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E EXECUTIVE SUMMARY

E.1 Project Description

The project road, SH-98 passes through Katihar districts of Bihar, starts from Km 23+250 of SH- 62 (Purnia-Katihar road) toward left near Sirsa military camp. It passes through major settlement like Sonoulli, Salmari, Barsoi and Balrampur besides a lot of rural settlements all along the road length and ends at Balrampur at border of Bihar and West Bengal. The project road continues in west Bengal and meets to two lane Raiganj- Dalkola secton of NH-34 at Tungidighi, which is 2 km from Border of Bihar and West Bengal. Project road is generally single/intermediate road configuration with fair to good pavement condition. The up-gradation to two lane of this road will improve the level of service and attract freight & passenger traffic. The section is generally of single/intermediate configurations. The condition of road is generally fair to poor and whole stretch passes trough plain terrain.

E.2 Alternative Alignments/Bypasses

Considering the future traffic, congestion, geometric improvements and avoiding level junctions, two bypasses proposal are given in SH 98 Alignments, one at Sonaili (Near km 20+000) and other at Meenapur (km 32+100).

E.2.1 Alignment Options for Sonaili

The Sonaili town extends on both side of existing SH-98 alignment between Km 20+000 to Km 22+000.

Option 1: This Option takes off near existing Km 18+800 (approx 2.20 km behind from Sonaili T-junction). This Option is totally new alignment and passes through agricultural land and crosses Old SH road and Katihar- Siliguri rail line before merging with the existing SH-98 near existing Km 24+000. Total length is approx 5.15 km. The overall geometry is good.

Option 2: This Option takes off near existing Km 19+300 (approx 1.70 km behind from Sonaili T-junction). It passes through agricultural land and cross Katihar- Siliguri rail line before merging with the existing SH-98 near existing Km 24+000. Total length is approx 5.70 km of which 1.00km length follows existing road SH-98. The overall geometry is good.

Option 3: This Option is Existing SH-98 and passes through dense settlement of Sonaili Town and Level Crossing with sharp U-turn. After Sonaili, alignment passes through mainly agricultural land with some minor settlement in some sections. The overall geometry is very poor consists of sharp curve with short tangent which leads low speed. Total length of this option is approx 5.00 km.

Option 2 has been approved during presentation meeting held at BSRDCL, Patna on 9th January' 2014 and included for detailed study.

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E.2.2 Alignment Option for Meenapur

The Meenapur and Sundargachhi village settlement presently exists along the existing SH-98. Proposal of Bypass is because of avoiding two level crossings and for geometric improvement.

Option 1: This Option 1 is Existing SH-98 and passes through medium settlement of Meenapur and Sundargachhi village and after that passes through mainly agricultural land. The alignment crosses a railway line two times of which first one level crossing is currently not in use. The overall geometry is good except these two level crossings. Total length of this option is approx 5.60 km.

Option 2: This Option 2 takes off from a T junction near Km 32+100 and passes through almost agricultural land and merge with the existing SH-98 near Km 37+400 at Salmari junction. It is a new alignment except 250m length before reaching Salmari junction follows existing SH-98 and total length is approx 3.65 km. The geometry is as per the design standard of state highway.

Option 3: This Option 3 is an existing PMGSY road which currently use for through traffic. It takes off forming T junction near Km 32+100 and passes through congested villages and merge with the existing SH-98 near Km 37+400 at salmari junction. Total length is approx 4.35 km. The overall geometry is very poor consists of sharp curve with short tangent which leads low speed and safety problem.

Option 2 has been approved during presentation meeting held at BSRDCL, Patna on 9th January' 2014 and included for detailed study.

E.3 Socio-Economic Profile

E.3.1 General

Katihar district is one of the thirty-eight districts of Bihar state, India, and Katihar town is the administrative headquarter of the district. The district is a part of Purnia Division. Katihar became a full-fledged district when it was split from Purnia in 1973. Earlier Katihar district was dominated by Choudhary Family who were the biggest landlords of Kosi zone . Founder of Choudhary family was Khan Bahadur Mohammad Baksh who holds lands of about 15000 acres in Katihar district, 8500 acres in Purnia.

