (OVER RIVERS/STREAMS/ NALLAS)

Sl. No.	Chainage (Km)	Span Arrangement c/c Expansion joint in Square direction (m)	Skew angle	Structure Type	Deck Configuration (m)	Width of Open Median (m)
1	49+395	29x33m	0	PSC I GIRDER	2x13.5	3
2	63+460	2x33m	0	PSC I GIRDER	2x13.5	3
3	66+530	11x33m	0	PSC I GIRDER	2x13.5	3
4	69+980	3x30m	0	PSC I GIRDER	2x13.5	3
5	71+930	5x30	0	PSC I GIRDER	2x13.5	3
6	74+000	3x30m	0	PSC I GIRDER	2x13.5	3
7	75+644	5x30	0	PSC I GIRDER	2x13.5	3
8	86+858	4x30m	0	PSC I GIRDER	2x13.5	3

MAJOR BRIDGE CUM UNDERPASS

Sl. No.	Chainage (in Km)	Span Arrangement c/c Expansion joint in Square direction (m)	Type of Structure	Deck Configuration (m)	Width of Open Median (m)	Minimum vertical clearance from Cross road (m)
NIL						

3.12.2 Minor Bridges

There are 11 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.
Minor Bridges (OVER RIVERS, STREAMS, NALLAS)

Sl. No.	Chainage (Km)	Span Arrangement c/c Expansion joint in Square direction (m)	Skew Angle	Type of Structure	Deck Configuration (m)	Width of Open Median (m)
1	55+300	1x20	17	PSC I Girder	2x13.5	3
2	59+091	1x20	0	PSC I Girder	2x13.5	3
3	67+360	1x30	0	PSC I Girder	2x13.5	3
4	67+940	2x30	0	PSC I Girder	2x13.5	3
5	70+940	2x30	0	PSC I Girder	2x13.5	3
6	72+386	1x30	0	PSC I Girder	2x13.5	3
7	72+725	2x30	0	PSC I Girder	2x13.5	3
8	73+500	2x30	0	PSC I Girder	2x13.5	3
9	81+950	2x8	31	RCC BOX	2x13.5	3
10	85+650	1x18	0	PSC I Girder	2x13.5	3
11	87+100	3x18	0	PSC I Girder	2x13.5	3

MINOR BRIDGE CUM UNDERPASS

Sl. No.	Chainage (Km)	Span Arrangement c/c Expansion joint in Square direction (m)	Type of Structure	Deck Configuration (m)	Width of Open Median (m)	Minimum vertical clearance from Cross road (m)
NIL						

3.12.3 Vehicular Under Pass

There are 11 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.	Chainage (km)	Type of Crossing	Type of Structure	Clear Span in square direction (m)	Skew angle	Deck Configuration (m)	Width of Open Median (m)
1	48+644	MDR	PSC I GIRDER	1x20	30	2x11.6	3
2	53+592	MDR	PSC I GIRDER	1x20	22	2x11.6	3
3	55+790	MDR/Village Road	PSC I GIRDER	1x20	0	2x11.6	3
4	56+800	MDR	PSC I GIRDER	1x20	0	2x11.6	3
5	61+420	MDR	PSC I GIRDER	1x20	0	2x11.6	3
6	77+010	Village Road	PSC I GIRDER	1x20	35	2x11.6	3
7	80+266	Village Road	PSC I GIRDER	1x20	0	2x11.6	3
8	87+592	MDR	PSC I GIRDER	1x20	0	2x11.6	3

3.12.4 Light Vehicular Under Pass

There are 18 numbers of LVUP proposed across the Village/ODR roads to facilitate the movement of the users. The details of the LVUP are summarized below in **Table 3.8**.

Table 3.8: Details of LVUP

S. No.	Chainage (km)	Type of Crossing	Type of Structure	Clear Opening in square direction (m)	Skew angle	Deck Configuration (m)	Width of Open Median (m)
1	51+718	village road	RCC BOX	1X12	30	2x11.6	3
2	52+165	local connectivity Road	RCC BOX	1X12	28	2x11.6	3
3	54+800	local connectivity Road	RCC BOX	1X12	30	2x11.6	3
4	57+795	local connectivity Road	RCC BOX	1X12	21	2x11.6	3
5	59+630	local connectivity Road	RCC BOX	1X12	30	2x11.6	3
6	60+310	local connectivity Road	RCC BOX	1X12	28	2x11.6	3
7	67+695	local connectivity Road	RCC BOX	1X12	30	2x11.6	3
8	69+765	local	RCC BOX		30	2x11.6	3

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Detailed Project Report.

S. No	Chainage (km)	Type of Crossing	Type of Structure	Clear Opening in square direction (m)	Skew angle	Deck Configuration (m)	Width of Open Median (m)
		connectivity Road		1X12			
9	70+640	local connectivity Road	RCC BOX	1X12	0	2x11.6	3
10	73+072	local connectivity Road	RCC BOX	1X12	30	2x11.6	3
11	74+621	local connectivity Road	RCC BOX	1X12	0	2x11.6	3
12	76+100	local connectivity Road	RCC BOX	1X12	0	2x11.6	3
13	78+200	local connectivity Road	RCC BOX	1X12	25	2x11.6	3
14	79+255	local connectivity Road	RCC BOX	1X12	21	2x11.6	3
15	81+162	local connectivity Road	RCC BOX	1X12	19	2x11.6	3
16	81+740	local connectivity Road	RCC BOX	1X12	0	2x11.6	3
17	82+940	local connectivity Road	RCC BOX	1X12	0	2x11.6	3
18	84+165	local connectivity Road	RCC BOX	1X12	0	2x11.6	3

3.12.5 Small Vehicular Under Pass

There are 11 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**.

Project:- Construction of Four lane access controlled Greenfield National Highway (NH-119D), starting from its junction with NH-19 (Old NH-02) near village Amas connecting Ramnagar, Kachhi Dargah, Kalyanpur (Hajipur), Tajpur and terminating at its junction with Nh-27 near village Bela Nawada (Darbhanga) under Bharatmala Pariyojna in the state of Bihar- Package-IV from village Balbhadarpur (Design Ch. 47+000) to village Bela Nawada (Darbhanga) (Design Ch. 89+210) Total Length – 42.210 Km.



Detailed Project Report.

Table 3.9: Details of SVUP

S. No.	Chainage (km)	Type of Crossing	Type of Structure	Clear Opening in square direction (m)	Skew angle	Deck Configuration (m)	Width of Open Median (m)
1	53+050	village road	RCC BOX	1X7.0	30	2x11.6	3
2	54+210	village road	RCC BOX	1X7.0	30	2x11.6	3
3	60+007	village road	RCC BOX	1X7.0	23	2x11.6	3
4	61+096	village road	RCC BOX	1X7.0	0	2x11.6	3
5	62+707	village road	RCC BOX	1X7.0	0	2x11.6	3
6	64+250	village road	RCC BOX	1X7.0	0	2x11.6	3
7	69+084	village road	RCC BOX	1X7.0	18	2x11.6	3
8	74+928	village road	RCC BOX	1X7.0	30	2x11.6	3
9	79+830	village road	RCC BOX	1X7.0	17	2x11.6	3
10	82+390	village road	RCC BOX	1X7.0	17	2x11.6	3
11	83+640	village road	RCC BOX	1X7.0	16	2x11.6	3

3.12.6 Fly-Over/Interchange

There are 06 numbers of Fly-Over that have been proposed in this section which are crossing the National/State Highways. The details of the Fly-Over and Interchange has been summarized in **Table 3.10**

Project:- Construction of Four lane access controlled Greenfield National Highway (NH-119D), starting from its junction with NH-19 (Old NH-02) near village Amas connecting Ramnagar, Kachhi Dargah, Kalyanpur (Hajipur), Tajpur and terminating at its junction with Nh-27 near village Bela Nawada (Darbhanga) under Bharatmala Pariyojna in the state of Bihar- Package-IV from village Balbhaddarpur (Design Ch. 47+000) to village Bela Nawada (Darbhanga) (Design Ch. 89+210) Total Length – 42.210 Km.



Detailed Project Report.

Table 3.10- Details of Fly-Over/Interchange

Sr. No.	Design Chainage (Km)	Intersecting Road	Type of Structure	Span Arrangement c/c Expansion joint (nos. x length) in Square direction (m)	Ske w angl e	Deck Configurati on (m)	Width of Open Media n (m)	Minimu m Vertical Clearanc e (m)	Remarks
1	50+607	State Highway 50	PSC I Girder	3x30	0	2x11.6	3.0m	5.5m	At Grade junction shall be developed with provision of Roundabout as per layout given in Appendix: B-V.
2	65+310	For Junction U-turn	PSC I Girder	1x30	0	2x11.6	3.0m	5.5m	
3	66+154	MDR	PSC I Girder	8x30	0	2x11.6	3.0m	5.5m	
4	77+765	MDR	PSC I Girder	3x30	0	2x11.6	3.0m	5.5m	
5	84+775	SH-56	PSC I Girder	3x30	0	2x11.6	3.0m	5.5m	
6	89+087	NH-27	PSC I Girder	10x30+1x32.28+5x30	0	2x11.6	3.0m	5.5m	Flyover cum viaduct at trumpet Interchange location



DETAILS OF STRUCTURES ON INTERCHANGES at LOOP AND RAMP

Sl. No.	Interchange	Connecting Roads	Structure Details	Super structure	Span Arrangement c/c Expansion joint in Square direction (m)/Clear Opening Square direction (m)	Skew Angle	Deck Configuration (m)	Remarks
1	Single trumpet Interchange at Km 89+087	NH-27	Viaduct structure for Exit Ramp	PSC I Girder	3x30+5x30	0	1x10.5	Deck width of First three spans (3x30m) varies from 0 to 10.5m
2		NH-27	Viaduct structure for Entry Ramp	PSC I Girder	3x30+5x30	0	1x10.5	Deck width of First three spans (3x30m) varies from 0 to 10.5m

3.12.7 Road Over Bridge

There are 02 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

Sl. No.	Chainage (Km)	Type of Structure	Span Arrangement c/c Expansion in square direction (m)	Skew Angle	Deck Configuration (m)	Median Width (m)
1	76+895	PSC I Girder	18+36+18	5	As per Approved GAD	3
2	88+680	PSC I Girder	15+60+15	0	As per Approved GAD	3



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
1.	89+087	10x30+1x32.28+5x30	PSC I Girder	Flyover

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 89 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 Chainage	Type Of Culvert	Size
			No x Width (m) x Height (m)
1	47+050	RCC Box	1x4x4
2	47+300	RCC Box	1x4x4
3	47+584	RCC Box	1x4x4
4	47+860	RCC Box	1x4x4
5	48+100	RCC Box	1x4x4
6	48+310	RCC Box	1x4x4
7	48+800	RCC Box	1x4x4
8	50+000	RCC Box	1x4x4
9	50+250	RCC Box	1x4x4
10	51+000	RCC Box	1x4x4
11	51+400	RCC Box	1x4x4
12	51+950	RCC Box	1x4x4
13	52+400	RCC Box	1x4x4
14	52+660	RCC Box	1x4x4
15	53+300	RCC Box	1x4x4
16	53+925	RCC Box	1x6x4
17	54+540	RCC Box	1x4x4
18	55+050	RCC Box	1x4x4

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Detailed Project Report.

S.No	Design Chainage	Type Of Culvert	Size
			No x Width (m) x Height (m)
19	55+500	RCC Box	1x4x4
20	56+080	RCC Box	1x4x4
21	56+390	RCC Box	1x4x4
22	57+200	RCC Box	1x4x4
23	57+470	RCC Box	1x4x4
24	58+100	RCC Box	1x4x4
25	58+440	RCC Box	1x4x4
26	58+750	RCC Box	1x4x4
27	59+340	RCC Box	1x4x4
28	60+700	RCC Box	1x4x4
29	60+850	RCC Box	1x4x4
30	61+300	RCC Box	1x4x4
31	61+860	RCC Box	1x4x4
32	62+240	RCC Box	1x4x4
33	62+450	RCC Box	1x4x4
34	62+920	RCC Box	1x4x4
35	63+200	RCC Box	1x4x4
36	63+710	RCC Box	1x4x4
37	63+950	RCC Box	1x4x4
38	64+500	RCC Box	1x4x4
39	64+900	RCC Box	1x4x4
40	65+667	RCC Box	1x3x3
41	66+900	RCC Box	1x4x4
42	67+200	RCC Box	1x4x4
43	67+560	RCC Box	1x4x4
44	68+360	RCC Box	1x4x4
45	68+850	RCC Box	1x4x4
46	69+350	RCC Box	1x4x4
47	69+550	RCC Box	1x4x4
48	70+200	RCC Box	1x4x4
49	70+400	RCC Box	1x4x4
50	70+760	RCC Box	1x4x4
51	71+100	RCC Box	1x4x4
52	71+325	RCC Box	1x4x4
53	71+600	RCC Box	1x4x4

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Detailed Project Report.

S.No	Design Chainage	Type Of Culvert	Size
			No x Width (m) x Height (m)
54	72+200	RCC Box	1x4x4
55	72+560	RCC Box	1x4x4
56	72+900	RCC Box	1x4x4
57	73+330	RCC Box	1x4x4
58	73+700	RCC Box	1x4x4
59	74+300	RCC Box	1x4x4
60	75+065	RCC Box	1x4x4
61	75+300	RCC Box	1x4x4
62	76+250	RCC Box	1x4x4
63	76+550	RCC Box	1x4x4
64	77+240	RCC Box	1x4x4
65	78+360	RCC Box	1x4x4
66	78+600	RCC Box	1x4x4
67	78+900	RCC Box	1x4x4
68	79+540	RCC Box	1x4x4
69	80+050	RCC Box	1x4x4
70	80+500	RCC Box	1x4x4
71	80+780	RCC Box	1x6x4
72	81+450	RCC Box	1x4x4
73	82+100	RCC Box	1x4x4
74	82+680	RCC Box	1x4x4
75	83+250	RCC Box	1x4x4
76	83+500	RCC Box	1x4x4
77	83+950	RCC Box	1x4x4
78	84+350	RCC Box	1x4x4
79	85+120	RCC Box	1x4x4
80	85+380	RCC Box	1x4x4
81	85+700	RCC Box	1x4x4
82	86+000	RCC Box	1x4x4
83	86+260	RCC Box	1x4x4
84	86+520	RCC Box	1x4x4
85	86+940	RCC Box	1x4x4
86	87+400	RCC Box	1x4x4
87	87+910	RCC Box	1x6x4
88	88+140	RCC Box	1x4x4

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Detailed Project Report.

S.No	Design Chainage	Type Of Culvert	Size
			No x Width (m) x Height (m)
89	88+400	RCC Box	1x4x4

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 5 Major Junctions and 32 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	50+607	X	Major	Darbanga	Flexible	SH-50
2	66+154	X	Major	HATHURI KOTHI	Flexible	(MDR)
3	77+765	X	Major	Baheri/Darbanga	Flexible	(MDR)
4	84+775	X	Major	Benipur/Darbanga	Flexible	SH-56
5	89+087	X	Major	Muzaffarpur/Jhanjharpur	Flexible	NH-27

Table 3.15: List of Minor Junctions

S.No	DesignCh.	JunctionType	Classification	Leading To	PavementType	Remarks
NIL						

3.15. TOLL Plaza

The Toll Plazas on loops / ramps / main carriageway shall be provided as per Schedule D and minimum lane requirement in the opening year are as follows.

