



NATIONAL HIGHWAYS AUTHORITY OF INDIA

(Ministry of Road Transport and Highways)

Government of India

Construction of 6-Lane Durg – Raipur bypass section of NH-53 from design ch. 0+000 (Vill. Tendesara) to design ch. 44+500 (Vill. Parsada) in the State of Chhattisgarh on EPC Mode under Bharatmala Pariyojana (Package A)

VOLUME-III

TECHNICAL SCHEDULES (A TO D)

JUNE 2022

G-5 & G-6, Sector – 10, Dwarka, New Delhi – 110 075

SCHEDULE – A*(See Clause 10.1)***SITE OF THE PROJECT****1 The Site**

- 1.1 Site of the Project Highway shall include the land, buildings, structures and road works as described in Annex-I of this Schedule-A.
- 1.2 The dates of handing over the Right of Way to the Contractor are specified in Annex-II of this Schedule-A.
- 1.3 An inventory of the Site including the land, buildings, structures, road works, trees and any other immovable property on, or attached to, the Site shall be prepared jointly by the Authority Representative and the Contractor, and such inventory shall form part of the memorandum referred to in Clause 8.2(i) of this Agreement.
- 1.4 The alignment plans of the Project Highway are specified in Annex-III. The proposed levels [FRL] as indicated in the alignment plan shall be treated as an approximate assessment. The contractor shall design the Road Profile of the project highway based on site/design requirement specified in Schedule-D.
- 1.5 The status of the environment clearances obtained or awaited is given in Annex IV.

Annex - I

(Schedule-A)

SITE FOR THE PROJECT**1.1 The Site**

Site of the proposed 6-lane access controlled highway comprises the section of National Highway No.53, commencing from existing km. 329+400 (Design Ch. 0+000) near Tendesara village of Rajnandgaon district and ending near Parsada village of Raipur district (Design Ch. 44+500), passing through greenfield area in the State of Chhattisgarh. The land, carriageway and structures comprising the site are described below.

1.2 Description of Project Highway

The project highway is a Greenfield alignment passing through Tendesara, Dewada, Thanod, Kolihapuri, Hanoda, Dhanora, Umarpoti, Purai, Utai, Selud, Funda, Arasnara, Patora, Tulsi and Parsada villages. Latitude and longitude of the project corridor lies between 21°8'18.30"N, 81°10'49.58"E and 21° 4'57.85"N, 81°35'6.72"E. An index map showing the existing features of the Project Highway is given at Appendix A-I.

1.3 Terrain

The terrain along the project stretch is predominantly plain terrain.

2. Land

The Site of the Project Highway comprises the land described below:

S. No	Existing Chainage		Proposed Chainage		Existing ROW (m)	Proposed ROW (m)
	From	To	From	To		
1	329/400	328/550	0+000	0+850	60	70
2	Green Field		0+850	44+500	-	70

The site of the project highway comprises the land (sum total of land already in possession and land to be possessed) is detailed in Annex-II of this Schedule A.

3. Carriageway

Following are the detail of existing carriageway.

4-Lane divided carriageway

Existing Chainage		C/way width (m)	Shoulder (m)			
			Paved		Earthen	
			LHS	RHS	LHS	RHS
From	To					
329/400	328/550	2x7.00	1.50	1.50	2.0	2.0

4. Major Bridges

The Site includes the following Major Bridges:

S. No.	Existing Chainage	Design Chainage	Type of Structure	Span	Width (m)	Remarks
NIL						

5. Road over-bridges (ROB)/ Road under-bridges (RUB)

The Site includes the following ROB (road over railway line)/RUB (road under railway line):

S. No.	Existing Chainage	Design Chainage	Type of Structure	Span	Width (m)	Remarks
NIL						

6. Grade separators

The Site includes the following grade separators:

S. No.	Existing Chainage	Design Chainage	Type of Structure	Span (m)	Vertical Clearance (m)	Width (m)
Nil						

7. Minor/Major bridges

The Site includes the following minor/major bridges:

S. No.	Existing Chainage	Type of Structure			Span (m)	Width (m)
		Foundation	Sub structure	Super Structure		
Nil						

8. Culverts

The Site includes the following Culverts:

Sl. No.	Exist. Chainage	Design Chainage	Type of Culvert	Span (m)
1	328/992	0+408	Slab	1 x 4 x 2.5

9. Bus bays

The details of bus bays on the Site are as follows:

S. No.	Chainage (km)	Length (m)	Location/Side
NIL			

10. Truck Lay byes

The details of truck lay byes are as follows:

S. No.	Chainage (km)	Length (m)	Left Hand Side	Right Hand Side
Nil				

11. Road side drains

The details of the roadside drains are as follows:

S. No.	Location		Type	
	From km	to km	Masonry/cc (Pucca)	Earthen (Kutcha)
Nil				

12. Major junctions

The details of major junctions are as follows:

S.No.	Existing Chainage (Km)	Design Chainage (Ch)	Category of Road	Type of Junction	Remarks
Nil					

Note: (NH: National Highway, SH: State Highway, MDR: Major District Road)

13. Minor junctions

The details of the minor junctions are as follows:

S. No.	Existing Chainage	Design Chainage	Side	Carriageway Width (m)	Surface Type	Leading to
1	328/880	0+520	RHS	4.50	Bituminous	Tendesara
2	328/855	0+545	LHS	7.00	Gravel	Tendesara

14. Bypasses

The details of the bypasses are as follows:

S. No.	Name of bypass (town)	Chainage (km)	Design Length (Km)	Carriageway	
				Width (m)	Type
Nil					

15. Detail of any other structures

Sl. No.	Chainage (km)	Type of Structure	No. of Spans with span length (m)	Width (m)
Nil				

16. Permanent Bridge, Bypass or Tunnel costing Rs. 50 crore or more

The Site includes the following permanent bridge/ bypass/ tunnel which was Constructed at the cost noted below:

- Nil -

17. Wayside Amenities / Truck Parking

The Site includes the parcels of land for provision of wayside Amenities / truck parking as given in Schedule C

18. Electrical Utilities

The Site includes the following Electrical Utilities: -

(a) Extra High-Tension Lines (EHT Lines)

Sl. No.	Chainage		Nos. of Crossings			
	From	To	765 KV	400 KV	220 KV	132 KV
1.	15+900	15+900				1
2.	19+400	19+400				1
3.	22+900	22+900			1	
4.	23+520	23+520		1		
5.	27+120	27+120		1		
6.	42+170	42+170			1	

(b) High Tension/Low Tension Lines (HT/LT Lines)

Chainage		11 KV Electrical poles in Nos.	33 KV Electrical poles in Nos.	Transform er in Nos.	LT Line	No. of Crossings
From	To					
TOTAL		292	179	12	471	83
0+000	3+020	58	30	4	88	9
3+020	15+720	87	70	3	157	19
15+720	32+110	51	29	2	80	20
32+110	44+500	96	50	3	146	35

19. Public Health Utilities (Water/Sewage Pipe Lines) *

The Site includes the following Public Health Utilities: -

Design Chainage		Tube well (Nos)		Tap (Nos)	Well		Pipe Line Length in Meter	
From	To	LHS	RHS	LHS	LHS	RHS	LHS	RHS
TOTAL		1	2	-	-	1	-	-
0+000	3+020	1	-	-	-	1	-	200mm DI pipe – 1200m 100mm GI pipe – 500m
3+020	15+720	-	-	-	-	-	-	-
15+720	32+110	-	2	-	-	-	-	-
32+110	44+500	-	-	-	-	-	-	-

(*This is illustrative and may change as per features of existing utilities.)

20. Any Other Lines – Nil

Change of scope shall be paid for any over-ground / underground utilities not mentioned in Schedule “B”, which shall be worked out as per the estimate to be given by concerned utility owning dept. and shall be payable.

Appendix A-I : Index Map of Project Highway



Construction of 6-Lane Durg – Raipur bypass section of NH-53 from design ch. 0+000 (Vill. Tendesara) to design ch. 44+500 (Vill. Parsada) in the State of Chhattisgarh on EPC Mode under Bharatmala Pariyojana (Package A)

Annex - II
(Schedule-A)

DATES FOR PROVIDING RIGHT OF WAY OF CONSTRUCTION ZONE

The dates on which the Authority shall provide Right of Way of Construction Zone to the Contractor on different stretches of the Site are stated below:

Sl. No	From	To	Length (km)	Date of providing RoW
1	0+000	44+500	44.50	90% ROW to be handed over on Appointed Date
2	0+000	44+500	44.50	Remaining 10% of RoW of the total length and RoW for Proposed Toll Plaza, Interchange and Wayside Amenities within 150 days from Appointed date

The co-ordinates of Centerline and RoW are given below: -

Design Chainage	Centre Line Co-Ordinate		LHS ROW Co-Ordinate		RHS ROW Co-Ordinate	
	Easting	Northing	Easting	Northing	Easting	Northing
0	518735.130	2337478.000	518721.820	2337510.370	518748.439	2337445.629
100	518827.617	2337516.026	518814.308	2337548.397	518840.927	2337483.656
200	518920.001	2337554.303	518906.257	2337586.492	518933.744	2337522.115
300	519011.297	2337595.095	518996.489	2337626.808	519026.106	2337563.382
400	519101.184	2337638.907	519085.327	2337670.109	519117.041	2337607.705
500	519189.695	2337685.441	519173.230	2337716.326	519206.160	2337654.556
600	519278.535	2337731.340	519262.967	2337762.687	519294.102	2337699.992
700	519368.800	2337774.366	519354.044	2337806.655	519383.348	2337742.532
800	519460.407	2337814.458	519443.741	2337854.273	519473.921	2337782.172
900	519553.259	2337851.575	519533.414	2337903.640	519565.724	2337818.870
1000	519647.259	2337885.677	519623.900	2337953.456	519658.664	2337852.587
1100	519742.311	2337916.731	519715.402	2338003.831	519752.642	2337883.290
1200	519838.315	2337944.702	519827.747	2337983.281	519849.676	2337903.230
1300	519935.171	2337969.563	519925.852	2338008.462	519945.188	2337927.746
1400	520032.778	2337991.286	520024.719	2338030.466	520041.964	2337946.632
1500	520131.036	2338009.851	520124.244	2338049.270	520139.760	2337959.209
1600	520229.841	2338025.237	520224.393	2338064.359	520241.190	2337943.722
1700	520329.090	2338037.427	520324.908	2338076.705	520349.435	2337846.375
1800	520428.682	2338046.411	520425.765	2338085.836	520447.647	2337790.004
1900	520528.511	2338052.178	520525.008	2338136.390	520539.023	2337799.479
2000	520628.474	2338054.722	520627.247	2338117.397	520629.570	2337937.128
2100	520728.467	2338054.041	520729.485	2338098.404	520727.517	2338012.636
2200	520828.387	2338050.135	520830.456	2338087.578	520826.318	2338012.692
2300	520928.128	2338043.008	520931.404	2338080.365	520924.853	2338005.652

Design Chainage	Centre Line Co-Ordinate		LHS ROW Co-Ordinate		RHS ROW Co-Ordinate	
	Easting	Northing	Easting	Northing	Easting	Northing
2400	521027.588	2338032.669	521032.067	2338069.900	521023.109	2337995.437
2500	521126.662	2338019.126	521131.961	2338053.723	521121.364	2337984.530
2600	521225.304	2338002.712	521231.220	2338037.208	521219.388	2337968.216
2700	521323.865	2337985.809	521329.781	2338020.306	521317.949	2337951.313
2800	521422.427	2337968.907	521428.342	2338003.403	521416.511	2337934.410
2900	521520.988	2337952.004	521526.904	2337986.501	521515.072	2337917.508
3000	521619.549	2337935.102	521625.465	2337969.598	521613.633	2337900.605
3100	521718.110	2337918.199	521724.026	2337952.696	521712.194	2337883.703
3200	521816.671	2337901.297	521822.587	2337935.793	521810.755	2337866.800
3300	521915.232	2337884.394	521921.148	2337918.891	521909.317	2337849.898
3400	522013.794	2337867.492	522019.709	2337901.988	522007.878	2337832.995
3500	522112.355	2337850.589	522118.271	2337885.086	522106.439	2337816.093
3600	522210.916	2337833.687	522216.832	2337868.183	522205.000	2337799.190
3700	522309.477	2337816.784	522315.393	2337851.280	522303.561	2337782.288
3800	522408.038	2337799.882	522413.954	2337834.378	522402.122	2337765.385
3900	522506.599	2337782.979	522512.515	2337817.475	522500.684	2337748.483
4000	522605.161	2337766.076	522611.076	2337800.573	522599.245	2337731.580
4100	522703.722	2337749.174	522709.638	2337783.670	522697.806	2337714.677
4200	522802.283	2337732.271	522808.199	2337766.768	522796.367	2337697.775
4300	522900.997	2337716.301	522906.162	2337750.918	522895.832	2337681.684
4400	523000.076	2337702.783	523004.374	2337737.518	522995.779	2337668.048
4500	523099.463	2337691.745	523102.891	2337726.577	523096.035	2337656.913
4600	523199.094	2337683.195	523201.650	2337718.102	523196.538	2337648.289
4700	523298.908	2337677.139	523300.591	2337712.098	523297.225	2337642.179
4800	523398.842	2337673.579	523399.650	2337708.570	523398.033	2337638.589
4900	523498.834	2337672.519	523498.767	2337707.519	523498.900	2337637.519
5000	523598.821	2337673.958	523597.879	2337708.946	523599.762	2337638.971
5100	523698.741	2337677.897	523696.925	2337712.850	523700.556	2337642.944
5200	523798.531	2337684.332	523795.457	2337724.223	523801.809	2337641.782
5300	523898.129	2337693.259	523893.043	2337743.000	523903.723	2337638.545
5400	523997.473	2337704.674	523991.323	2337752.875	524003.949	2337653.913
5500	524096.500	2337718.568	524090.225	2337759.559	524102.798	2337677.424
5600	524195.280	2337734.138	524189.814	2337768.708	524200.747	2337699.568
5700	524294.053	2337749.756	524288.587	2337784.327	524299.520	2337715.186
5800	524392.826	2337765.375	524387.360	2337799.945	524398.292	2337730.804
5900	524491.599	2337780.993	524486.132	2337815.563	524497.065	2337746.422
6000	524590.372	2337796.611	524584.905	2337831.182	524595.838	2337762.041
6100	524689.144	2337812.229	524683.678	2337846.800	524694.611	2337777.659
6200	524787.917	2337827.848	524782.451	2337862.418	524793.384	2337793.277
6300	524886.690	2337843.466	524881.224	2337878.036	524892.156	2337808.895
6400	524985.463	2337859.084	524979.996	2337893.655	524990.929	2337824.514
6500	525084.236	2337874.703	525078.769	2337909.273	525089.702	2337840.132
6600	525183.008	2337890.321	525177.542	2337924.891	525188.475	2337855.750
6700	525281.782	2337905.932	525276.375	2337940.512	525287.189	2337871.353

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Design Chainage	Centre Line Co-Ordinate		LHS ROW Co-Ordinate		RHS ROW Co-Ordinate	
	Easting	Northing	Easting	Northing	Easting	Northing
6800	525380.745	2337920.282	525376.108	2337954.973	525385.383	2337885.590
6900	525480.003	2337932.429	525476.138	2337967.215	525483.868	2337897.643
7000	525579.506	2337942.367	525576.414	2337977.230	525582.597	2337907.504
7100	525679.205	2337950.092	525676.889	2337985.015	525681.521	2337915.168
7200	525779.051	2337955.599	525777.512	2337990.565	525780.590	2337920.633
7300	525878.995	2337958.887	525878.233	2337993.879	525879.757	2337923.895
7400	525978.987	2337959.953	525979.003	2337994.953	525978.971	2337924.953
7500	526078.978	2337958.797	526079.772	2337993.788	526078.185	2337923.806
7600	526178.919	2337955.419	526180.490	2337990.384	526177.348	2337920.454
7700	526278.760	2337949.821	526281.108	2337984.743	526276.413	2337914.900
7800	526378.453	2337942.007	526381.575	2337976.867	526375.330	2337907.146
7900	526477.993	2337932.434	526481.393	2337967.268	526474.593	2337897.599
8000	526577.520	2337922.719	526580.920	2337957.553	526574.120	2337887.884
8100	526677.047	2337913.004	526681.028	2337953.789	526673.066	2337872.219
8200	526776.574	2337903.289	526780.946	2337948.076	526772.202	2337858.502
8300	526876.101	2337893.574	526880.704	2337940.727	526871.500	2337846.443
8400	526975.628	2337883.859	526980.581	2337934.600	526970.666	2337833.031
8500	527075.155	2337874.144	527079.527	2337918.931	527070.783	2337829.357
8600	527174.682	2337864.429	527179.054	2337909.216	527170.310	2337819.642
8700	527274.209	2337854.714	527278.581	2337899.501	527269.200	2337803.400
8800	527373.736	2337844.999	527378.108	2337889.786	527369.364	2337800.212
8900	527473.263	2337835.284	527477.635	2337880.071	527468.891	2337790.497
9000	527572.790	2337825.569	527577.162	2337870.356	527568.418	2337780.782
9100	527672.317	2337815.854	527676.688	2337860.641	527667.945	2337771.067
9200	527771.844	2337806.139	527776.215	2337850.927	527767.472	2337761.352
9300	527871.371	2337796.424	527875.944	2337843.280	527866.796	2337749.560
9400	527970.898	2337786.710	527974.614	2337824.779	527967.371	2337750.580
9500	528070.425	2337776.995	528073.825	2337811.829	528067.024	2337742.160
9600	528169.952	2337767.280	528173.352	2337802.114	528166.551	2337732.445
9700	528269.479	2337757.565	528272.879	2337792.399	528266.078	2337722.730
9800	528369.006	2337747.850	528372.406	2337782.684	528365.605	2337713.015
9900	528468.533	2337738.135	528471.933	2337772.969	528465.132	2337703.300
10000	528568.060	2337728.420	528571.460	2337763.254	528564.659	2337693.585
10100	528667.587	2337718.705	528670.987	2337753.539	528664.186	2337683.870
10200	528767.114	2337708.990	528770.514	2337743.824	528763.713	2337674.156
10300	528866.641	2337699.275	528870.041	2337734.109	528863.240	2337664.441
10400	528966.168	2337689.560	528969.568	2337724.395	528962.767	2337654.726
10500	529065.695	2337679.845	529069.095	2337714.680	529062.294	2337645.011
10600	529165.221	2337670.130	529168.622	2337704.965	529161.821	2337635.296
10700	529264.748	2337660.415	529268.149	2337695.250	529261.348	2337625.581
10800	529364.275	2337650.700	529367.676	2337685.535	529360.875	2337615.866
10900	529463.802	2337640.985	529467.203	2337675.820	529460.402	2337606.151
11000	529563.329	2337631.270	529566.730	2337666.105	529559.929	2337596.436
11100	529662.856	2337621.556	529666.257	2337656.390	529659.456	2337586.721

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Design Chainage	Centre Line Co-Ordinate		LHS ROW Co-Ordinate		RHS ROW Co-Ordinate	
	Easting	Northing	Easting	Northing	Easting	Northing
11200	529762.383	2337611.841	529765.784	2337646.675	529758.983	2337577.006
11300	529861.910	2337602.126	529865.311	2337636.960	529858.510	2337567.291
11400	529961.437	2337592.411	529964.838	2337627.245	529958.037	2337557.576
11500	530060.964	2337582.696	530064.365	2337617.530	530057.564	2337547.861
11600	530160.491	2337572.981	530163.892	2337607.815	530157.091	2337538.146
11700	530260.018	2337563.266	530264.876	2337613.029	530256.618	2337528.431
11800	530359.545	2337553.551	530372.660	2337687.912	530356.145	2337518.716
11900	530459.072	2337543.836	530472.187	2337678.197	530455.672	2337509.002
12000	530558.599	2337534.121	530561.999	2337568.955	530555.199	2337499.287
12100	530658.126	2337524.406	530661.526	2337559.241	530654.726	2337489.572
12200	530757.653	2337514.691	530761.053	2337549.526	530754.253	2337479.857
12300	530857.180	2337504.976	530860.580	2337539.811	530853.780	2337470.142
12400	530956.707	2337495.261	530960.107	2337530.096	530953.307	2337460.427
12500	531056.234	2337485.546	531059.634	2337520.381	531052.834	2337450.712
12600	531155.761	2337475.831	531159.161	2337510.666	531152.361	2337440.998
12700	531255.288	2337466.116	531258.688	2337500.951	531251.889	2337431.290
12800	531354.815	2337456.401	531358.215	2337491.236	531351.416	2337421.583
12900	531454.342	2337446.687	531457.742	2337481.521	531450.942	2337411.852
13000	531553.869	2337436.972	531557.269	2337471.806	531550.469	2337402.137
13100	531653.396	2337427.257	531656.796	2337462.091	531649.996	2337392.422
13200	531752.923	2337417.542	531756.323	2337452.376	531749.523	2337382.707
13300	531852.450	2337407.827	531855.850	2337442.661	531849.050	2337372.992
13400	531951.977	2337398.112	531955.377	2337432.946	531948.577	2337363.277
13500	532051.504	2337388.397	532054.904	2337423.231	532048.104	2337353.562
13600	532151.031	2337378.682	532154.431	2337413.516	532147.631	2337343.848
13700	532250.558	2337368.967	532253.958	2337403.801	532247.158	2337334.133
13800	532350.085	2337359.252	532353.485	2337394.087	532346.685	2337324.418
13900	532449.612	2337349.537	532453.012	2337384.372	532446.212	2337314.703
14000	532549.139	2337339.822	532552.539	2337374.657	532545.739	2337304.988
14100	532648.666	2337330.107	532652.066	2337364.942	532645.266	2337295.273
14200	532748.193	2337320.392	532751.593	2337355.227	532744.793	2337285.558
14300	532847.720	2337310.677	532851.120	2337345.512	532844.320	2337275.843
14400	532947.247	2337300.962	532950.647	2337335.797	532943.847	2337266.128
14500	533046.774	2337291.247	533050.174	2337326.082	533043.374	2337256.413
14600	533146.301	2337281.533	533149.701	2337316.367	533142.900	2337246.698
14700	533245.828	2337271.818	533249.228	2337306.652	533242.427	2337236.983
14800	533345.355	2337262.103	533348.755	2337296.937	533341.954	2337227.268
14900	533444.882	2337252.388	533448.282	2337287.222	533441.481	2337217.553
15000	533544.409	2337242.673	533547.809	2337277.507	533541.008	2337207.838
15100	533643.936	2337232.958	533647.336	2337267.792	533640.535	2337198.123
15200	533743.384	2337222.500	533747.588	2337257.246	533739.180	2337187.753
15300	533842.425	2337208.718	533847.867	2337243.293	533836.983	2337174.144
15400	533940.910	2337191.409	533947.583	2337225.767	533934.237	2337157.051
15500	534038.714	2337170.594	534046.610	2337204.692	534030.819	2337136.497

Construction of 6-Lane Durg – Raipur bypass section of NH-53 from design ch. 0+000 (Vill. Tendesara) to design ch. 44+500 (Vill. Parsada) in the State of Chhattisgarh on EPC Mode under Bharatmala Pariyojana (Package A)

Design Chainage	Centre Line Co-Ordinate		LHS ROW Co-Ordinate		RHS ROW Co-Ordinate	
	Easting	Northing	Easting	Northing	Easting	Northing
15600	534135.713	2337146.301	534144.821	2337180.095	534126.605	2337112.507
15700	534231.782	2337118.559	534242.091	2337152.006	534221.473	2337085.112
15800	534326.800	2337087.405	534338.297	2337120.463	534315.303	2337054.347
15900	534420.645	2337052.877	534433.314	2337085.504	534407.975	2337020.251
16000	534513.196	2337015.021	534527.023	2337047.175	534499.370	2336982.868
16100	534604.338	2336973.885	534619.304	2337005.524	534589.372	2336942.246
16200	534693.952	2336929.520	534710.038	2336960.604	534677.866	2336898.436
16300	534781.925	2336881.984	534799.111	2336912.474	534764.739	2336851.493
16400	534868.144	2336831.336	534886.408	2336861.193	534849.881	2336801.479
16500	534952.500	2336777.643	534971.818	2336806.829	534933.182	2336748.457
16600	535034.885	2336720.971	535055.233	2336749.449	535014.537	2336692.494
16700	535115.194	2336661.394	535136.546	2336689.127	535093.843	2336633.662
16800	535193.325	2336598.988	535215.653	2336625.941	535170.996	2336572.035
16900	535269.177	2336533.831	535292.453	2336559.970	535245.900	2336507.693
17000	535342.654	2336466.008	535366.849	2336491.299	535318.459	2336440.718
17100	535413.663	2336395.604	535438.746	2336420.015	535388.580	2336371.194
17200	535482.520	2336323.089	535507.984	2336347.100	535457.055	2336299.077
17300	535551.124	2336250.333	535576.589	2336274.345	535525.660	2336226.321
17400	535619.729	2336177.577	535645.193	2336201.589	535594.264	2336153.565
17500	535688.333	2336104.821	535713.798	2336128.833	535662.869	2336080.810
17600	535756.938	2336032.065	535782.402	2336056.077	535731.473	2336008.054
17700	535825.542	2335959.309	535851.007	2335983.321	535800.078	2335935.298
17800	535894.147	2335886.553	535919.611	2335910.565	535868.682	2335862.542
17900	535962.751	2335813.797	535988.216	2335837.809	535937.287	2335789.786
18000	536031.356	2335741.041	536056.820	2335765.053	536005.891	2335717.030
18100	536099.960	2335668.286	536125.425	2335692.297	536074.496	2335644.274
18200	536168.565	2335595.530	536204.943	2335629.832	536143.100	2335571.518
18300	536237.169	2335522.774	536273.547	2335557.076	536211.705	2335498.762
18400	536305.774	2335450.018	536342.152	2335484.320	536280.309	2335426.006
18500	536374.378	2335377.262	536399.843	2335401.273	536348.914	2335353.250
18600	536442.983	2335304.506	536468.447	2335328.517	536417.518	2335280.494
18700	536511.587	2335231.750	536537.052	2335255.761	536486.123	2335207.738
18800	536580.192	2335158.994	536605.656	2335183.006	536554.727	2335134.982
18900	536648.796	2335086.238	536674.261	2335110.250	536623.331	2335062.227
19000	536717.401	2335013.482	536742.865	2335037.494	536691.936	2334989.471
19100	536786.005	2334940.726	536822.387	2334975.033	536760.540	2334916.715
19200	536854.609	2334867.970	536891.016	2334902.299	536829.145	2334843.959
19300	536923.268	2334795.265	536948.581	2334819.436	536897.954	2334771.095
19400	536994.034	2334724.624	537018.135	2334750.004	536969.932	2334699.245
19500	537068.238	2334657.605	537091.041	2334684.158	537045.435	2334631.052
19600	537145.699	2334594.378	537167.147	2334622.037	537124.252	2334566.719
19700	537226.224	2334535.101	537246.262	2334563.798	537206.186	2334506.405
19800	537309.611	2334479.923	537328.189	2334509.586	537291.032	2334450.261
19900	537395.651	2334428.982	537412.724	2334459.536	537378.578	2334398.429

Construction of 6-Lane Durg – Raipur bypass section of NH-53 from design ch. 0+000 (Vill. Tendesara) to design ch. 44+500 (Vill. Parsada) in the State of Chhattisgarh on EPC Mode under Bharatmala Pariyojana (Package A)

Design Chainage	Centre Line Co-Ordinate		LHS ROW Co-Ordinate		RHS ROW Co-Ordinate	
	Easting	Northing	Easting	Northing	Easting	Northing
20000	537484.129	2334382.405	537499.654	2334413.773	537468.605	2334351.036
20100	537574.825	2334340.307	537588.763	2334372.413	537560.888	2334308.202
20200	537667.512	2334302.796	537679.827	2334335.558	537655.196	2334270.034
20300	537761.957	2334269.963	537772.620	2334303.300	537751.295	2334236.627
20400	537857.926	2334241.892	537866.909	2334275.720	537848.942	2334208.065
20500	537955.005	2334217.911	537963.195	2334251.940	537946.815	2334183.883
20600	538052.228	2334194.511	538060.419	2334228.539	538044.038	2334160.483
20700	538149.452	2334171.111	538157.642	2334205.139	538141.262	2334137.082
20800	538246.676	2334147.710	538254.866	2334181.739	538238.485	2334113.682
20900	538343.899	2334124.310	538352.089	2334158.338	538335.709	2334090.282
21000	538441.123	2334100.910	538449.313	2334134.938	538432.933	2334066.882
21100	538538.346	2334077.509	538546.536	2334111.538	538530.156	2334043.481
21200	538635.570	2334054.109	538643.760	2334088.137	538627.380	2334020.081
21300	538732.794	2334030.709	538740.984	2334064.737	538724.603	2333996.681
21400	538830.017	2334007.309	538838.207	2334041.337	538821.827	2333973.280
21500	538927.241	2333983.908	538935.431	2334017.936	538919.051	2333949.880
21600	539024.464	2333960.508	539032.654	2333994.536	539016.274	2333926.480
21700	539121.688	2333937.108	539129.878	2333971.136	539113.498	2333903.079
21800	539218.911	2333913.707	539227.102	2333947.735	539210.721	2333879.679
21900	539316.135	2333890.307	539324.325	2333924.335	539307.945	2333856.279
22000	539413.359	2333866.907	539421.549	2333900.935	539405.168	2333832.878
22100	539510.582	2333843.506	539518.772	2333877.535	539502.392	2333809.478
22200	539607.806	2333820.106	539615.996	2333854.134	539599.616	2333786.078
22300	539705.066	2333796.859	539713.121	2333830.919	539697.011	2333762.798
22400	539802.439	2333774.087	539810.323	2333808.188	539794.554	2333739.987
22500	539899.924	2333751.803	539907.638	2333785.942	539892.210	2333717.664
22600	539997.520	2333730.007	540005.063	2333764.184	539989.976	2333695.829
22700	540095.223	2333708.698	540102.595	2333742.913	540087.851	2333674.484
22800	540193.023	2333687.837	540200.295	2333722.074	540185.751	2333653.601
22900	540290.841	2333667.061	540298.112	2333701.297	540283.569	2333632.825
23000	540388.658	2333646.284	540395.930	2333680.521	540381.387	2333612.048
23100	540486.476	2333625.508	540493.748	2333659.744	540479.205	2333591.271
23200	540584.294	2333604.731	540591.566	2333638.967	540577.022	2333570.495
23300	540682.112	2333583.954	540689.384	2333618.191	540674.840	2333549.718
23400	540779.883	2333562.960	540787.317	2333597.162	540772.450	2333528.759
23500	540877.549	2333541.478	540885.153	2333575.642	540869.944	2333507.314
23600	540975.105	2333519.508	540982.880	2333553.634	540967.330	2333485.383
23700	541072.551	2333497.051	541080.496	2333531.137	541064.605	2333462.965
23800	541169.925	2333474.285	541177.895	2333508.365	541161.955	2333440.204
23900	541267.298	2333451.514	541275.268	2333485.594	541259.328	2333417.433
24000	541364.671	2333428.743	541372.641	2333462.823	541356.701	2333394.662
24100	541462.043	2333405.971	541470.013	2333440.052	541454.074	2333371.891
24200	541559.416	2333383.200	541567.386	2333417.281	541551.446	2333349.120
24300	541656.789	2333360.429	541664.759	2333394.509	541648.819	2333326.348