E.3.2 Economic Situation

The social and economic profile of the state during the past decade has undergone tremendous change. State Domestic Product (SDP), popularly known as 'State Income', is an important and reliable indicator to measure the growth of the economy as well as level of development in various socio-economic sectors of a state. The per capita Net State Domestic Product or Per Capita Income (PCI) is used to determine the absolute as well as the relative performance of the State Economy. In other words State Domestic product (SDP) and Per Capita Income (PCI) reflect overall performance of economy of the State and also the well being of the people during a given period of time.

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E.4 Traffic Analysis

The data (primary and secondary) collected has been analyzed to obtain information on ADT, Seasonal Variation, AADT, traffic composition, travel pattern and commodity movement pattern, Traffic Demand Forecasting. This information along with appreciation of other relevant parameters formed part of the basic input for the design and evaluation of the recommended improvement. These are discussed in the following paragraphs.

E.4.1 Traffic Characteristics

The data collected from primary and secondary sources has been computerised, compiled, checked and corrected before further proceeding for analysis. The data from various traffic surveys has been analysed to understand traffic characteristics and travel pattern in the study area. The analysis of the directional classified traffic volume counts observed for homogeneous sections has been carried out to work out the following traffic characteristics:

- Average Daily Traffic (ADT)
- Hourly Variation
- Daily Variation in Traffic Volume
- Directional Distribution
- Composition of ADT
- Annual Average Daily Traffic (AADT)

The various vehicle types having different sizes and characteristics were converted into Equivalent Passenger Car Units. The Passenger Car Unit (PCU) factors recommended by Indian Road Congress in "Guidelines for Capacity of Roads in Rural Areas" (IRC-64-1990) have been used for conversion, and are presented in Table E.1.

Table E.1: PCU Factors Adopted for Study

Fast Vehicles	PCU	Slow Vehicles	PCU
Car	1.0	Agricultural Tractor	1.5
Taxi	1.0	Agricultural Tractor & Trailer	4.5
Mini Bus	1.5	Animal/Hand Cart	6.0
Tata Magic	1.0	Cycle	0.5
Standard Bus	3.0	Cycle Rickshaw	2.0
3 wheeler Tempo	1.0		
4 wheeler Tempo	1.0		
LCV/LGV	1.5		
2-Axle Truck	3.0		
3 Axle Truck	3.0		
MAV	4.5		
Two Wheeler	0.5		
Auto Rickshaw	1.0		

Source: IRC: 64-1990

E.4.1.1 Traffic Intensity

The Classified Traffic Volume count survey has been conducted for 7 days continuously for each homogenous sections and 1 day on alternate corridor. For analysis purpose an average of 7 days count has been considered has been considered to get the Average Daily Traffic (ADT). Table E.2 presents the Average Daily Traffic (ADT). The obtained average daily traffic

will have to be adjusted to account for the seasonal variation to obtain the Annual Average Daily Traffic (AADT). Following are the salient findings:

Table E.2: Average Daily Traffic at Traffic Homogeneous Sections

Vehicle Type		Project Corridor		Alternate Corridor
		Sauria Km 11+000	Gorakhpur More Km 43+100	Dalkola Check Post Km 418+000 on Nh-31
Two Wheeler		1,254	1,644	2005
Three Wheeler		521	491	1364
Car/Van/Jeep		229	142	1274
Mini Bus		1	-	35
Pvt Bus		1	-	164
Govt Bus		-	-	13
3 wheeler Tempo		50	16	135
4 wheeler Tempo		61	87	251
LCV		9	14	344
2 Axle Truck		34	14	418
3 Axle Truck		31	34	1106
MAV		1	-	813
MAV>6A		-	-	39
HCM/EME		1	1	0
Agricultural Tractor		19	12	7
Agricultural Tractor & Trailer		105	92	132
Non Motorised Vehicles	Animal & Hand drawn	2	-	3
	Cycle	1,220	1,377	291
	Cycle Rickshaw	2	7	32
	Others	-	-	0
Vehicles	Motorised	2,317	2,547	8100
	Non Motorised	1,224	1,384	326
	Total	**3,541**	**3,931**	**8426**
PCU	Motorised	2,211	2,160	14137
	Non Motorised	626	703	228
	Total	**2,837**	**2,863**	**14365**