S. No.	Location	Chainage.	No of Toll lanes (ETC + Extra Wide)	Remarks
1	On Main Carriageway	86+140	(6+2)	-

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Detailed Project Report.

Toll Plaza location and Minimum Lane Requirement in the Opening Year

Interchange No.	Toll Plaza	Location	Direction (Entry: to highway, Exit: from highway)	No. of toll lanes (ETC + Extra Wide)
Interchange 1 At km 50+607 (NH-50 crossing)	TP-1	On Slip road At km 50+300) & (50+400)	Exit (LHS)	(2+1)
			Entry (RHS)	(2+1)
	TP-2	On Slip road At km-(50+750) & (50+850)	Entry (LHS)	(2+1)
			Exit (RHS)	(2+1)
Interchange 2 At km 66+160 (MDR crossing)	TP-3	On Slip road At km- (65+900)& (65+950)	Exit (LHS)	(2+1)
			Entry (RHS)	(2+1)
Interchange 3 At km 77+765 (MDR crossing)	TP-5	On Slip road At km- 77+500 & 77+600	Exit (LHS)	(2+1)
			Entry (RHS)	(2+1)
	TP-6	On Slip road At km 77+950	Entry (LHS)	(2+1)
			Exit (RHS)	(2+1)
Interchange 4 At km 84+775 (MDR crossing)	TP-7	On Slip road At km84+450 & 85+550	Exit (LHS)	(2+1)
			Entry (RHS)	(2+1)
	TP-8	On Slip road At km(84+950)&(85+950)	Entry (LHS)	(2+1)
			Exit (RHS)	(2+1)

Toll plaza on the project highway shall be constructed at the location specified above and in accordance with the provisions specified in IRC SP – 84 -2019 and as per NHA Policy Guidelines specified in Policy Circular No. 17.5.82 dated 24th May 2021.

Project:- Construction of Four lane access controlled Greenfield National Highway (NH-119D), starting from its junction with NH-19 (Old NH-02) near village Amas connecting Ramnagar, Kachhi Dargah, Kalyanpur (Hajipur), Tajpur and terminating at its junction with Nh-27 near village Bela Nawada (Darbhanga) under Bharatmala Pariyojna in the state of Bihar- Package-IV from village Balhadarpur (Design Ch. 47+000) to village Bela Nawada (Darbhanga) (Design Ch. 89+210) Total Length – 42.210 Km.



Detailed Project Report.

3.16. Way Side Amenity Center

Rest Area/Wayside amenities shall be developed at the following locations in accordance to **Schedule - D**.

S. No.	Start (Km)	End (Km)	Side	Area	Length & Width	Remarks
1	60+460	60+660	RHS	2 Ha	200mX100m	Only development of land shall be done. (Complete area shall be filled, leveled and compacted (95%) with borrow area soil up to the height of main carriageway road level of the project Highway.
2	68+353	68+845	LHS	2 Ha	200mX100m	

3.17. Religious Structures

There are no religious structures along the project road.

3.18. School and Colleges.

There are no school or colleges in this project road.

3.19. Hospitals

There is no hospital in this project road.

3.20. POINTS OF CONSIDERATION

It is proposed to have Rigid 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: 84-2019) 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 / Built-up Area	60m
3.	Width of	14 m

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Detailed Project Report.

Sr. No.	Item	Standards for Plain / Rolling Terrain
	Carriageway	
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 Draft 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 Draft Feasibility Report has been prepared in the following volume:

- | | |
|-------------|--|
| 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 |



Detailed Project Report.

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 **Sarai Toll Plaza is 30148 PCU and at Ughara is 13432 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.

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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:

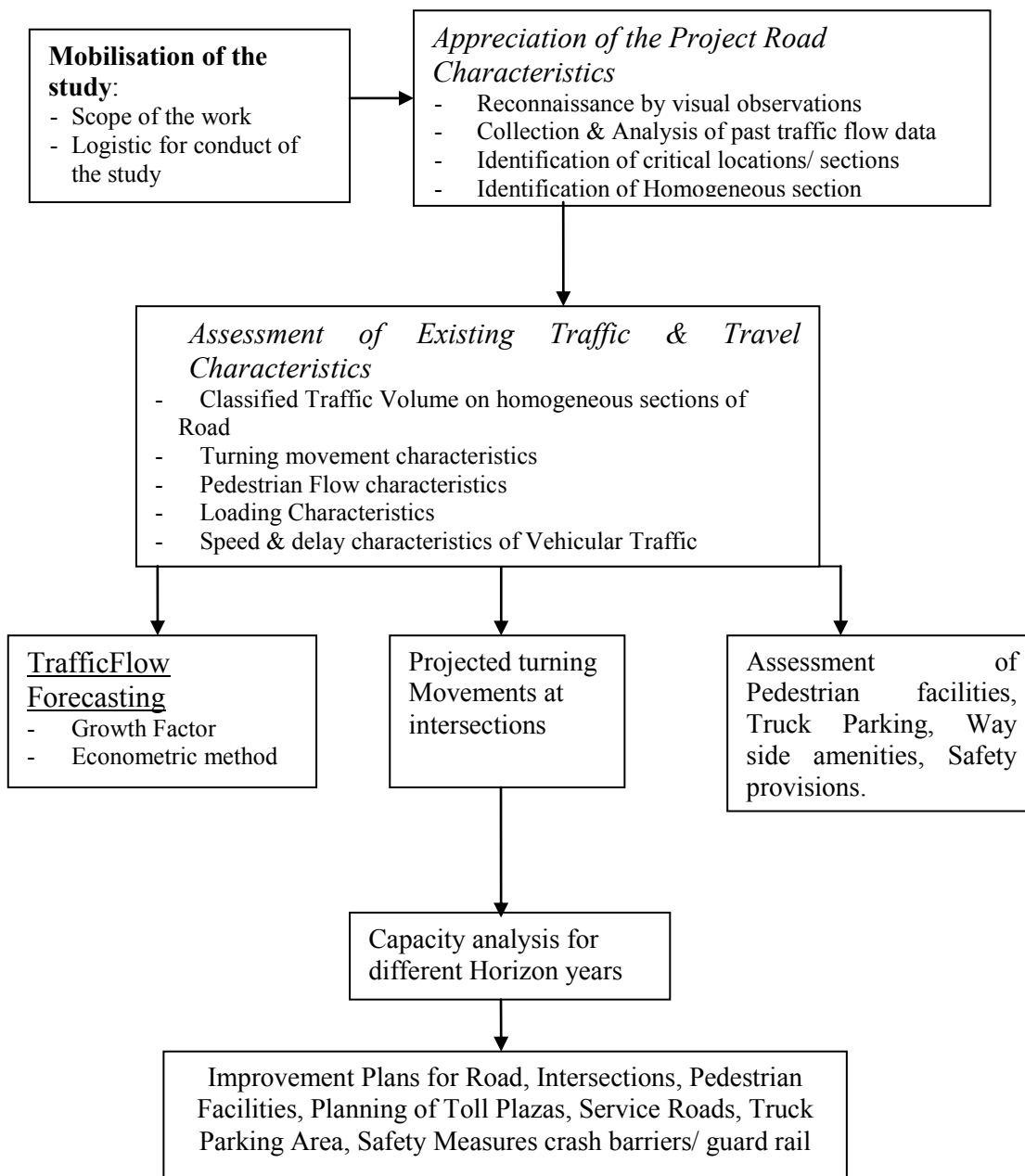
- i) Reconnaissance Survey
- ii) Planning, design of survey performa and conduct of various traffic studies along with coding and feeding of data
- iii) Analysis of Traffic Flow
- iv) Existing traffic flow analysis
- v) Existing travel demand analysis
- vi) Traffic flow forecasting of different sections 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**.



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Methodology for Traffic Study

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

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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.

Detailed Project Report.

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

Detailed Project Report.

were taken as the measure of unevenness index for the carriageway. Based on the MoRT&H & IRC recommendations on 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.

Detailed Project Report.

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: 37-2018. The methods prescribed in IRC: 37-2018(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: 58-2015, 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

Detailed Project Report.

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;

Detailed Project Report.

- 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.

$$Q = A \times 4.43 \times \left[\frac{H}{1 + K_e + K_f} \right]^{1/2}$$

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.

Detailed Project Report.

- 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

Detailed Project Report.

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-V) 1985. The soil sample was taken and kept in a series of sieves i.e. 4.75mm, 3.35mm, 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

Detailed Project Report.

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 where 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: 624-1971, 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

Detailed Project Report.

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.

Detailed Project Report.

- 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

Detailed Project Report.

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**.

Detailed Project Report.

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.

Detailed Project Report.

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:

SI 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 Department for cutting the affected trees.

Detailed Project Report.

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 compiled. 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

Detailed Project Report.

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 expressed 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 form 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 (notwithstanding 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.), thereby 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).

Detailed Project Report.

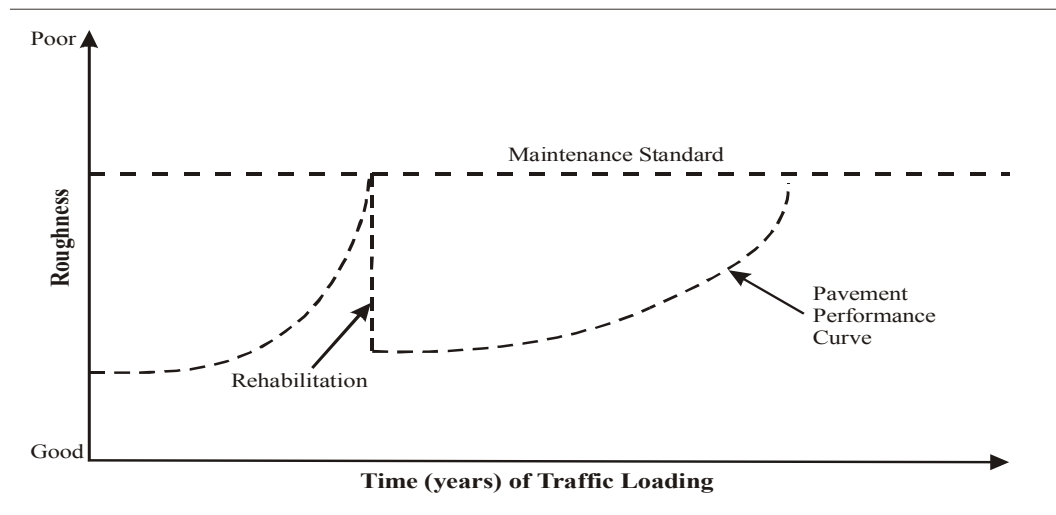


Figure 4.2: Concept of Life-cycle analysis in HDM-4

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 :

Detailed Project Report.

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:

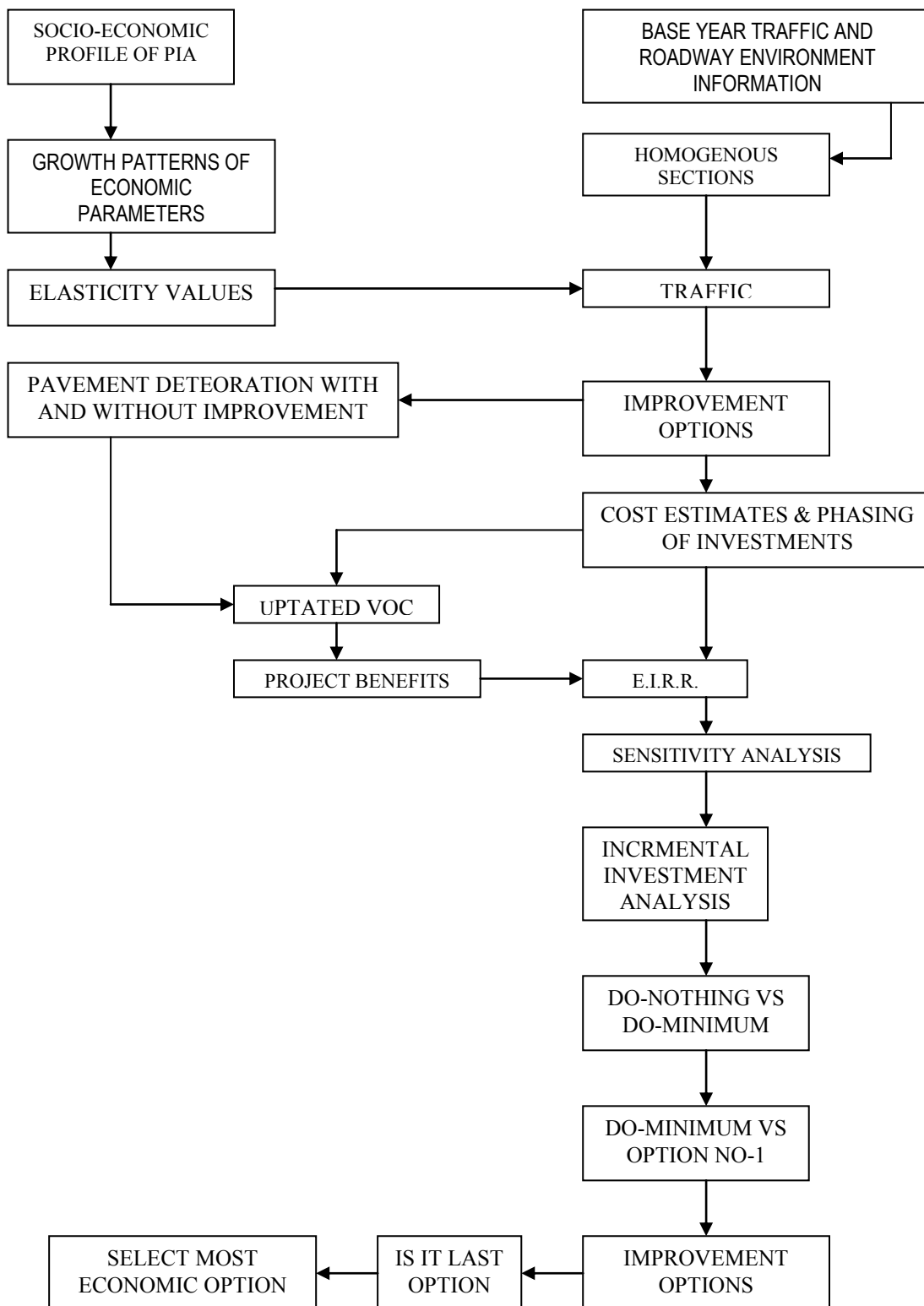
- Increase in cost by 15 %
- Decrease in benefits by 15 %
- Increase in cost by 15 % and decrease in benefits by 15 %



Detailed Project Report.

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.

Detailed Project Report.

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



Detailed Project Report.

- 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 Darbhanga- Project Influence District

Darbhanga district is one of the thirty-eight districts of Bihar state in eastern India, and Darbhanga city is the administrative headquarters of this district and 6th largest city of Bihar as well. Darbhanga district is a part of Darbhanga Division. The district is bounded on the north by Madhubani district, on the south by Samastipur district, on the east by Saharsa district and on the west by Sitamarhi and Muzaffarpur districts. The district covers an area of 2,279 km² (880 sq mi).

5.2.1 Demography

According to the 2011 census Darbhanga district has a population of 3,937,385 roughly equal to the nation of Liberia or the US state of Oregon. This gives it a ranking of 64th in India (out of a total of 640). The district has a population density of 1,721 inhabitants per square kilometre (4,460/sq mi). Its population growth rate over the decade 2001-2011 was 19%.