Construction of 6-Lane Durg – Raipur bypass section of NH-53 from design ch. 0+000 (Vill. Tendesara) to design ch. 44+500 (Vill. Parsada) in the State of Chhattisgarh on EPC Mode under Bharatmala Pariyojana (Package A)

Design Chainage	Centre Line Co-Ordinate		LHS ROW Co-Ordinate		RHS ROW Co-Ordinate	
	Easting	Northing	Easting	Northing	Easting	Northing
24400	541754.162	2333337.658	541762.132	2333371.738	541746.192	2333303.577
24500	541851.535	2333314.887	541859.505	2333348.967	541843.565	2333280.806
24600	541948.908	2333292.115	541956.878	2333326.196	541940.938	2333258.035
24700	542046.281	2333269.344	542054.251	2333303.425	542038.311	2333235.264
24800	542143.653	2333246.573	542151.623	2333280.654	542135.684	2333212.493
24900	542241.026	2333223.802	542248.996	2333257.882	542233.056	2333189.721
25000	542338.399	2333201.031	542346.369	2333235.111	542330.429	2333166.950
25100	542435.772	2333178.260	542443.742	2333212.340	542427.802	2333144.179
25200	542533.145	2333155.488	542541.115	2333189.569	542525.175	2333121.408
25300	542630.518	2333132.717	542638.488	2333166.798	542622.548	2333098.637
25400	542727.891	2333109.946	542735.861	2333144.027	542719.921	2333075.866
25500	542825.218	2333086.984	542833.548	2333120.979	542816.888	2333052.990
25600	542921.991	2333061.800	542931.289	2333095.542	542912.694	2333028.057
25700	543018.006	2333033.861	543028.264	2333067.324	543007.748	2333000.398
25800	543113.183	2333003.191	543124.393	2333036.348	543101.982	2332970.062
25900	543207.445	2332969.815	543219.597	2333002.637	543195.476	2332937.487
26000	543300.715	2332933.759	543313.800	2332966.221	543287.583	2332901.181
26100	543392.917	2332895.053	543406.924	2332927.128	543378.910	2332862.978
26200	543483.975	2332853.730	543498.623	2332884.818	543469.058	2332822.068
26300	543573.816	2332809.821	543589.357	2332840.500	543558.000	2332778.599
26400	543662.366	2332763.365	543679.068	2332794.123	543645.665	2332732.606
26500	543749.553	2332714.397	543767.126	2332744.666	543731.979	2332684.129
26600	543835.305	2332662.959	543853.736	2332692.713	543816.874	2332633.205
26700	543919.553	2332609.092	543938.826	2332638.307	543900.279	2332579.877
26800	544002.227	2332552.840	544022.327	2332581.493	543982.127	2332524.187
26900	544083.261	2332494.250	544104.171	2332522.317	544062.350	2332466.183
27000	544162.588	2332433.368	544184.291	2332460.826	544140.884	2332405.910
27100	544240.143	2332370.245	544262.622	2332397.072	544217.664	2332343.418
27200	544315.968	2332305.051	544338.954	2332331.445	544292.981	2332278.658
27300	544391.378	2332239.375	544414.364	2332265.769	544368.391	2332212.982
27400	544466.788	2332173.699	544489.774	2332200.093	544443.801	2332147.306
27500	544542.197	2332108.023	544565.184	2332134.417	544519.211	2332081.630
27600	544617.607	2332042.347	544640.594	2332068.741	544594.621	2332015.954
27700	544693.017	2331976.671	544716.004	2332003.065	544670.031	2331950.278
27800	544768.427	2331910.995	544791.414	2331937.389	544745.441	2331884.602
27900	544843.837	2331845.319	544866.824	2331871.713	544820.851	2331818.926
28000	544919.247	2331779.643	544942.234	2331806.037	544896.280	2331753.272
28100	544994.657	2331713.967	545017.644	2331740.361	544971.727	2331687.639
28200	545070.067	2331648.291	545093.054	2331674.685	545047.175	2331622.006
28300	545145.477	2331582.615	545168.464	2331609.009	545122.622	2331556.373
28400	545221.590	2331517.759	545243.957	2331544.680	545199.223	2331490.839
28500	545299.297	2331454.821	545320.984	2331482.293	545277.610	2331427.350
28600	545378.552	2331393.846	545399.546	2331421.850	545357.558	2331365.841
28700	545459.307	2331334.870	545479.594	2331363.391	545439.020	2331306.349

Construction of 6-Lane Durg – Raipur bypass section of NH-53 from design ch. 0+000 (Vill. Tendesara) to design ch. 44+500 (Vill. Parsada) in the State of Chhattisgarh on EPC Mode under Bharatmala Pariyojana (Package A)

Design Chainage	Centre Line Co-Ordinate		LHS ROW Co-Ordinate		RHS ROW Co-Ordinate	
	Easting	Northing	Easting	Northing	Easting	Northing
28800	545541.511	2331277.932	545561.079	2331306.951	545521.943	2331248.913
28900	545625.113	2331223.066	545643.949	2331252.565	545606.276	2331193.567
29000	545710.060	2331170.307	545728.153	2331200.268	545691.967	2331140.346
29100	545796.299	2331119.688	545813.637	2331150.092	545778.960	2331089.284
29200	545883.776	2331071.241	545900.349	2331102.068	545867.203	2331040.413
29300	545972.438	2331024.995	545988.235	2331056.227	545956.641	2330993.763
29400	546061.731	2330979.977	546077.487	2331011.230	546045.976	2330948.723
29500	546151.027	2330934.962	546166.782	2330966.215	546135.271	2330903.708
29600	546240.322	2330889.946	546256.077	2330921.200	546224.566	2330858.693
29700	546329.617	2330844.931	546345.372	2330876.184	546313.862	2330813.678
29800	546418.912	2330799.916	546434.667	2330831.169	546358.142	2330769.367
29900	546508.207	2330754.901	546523.963	2330786.154	546447.437	2330724.352
30000	546597.502	2330709.886	546613.258	2330741.139	546581.747	2330678.632
30100	546686.798	2330664.870	546702.553	2330696.124	546671.042	2330633.617
30200	546776.093	2330619.855	546791.848	2330651.108	546760.338	2330588.602
30300	546865.388	2330574.840	546881.143	2330606.093	546849.633	2330543.587
30400	546954.683	2330529.825	546970.439	2330561.078	546938.928	2330498.571
30500	547043.978	2330484.809	547059.734	2330516.063	547028.223	2330453.556
30600	547133.274	2330439.794	547149.029	2330471.048	547117.518	2330408.541
30700	547222.569	2330394.779	547238.324	2330426.032	547206.813	2330363.526
30800	547311.864	2330349.764	547327.619	2330381.017	547296.109	2330318.511
30900	547401.159	2330304.749	547416.915	2330336.002	547385.404	2330273.495
31000	547490.454	2330259.733	547506.210	2330290.987	547474.699	2330228.480
31100	547579.750	2330214.718	547595.505	2330245.971	547563.994	2330183.465
31200	547669.045	2330169.703	547684.800	2330200.956	547653.289	2330138.450
31300	547758.472	2330124.954	547773.744	2330156.446	547743.200	2330093.461
31400	547849.299	2330083.131	547863.299	2330115.209	547835.299	2330051.053
31500	547941.726	2330044.973	547954.432	2330077.586	547929.019	2330012.361
31600	548035.604	2330010.543	548046.996	2330043.637	548024.212	2329977.449
31700	548130.785	2329979.894	548140.844	2330013.417	548120.725	2329946.371
31800	548227.115	2329953.076	548235.826	2329986.974	548218.404	2329919.177
31900	548324.440	2329930.131	548331.788	2329964.351	548317.092	2329895.911
32000	548422.605	2329911.097	548428.579	2329945.583	548416.631	2329876.610
32100	548521.453	2329896.003	548526.043	2329930.701	548516.862	2329861.305
32200	548620.825	2329884.875	548624.024	2329919.728	548617.626	2329850.021
32300	548720.562	2329877.729	548722.365	2329912.682	548718.760	2329842.775
32400	548820.506	2329874.577	548820.909	2329909.575	548820.103	2329839.579
32500	548920.496	2329875.425	548919.499	2329910.410	548921.492	2329840.439
32600	549020.372	2329880.270	549017.977	2329915.188	549022.766	2329845.352
32700	549119.974	2329889.105	549116.185	2329923.900	549123.763	2329854.311
32800	549219.143	2329901.917	549213.966	2329936.532	549224.321	2329867.302
32900	549317.721	2329918.684	549311.163	2329953.064	549324.278	2329884.303
33000	549415.549	2329939.379	549407.622	2329973.470	549423.476	2329905.289
33100	549512.598	2329963.483	549503.993	2329997.409	549521.203	2329929.557

Construction of 6-Lane Durg – Raipur bypass section of NH-53 from design ch. 0+000 (Vill. Tendesara) to design ch. 44+500 (Vill. Parsada) in the State of Chhattisgarh on EPC Mode under Bharatmala Pariyojana (Package A)

Design Chainage	Centre Line Co-Ordinate		LHS ROW Co-Ordinate		RHS ROW Co-Ordinate	
	Easting	Northing	Easting	Northing	Easting	Northing
33200	549609.529	2329988.069	549600.924	2330021.994	549618.134	2329954.143
33300	549706.460	2330012.654	549697.855	2330046.580	549715.065	2329978.729
33400	549803.390	2330037.240	549794.785	2330071.166	549811.995	2330003.314
33500	549900.321	2330061.826	549891.716	2330095.752	549908.926	2330027.900
33600	549997.251	2330086.412	549988.646	2330120.337	550005.856	2330052.486
33700	550094.182	2330110.997	550085.577	2330144.923	550102.787	2330077.072
33800	550191.113	2330135.583	550182.508	2330169.509	550199.718	2330101.658
33900	550288.043	2330160.169	550279.438	2330194.095	550296.648	2330126.243
34000	550384.974	2330184.755	550374.648	2330225.466	550393.579	2330150.829
34100	550481.904	2330209.341	550473.299	2330243.266	550490.509	2330175.415
34200	550578.835	2330233.926	550570.230	2330267.852	550587.440	2330200.001
34300	550675.765	2330258.512	550667.160	2330292.438	550684.371	2330224.586
34400	550772.696	2330283.098	550762.862	2330321.870	550781.553	2330248.178
34500	550869.694	2330307.415	550861.342	2330341.404	550878.371	2330272.104
34600	550966.923	2330330.793	550951.603	2330395.938	550974.930	2330296.744
34700	551064.380	2330353.197	551055.379	2330393.268	551072.083	2330318.907
34800	551162.057	2330374.626	551154.728	2330408.850	551169.386	2330340.402
34900	551259.943	2330395.077	551252.304	2330432.574	551266.929	2330360.781
35000	551358.029	2330414.548	551351.057	2330450.613	551364.672	2330380.184
35100	551456.304	2330433.037	551450.005	2330467.465	551463.289	2330394.860
35200	551554.759	2330450.542	551548.805	2330485.032	551560.715	2330416.050
35300	551653.385	2330467.062	551647.776	2330501.610	551658.994	2330432.515
35400	551752.171	2330482.595	551746.907	2330517.197	551757.434	2330447.994
35500	551851.107	2330497.140	551846.190	2330531.793	551856.024	2330462.487
35600	551950.184	2330510.694	551945.613	2330545.395	551954.754	2330475.994
35700	552049.391	2330523.257	552045.168	2330558.001	552053.614	2330488.513
35800	552148.665	2330535.287	552144.455	2330570.033	552152.875	2330500.541
35900	552247.939	2330547.316	552243.729	2330582.062	552252.149	2330512.570
36000	552347.213	2330559.345	552343.003	2330594.091	552351.423	2330524.599
36100	552446.487	2330571.374	552442.276	2330606.119	552450.697	2330536.628
36200	552545.760	2330583.403	552541.550	2330618.148	552549.971	2330548.657
36300	552645.034	2330595.432	552640.824	2330630.177	552649.244	2330560.686
36400	552744.308	2330607.460	552740.098	2330642.206	552748.518	2330572.715
36500	552843.582	2330619.489	552839.372	2330654.235	552847.792	2330584.744
36600	552942.856	2330631.518	552938.646	2330666.264	552947.066	2330596.772
36700	553042.130	2330643.547	553037.920	2330678.293	553046.340	2330608.801
36800	553141.404	2330655.576	553137.194	2330690.322	553145.614	2330620.830
36900	553240.678	2330667.605	553236.468	2330702.351	553244.888	2330632.859
37000	553339.952	2330679.634	553335.741	2330714.380	553344.162	2330644.888
37100	553439.225	2330691.663	553435.015	2330726.409	553443.436	2330656.917
37200	553538.499	2330703.692	553534.289	2330738.438	553542.709	2330668.946
37300	553637.773	2330715.721	553633.563	2330750.467	553641.983	2330680.975
37400	553737.047	2330727.750	553732.837	2330762.496	553741.257	2330693.004
37500	553836.321	2330739.779	553832.111	2330774.525	553840.531	2330705.033

Construction of 6-Lane Durg – Raipur bypass section of NH-53 from design ch. 0+000 (Vill. Tendesara) to design ch. 44+500 (Vill. Parsada) in the State of Chhattisgarh on EPC Mode under Bharatmala Pariyojana (Package A)

Design Chainage	Centre Line Co-Ordinate		LHS ROW Co-Ordinate		RHS ROW Co-Ordinate	
	Easting	Northing	Easting	Northing	Easting	Northing
37600	553935.595	2330751.808	553931.385	2330786.554	553939.805	2330717.062
37700	554034.869	2330763.837	554030.659	2330798.583	554039.079	2330729.091
37800	554134.143	2330775.866	554129.932	2330810.611	554138.353	2330741.120
37900	554233.417	2330787.895	554229.206	2330822.640	554237.627	2330753.149
38000	554332.690	2330799.923	554328.480	2330834.669	554336.901	2330765.178
38100	554431.964	2330811.952	554427.754	2330846.698	554436.174	2330777.207
38200	554531.238	2330823.981	554527.028	2330858.727	554535.448	2330789.236
38300	554630.512	2330836.010	554626.302	2330870.756	554634.722	2330801.264
38400	554729.786	2330848.039	554725.576	2330882.785	554733.996	2330813.293
38500	554829.060	2330860.068	554824.850	2330894.814	554833.270	2330825.322
38600	554928.334	2330872.097	554924.124	2330906.843	554932.544	2330837.351
38700	555027.608	2330884.126	555023.397	2330918.872	555031.818	2330849.380
38800	555126.881	2330896.155	555122.671	2330930.901	555131.092	2330861.409
38900	555226.155	2330908.184	555221.945	2330942.930	555230.366	2330873.438
39000	555325.429	2330920.213	555321.219	2330954.959	555329.639	2330885.467
39100	555424.703	2330932.242	555420.493	2330966.988	555428.913	2330897.496
39200	555523.977	2330944.271	555519.767	2330979.017	555528.187	2330909.525
39300	555623.251	2330956.300	555619.041	2330991.046	555627.461	2330921.554
39400	555722.525	2330968.329	555718.315	2331003.074	555726.735	2330933.583
39500	555821.799	2330980.358	555817.589	2331015.103	555826.009	2330945.612
39600	555921.073	2330992.387	555916.862	2331027.132	555925.283	2330957.641
39700	556020.346	2331004.415	556016.136	2331039.161	556024.557	2330969.670
39800	556119.620	2331016.444	556115.410	2331051.190	556123.830	2330981.699
39900	556218.869	2331028.681	556214.475	2331063.404	556223.262	2330993.957
40000	556318.035	2331041.564	556313.410	2331076.257	556322.660	2331006.871
40100	556417.114	2331055.108	556412.258	2331089.769	556421.970	2331020.446
40200	556516.099	2331069.312	556511.012	2331103.941	556521.186	2331034.684
40300	556614.988	2331084.176	556609.671	2331118.770	556620.306	2331049.582
40400	556713.776	2331099.699	556708.228	2331134.256	556719.324	2331065.141
40500	556812.458	2331115.880	556806.680	2331150.400	556818.237	2331081.360
40600	556911.030	2331132.718	556905.010	2331167.197	556917.050	2331098.240
40700	557009.488	2331150.214	557003.249	2331184.653	557015.726	2331115.774
40800	557107.863	2331168.168	557101.573	2331202.598	557114.152	2331133.737
40900	557206.235	2331186.138	557199.945	2331220.568	557212.524	2331151.708
41000	557304.607	2331204.108	557298.317	2331238.538	557310.896	2331169.678
41100	557402.979	2331222.078	557396.689	2331256.508	557409.269	2331187.648
41200	557501.351	2331240.048	557495.061	2331274.479	557507.641	2331205.618
41300	557599.723	2331258.019	557593.434	2331292.449	557606.013	2331223.588
41400	557698.095	2331275.989	557691.806	2331310.419	557704.385	2331241.559
41500	557796.467	2331293.959	557790.178	2331328.389	557802.757	2331259.529
41600	557894.839	2331311.929	557888.550	2331346.360	557901.129	2331277.499
41700	557993.261	2331329.623	557987.260	2331364.105	557999.262	2331295.141
41800	558091.885	2331346.152	558086.316	2331380.706	558097.454	2331311.598
41900	558190.708	2331361.448	558185.571	2331396.069	558195.845	2331326.827

Construction of 6-Lane Durg – Raipur bypass section of NH-53 from design ch. 0+000 (Vill. Tendesara) to design ch. 44+500 (Vill. Parsada) in the State of Chhattisgarh on EPC Mode under Bharatmala Pariyojana (Package A)

Design Chainage	Centre Line Co-Ordinate		LHS ROW Co-Ordinate		RHS ROW Co-Ordinate	
	Easting	Northing	Easting	Northing	Easting	Northing
42000	558289.714	2331375.506	558285.010	2331410.189	558294.418	2331340.824
42100	558388.888	2331388.327	558384.618	2331423.065	558393.158	2331353.588
42200	558488.215	2331399.906	558484.379	2331434.695	558492.050	2331365.117
42300	558587.678	2331410.243	558584.278	2331445.077	558591.079	2331375.409
42400	558687.263	2331419.336	558684.299	2331454.210	558690.228	2331384.462
42500	558786.954	2331427.183	558784.426	2331462.092	558789.483	2331392.275
42600	558886.736	2331433.784	558884.644	2331468.722	558888.828	2331398.847
42700	558986.592	2331439.137	558984.936	2331474.116	558988.247	2331404.176
42800	559086.507	2331443.242	559085.305	2331477.765	559087.707	2331408.774
42900	559186.465	2331446.097	559185.689	2331480.883	559187.246	2331411.096
43000	559286.452	2331447.702	559286.109	2331482.701	559286.795	2331412.704
43100	559386.450	2331448.058	559386.545	2331483.058	559386.356	2331413.058
43200	559486.446	2331447.163	559486.978	2331482.159	559485.914	2331412.168
43300	559586.422	2331445.019	559587.391	2331480.006	559585.453	2331410.033
43400	559686.373	2331441.890	559687.495	2331476.872	559685.251	2331406.908
43500	559786.322	2331438.685	559787.444	2331473.667	559785.200	2331403.703
43600	559886.270	2331435.480	559887.392	2331470.462	559885.149	2331400.498
43700	559986.219	2331432.275	559987.341	2331467.257	559985.097	2331397.293
43800	560086.168	2331429.070	560087.289	2331464.052	560085.046	2331394.088
43900	560186.116	2331425.865	560187.238	2331460.847	560184.994	2331390.883
44000	560286.065	2331422.660	560287.187	2331457.642	560284.943	2331387.678
44100	560386.014	2331419.455	560387.135	2331454.437	560384.892	2331384.473
44200	560485.962	2331416.250	560487.084	2331451.232	560484.840	2331381.268
44300	560585.911	2331413.045	560587.033	2331448.027	560584.789	2331378.063
44400	560685.859	2331409.839	560686.981	2331444.822	560684.738	2331374.857
44500	560785.808	2331406.634	560786.930	2331441.616	560784.686	2331371.652

Annex – III

(Schedule-A)

Alignment Plans

The alignment plan of the Project Highway is given in Schedule B.

Annex – IV*(Schedule-A)***Environment and Forest Clearances**

Sr. No.	Clearances	Present Status
1	Environmental Clearance	MOEF&CC has accorded the Project for grant of Environmental Clearances vide letter to NHAI with F.No. 10-72/2018-IA-III dated 8th April 2019
2	Forest Clearance	Not Required

SCHEDULE – B*(See Clause 2.1)***DEVELOPMENT OF THE PROJECT HIGHWAY****1. Development of the Project Highway**

Development of the Project Highway shall include construction of the project as described in this Schedule B and in Schedule C.

2. Six Laning without paved shoulders

Six Laning without paved shoulders shall include construction of 6-lane green field access controlled Durg – Raipur bypass Section of NH-53, Package – A starting from design chainage 0+000 (Vill – Tendesara, existing km 329/400) to design chainage 44+500 (Vill – Parsada), Length 44.50km in the state of Chhattisgarh as described in Annex-I of Schedule-B and in Schedule-C.

3 Specifications and Standards

The Project Highway shall be designed and constructed in conformity with the Specifications and Standards specified in Schedule-D.

Annex - I
(Schedule-B)

DESCRIPTION OF DEVELOPMENT

Construction of 6-lane green field access controlled Durg – Raipur bypass Section of NH-53, Package – A starting from design chainage 0+000 (Vill – Tendesara, existing km 329/400) to design chainage 44+500 (Vill – Parsada), Length 44.50km on EPC Mode under Bharatmala Pariyojana in the State of Chhattisgarh.

1. Construction of Project Highway

1.1 Alignment

The Project Highway shall follow the alignment shown in the plan and profile specified in **Appendix B-II of Schedule-B**, unless otherwise specified by the Authority. Notwithstanding anything to the contrary contained in this Agreement or Manual, the proposed profile of the project highway as indicated in **Appendix B-II of Schedule-B** shall be treated as an approximate assessment. The Contractor shall design the alignment plans and profiles of the project highway based on site/design requirement mentioned in Schedule D with approval from the Authority's Engineer within the available Right of Way. The same shall not constitute a change of scope, save and except any variations arising out of a change of scope expressly undertaken in accordance with the provision of Article 13.

1.2 Width of Carriageway

- a. Main Road: Six laning without paved shoulders shall be undertaken. The paved width shall be as indicated in **Appendix B-I** of this Schedule B.
- b. Loops/Ramps: The Paved width for loops and ramps at interchanges shall be as indicated in **Appendix B-I** of this Schedule B.
- c. In addition to the width of paved carriageway mentioned in above clauses, additional lanes shall be provided as acceleration/deceleration lane and taper to the required length shall be provided at entry/exit locations as per Specifications.
- d. The entire cross-sectional elements shall be accommodated in the available/proposed ROW. If required, suitable retaining structures shall be provided to accommodate the highway cross section within the available/proposed ROW and the same shall not constitute a Change of Scope.
- e. Except as otherwise provided in this Agreement, the width of the paved carriageway and cross-sectional features shall confirm to above clauses.

2. Geometric Design and General Features

2.1 General

Geometric design and general features of the Project Highway shall be in accordance with Section 2 of IRC: SP: 87-2019 (Manual)

2.2 Design Speed

The design speed of the Project Highway shall be in accordance with Section 2 of the Manual.

2.3 Improvement of the Existing Road Geometrics

In the following sections, where improvement of the existing road geometrics to the prescribed standards is not possible, the existing road geometrics shall be improved to the extent possible within the given right of way and proper road signs and safety measures shall be provided:

S. no.	Stretch	Length (km)	Type of deficiency	Remarks
NIL				

The existing geometry of the crossroads at Vehicular overpass/underpass/SVUP locations and cross roads at Interchange locations shall be improved as shown in Plan&Profile drawings in accordance with Schedule D. Deficiencies, if any shall be corrected as per prescribed standards to the extent land is available.

2.4 Right of Way

Details of the Right of Way are given in **Annex-II of Schedule A**.

2.5 Type of Shoulders

- a) The width of paved and earthen shoulders shall be as indicated in **Appendix B-I** of this Schedule B.
- b) For main carriageway earthen shoulders of 3.0 m width shall be provided on either side of the carriageway. The earthen shoulder shall be stabilized with cement/suitable admixtures to prevent erosion as well as to provide a stable platform for occasional parking of errant vehicles. Earthen shoulders shall meet the following strength parameters.
 - (i) Unconfined compressive strength (UCS) equivalent to the strength defined for the bound sub-base layer as per IRC: 37.
 - (ii) CBR of laboratory mix at 97% MDD and 7 days cure+7 days soak: Minimum CBR 60.

For Service Road/Connecting Road/Cross Roads/Ramp, earthen shoulders shall be covered with 150mm thick compacted granular material. Design and specifications shall conform to the requirements specified in the manual.

2.6 Typical Cross Sections

- a) The Project Highway shall be constructed to 6 lane fully access controlled highway configuration without paved shoulders and with or without connecting Roads. Typical cross sections for different segments of the project highway shall be as specified in **Appendix B-I**.
- b) The Loops/Ramps of Interchanges shall be constructed with the lane configuration except toll plaza as given in **Appendix B-I**. At toll plaza location, the lane width shall be as per lane requirement and taper.

2.7 Alignment Plan and Longitudinal Section

An alignment plan and vertical profile of project highway including ramps & loops at interchanges is given at **Appendix B-II** in soft copy. The proposals shown in alignment plans shall be treated as an approximate assessment and minimum specified. The proposals as required on the basis of detailed investigations shall be determined by the Contractor in accordance with this Schedule B, C and D.

2.8 Service roads and Connecting Roads

2.8.1 Service Road shall be constructed as per the details given below:

S. No	LHS				RHS			
	Chainage		Length (m)	C/Way Width (m)	Chainage		Length (m)	C/Way Width (m)
	From	To			From	To		
1	0+000	0+900	900	7.50	0+000	1+730	1730	7.50
2	Along Exist NH53		1500	7.50				
	Total (m)		2400		Total (m)		1730	

2.8.2 Connecting Road shall be constructed as per the details given below:

S. No	LHS				RHS			
	Chainage		Length (m)	C/Way Width (m)	Chainage		Length (m)	C/Way Width (m)
	From	To			From	To		
1	6+620	7+140	520	3.75	13+990	14+190	200	3.75
2	9+920	10+470	550	3.75	19+840	19+980	140	3.75
3	17+680	18+580	900	3.75	22+800	22+930	130	3.75
4	20+740	20+830	90	3.75	33+850	33+910	60	7.00
5	22+770	22+930	160	3.75	40+180	40+400	220	3.75
6	33+910	34+060	150	7.00				
7	Interchange at Ch. 1+963		200	5.50				
	Total (m)		2570		Total (m)		750	

2.8.3 Ramps to Wayside Amenities shall be constructed as per the details given below:

S. No	LHS				RHS			
	Chainage		Length (m)	C/Way Width (m)	Chainage		Length (m)	C/Way Width (m)
	From	To			From	To		
1	11+460	12+260	800	8.00	11+460	12+260	800	8.00
	Total (m)		800		Total (m)		800	

Note:

- a) Above length of the service road/connecting roads/ramp is indicative and minimum specified. The actual length shall be determined by the Contractor in accordance with IRC: SP: 87-2019 and actual site requirement with approval from the Independent Engineer. Any variations in the length specified in this Clause of Schedule-B shall not constitute a Change of Scope, save and except any variations in the length arising out of a Change of Scope expressly undertaken in accordance with the provisions of Article 13.
- b) Length of service roads/ramp given in above table excludes acceleration/deceleration lanes along project highway and the same shall be provided as per schedule D
- c) The realignment of existing track to the SVUP/LVUP/VUP/Flyover outside the PROW and connecting roads between consecutive underpasses wherever required as per plan & profile uploaded with bid document and specified in this schedule shall be constructed by the Contractor as per site requirement in consultation with Authority Engineer. Any variation in the length specified in this Clause shall not constitute a Change of Scope.
- d) Width of connecting road shall not to be less than the width of the existing road subject to minimum width specified above.
- e) All structures falling along connecting roads shall be widened/reconstructed in accordance with manual.

3. Intersections and Grade Separators**3.1 At grade Intersections**

The Project Highway shall be constructed as fully access controlled highway and no at grade intersection will be permissible with main carriageway. Intersections with service road shall be as constructed as per section 3 of the Manual at the locations mentioned below:

Sl. No	Design Chainage	Leading to	Category of Road	Side	Type of Junction.
1	0+520	Tendesara	Village Road	RHS	T
2	0+560	Tendesara	Village Road	LHS	T
3	1+100	Tendesara	Village Road	RHS	T
4	1+980	Dewada	Village Road	RHS	T

Note:

- a) *The Number, location & type of junction shown in above table are indicative and it may increase as per actual site condition and provisions of Manual.*
- b) *Any other junction not mentioned above but observed during the construction of the project shall be improved as per IRC: SP: 87-2019 requirements. The same shall not constitute a Change of Scope, save and except any variations arising out of a Change of Scope expressly undertaken in accordance with the provisions of Article 13.*
- c) *The Contractor shall take up 'Detailed Engineering study' to ascertain further details of all intersections and treatment of the intersections shall be designed in accordance with IRC: SP: 87-2019. The same shall not constitute a Change of Scope, save and except any variations arising out of a Change of Scope expressly undertaken in accordance with the provisions of Article 13.*
- d) *The cross roads at Underpasses/Overpasses/Flyover shall be treated as at grade junction. These junctions of the crossroads shall be developed as per Section 3 of the manual and MoRT&H type design for intersections on National Highways, 1992. Minimum length of improvement along cross roads shall be 100m on either side of main carriageway center line.*

3.2 Interchanges

Interchanges shall be constructed at the locations indicated below:

Sl.No	Design Chainage	Connecting Road	Type of Junction	Remarks
1	1+963	(Nagpur-Kolkata) NH-53	Trumpet	Details of Ramps as per Appendix B-I and Interchange layout as per Appendix B-III
2	8+720	Durg-Balod (SH-7)	Diamond Interchange	Details of Ramps as per Appendix B-I and Interchange layout as per Appendix B-III
3	34+750	Durg-Patan (SH-22)	Diamond Interchange with Rotary	Details of Ramps as per Appendix B-I and Interchange layout as per Appendix B-III

Junction improvement under grade separators/ interchanges shall be carried out as per IRC:SP:87-2019 and typical layout drawing attached with proper entry/exit and pavement composition as indicated in this Schedule B.