- The average daily traffic on the corridor vary between 3541 vehicles (2837 PCU) between 3931 vehicles (2863 PCU)
- The variation in the directional split 50:50 and 49:51 at Sonali and Gorakhpur more respectively;
- The traffic intensity in Salmari - Balrampur section is higher than the Sirsa - Salmari section and is primarily due to the influence of local non motorised traffic near Salmari and Barsoi
- Share of cars and Autos are more at Sonali compare to the Gorakhpur more but share of 2 wheeler and non motorised traffic is high at Gorakhpur more.
- Commercial vehicles are very less at both the sections on the project corridor.

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E.4.1.2 Annual Average Daily Traffic

The AADT has been estimated by applying the seasonal correction factor as estimated above to the average daily traffic from primary surveys. Table E.3 presents the Annual Average Daily Traffic (AADT). The salient findings are presented below:

Table E.3: Annual Average Daily Traffic

Vehicle Type		Sauria Km 11+000	Gorakhpur More Km 43+100
Two Wheeler		1,467	1,923
Three Wheeler		610	574
Car/Van/Jeep		268	166
Mini Bus		1	-
Pvt Bus		1	-
Govt Bus		-	-
3 wheeler Tempo		59	19
4 wheeler Tempo		71	102
LCV		11	16
2 Axle Truck		40	16
3 Axle Truck		36	40
MAV		1	-
MAV>6A		-	-
HCM/EME		1	1
Agricultural Tractor		19	12
Agricultural Tractor & Trailor		105	92
Non Motorised Vehicles	Animal & Hand drawn	2	-
	Cycle	1,220	1,377
	Cycle Rickshaw	2	7
	Others	-	-
Vehicles	Motorised	2,690	2,962
	Non Motorised	1,224	1,384
	Total	**3,914**	**4,346**
PCU	Motorised	2,502	2,453
	Non Motorised	626	703
	Total	**3,128**	**3,156**

The salient findings are briefed below:

- Traffic is high at Gorakhpur more in numbers compare to the Sonali
- There is no much variation in the traffic in terms of PCUs at both the homogeneous sections

E.4.2 Traffic Projection

The total corridor traffic is the sum of normal traffic, induced, diverted traffic and generated traffic. The total estimated traffic on to the project corridor has been presented in the Table E.4.

Table E.4: Traffic Projection for Sirsa-Salmari Section and Salmari-Balrampur Section

Year	Sirsa-Salmari	Salmari-Balrampur

	Vehicles	PCU	Vehicles	PCU
2013	3914	3127	4345	3154
2014	4135	3303	4592	3332
2015	4376	3493	4860	3524
2016	4649	3709	5165	3743
2017	5394	4639	5943	4675
2018	6073	5237	6659	5276
2019	6726	5797	7352	5840
2020	7206	6202	7877	6249
2021	7723	6639	8439	6690
2022	8285	7113	9051	7167
2023	8897	7628	9717	7685
2024	9564	8186	10442	8247
2025	10289	8791	11231	8858
2026	11141	9490	12163	9566
2027	12074	10252	13184	10340
2028	13097	11085	14304	11185
2029	14218	11994	15531	12108
2030	15447	12986	16876	13117
2031	16715	14002	18268	14153
2032	18098	15106	19787	15280
2033	19606	16305	21444	16505
2034	21250	17609	23252	17837
2035	23044	19026	25224	19287
2036	25001	20567	27377	20863
2037	27135	22242	29725	22579
2038	29463	24064	32288	24446
2039	32003	26045	35086	26477
2040	34774	28200	38138	28688
2041	37797	30545	41470	31095
2042	41096	33095	45106	33714
2043	44695	35870	49075	36566

E.5 Capacity Analysis

IRC: 64 - 1990 stipulates a design service volume of 15,000 PCU per day for a two lane undivided carriageway without paved shoulders at level of service B in plain terrain. The capacity of the 2 lane road can be increased upto 15% by providing 1.5m paved shoulder. The traffic projections on the sections of the project corridor have been compared with the design service volume for a 2 lane carriageway with and without paved shoulder. As per the Traffic projection 2 lane can serve for next 20 years.