Population of this district as per 2011 census is 3,985,493 of which rural population is 3,554,057 and urban population is 383,328. According to the Census of India 2011, literacy rate of the district is 56.56%(male 66.83%, female 45.24%).

At the time of the 2011 Census of India, 72.75% of the population in the district spoke Maithili, 20.67% Urdu and 6.51% Hindi as their first language.

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 5.3 Employment profile in Darbhanga

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 Kalyanpur and terminates at Bela Nawada at East West Expressway. 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 Samastipur- Project Influence District

Samastipur is a city and a municipality (nagar parishad) in Bihar, India. It is the headquarters of Samastipur district. It comes under Darbhanga commisenary. The Burhi Gandak River flows through the town. This is one of the five Rail Division of ECR, Hajipur. The Samastipur junction is one of the busiest station in North Bihar



5.3.1 Demography

As of 2011 Indian Census, Samastipur had a total population of 62,935, of which 33,025 were males and 29,910 were females. Population within the age group of 0 to 6 years was 8,252. The total number of literates in Samastipur was 46,416, which constituted 73.8% of the population with male literacy of 77.2% and female literacy of 69.9%. The effective literacy rate of 7+ population of Samastipur was 84.9%, of which male literacy rate was 88.9% and female literacy rate was 80.4%. The Scheduled Castes and Scheduled Tribes population was 9,219 and 249 respectively. Samastipur had 12062 households in 2011

5.3.2 Education

Samastipur has several schools and colleges. Most of the colleges are affiliated to the Lalit Narayan Mithila University, Darbhanga. The Rajendra Agricultural University is located near the town, in Pusa.

IGNOU has several study centres in Samastipur

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 5.5 Employment profile in Samastipur

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.

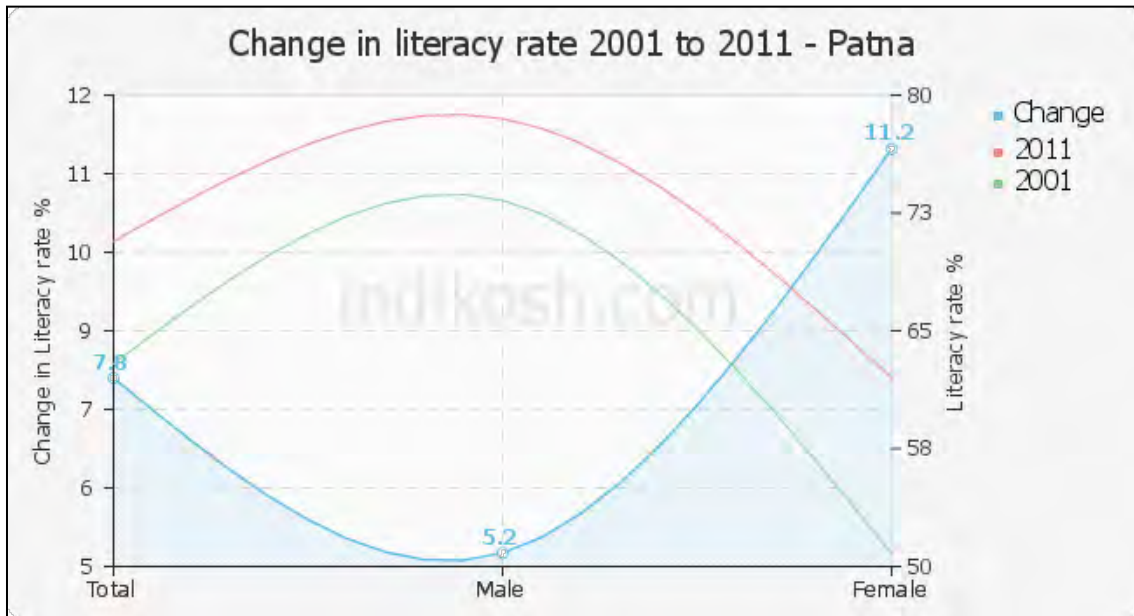
The majority of the population, nearly 57% (about 33.2 lakh) live in Patna District rural part and 43% (about 25.1 lakh) population live in the Patna District urban part. Rural population density of Patna district is 1134 and urban population density is 9321 persons per km².

Table 5.6 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

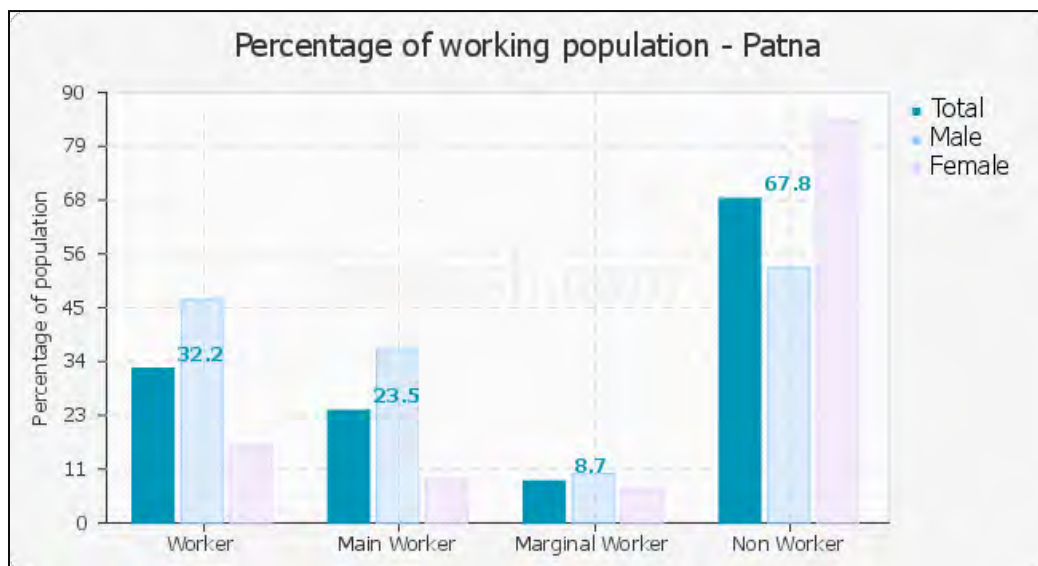
5.4.2 Education

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	Balbhadarpur	10	Manihas
2	Mathura Mandal	11	Bela Yakub
3	Harpur, Silaut	12	Mausimpur
4	Chal Rukum	13	Bela Nevada
5	Manjil	14	Simaria Bhindi
6	Mobarak	15	KoilaKund
7	Kharsand	16	Kolwara,Bihari
8	Mukund	17	Usma
9	Mirzapur	18	Asgaon

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 Balbhadarpur to Bela Nawada (PKG-4) of Amas to Darbhanga NH-119D 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 60m 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 2019 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:84:2019, 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:84:2019, 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 flushed median of width 5m for open country sections in which GSB layer shall be extended in the median gap to avoid water logging and effective water drainage.

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 500 mm.

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.

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- *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-07

Traffic Survey and Analysis

7.1 INTRODUCTION

National Highway Authority of India has appointed M/s SA infrastructure Consultants Pvt. Ltd., a leading Infrastructure Consulting Company, based at Noida, for “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 Balbhaddarpur (Km 47+000) to Bela Nawada (Km 89+210) (PKG-4) of Amas to Darbhanga Greenfield highway NH-119D”.

7.2 OBJECTIVE

The objective of the study is to estimate the base year traffic, projected traffic

- Review the past traffic data on the project stretch and other competing / alternative routes;
- Analyze the network conditions, traffic characteristics
- Establish seasonality factors using available past traffic data and /or from using fuel sales data or any other relevant data. Detailed justifications for SCF to be brought out in the report;
- A study of the Project Influence Area, alternate routes to the Project and assessing the possibility of diversion of traffic from / to the Project road under consideration due to existing or future developments;
- Identify factors which may have a positive and / or negative impact on the Traffic;
- Estimation of the ADT & AADT based on the findings of the study done on the above points;
- Forecast of category wise traffic annually from current year till end of concession period;

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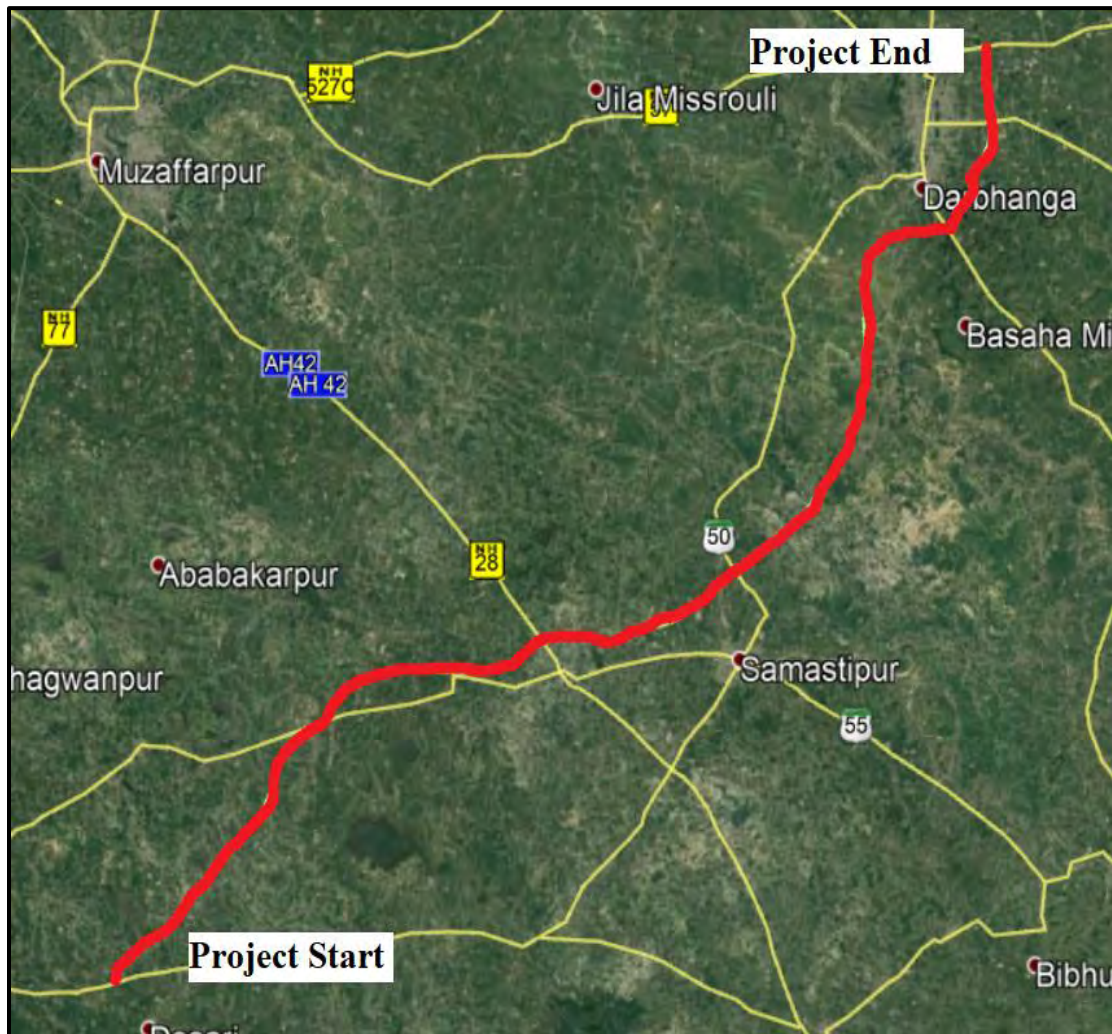


Figure 7-1: Project Stretch

Darbhanga District

Darbhanga district is one of the thirty-eight districts of Bihar state in eastern India, and Darbhanga city is the administrative headquarters of this district and 6th largest city of Bihar as well. Darbhanga district is a part of Darbhanga Division. The district is bounded on the north by Madhubani district, on the south by Samastipur district, on the east by Saharsa district and on the west by Sitamarhi and Muzaffarpur districts. The district covers an area of 2,279 km² (880 sq mi)

Samastipur District

Samastipur is one of the thirty-eight districts of Bihar in India. The district headquarters are located at Samastipur. The district occupies an area of 2904 km² and has a population of 4,261,566. Samastipur district occupies an area of 2,904 square kilometres (1,121 sq mi), Samastipur is bounded on the north by the

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Bagmati River which separates it from Darbhanga district. On the west it is bordered by Vaishali and some part of Muzaffarpur district, on the south by the Ganges, while on its east it has Begusarai and some part of Khagaria district. The district headquarters is located at Samastipur.

7.3 TRAFFIC STUDIES

To capture traffic flow characteristics, travel pattern of traffic passing through the project road and other characteristics related to miscellaneous requirements on the project road, the consultant has carried out Automatic Traffic Volume Count (ATCC) Survey for Traffic volume count, Origin & Destination Survey and Axle load survey at following locations.

Table 7-1: Traffic surveys schedule

S. No	Location	Type of survey
1	Sarai toll Plaza NH-77B	TVC, OD, Axle load Survey
2	Uaghara SH-50	TVC, OD
3	Gada Mahua Tajpur Road	TVC, OD

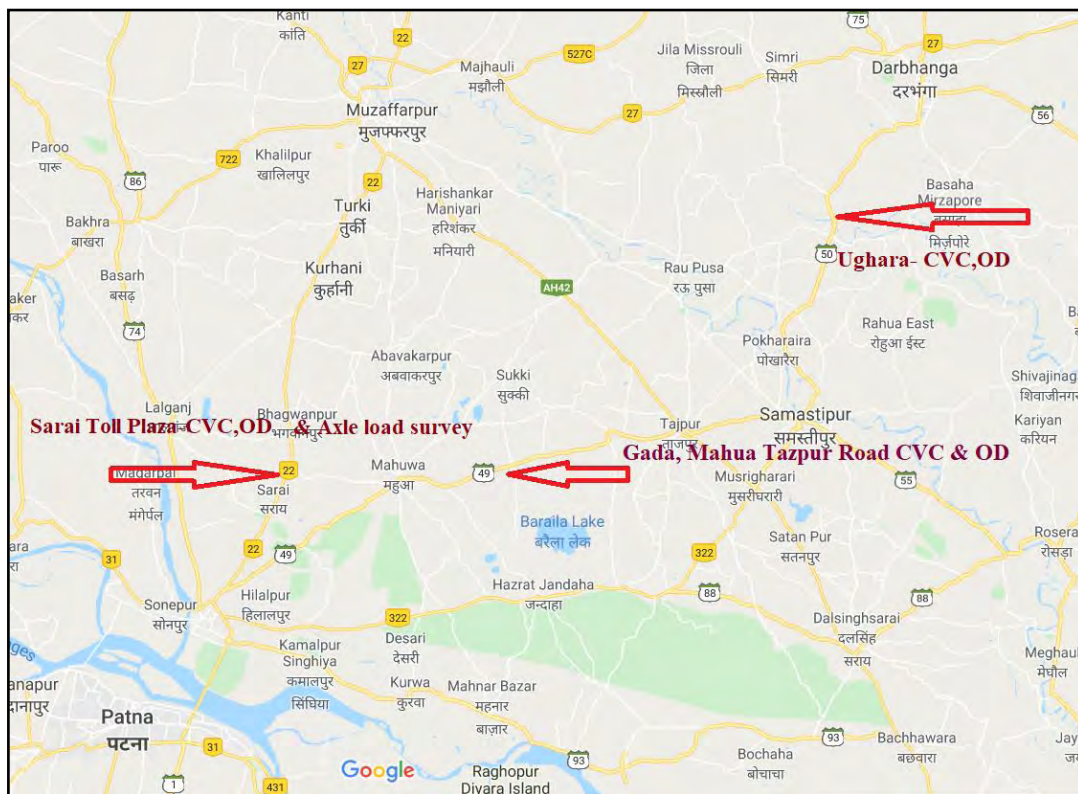


Figure 7-2: Traffic Survey Location Map

7.4 TRAFFIC INTENSITY

7.5.1 Classified Traffic Volume Counts

Traffic volume count survey carried out using ATCC at the above mention locations. The vehicle classification used in the survey along with their PCU factors, as suggested in IRC: 64 – 1990, are presented in **Table 7-2**

Table 7-2: Vehicle Classification and PCU Factors Used in the Study

Vehicle Type	PCU Factor
Fast Moving Vehicles	
Car, jeep, van	1.0
Taxi	1.0
Mini bus	1.5
Standard Bus (private and government classified)	3.0
Light Motor Vehicles (LMV)	1.0
Light commercial vehicle (passenger & goods)	1.5
Truck 2-axle	3.0
Truck 3-axle	3.0
4 to 6-axle truck	4.5
More than 6-axle truck	4.5

The analysis of the classified traffic volume at the toll plaza locations was carried out to arrive at the following:

- Average Daily Traffic (ADT) and Annual Average Daily Traffic (AADT)
- Daily variation of traffic volume
- Average Composition of traffic

7.5.2 Average daily traffic (ADT)

Traffic volume data was averaged to determine Average Daily Traffic (ADT). ADT by vehicle type is presented in **Table 7-3**.