3.3 Grade separated structures

3.3.1 Grade separated structures shall be provided as per paragraph 2.13 of manual. The requisite particulars are given below:

3.3.2 Details of Light Vehicular Underpasses (LVUP)

Sl. No	Chai nage	Intersecting Road	Category of cross road	Square Span (Clear Opening) (m)	Skew (deg)	Width of Structure (m)
1	3+145	Anjora - Dharampur	Village Road (1-Lane BT)	1x12x4	44	2 x 14.6
2	6+640	Anjora - Pisegaon	Village Road (Cart Track)	1x12x4	43	2 x 14.6
3	12+842	Borsi - Hanoda	Village Road (1-Lane BT)	1x12x4	3	2 x 14.6
4	19+955	Utai - Pauwara	Village Road (1-Lane BT)	1x12x4	0	2 x 14.6
5	20+830	Utai - Kargadih	Village Road (1-Lane BT)	1x12x4	0	2 x 14.6
6	22+930	Utai - Khapli	Village Road (1-Lane BT)	1x12x4	0	2 x 14.6
7	23+740	Utai - Selud	Village Road (1-Lane BT)	1x12x4	40	2 x 14.6
8	31+582	Chunkatta - Santra	Village Road (1-Lane BT)	1x12x4	20	2 x 14.6
9	36+932	Loharsi - Arasnara	Village Road (1-Lane BT)	1x12x4	12	2 x 14.6

3.3.3 Details of Vehicular Underpasses (VUP)

Sl. No	Chai nage	Intersecting Road	Category of cross road	Span (Clear Opening) (m)	Skew (deg)	Width of Structure (m)
1	14+160	Dhanora - Hanoda	Village Road (2-Lane BT)	1x20x5.5	-	2 x 14.6
2	15+326	Borsi - Khamariya	Village Road (2-Lane BT)	1x20x5.5	27	2 x 14.6
3	18+575	Utai - Purai	Village Road (2-Lane BT)	1x20x5.5	20	2 x 14.6
4	21+766	Utai - Khapli	Village Road (1-Lane BT)	1x20x5.5	13	2 x 14.6
5	26+081	Chunkatta - Selud	Village Road (1-Lane BT)	1x20x5.5	24	2 x 14.6
6	28+763	Chunkatta - Godadih	Village Road (1-Lane BT)	1x20x5.5	44	2 x 14.6
7	33+910	Funda - Santra	Village Road (2-Lane BT)	1x20x5.5	30	2 x 21.6
8	40+179	Sawni - Patan	Village Road (2-Lane BT)	1x20x5.5	11	2 x 14.6
9	42+636	Tulasi - Patan	Village Road (2-Lane BT)	1x20x5.5	9	2 x 14.6

3.3.4 Details of Vehicular Overpasses (VOP)

Sl. No	Chainage	Intersecting Road	Category of cross road	Span (Clear Opening) (m)	Skew (deg)	Width (m)
			NIL			

3.3.5 Details of Flyovers

Sl. No	Chainage	Intersecting Road	Square Span C/C of Exp. Joint (m)	Skew (deg)	Vertical Clearance (m)	Width of Structure (m)
1	1+963	NH-53	2x25	3	5.5	1x14.6 + 1x21.6
2	8+725	SH-7	9x30	-	5.5	2 x 14.6
3	34+750	SH-22	4x30	-	5.5	2 x 14.6

Note:

- All structures shall be designed and constructed in accordance with Section 7 of the Manual and shall conform to the cross-sectional features and details specified in Appendices of this Schedule B.*
- Proposed levels at structure locations as shown in plan & profile specified in Appendix B-II of schedule B are only for guidance and any changes in levels shall not constitute change of scope.*
- Special vehicle loading is to be considered in Design of structures. Congestion factor to be considered as per IRC 6-2017*
- Wherever liquefaction is observed, Ground improvement shall be done to compact the soil to increase its penetration resistance and satisfy clause 8.4.4 (v) of IRC114.*
- Any structures falling within acceleration / deceleration lane /taper shall be constructed to the required width. These changes shall not be treated as change of scope.*
- Any additional LVUP/VUP not provided for in the Schedule B but required during the execution of work will be dealt under the provisions of Article 13.*
- Expansion joints shall be minimized by deck continuity/ continuous superstructure over multiple spans. Deck length between two expansion joints shall not be less than 120m and 3 spans except where structure length falls short of it. Number of expansion joints shall be as per clause 6.8 of IRC: SP: 99-2013*

3.4 Entry/Exits

Additional lanes for entering into or exiting from the project highway shall be provided as per schedule D at the following locations:

Sl.No	Chainage	LHS	RHS	Remarks
1	1330	Exit	Entry	

Sl.No	Chainage	LHS	RHS	Remarks
	1870		Exit	At Trumpet Interchange 1+963 with existing NH-53, Start of project highway
	2610	Entry		
2	8010	Exit	Entry	At Flyover 8+720 with SH-7
	9540	Entry	Exit	
3	11460	Exit	Entry	Way Side Amenities at km. 47+850
	12260	Entry	Exit	
4	34010	Exit	Entry	At Flyover 34+750 with SH-22
	35300	Entry	Exit	

Layout of entry/exits as shown in Plan & Profile drawings shall be provided. Any change in in number and type of entry/exit shall not be treated as change in scope of work.

4. Road Embankment and Cut Section

4.1 The height of the embankment shall be measured with respect to the Finished Road Levels. No section of the highway shall be overtopped. The finished pavement profile of main carriageway shall be designed so that the bottom of the sub grade is minimum 1.0m above the Highest Flood Level (HFL)/ High water table /NGL/Pond level. The Construction of embankment/cutting shall conform to the Specifications and Standards given in Manual and the specified cross-sectional details.

4.2 Raising of existing road – As per geometric design requirements

5. Pavement Design

5.1 Pavement design shall be carried out in accordance with Section-5 of manual, IRC 37 & IRC 58.

5.2 Flexible pavement shall be provided for entire length of project highway except at Toll Plazas. Rigid Pavement shall be provided at Toll Plaza and approaches.

5.3 Flexible pavement is to be designed for a design period of 20 years. Rigid pavement shall be designed for a design period of 30 years. Stage construction shall not be permitted.

5.4 Notwithstanding anything to the contrary contained in this Agreement or the IRC: SP: 87-2019, the Contractor shall design the pavement in accordance with Section 5 of the Manual subject to the design requirement as detailed below.

S. No	Section	Min. MSA	Max. CBR (%)*
1	Main Carriageway including Cross roads at Interchanges	150	10
2	Ramps at Interchange 1+963	90	10
3	Ramps at Interchange 8+720, 34+750 and Wayside Amenities	50	10

S. No	Section	Min. MSA	Max. CBR (%)*
4	Service Road/Connecting Road/ Cross roads at minor junctions	10	10

*Note : The maximum CBR OF 10% shall be capped only without soil improvement and this shall be adhered unless specialized soil stabilization is adopted by contractor in consultation with Authority Engineer.

Rigid Pavement at Toll plaza and its approaches

Minimum Pavement Composition	Toll Plaza on MCW	Toll Plaza on Ramps
Pavement Quality Concrete (PQC)	300 mm	280 mm
Dry Lean Concrete (DLC)	150 mm	150 mm
Granular Sub-base (GSB)	150 mm	150 mm

Note: De-bonding interlayer of polythene sheet having a minimum thickness of 125 micron is shall be provided as separation layer between DLC and PQC.

- 5.5 The following stretches of the existing road shall be reconstructed. These shall be designed as new pavement.

Sl.no	Design Chainage		Length (m)
	From	To	
1	0+000	0+850	850

6. Roadside Drainage

In addition to the provisions given in TCS, adequate Drainage system including surface and subsurface drains and median drainage system shall be provided as per Schedule D. At Cross roads/Connecting roads/other locations necessary drainage arrangements shall be provided as per site condition and the same shall not constitute a Change of Scope.

7. Design of Structures

7.1 General

- All bridges, Culverts and other structures shall be designed and constructed in accordance with Section 7 of the Manual and shall conform to the cross-sectional features and details specified in respective Appendices of this Schedule B.
- Expansion joints shall be minimized by deck continuity/ continuous superstructure over multiple spans. Deck length between two expansion joints shall not be less than 120m and 3 spans except where structure length falls short of it. Number of expansion joints shall be as per clause 6.8 of IRC: SP: 99-2013
- Project Highway is proposed to be constructed to six lane configuration with provision for outer-side widening to ten-lane configuration in future. As such, superstructure of all bridges, culverts and structures is to be designed for edge

movement of the vehicle considering stitching of new superstructure in future due to widening for additional lanes.

- d) Special vehicle loading is to be considered in Design of structures.
- e) Wherever liquefaction is observed, Ground improvement shall be done to compact the soil to increase its penetration resistance and satisfy clause 8.4.4 (v) of IRC114.
- f) Proposed levels at structure locations as shown in plan & profile specified in Appendix B-II of schedule B are only for guidance and any changes in levels shall not constitute change of scope.
- g) The structures falling within acceleration / deceleration lane /taper shall be constructed to the required width. These changes shall not be treated as change of scope.
- h) An effective drainage system for bridge decks shall be provided as specified in the Manual.
- i) Floor protection works shall be as specified in the relevant IRC Codes and Specifications.

7.2 Culverts

7.2.1 Overall width of all culverts shall be equal to the roadway width of the approaches.

7.2.2 Reconstruction of existing culverts:

Sl. No.	Culvert location	Span/Opening (m)	Remarks, if any
Nil			

7.2.3 Widening of existing culverts

Existing culverts at the following locations shall be widened to roadway width of approaches as per the typical cross sections given in Appendix B-I. Repairs and strengthening of existing structures wherever required shall be carried out.

Sl.No	Design Chainage	Type of Culvert	Span/Dia. (m)	Min. width of Widening (m) (LHS + RHS)
1	0+408	Slab	1 x 4 x 2.5	19+19

7.2.4 Additional new culverts for cross drainage shall be constructed as per the particulars given below:

Sl.No	Chainage	Type of Culvert	Size
			No x Span (m) x Vent (m)
Main Carriageway including Service Road, Ramps and connecting roads			
1	2+620	RCC BOX	1 x 3 x 3
2	3+030	RCC BOX	1 x 2 x 2

Sl.No	Chainage	Type of Culvert	Size
			No x Span (m) x Vent (m)
3	3+860	RCC BOX	1 x 3 x 3
4	5+520	RCC BOX	1 x 6 x 4
5	6+030	RCC BOX	1 x 6 x 4
6	6+670	RCC BOX	1 x 3 x 3
7	7+150	RCC BOX	1 x 3 x 3
8	7+590	RCC BOX	1 x 3 x 2.5
9	7+990	RCC BOX	1 x 6 x 3
10	8+240	RCC BOX	1 x 3 x 2.5
11	9+070	RCC BOX	1 x 2 x 2
12	9+530	RCC BOX	1 x 3 x 3
13	10+723	RCC BOX	1 x 3 x 3
14	11+300	RCC BOX	1 x 3 x 3
15	12+000	RCC BOX	1 x 3 x 2.5
16	12+400	RCC BOX	1 x 3 x 2.5
17	13+190	RCC BOX	1 x 3 x 2.5
18	13+670	RCC BOX	1 x 3 x 3
19	14+066	RCC BOX	1 x 5 x 3
20	14+401	RCC BOX	1 x 3 x 3
21	14+910	RCC BOX	1 x 3 x 3
22	15+950	RCC BOX	1 x 3 x 3
23	16+400	RCC BOX	1 x 3 x 3
24	17+150	RCC BOX	1 x 3 x 3
25	17+420	RCC BOX	1 x 3 x 3
26	17+770	RCC BOX	1 x 3 x 2.5
27	19+650	RCC BOX	1 x 6 x 3
28	20+400	RCC BOX	1 x 3 x 3
29	20+880	RCC BOX	1 x 3 x 3
30	21+390	RCC BOX	1 x 3 x 3
31	21+580	RCC BOX	1 x 6 x 4
32	22+100	RCC BOX	1 x 3 x 3
33	22+580	RCC BOX	1 x 3 x 3
34	23+607	RCC BOX	1 x 2 x 2
35	24+090	RCC BOX	1 x 3 x 3
36	24+390	RCC BOX	1 x 3 x 3
37	25+260	RCC BOX	1 x 3 x 3
38	25+785	RCC BOX	1 x 3 x 3
39	26+100	RCC BOX	1 x 2 x 2
40	26+150	RCC BOX	1 x 2 x 2
41	26+650	RCC BOX	1 x 3 x 3

Sl.No	Chainage	Type of Culvert	Size
			No x Span (m) x Vent (m)
42	27+170	RCC BOX	1 x 3 x 3
43	27+543	RCC BOX	1 x 3 x 3
44	27+675	RCC BOX	1 x 3 x 3
45	27+880	RCC BOX	1 x 3 x 3
46	28+733	RCC BOX	1 x 2 x 2
47	29+260	RCC BOX	1 x 3 x 3
48	29+650	RCC BOX	1 x 3 x 2.5
49	30+050	RCC BOX	1 x 3 x 2.5
50	30+450	RCC BOX	1 x 3 x 2.5
51	31+440	RCC BOX	1 x 3 x 3
52	31+595	RCC BOX	1 x 2 x 2
53	31+800	RCC BOX	1 x 3 x 3
54	32+110	RCC BOX	1 x 3 x 3
55	32+520	RCC BOX	1 x 3 x 3
56	32+940	RCC BOX	1 x 3 x 3
57	33+960	RCC BOX	1 x 2 x 2
58	34+517	RCC BOX	1 x 6 x 2.5
59	35+400	RCC BOX	1 x 3 x 2.5
60	36+200	RCC BOX	1 x 3 x 3
61	36+640	RCC BOX	1 x 3 x 3
62	36+920	RCC BOX	1 x 2 x 2
63	37+900	RCC BOX	1 x 3 x 3
64	38+400	RCC BOX	1 x 3 x 3
65	38+800	RCC BOX	1 x 2 x 2
66	38+835	RCC BOX	1 x 2 x 2
67	39+160	RCC BOX	1 x 3 x 3
68	39+570	RCC BOX	1 x 3 x 3
69	39+930	RCC BOX	1 x 3 x 3
70	40+625	RCC BOX	1 x 3 x 3
71	41+080	RCC BOX	1 x 3 x 3
72	41+720	RCC BOX	1 x 6 x 3
73	42+200	RCC BOX	1 x 3 x 3
74	43+140	RCC BOX	1 x 6 x 4
75	44+100	RCC BOX	1 x 3 x 3

7.2.5 Additional new culverts for connecting roads/road cum drain shall be constructed as per the particulars given below:

Sl.No	Chainage	Type of Culvert	Size	Type of Crossing
			No x Span (m) x Vent (m)	
Main Carriageway including Service Road, Ramps and connecting roads				
1	3+323	RCC BOX	1 x 6 x 4	Earthen Track cum Drain
2	4+163	RCC BOX	1 x 6 x 4	BT Road cum Drain
3	4+822	RCC BOX	1 x 6 x 4	BT Road cum Drain
4	9+060	RCC BOX	1 x 6 x 4	Earthen Track cum Drain
5	9+910	RCC BOX	1 x 6 x 4	Earthen Track cum Drain
6	10+456	RCC BOX	1 x 3 x 3	Earthen Track cum Drain
7	30+872	RCC BOX	1 x 6 x 4	Earthen Track cum Drain
8	33+472	RCC BOX	1 x 6 x 4	Earthen Track cum Drain
9	35+789	RCC BOX	1 x 6 x 4	Earthen Track cum Drain
10	37+375	RCC BOX	1 x 6 x 4	Earthen Track cum Drain
11	38+822	RCC BOX	1 x 6 x 4	Earthen Track cum Drain
12	43+965	RCC BOX	1 x 6 x 4	Earthen Track cum Drain

7.2.6 Additional new culverts at interchanges shall be constructed as per the particulars given below:

Sl.No	Chainage	Type of Culvert	Size	Remarks
			No x Span (m) x Vent (m)	
Interchange at 1+963				
1	0+220	RCC BOX	1 x 2 x 2	Ramp 1A
2	0+970	RCC BOX	1 x 2 x 2	Ramp 1A
3	0+350	RCC BOX	1 x 2 x 2	Ramp 1B
4	0+650	RCC BOX	1 x 2 x 2	Ramp 1B
5	0+060	HUME PIPE	1 x 1.2	Ramp 1C
6	0+590	HUME PIPE	1 x 1.2	Ramp 1C
7	0+190	HUME PIPE	1 x 1.2	Ramp 1D
8	0+660	HUME PIPE	1 x 1.2	Ramp 1D
Interchange at 8+725				
1	0+070	HUME PIPE	1 x 1.2	Ramp 2A
2	0+230	RCC BOX	1 x 3 x 2.5	Ramp 2A
3	0+470	RCC BOX	1 x 3 x 2.5	Ramp 2B
4	0+630	HUME PIPE	1 x 1.2	Ramp 2B
5	0+220	RCC BOX	1 x 2 x 2	Ramp 2C
6	0+325	RCC BOX	1 x 6 x 4	Ramp 2C

Sl.No	Chainage	Type of Culvert	Size	Remarks
			No x Span (m) x Vent (m)	
7	0+335	RCC BOX	1 x 2 x 2	Ramp 2C
8	0+680	RCC BOX	1 x 2 x 2	Ramp 2C
9	0+800	RCC BOX	1 x 3 x 3	Ramp 2C
10	0+010	RCC BOX	1 x 3 x 3	Ramp 2D
11	0+130	RCC BOX	1 x 2 x 2	Ramp 2D
12	0+465	RCC BOX	1 x 2 x 2	Ramp 2D
13	0+476	RCC BOX	1 x 6 x 4	Ramp 2D
14	0+590	RCC BOX	1 x 2 x 2	Ramp 2D
Interchange at 34+688				
1	0+140	HUME PIPE	1 x 1.2	Ramp 3A
2	0+490	RCC BOX	1 x 6 x 2.5	Ramp 3A
3	0+165	RCC BOX	1 x 6 x 2.5	Ramp 3B
4	0+550	HUME PIPE	1 x 1.2	Ramp 3B
5	0+300	HUME PIPE	1 x 1.2	Ramp 3C
6	0+200	HUME PIPE	1 x 1.2	Ramp 3D
7	0+250	RCC BOX	1 x 2 x 2	SH-22
8		HUME PIPE	1 x 1.2	Roundabout
9		HUME PIPE	1 x 1.2	Roundabout

7.2.7 Details of Culverts for field canal/utility crossing

Sl. No	Location	Type of Culvert	Dia (m)	Remarks
1	As per site requirement	Hume Pipe	1 x 1.2	New Culvert

25 no. of Pipe culverts of 1x1200mm dia. shall be provided across the Highway for field canal/ utility crossings as per the site requirement. Location for such culverts shall be finalized in consultation with Authority Engineer and NHA.

Note:

- The overall width of the culverts shall be equal to Roadway width including median and the gap between main carriageway & service road, in case there is any service road. Any additional Barrel length required as per site condition shall not constitute a Change of Scope.*
- Location of the above culverts are indicative and span arrangement is minimum specified. Exact location of these culverts shall be decided in consultation with Independent Engineer. The vent way/span arrangements of culverts shall be determined on the basis of detailed investigations by the Contractor in accordance*

with the Specifications and Standards. Any variations in vent way/span arrangements specified above shall not constitute a Change of Scope.

- c) *For the culverts over connecting roads/road cum drain, minimum vent height specified above shall be measured from FRL of cross road.*
- d) *At Cross roads/Connecting roads culverts shall be provided as per site condition in accordance with the manual. Also, Culverts required for the disposal of median drain/longitudinal drains are to be constructed as per site requirement in accordance with the manual. Construction of these culverts is deemed to be part of the project.*
- e) *In case of culverts proposed for widening, the same shall be re-constructed if the design shows that these are unsafe for design loads. No change of scope shall be considered in such cases.*

7.3 Bridges

7.3.1 Existing bridges to be re-constructed

The existing bridges at the following locations shall be re-constructed:

Sl.No	Chainage	Span (m)	Width of Structure (m)	Remarks
NIL				

7.3.2 Existing bridges to be widened

The following narrow bridges shall be widened:

Sl.No	Chainage	Span (m)	Width of Structure (m)
NIL			

7.3.3 New Major Bridges over Rivers/Streams/Nallah

New Major Bridges over Rivers/Streams/Nallah shall be constructed as per the following details:

Sl. No	Chainage	Name of Stream	Square Span C/C of Exp. Joint (m)	Width of Structure (m)
1	5+875	-	2x35	2 x 14.6
2	6+360	Seonath River	16x30	2 x 14.6
3	11+090	Pulgaon Nallah	4x26.5	2 x 14.6
4	43+780	Karun River	8x30	2 x 14.6
5	0+115/ Ramp 2C	Pond	12x15	1 x 10
6	0+705/ Ramp 2D	Pond	12x15	1 x 10

7.3.4 New Major Bridges over Irrigation Canals

New Major Bridges over Irrigation Canals shall be constructed as per the following details:

Sl. No	Chainage	Name of Stream	Square Span C/C of Exp. Joint (m)	Width of Structure (m)
1	23+430	Tandula Canal	1x20 + 1x60 + 1x20	2 x 14.6

For the bridges over canals, minimum vertical clearance of 4m shall be provided from Canal bund level.

7.3.5 New Minor Bridges over Rivers/Streams/Nallah

New Minor Bridges over Rivers/Streams/Nallah shall be constructed as per the following details:

Sl. No	Chainage	Square Span (m)	Skew (deg.)	Width of Structure (m)
1	1+297	1x10	20	1x23 + 1x35.60
2	15+615	2x12		2 x 14.6
3	17+489	2x12		2 x 14.6
4	18+185	2x12	30	2x14.6 + 1x10
5	18+650	1x12	30	2 x 14.6
6	19+095	1x12	30	2 x 14.6
7	30+834	1x10	27	2 x 14.6
8	33+380	2x8		2 x 14.6
9	40+225	3x10		2x14.6 + 1x10
10	42+461	1x40		2 x 14.6

7.3.6 New Minor Bridges over Irrigation Canals

New Minor Bridges over Irrigation Canals shall be constructed as per the following details:

Sl. No	Chainage	Name of Nala/ Canal	Square Span (m)	Skew (deg.)	Width of Structure (m)
1	16+174	Canal	2x7	15	2 x 14.6
2	20+996	Kokri Canal	3x7		2 x 14.6
3	24+678	Patora Minor	2x7	46	2 x 14.6
4	28+405	Selud Distributory	1x30		2 x 14.6

For the bridges over canals, minimum vertical clearance of 4m shall be provided from Canal bund level.

7.3.7 New Minor Bridges along Interchange Ramps

New Minor Bridges along interchange ramps shall be constructed as per the following details:

Sl. No	Chainage	Square Span (m)	Skew (deg.)	Width of Structure (m)
NIL				

7.3.8 The railings of existing bridges shall be replaced by crash barriers at the following locations: - NIL -

7.3.9 Repairs/replacements of railing/parapets of the existing bridges shall be undertaken as follows: - NIL -

7.3.10 Drainage system for bridge decks

An effective drainage system for bridge decks shall be provided as specified in the Manual.

7.3.11 Structures in marine environment: - NIL -

7.4 ROB

7.4.1 Design, construction and detailing of ROB shall be as specified in section 7 of the Manual.

7.4.2 Road over bridges (road over rail) shall be provided at the following locations, as per GAD drawings attached.

Sl. No	Design Chainage	Location of crossing	Crossing line	Railway Chainage	Span C/C of Exp. Joint (m)	Width of Structure (m)
1	16+812.932	DD-12, Between Railway Stations Maroda - Pauwara	Bhilai to Dalli Rajahara (Raipur, South East Central Railway)	881+209	LHS - 1x76 RHS - 2x51.480	2 x 14.6

Note:

- Any change in length/span arrangement/width of structure shall not be considered as change of scope.
- ROBs shall be designed, constructed and maintained as per the requirements of Railway authorities. The construction plans shall be prepared in consultation with the concerned railway authority.

- c) The ROB's shall be constructed and maintained by the Contractor under supervision of the Railways.
- d) All expenditure related to construction, maintenance and supervision of ROB's (except P&E charges) shall be borne by the Contractor.
- e) During construction, at the location of the existing level crossing, diversion road with level crossing if any shall be suitably provided by the Contractor.

7.5 Repairs and Strengthening of Bridges and Structures

The existing bridges and structures to be repaired/ strengthened, and the nature and extent of repairs /strengthening required are given below: - NIL –

8. Retaining Structures

Retaining Wall/Reinforced Earth Wall/Toe Wall shall be constructed at the locations indicated below and in accordance with Schedule D.

A) Stretches for provision of Reinforced Earth Wall

Sl. No	Chainage		Length (m)	Remarks
	From	To		
1	33+810	34+010	400	On Both Shoulder edges of Main C/Way
2	0+000	0+320	320	On LHS Shoulder edge of Ramp 3A
3	0+370	0+690	320	On LHS Shoulder edge of Ramp 3B

B) Stretches for provision of Toe Wall

Sl. No	Chainage		Length (m)	Remarks
	From	To		
1	1+500	1+860	360	On LHS Between Main C/Way and Ramp
2	2+070	2+400	330	On LHS Between Main C/Way and Ramp
3	8+310	8+670	720	On Both Sides Between Main C/Way and Ramp
4	9+920	10+040	120	On LHS Between Main C/Way and Connecting Road
5	14+020	14+150	130	On RHS Between Main C/Way and Connecting Road
6	16+450	16+750	600	On Both Sides at the toe of Main C/Way
7	16+880	17+100	440	On Both Sides at the toe of Main C/Way
8	18+290	18+560	270	On LHS Between Main C/Way and Connecting Road
9	18+680	18+830	150	On RHS at the toe of Main C/Way
10	23+100	23+360	520	On Both Sides at the toe of Main C/Way
11	23+500	23+650	300	On Both Sides at the toe of Main C/Way
12	34+170	34+690	1040	On Both sides Between Main C/Way and Ramp
13	34+810	35+120	620	On Both sides Between Main C/Way and Ramp

B) Stretches for provision of Toe Wall

Sl. No	Chainage		Length (m)	Remarks
	From	To		
14	40+190	40+210	20	On RHS Between Main C/Way and Connecting Road
15	0+490	0+690	200	On LHS at the toe of Ramp 2A
16	0+020	0+200	180	On LHS at the toe of Ramp 2B
17	0+210	0+470	260	On LHS at the toe of Ramp 2C
18	0+360	0+600	240	On LHS at the toe of Ramp 2D

Note:

- a) Above length of Retaining wall/ Reinforced Earth Wall/Toe Wall is tentative and minimum specified. The actual length shall be determined by the Contractor in accordance with the manual requirements with approval from the Authority's Engineer. Any variation in the length specified in this Clause of Schedule-B shall not constitute a Change of Scope, save and except any variations in the length arising out of a Change of Scope expressly undertaken in accordance with the provisions of Article 13.

9. Traffic control devices and road safety works

Traffic control devices and road safety works shall be provided as mentioned in Schedule C in accordance with the manual.

10. Roadside furniture

- 10.1 Roadside furniture like km/Hectometer Stones, Railings, Traffic Impact Attenuators, and Delineators shall be provided in accordance with the provisions of manual.
- 10.2 Traffic signs as per details given below and indicated in the traffic signage plan mentioned in Appendix B-II of this Schedule shall be provided in accordance to manual. The traffic signage plan mentioned in Appendix B-II shall be deemed to be part of this Schedule-B.

Sl. No.	Description	Nos.
A) Mandatory/Regulatory Signs		
1	Give Way	20
2	Speed Limit	29
3	Height Limit	18
4	Bull and Hand Cart Prohibited	13
5	Compulsory Ahead Only	16
6	U Turn Prohibited	13
B) Cautionary/Warning Signs		
1	Left/Right Hand Curve	8
2	Roundabout Sign	4
3	Merging Traffic ahead	26

Sl. No.	Description	Nos.
4	Pedestrian Crossing	22
5	Rumble Strip	22
6	Overhead Cables	8
7	Chevron	294
C) Informatory Signs		
1	Advance Direction - Overhead Gantry	14
2	Advance Direction - Cantilever Gantry	20
3	Reassurance Sign- Full Gantry	14
4	Reassurance Sign- Shoulder Mounted	18
5	Advance Direction - Shoulder Mounted	18
6	Flag Type Direction	18
7	Map type Advance Direction Sign	4
8	Entry/ Exit Sign	16
9	Route Marker	18
10	Temple/Mosque/Other Information	35
D) Hazard Markers		
1	One Way Object Hazard Marker	205
2	Two Way Object Hazard Marker	68
3	Triple Chevron Marker (At roundabout)	4

The type, numbers and location of Traffic Signage shown above and in Traffic Signage Plan (Appendix B-II) are tentative and minimum specified. The actual numbers and location of Traffic Signage shall be determined by the Concessionaire in accordance with the IRC: SP: 87-2019 with approval from the Authority Engineer. Any increase in the number and type of road sign shall not constitute a Change of Scope, save and except any variations arising out of a Change of Scope expressly undertaken in accordance with the provisions of Article 13.

11. Slope Protection

The side slope shall be protected by using suitable slope protection measures wherever required in accordance with Schedule D.

12. Fencing/ Boundary Wall

RCC boundary wall shall be provided along the entire length on either side (including transverse requirements at structure locations) as per typical layout drawing as mentioned in Schedule C.

13. Rainwater Harvesting Structure

Ground water recharging/Rain water harvesting structure shall be provided at every 500m interval on both sides and shall be executed as per requirement of IRC SP: 42-2017 and IRC SP: 50-2013.

14. Hazardous Locations

The safety measures shall be provided as given in Schedule C. In addition to Schedule C, additional location as directed by IE/NHAI shall be identified and provided in accordance to Manual and the same shall not constitute a Change of Scope.

15. Utilities

A minimum 2m wide strip of land at the extreme edge of ROW shall be kept for accommodating utilities. Culverts proposed in Schedule B shall be used for crossing of utilities, wherever required. If the distance between two adjacent box culverts is more than 1 km, utility ducts in form of NP-4 Hume Pipe 1.2m diameter shall be provided across the Project Highway. Location for such utility crossing shall be finalized in consultation with Independent Engineer.

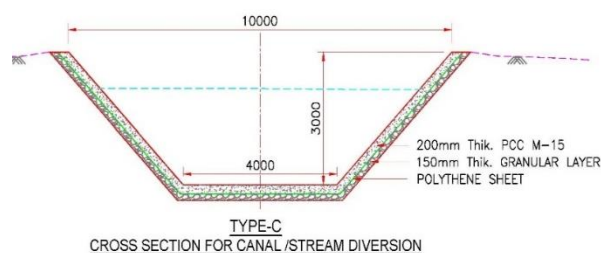
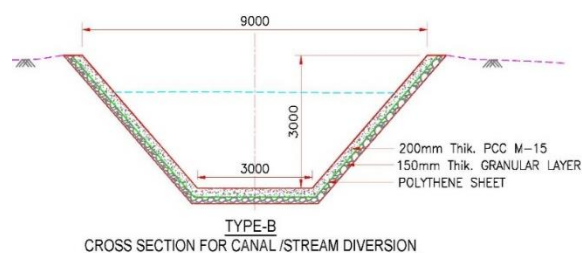
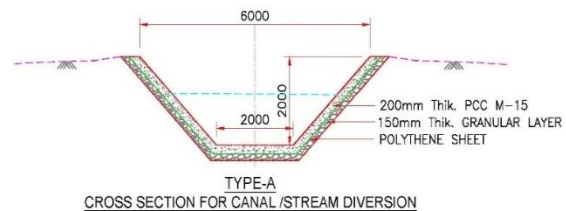
16. Diversion of Nallah/Drain/Canal

Contractor shall shift the existing irrigation Canal/Nala at the locations detailed below:

Sl. No.	Design Chainage		Side	Length (m)	Remarks
	From	To			
1	18190	18400	Left	210	Cross Section Type C
2	19100	19300	Left	200	Cross Section Type B
3	19650	19820	Right	170	Cross Section Type A

Note:

The actual cross-section of canal/stream to be shifted and extent of such shifting (length) shall be determined by the Contractor as per the site/ design requirement with approval of concerned irrigation authority & Authority's Engineer. Any variation in the cross-section and length specified in this Clause of Schedule-B shall not constitute a Change of Scope, save and except any variations in the length arising out of a Change of Scope expressly undertaken in accordance with the provisions of Article 13.