E.5.1 Proposals along Major Settlements

The details of major settlements and improvement proposals along settlements on existing road are given in Table E.5 below.

Table E.5: Improvement Proposals along Major Settlements

S. No.	Name of Settlement	Existing Km	Approx. Length	Proposal

			(m)	
1	Sonaili Town	From Km 20+750 to Km 22+000	1250	Standard 2-lane Sonaili Bypass (from km18+500 to km 23+000)
2	Salmari Town	From Km 37+500 to Km 39+500	2000	Standard 2-lane flexible/rigid pavement with both side Widening
3	Barsoi Town	From Km 48+000 to Km 49+785	1785	4-lane rigid pavement with both side Widening
4	Raghunathpur Town	From Km 52+500 to Km 53+000	500	Standard 2-lane with both side slip road

E.5.2 Typical Cross-Sections

Typical cross-sections for widening and new construction of highway have been developed based on site requirements and to meet design standards stated in the two lanes manual for the State Highways. A schedule, detailing type of cross-section adopted in different sections of the project road is presented in Table E.6.

Table E.6: Typical Cross-Section Details

Type of TCS	Description
Type 1	**Both side widening** with 7m carriageway width and 2.5 m earthen shoulder on both side of carriageway.
Type 2	**One side widening** with 7m carriageway width and 2.5 m earthen shoulder on both side of carriageway.
Type 3	**New construction** with 7m carriageway width and 2.5 m earthen shoulder on both side of carriageway for realignment/bypasses.
Type 4	**New construction** with 7m carriageway width, 1m paved shoulder and 1.5 m raised footpath cum lined drain on both side of carriageway with rigid pavement in built-up areas.
Type 5	**New construction** with 7.5m carriageway, 1.5 m raised median and 1.5m raised footpath cum lined drain on both side of carriageway with rigid pavement at Barsoi town.
Type 6	**New construction for ROB approaches in Semi urban areas** with both side slip road of 5.5m width with 7m carriageway, 2.5 m granular shoulder and 1m raised footpath cum lined drain on both side of slip road
Type 7	**New construction for ROB approaches in Rural areas** without slip road with 8m carriageway, 2 m raised shoulder and open drain of 1.5m width on both side of carriageway

E.5.3 Widening Schedule

The widening options developed section wise is presented in **Table E.7** below. The length of sections according to the type of widening i.e. left/right/both is as follows:

Both side widening	39.343 km
Left hand side widening	1.470 km
Right hand side widening	0.630 km
Realignment & curve improvement	7.652 km
Bypasses	6.870 km
Four lane road	1.785 km
ROB with approaches	4.770 km
Slip road	2.550 km

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Table E.7: Widening Schedule