Table 7-3: Average Daily Traffic

Mode of Vehicle		Sarai Toll	Ughara	Mahuwa
Tollable vehicles	Car	5963	2516	1930
	Minibus	130	109	0
	Bus	1934	436	459
	LCV	3253	932	731
	2Axle Truck	2106	576	553
	3 Axle Truck	245	542	454

Mode of Vehicle		Sarai Toll	Ughara	Mahuwa
	MAV (4-6) Axle	49	250	403
Non-Tollable vehicles	2Wheeler	9779	3601	5911
	3 Wheeler	1625	946	596
	Tractor	80	74	31
	Tractor with Trailer	51	25	143
	Bicycle	200	-	532
	Cycle Rickshaw	0	-	65
Total	Grand Total (Nos.)	25414	10007	11809
	Grand Total (PCU)	31075	12835	13876

7.5.3 Seasonal Correction Factor

The traffic plying on any road generally varies over different periods of the year depending on the cycle of different socio-economic activities in the regions through which it passes. Therefore, in order to have a more realistic picture of the traffic on the project road, it is required to assess its seasonal variation to estimate the annual average daily traffic (AADT).

AADT is the base year (2020-2021) traffic. This is a product of ADT and seasonal variation factor. Seasonal variation factor can be derived using various methods. Vehicle data from toll booths check posts etc. or sale details of petrol and diesel fuels along the corridor are the commonly used sets of data.

For the present study, fuel sales data for the last has been collected from various petrol pumps and analyzed. Thus, for cars & bikes the final SCF has been arrived at by taking an average of MS -1.02 and HSD for trucks / bus it has been considered - 1.06.

7.5.4 Annual Average Daily Traffic (AADT)

The traffic volume survey along the project road has been carried out in month of May 2019 and seasonal factors for these months were considered for converting ADT to AADT. AADT vehicle type wise is shown in **Table 7-4**. The AADT values for base year have been used for the traffic volume projection up to horizon year and for projecting the toll revenue.

Table 7-4: Annual Average Daily Traffic (PCU)

		Sarai Toll	Ughara	Mahuwa
Toll able	Car	6023	2566	1969
	Minibus	138	116	0
	Bus	2050	462	486
	LCV	3448	988	775

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		Sarai Toll	Ughara	Mahuwa
vehicles	2AxleTruck	2232	611	586
	3 Axle Truck	260	575	481
	MAV (4-6) Axle	52	265	427
Non-Toll able vehicles	2 Wheeler	9877	3673	6029
	3 Wheeler	1641	1003	608
	Tractor	85	78	33
	Tractor with Trailer	54	27	151
	Bicycle	200	-	532
	Cycle Rickshaw	0	-	65
Total	Grand Total (Nos.)	26059	10363	12144
	Grand Total(PCU)	32309	13432	14466

7.5.5 Daily variation of traffic volume

Daily variation of traffic (mode wise) is shown in **Figure7-3** below. Daily variation of traffic in terms of day factors is presented in.

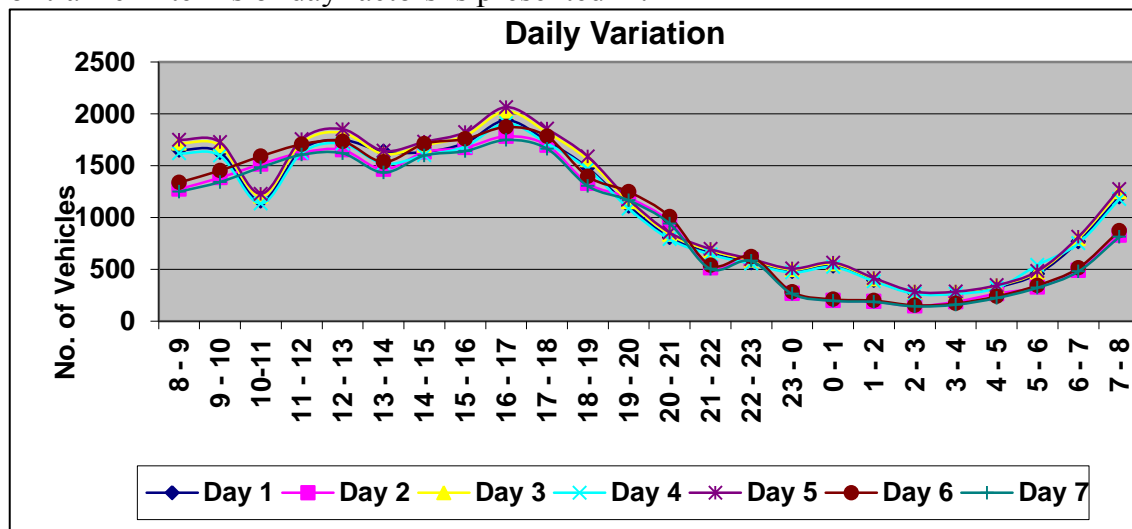


Figure 7-3: Daily variation of Traffic Sarai Toll Plaza

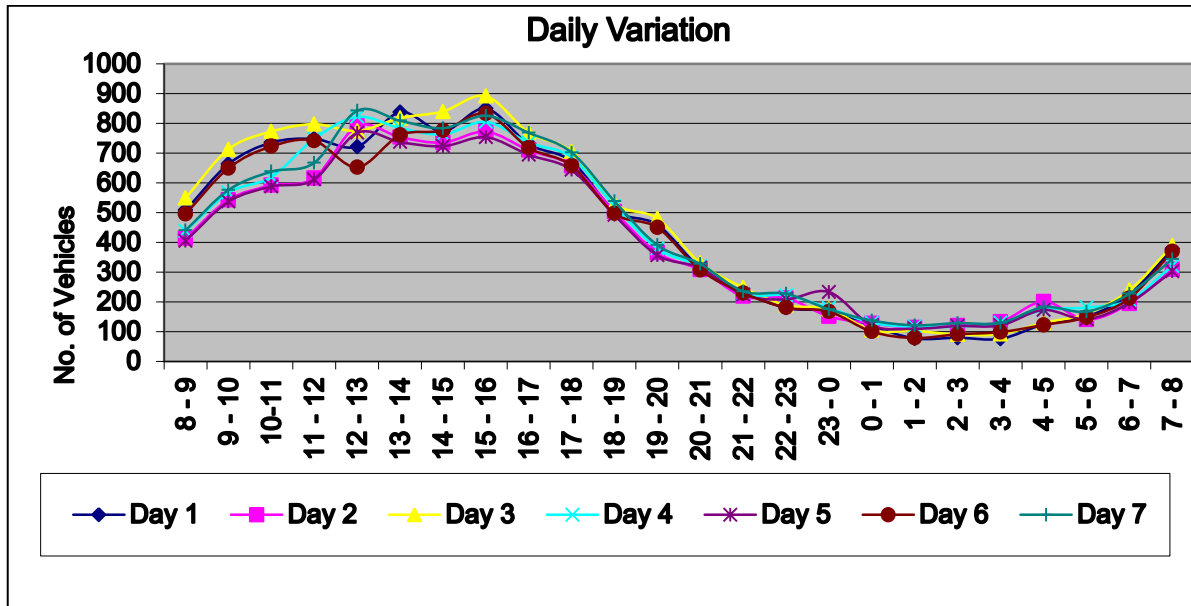


Figure 7-4: Daily variation of Traffic Ughara

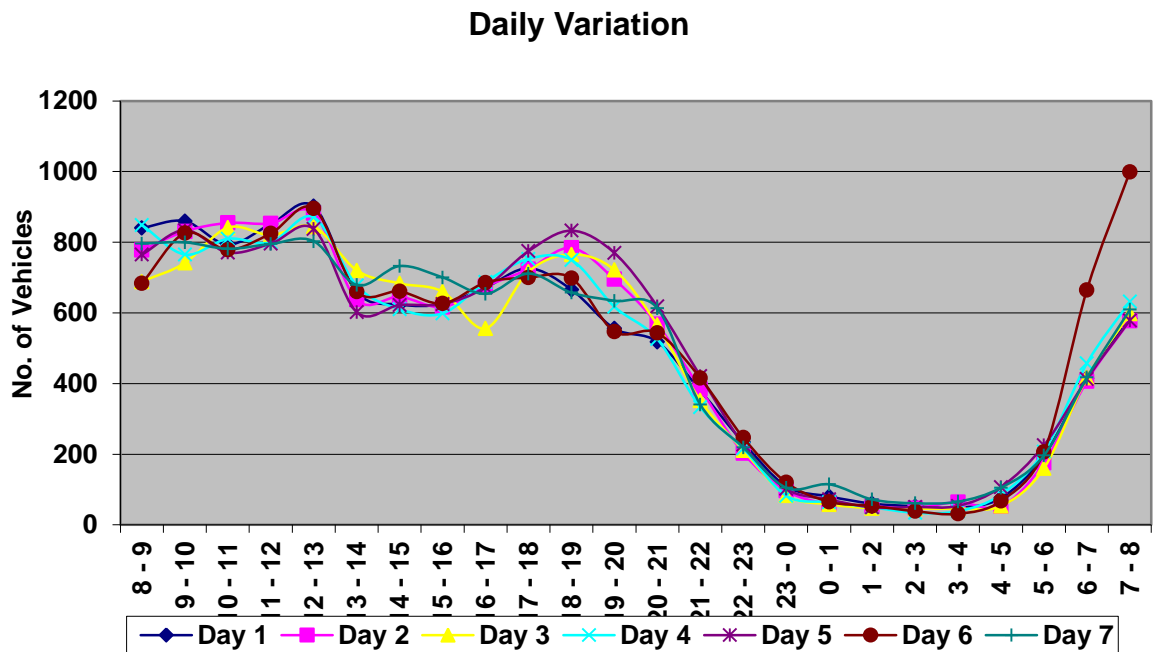


Figure 7-5: Daily variation of Traffic at Mahuwa

Day factor is the variation of each day’s traffic to the average daily traffic. Day wise variations are observed at all locations.