17. Plantation/Compulsory Afforestation

Roadside Plantation, Median plantation, Landscaping and Compulsory afforestation shall be as given Schedule 'C'

18. Emergency Crossover

Emergency crossovers shall be provided in accordance to Manual.

19. Traffic Management Systems

In addition to the list given below, additional locations shall be identified and provided in accordance to schedule D.

Sl. No.	Type of ATMS	Location
1	Mobile Communication System	At such locations so as to cover entire length with mobile communications.
2	Variable Message Signs	As per Schedule D
3	Meteorological Data System	One location (Interchange/near toll plaza)
4	Automatic Traffic Counter and Vehicle Classification	At every Toll Plaza
5	Video Surveillance System	At each side of all Interchanges on both directions and other such locations to cover entire length
6	Video Incident Detection System	At each side of all Interchanges on both directions and other such locations to cover entire length

20. Utilities Shifting

Shifting of obstructing existing utilities indicated in Schedule A to an appropriate location in accordance with the standards and specifications of concerned Utility Owning Department is part of the scope of work of the Concessionaire. The bidders may visit the site and assess the quantum of shifting of utilities for the project before submission of their bid. Copy of utility relocation plan is enclosed in Appendix B-II. The specifications of concerned Utility Owning Department shall be applicable and followed.

Note I:

- a) The type/spacing/size/specifications of poles/towers/lines/cables to be used in shifting work shall be as per the guidelines of Utility Owning Department and it is to be agreed solely between the Contractor and the Utility Owning Department. No change of scope shall be admissible and no cost shall be paid for using different type/spacing/size/specifications in shifted work in comparison to those in the existing work or for making any overhead crossings to underground as per requirement of Utility owning Department and/or construction of project highway. The Concessionaire shall carry out joint inspection with Utility Owning Department and get the estimates from utility Owning Department. The assistance of the

Authority is limited to giving forwarding letter on the proposal of Concessionaire. The decision/approval of Utility owning Department shall be binding on the Contractor.

- b) The supervision charges at the rates/charges applicable of the Utility owning Department shall be paid directly by the Authority to the Utility owning Department as and when Concessionaire furnished demand of Utility Owning Department along with a copy of estimated cost given by the latter.
- c) The dismantled material/scrap of existing Utility to be shifted/dismantled shall belong to the Concessionaire who would be free to dispose-off the dismantled material as deemed fit by them unless the Concessionaire is required to deposit the dismantled material to Utility Owning Department as per the norms and practice and, in that case the amount of credit for dismantled material may be availed by the Concessionaire as per the estimate agreed between them.
- d) The utilities shall be handed over after shifting work is completed to Utility Owning Department to their entire satisfaction. The maintenance liability shall rest with the Utility Owning Department after handing over process is complete as far as utility shifting works are concerned.

Note II: - Copy of Utility shifting plan enclosed

4.27 Change of Scope

The length of structures and bridges specified hereinabove shall be treated as an approximate assessment. The proposed span arrangement of structures may be changed based on innovative design of structure, latest construction techniques and aesthetics of structures. Actual lengths of structures and bridges as required on the basis of detailed investigations shall be determined by the Contractor in accordance with the Specifications and Standards. Any variations in the lengths specified in this Schedule-B shall not constitute a Change of Scope, save and except any variations in the length arising out of a Change of Scope expressly undertaken in accordance with the provisions of Article 13.

Appendix B-I**Typical Cross Section Schedule – Main Carriageway**

Sl. No	Design Chainage		Length (m)	TCS Type	Remarks
	From	To			
1	0+000	0+900	900	TCS 9	6-lane Highway with Service Road/Ramp on both sides
2	0+900	1+330	430	TCS 7	6-lane Highway with Service Road/ Ramp on LHS/RHS
3	1+330	1+860	530	TCS 6	6-lane Highway with Ramp and Toe Wall on one side and Emb. on other side
4	1+860	1+938	78	TCS 1	6-lane Highway in Embankment
5	1+938	1+988	50	TCS 3	6-lane Flyover/VUP/LVUP/Bridge/ROB
6	1+988	2+070	82	TCS 1	6-lane Highway in Embankment
7	2+070	2+610	540	TCS 6	6-lane Highway with Ramp and Toe Wall on one side and Emb. on other side
8	2+610	3+137	527	TCS 1	6-lane Highway in Embankment
9	3+137	3+154	17	TCS 3	6-lane Flyover/VUP/LVUP/Bridge/ROB
10	3+154	5+070	1916	TCS 1	6-lane Highway in Embankment
11	5+070	5+590	520		Toll Plaza (Refer P&P)
12	5+590	5+840	250	TCS 1	6-lane Highway in Embankment
13	5+840	5+910	70	TCS 3	6-lane Flyover/VUP/LVUP/Bridge/ROB
14	5+910	6+120	210	TCS 1	6-lane Highway in Embankment
15	6+120	6+600	480	TCS 3	6-lane Flyover/VUP/LVUP/Bridge/ROB
16	6+600	6+632	32	TCS 1	6-lane Highway in Embankment
17	6+632	6+648	16	TCS 3	6-lane Flyover/VUP/LVUP/Bridge/ROB
18	6+648	7+140	492	TCS 8	6-lane Highway with Connecting Road on LHS/RHS
19	7+140	8+010	870	TCS 1	6-lane Highway in Embankment
20	8+010	8+680	670	TCS 5	6-lane Highway with/without Toe Wall and Entry/Exit Ramps
21	8+680	8+950	270	TCS 3	6-lane Flyover/VUP/LVUP/Bridge/ROB
22	8+950	9+540	590	TCS 5	6-lane Highway with/without Toe Wall and Entry/Exit Ramps
23	9+540	9+920	380	TCS 1	6-lane Highway in Embankment
24	9+920	10+470	550	TCS 8	6-lane Highway with Connecting Road on LHS/RHS
25	10+470	11+037	567	TCS 1	6-lane Highway in Embankment
26	11+037	11+142	105	TCS 3	6-lane Flyover/VUP/LVUP/Bridge/ROB
27	11+142	11+460	318	TCS 1	6-lane Highway in Embankment
28	11+460	12+260	800	TCS 9	6-lane Highway with Service Road/Ramp on both sides
29	12+260	12+836	576	TCS 1	6-lane Highway in Embankment

Construction of 6-Lane Durg – Raipur bypass section of NH-53 from design ch. 0+000 (Vill. Tendesara) to design ch. 44+500 (Vill. Parsada) in the State of Chhattisgarh on EPC Mode under Bharatmala Pariyojana (Package A)

Sl. No	Design Chainage		Length (m)	TCS Type	Remarks
	From	To			
30	12+836	12+848	12	TCS 3	6-lane Flyover/VUP/LVUP/Bridge/ROB
31	12+848	13+990	1142	TCS 1	6-lane Highway in Embankment
32	13+990	14+150	160	TCS 8	6-lane Highway with Connecting Road on LHS/RHS
33	14+150	14+170	20	TCS 3	6-lane Flyover/VUP/LVUP/Bridge/ROB
34	14+170	15+315	1145	TCS 1	6-lane Highway in Embankment
35	15+315	15+337	22	TCS 3	6-lane Flyover/VUP/LVUP/Bridge/ROB
36	15+337	15+605	268	TCS 1	6-lane Highway in Embankment
37	15+605	15+625	20	TCS 3	6-lane Flyover/VUP/LVUP/Bridge/ROB
38	15+625	16+167	542	TCS 1	6-lane Highway in Embankment
39	16+167	16+181	14	TCS 3	6-lane Flyover/VUP/LVUP/Bridge/ROB
40	16+181	16+765	584	TCS 1	6-lane Highway in Embankment
41	16+765	16+855	90	TCS 3	6-lane Flyover/VUP/LVUP/Bridge/ROB
42	16+855	17+483	628	TCS 1	6-lane Highway in Embankment
43	17+483	17+495	12	TCS 3	6-lane Flyover/VUP/LVUP/Bridge/ROB
44	17+495	17+680	185	TCS 1	6-lane Highway in Embankment
45	17+680	18+565	885	TCS 8	6-lane Highway with Connecting Road on LHS/RHS
46	18+565	18+585	20	TCS 3	6-lane Flyover/VUP/LVUP/Bridge/ROB
47	18+585	18+663	78	TCS 1	6-lane Highway in Embankment
48	18+663	18+677	14	TCS 3	6-lane Flyover/VUP/LVUP/Bridge/ROB
49	18+677	19+088	411	TCS 1	6-lane Highway in Embankment
50	19+088	19+102	14	TCS 3	6-lane Flyover/VUP/LVUP/Bridge/ROB
51	19+102	19+840	738	TCS 1	6-lane Highway in Embankment
52	19+840	19+948	108	TCS 8	6-lane Highway with Connecting Road on LHS/RHS
53	19+948	19+961	13	TCS 3	6-lane Flyover/VUP/LVUP/Bridge/ROB
54	19+961	20+740	779	TCS 1	6-lane Highway in Embankment
55	20+740	20+824	84	TCS 8	6-lane Highway with Connecting Road on LHS/RHS
56	20+824	20+836	12	TCS 3	6-lane Flyover/VUP/LVUP/Bridge/ROB
57	20+836	20+985	149	TCS 1	6-lane Highway in Embankment
58	20+985	21+006	21	TCS 3	6-lane Flyover/VUP/LVUP/Bridge/ROB
59	21+006	21+756	750	TCS 1	6-lane Highway in Embankment
60	21+756	21+776	20	TCS 3	6-lane Flyover/VUP/LVUP/Bridge/ROB
61	21+776	22+770	994	TCS 1	6-lane Highway in Embankment
62	22+770	22+924	154	TCS 8	6-lane Highway with Connecting Road on LHS/RHS
63	22+924	22+936	12	TCS 3	6-lane Flyover/VUP/LVUP/Bridge/ROB

Sl. No	Design Chainage		Length (m)	TCS Type	Remarks
	From	To			
64	22+936	23+380	444	TCS 1	6-lane Highway in Embankment
65	23+380	23+480	100	TCS 3	6-lane Flyover/VUP/LVUP/Bridge/ROB
66	23+480	23+732	252	TCS 1	6-lane Highway in Embankment
67	23+732	23+748	16	TCS 3	6-lane Flyover/VUP/LVUP/Bridge/ROB
68	23+748	24+668	920	TCS 1	6-lane Highway in Embankment
69	24+668	24+688	20	TCS 3	6-lane Flyover/VUP/LVUP/Bridge/ROB
70	24+688	26+070	1382	TCS 1	6-lane Highway in Embankment
71	26+070	26+092	22	TCS 3	6-lane Flyover/VUP/LVUP/Bridge/ROB
72	26+092	28+389	2297	TCS 1	6-lane Highway in Embankment
73	28+389	28+420	31	TCS 3	6-lane Flyover/VUP/LVUP/Bridge/ROB
74	28+420	28+749	329	TCS 1	6-lane Highway in Embankment
75	28+749	28+777	28	TCS 3	6-lane Flyover/VUP/LVUP/Bridge/ROB
76	28+777	30+828	2051	TCS 1	6-lane Highway in Embankment
77	30+828	30+840	12	TCS 3	6-lane Flyover/VUP/LVUP/Bridge/ROB
78	30+840	31+576	736	TCS 1	6-lane Highway in Embankment
79	31+576	31+589	13	TCS 3	6-lane Flyover/VUP/LVUP/Bridge/ROB
80	31+589	33+370	1781	TCS 1	6-lane Highway in Embankment
81	33+370	33+390	20	TCS 3	6-lane Flyover/VUP/LVUP/Bridge/ROB
82	33+390	33+898	508	TCS 1	6-lane Highway in Embankment
83	33+898	33+922	24	TCS 3	6-lane Flyover/VUP/LVUP/Bridge/ROB
84	33+922	34+010	88	TCS 1	6-lane Highway in Embankment
85	34+010	34+690	680	TCS 4	6-lane Highway with Toe Wall and Entry/Exit Ramps
86	34+690	34+810	120	TCS 3	6-lane Flyover/VUP/LVUP/Bridge/ROB
87	34+810	35+300	490	TCS 4	6-lane Highway with Toe Wall and Entry/Exit Ramps
88	35+300	36+926	1626	TCS 1	6-lane Highway in Embankment
89	36+926	36+938	12	TCS 3	6-lane Flyover/VUP/LVUP/Bridge/ROB
90	36+938	40+169	3231	TCS 1	6-lane Highway in Embankment
91	40+169	40+189	20	TCS 3	6-lane Flyover/VUP/LVUP/Bridge/ROB
92	40+189	40+400	211	TCS 8	6-lane Highway with Connecting Road on LHS/RHS
93	40+400	42+441	2041	TCS 1	6-lane Highway in Embankment
94	42+441	42+481	40	TCS 3	6-lane Flyover/VUP/LVUP/Bridge/ROB
95	42+481	42+626	145	TCS 1	6-lane Highway in Embankment
96	42+626	42+646	20	TCS 3	6-lane Flyover/VUP/LVUP/Bridge/ROB
97	42+646	43+660	1014	TCS 1	6-lane Highway in Embankment
98	43+660	43+900	240	TCS 3	6-lane Flyover/VUP/LVUP/Bridge/ROB
99	43+900	44+500	600	TCS 1	6-lane Highway in Embankment

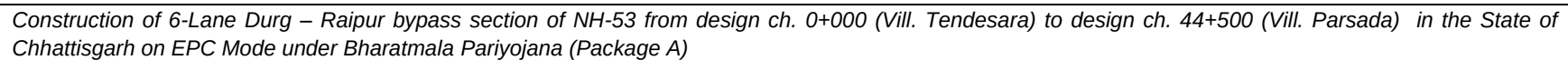
Typical Cross Section Schedule – Loop/Ramps at Interchanges

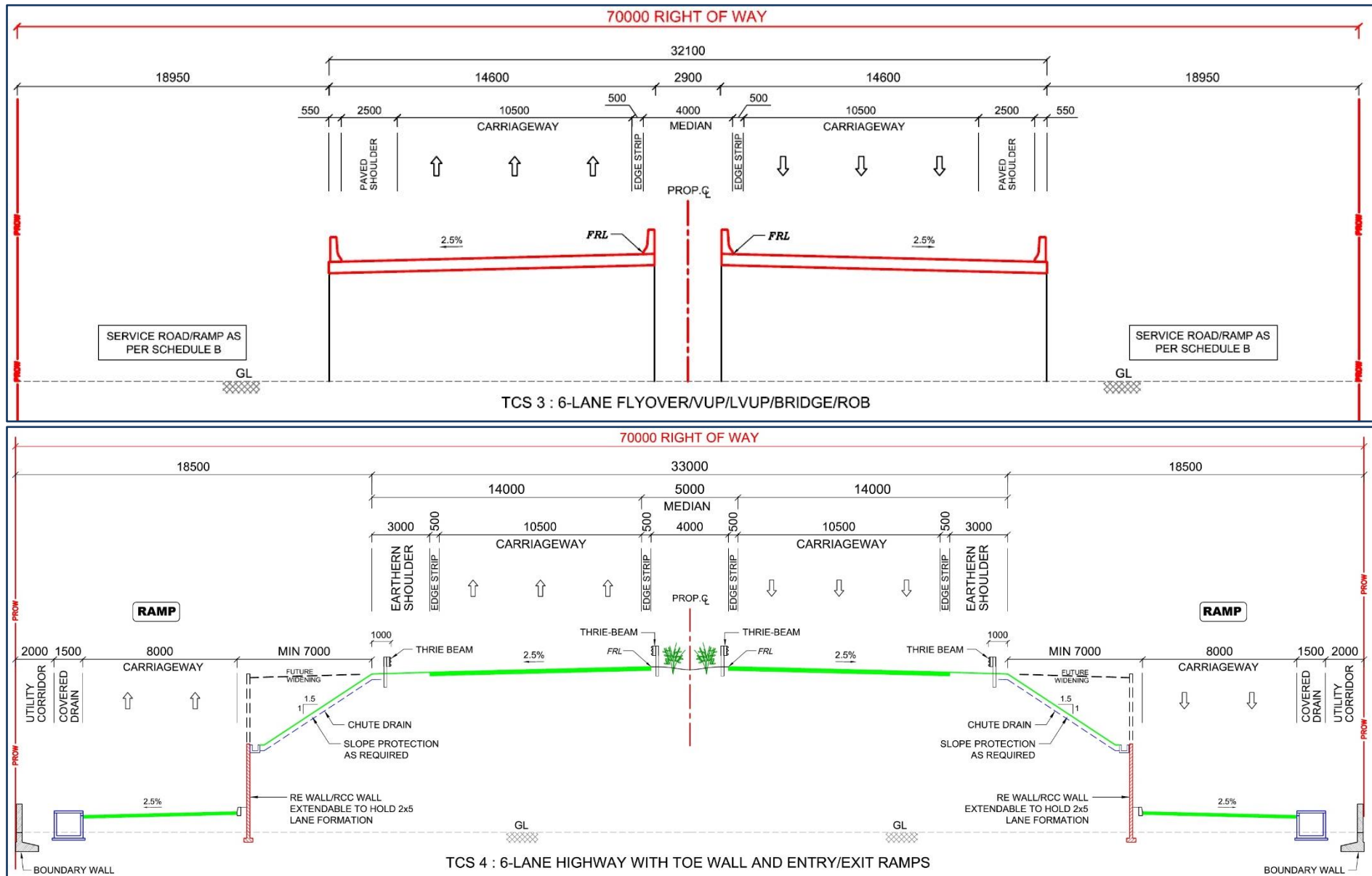
Interchange Location	Ramp No.	Description	Chainage		Length (m)	TCS Type
			Start	End		
Interchange 1 at Ch. 1+963	1A	Exit (Arang to Durg)	0+000	0+650	650	TCS 10
			0+650	1+220	570	TCS 12
	1B	Entry (Durg to Rajnandgaon)	0+000	1+470	1470	TCS 12
	1C	Exit (Rajnandgaon to Durg)	0+000	0+530	530	TCS 6
	1C		0+530	0+750	220	TCS 11
	1D	Entry (Durg to Arang)	0+000	0+210	210	TCS 11
	1D		0+210	0+750	540	TCS 6
				Total (m)	4190	
Interchange 2 at Ch. 8+720	2A	Exit (Rajnandgaon to SH-7)	0+000	0+700	700	TCS 5
	2B	Entry (SH-7 to Rajnandgaon)	0+000	0+700	700	TCS 5
	2C	Entry (SH-7 to Arang)	0+000	0+810	810	TCS 5
	2D	Exit (Arang to SH-7)	0+000	0+810	810	TCS 5
	2E	SH-7	0+000	0+050	50	TCS 12
			0+050	0+400	350	TCS 10
			0+400	0+450	50	TCS 12
				Total (m)	3470	
Interchange 3 at Ch. 34+750	3A	Exit (Durg to SH-22)	0+000	0+690	690	TCS 4
	3B	Entry (SH-22 to Durg)	0+000	0+690	690	TCS 4
	3C	Entry (SH-22 to Arang)	0+000	0+500	500	TCS 4
	3D	Exit (Arang to SH-22)	0+000	0+500	500	TCS 4
	3E	SH-22	0+000	0+080	80	TCS 12
			0+080	0+300	220	TCS 10
			0+390	0+480	90	TCS 10
			0+480	0+540	60	TCS 12
	3F	Roundabout (40m Inner Radius)	0+000	0+290	290	3-Lane + PS C/Way
				Total (m)	3120	

Note:

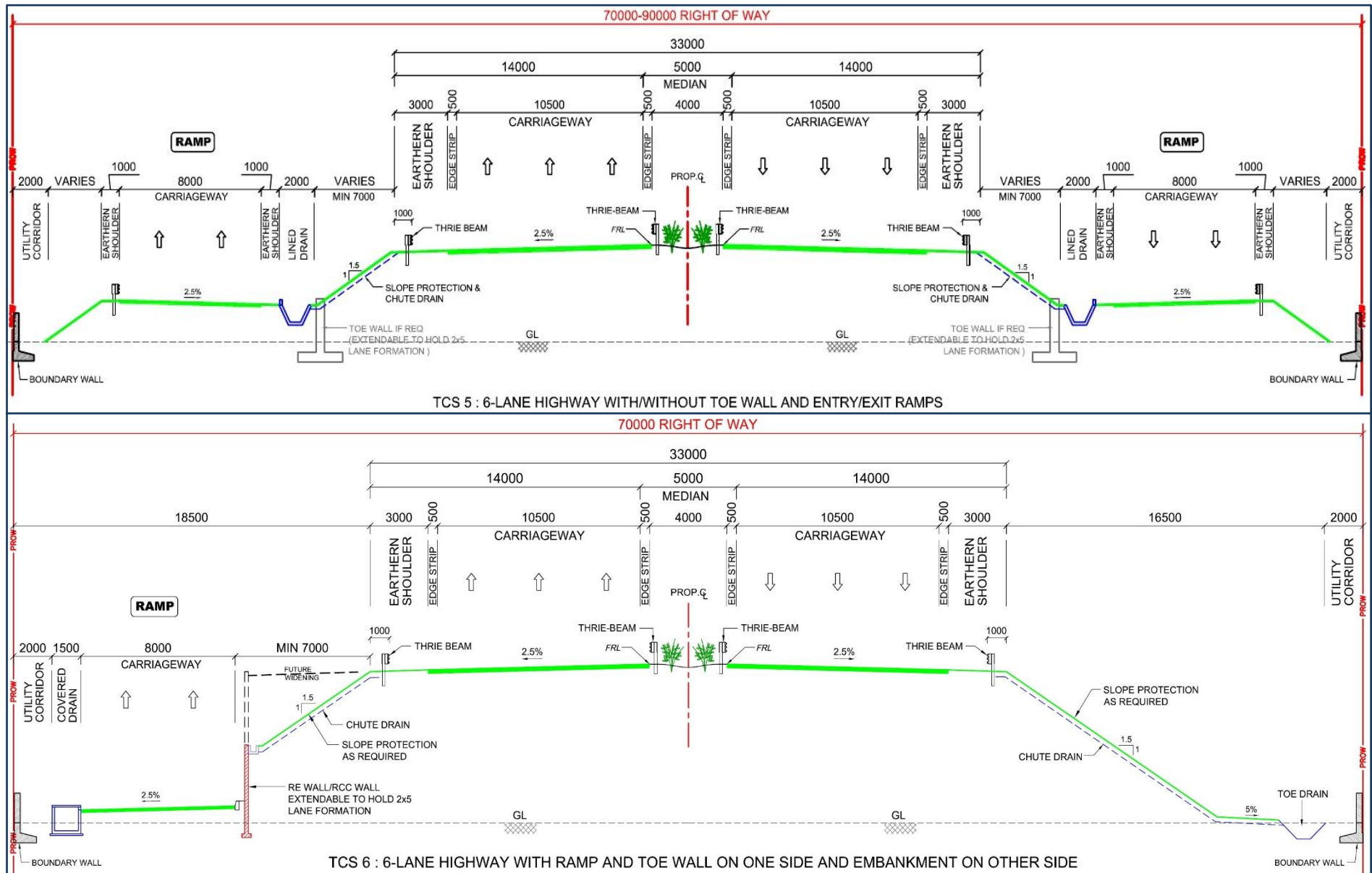
- The lane configuration and width of all structures shall be as per respective paragraph appendices of this schedule.
- Minimum Radius of Loops/Ramps at interchanges shall be as shown in Plan & Profile drawings specified in Appendix B-II of Schedule-B

- *If the paved carriageway width of structure is more than the carriageway width of approaches, then proper pavement tapering (as per manual) shall be provided.*
- *TCS schedule as given above shall be treated as an approximate assessment. Actual length of the TCS schedule shall be prepared by the Contractor based on detailed investigations and site requirements. Any variation in length of respective TCS specified in Schedule B shall not constitute a change of scope, save and except any variations in the design length arising out of a change of scope expressly undertaken in accordance with the provisions of Article 13.*

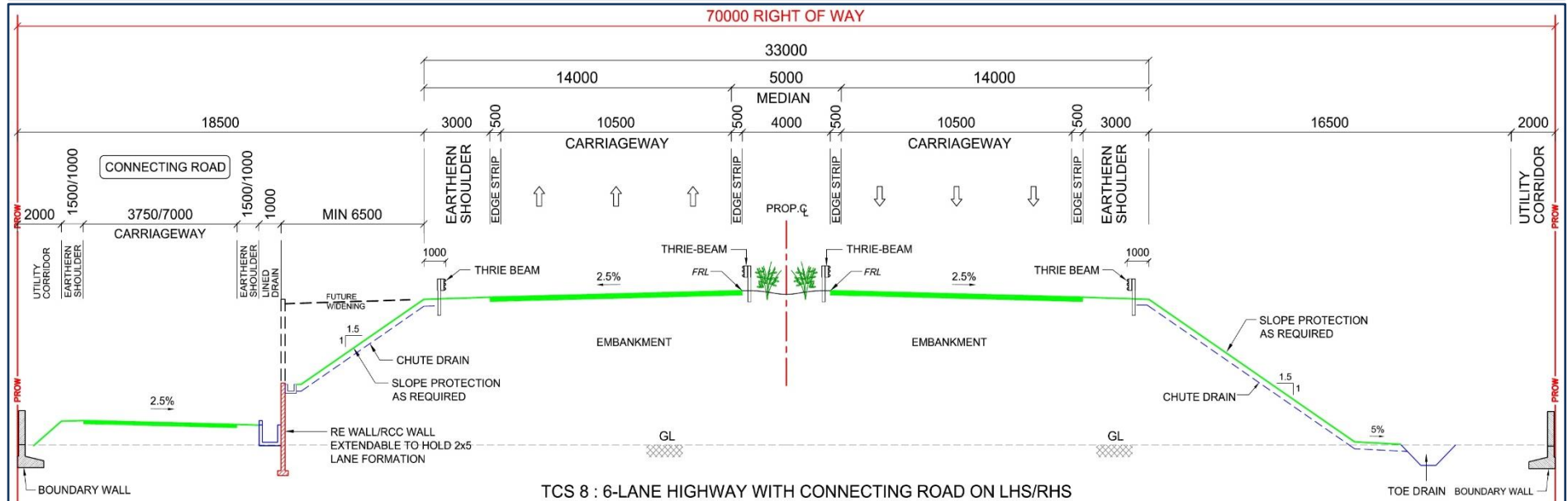
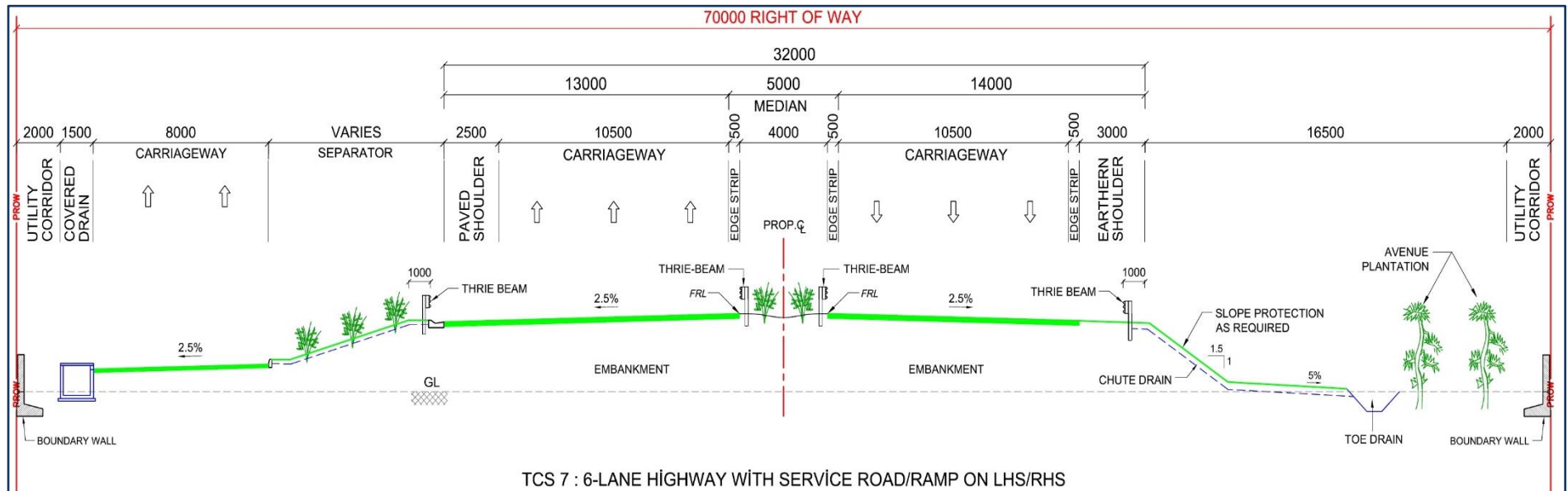