Design Chainage (Km)		Proposed Length (m)	Widening (LHS/RHS/ Both)	Type of TCS	Remarks
From	To				
0+000	0+448	448	Both side	TYPE-1	
0+448	0+873	425	New ROB approache with slip road	TYPE-6	
0+873	0+928	55		ROB	
0+928	1+353	425	New ROB approache with slip road	TYPE-6	
1+353	1+450	98	Minor realignment & Curve improvement	TYPE-3	
1+450	1+530	80	RHS	TYPE-2	
1+530	1+630	100	Minor realignment & Curve improvement	TYPE-3	
1+630	2+000	370	Both side	TYPE-1	
2+000	2+100	100	RHS	TYPE-2	
2+100	2+610	510	Both side	TYPE-1	
2+610	2+740	130	Minor realignment & Curve improvement	TYPE-3	
2+740	2+990	250	Both side	TYPE-1	
2+990	3+100	110	LHS	TYPE-2	
3+100	3+200	100	Both side	TYPE-1	
3+200	3+320	120	LHS	TYPE-2	
3+320	3+500	180	Minor realignment & Curve improvement	TYPE-3	
3+500	3+780	280	Both side	TYPE-1	
3+780	3+950	170	Minor realignment & Curve improvement	TYPE-3	
3+950	4+030	80	Both side	TYPE-1	
4+030	4+120	90	Minor realignment & Curve improvement	TYPE-3	
4+120	4+380	260	Both side	TYPE-1	
4+380	4+730	350	Minor realignment & Curve improvement	TYPE-3	
4+730	5+110	380	Both side	TYPE-1	
5+110	5+300	190	Minor realignment & Curve improvement	TYPE-3	
5+300	5+380	80	Both side	TYPE-4	Rigid Pavement
5+380	5+540	160	Minor realignment & Curve improvement		
5+540	5+800	260	Both side		
5+800	5+900	100	Minor realignment & Curve improvement		
5+900	6+000	100	Both side		
6+000	6+100	100	Minor realignment & Curve improvement		
6+100	6+370	270	Minor realignment & Curve improvement	TYPE-3	
6+370	6+620	250	LHS	TYPE-2	
6+620	6+810	190	Minor realignment & Curve improvement	TYPE-3	
6+810	7+300	490	Both side	TYPE-1	
7+300	7+400	100	LHS	TYPE-2	
7+400	7+750	350	Both side	TYPE-1	
7+750	8+175	425	Both side	TYPE-4	Rigid Pavement
8+175	8+300	125	Minor realignment & Curve improvement	TYPE-3	
8+300	8+450	150	LHS	TYPE-2	
8+450	9+250	800	Both side	TYPE-1	
9+250	9+380	130	Both side	TYPE-4	Rigid Pavement
9+380	9+420	40	Minor realignment & Curve improvement		
9+420	9+550	130	Both side		

Design Chainage (Km)		Proposed Length (m)	Widening (LHS/RHS/ Both)	Type of TCS	Remarks
From	To				
9+550	9+670	120	Both side	TYPE-1	
9+670	9+740	70	Minor realignment & Curve improvement	TYPE-3	
9+740	9+850	110	Both side	TYPE-1	
9+850	9+970	120	Minor realignment & Curve improvement	TYPE-3	
9+970	10+070	100	Both side	TYPE-1	
10+070	10+220	150	Minor realignment & Curve improvement	TYPE-3	
10+220	10+400	180	Both side	TYPE-1	
10+400	10+720	320	Both side	TYPE-4	Rigid Pavement
10+720	10+830	110	Minor realignment & Curve improvement		
10+830	11+200	370	Both side		
11+200	11+430	230	Minor realignment & Curve improvement	TYPE-3	
11+430	11+740	310	Both side	TYPE-1	
11+740	11+900	160	LHS	TYPE-2	
11+900	12+050	150	Minor realignment & Curve improvement	TYPE-3	
12+050	12+650	600	Both side	TYPE-1	
12+650	12+800	150	Minor realignment & Curve improvement	TYPE-3	
12+800	12+910	110	Both side	TYPE-1	
12+910	14+150	1240	Minor realignment & Curve improvement	TYPE-3	
14+150	14+550	400	Both side	TYPE-1	
14+550	14+670	120	Minor realignment & Curve improvement	TYPE-3	
14+670	14+900	230	Both side	TYPE-1	
14+900	15+120	220	Minor realignment & Curve improvement	TYPE-3	
15+120	15+290	170	Both side	TYPE-1	
15+290	15+400	110	RHS	TYPE-2	
15+400	15+470	70	Both side	TYPE-1	
15+470	15+710	240	Minor realignment & Curve improvement	TYPE-3	
15+710	16+320	610	Both side	TYPE-1	
16+320	16+360	40	LHS	TYPE-2	
16+360	16+450	90	LHS	TYPE-4	Rigid Pavement
16+450	16+900	450	Both side		
16+900	16+975	75	LHS		
16+975	17+040	65	LHS	TYPE-2	
17+040	17+330	290	Both side	TYPE-1	
17+330	17+400	70	LHS	TYPE-2	
17+400	17+610	210	Both side	TYPE-1	
17+610	17+700	90	RHS	TYPE-2	
17+700	18+320	620	Both side	TYPE-1	
18+320	18+420	100	LHS	TYPE-2	
18+420	18+500	80	Both side	TYPE-1	
18+500	19+526	1026	Major realignment	TYPE-3	Sonaili Bypass
19+526	19+951	425	New ROB approache without slip road with normal embankment slope	TYPE-7	
19+951	20+031	80		ROB	
20+031	20+456	425	New ROB approache without slip road with normal embankment slope	TYPE-7	
20+456	23+000	2544	Major realignment	TYPE-3	
23+000	23+370	370	Both side	TYPE-1	