7.5.6 Traffic Composition

The traffic composition of vehicles is given in Figure 7-5 to 7-6

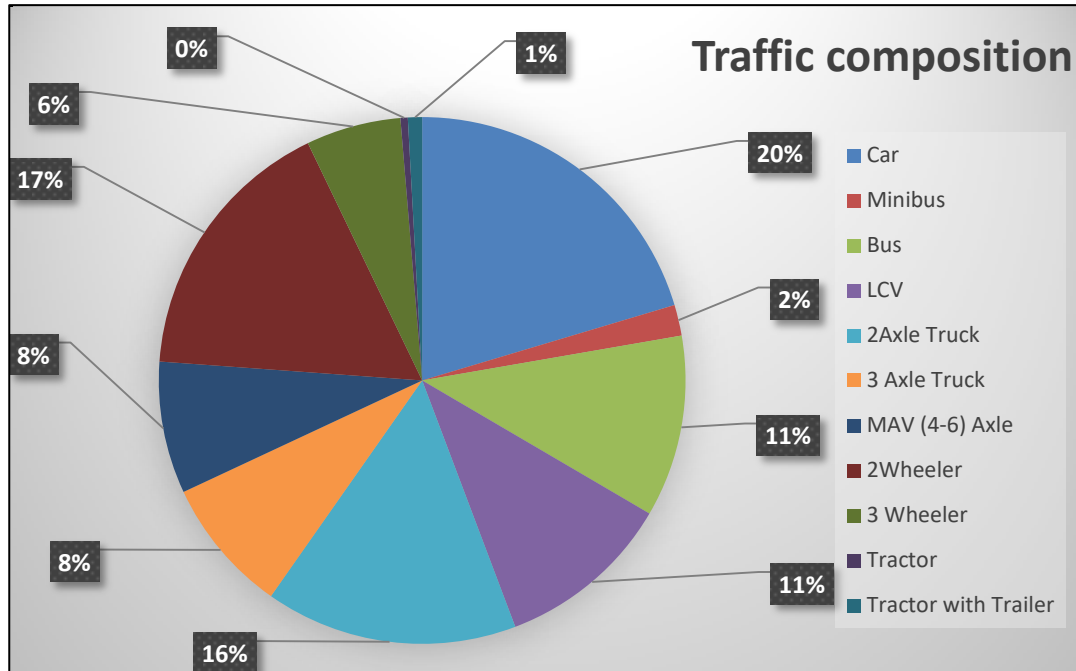


Figure 7-6: Traffic composition of All Vehicles Sarai Toll Plaza

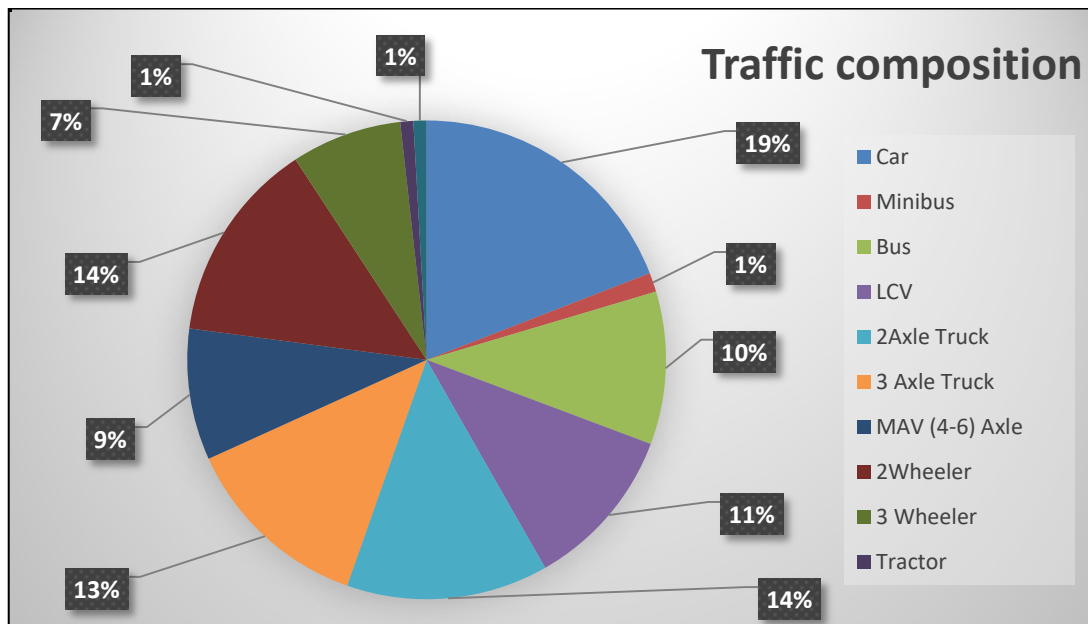


Figure 7-7: Traffic composition of All Vehicles Ughara

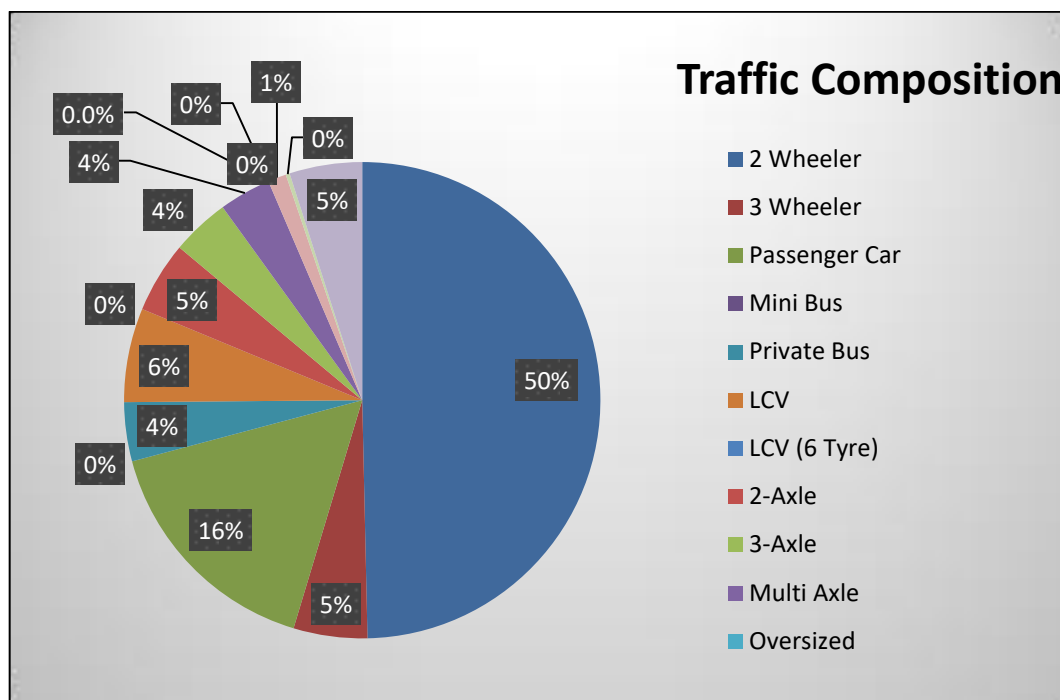


Figure 7-8: Traffic composition of All Vehicles Mahuwa

7.6 TRAVEL PATTERN ORIGIN DESTINATION SURVEY

Origin - destination (O-D) surveys were conducted to elicit information related to the base year travel characteristics of goods and passenger trips using the project road and likely future traffic diversions to or from the project road. The travel characteristics obtained by O-D survey would facilitate the identification of (i) local and through traffic on the project road, and (ii) the toll able traffic at the existing toll plazas.

The O-D survey locations on the Project road are also shown in **Figure 7.2** along with other survey locations.

The origin-destination survey was carried out using the road side interview (RSI) technique. The survey was conducted for 1 day to understand the road user characteristics. Road users were interviewed by trained enumerators to obtain the required data under the guidance of traffic engineers and supervisors. For this purpose, cars (private and taxi cars) and buses were considered as passenger vehicles. Similarly, LCVs, 2-axle trucks, 3- axle trucks, 4 to 6-axle trucks and more than 6-axle trucks were considered as goods vehicles.

The information collected contained trip origin and trip destination. In addition, type of commodity for goods vehicles and purpose and occupancy for passenger vehicles were also collected. Further, trip length and frequency also elicited during O-D surveys. The sample size of each vehicle type is given in **Table 7-5**.

The data collected from RSI were entered into the computer and checked manually. Incorrect entries were corrected by cross-checking it with original field data sheets. The data was also checked for inconsistencies. The checking included:

- Trips from zones to zones which cannot possibly ply through the survey location
- Vehicle type with their corresponding lead / load / occupancy for any inconsistencies the checked and corrected data were used for final analysis.

Table 7-5: Sample size of OD survey

Vehicle Type	Sarai Toll Plaza	Ughara	Mahuwa
Car/ Jeep/Van	577	198	202
Bus	277	62	177
Minibus	90	0	6
LCV	204	77	148
2 Axle Truck	199	65	116
3 Axle Truck	40	64	75
MAV (4-6) Axle	32	57	49

7.6.1 Zoning System

For analysis of data collected from the field, it is required to code them for developing origin and destination matrices of trips. The local traffic needed to be assessed precisely, at the same time through traffic and its geo-regional representation also should be assessed.

For the purpose of delineating the growth centers affecting the influence area, the entire country was broadly divided into two regions. They are, Immediate Influence Area (IIA) and Broad Influence Area (BIA) of the project.

While defining zone boundaries the following were considered:

- Important towns and industrial areas along or near the project road
- Important roads, Administrative boundaries, e.g., district and state boundaries.

Table 7-6: Adopted zoning system

Zone Number	Zone Name
1	Patna
2	Nalanda , Bihar Sharif
3	Arwal, Jehanabad
4	Gaya
5	Nawada

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Zone Number	Zone Name
6	Aurangabad
7	Sheikhpura
8	Lakhisarai
9	Begusarai , Barauni
10	Samastipur
11	Vaishali
12	Saran, Chhapra
13	Saharsa
14	Jamui
15	Munger
16	Banka
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	Champan, 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, Dakshin Dinajpur

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Detailed Project Report.

Zone Number	Zone Name
39	Darjeeling, Hooghly, Howrah, Jalpaiguri,
40	Jhargram, Kalimpong, Kolkata, Malda, Murshidabad
41	Nadia, North 24 Parganas, Paschim Bardhaman, Paschim Medinipur
42	Purba Bardhaman, Purba Medinipur, Purulia, South 24 Parganas, Uttar Dinajpu
43	Rest Of West Bangal
44	Lucknow, Gorakhpur, Jaunpur, Varanasi, Prayagraj, 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
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

7.6.2 Expansion factors and development of O – D matrices

The origin – destination details were collected from the trip makers during the survey on sample basis. Sampling varied with the changes in traffic flow across the day. Care has been taken to eliminate any element of bias in sampling. Since data was collected on sample basis, expansion factors are required to replicate the pattern as reflected in the sample to the total number of vehicular trips made during the day. These expansion factors are calculated separately for each class of vehicle. For example, if x_c is number of cars interviewed and X_c is the total number of cars counted during the day, then X_c/x_c would be the expansion factor for cars.

7.6.3 Commodity Groups and Analysis

The different commodities recorded during the O-D survey have been classified in 16 categories as presented in **Table 7-7**. Due consideration has been given to include all possible commodities and to categorize them into homogeneous groups, accounting the pattern of movement along the corridor.

Table 7-7: Classification of commodities

No.	Commodity Type
1	Food grains and other agricultural products (Rice, wheat, pulses, maize, chilly, coconut, sugarcane, sugar, cotton, coffee, tea, eggs etc.)
2	Fruits, vegetables - perishables
3	Wood and Forest Products
4	Petroleum, oil, Gas and lubricants product
5	Minerals, chemicals, fertilizer
6	Iron , Metal and steel
7	Finished and manufactured products (Vehicles, Products of machinery, rubber, electric & electronics, textile, automobile, glass, plastic etc.)
8	Parcel Service & Containers
9	Medicines
10	Building materials (Brick, Tiles, Mud and Blocks)
11	Mining (Sand, Bajri and Coarse Aggregate)
12	Cement
13	Marble, stone
14	Textiles & Fibre
15	Miscellaneous goods (Livestock, Waste, paper etc)
16	Empty vehicles

The percentage of each commodity mode-wise for all four toll plaza are given in **Table 7-8 to 7-9**

Table 7-8: Commodity distribution (%)

Commodity Type	LCV	2A	3A	MAV	LCV	2A	3A	MAV	LCV	2A	3A	MAV
	Sarai Toll Plaza				Ughara				Mahuwa			
1	13.3	3.5	5.3	2.9	16.9	13.8	4.6	6.9	6.1	6.0	5.3	4.1
2	12.8	2.5	2.6	0.0	15.6	7.7	3.1	0.0	6.8	9.5	3.9	4.1
3	0.0	0.0	0.0	0.0	2.6	3.1	0.0	1.7	0.7	0.0	3.9	0.0
4	5.4	9.5	26.3	11.4	7.8	9.2	3.1	1.7	0.7	0.9	7.9	6.1
5	1.5	0.0	0.0	5.7	0.0	1.5	3.1	10.3	0.0	0.0	0.0	0.0
6	0.5	1.0	2.6	2.9	0.0	3.1	6.2	17.2	1.4	9.5	7.9	6.1
7	7.9	2.0	2.6	0.0	6.5	4.6	1.5	0.0	14.2	13.8	1.3	10.2
8	1.0	1.5	0.0	0.0	1.3	1.5	0.0	0.0	1.4	1.7	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Commodity Type	LCV	2A	3A	MAV	LCV	2A	3A	MAV	LCV	2A	3A	MAV
10	0.0	0.0	0.0	0.0	1.3	6.2	12.3	8.6	8.8	12.1	11.8	8.2
11	0.0	3.0	21.1	14.3	0.0	3.1	3.1	8.6	1.4	3.4	15.8	26.5
12	3.4	0.5	0.0	2.9	0.0	4.6	4.6	3.4	1.4	11.2	2.6	0.0
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	0.0	0.0	0.0	0.0	5.2	7.7	0.0	0.0	29.7	12.1	6.6	0.0
16	13.3	3.5	5.3	2.9	42.9	33.8	58.5	41.4	27.7	19.8	32.9	34.7
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Table 7-8: Commodity distribution (%)

The distribution spectrum shows that commodity type food grains, vegetables, milk products, consumer items, construction materials and manufactured goods are being transported maximum along the corridor.

7.6.4 THROUGH TRAFFIC:

Table 7-9: Through traffic

Location	Car	Bus	Mini Bus	LCV	2-Axle	3-Axle	MAV	Total
OD-01 Sarai								
Potential Divertible Trips	101	32	7	9	6	5	1	161
AADT OD	577	227	90	204	199	40	32	1369
%age	17.50%	14.10%	7.78%	4.41%	3.02%	12.50%	3.13%	11.76%
Base Year Traffic	6023	2050	138	3448	2232	260	52	14203
Through Traffic	1054	289	11	152	67	33	2	1608
Through Traffic (PCU)	1054	867	16	228	202	98	7	2472
OD-02 Ughara								
Potential Divertible Trips	145	46	0	53	52	49	41	386
AADT OD	198	62	1	77	65	64	57	524
%age	73.23%	74.19%	0.00%	68.83%	80.00%	76.56%	71.93%	73.66%
Base Year Traffic	2566	462	116	988	611	575	265	5582

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Detailed Project Report.

Through Traffic	1879	343	0	680	488	440	191	4021
Through Traffic (PCU)	1879	1029	0	1020	1465	1320	858	7571
OD-03 Mahuwa								
Potential Divertible Trips	34	89	6	34	34	27	10	234
AADT OD	243	179	6	133	109	82	49	801
%age	14%	50%	100%	26%	31%	33%	20%	29%
Base Year Traffic	2067	510	0	814	615	505	449	4960
Through Traffic	289	254	0	208	192	166	92	1201
Through Traffic (PCU)	289	761	0	312	576	499	412	2849

7.6.5 POTENTIAL DIVERTED TRAFFIC:

- Potential Diverted Toll-able Traffic through project Stretch = $1608+4021+1201=6829$ No. , $2268+7571+2849=12892$ PCU
- Total traffic on project Stretch = **17375 PCU**

Table 7-9: Potential Diverted Traffic on Project Stretch

2-wheeler	3-wheeler	Car	Bus	Mini Bus	LCV	2-Axle	3-Axle	MAV	Tractor	Tractor with Trailer	Total (No.)	Total (PCU)
Diverted Traffic												
-	-	3223	885	11	1040	748	639	284	-	-	6829	12892
Generated Traffic												
1900	280	645	177	2	208	150	128	57	45	135	3726	4483
Total Traffic Estimate to be moved on Project Stretch												
1900	280	3867	1063	13	1248	897	766	341	45	135	10555	17375

7.7. TRAFFIC GROWTH RATES AND PROJECTION

7.7.1 INTRODUCTION

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.

7.7.2 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:

$$\text{Loge (P)} = A_0 + A_1 \text{ Loge (EI)}$$

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 Bihar, Uttar Pradesh, Jharkhand 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.

7.7.3 PAST VEHICLE REGISTRATION DETAILS

In order to analyse the vehicle growth in the states, the vehicle registration data of Bihar, and Rest of India has been collected and presented in **Table 7-10** below.

Table 7-10: Past vehicle registration data of influencing states

Year	Two Wheeler	Cars	LCV	Buses	Trucks	Total Vehicles
Bihar						
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
India						
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

7.7.4 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 7-11** depicts the growth of economic indicators (The datum for GDP and other income levels have been modified to 2004-05 prices).

Table 7-11: Economic indices of states and India at constant prices (2004 - 05)

Year	NSDP (Corers.)	PCI (Rs)	Papulations	NSDP (Corers.)	PCI (Rs)	Papulations
Bihar			India			
2004-05	70167	7914	89264	2971464	24143	1095722
2005-06	70447	7813	90752	3253073	26015	1112186
2006-07	83846	9150	92208	3564364	28067	1128521
2007-08	90133	9685	93633	3896636	30332	1144734
2008-09	103867	10994	95026	4158676	31754	1160813
2009-10	115131	12012	96389	4507637	33843	1176742

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Detailed Project Report.

Year	NSDP (Corers.)	PCI (Rs)	Populations	NSDP (Corers.)	PCI (Rs)	Populations
2010-11	132488	13632	97720	4885954	35993	1192506
2011-12	150398	15268	99020	5202514	37851	1192506

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

7.7.5 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, R² values and t-statistic are presented in **Table 7-12** based on best fit.

Table 7-12: Observed transport demand elasticity values and traffic growth

Vehicle Type (a)		Elasticity (c)	R-square (f)
Bihar			
Two wheeler	PCI	1.13	0.98
Car	PCI	1.2	0.84
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

7.7.6 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 household 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.