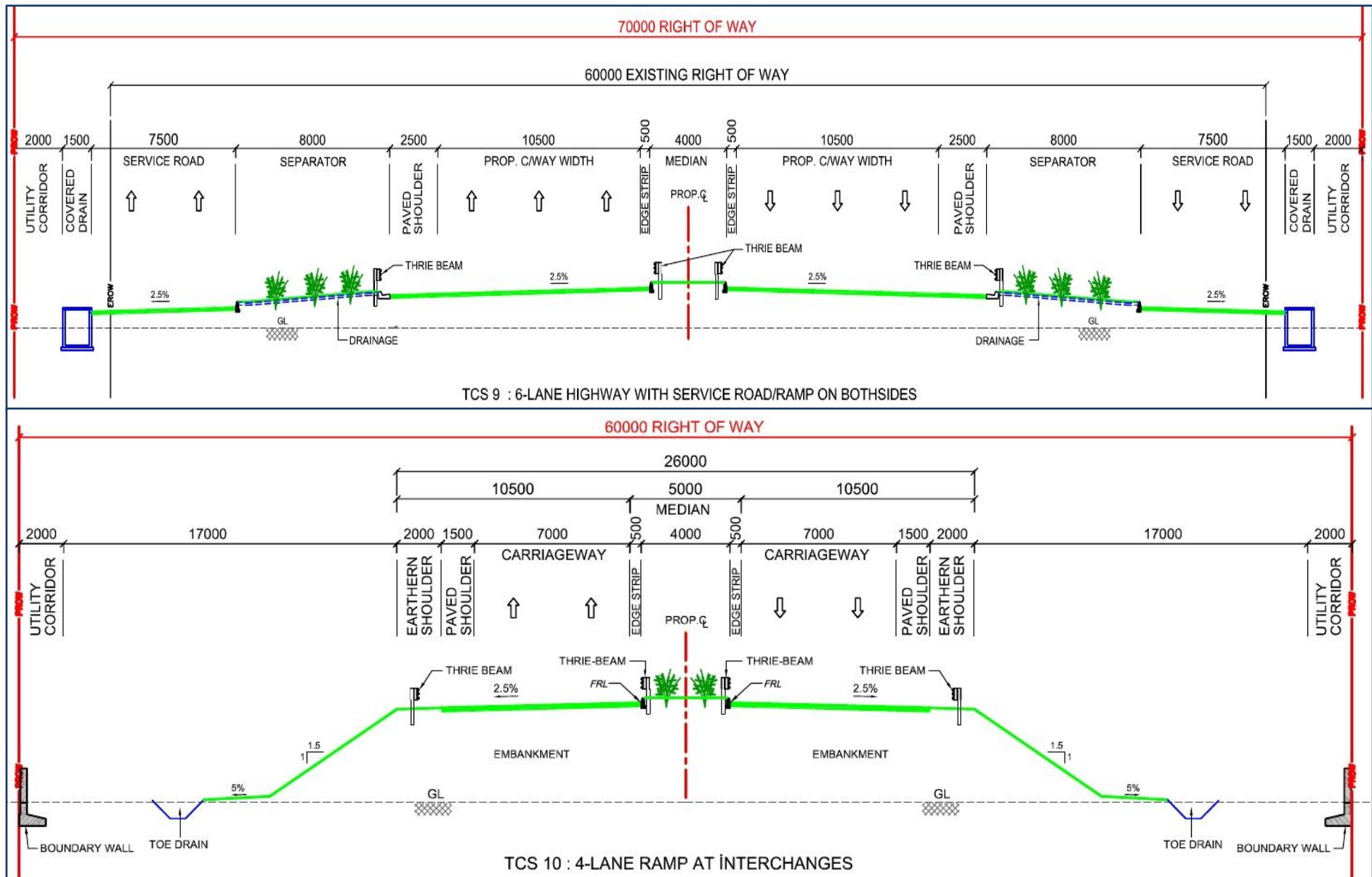
Construction of 6-Lane Durg – Raipur bypass section of NH-53 from design ch. 0+000 (Vill. Tendesara) to design ch. 44+500 (Vill. Parsada) in the State of Chhattisgarh on EPC Mode under Bharatmala Pariyojana (Package A)



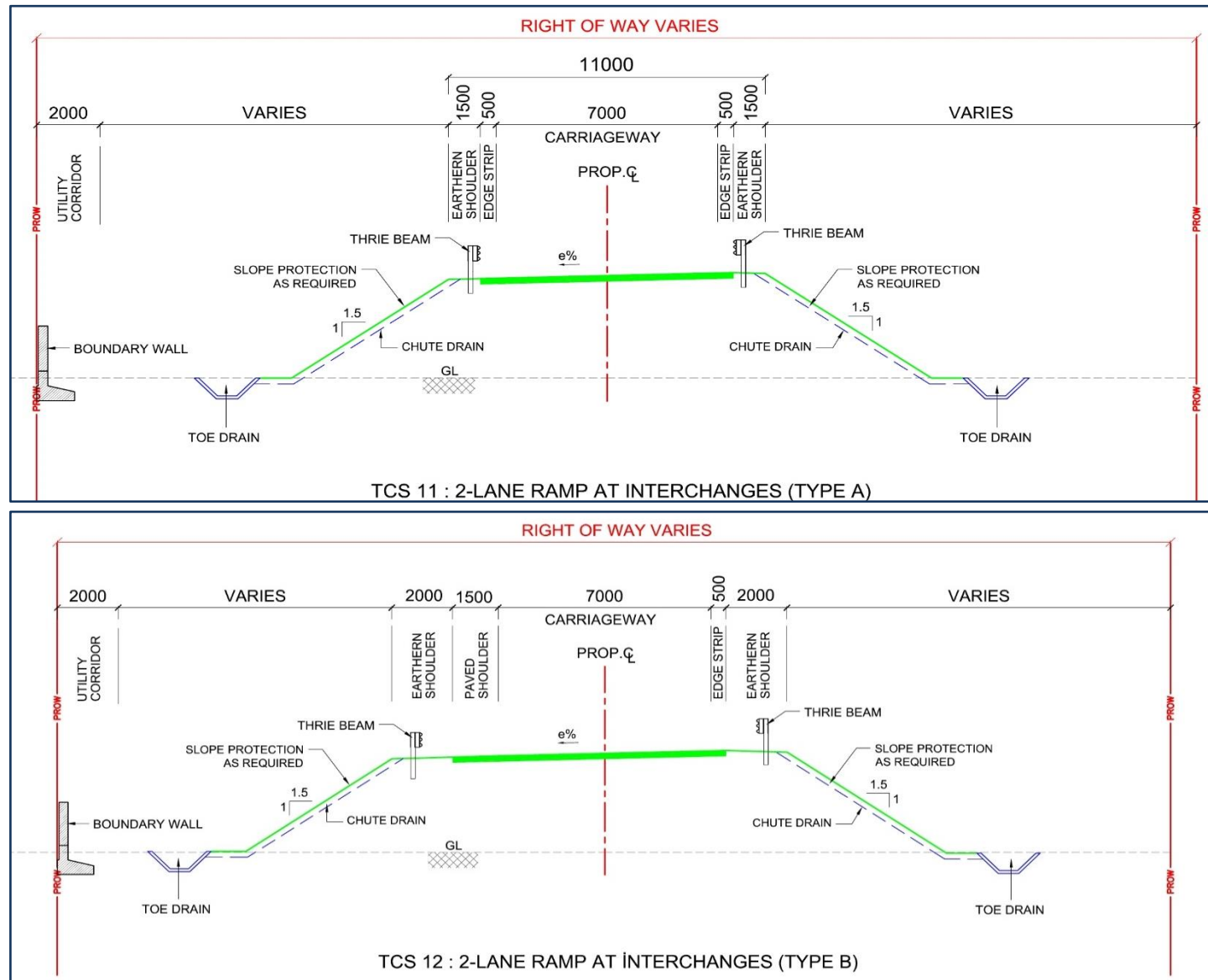
Construction of 6-Lane Durg – Raipur bypass section of NH-53 from design ch. 0+000 (Vill. Tendesara) to design ch. 44+500 (Vill. Parsada) in the State of Chhattisgarh on EPC Mode under Bharatmala Pariyojana (Package A)



Construction of 6-Lane Durg – Raipur bypass section of NH-53 from design ch. 0+000 (Vill. Tendesara) to design ch. 44+500 (Vill. Parsada) in the State of Chhattisgarh on EPC Mode under Bharatmala Pariyojana (Package A)



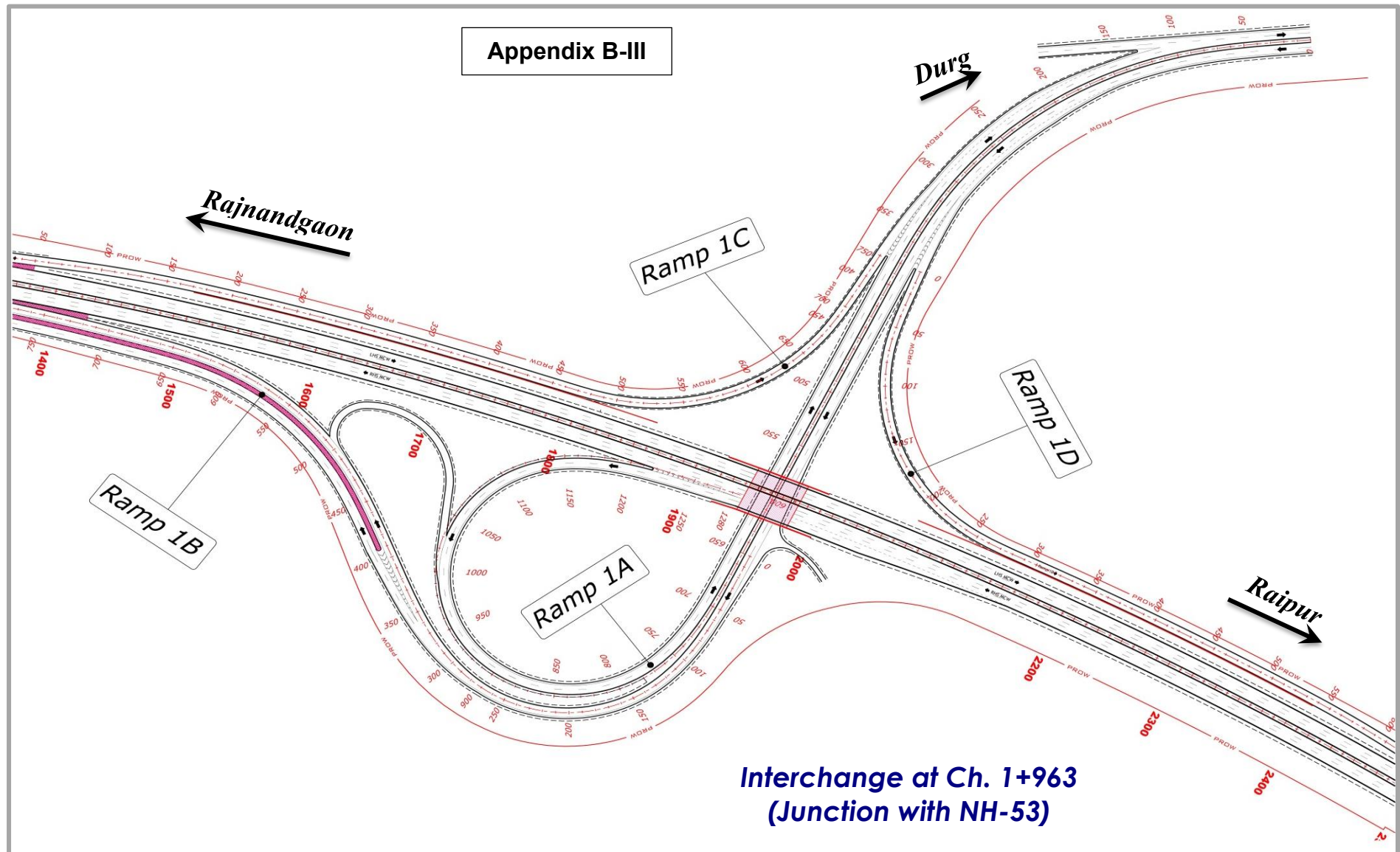
Construction of 6-Lane Durg – Raipur bypass section of NH-53 from design ch. 0+000 (Vill. Tendesara) to design ch. 44+500 (Vill. Parsada) in the State of Chhattisgarh on EPC Mode under Bharatmala Pariyojana (Package A)



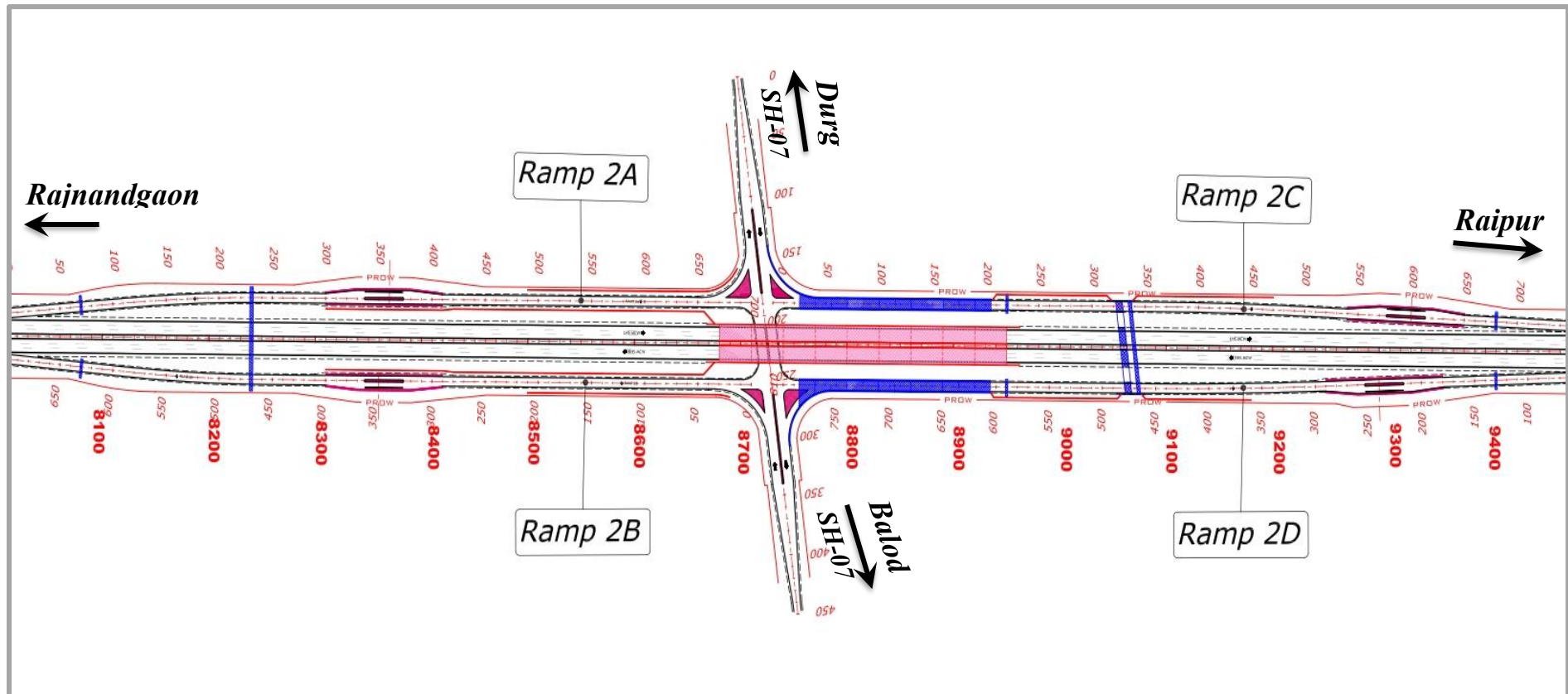
Appendix B-II

Following drawings are enclosed in digital form marked as Appendix B-II

- a) Alignment Plan & Longitudinal Profile
- b) GAD of Structures
- c) Traffic Signage Plan
- d) Utility Relocation Plan

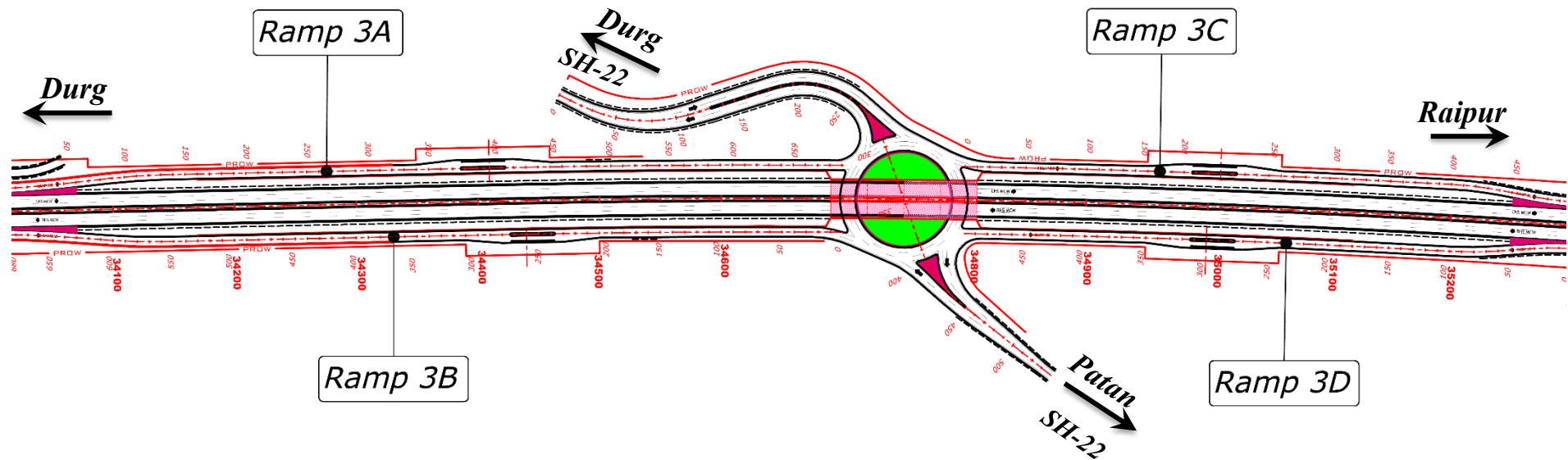


Appendix B-III



Interchange at Ch. 8+720 (Junction with SH-7)

Appendix B-III



Interchange 3 at Ch. 34+750 (Junction with SH-22)

SCHEDULE – C*(See Clause 2.1)***PROJECT FACILITIES****1. Project Facilities**

1.1 The Contractor shall construct the Project Facilities in accordance with the provisions of this Agreement. Such Project Facilities shall include.

- a) Toll plazas
- b) Road side furniture
- c) Operation and Maintenance Centers
- d) Way side amenities / Service Areas
- e) Lighting
- f) Landscaping and Tree Plantation
- g) Advanced Traffic Management System (ATMS)
- h) Highway Patrol Unit
- i) Emergency Medical Services
- j) Crane Services
- k) Facility for Authority

1.2 Project Facilities have been described in **Annex-I** of this **Schedule-C** and the same to be completed on or before project completion date.

Annex - I
(Schedule-C)

1. Project Facilities

The Contractor shall construct the Project Facilities described in this Annex-I to form part of the Project Highway. The Project Facilities shall include:

- a) Toll plazas
- b) Road side furniture
- c) Operation and Maintenance Centers
- d) Way side amenities / Service Areas
- e) Lighting
- f) Landscaping and Tree Plantation
- g) Advanced Traffic Management System (ATMS)
- h) Highway Patrol Unit
- i) Emergency Medical Services
- j) Crane Services
- k) Facility for Authority

2. Description of Project Facilities

2.1 Toll plazas

Close tolling system shall be provided in entire length of the project and the same is integrated with the adjoining packages. The Toll Plazas shall be provided as per NHA circular No. 17.5.82 dated 24/5/2021 and Schedule D. Minimum lane requirement in the opening year are as follows.

Location of toll plaza along main carriageway:

Sl. No.	Chainage	No. of Lanes (All lanes ETC)
1	5+330	8 + 8

Location of toll plazas along Interchange Ramps:

Sl. No.	Interchange Chainage	Ramp ID.	Ramp Chainage	Direction (Entry/Exit)	No. of Lanes (All lanes ETC)
1	8+720	Ramp 2A	0+360	EXIT	2
2		Ramp 2B	0+350	ENTRY	2
3		Ramp 2C	0+600	ENTRY	2
4		Ramp 2D	0+240	EXIT	2
5	34+750	Ramp 3A	0+400	EXIT	2
6		Ramp 3B	0+260	ENTRY	2
7		Ramp 3C	0+210	ENTRY	2
8		Ramp 3D	0+300	EXIT	2

Entry approach to each toll plaza shall be having Weigh in Motion equipment for connecting toll booths and toll office for collection of toll fees as per as per Schedule D.

Medium speed WIM (Weigh in motion) with bending plate technology shall be installed in each lane and to be configured with Advance Traffic Management System.

Based on the minimum toll lane requirement as given above, toll booths, toll plaza complex, weigh bridges, electrical systems and all other facilities required/mentioned in manual shall be provided as per Schedule D with approval from AE and NHAI. All the structures shall be RCC framed structure as per Schedule D.

Earth retaining structure shall be provided at toll plaza locations, if required to restrict the embankment slope within the right of way.

No. of toll lanes specified above are minimum indicative. The Contractor shall design and provide toll lane as per NHAI circular No. 17.5.82 dated 24/5/2021 subject to minimum specified above. Any increase in no. of toll lane shall not be treated as change of scope, save and except any variations in the length arising out of a Change of Scope expressly undertaken in accordance with the provisions of Article 13.

Separate Toilet Blocks with full facilities for public use shall be provided within the toll plaza for public access. The provisions listed below are

- i. 4 Nos. urinals (Ladies) along with wash basin
- ii. 4 Nos. urinals (Gents) along with wash basin
- iii. 2 Nos WC in each washroom
- iv. Drinking Water facilities shall also be provided.
- v. Water Supply/Electrical fixtures shall also be provided.

Landscaping along with parking space shall also be provided

2.2 Road side furniture

Road furniture shall be provided in entire length as per Schedule D.

2.2.1 Kilometer and Hectometer Stones

Kilometer and Hectometer stones shall be provided in accordance with Schedule D.

2.2.2 Road Signs

Road Signs shall be provided in accordance with Schedule D. In addition to signs prescribed in Schedule D, other signs such as signs showing safety slogans, toll free numbers, nearby hospital and police station facilities, lane discipline signs on gantry, headway etc. shall also be provided as directed by Authority Engineer.

2.2.3 Road Marking

Road Markings shall be provided in accordance with Schedule D. Acrylic water-based road marking paint shall be used for kerb, concrete barrier painting, and to display

details of structure number; span arrangement etc. on all culverts and bridges with required description as per MoRT&H guidelines.

Raised profile edge lines as per Clause 7.7 of IRC 35 shall be provided on main carriageway, loop, ramp edges (both sides i.e. shoulder and median side/right lane).

2.2.4 Road Delineators

The Road Delineators shall be provided in accordance with Schedule D.

2.2.5 Reflective Pavement Markers & Solar Studs

Reflective Pavement Markers & Solar Studs shall be provided in accordance with Schedule D.

2.2.6 Traffic Impact Attenuators

The Traffic Impact Attenuators shall be provided in accordance with Schedule D.

2.2.7 Crash Barriers

Thrie beam metal crash barriers shall be provided in entire length on outer side earthen shoulder of each main carriageway, on both edges of median and loops/ ramps at interchanges as per TCS referred in schedule-B but excluding stretches covered by bridges, grade separated structures and RE wall. Concrete barriers shall be provided on bridges/structures, RE Walls/ retaining walls as specified in Schedule B and Schedule D. Retro-reflective (same material as of road signs and Fluorescent yellow / white color) Stickers (150mm width) shall be provided on alternative vertical posts of Thrie beam barrier throughout.

2.2.8 Boundary Wall

As the Highway is completely access controlled facility, boundary wall is its integral part to help enforcing of the acquired access rights. Access control extends to the limits of the legal access control on the ramps i.e., along the ramps to the beginning of the taper on the local road.

RCC boundary wall shall be provided in entire length on either side (including transverse requirements at structure locations) as per typical drawing enclosed with this Schedule and Schedule D.

2.2.9 LED Traffic Blinkers

LED Traffic Blinkers shall be provided at entry/exit locations, all major & minor junctions, Pedestrian Crossings, Built-up areas and any other locations as specified in Schedule D.

2.3 Operation and Maintenance Centers

Dedicated operation and maintenance center shall be provided at Toll Plaza (Design Chainage 5+330) in accordance to Schedule D.

2.4 Way side Amenities / Service Areas

2.4.1 Facilities

a) Way side Amenities / Service Areas

Wayside amenities shall be a part of the Highway and shall be constructed with the minimum facilities such as Parking areas (Truck, Buses, Cars, Mini Buses), Fuel Station and garage for minor repair, Hotel/ Motel, Trauma Center, Rest Areas, Fast Food Centre, Travel Information Facilities, Toilets and Bath Facilities, space for Maintenance staff & Vehicle Service Station, Dormitory etc.

Wayside amenities shall be developed at the following locations in accordance to Schedule -D & MoRT&H circular No. RW/NH-33044/14/2003-S& R(R)·Pt. dated 11th Feb. 2021. The layout and minimum number of units per facility and the minimum area per facility to be developed is given in Appendix C-1. However, the provisions given in Appendix C-1 are minimum. The connecting ramps (all ramps shall be constructed with same specifications of loop/ramps of interchange given in Schedule-B) from/to highway shall be provided.

Sl. No.	Chainage	Area	Side
1	11+850	2 ha	LHS
2	11+850	2 ha	RHS

Apart from the above-mentioned facilities, Traffic Aid Booth (plinth area 25 sqm.) and Medical Aid Booths (including an aid post building and 2 (two) residential quarters) shall be considered as Mandatory facilities over and above the plinth area mentioned. Traffic Aid Booth and Medical Aid Booths shall be constructed with the type designs prescribed for such buildings by the State Government or a substitute thereof within the site premises with easy accessibility and shall vest with the Authority. All the facilities shall be developed by the Contractor at its own cost.

Notes: for all facilities mentioned in Para above

- Dhaba shall be an economic and a no-frills facility which serves inexpensive local cuisine and primarily caters to the food requirements of the Truckers.
- Toilet should be provided separately for men, women and physically challenged.
- Contractor will not be allowed to charge rents from the customers for drinking water, toilets, parking, first aid box and emergency telephone services.

2.4.2 Specifications and Standards for above facilities

The Project shall be constructed in conformity with the Specifications and Standards specified in this schedule and **Schedule-D**.

2.4.3 Scope of Work

The project scope would include the following major activities:

Design and Construction of the Project

- (a) The Contractor will be required to develop the facilities as warm shell structures with detailed conceptual plan, layout plan, detailed architectural and structural designs, engineering drawings, construction methodology, quality assurance procedures, and the procurement, engineering and construction time schedule for all the areas and facilities forming a part of the Project using the basic layout plan provided by the Authority at the time of bidding and/or thereafter. The detailed development proposal for the site shall be submitted to the Independent Engineer and subsequently to the Authority for approval. The Contractor shall not deviate from the broad layout. However, the Contractor will be allowed to modify the site-specific layout, subject to approval from the Authority, while developing at least the minimum areas and facilities mentioned in this Schedule.
- (b) The land earmarked as future expansion shall, in conformity with Applicable Laws and in conformity with all conditions specified in this document, be utilized for provision of such amenities or facilities which are useful for the Users of the Project and the local population in future.
- (c) The total covered area of the site after development of any facilities shall not be more than 20% of the total site area. For the Fuel station, the ground coverage shall be considered only for the actual area covered by the administrative buildings, equipment and other such objects and shall not include the open hardstand space for vehicle movement under the canopy.
- (d) Review of all the site-specific information provided along with the bid documents carrying out necessary revisions or additions, preparation of all engineering drawings as required for proper execution and completion of the project as envisaged with the approval of the Authority in compliance with applicable local bye-laws, National Building Code and other standards mentioned in Schedule D. To save time and prevent wastage of effort, it is suggested that the Contractor gets the Line Plan of all the buildings in the Project reviewed by the Authority within 15 days of receiving the Letter of Award.
- (e) Site Development, Procurement etc. for construction of the Project as per Design, Codes, Architectural and Engineering Drawings, complying all relevant codal provisions, Standards and Technical Specifications mentioned in schedule D. The Project shall include facilities specified above along with site boundary wall, roads / driveway, parking & pathway, roads marking and rumble strips / speed breakers for parking areas, septic tank/soakage well/sewer line, waste compost plant, water supply, storm water drain, street lighting with LED/CFL lamps, underground sump/overhead tank, firefighting, security features, HVAC, signage, landscaping, horticulture operations / arboriculture etc., RO water plant, rainwater harvesting, provision for tube/bore wells & pumps including water tank, electrical substation / transformer, trenches / ducts for UG cables / pipeline, DG set, shading device, children play area, outdoor furniture, digital display wall system, solar power panel, high mast lamp and hoarding board etc. Actual project facilities to be provided in a particular location will vary.

- (f) Construction of modern user and environment friendly facilities as per the specifications approved by the Authority. The site shall be developed based on green design principles like GRIHA three-star ratings for building norms, zero effluent discharge, use of recycled water, use of renewable energy system as an alternate source of power generation, bio- mechanization technology for generation of cooking gas, rainwater harvesting etc. to make the facility self-sustaining.
- (g) The Contractor shall provide, construct and maintain the basic infrastructure for the wayside amenities as per the typical layout and requirements specified in Schedule C and Schedule D with prior approval from IE/AE and NHAI. Subsequent establishment and operation of the wayside amenities including fuel stations shall be responsibility of the Authority.

2.4.4 Project Facilities development

The Project Facilities may include the following activities; however, the final detailed set of activities to be performed shall be submitted to the IE/AE and NHAI for approval prior to initiating development on the site:

Sl. No.	Description
I (a)	Site Development
	i. Site clearances & Area development
	a. Leveling, Cutting & Filling Soil (Total Plot Area)
	ii. a. Cutting of Trees - As required to match site Specific Layouts.
	b. Dismantling / Demolishing including disposal
	c. Rerouting of EB, Water & Telephone Services (Above / Below Ground)– including local liasioning charges
	d. Additional Filling/Cutting - To match levels indicated in the Site Specifications Drawings.
	iii. 1. Construction of Retaining wall / Slope Stability Arrangements
	2. Compound Wall, Fencing, Gate, Culvert & Kerb wall, Deceleration Zone, Acceleration Zone, Buffer Zone and Service / Access Road.
	a. Compound Wall
	b. Fencing
	c. Gate - Shall be provided for Entrance to Children Play Area
	d. RCC Slab / Pipe Culvert (Outside the Premises)
	e. Kerb wall - All along the Driveway, Parking Areas, Landscaping and Pathways
	f. Bollards to be provided in front of Dhaba / Food Court / Restaurants / Kiosks
	g. Access Road (outside the premises) / Approach Road
	h. Deceleration Zone (outside the premises)
	i. Acceleration Zone (outside the premises)
	j. Buffer Zone

Sl. No.	Description
	k. Service Road (outside the premises) / Exit Road / Existing Service Roads including necessary crash barriers as per codes
I b.	Services: -
	i. Roads & Pathway as per MoRT&H Specifications
	a. Roads / Driveway, Parking & Pathway (BT / CC Paver Block): (All Driveway / Roads / Parking facing Dhaba / Food Court / Restaurants and Kiosks within the premises shall be of CC Paver Blocks. All other areas inside the premises and approach roads outside premises shall be of BT.
	b. Roads marking and Rumble Strips, Speed Breakers (Readymade speed breakers with reflective arrow) for parking area.
	ii. Sewer Line including Chambers, Manholes, Gully Trap, etc.
	iii. Water supply & Distribution System
	iv. Storm water drain with Gratings / Cover Slab
	v. External Electrical Works Including Street Light
	vi. a. Underground Sump / RCC water Retaining Structures
	b. Fire Fighting
	vii. Signages:
	a. External Signages (Building Signages, Parking Signages, Prohibition Signages, Safety Signages, etc.)
	b. Internal Signages
	c. Neon Signages
	d. Key Map Signages
	e. Highway Way finding Signages on the Main Road (on both sides of the project) - 1Km, 500m and 100m
I c.	Landscaping and Arboriculture
	a. Landscaping
	b. Horticulture Operations / Arboriculture
II	Civil Work / Buildings (Including Internal services)
	1. Food Court with Motels
	2. Branded / AC Restaurant
	3. Dhaba
	4. Dormitory
	5. Minor Repair Shop
	6. Kiosks for misc. items
	7. Toilet Blocks
	a. Toilet Block (Near Food Court/ Restaurant)
	Ladies Toilet:
	IWC
	EWC
	Trough

Sl. No.	Description	
		PC Toilet
		Gents Toilet:
		Urinals
		IWC
		EWC
		Trough
		PC Toilet
	b. Toilet Block (Car & Bus user parking zone)	Ladies Toilet:
		IWC
		EWC
		Trough
		Gents Toilet:
		Urinals
		IWC
		EWC
		Trough
		PC Toilet
	c. Toilet Block (Near Dhaba)	Ladies Toilet:
		IWC
		EWC
		Trough
		Gents Toilet:
		Urinals
		IWC
		EWC
		Trough
		PC Toilet
	Parking	
	a) Car	
	b) Car – PC	
	c) Bus	
	d) Truck	
	e) Trailer	
III	Equipment	
	a. Special Items of Work	
	i. RO Water Plant	
	ii. Rainwater Harvesting	
	iii. Septic Tank & Soak Pit with Anaerobic Filter	

Sl. No.	Description
	iv. Tube wells & pumps including overhead water tank and sump
	v. CCTV & Security system
	vi. Electrical substation / Transformer / Panel Board / Earth pit / LT Switch Board / Panel Boards
	vii. Trenches/Ducts for UG cables / Pipe line
	viii. DG Set(s)
	ix. Entertainment - Satellite TV & WIFI
	x. Shading Device As required for operations. (For certain openings / areas requiring protection from sun/rain. Shading device includes Awnings, Tension structures, etc.,)
	xi. Outdoor Furniture
	xii. Children Play Area Developments
	xiii. Digital Display Wall System
	xiv. Solar Power Panel
	xv. Hoarding Board
	xvi. High Mast Lamp & Lightening Arrester
	b. Additional Green Building Features: -
	i. Wind Mill
	ii. Solar Lighting
	iii. Provision for Cooking Gas from Food Waste
	iv. All Utility Connections, Deposits etc.,
	c. Other Equipment:
	HVAC

2.5 Lighting

The Contractor shall provide lighting as per **Schedule - D** at the following locations:

- (i) Toll Plazas including approaches
- (ii) Operation and maintenance centers
- (iii) Wayside amenities, traffic aid posts, vehicle rescue posts, medical aid posts and all other facility & service buildings
- (iv) Interchanges including all ramps and approaches
- (v) Flyovers/ Underpasses/Overpasses/Major Bridges/ROB including approaches of these structures
- (vi) Service Road/Entry/Exit locations – on both main carriageway and service road
- (vii) Major/Minor Junctions
- (viii) Interior illuminated signs
- (ix) Yellow flashing lights to alert drivers

Minimum level illumination where exterior lighting is provided shall be 40 lux. In general, 'code of practice for lighting of public thoroughfare IS 1944 shall be followed. All facility buildings shall be illuminated adequately.