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Design Chainage (Km)		Proposed Length (m)	Widening (LHS/RHS/ Both)	Type of TCS	Remarks
From	To				
23+370	23+640	270	Minor realignment & Curve improvement	TYPE-3	
23+640	23+800	160	Both side	TYPE-1	
23+800	24+000	200	Minor realignment & Curve improvement	TYPE-3	
24+000	24+100	100	Both side	TYPE-1	
24+100	24+670	570	Minor realignment & Curve improvement	TYPE-3	
24+670	24+750	80	Both side	TYPE-1	
24+750	25+300	550	Minor realignment & Curve improvement	TYPE-3	
25+300	25+450	150	Both side	TYPE-1	
25+450	25+830	380	Minor realignment & Curve improvement	TYPE-3	
25+830	25+940	110	RHS	TYPE-2	
25+940	26+260	320	Both side	TYPE-1	
26+260	26+400	140	Minor realignment & Curve improvement	TYPE-3	
26+400	26+550	150	Both side	TYPE-1	
26+550	26+690	140	LHS	TYPE-2	
26+690	26+830	140	Both side	TYPE-1	
26+830	26+930	100	Minor realignment & Curve improvement	TYPE-3	
26+930	27+040	110	Both side	TYPE-1	
27+040	27+270	230	Minor realignment & Curve improvement	TYPE-3	
27+270	27+475	205	Both side	TYPE-1	
27+475	27+700	225	Both side	TYPE-4	Rigid Pavement
27+700	27+760	60	Both side	TYPE-1	
27+760	27+880	120	Minor realignment & Curve improvement	TYPE-3	
27+880	30+000	2120	Both side	TYPE-1	
30+000	30+140	140	RHS	TYPE-2	
30+140	30+220	80	Both side	TYPE-1	
30+220	30+794	573	Retained	MJBR	
30+794	31+600	806	Both side	TYPE-1	
31+600	34+900	3300	Major realignment	TYPE-3	Meenapur bypass
34+900	35+000	100	Both side	TYPE-1	
35+000	35+750	750	Both side	TYPE-4	Rigid Pavement
35+750	36+550	800	Both side	TYPE-1	
36+550	36+850	300	Both side	TYPE-4	Rigid Pavement
36+850	39+874	3024	Both side	TYPE-1	
39+874	40+299	425	New ROB approache with slip road	TYPE-6	
40+299	40+394	95		ROB	
40+394	40+819	425	New ROB approache with slip road	TYPE-6	
40+819	45+480	4661	Both side	TYPE-1	
45+480	47+265	1785	Both side	TYPE-5	New 4-lane road with Rigid Pavement
47+265	48+384	1119	Both side	TYPE-1	
48+384	48+536	152	Retained	MJBR	
48+536	50+090	1553	Both side	TYPE-1	
50+090	50+515	425	New ROB approache with slip road	TYPE-6	
50+515	50+670	155		ROB	
50+670	51+095	425	New ROB approache with slip road	TYPE-6	
51+095	51+887	793	Both side	TYPE-1	