7.7.7 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. Following are the Estimated and adopted Traffic growth rates for future traffic prediction (%)

Table 7-13: Estimated and adopted Traffic growth rates for future traffic prediction (%)

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-37:2018, for pavement design traffic growth rate should not be less than 5%. The final adopted growth rates are given in Table 7-14.

Table 7-14: Adopted Traffic growth rates for pavement design (%)

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%

7.7.8 TOTAL TRAFFIC PROJECTION

The summary of projected total is presented in Table 7-15 below.

Table 7-15: Traffic Projection

Year	2 Wheeler	3 Wheeler	Car	Mini bus	Bus	LCV	2-Axle	3-Axle	Multi Axle	Tractor With Trailer	Tractor	Total All Vehicles (Nos.)	Total All Vehicles (PCU)
2020	1900	280	3867	13	1063	1248	897	766	341	135	45	10555	17376
2021	2037	288	4155	13	1095	1324	926	790	352	139	46	11167	18181
2022	2184	297	4465	14	1128	1405	955	815	363	144	48	11818	19029

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Detailed Project Report.

Year	2 Wheeler	3 Wheeler	Car	Mini bus	Bus	LCV	2-Axle	3-Axle	Multi Axle	Tractor With Trailer	Tractor	Total All Vehicles (Nos.)	Total All Vehicles (PCU)
2023	2315	304	4741	14	1156	1473	979	836	372	147	49	12388	19759
2024	2453	312	5035	14	1185	1545	1004	857	382	151	50	12988	20522
2025	2600	320	5348	15	1214	1620	1029	879	391	155	52	13622	21319
2026	2756	328	5679	15	1244	1698	1055	901	401	159	53	14289	22153
2027	2921	336	6031	16	1275	1780	1081	924	411	163	54	14993	23026
2028	3072	343	6353	16	1303	1851	1104	943	420	166	55	15626	23800
2029	3230	350	6691	16	1330	1926	1127	962	428	170	57	16289	24605
2030	3397	358	7048	17	1359	2003	1150	982	437	173	58	16982	25443
2031	3572	366	7424	17	1388	2083	1174	1003	446	177	59	17709	26314
2032	3757	373	7819	17	1418	2167	1199	1024	456	180	60	18470	27221
2033	3927	380	8187	18	1445	2241	1220	1042	464	184	61	19168	28044
2034	4106	388	8572	18	1472	2318	1242	1060	472	187	62	19896	28896
2035	4292	395	8974	18	1500	2397	1264	1079	480	190	63	20654	29780
2036	4487	402	9396	19	1528	2479	1286	1099	489	194	65	21443	30696
2037	4690	410	9838	19	1557	2564	1309	1118	498	197	66	22266	31645
2038	4881	417	10252	19	1583	2640	1330	1135	505	200	67	23030	32518
2039	5080	424	10684	20	1610	2719	1350	1153	513	203	68	23824	33421
2040	5287	431	11133	20	1637	2800	1371	1171	521	206	69	24647	34353
2041	5502	439	11602	20	1665	2883	1392	1189	529	210	70	25501	35315
2042	5726	446	12091	21	1693	2969	1414	1207	538	213	71	26388	36310
2043	5937	453	12553	21	1719	3047	1433	1224	545	216	72	27220	37236
2044	6156	460	13032	21	1745	3128	1453	1241	552	219	73	28080	38189
2045	6383	467	13530	22	1772	3210	1473	1258	560	222	74	28970	39172
2046	6619	474	14047	22	1799	3295	1493	1275	568	225	75	29891	40185
2047	6863	481	14583	22	1826	3382	1514	1292	575	228	76	30844	41228
2048	7095	488	15094	23	1852	3462	1532	1308	582	231	77	31744	42209
2049	7335	495	15622	23	1878	3544	1551	1324	590	233	78	32674	43217
2050	7583	502	16169	23	1905	3628	1570	1341	597	236	79	33633	44254

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Detailed Project Report.

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-

Project: Construction of Four lane access controlled Greenfield National Highway (NH-119D), starting from its junction with NH-19 (Old NH-02) near village Amas connecting Ramnagar, Kachhi Dargah, Kalyanpur (Hajipur), Tajpur and terminating at its junction with Nh-27 near village Bela Nawada (Darbhanga) under Bharatmala Pariyojna in the state of Bihar- Package-IV from village Balbhadarapur (Design Ch. 47+000) to village Bela Nawada (Darbhanga) (Design Ch. 89+210) Total Length – 42.210 Km.



Detailed Project Report.

5/Package-7) from to Balbhadarapur (Km 47+000) to Bela Nawada (PKG-4) of Amas to Darbhanga section of NH-119D .

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

Vide SO 1043 (E) dated 04.03.2021, the highway starting from its junction with NH-19 near Amas connecting Ramnagar, Kacchi Dargah, Kalyanpur (Hajipur) , Tajpur and terminating at its junction with NH-27 near Bela Nawada (Darbhanga) in the state of Bihar is declared as New National highway no. 119D. the project will be developed in four packages.

Package I– Amas to Shivrampur - Length -55.002 Kms.

Package-II – Shivrampur to Ramnagar – Length- 54.322 kms.

Package III– Kalyanpur (near Hajipur) to Tal Dasraha (near Samastipur) - Length - 47.00Kms.

Package-IV – Tal Dasraha (near Samastipur) To Bela Nawada (near Darbhanga) – Length- 42.210 kms.

In this report we will discuss the project features of this new proposed green field alignment from “Kalyanpur” to “Balbhadarapur” treated as **Package -3** as mentioned above.

8.6 Settlements

Project: Construction of Four lane access controlled Greenfield National Highway (NH-119D), starting from its junction with NH-19 (Old NH-02) near village Amas connecting Ramnagar, Kachhi Dargah, Kalyanpur (Hajipur), Tajpur and terminating at its junction with Nh-27 near village Bela Nawada (Darbhanga) under Bharatmala Pariyojna in the state of Bihar- Package-IV from village Balbhadarpur (Design Ch. 47+000) to village Bela Nawada (Darbhanga) (Design Ch. 89+210) Total Length – 42.210 Km.



Detailed Project Report.

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.

Table 8.1: Detail of Settlements

S.No	Settlements	S.No	Settlements
1	Balbhadarpur	10	Manihas
2	Mathura Mandal	11	Bela Yakub
3	Harpur, Silaut	12	Mausimpur
4	Chal Rukum	13	Bela Nevada
5	Manjil	14	Simaria Bhindi
6	Mobarak	15	KoilaKund
7	Kharsand	16	Kolwara,Bihari
8	Mukund	17	Usma
9	Mirzapur	18	Asgaon

8.7 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.

8.8 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

Project: Construction of Four lane access controlled Greenfield National Highway (NH-119D), starting from its junction with NH-19 (Old NH-02) near village Amas connecting Ramnagar, Kachhi Dargah, Kalyanpur (Hajipur), Tajpur and terminating at its junction with Nh-27 near village Bela Nawada (Darbhanga) under Bharatmala Pariyojna in the state of Bihar- Package-IV from village Balbhadarpur (Design Ch. 47+000) to village Bela Nawada (Darbhanga) (Design Ch. 89+210) Total Length – 42.210 Km.



Detailed Project Report.

- 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.

8.9 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.

8.10 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

Project: Construction of Four lane access controlled Greenfield National Highway (NH-119D), starting from its junction with NH-19 (Old NH-02) near village Amas connecting Ramnagar, Kachhi Dargah, Kalyanpur (Hajipur), Tajpur and terminating at its junction with Nh-27 near village Bela Nawada (Darbhanga) under Bharatmala Pariyojna in the state of Bihar- Package-IV from village Balbhadarpur (Design Ch. 47+000) to village Bela Nawada (Darbhanga) (Design Ch. 89+210) Total Length – 42.210 Km.



Detailed Project Report.

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

8.11 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

8.12 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 Gol, Forests & Env. Dept., GoB, CPCB, BSPCB

Project: Construction of Four lane access controlled Greenfield National Highway (NH-119D), starting from its junction with NH-19 (Old NH-02) near village Amas connecting Ramnagar, Kachhi Dargah, Kalyanpur (Hajipur), Tajpur and terminating at its junction with Nh-27 near village Bela Nawada (Darbhanga) under Bharatmala Pariyojna in the state of Bihar- Package-IV from village Balbhadarpur (Design Ch. 47+000) to village Bela Nawada (Darbhanga) (Design Ch. 89+210) Total Length – 42.210 Km.



Detailed Project Report.

2.	Environmental Impact Assessment (EIA) Notification	2006	To provide environmental clearance to new development activities following environmental impact assessment	No	The project does not attract the conditions of EIA Notification 2006 and further amendments	MoEF&CC
3.	Forest (Conservation) Act	1980	To check deforestation by restricting conversion of forested areas into non-forested areas	Yes	There is 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
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

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Detailed Project Report.

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&C
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 persons affected by accident occurring while handling any hazardous substance and for matters connected therewith or incidental thereto	Yes	Contractor need to stock hazardous material like diesel, Bitumen, Emulsions etc. safely	BSPCB
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&C
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

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Detailed Project Report.

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
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 be applicable.	Forest Department Gol and GoB

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Detailed Project Report.

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

8.13 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	State Pollution Control Board	For establishing plants	Construction (Prior to work initiation)	2-3 Months	Concessionaire / Contractor

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Detailed Project Report.

S. No.	Type of Clearance	Statutory Authority	Applicability	Project stage	Time required	Responsibility
	of SPCB					
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
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	Dept. of Geology	Quarrying and borrowing	Construction (Prior to work initiation)	2-3 Months	Concessionaire / Contractor

Project: Construction of Four lane access controlled Greenfield National Highway (NH-119D), starting from its junction with NH-19 (Old NH-02) near village Amas connecting Ramnagar, Kachhi Dargah, Kalyanpur (Hajipur), Tajpur and terminating at its junction with Nh-27 near village Bela Nawada (Darbhanga) under Bharatmala Pariyojna in the state of Bihar- Package-IV from village Balbharpur (Design Ch. 47+000) to village Bela Nawada (Darbhanga) (Design Ch. 89+210) Total Length – 42.210 Km.



Detailed Project Report.

S. No.	Type of Clearance	Statutory Authority	Applicability	Project stage	Time required	Responsibility
	license	and Mines	operations	work initiation)		
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 22 nd Aug 2013 S.O. 2559 (E) expansion road projects involved acquisition up to 40 meters and 60 meters on realignment/ bypasses are 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

8.14 Baseline Environmental Conditions

A brief description of key environmental features of project districts i.e. Samastipur and Badharpur (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.

Project: Construction of Four lane access controlled Greenfield National Highway (NH-119D), starting from its junction with NH-19 (Old NH-02) near village Amas connecting Ramnagar, Kachhi Dargah, Kalyanpur (Hajipur), Tajpur and terminating at its junction with Nh-27 near village Bela Nawada (Darbhanga) under Bharatmala Pariyojna in the state of Bihar- Package-IV from village Balbhadarpur (Design Ch. 47+000) to village Bela Nawada (Darbhanga) (Design Ch. 89+210) Total Length – 42.210 Km.



Detailed Project Report.



Figure 8.2: Map of 2 Project Districts

Project: Construction of Four lane access controlled Greenfield National Highway (NH-119D), starting from its junction with NH-19 (Old NH-02) near village Amas connecting Ramnagar, Kachhi Dargah, Kalyanpur (Hajipur), Tajpur and terminating at its junction with Nh-27 near village Bela Nawada (Darbhanga) under Bharatmala Pariyojna in the state of Bihar- Package-IV from village Balbhadarapur (Design Ch. 47+000) to village Bela Nawada (Darbhanga) (Design Ch. 89+210) Total Length – 42.210 Km.



Detailed Project Report.

8.15 Location & Topography

Vide SO 1043 (E) dated 04.03.2021, the highway starting from its junction with NH-19 near Amas connecting Ramnagar, Kacchi Dargah, Kalyanpur (Hajipur) , Tajpur and terminating at its junction with NH-27 near Bela Nawada (Darbhanga) in the state of Bihar is declared as New National highway no. 119D. the project will be developed in four packages.

Package I– Amas to Shivrampur - Length -55.002 Kms.

Package-II – Shivrampur to Ramnagar – Length- 54.322 kms.

Package III– Kalyanpur (near Hajipur) to Tal Dasraha (near Samastipur) - Length -47.00Kms.

Package-IV – Tal Dasraha (near Samastipur) To Bela Nawada (near Darbhanga) – Length-42.210 kms.

In this report we will discuss the project features of this new proposed green field alignment from “Balbhadarapur” to “Bela Nawada” treated as Package -4 as mentioned above.

Latitude and longitude of this package of project corridor lies between 25.888289, 85.750183 and 26.186044°, 85.937056

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°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: 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

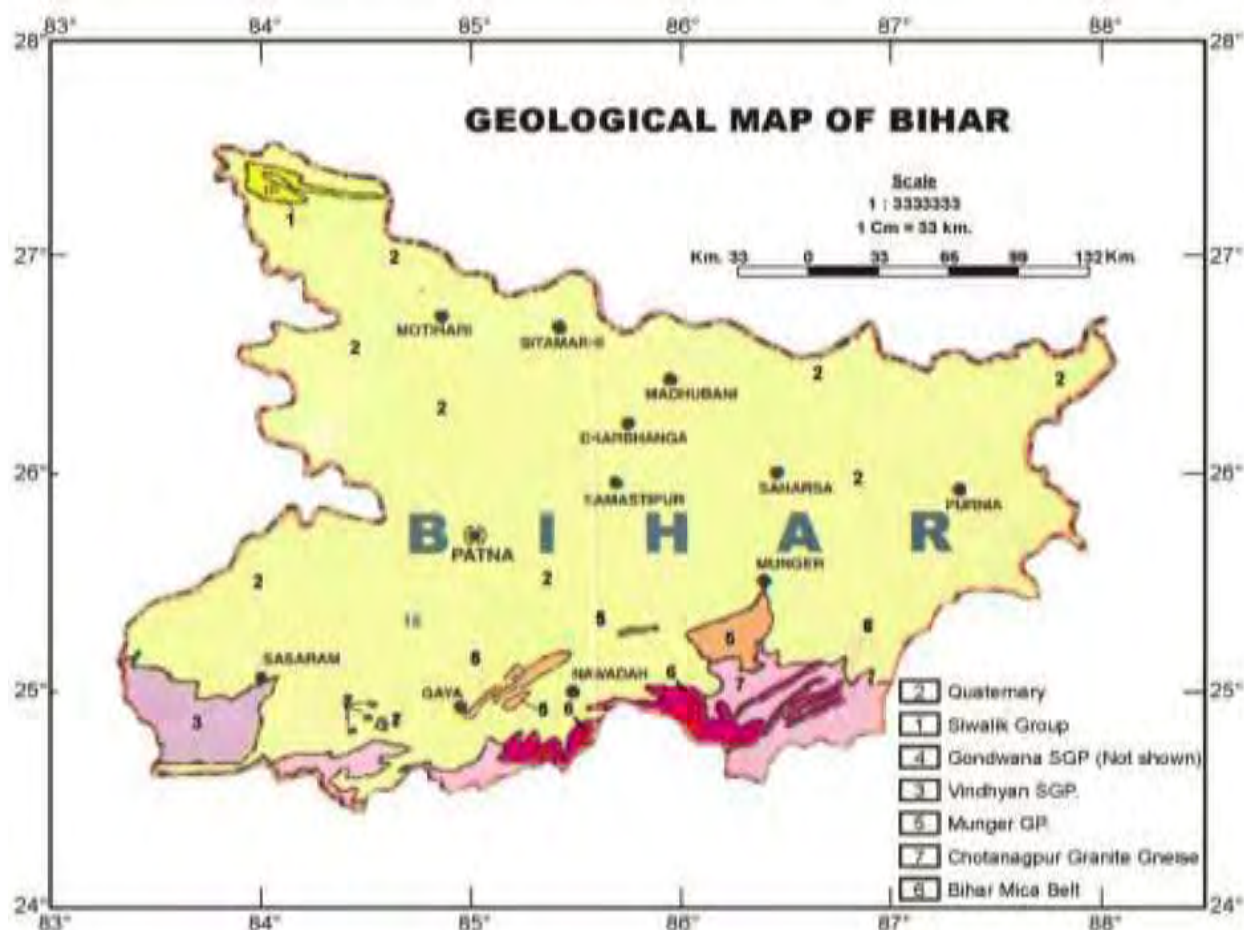
Project: Construction of Four lane access controlled Greenfield National Highway (NH-119D), starting from its junction with NH-19 (Old NH-02) near village Amas connecting Ramnagar, Kachhi Dargah, Kalyanpur (Hajipur), Tajpur and terminating at its junction with Nh-27 near village Bela Nawada (Darbhanga) under Bharatmala Pariyojna in the state of Bihar- Package-IV from village Balbhadarpur (Design Ch. 47+000) to village Bela Nawada (Darbhanga) (Design Ch. 89+210) Total Length – 42.210 Km.