The lighting fittings (with LED features) shall be powered by solar system with back up facilities (power and battery both) at all locations.

The solar system will be used for the entire highway. The solar panel at interchange, toll plazas and bridges shall be grid connected whereas the other places shall be battery backup. The electrical connection with all its infrastructures shall be done by the Contractor. Additional battery backup shall be provided.

2.6 Landscaping and Tree Plantation

The Contractor shall plant trees and shrubs of required numbers and types at the appropriate locations within Right of Way and in the land earmarked by the Authority for afforestation as per Schedule D at the following areas.

Sl. No.	Types of Plantation	Location (Km)	Remarks
1	Shrubs	In median except Structures	Ornamental type plantation shall be provided
2	Landscaping	All interchanges/ Junctions/ Islands/ Separators/Service Areas / Toll plazas / Wayside Amenities/ O & M Centers etc.	Ornamental type plantation shall be provided
3	Avenue Plantation	Available open land within ROW	Minimum 7037 no. of trees shall be planted as per Schedule D. The type of species of tree shall be finalized in consultation with AE/Authority.
4	Compensatory Afforestation	Land earmarked by the Authority for afforestation	36130 no. of trees are required to be planted by the contractor as compensatory afforestation in accordance with IRC: SP: 87-2019 and IRC: SP:21-2009

Drip irrigation system for median plantation by gravity/pressure sources with all necessary components / systems and emitting devices at plants shall be provided. The Contractor shall maintain the trees and shrubs in good condition during maintenance period as per the maintenance schedule.

2.7 Advanced Traffic Management System (ATMS)

Advance Traffic Management System (ATMS) shall be provided in entire length, at the following minimum locations in accordance with Schedule D. The Contractor shall coordinate / integrate / interface closely with other adjoining packages Contractor for effective and efficient work of ATMS.

The ATMS shall inter alia include:

- a) Video Surveillance System (CCTV) /TMCS / Video Incident Detection System (VIDS)/ VSDS Camera, PTZ Camera, Road-side Housing and Support Structure
- b) Vehicle Actuated Speed Display along with support system;
- c) Variable Message Signs (VMS) [Fixed and Portable] with Road-side Housing and Support Structure;
- d) ATMS Control Centre: Ergonomic design of Control rooms & Ingress design of the projection of Graphics display
- e) Cable and conduits

The ATMS shall be integrated with Central Control Room (CCR) provided at toll plaza location.

In addition to above the provision required to implement robust and efficient ATMS shall be provided in accordance to schedule D in consultation with Independent Engineer / NHAI. The same shall not constitute a Change of Scope, save and except any variations in the length arising out of a Change of Scope expressly undertaken in accordance with the provisions of CA.

2.8 Highway Patrol Units

1 no. Highway Patrol Vehicle (Vehicle shall be of GPS mounted with tracking facility) for covering the entire project highway. These shall conform to the specifications mentioned in Schedule D

2.9 Emergency Medical Services

Emergency Medical Services (EMS) shall be provided as per Manual. These services shall include setting up medical aid posts by the Contractor. The Contractor shall provide GPS fitted "Two Patient Capacity" rescue ambulance(s) with all lifesaving equipment, trained staff and first aid items including the supply of consumable items, which will be replenished as and when required.

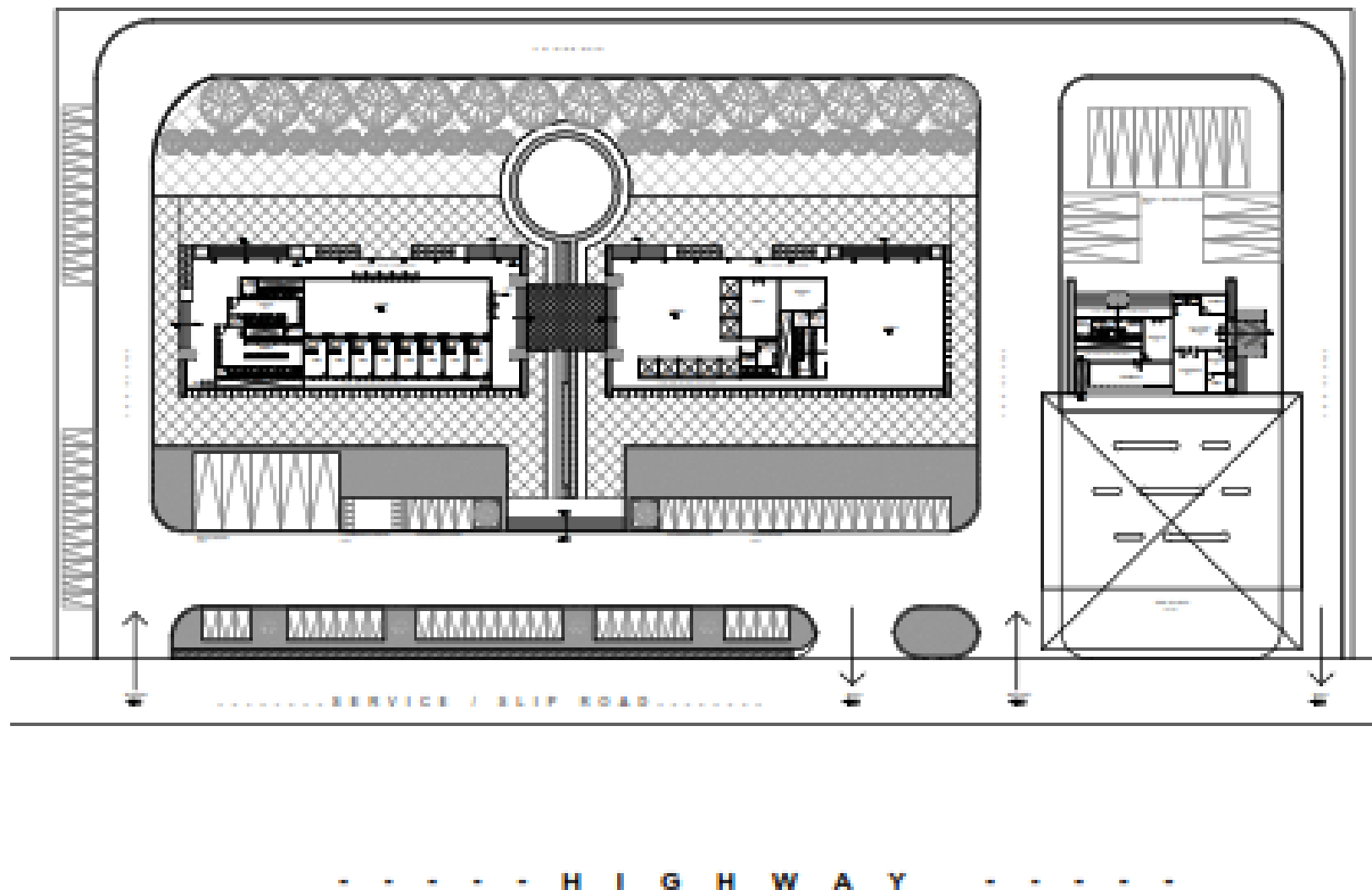
2.10 Crane Services

The EPC Contractor shall provide cranes as per Manual at suitable location with all necessary equipment so that it can reach the site of the incident within 30 minutes of call and clear the disabled/accident met vehicles. It shall also be fitted with GPS based Vehicle Tracking System to monitor its movement on 24 hours x 7 days of a week basis.

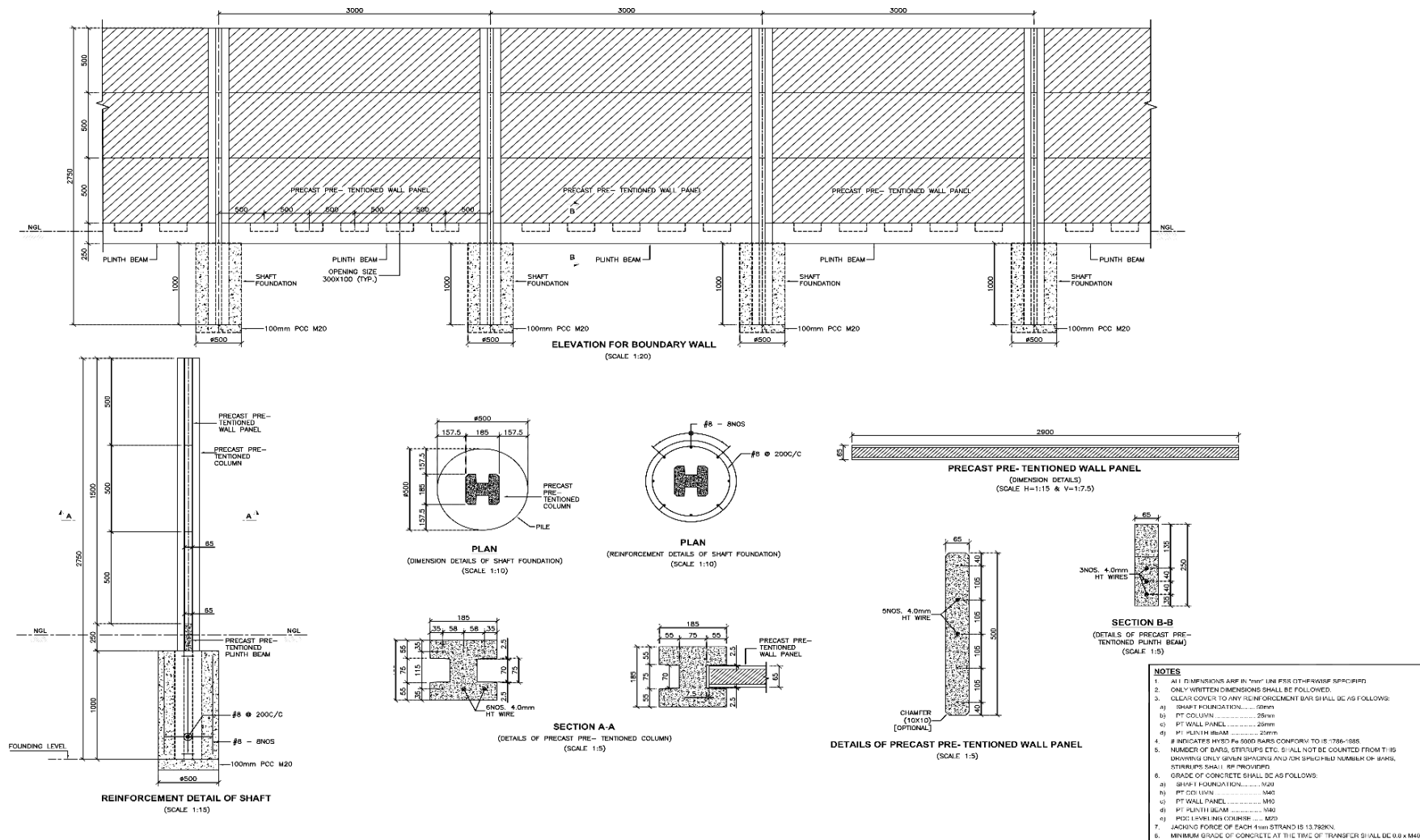
2.11 Facility for Authority

The contractor shall provide one vehicle (Brand new latest model Innova or equivalent) including all running / maintenance expenses for the use of Authority for entire period of construction & operation.

Annexure C-1: Typical Drawing of Wayside Amenity/Rest Area



Annexure C-2 : Typical Drawing of Boundary Wall



SCHEDULE – D

(See Clause 2.1)

SPECIFICATIONS AND STANDARDS

1 Construction

The Contractor shall comply with the Specifications and Standards set forth in **Annex-I** of this **Schedule-D** for construction of the Project Highway.

2 Design Standards

The Highway including Project Facilities shall conform to design requirements set out in the following documents.

Annex - I*(Schedule-D)***SPECIFICATIONS AND STANDARDS FOR HIGHWAY****1 Manual of Specifications and Standards to apply**

- a) Six laning of the Project Highway shall conform to the 'Manual of Specifications and Standards for Highway' published as IRC: SP: 87-2019 with all amendments and additions *up to Bid date* (Referred to as "Manual" in this Schedule) and MORTH Specifications for Road and Bridge Works (5th revision). Where the specification for a work is not given, Good Industry Practice shall be adopted to the satisfaction of the Independent Engineer.
- b) As regards, the work of utility shifting, the relevant specifications, relevant rules, regulations and acts of Utility Owning Department/Agencies shall be applicable.

2 Deviations from the Manual

Notwithstanding anything to the contrary contained in the aforesaid Manual, the Specifications and Standards shall apply to the Project Highway, and for purposes of this Agreement, the aforesaid Manual shall be deemed to be amended to the extent set forth below:

Sl. No.	Clause No.	Details of Item	Description of Deviation
1	2.5.1	Median	The median shall be as given in Schedule B (TCS). Median shall include 0.50m wide edge strip on each side, which shall have same pavement configuration of Main Carriageway as per Clause no. 2.5.3 of Manual.
2	2.6.1	Shoulders	The shoulders shall be as given in Schedule B (TCS).
3	2.10.2	Lateral & vertical clearance at VUP /LVUP	The lateral and vertical clearance of all underpasses shall be as given in Schedule B.
4	2.17	Typical Cross Section	The typical cross section as given in Schedule B.
5	5.2 and 5.5	Type of Pavement and Design Requirements	The type of pavement and Design Requirements as specified in Schedule B.
6	2.6 & 5.11	Earthen Shoulders	3.0 m wide hard earthen shoulders shall be provided on each side of main carriageway as shown in TCS, Schedule B. Edge strip shall have same pavement configuration of

Sl. No.	Clause No.	Details of Item	Description of Deviation
			the Main carriageway. Hard Earthen Shoulder shall be to prevent erosion as well as to provide a stable platform for occasional parking of errant vehicles. Hard Earthen shoulders shall meet the following strength parameters: (i) Unconfined Compressive Strength (UCS) equivalent to the strength defined for the bound sub-base layers as per IRC: 37. (ii) CBR of laboratory mix at 97% MDD and 7 days cure+7 days soak: Minimum CBR 60.
7	7.3	Overall width of structures	The Overall Deck Configuration of all structures shall be as per Schedule B and all Road Over Bridges shall be as per the GAD approved by Railways Authority.
8	6.2	Surface Drains	Lined/Unlined Side Drains shall be provided throughout the Project as per typical cross section except cross drainage (River, nala, canal etc.)
9	6.4.2	Drainage where Embankment Height is more than 6 meters	Continuous RCC lined surface drain (Except Structures having approach slabs) shall be provided on both side slopes including Chutes at designed intervals with energy dissipation basin irrespective of Height of embankment. The drainage system shown in TCS shall be treated as minimum.
10	9.7.5	Median Barriers	Thrie-beam metal crash barriers shall be provided in entire length but excluding stretches covered by RCC crash barrier at bridges and other structures
11	9.7.1	Road side safety barriers	Thrie beam metal crash barriers shall be provided in entire length on outer side earthen shoulder of each main carriageway and Loops/ Ramps of interchanges as per TCS referred in Schedule-B but excluding stretches covered by bridges and RE wall structures, where concrete barriers to be provided.
12	Section 9	Traffic Management	Additional specification for Traffic Management System shall be as given in

Sl. No.	Clause No.	Details of Item	Description of Deviation
		System	Annex II of Schedule D.
13	Section 12	Project Facilities	The project facilities and building structures shall be constructed in accordance to Annex I of Schedule-C.
14	12.5	Street lighting	Swaged steel tabular pole with swan neck shall be used for roadside lighting conforming to IS 2713-1980 controlled by suitable digital time switch and other specifications shall be as per Clause no 12.5 of IRC:SP:87-2019. The average level of Illumination shall be 40 Lux.
15	4.2.3	Embankment Fill Side Slopes	In fill section the embankment side slope shall be designed for minimum 1.5(H): 1(V). The embankment height >6m shall be designed in accordance with IRC: 75.
16	Section 4	Side Slope Protection	The side slopes shall be protected against erosion by providing a suitable vegetative cover, Geocell, stone/cement concrete block pitching or any other suitable protection measures depending on the height of the embankment as per manual

Annex - II*(Schedule-D)***ADVANCED TRAFFIC MANAGEMENT SYSTEMS (ATMS)**

The following Specifications and Standards shall be applied in addition to 'Manual on Specifications and Standards for Highway' published as IRC: SP: 87-2019 with all amendments and additions up to Bid date.

1. Advanced Traffic Management Systems (ATMS)**1.1 General**

The work would cover design, supply, installation, commissioning and/or operation and maintenance of Advance Traffic Management Systems (which is one of the components of Intelligent Transport Systems - ITS). The system would include

- 1) Traffic Monitor Camera System (TMCS)
- 2) Video Incident Detection System (VIDS)
- 3) Automatic Traffic Counter and Classifier (ATCC)
- 4) Travel Time Measurement System (TTMS)
- 5) Central Processing System
- 6) Variable Message Sign (VMS)
- 7) Vehicle Speed Detection System (VSD)
- 8) Digital Transmission System and Communication Cable
- 9) Power and Other Cables
- 10) Facility Monitoring System, etc
- 11) Adaptive Traffic Signal Control System

Any new technology, meeting the requirements specified in these specifications should not be excluded. The systems shall meet following objectives:

- Smooth and uninterrupted traffic flow
- Enhance road safety
- Real time information and guidance to users
- Emergency assistance round the clock
- Alerts for abnormal road and weather conditions
- Reduced journey time and inconvenience

1.2 System Requirement

ATMS shall provide the following facilities to highway users:

- make emergency calls to Control Centre in case of accidents, breakdown, fire and ambulance.
- pre-warn the highway users about unusual condition on the road.

ATMS shall provide the following information/data to traffic managers for efficient and effective handling of traffic.

- information regarding location of any incident, incoming calls, help required and messages to be passed to third parties.
- Information regarding traffic congestion, speed and weather conditions.

ATMS shall provide the following controls to traffic managers:

- change the variable message signs from the Control Centre.
- mobilize the movement of ambulances, cranes & patrolling vehicles.

ATMS shall provide online recording and reviewing of the voice & visual information for record and analysis.

Value Added Systems in information dissemination to users of the Project, may be taken up in future. These shall include the following:

- Value Added Systems in the form of real time information on traffic conditions, unusual events, congestion levels, weather conditions etc.; to facilitate project users as also the operator.
- Through relevant websites including that for the Project SPV/Contractor
- Subscription based alert systems
- Dedicated TV channels pertaining to traffic movement
- Tie ups with FM radio channels or creation of dedicated AM radio channel
- Dedicated Toll Free Telephone Systems

Note: Local language is emphasized in above systems.

The ATMS shall among many things comprise following sub-systems:

- Communication backbone
- Mobile Communication System
- Variable Message Sign System
- Meteorological Data System
- Automatic traffic counter-cum-classifier system
- Video Surveillance System
- Video Incident Detection System (VIDS)
- Central Control Room (CCR)
- Weigh in motion for axle load measurement
- Power Supply System

These systems shall have outdoor equipment consisting of ECBs, VMS panels, weather sensors, traffic sensors, video camera etc. The outdoor equipment shall be connected to the control centre through transmission system preferably comprising optical fibre cable, copper cable and interface equipment. There shall be one control centre in this package and shall be located at main toll plaza or administrative building and shall have monitoring equipment, on line information acquisition equipment, processing equipment etc. It shall also have graphic display board showing the highway and the locations of equipment and of incidents.

- 1.3** TMCS cameras shall be installed at every 1 km in order to monitor road, traffic and weather conditions on the highway/expressway visually on real time basis from the Traffic Management Centre, detect abnormal conditions on the highway/ expressway within the coverage of PTZ camera in order to take necessary actions such as lane control, etc. in case any incident occurs, confirm traffic flows on the highway/expressway by live camera images to provide drivers with re-route information when a congested area is identified. The TMCS collects real-time camera image from each PTZ camera located at roadside and monitor and control the camera images in the Traffic Management Centre (TMC). The TMCS can monitor the real-time images at accident prone areas and/or traffic congestion prone areas. The camera is equipped with zoom and pan-tilt functions (PTZ functions) to secure wider area and longer distance coverage. These cameras shall have functionality to take images even in night-time up to a distance of 500m.

The proposed TMCS system shall enable seamless monitoring of the entire stretch of the highway/expressway, as a result each and every portion of the highway/expressway shall be

covered and provide better and real-time monitoring of each and every incident happening on the stretch.

- 1.4** VIDS shall be installed to detect abnormal conditions on the highway/expressway such as accident, broken-down vehicle, stationary vehicle/object, wrong direction movement, fire, low visibility in order to take urgent actions in case such incident occur. The VIDS shall detect incidents by fixed camera with image processing function. The VIDS shall transmit an incident information to Traffic Management Centre on real time basis.

VIDS shall be installed at the location to identified by the Contractor/Contractor and approved by the ITS Engineer. The VIDS shall be installed at a suitable location from the connecting / merging road to monitor the sectional traffic volume on the main carriageway and at every 5km interval along the main road. The exact location of VIDS shall be finalized in consultation with IE/NHA.

- 1.5** VSDS to be provided for detection of over speeding vehicles, data collection and enforcement purpose. The software shall be configurable to provide the required details of defaulters and errant drivers to the state authorities for enforcement. Vehicle actuated speed displays shall be provided to display the speed of the vehicle in real time thereby alerting the road users of over speeding and acting as speed calming device.

1.6 Central Control Room (CCR)

Purpose and General Information

The purpose of the CCR is to monitor the highway and to provide information to the road user. The CCR also houses the central servers and data processing equipment. The CCR shall provide the real-time information and assistance to the highway users, collect data for the use of highway authorities and to monitor and control the Traffic on the highway as per the requirements.

The CCR shall be designed for round the clock operations of monitoring, on-line information acquisition and processing the same for decision making. The CCR shall be the repository of all the data acquired from the field and their processing, storing, and archiving. All the information for real time monitoring oh highway shall be generated at the CCR and the relevant information shall be disseminated to the users through VMS, and to O&M teams through mobile radio.

Location

The Central Control Room (CCR) shall be provided at the Toll Plaza location. The Contractor shall coordinate / integrate / interface closely with other adjoining packages/highways/expressways Contractor for effective and efficient work of ATMS.

Major Components

- Emergency Call Operator Station (Emergency calls from ECB"s)
- Mobile Call Operator Station (Mobile radio calls)
- Integrated Highway Management / Traffic Manager station (Operating Variable Message Signs, Traffic Counting & Classifying System, Meteorological Data System, CCTV & Video Incident Detection)
- Video Wall
- Servers

- Switches
- Administration Computer and Network Printer
- Computer for NMS for fiber Optic Communication system.
- CCTV console equipment
- VIDS control equipment
- Computers for VMS, AVCC, Met, Traffic Control
- A network printer
- An office computer (administration terminal)
- A power supply and backup system

Functional Specification

The CCR shall have the following functions and capabilities:

- 1) Real time images of the highway locations (from camera locations) to the control centre.
- 2) Emergency communication system for communication from the predefined ECB locations to the control centre.
- 3) Real time information to the users from control centre (about the route conditions, traffic situation, etc.) using variable message signs installed on gantries.
- 4) Real time monitoring of the traffic situation and collection of traffic data using traffic counting and classifying system
- 5) Monitoring of the weather conditions
- 6) Dedicated Mobile Radio system for communication between the control centre, ambulances, patrol vehicles, etc.
- 7) Traffic Control System at the interchanges
- 8) Monitoring and control of the highway traffic from the main control centre using integrated highway system
- 9) Compilation, recording, analysis, processing, storage of traffic information and data
- 10) Monitoring and control of the various sub-systems and devices installed on the highway
- 11) The following shall be the servers at CCR:
 - Server for Emergency Call System
 - Server for Video Surveillance system, VIDS system
 - Common server for VMS, ATCC, Meteorological Data
 - Server for Mobile Radio Communication System

1.7 Event management method**1) Event entry and release**

The system shall have the function to associate the location (Up/Down lane), the event type, and the event detection time with TMCS camera which detect event. And it also shall provide event management method to register and release traffic events. e.g. Register and Release

events by pull down operation, specifying the type of event and the number of cameras which detected the event.

2) Supporting function

In general, the events (e.g. car incident) are supposed to be released by the operator manually. But to prevent neglecting release of events, the system shall provide notification function to ask confirmation of operator for events which keeps ongoing after specified time period.

e.g. Alarm is raised for the event which keeps ongoing more than 30 min

1.7.1 Relationship with another agency

- 1) Integration on related information of another agency
Supposing that the same level traffic information as Project in the future from the connected roads, traffic information status both for Project and the connected roads shall be integrated as one seamless traffic information.
- 2) Increased capacity of connecting roads
The system shall be prepared for the expansion of the connected roads and information service area.

1.7.2 Call recording

Conversation of all Emergency calls including the call transferred to other telephone shall be automatically recorded in the storage device of the Emergency Telephone Console workstation with time stamp and operator details. It shall be possible to assign type of call for each record and search the recorded messages with type of call, date, operator, and location.

1.7.3 Internet Server and Project website

- a. Information of road and traffic condition will be disseminated to the public via Internet. A website of Highway/expressway-traffic-information will be set up and the Contractor/Contractor shall design the website layout and prepare the contents.
- b. The site shall present the Highway/expressway graphically and the existing events such as congestion, maintenance work, lane closure and others that affect normal operation. They shall be indicated on the map by icons and colour. The map shall be updated, when there is any change in the event status without delay.
- c. The highway map shall show also camera-icon at the installation points of TMCS camera. If a camera-icon is clicked, the site shall be designed to display in another window, live video taken by the selected camera with clicking. Resolution and frame rate of live video shall be variable to reduce the bandwidth required to access the site.
- d. The Website shall be hosted on the NIC only and the link of this website shall be provided on the NHA and MoRTH websites. The Contractor/Contractor shall be responsible for coordinating with the concerned agencies and shall the cost of hosting and development charges shall be in the scope of the Contractor/ Contractor.
- e. At least following information (Road and Traffic condition) shall be provided via Internet:
 1. GIS Map
 2. Live Video from TMCS camera
 3. Traffic Condition like congestion
 4. Traffic Event using Image Icon (Type and Location)
 5. Traffic Violation details with an option to search by vehicle number
 6. Traffic guidance in the form of alternate routes

- f. SMS Server shall be set up for sending the SMS alerts to the road users and violators. The mobile number of the user shall be obtained from the NPCI FASTag Mapper and/ or Vaahan database. In case the mobile number is available / fetched from both mapper and database, the number obtained from NPCI FASTag Mapper shall be preferred. All the messages sent shall contain the emergency helpline number '1033' and other details specific for the project. The Contractor/Contractor shall coordinate with the telecom service providers for sending the welcome message to the commuters entering the project stretch. The format shall be finalised in consultant with the Authority and ITS Engineer.

1.7.4 Information Exchange with Another agencies

Traffic information must be created including road traffic condition of other agencies. For that purpose, Contractor/Contractor must introduce dedicated device to make information exchange with other organizations. Moreover, the system must include conversion/integration functions of data formats in order to recognize exchanged data as of continuous roads for the integrated traffic information provision.