Design Chainage (Km)		Proposed Length (m)	Widening (LHS/RHS/ Both)	Type of TCS	Remarks
From	To				
51+887	52+312	425	New ROB approache without slip road with normal embankment slope	TYPE-7	
52+312	52+447	135		ROB	
52+447	52+872	425	New ROB approache without slip road with normal embankment slope	TYPE-7	
52+872	53+075	203	Both side	TYPE-1	
53+075	53+375	300	Both side	TYPE-4	Rigid Pavement
53+375	54+275	900	Both side	TYPE-1	
54+275	54+451	176	Both side	TYPE-4	Rigid Pavement
54+451	54+547	97	Retained	MJBR	
54+547	61+050	6503	Both side	TYPE-1	
61+050	61+825	775	Both side	TYPE-4	Rigid Pavement
61+825	62+520	695	Both side	TYPE-1	

Slip Roads

Slip roads of 5.5m width are mainly proposed on ROB to provide all direction movements at such locations. The schedule is presented in Table E.8 below:

Table E.8: Locations of Slip Roads

Design Chainage		Existing Km		Width(m)	Length(m)	Side	Remarks
From	To	From	To				
0+420	0+873	0+422	0+877	5.5	453	BOTH	Near ROB @km 0+900
0+928	1+400	0+932	1+406	5.5	472	BOTH	
39+800	40+264	37+348	37+809	5.5	464	BOTH	Near ROB @km 40+301
40+359	40+820	37+904	38+362	5.5	461	BOTH	
49+990	50+480	47+487	47+974	5.5	490	BOTH	Near ROB @km 50+527
50+635	51+120	48+128	48+611	5.5	485	BOTH	

E.5.4 Design of Pavement for New Construction

Design of new flexible pavement applies to the new carriageway, widened portions of existing carriageway, bypasses and reconstruction stretches. The objective of the pavement design is to provide the best combination and thickness of pavement structure materials, over the sub-grade that will reduce the stress caused by loading to within the load-carrying capacity of the sub-grade soil. Flexible Pavement with Granular Base and Sub-Base (Conventional)

Flexible Pavement with Granular Base and Sub-Base

The methodology recommended in IRC: 37-2012 is adopted for the design of flexible pavement structure.

Bituminous pavement with granular base and sub-base is considered as a three layer elastic structure consisting of bituminous surfacing, granular base and sub-base and the sub grade. The granular layers are treated as a single layer. Strain and stresses are computed for three layer elastic system. For traffic < 30 msa, VG 30 bitumen is recommended for BC as well as DBM.

The pavement thickness worked out for 15 years design period is given in the table below.

Table E.9 : New Pavement Structure for 15 Years Design Life

S. No.	Lanes	Traffic Homogenous Sections		Estimated Traffic	Recommended Traffic		Design CBR (%)	New Construction/ Widening (mm) as per IRC:37-2012					When Bottom of SG is within 1.5m from water level during monsoons
		Existing Chainage (km)			For BT Layers	For Granular Layers							
		From	To	(msa)	(msa)	(msa)		BC	DBM	WMM	GSB	Total	Capillary Cut Off-Coarse Sand
1	2 Lane	0+000	37+400	4.2	5	10	4	30	55	250	330	665	150
2	2 Lane	37+400	65+100	3.9	5	10	4	30	55	250	330	665	150

E.5.1 Strengthening Design for Existing Carriageway

Based on the studies and investigations, it is found that the use of Benkelman Beam method will not result in a realistic assessment of the strengthening treatment. At few locations the pavement distresses have been covered, where recent overlays have been provided to improve the riding quality of the pavement. Therefore strengthening of existing pavement with bituminous overlay as per BBD deflections is not suggested for the current road project.

E.5.2 Design of Concrete Pavement

The concrete pavement has been proposed in following location.