Detailed Project Report.

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 m²/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 m³.



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

Figure 8.3: Geological Map of Bihar and Project Area

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.

Project: Construction of Four lane access controlled Greenfield National Highway (NH-119D), starting from its junction with NH-19 (Old NH-02) near village Amas connecting Ramnagar, Kachhi Dargah, Kalyanpur (Hajipur), Tajpur and terminating at its junction with Nh-27 near village Bela Nawada (Darbhanga) under Bharatmala Pariyojna in the state of Bihar- Package-IV from village Balbhadarpur (Design Ch. 47+000) to village Bela Nawada (Darbhanga) (Design Ch. 89+210) Total Length – 42.210 Km.



Detailed Project Report.

The project site of proposed road is situated in moderately stable zone which falls under seismic zone IV (as per IS 1893 (Part-I): 2002) category.

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.

Project: Construction of Four lane access controlled Greenfield National Highway (NH-119D), starting from its junction with NH-19 (Old NH-02) near village Amas connecting Ramnagar, Kachhi Dargah, Kalyanpur (Hajipur), Tajpur and terminating at its junction with Nh-27 near village Bela Nawada (Darbhanga) under Bharatmala Pariyojna in the state of Bihar- Package-IV from village Balbhadarpur (Design Ch. 47+000) to village Bela Nawada (Darbhanga) (Design Ch. 89+210) Total Length – 42.210 Km.



Detailed Project Report.



Figure 8.4: Seismic Zonation Map of India and Project Region

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Detailed Project Report.

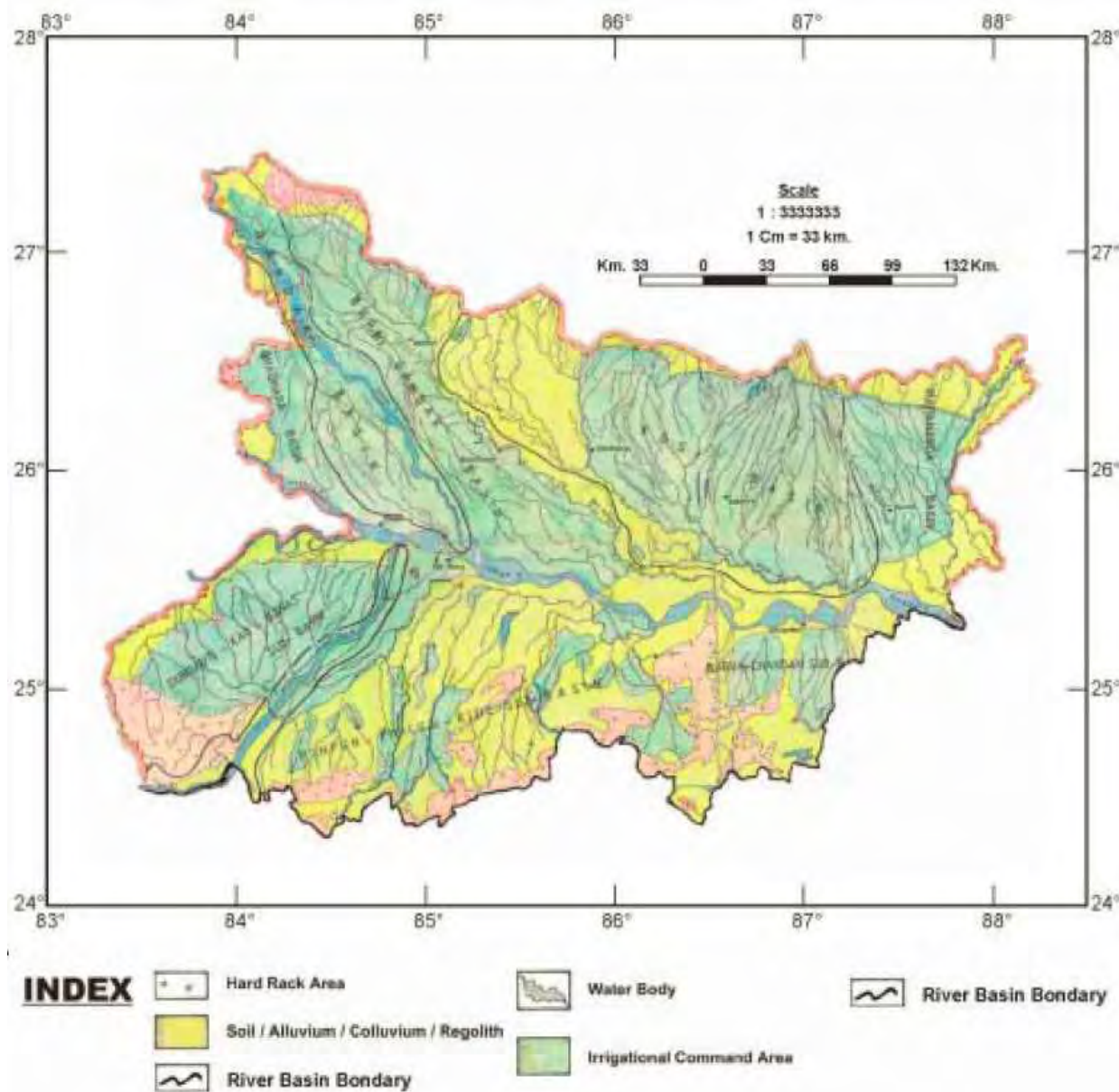


Figure 8.5: Drainage Pattern and River Basin Map of Bihar and Project Region

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

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Detailed Project Report.

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 Hajipur, Desari, Tajpur, Samastipur 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 district Hajipur is mainly drained by the Ganga River, Gandak River and Baya River. Samastipur is traversed by a number of rivers including Budhi Gandak, Baya, Kosi, Kamla, Kareh and Jhamwari and Balan, which are both the offshoots of Burhi Gandak. The Ganges also skirts the district on the south.

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 drawn 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 Vaishali) are affected by excess arsenic content in drinking water sources. Excess nitrate in few habitations has also been noticed.

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Detailed Project Report.

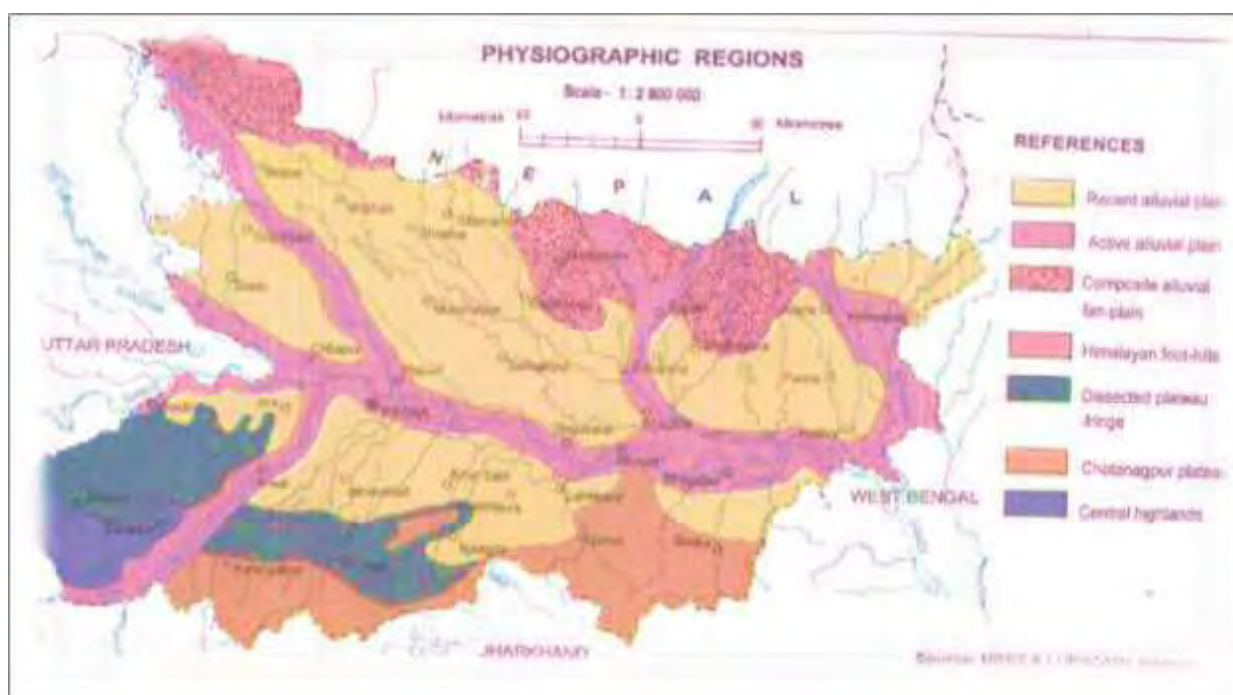
8.15.7 Physiography & Soil

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 road 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.



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Detailed Project Report.

Figure 8.6: Physiographic Map of Project Area

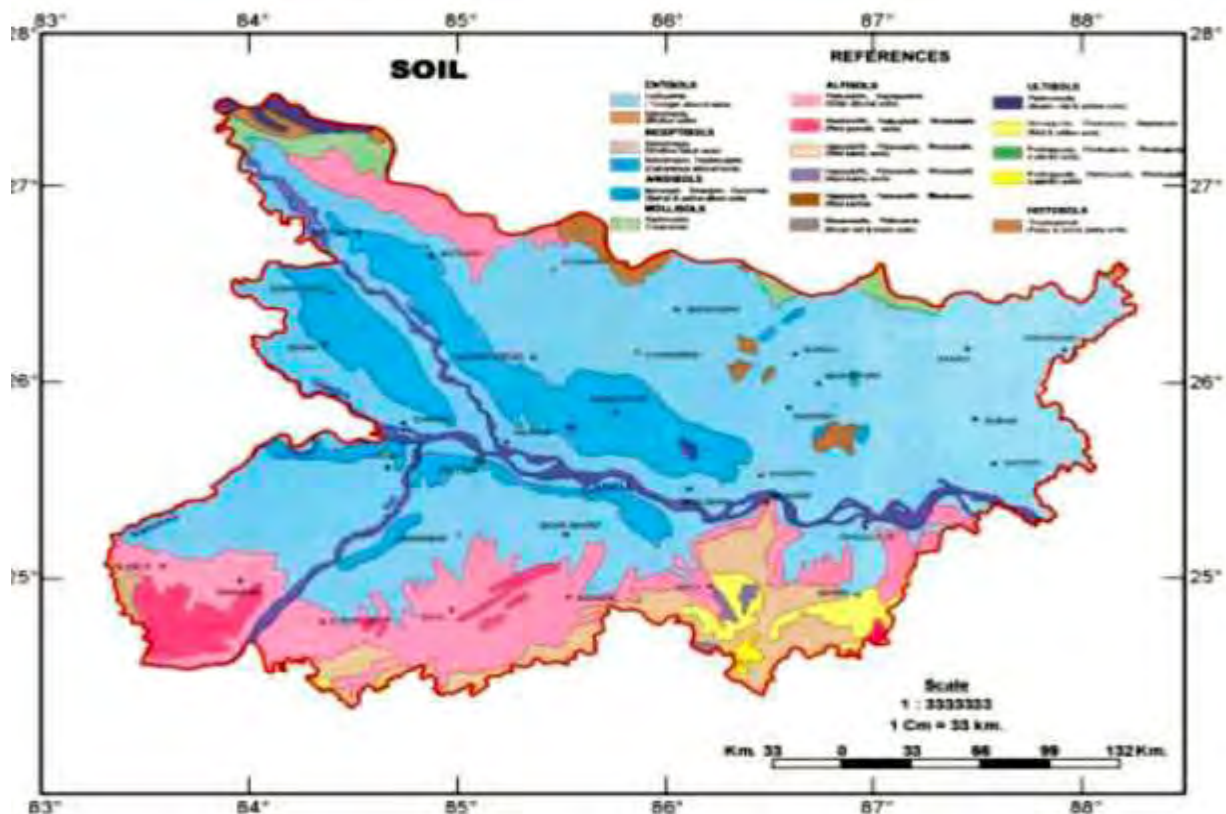


Figure 8.7: Soil Map of the State and Project Area

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.

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Detailed Project Report.

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.

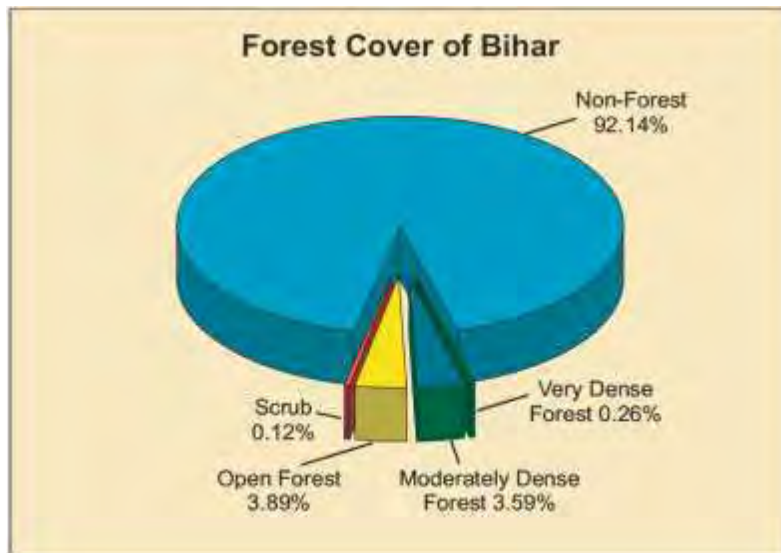


Figure 8.8: Forest Cover Distribution of Bihar



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Detailed Project Report.

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 bellayocica* (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*, *Flemingia chappar*, *Zizyphus xylopyra*, *Bauhinia vahlii*, *Smilex protifrera*, *Butea superba*, *Butea parviflora*.