2. Software

1) General

- a. The ATMS software integrates the field equipment like CCTV cameras, VIDS & VMS with the Integrated Traffic Management (ITM) console to ensure the availability of an effective system for Traffic monitoring & incident / accident management. In addition, it shall also have the capability to integrate and exchange data (using standard protocols) with multiple IoT (Internet of Things) devices that have been temporarily / permanently located on the project highway for Traffic study / Traffic management / Road safety purposes.
- b. The ATMS software shall be based on a modern architecture and shall optimally execute on the ITM workstation and the ATMS server to ensure that
 - i. The system response times are instantaneous to support effective Traffic Management (i.e. Traffic monitoring and incident / accident management) actions on the ITM workstation.
 - ii. No information (data, video stream & audio stream) from any source is lost. Further all such information is made available on the Integrated Traffic Terminal, with no delay, precisely at the time they are required.
 - iii. Effective integration with the CCTV system, VIDS system, VMS system and other relevant ATMS equipment is carried out in a seamless manner with no disruption of / disturbance to the Traffic management function (i.e. Traffic monitoring and incident / accident management). For such integration, standard interfaces (e.g. NTCIP) shall be used wherever available.
 - iv. All information (Data, video and audio streams) collected from various sources shall be archived in the ATMS server for quick retrieval by authorized personnel. However, the performance of the ATMS software in terms of response times shall not be affected during such a retrieval process.
- c. The ATMS software shall be a modular system comprising of at least the following modules:
 - i. Data acquisition module for acquiring data, video streams and audio streams from field equipment

- ii. Highway Traffic Monitoring module
 - iii. Incident / Accident Management Module
 - iv. Integrated audio communication module
 - v. Report generation module
 - vi. System Administration module
 - vii. Communication module for authorized access by external systems (e.g. NHAI's Regional control centre & the Main control centre)
- d. The Contractor/Contractor shall provide a set of software to operate on the servers, workstations, terminal equipment, and other components and devices to be provided under the Contract. The software shall function as a system to provide end results required in the Contract.
- e. The software will be either the software that the Contractor/Contractor has, modification of the existing software, or the new software to be developed for the Project. The copyright of the software specifically developed for the project shall remain with the Contractor/Contractor.
- f. The set of the software to be provided shall consist of those provided by third party and those specifically developed for the project. All third-party software shall be legally licensed and there shall be no restriction on the use in the Advanced Traffic Management System. They shall be registered under the name of NHAI and any supports and services provided by the software developer including update and revision shall be available to the NHAI.
- g. The software to be specifically developed for the Project shall be fully tested and shall be free from bugs. The Contractor/Contractor shall include in the Technical Proposal and design document the software quality assurance program that he intends to adopt in developing the software.
- h. The programming of the applications shall be arranged in such a way that maximum flexibility is afforded by the design to allow the NHAI to implement modifications or additional equipment which may become available or desirable during the working life of the system. Such future modifications or changes shall not be the part of the current scope of the contract and shall be estimated and paid time to time by the NHAI if required but comprehensive documentation of the software and source codes shall be provided under the Contract to allow such changes to be implemented by the NHAI without recourse to the Contractor/Contractor.
- i. The NHAI may wish to implement additional software packages to run concurrently with the software provided under the Contract. These packages may include but will not be limited to the following:
- 1) Programs allowing the TMC system to operate with other systems such as Toll Management System / ETC/ HES interfaced to the data network and involving bi- directional transfer of files.
 - 2) Analytical and statistical program to process the data collected by the system.
 - 3) Software that offers new service to the road users through Internet.
- j. The Contractor/Contractor shall be responsible for Integration of ATMS system and sub-systems with the NHAI Mobile App for the road users as per the requirement raised from time to time by the Electronics department of NHAI or its authorized agency.
- k. The Contractor/Contractor shall be responsible for Integration of ATMS system and sub-systems with the NHAI Command Centre in NHAI HQ as per the requirement raised from time to time by the Electronics department of NHAI or its authorized

agency.

- I. The video stream captured and displayed at any location under this project shall be authenticated through Digital Watermarking containing NHAI logo. The purpose of Digital Watermarking is to ensure following:
 - 1) Copyright protection
 - 2) Source tracking
 - 3) Broadcast monitoring
 - 4) Video authentication
- 2) **Third Party Software**
 - a. The third-party software to be provided shall include but not be limited to the following:
 - 1) Server operating system
 - 2) Storage device operating system
 - 3) Client operating system
 - 4) Database management software
 - 5) Firewall and antivirus program
 - 6) Network Management System
 - 7) Facility Management System
 - 8) Network Video Management Software
 - 9) Microsoft office Pro 2016 or latest license for all workstations
 - b. All third-party programs to be provided shall be widely used and suitable for the application of Advanced traffic management system in terms of functions, capacity, speed, and interface with other software, maintenance and user friendliness. The Contractor/Contractor shall state in the Technical Proposal of the Tender, the third-party software that he proposes. If the Contractor/Contractor proposes the third-party program that is of limited use, he shall explain the reason for using it in the Technical Proposal of the Tender.
 - c. If the third-party software is provided in CD or DVD, the original CD or DVD shall be submitted as part of documentation. The requirement is not applicable to the software preinstalled in the server or workstation.
 - d. If the cost of the operating system is included in the Server and Workstation hardware price, the same may not be mentioned in the schedule of prices.
- 3) **Advance Traffic Management Centre software**
 - a. The Contractor/Contractor shall develop new software or modify the existing software to provide the Advance traffic management system functions specified herein and as per the General Technical Specifications and Particular Technical Specifications.
 - b. The software to be provided as Advance traffic management system software shall include but not be limited to the following:
 - 1) Core Advance Traffic Management Centre software
 - 2) Utility software
 - 3) Maintenance activity tracking and logging software
 - 4) Enterprise web enabled GIS and Image Processing module
 - c. The actual configuration of software modules may not be limited to as listed above; but it shall fulfil the General Technical Specifications and Particular Technical Specifications.
 - d. All software shall be of modular construction and the interaction between the modules shall be kept minimum. They shall be designed to operate continuously, and no

periodical maintenance of the software shall be required.

- e. All the display on the display monitor and printed report shall be in English.
- f. The utility software shall include but not be limited to the system backup and restoration, database backup and restoration, and access control and operation log functions. Usage of the server and workstations shall be controlled by log in/out procedure and different levels of access control shall be provided to restrict the use of certain software by unauthorized persons. All operations shall be recorded as log together with staff identification number.
- g. The software that interacts with the system operator shall be provided with fault tolerant functions and access control functions. They shall be designed in such a way that any operation error shall not cause damage to the system, loss of data or system shut down.
- h. All software shall be tested under the different conditions and cases including incorrect operation by the system operator and erroneous data to verify the sturdiness of the software. The software testing shall also include appropriate load and stress testing.
- n. The ATMS software shall be a modular system comprising of at least the following modules:
 - 1) Data acquisition module for acquiring data, video streams and audio streams from field equipment
 - 2) Highway Traffic Monitoring module
 - 3) Incident / Accident Management Module
 - 4) Integrated audio communication module
 - 5) Report generation module
 - 6) System Administration module
 - 7) Communication module for authorized access by external systems (e.g. NHAI's Regional control centre & the Main control centre)

1. Data Acquisition module

- a) The Data Acquisition enables the acquiring of data from the various field equipment in the form of data strings, video streams and audio streams. Examples include
 - Data strings from VID system, VSDS system
 - Video Streams from TMCS Camera, VID Camera
 - Audio Streams related to conversations on the 1033 Emergency Telephone, Road-side Emergency Telephone
- b) The module allows the user to configure the acquisition conditions as follows:
 - At regular intervals of time with the interval being user
 - On the occurrence of Traffic related events in the field (e.g. data from the VID system, instances of calls from Emergency helpline number and 1033)
 - On demand (e.g. Video stream from a Camera)
 - On the occurrence of system related events like equipment failure and restoration, user login / logout
- c) The above information thus acquired shall be stored in the ATMS server using an established database package like Oracle and MS SQL.

2. Highway Traffic Management module

- a) This module shall support effective Traffic monitoring on the highway including the

display of the road on the Large display and Integrated Traffic Management (ITM) workstation, in the form of animated screens including Graphic User interfaces specified under Clause 816.1 to 816.17 of Specifications for Road and Bridge Works of MoRTH and including locations of all ATMS field devices on a GIS map with the ability to display alongside the current information (e.g. CCTV video Images, VMS messages) relevant for each field device, either permanently or on selecting the device with a mouse. The details of the project-specific composition of the GUI will be finalized during the project execution phase between the Contractor/Contractor and ITS Engineer in consultant with NHAI.

- b) The module shall display the events acquired by the system (Traffic related, and system related) on a window at the bottom of the ITM / Graphic display, with the window size in terms of the number of events displayed being user configurable. Further the system shall provide a feature for the user to acknowledge such events and the subsequent display of the same.
- c) In addition to the above, the module shall also display the related event (where relevant e.g. a road-side emergency helpline call, VIDS event) on the GIS map using suitable animated icons. The animation shall suitably change when the event has been acknowledged and when the condition causing the event has disappeared.

3. Incident / Accident Management module

This module shall support Incident / Accident Management by

- a) Allowing the Traffic Management console operator to locate and mark (with a mouse) an accident / incident on the GIS map of the highway and initiate the Incident management actions.
- b) Displaying a contextual on-line checklist for the operator to follow in sequence. Further the clicking on each item of the checklist shall automatically activate the related ATMS equipment to aid in the management viz.,
 - i) seamless audio connection for the Traffic Management console operator, via the integrated audio communication unit, irrespective of the communication media (Mobile radio, Mobile phone/landline, road-side Emergency telephone), to the ambulance, Trauma Care Centres, Patrol & other O&M vehicles
 - ii) automatic Pan, Tilt and Zoom of the nearby camera to view the accident
 - iii) Bringing on the VMS –wise message edit screen (by interfacing with the VMS Control software) to create and dispatch messages to VMS boards and mobile apps of registered road users). The checklist itself shall be derived from the relevant Traffic Management and rescue procedures captured either in the Operation (O&M) manual of the highway or based on world-class practices relevant for the highway.
- c) Logging the timestamp of the operator operating each element of the checklist to aid in 'post-mortem' analysis of the operator's performance towards establishing his /her efficiency and further training needs.
- d) Automatically performing pre-defined actions related to each of the above elements (e.g. Identification of the accident spot on the road shall control the nearby cameras to 'look' in the direction of the accident spot)
- e) Aiding on-line tracking (via GPS) of the various O&M vehicles like the Ambulance, Tow-vehicle and the Patrol vehicle supported with dynamic display of information like shortest route, travel time to the accident spot, Trauma Care Centre etc.
- f) Providing a user-programmable facility, as an aid, for the automatic generation of VMS

messages depending on incidents based on e.g. information measured by the MET sensors and sensors installed on the highway (e.g. the generation of a Visibility Alert signal in the event of visibility going below 1 km). This module shall alert the operator on generating the message which shall then be deployed on the operator's approval.

4. Integrated audio communication module

This module shall interface with and control the integrated audio communication unit to aid the operator seamlessly communicate with various stakeholders via a host of communication media like telephone landlines, mobile telephony, mobile wireless etc. The Integrated Audio communication unit enables the Traffic Manager / operator to communicate with all stakeholders in a seamless manner irrespective of the medium of communications. Using a hardware like a digital telephone exchange that supports software control, this unit allows the Traffic manager wearing a headset with a microphone (or a handset) to seamlessly communicate with the stakeholders in traffic operations using various audio communication media like Mobile wireless radios, Mobile (GSM) telephones, Telephone landlines as well as the road-side Emergency Telephone. The communication is initiated on selection of a context sensitive checklist element or by selection of suitable icons on the ITM workstation screen during the Traffic monitoring or accident / incident management. This unit shall support communication between the Traffic manager and a single stake holder or a group of stakeholders. As a back-up option this unit shall also enable such communication via physical pushbuttons located on the unit.

5. Report generation module

- a. This module shall generate periodic as well as on-demand statistical reports using data received from WIM, Automatic Traffic counter cum Classifier and Met sensors for traffic planning and management, Accurate forecasting. There shall also be a provision to generate reports to aid planning and strategizing enforcement.
- b. The module shall provide a range of reports on demand including those
 - related to the acquired data,
 - VMS messages edited and sent,
 - Equipment availability,
 - System related events including those related to
 - System malfunction and restoration
 - User login – logout
 - VIDs events detected
 - Mobile App messages received
- c. The module shall further provide detailed performance reports on all aspects ranging from detection of incidents, through the field Operations team (Patrol vehicles, Break-down cranes and Ambulances) actions, Traffic Management Console operator and other ATMS Control Centre operator actions.
- d. Detailed formats of each report shall be provided by the ITS Engineer during Detail Design Phase.

6. System Administration module

This module shall essentially enable the definition and maintenance of user accounts.

7. Communication module

This module will manage authorized access to the ATMS system by

1. Authorized NHA personnel / representatives / ITS Engineer
2. Other authorized NHA systems like the Regional office Control Centre ATMS system and the Main Control centre ATMS system
3. Any other system authorized by NHA

Based on requests from the above entities the communication module shall provide the following information to the requesting entity:

- i. Video Streams (Live and Archived)
- ii. Audio streams (Live and Archived)
- iii. Data strings and Data elements (Live and Archived)

The standard data exchange protocols for the above will be shared by NHA with the successful Contractor/Contractor.

Enterprise web enabled GIS and Image Processing module shall be deployed at the TMC and sub-centres that shall form the part of the Dashboard and shall have following functionalities:

- a. Map analysis of ATMS planning and operations.
- b. Asset Management of ATMS like TMCS, VIDS, VSDS, Route Patrol, Maintenance, Recovery vehicle location, and Route to reach the incident spot.
- c. Identify surrounding development by other Authorities or illegal development which can potentially be a hazardous to road using temporal satellite imagery for example detection of queue length at the toll plazas, detecting the changes around highway like unauthorised structure built nearby highway or unauthorised occupancy on ROW/buffer area, nearby water body analysis, agriculture land and green belt analysis etc. This will help the NHA to identify gaps and improve those by implementing various strategies like position of barricading at unauthorised access points, identifying the congestion at toll plazas, identifying water logging probability, removal of illegal encroachment, positioning of CCTV surveillance etc.
- d. Demarking area of highway which is more susceptible to potential hinderances on highway like by cattle, wildlife, prohibited vehicle entry from etc. from nearby inhabitancies.
- e. Road condition analysis on Map and satellite imagery for regular monitoring, improvement planning and implementation. Along with monitoring of implementation/ upgradation works.
- f. GIS based road maintenance planning and monitoring by marking them on Map and monitoring the activity through GIS enabled mobile app by tagging location and photographs of respective location of road asset and work in progress.
- g. GIS enabled planning of diversions for safety of vehicle movement on maintenance area, installation area, and work in progress. This feature shall be made available by the Contractor/Contractor to NHA and ITS Engineer before the start of the installation of roadside equipment at the site, for planning of the diversion and monitoring of the work in progress.
- h. The Software should have capability of visualising GIS layers, attribute integration and analysis of layers.
- i. The software should support GPS data for showing emergency and maintenance vehicle on Map
- j. The web module should have out of box standard GIS functions like: Pan, Zoom, Identify, Measurement (Line, Area), Search, query, etc.

- k. The software should have tool for creation of topology. Symbology tools for visualizing the spatial data as per the defined colour scheme and annotation tools facility for visualizing the spatial data as per defined label placements or placing the labels from attribute table.
- l. Software should have facility of advanced rule base labelling for dynamic placement of labels as per the extent, defined position and priority of layers by defining the different classes and should have the option to set the scale labels at specified scale.
- m. Geo-Processing feature and functions like Buffer, Union, Intersection, Identity, Update, Eliminate, Dissolve, Clip/Erase, Convex Hull, Thiessen, Merge, simplify should be available.
- n. It should have CAD tools for 2D & 3D GIS data conversion, CAD tool for Raster to vector (R2V) and topology creation.
- o. The software CAD functionality should support native drawing file formats like DWG, DXF, DGN and should have capability to render photo-realistic 3D rendering.
- p. The software should be COTS based and OGC certified.
- q. It should have Image processing capability georeferencing, visual interpretation of the satellite imagery and classification tools to helps in classifying images in user defined classes. image enhancement algorithm such as Linear, Logarithmic, Histogram Equalize, Histogram Matching, Density Slice, Gaussian, Squire root, Tone Balancing, and Raster Vector Analysis,
- r. The software should have image filtering, vegetation indices calculation, linear algebraic combination, band Math, change detection, image extraction, mosaicking, image visualization, filtering, georeferencing, atmospheric correction, transformation tools, change management, feature extraction, classification etc.
- s. The software should support all type of Standard GIS Data format, Imagery formats, and RDBMS.
- t. GIS Tools functionalities such as Data creation, Import/Export tools, Transformation Techniques, Theme management, Geometric correction.
- u. The software should have feature to identify and query various spatial Data.
- v. The software should have Map composer, report module and Map print layout functionality.

2.1 ATCC and TTMS Modules of ATMS Control centre software

ATCC and TTMS modules shall be provided with ATMS Control centre software. The ATCC functionality shall be provided for collection of traffic data and TTMS functionality shall be provided for estimation and calculation of traffic data. No additional hardware or field equipment shall be installed on the Project for ATCC and TTMS functionalities. The ATMS Software shall processes the data from ANPR and VIDS cameras for traffic counting and classification, and travel time estimation.

2.1.1 Automatic Traffic Counter and Classifier (ATCC) Module

The ATCC module shall be provided in the ATMS Software for automatic traffic counting and classification of vehicle class based on the data collected through ANPR camera and VIDS camera.

The system shall identify and record all types of vehicles on the highway for effective monitoring and data collection at ATMS Control Centre. Besides, the system shall be capable of classifying any other vehicle category as per user needs. Vehicle classification should be user selectable based on length of vehicle and / or detuning of the loop inductivity.

The software module shall be robust and be capable of operating with minimum maintenance.

Software and manuals to analyse the data from output of vehicle counts, classifications speeds and headways shall be provided. Capability of graphic/tabular presentation of analysed data shall also be offered.

System Accuracy Requirements

Parameter	Accuracy	Conditions
Average Speed	10 percent	There are at least 25 vehicles in the group, individual vehicle speeds are between 10 kmph and 195 kmph and the vehicles conform to normal highway driving behavior.
Average Headway	10 percent	There are at least 25 vehicles in the group, individual vehicle speeds are between 10 kmph and 195 kmph, individual vehicle head-ways are between 1 and 10 seconds and the vehicles conform to normal highway driving behavior.
Flows	5 percent	There are at least 100 vehicles of each category in group and vehicles conform to normal highway driving behavior.
Vehicle classification	5 percent	Out of a group of 100 vehicles, conforming to normal highway driving behavior, at least 95 shall be accurately classified as per the classification scheme as per MoRTH guidelines.
Occupancy	10 percent	There are at least 25 vehicles in the group, individual vehicle speeds are between 10 kmph and 195 kmph, individual vehicle headway are between 1 and 10 seconds and the vehicles conform to normal highway driving behavior.

The ATCC module shall be cross-verify the vehicle class fetched by the VSDS system through integrated with the Vaahan Database. In case of any discrepancy, such transactions shall be audited by the operator using the ANPR image / video available in the ATCC central system.

The data shall be segregated and provided in the report format on the bases of Section wise, direction wise, class wise, etc. as approved by the ITS Engineer.

2.1.2 Travel Time Measurement System (TTMS) Module

Travel Time Measurement System (TTMS) module shall be provided for measuring required travelling time between major section of the project. The ANPR cameras shall be installed at VSDS locations on the entire stretch. TTMS shall use these ANPR data to detect the current vehicle location. Using this location data, TTMS module shall calculate the

actual travelling time per section for each vehicle and derive the average travelling time by the statistics process.

The ANPR cameras will capture the image of each vehicle crossing the VSDS location and shall extract the vehicle number. The image and vehicle number shall be stamp with time and location for the purpose of section speed calculation of each vehicle. The same data shall be used for travel time estimation.

TTMS module shall calculate the actual travel time and velocity (speed) of each vehicle between every checkpoint (VSDS location). Speed data from all vehicles shall be processed statistically by TTMS module to calculate the average travel time between two consecutive check points (VSDS location), to calculate the average speed and average travel time for each section and the entire project stretch in both the directions. Route Travel Time Estimation Models in IRC:SP:110-2017 shall be referred for estimation of travel time.

Integration with Vaahan Database, NPCI FASTag Mapper, Police Control Rooms, Dial 112, Smart City ICCC and other systems

The ATMS Software shall be integrated with Vaahan Database and NPCI FASTag Mapper for fetching the Vehicle owner contact details of errant commuters detected by the ATMS System (ANPR, VIDS, TMCS, etc.) or reported by the route patrolling team with an evidence under violation of any traffic and safety rule / law on the project stretch.

In case the incident/ violation is reported manually, the evidence received from the ground staff / enforcement agency shall be verified by the control room manager and upon authentication from manager, the operator shall create and event in the ATMS application.

The data fetched from the Vaahan database or NPCI FASTag Mapper shall be done only at the backend through the ATMS software and only the relevant fetched result shall be displayed on the operator screen or in the reports. The ATMS software shall fetch the data for events generated and audited by the operator. The vehicle numbers shall be audited by the operator by matching the system generated vehicle number with the vehicle number on the image captured by the camera. The operator shall have the option to edit the vehicle number. The logs shall be maintained for each such correction done by the operator and shall be 100% audited by the manager for each operator to minimize human and system errors.

Following actions shall be taken automatically by the ATMS Software after the violation is detected and audited.

- i) Generate e-challan
- ii) Send SMS regarding violation on the registered mobile number of the vehicle fetched from Vaahan database and NPCI FASTag mapper.
- iii) Email the daily e-challan report to the concerned enforcement agency(ies) as applicable for each state, district, etc. the project crosses through, so the e-challans shall be send accordingly to the concerned enforcement agency under whose jurisdiction the incident / violation detection point / spot / section falls.
- iv) To avoid any discrepancy in section based overspeed enforcement, the VSDS (ANPR camera) location shall be selected such that the one section is not falling in jurisdiction of two different agencies. In case if the same can't be avoided, the section based overspeed e- challan shall be sent to the agency under which the end point/2nd checkpoint of the section falls.

The formats of e-challan, warning/ information messages (SMS), emails, etc shall be finalised in consultation with ITS Engineer / NHAI and concerned enforcement agency.

ATMS Software shall be integration with police control rooms of the state, district as applicable, as well as the ICCC of smart city projects (as applicable), and National Disaster Management Authority (NDMA), State Disaster Management Authority (SDMA), the District Disaster Management Authority (DDMA), etc.

The police control room shall be provided with the limited access of the ATMS application through On-line Access Facility and shall be able to perform the functions are described in the On-line Access Facility section. The functions specified there are the minimum requirement and the application shall be designed to meet the actual requirement of the Police and Enforcement agencies in consultation with ITS Engineer and the concerned agency and any additional information shall be approved by the NHAI.

2.3 Outline of TMC Software

The Contractor/Contractor shall describe in his Technical Proposal application software to be provided to the servers and workstation in the Traffic Management Centre required hereunder.

- 1) Graphical presentation of module and components comprising application of servers and workstation.
- 2) Data processing flow in the form of class diagram, use case diagram, sequence diagram, or data flow diagram
- 3) GIS and Image Processing module
- 4) Scale or size of the module and components, and programming language used
- 5) Extent of the development required for the Project.

3. Video Analytics and Management System (VAMS)

- a) The Video Analytics and Management System (VAMS) software shall be provided to view live and recorded video from all the cameras connected to local and wide area network.
- b) The VAMS software shall have a client/server-based architecture that can be configured as a standalone VAMS system with the client software running on the server hardware and/or the client running on any network-connected TCP/IP workstation. It shall support all major of operating systems (windows, Linux, Mac). It shall support web client interface and shall operate without requirement of installation of any software.
- c) The contractor shall obtain the license for the total number of cameras to be provided for the project based on the MAC address of each NIC. The VAMS shall have a single page that displays the status of all servers and cameras currently connected. This page shall display any alarms, events, MAC addresses, camera configuration, format and frame rate from each individual camera.
- d) The VAMS system shall have the ability to record an audit trail of when users log in that shows what changes they have made, what video they have viewed and what they have exported.
- e) The VAMS shall allow for the configuration of what drives to use for recording video. Those drives may be local drives, direct attached storage drives or iSCSI drives.
- f) VAMS shall support the mobile application for both iOS and Android platform capable

of viewing multiple simultaneous live video streams and playing a recorded video stream.

- g) The VAMS software shall have an open architecture supporting IP cameras and encoders from multiple manufacturers providing high-resolution megapixel features.
- h) Multiple control room consoles/workstations shall be able to simultaneously view live video and audio and/or recorded video and audio from the storage/video server. All storage / video servers shall also be able to simultaneously provide live and/or recorded video to one or more consoles. Its operator shall be able to push the video to another operator console seamlessly.
- i) The VAMS software shall be able to send a predefined email based on an event trigger. The VAMS software shall also support SSL and TLS connections for transmissions of the mail.
- j) The VAMS shall be capable of multi streaming on all connected workstations/ consoles in the entire network of the project stretch as well as minimum 20 remote users simultaneously. The remote users shall have full functionalities as are available for the control centre operators.
- k) It shall be possible to configure multiple monitors on one workstation / console i.e. multiple VAMS application simultaneously on one workstation.
- l) Recording of all video transmitted to the VAMS shall be continuous, uninterrupted and unattended.
- m) The VAMS system shall have video motion detection recording, such that video is recorded when the VAMS detects motion within a region of camera's view.
- n) VAMS shall have Suspect Tracking feature to configure camera links between cameras to follow a suspect between different camera scenes.
- o) Inactivity timeout feature shall be provided to save the bandwidth
- p) Archive bookmarks feature shall be available to specifically archive bookmarked video and create a second copy of important video.
- q) VAMS shall automatically generate alarm / alert in case of any video loss or failure.
- r) The VAMS software shall be used to connect different types of events, such as input triggers, to a desired action such as recording video or triggering an alarm. The VAMS software shall recognize the following event types: video motion, video loss, input trigger, health monitoring, IP camera connection, software trigger and analytics, camera preview style, hovering, server disconnect, archive alarm - failure on archiving target, such as bad mount point. The VAMS shall provide the search and display analytic meta data when searching analytic event linkages etc.

4. Emergency Telephone console

- a. There shall be a Control System with a Control Software to receive all Emergency Communication from the NHAI 24X7 National Highways helpline and Route Patrol.
- b. All the Calls coming on NHAI 24x7 helpline for this section shall be automatically routed to the TMC. The required integration with the telecom operator and 1033 helpline services shall be in the scope of the Contractor/Contractor.
- c. The Software shall be integrated with all the Telecom operators for obtaining live location of the caller and the same shall be plotted automatically on the GIS Map, so that the location of the caller can be identified automatically for providing required service. This will also enable the software to identify the fake callers and the caller calling outside the Highway ROW.

- d. The software shall operate on open architecture and integrate with other subsystem software that are installed to manage Cameras, VMS, and Speed Display, apart from the Traffic Management module (where applicable) etc.
- e. The software shall store configuration Emergency call ID, Location on the highway stretch etc.) of each Emergency call received. There shall be options to generate reports of stored device configuration.
- f. The system shall record all calls on to a dedicated server with adequate indexing to retrieve the same on a later date.
- g. The help desk will be manned by call managers / operators. The administrator should be able to create, add, edit & delete users (call managers/ operators). He should be able to administer access rights of the entire highway or a section thereof to the call manager.
- h. The administrator should be able to place call managers in a hierarchy. The higher priority manager should inherit the rights of a lower priority manager automatically when he is taking overriding control of Emergency calls, which are already being controlled by a lower priority manager. There should be minimum 3 hierarchical levels of security for providing user level log in.
- i. The system shall provide activity log (audit trail) with user id, time stamp, and action performed, etc.
- j. The system shall perform communication health check (link quality check) on all the connected communication devices and report errors if any on the administrator console.
- k. ATMS Control Centre will have dedicated workstations for Call management. For monitoring purposes, Video monitors shall be setup and would show the location of originating calls clearly on GIS map sections of the highway.
- l. The user shall have the facility to request for control of any section of highway outside his rights for a reservation period. Control of the said section is released after the reservation period (Request enhanced control rights for a short duration).
- m. ATMS Control Centre may have one or more Operators simultaneously logged in to the communication software to manage their respective sections of the highway.
- n. Each workstation and the associated software should allow up to nine calls to be maintained on hold while the current call is being serviced.
- o. Call manager/operator logoff shall be allowed only when no call is in progress or on hold.
- p. System should ensure that once recorded, the audio cannot be altered; ensuring the audit trail is intact for evidential purposes.
- q. System shall provide sufficient storage of all call recordings for the entire Contract period or more.
- r. The call manager/operator shall have the facility to call back the caller.
- s. The call manager/ operator shall also have the facility to patch any call on Emergency helpline to an external telephone line (fixed and mobile), local intercom at the ATMS Control Centre, sub-centre, and the local mobile radio network (if applicable).
- t. The call manager/operator shall have the facility to initiate communication health check on any device within his section of the highway.
- u. It shall be possible to switch calls. That is, if a call # 1 is in progress, the call manager can open any other call that is in hold status. Call # 1 shall go hold status.
- v. The offered system shall have facility to retrieve/export/ backup (on CD, DVD or Blu-

ray recorders) the desired portion of call record (from a desired date/time to another desired date/time) through the search functionality of the application software.

- w. It shall be possible to archive old call records and logs on CD, DVD, Blu-ray recorders, or RAID backup devices. Log of any such activity should be maintained by the system for audit purposes.
- x. Database Server shall keep track of all configurations, error data, configuration events, usage events and error events.
- y. All the workstations shall be provided with software to play recordings, archive and manage calls. However, managers would require sufficient access rights to use play and archive modules.

5. Probe Data System

- 1) A probe car system is envisaged that receives and processes location data from the project vehicles equipped with GPS device and show the location of GPS devices attached to patrol vehicle or another management vehicle as one of the components of ATMS.
- 2) The system will use the vehicle location data of maintenance, patrol and emergency vehicles fitted with GPS device and deployed on the project.
- 3) The supply and installation of GPS devices is not under the scope of this Contract except for the maintenance vehicles to be provided by the Contractor/Contractor on the project during O&M period of this Contract. The Contractor/Contractor shall only be required to establish the data communication system between vehicles and Probe Data System console in TMC under the scope of work of this Contract.
- 4) However, the Contractor/Contractor shall provide the GPS devices for the vehicles and portable VMS provided by the Contractor/Contractor.
- 5) It shall be the responsibility of the Contractor/Contractor to furnish all necessary hardware, software and database, install equipment at the specified location, provide necessary cabling, integrate all system components, and deliver a complete operational system including such works as required for the transmission of the probe data on 24/7 basis.
- 6) The probe car system will be prepared for generating traffic condition information and utilising the cumulated data as statistics for the measures on transport such as traffic management etc.
- 7) It collects vehicle location information dynamically. A probe sensor installed in vehicle consists of Global Positioning System (GPS) unit, processor unit, communication unit and power supply unit.
- 8) The satellites send time signals. The time signals are received by the GPS unit on the earth. The GPS unit receives the signals from several satellites and identifies its location on the earth.
- 9) The accuracy of the location generally ranges 10 to 100 m, depending on such factors as quality of GPS unit, high-rise buildings around etc. The probe sensor periodically sends the recorded data such as vehicle location in terms of longitude/latitude and recording time to the TMC.
- 10) The vehicle locations shall be displayed on the GIS map in real-time in TMS and all sub-centres.
- 11) The probe data will be received periodically at the TMC and shall be analysed to show the location of maintenance vehicle on the road network of digital road map.