Table E.100: Location of Concrete Pavement

Existing Chainage (Km)		Design Chainage (Km)		Proposed Length (m)	Location	Remarks
From	To	From	To			
5+458	6+286	5+300	6+100	800	Belwa	2-Lane
7+981	8+412	7+750	8+175	425	Govind Chowk	
9+502	9+806	9+250	9+550	300	Bourani	
10+661	11+469	10+400	11+200	800	Souria	
17+268	17+886	16+360	16+975	615	Bhelai	
28+001	28+228	27+475	27+700	225	Jhauwa	
37+401	38+156	35+000	35+750	750	Salmari	
38+962	39+264	36+550	36+850	300	Salmari	
47+861	49+868	45+400	47+400	2000	Barsoi	4-Lane
55+573	55+874	53+075	53+375	300	Manman	2-Lane
56+776	56+952	54+275	54+451	176	Lahgaria	
63+599	64+378	61+050	61+825	775	Balrampur	
			Total	7466		

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E.6 Environmental Clearances Required for the Project

After reviewing the various applicable acts and statutes, the following clearances and permission are required for the project. A summary of clearances required for the present project is shown in the following table:

S. No.	Subject	Authority Granting Clearance	When Required	Remarks
1	Forest Clearance and Tree cutting permission	Department of Forest, Govt. of Bihar (GoB).	Before Construction	BSRDCL's responsibility. Application for forest clearance will be submitted to Principal Chief Conservator of Forest (PCCF), Patna, Bihar
2	Consents under Water Act, 1974 & Air Act, 1981 for Batching plant, Hot Mix Plant, Crusher and DG sets	Bihar State Pollution Control Board (BSPCB), Patna	Before Construction	BSRDCL's responsibility through appointed Concessionaire
3	Permission for extraction of boulder /Stone Quarry lease	Department of Mines & Geology/ Local Bodies	Before Quarrying	If the extraction of boulders is being procured from the existing stone quarry/supplier, it shall be ensured that requisite license/lease has been obtained from the concerned Authority.
4	Permission for extraction of sand	Department of Mines & Geology, Government of Bihar	Before Quarrying	If the extraction of sand is being procured from the existing sand quarry/supplier, it shall be ensured that requisite license/lease has been obtained from the concerned Authority
5	Labour license	Labour Commissioner	During Construction	Concessionaire's responsibility
6	License for storing diesel	Commissioner of Explosives & BSPCB	During Construction	Concessionaire's responsibility
7	Labour camps	District Health Officer	During Construction	Concessionaire's responsibility
8	If water has to be taken from river / Reservoir	Concerned Water Authority	During Construction at the specific site	Concessionaire's responsibility

E.7 Rehabilitation and Resettlement Issues

Category	Characteristics	Safeguard Requirements
A (Significant impact)	200 or more persons experience major impacts, which are defined as (i) being physically displaced from housing, or (ii) losing 10% or more of their productive (income generating) assets.	Resettlement plan, including assessment of social impacts;
B (Not Significant impact)	Involuntary resettlement impacts are deemed not significant	Short Resettlement Plan, including assessment of social impacts.
C (No Involuntary Resettlement impact)	No involuntary resettlement impacts are foreseen.	No action (a (desk) due diligence report may be required)
FI (Financial Intermediary)	Has potential resettlement impact, to be determined	Environmental and social management system

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E.8 Economic Analysis

The economic analysis has been based on comparison of costs and benefits under 2 scenarios 'without the Katihar-Balrampur road project' and 'with the Katihar- Balrampur road project'. All costs and benefits are valued in monetary terms and expressed in economic prices to have the analysis on resource based frame-work. The analysis is made project-wise. The results are expressed in terms of Economic Internal Rate of Return (EIRR) and Economic Net Present Value (ENPV).

The project road is found viable *returning* a NPV of Rs 407.32 million and an EIRR of 12.6% EIRR is above the threshold of 12%. A sensitivity analysis on the project has been performed under various scenarios i.e. change in capital cost and traffic volume, It has been found that the project is economically viable in base cost only. This is because of higher cost of land acquisition as per new land act.

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