8.15.8.2 Wildlife and Protected Area

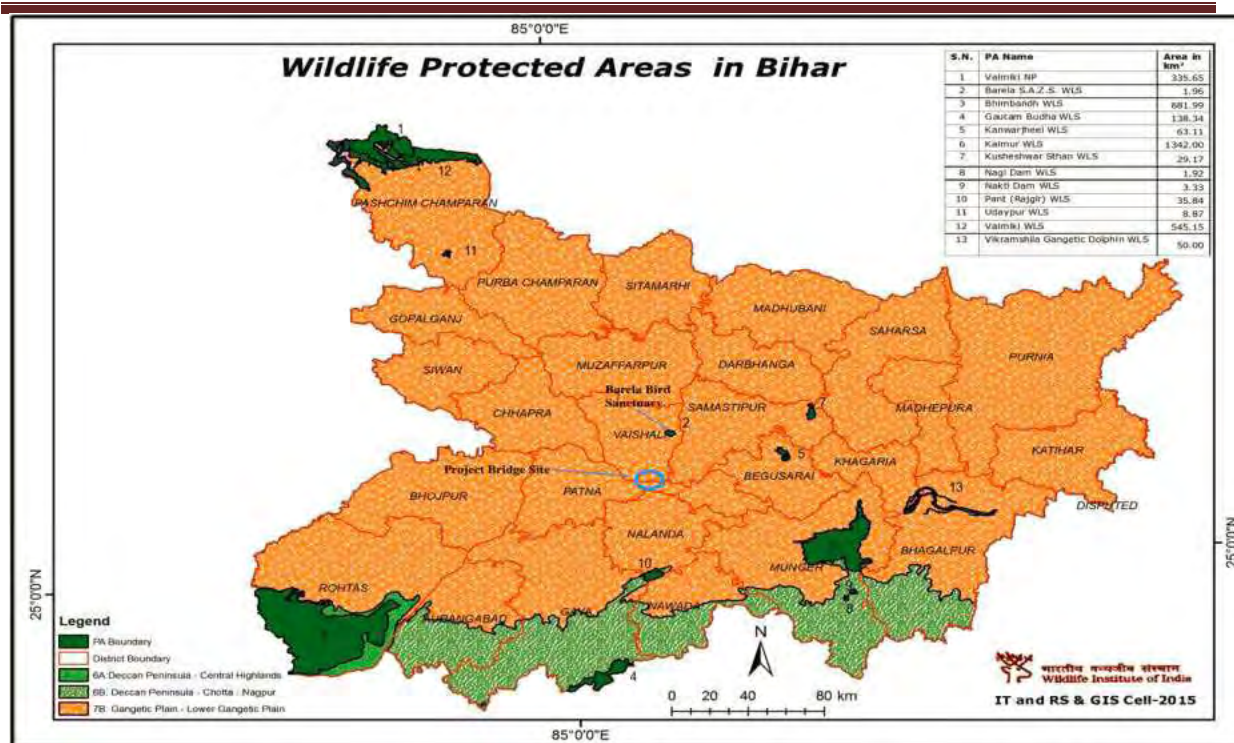
Protected Area Network: The protected area network of Bihar consists of wildlife sanctuaries and national parks. There is one national park and twelve wildlife sanctuaries covering an area of 0.32 million hectares, which constitutes 3.38% of the total geographical area of the state. The lone tiger reserve 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.

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Detailed Project Report.



(Source: Wildlife Institute of India, Dehradun)

Figure 8.10: Protected Area Map of Bihar and Project Area

Mammals: Local people reported the presence of the Indian mongoose (*Herpestes edwardsii*) and five striped 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 caeruleus*) 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.

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Detailed Project Report.

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/km² compared to 325 persons/km² 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 Vaishali district has a population of 3,495,021. This gives it a ranking of 86th in India (out of a total of 640). The district has a population density of 1,717 inhabitants per square kilometer. Its population growth rate over the decade 2001-2011 was 28.58%. Vaishali has a sex ratio of 892 females for every 1000 males and a literacy rate of 66.60%. At the time of the 2011 Census of India, 95.09% of the population in the district spoke Maithili and 4.80% Urdu as their first language. According to the 2011 census Samastipur district has a population of 4,261,566. This gives it a ranking of 45th in India (out of a total of 640). The district has a population density of 1,465 inhabitants per square kilometer. Its population growth rate over the decade 2001-2011 was 25.33%. Samastipur has a sex ratio of 909 females for every 1000 males, and a literacy rate of 64.21%. At the time of the 2011 Census of India, 60.74% of the population in the district spoke Hindi, 30.79% Maithili and 8.40% Urdu 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

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Detailed Project Report.

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 adhoc basis with no specific regular fishing locations.
- 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

Project: Construction of Four lane access controlled Greenfield National Highway (NH-119D), starting from its junction with NH-19 (Old NH-02) near village Amas connecting Ramnagar, Kachhi Dargah, Kalyanpur (Hajipur), Tajpur and terminating at its junction with Nh-27 near village Bela Nawada (Darbhanga) under Bharatmala Pariyojna in the state of Bihar- Package-IV from village Balbhadarpur (Design Ch. 47+000) to village Bela Nawada (Darbhanga) (Design Ch. 89+210) Total Length – 42.210 Km.



Detailed Project Report.

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

Project: Construction of Four lane access controlled Greenfield National Highway (NH-119D), starting from its junction with NH-19 (Old NH-02) near village Amas connecting Ramnagar, Kachhi Dargah, Kalyanpur (Hajipur), Tajpur and terminating at its junction with Nh-27 near village Bela Nawada (Darbhanga) under Bharatmala Pariyojna in the state of Bihar- Package-IV from village Balbhadarpur (Design Ch. 47+000) to village Bela Nawada (Darbhanga) (Design Ch. 89+210) Total Length – 42.210 Km.



Detailed Project Report.

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.

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Detailed Project Report.

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).

Project: 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 Kalyanpur to Tal-Dasraha of Hajipur to Darbhanga Section.

Detailed Project Report.

Table 8.6: Environmental Impact Matrix

Activities under Project	Planning & Design Phase	Construction Phase						Operation Phase	Indirect effect of operation
		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		
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 Ecosysteme	-	-	-

Project: 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 Kalyanpur to Tal-Dasraha of Hajipur to Darbhanga Section.

Detailed Project Report.

Activities under Project	Planning & Design Phase	Construction Phase						Operation Phase	Indirect effect of operation
						ms 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	-	-		-	-	-

Project: 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 Kalyanpur to Tal-Dasraha of Hajipur to Darbhanga Section.

Detailed Project Report.

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	-	-	-	-	-

Project: 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 Kalyanpur to Tal-Dasraha of Hajipur to Darbhanga Section.



Detailed Project Report

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 in Table 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	<ul style="list-style-type: none"> • 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	<ul style="list-style-type: none"> • 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	<ul style="list-style-type: none"> • 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.

Project: 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 Kalyanpur to Tal-Dasraha of Hajipur to Darbhanga Section.

Detailed Project Report



S. No.	Potential Impact	Mitigation Measures / Enhancement
9	Scarified Non Bituminous Material	Used in the normal GSB layer (not the drainage layer)
10	Cut material	<ul style="list-style-type: none"> 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	<ul style="list-style-type: none"> 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 team 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	<ul style="list-style-type: none"> 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 all the spilled material to the oil interceptor.

Project: 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 Kalyanpur to Tal-Dasraha of Hajipur to Darbhanga Section.

Detailed Project Report



S. No.	Potential Impact	Mitigation Measures / Enhancement
15	Meteorological factors and climate	<ul style="list-style-type: none"> Comprehensive Afforestation Avenue plantation Shrub plantation in the median / island
16	Dust generation	<ul style="list-style-type: none"> 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	<ul style="list-style-type: none"> 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 statutory 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	<ul style="list-style-type: none"> 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	<ul style="list-style-type: none"> Silt fencing to be provided Guidelines for Sediment Control to be framed
23	Contamination of Water	<ul style="list-style-type: none"> 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	<ul style="list-style-type: none"> Options for Noise barriers to be analysed No Horn Zone sign Post.
26	Noise Pollution (Pre-Construction Stage)	<ul style="list-style-type: none"> Machinery to be checked and complied with noise pollution regulations. Camps to be setup away from the settlements, in

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Detailed Project Report



S. No.	Potential Impact	Mitigation Measures / Enhancement
		the down wind direction
27	Noise Pollution (Construction Stage)	<ul style="list-style-type: none"> Camps to be setup away from the settlements, in the down wind direction. 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	<ul style="list-style-type: none"> Minimum acquisition of land Permission for acquisition from forest department as per Forest Act Plantation of trees as per Forest Department
31	Trees Cutting	<ul style="list-style-type: none"> 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	<ul style="list-style-type: none"> 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.

Project: 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 Kalyanpur to Tal-Dasraha of Hajipur to Darbhanga Section.

Detailed Project Report



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

Project: 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 Kalyanpur to Tal-Dasraha of Hajipur to Darbhanga Section.

Detailed Project Report



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.

Project: 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 Kalyanpur to Tal-Dasraha of Hajipur to Darbhanga Section.

Detailed Project Report



- 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.

Project:- Construction of Four lane access controlled Greenfield National Highway (NH-119D), starting from its junction with NH-19 (Old NH-02) near village Amas connecting Ramnagar, Kachhi Dargah, Kalyanpur (Hajipur), Tajpur and terminating at its junction with Nh-27 near village Bela Nawada (Darbhanga) under Bharatmala Pariyojna in the state of Bihar- Package-IV from village Balbhadarpur (Design Ch. 47+000) to village Bela Nawada (Darbhanga) (Design Ch. 89+210) Total Length – 42.210 Km.



Detailed Project Report.

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

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Detailed Project Report.

earthwork as well as materials have been calculated with the areas obtained at 10m intervals.

10.5 PAVEMENT MATERIAL

The pavement work includes construction of proposed carriageway. The Rigid Pavement includes PQC, DLC & GSB while the flexible pavement includes BC, DBM, WMM & CTSB and Subgrade and other related items like prime coat and tack coat etc. over road formation. The quantities of Rigid and 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 plan.

10.8 ROAD FURNITURE AND SAFETY WORKS

Provisions for road safety measures road signs, markings, road appurtenant have been made.

The cost estimate for works item is presented in **Table 10.1 in which SOR, Bihar, 2021-2022 has been used applicable from 1st April 2021.**

Sl. No.	Description of Item	Amount
		(Rs. in Crore)
1	Site Clearance	4.96
2	Earth Work	129.00
3	Non-Bituminous Courses	81.67
4	Rigid Pavement (PQC & DLC)	231.15
5	Major Bridges	294.73
6	Minor Bridges	66.07
7	VUP/LVUP/SVUP	79.54
8	Flyover	103.66
9	Overpass	-
10	Culverts	28.50

Project:- Construction of Four lane access controlled Greenfield National Highway (NH-119D), starting from its junction with NH-19 (Old NH-02) near village Amas connecting Ramnagar, Kachhi Dargah, Kalyanpur (Hajipur), Tajpur and terminating at its junction with Nh-27 near village Bela Nawada (Darbhanga) under Bharatmala Pariyojna in the state of Bihar- Package-IV from village Balbhadarpur (Design Ch. 47+000) to village Bela Nawada (Darbhanga) (Design Ch. 89+210) Total Length – 42.210 Km.



Detailed Project Report.

11	RE Wall	34.53
12	Drainage and Protective Works	101.76
13	Junctions	28.90
14	Traffic Signs, Marking, Road Studs and Road Appurtenances	8.48
15	Miscellaneous works	0.20
16	Rest Area Location	14.67
17	Toll Plaza	25.70
18	ROB	32.48
19	Lighting Cost	2.54
20	Bituminous Courses	2.12
A	Total civil cost excuding GST	1,270.64
B	Labour Cess 1%	12.71
C	Seigniorage	6.99
D	Cost of Utility Shifting (Under finalization)	63.53
E	Total civil cost	1,353.86
F	Centages @ 5% on (D)	67.69
G	Estimated Project Cost (D+E+F)	1,421.56
H	GST (12%) on Civil Cost	152.48
I	Land Acquisition Cost (Under finalization)	600.00
J	Environmental Screening, supervision charges (Under finalization)	4.50
Sub Total (G+H+I+J)		756.98
Total Capital Cost (including LA, US & FC)		2,178.53
Civil Cost per Km. (A/42.127 Km)		30.16
Project Cost per Km. (J/42.127 Km) (Excluding LA, US & FC)		51.71

Project:- Construction of Four lane access controlled Greenfield National Highway (NH-119D), starting from its junction with NH-19 (Old NH-02) near village Amas connecting Ramnagar, Kachhi Dargah, Kalyanpur (Hajipur), Tajpur and terminating at its junction with Nh-27 near village Bela Nawada (Darbhanga) under Bharatmala Pariyojna in the state of Bihar- Package-IV from village Balbhadarpur (Design Ch. 47+000) to village Bela Nawada (Darbhanga) (Design Ch. 89+210) Total Length – 42.210 Km.



Detailed Project Report.

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 11.1**.

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:- Construction of Four lane access controlled Greenfield National Highway (NH-119D), starting from its junction with NH-19 (Old NH-02) near village Amas connecting Ramnagar, Kachhi Dargah, Kalyanpur (Hajipur), Tajpur and terminating at its junction with Nh-27 near village Bela Nawada (Darbhanga) under Bharatmala Pariyojna in the state of Bihar- Package-IV from village Balbhadarpur (Design Ch. 47+000) to village Bela Nawada (Darbhanga) (Design Ch. 89+210) Total Length – 42.210 Km.



Detailed Project Report.

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%.

7.2 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.

Project:- Construction of Four lane access controlled Greenfield National Highway (NH-119D), starting from its junction with NH-19 (Old NH-02) near village Amas connecting Ramnagar, Kachhi Dargah, Kalyanpur (Hajipur), Tajpur and terminating at its junction with Nh-27 near village Bela Nawada (Darbhanga) under Bharatmala Pariyojna in the state of Bihar- Package-IV from village Balbhadarpur (Design Ch. 47+000) to village Bela Nawada (Darbhanga) (Design Ch. 89+210) Total Length – 42.210 Km.



Detailed Project Report.

HDM4 results shall be provided in Final Feasibility Report.

7.3 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

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)

Equity IRR for contractor will be 15%. It is given in five tranches linked to milestones. The balance 60 per cent is arranged by the developer. Here, the developer usually invests not more than 20-25 per cent of

Project:- Construction of Four lane access controlled Greenfield National Highway (NH-119D), starting from its junction with NH-19 (Old NH-02) near village Amas connecting Ramnagar, Kachhi Dargah, Kalyanpur (Hajipur), Tajpur and terminating at its junction with Nh-27 near village Bela Nawada (Darbhanga) under Bharatmala Pariyojna in the state of Bihar- Package-IV from village Balbhadarpur (Design Ch. 47+000) to village Bela Nawada (Darbhanga) (Design Ch. 89+210) Total Length – 42.210 Km.



Detailed Project Report.

the project cost (as against 40 percent or more before), while the remaining is raised as debt.

Financial analysis is done for Balbhadarpur to Bela Nawada 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	30 Years

Based on the above results, it is found that VGF is greater than 30%, for concession period of 30 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 Balbhadarpur to Bela Nawada PKG-4 stretch of Amas to Darbhanga greenfield highway NH-119D project in HAM model.