- 12) The analysed data is converted into traffic congestion information and provided to the road users. The cumulated probe data is processed as historical data for higher accuracy of congestion information.
- 13) **Data List** - The vehicle location data shall be generated at an interval of 10 seconds in each GPS device on board vehicle. The probe car system shall receive all vehicle location data as they are sent from vehicles. The data includes the following items:
- Device ID
 - Vehicle type
 - Location (Longitude and Latitude)
 - Date & time of data
 - More detailed structure of the GPS data will be provided to the Contractor/Contractor.
- 14) **Data validation:** The system shall scrutinize the data received and any abnormal data such as data without time stamp, data value outside of the range, and data with longitude and latitude outside of the vehicle coverage area shall be removed from the data.
- 15) **Map matching:** The system shall have map matching function to project the location of vehicle onto the nearest point along the vehicle route. If the distance between original point and projected point is longer than the pre-set threshold, the data shall be disregarded.
- 16) **Data storage and retrieval function**
- All data shall be recorded and stored in the probe car server for analysis and future usage. The raw vehicle location data sent from GPS device and processed location data after map matching shall be kept for three (3) months.
 - Data retrieval and presentation software shall be provided that shows the original location data, location data after map matching.
- 17) **Screen Display Functions**
- The information display shall be schematic map-based interface and as well in the form of a list. The schematic map-based display shall cover the entire Project and be able to enlarge individual locations on the map when selected. The enlarged view shall be able to display the details for each selected location.
- 18) **Reporting functions**
- Probe Data System Server shall publish/print as a minimum the reports listed below. The reports shall be produced as pre-scheduled or on-demand by system operator. It shall be possible to produce the reports in a portable file format.
 - Operation and error log List of roadside equipment those are operational or malfunctioned
 - Error record
- 19) **Communication Network**
- The data transmission of vehicle tracking data shall be made through IP based network provided by communication provider. The network equipment of the system shall have high reliable and secure connectivity.

- 20) All the third-party GPS on board Unit shall be subjected to test before Acceptance test, during installation work and upon completion depending on the test item.
- 21) Two types of test, function and performance test and general test shall be conducted. They include (as a minimum):
- i. Communication and performance of GPS On Board Unit.
 - ii. Probe Data System Server application and reports.
 - iii. Locating function on map.
 - iv. Data logging function.

6. Hardware for Central Processing System

The Central Processing System shall comprise of following minimum components:

1. TMC Central Processing Servers in hot standby configuration (Primary + Secondary)
2. Video Recording Server with 120 TB inbuilt storage
3. Backup Video Recording (Only Incidents) Server with 120 TB inbuilt storage
4. Internet and SMS Server
5. Operations Laser Printer (Colour)
6. Operations Laser Printer (Black)
7. Operator Consoles each with 4 nos. 21" touchscreen monitors
8. Emergency Telephone Console 2 nos. 21" touchscreen monitors
9. ATSC Console 2 nos. 21" touchscreen monitors
10. RLVD Console 2 nos. 21" touchscreen monitors
11. Graphic Display with Graphics Display management software and Controller
12. Firewall, IDS, IPS and other network security components
13. Core Switch
14. Routers
15. Network Equipment – Layer 3 Switch, Layer 2 Switch etc.
16. Network Management System (NMS)

6.1 TMC Central Processing Servers and Sub-Centre Servers

The Traffic Management Centre (TMC) application server system shall consist of two servers with cluster configuration, one primary server and one stand-by server. Each of the two servers in the cluster shall meet or exceed the minimum requirements stated hereunder.

The TMC server and workstation computer hardware shall be standard models manufactured by organizations of international repute. Custom built or non-standard equipment will not be acceptable. All the servers and computing shall be UL, CE, FCC, BIS certified.

Full maintenance support services and ready availability of consumables, spare parts or replacement units shall also be assured from a third party, based in India, who is not connected with the Contractor/Contractor and his agent.

The specifications in this section are provided as reference. The workstations to be provided by the Contractor/Contractor shall materially comply with these specifications and shall be subject to the approval by the ITS Engineer.

- a. Each server shall have a minimum of four numbers of latest generation Intel Xeon 14-Core processor 2.2 Ghz CPU of 19.25 MB Cache, 105W.

- b. The server shall have 256 GB RAM memory using 32GB Module scalable to at least up to 1.5TB, using DDR4 2666MHz DIMM (RDIMM) memory modules.
- c. Server shall have 4* 1.6 TB SSD HDD bays with each SSD having minimum endurance of 3 DPWD
- d. One optical drive DVD-RW shall be provided in each server.
- e. Server should have RAID controller with 4GB Lithium-ion battery backed write cache (onboard or in a PCI Express slot).
- f. Server should support 1Gb 2-port network adaptor supporting advanced features and 10Gb 2- port with dual SFP+
- g. Server shall have Dual 16GB single port PCIe Fibre Channel Host Bus Adapter with Optical Module and Minimum 6 PCIe Gen 3.0 x4 Slots
- h. The power supply shall be Redundant 1500W Platinum hot plug and redundant hot-plug system fans. The display controller should support VGA.
- i. The server should be provided along with the out-of-band remote management and maintenance capability. Remote management should be possible by using API and Web based GUI.

6.2 Video Recording Server (VRS)

The Video Recording servers shall be provided at TMC and sub-centres for recording the live video feed from all the cameras (TMCS, VIDS, ANPR). The VMS (Video Analytics and Management System) software shall be installed on the VRS. The inbuilt storage prescribed for VRS herewith are estimated for 60 days @ 25 FPS, 2 MP at 80% load. The Contractor/Contractor shall propose the storage capacity of VRS as per its own calculation and proposed solution to provide video recording of all the cameras for minimum of 60 days keeping 20% buffer. The specified storage here is the minimum requirement to be provided by the Contractor/Contractor. Minimum 2 nos. VRS shall be provided at each location (TMC and sub-centres).

- a) Each server shall have a minimum one latest generation Intel Xeon 4-Core processor 3.5 Ghz CPU of 8 MB Cache, 256 SSD for the preloaded operating system and video management software. Each server shall support at least 128 channels at full HD along with 2-way audio feature.
- b) The server shall have 16 GB RAM memory DDR3 memory.
- c) Server shall have 12* 12 TB SSD HDD bays such that minimum 120 TB useable storage space is available after applying RAID 6 configuration. The server shall support up to 200 TB internal storage.
- d) One optical drive DVD-RW shall be provided in each server.
- e) Server should support 1Gb 2-port network adaptor supporting advanced features and 10Gb 2- port with dual SFP+
- f) The power supply and fan shall be Redundant
- g) The display controller should support VGA, HDMI, DVI.
- h) The server shall support minimum 1000 Mbps bandwidth for read and write the video recording and shall support 8 input and 4 output alarm.

8. Note: Total number servers required at each location / Sub-system shall be as per the solution design of the Contractor/Contractor. The Quantity

mentioned in the BOQ is the minimum requirement and shall be provided by the Contractor/Contractor.

All the Servers shall come with 5 years OEM Warranty with 24X7 support and Next Business Day (NBD) resolution.

6.3 Graphic Display for TMC

- j. The Contractor/Contractor shall provide Graphic Display cubes with DLP based technology with Laser light source. Graphic Display shall show large-scale presentation of central server monitor screen and live video streaming from the all the cameras (TMCS, VIDS, ANPR), ATMS Dashboard and GIS Map.
- k. Number of cubes and configuration shall be based on the space available in the TMC to achieve the required resolution. It should be based on suitable architecture with controller and Graphics Display management software.
- l. It shall be able to show multiple screens at a time and the number of screens on the display shall be flexible.
- m. It should not have end of life for at least next 7 years.
- n. The Graphic Display shall be made up of several units. It should have automatic and continuous color calibration and uniform brightness amongst all cubes. Each cube should be able to take HD signal and the total cubes shall be finalised such that minimum 23040 x 4320 pixel resolution is achieved from the entire graphic display wall i.e. suitable to display minimum 30 cameras along with GIS Map and ATMS dashboard in full high definition. The size of the display shall be calculated on the basis of the project requirement, such that at least 50% of the TMCS cameras can be viewed in full high definition at same time along with GIS Map and ATMS dashboard.
- o. The brightness of the cube shall be 400 nits and should be adjustable for lower or even higher brightness requirements with brightness uniformity of more than 95%. The dynamic contract ratio shall be 1000000:1 or more.
- p. The ingress design of the projection unit shall be conforming to IEC-60529 standard. Test certificate shall be submitted by the Contractor/Contractor in the Technical Proposal.
- q. The depth of the cube shall not more than 750mm to avoid wastage of space in the TMC and sub-centres.
- r. Graphic Display Controller and management software shall be from the same OEM. The number of output shall be equal to the number of cubes required to achieve the resolution.
- s. The Operator shall be able to see multiple source in one window and shall be able to specify time interval and sequence. The software shall provide the option to split the entire display in multiple sections and layouts. The operator shall be able to define multiple layouts that can be launched based on time schedule or sequence as defined by the operator or control room Manager. The layouts shall be finalised in consultation with the ITS Engineer and NHAI.
- t. The software shall have self health diagnostics function and shall raise alert or popup in case of any error is diagnosed in the graphic display. The operator shall notify the maintenance engineer regarding such alerts through FMS.
- u. At least following information (Road and Traffic condition) shall be provided on Graphic Display:

- 1) GIS Map of the Stretch with each lane
- 2) TMCS Camera live video streaming
- 3) VIDS live video streaming and Incident Pop-ups
- 4) ANPR and speed radar live data
- 5) Traffic Condition
- 6) Traffic count and classification
- 7) Travel time
- 8) Traffic Event using Image Icon (Type and Location)
- 9) Emergency call status
- 10) Information Provision by VMS
- 11) Status of each equipment plotted on the GIS Map
- 12) NMS

6.4 Graphic Display for Sub Centre

- a. The information terminal to be installed at the sub-centre shall be a Laser DLP Graphics Display made of suitable diagonal cubes of depth no more than 750mm such that the resolution of the graphic display is minimum of 15360 x 4320 pixel i.e. suitable to display minimum 30 cameras in full HD mode at a time.
- b. The Contractor/Contractor shall supply and install the information terminal at the specified location in the sub centre and connect it with the central server system through the digital transmission system. Software required to operate the information terminal shall also be provided.
- c. Information (Road and Traffic condition) as below shall be provided on Display as same as in main centre but **only of the stretch and equipment covered under that Sub-Centre**:
 - 1) GIS Map of the Stretch with each lane
 - 2) TMCS Camera live video streaming
 - 3) VIDS live video streaming Incident Pop-ups
 - 4) ANPR and speed radar live data
 - 5) Traffic Condition
 - 6) Traffic count and classification
 - 7) Travel time
 - 8) Traffic Event using Image Icon (Type and Location)
 - 9) Emergency call status
 - 10) Information Provision by VMS
 - 11) Status of each equipment plotted on the GIS Map
 - 12) NMS

Note: For the ergonomic design of the TMS and the Sub Centres ISO 11064 shall be followed.

6.5 Network Equipment

6.5.1 General

- a. The Contractor/Contractor shall supply and install network equipment at each location to connect each peripheral to the TMC systems. The Contractor/Contractor shall supply and install all equipment, cables, connectors, terminals and other miscellaneous materials necessary to establish a working local area network connecting these systems.

- b. The network between the TMC and sub-systems shall either use the optical fibre cable network or high-end Wireless Access Points along the stretch and a data communication network shall be established using layer 3 switch to be supplied by the Contractor/Contractor. The Contractor/Contractor shall supply and install the network equipment suitable for interfacing the layer 2 switch to the layer 3 switch.
- c. The type and the number of the network equipment proposed by the Contractor/Contractor as per the network design shall be mentioned by the Contractor/Contractor in the BOQ. The network configuration shall be determined by the Contractor/Contractor. The cost of the network devices and materials that is not explicitly listed in the BOQ of the Bid submitted by the Contractor/Contractor or supplied by the Contractor/Contractor during the installation works but deemed necessary for the system during any stage of this Contract shall be included in the cost of appropriate items and the Contract Price, and no separate payment shall be made.

6.5.2 Network design

- a. The Contractor/Contractor shall undertake the detailed design of the digital transmission system. The design work shall include but not be limited to transmission protocol, network and transmission equipment, type and size of cable, cable splicing, conduit and cable installation work, manhole, hand-hole and pull box at bridge and earth sections.
- b. Digital transmission system shall adopt IP. Suitable media and transmission protocol at Layers 1 and 2 shall be decided type of digital station equipment shall be selected. In developing the design, various factors such as amount and type of data, transmission distance, quality of service (QoS), reliability, latency, and changeover time to backup route shall be considered. Type of optical fibre cable shall also be considered in the design. Packet based transmission system will be preferred than circuit-based transmission system such as Gigabit Ethernet.
- c. Loop topology based on resilient packet ring (RPR) shall be adopted for local line transmission system for redundant operation. A cut in the communication at a point in the loop shall not affect the normal operation of the communication system.
- d. Physically separate optical fibre cables shall be used to for a ring topology and for back up route in the future trunk line transmission system. Compressed image data and data from other devices must be separately allocated to the optical fibre core.
- e. Layer 2 switch will be used at each node to connect local network or device to the local line network. Layer 2 switch will also be used to connect devices to the local network. The switches used at the field nodes shall only be of industrial grade for operations under extreme weather and outdoor conditions.
- f. In addition to the equipment listed above, the system requires fibre distribution frame and main distribution frame for cable termination, surge arrester or similar surge protection device to protect the equipment from the lightening, and accessories necessary for cable installation. The Contractor/Contractor shall supply and install these devices and accessories.

6.5.3 Reliability

Digital transmission system shall have high reliability to ensure continuous operation of the system. Bit error rate for the end to end data communication must be 1×10^{-6} or better.

6.5.4 Capacity and Quality of service

- a. The digital transmission shall have a sufficient capacity in terms of speed and bandwidth to meet the demands to be decided based on the estimated amount of data including digitized voice data at each facility such as Traffic Management Centre, and service area. Video signal from the TMCS camera shall be transmitted in H.264/H.265 format and the digital transmission system shall provide sufficient capacity for it. The Contractor/Contractor shall estimate the type, amount and location of data transmission need and design the system, equipment and cables that satisfy the demand.
- b. Quality of service (QoS) capability shall be provided to the digital transmission system to ensure smooth and uninterrupted delivery of data for voice and video image transmission required for emergency telephone system and TMCS camera system.

6.5.5 System supervision

The digital transmission system shall be equipped with a supervisory function which continuously monitors the system operation and issues an alarm in case malfunction is found. The supervisory shall have the following functions:

- 1) Management of occurrence and recovery of malfunction
- 2) Registration and modification of system configuration
- 3) Registration and modification of network configuration
- 4) Testing of equipment and circuit
- 5) Logging of equipment operation and cable performance
- 6) Changeover between primary and backup routes

7. Closed Circuit Television (CCTV) and Access Control System (ACS) for TMC and Sub-Centre Building and Security

7.1 General

- a. This part of the RFP covers the equipment and services to be supplied under this Contract for CCTV equipment and Access Control System (ACS) to be installed at the Traffic Management Centre and Sub-Centres. The CCTV and ACS equipment shall be categorized as two types, CCTV and ACS for Building and CCTV for Security.
- b. All the cameras shall be IP based and shall be connected to the Video server. The cameras shall support ONVIF profile S&G and shall be FCC Class A, UL, CE, BIS certified. The NVMS installed on video server shall provide the facility to control the cameras at the Supervision workstation in the Control room Buildings. The video recording of each camera shall be stored at the Video server/storage for a period of minimum 60 days at 2MP (full HD), and 25 FPS and incident video clips shall be stored for the entire Contract period.
- c. All Cameras shall have inbuilt IR illuminator for night vision functionality. External IR illuminator shall be acceptable for PTZ and box type cameras, however inbuilt IR shall be preferred for these types of cameras also.
- d. The Video Server of each location shall be interfaced to TMC system and NHAI HQ Command Centre to be able to watch and control the cameras for the PTZ activities from

the TMC control room, NHAI HQ Command Centre, and On-line access facility. The priority shall be given to the local control room staff.

- e. The functionality of the CCTV cameras provided by the Contractor/ Contractor shall be described as follows:
 - i. Building Surveillance CCTV cameras – These cameras installed on a sufficient height mast shall be intended for general surveillance of the building area and field activity outside the building and walkways. These cameras shall also be linked for remote monitoring. As both the traffic control room staff and sub-control room staff can control the pan, tilt and zoom function, the priority shall be given to the local control room staff.
 - ii. Building Security CCTV cameras – These cameras shall be intended for monitoring of security areas such as the building compound, general parking area, Control Room, supervisor room, building lobby, walkway, server room, UPS room, and emergency vehicle parking area.
 - iii. These cameras shall have inbuilt voice recording and Class 10 SD memory card of minimum 128GB for local storage of videos and voice recordings.
 - iv. These cameras shall be of two types
 - 1) Motorised Bullet/Box colour cameras.
 - 2) Motorised Dome colour cameras
 - v. The box cameras installed outdoor shall be installed in the weatherproof enclosure.
- f. The design of the CCTV system shall consider the following: -
 - i. Provide effective supervision and control
 - ii. Easy to use
 - iii. Self-contained system
 - iv. Increase span of management
 - v. Reduce unnecessary travel
 - vi. View / evaluate situations quickly
 - vii. Motion detection
 - viii. Savings on time and manpower
 - ix. Easy access to video information and quick playback
 - x. Minimize the use of security guards
 - xi. Eliminate unnecessary responses to false alarms
 - xii. Provision for future scalability
- g. The camera and VAMS shall be capable of triggering alarms in case of Video motion detection, manual trigger, digital input, periodical trigger, system boot, recording notification, camera tampering detection and audio detection. The triggering alerts can be controlled by the control room operator.
- h. The system should support intelligent video motion detection to track objects, learn the scene and adapt to a changing outdoor environment. Environmental changes such as rain, hail, wind, swaying trees and gradual light changes should have minimum effect on the settings.
- i. The control software should provide for alarms and alarm log. Alarm settings need to be individually configurable for each alarm and each camera prerecord duration. The duration shall be selectable from a list of values ranging between 2 seconds or less to 5 minutes or more. There shall be provision to achieve, print and display the log using device filter, device group filter and/or a time window.
- j. The administrator should be able to create, add, edit & delete users. He should be able to

administer access rights to system resources and functionality as well as access permissions to a list of cameras a user can view and control.

- k. The system shall provide User activity log (audit trail) with user id, time stamp, health monitoring, etc.
- l. ATMS Control Centre will have workstations along with controllers for Camera operation.
- m. The Workstation Frontend Software should also be working on a browser-based system and mobile application for remote users to allow any authorized user to display the video of any desired camera on the monitor with full PTZ and associated controls.

7.2 CCTV Specifications

7.2.1 Dome Camera

- a) A surveillance camera of 2MP at 25 FPS shall be provided. The IP camera shall be POE powered dome type with inbuild IR of 30 meters with illumination at 0.1 lux for colour image and black& white at 0 lux with IR. The lens shall be of 2.8-12 mm motorised varifocal with true WDR, 3D DNR, BLC, AGC and dual streaming. The Camera shall have inbuild SD card slot and shall be provided with at least 128 GB class 10 SD card. The shutter speed of the camera shall be 1/3 second to 1/100000 seconds for capturing the motion detection even during low light condition and provide proper image. The housing shall be IP 67 rated with IK10 protection against vandalism. The camera shall support one alarm I/O port and audio I/O.
- b) The face detection function shall be activated as soon as the motion detection is triggered.
- c) The camera shall also detect any object addition, object removal, and line crossing.
- d) Whenever any event is triggered, the camera shall record the event on SD card.

7.2.2 Bullet Camera

- a) A surveillance camera of 2MP at 25 FPS shall be provided. The IP camera shall be POE powered bullet type with inbuild IR of 50 meters with illumination at 0.1 lux for colour image and black& white at 0 lux with IR. The lens shall be of 2.8-12 mm motorised varifocal with true WDR, 3D DNR, BLC, AGC and dual streaming. The Camera shall have inbuild SD card slot and shall be provided with at least 128 GB class 10 SD card. The shutter speed of the camera shall be 1/3 second to 1/100000 seconds for capturing the motion detection even during low light condition and provide proper image. The housing shall be IP 67 rated with IK10 protection against vandalism. The camera shall support one alarm I/O port and audio I/O.
- b) The face detection function shall be activated as soon as the motion detection is triggered.
- c) The camera shall also detect any object addition, object removal, and line crossing.
- d) Whenever any event is triggered, the camera shall record the event on SD card.

7.2.3 Access Control System

- a. Door / premises entry Access control system shall be provided in each TMC and sub-centre building and rooms including server room, UPS room, generator room, etc.
- b. The system shall provide an integral software tool designed to reduce or eliminate tailgating.
- c. Restricting or denying access to a card holder shall happen automatically if they have entered a zone without a valid card transaction.

- d. The access control system should be modular in nature, with the below mentioned modules-
 - i. Card Management and enrolment module
 - ii. Alarm Management Module
 - iii. Rolling Transaction Display Module
 - iv. Web Dash Board
 - v. Zone Management and Broadcast
 - vi. Time & Attendance Module
 - vii. Visitor Management System Module
 - viii. Reporting module
- e. The dashboard shall display data in multiple formats such as bar, line, and pie charts, and tabular formats and shall provide following information:
 - i. Card Swipes & Zones Swipes
 - ii. Cards Parked
 - iii. Zone Occupancy & Muster zone swipes
 - iv. Type of Cards Issued and their status
 - v. Licensing
 - vi. Diagnostics
 - vii. Users logged on
 - viii. Invalid Swipe Analysis
 - ix. Average Alarm Acknowledgement/Cancel Locked Out Accounts
 - x. Top current alarms
 - xi. System and capacity & software licensing information
 - xii. Alarm acknowledgment analysis
 - xiii. Locked out workstation user accounts
 - xiv. Users currently logged on
 - xv. System Time and Date
 - xvi. Last backup status and Backup history report
- f. Reporting Module shall provide the following information:
 - i. Access Level changes
 - ii. Alarm Reports
 - iii. Transaction Reports
 - iv. First & Last transaction report
 - v. Device Reports
 - vi. Device Access Report
 - vii. Device configuration reports
 - viii. Personnel Reports
 - ix. Card parking Reports
 - x. Absentee Report
- g. The ACS shall have following features:
 - i. Record cardholder personal and access information.
 - ii. Control card verification (i.e. the recording of cards on the system).
 - iii. Control data flow to the Ethernet Reader Controllers - card and configuration information.
 - iv. Provide automatic updates of Ethernet Reader Controllers and field device changes, so that the system is continually updated.
 - v. Pass alarm and status information in real-time to client PC workstation computers being used for system monitoring.

- vi. Pass alarms to an integrated Short Message Service (SMS) for a text messaging service to user defined recipients.
 - vii. Issue broadcast messages to the Ethernet Reader Controllers.
- h. The ACS shall be integrated with following sub-systems of the building
 - i. Video Analytics and Management System (VAMS)
 - ii. Fire Systems (FS)
 - iii. Intrusion Detection Systems (IDS)
 - iv. Perimeter Intrusion Detection Systems (PIDS)
 - v. Generic Lift or Elevator interface
 - vi. Building Management Systems (BMS)
 - vii. Time and Attendance (T&A) Module
 - viii. Visitor Management System
- i. The ACS system shall be CE certified and designed for UL294, with IP 20 rating. The readers shall be RS485 OSDP compliant, communicate through encrypted OSDP RS485 Wiegand, and encrypted host communications with TLS and AES encryption.
- j. The single door and true four door ACS shall have touch screen terminals for easy access with 12 keys (10 numeric keys, 2 context sensitive function keys), capacitive, light touch and 10/100 Mbps ethernet port.
- k. The system shall have sufficient offline data storage capacity of minimum 500,000 cardholders transactions and 75,000 offline events (transactions and alarms).
- l. Shall have inbuilt battery and charging system. It shall automatically switch over on detection of power supply.
- m. The system shall have tamper detection capabilities and shall raise alarm that shall be configurable as per site requirement.

Section - Traffic Monitor Camera System (TMCS)**1. General**

The Contractor/Contractor shall provide and construct Traffic Monitor Camera System (TMCS) as a closed-circuit television system that meets the requirements stated herein for the surveillance of the traffic and vehicle on the project. Digital type system shall be used and video signal output from the camera shall be digitized and compressed to reduce the bandwidth requirement for digital transmission system. The system and its component devices shall be of rugged construction for outdoor industrial use capable of continuous operation.

2. System Configuration and Main Function

The system shall consist of camera at site, and control equipment and VMS at the Traffic Management Centre / Sub-centres, and digital transmission system shall transmit video signal from the camera to the TMC/Sub-centres.

3. Equipment Location and Type

- a. TMCS camera shall be installed in the median or shoulder (as per the availability of space and OFC cable and chamber location) approximately at every 1 Km such that the monitoring of the entire route is ensured. In addition to this TMCS Camera shall be installed beneath all the vehicular underpasses/flyovers/interchange structures to monitor cross road traffic movement. The number of cameras shall be sufficient to monitor the key location, accident prone areas, junctions, major median openings, major structures, urban areas, major villages junctions etc. through entire journey of every vehicle on the road.
- b. The Contractor/Contractor shall propose the actual locations to satisfy the above requirement. The exact location will be determined based on the alignment, geometry, viewing area (based on site visit) and shall be approved by the ITS Engineer.
- c. The TMCS camera shall be supplied power from the solar panel attached to Camera Pole. The UPS and Lithium-ion battery bank shall be able to provide the power backup for minimum of 72 hours.

4. System Function**4.1 Camera**

Camera shall be for industrial use, capable of continuous operation under harsh environment on the highway. Camera shall be IP based full HD colour type with 1/1.9" image sensor (CMOS) or better. It shall have frame rate of up to 60 frames per second in all compression mode and shall have 3 simultaneous streams and live view for more than 5 users.

4.1.1 Lens

Motorized zoom lens with minimum 36x Optical zoom and minimum 16x digital zoom having optical defog feature and auto focus covering suitable range of focal length shall be provided and mounted on the camera. The lens size shall be approx. 5.7-205 mm suitable to achieve the required optical zoom.

4.1.2 Night vision capability

Cameras shall have inbuilt IR illuminator of 500 meters for night vision functionality. External IR illuminator shall be acceptable for PTZ cameras, however inbuilt IR shall be preferred. The minimum illumination shall be of 0.002 lux for colour and 0.0002 lux for black and white image with automatic gain control on in auto/ manual mode. The camera shall be capable of recording black and white video even in 0 lux with IR up to a distance of 500 meters.

4.1.3 Image enhancement capability

Camera shall have electronically image stabilisation, hue light compensation, back light compensation, and three-dimensional digital noise reduction features. The camera shall support true wide dynamic range of minimum 120 dB.

4.1.4 Camera Housing

The camera shall be housed in a suitable housing to protect them from solar radiation, UV, dust and rain. An inbuilt wiper shall be provided with the housing to permit cleaning of the camera gimble during a rainstorm/ dust etc. The field of view of the camera shall not be obstructed by the housing nor by the wiper, which shall automatically park out of view. Picture quality or optical performance shall not be degraded by the housing. The Housing shall have IP-66 or higher rating for Weather-proof, and NEMA 4X-rating or IK10 or higher rating for Vandal-proof. The housing shall have inbuilt heater and blower function.

4.1.5 Pan-tilt Head

Camera housing shall be mounted on a motorized pan-tilt head. The angles of the head and rotating and tilting speed shall be as follows:

Rotating angle: 360 degrees endless with pre-set pan and tilt speed of 200° per second faster.

4.1.6 Camera Control

- a. The following control functions shall be provided to the system to cover wider area and longer distance:
 - 1) Pan (right – left)
 - 2) Tilt (up – down)
 - 3) Zoom (wide – telescope)
 - 4) Focus (near – far)
 - 5) Wiper (on – off)
- b. The Contractor/Contractor shall state the angle range of pan and tilt movements and their speed.
- c. The TMCS Camera shall support H.264/H.265 video compression and shall support latest ONVIF S&G protocol. The camera shall have auto motion detection and shall be capable of auto tracking the moving object, wrong direction detection, stationary object detection, face detection, 300 plus pre-set, patrolling mode, audio I/O ports, alarm I/O, privacy masking features.
- d. The Camera shall have applicable CE, UL and FCC class A certifications.

4.2 Quality

- a. TMCS camera system shall be designed to operate 24 hours a day and 7 days a week without shutdown. Thus, high reliability and availability shall be achieved.

- b. Design target of MTBF shall be 3×10^4 hours or better except the mechanical part of pan- tilt head. Expected MTBF shall be calculated based on the announced reliability of parts and component, or operation record of similar products.
- c. Availability of the system and each camera shall be 99% or better.

4.3 Motion Detection surveillance camera, hooter alarm with beacon, and all-in-one solar streetlight

- a. A surveillance camera of 2MP at 25 FPS shall be provided at each equipment location along with hooter alarm and beacon. The IP camera shall be POE powered bullet type with inbuilt IR of 50 meters with illumination at 0.1 lux for colour image and black& white at 0 lux with IR. The lens shall be of 2.8-12 mm motorised varifocal with true WDR, 3D DNR, BLC, AGC and dual streaming. The Camera shall have inbuilt SD card slot and shall be provided with at least 128 GB class 10 SD card. The shutter speed of the camera shall be 1/3 second to 1/100000 seconds for capturing the motion detection even during low light condition and provide proper image. The housing shall be IP 67 rated with IK10 protection against vandalism. The camera shall support one alarm I/O port for activation of Hooter and beacon.
- b. The function of this camera is to monitor the cabinet and pole surrounding for pilferage and vandalism attempts. The motion detection feature shall raise the alert in the control centre as soon as any movement is detected nearby the cabinet and camera pole to alert the control centre operators regarding any possibility of pilferage and vandalism attempt.
- c. Hooter shall be controlled locally by the camera and shall sound when the motion detection period is greater than 5 seconds. The alert in the TMC/Sub-centre shall be raised by VMS/ATMS software as soon as hooter is activated.
- d. The face detection function shall be activated as soon as the motion detection is triggered.
- e. The camera shall also detect any object addition, object removal, and line crossing.
- f. Whenever any event is triggered, the camera shall record the event on SD card also.
- g. The camera and hooter beacon alarm shall be installed at height of 8 meters to prevent vandalism.
- h. The camera shall be mounted on 1-meter cantilever arm attached to the pole.
- i. All-in-one solar streetlight of 15W 2000 Lumens with inbuilt motion detection sensor and auto on-off and auto dimming function shall be installed at each location at a suitable height.

4.4 Power supply system

- a. A solar power supply system consisting of a solar panel, a controller, a UPS and Lithium- ion battery bank shall be provided at each TMCS camera location that operates on solar power. Solar power equipment except solar panel shall be accommodated in the same cabinet as TMCS camera controller or in a separate cabinet. The solar panel shall have sufficient size to generate the power required. The Contractor/Contractor shall provide the support for solar panel and connection between the panel and the controller, which shall not be exposed. A mechanism shall be provided to adjust the angle of solar panel to the solar panel support and prevent pilferage. The solar panel shall be installed at the minimum height of 8 meters.
- b. The Lithium-ion battery shall be custom built so that it cannot be used for any other

application / purpose. It shall be designed such that the terminals/ cells get damaged upon unauthorised removal of battery from the enclosure / cabinet to prevent pilferage.

- c. The Lithium-ion battery shall provide power for Camera at least for 3 days even if solar power cannot be generated due to the weather condition. The Contractor/Contractor shall present the calculation of power consumption and capacity of solar power supply system to be used for the TMCS system. The Contractor/Contractor shall also consider the power requirement of network devices, wireless access points, PoE switch, SPD etc. suitably during the calculation.
- d. Proper earthing shall be provided at each equipment location.

5. Installation

TMCS camera shall be mounted on a tilt pole installed beside the Highway/expressway on the shoulder as specified. Height of camera shall be 12 meters. Pole shall be rigid enough so as not to vibrate under strong wind and passage of heavy vehicle. Optical fibre cable and power cable shall be extended from the nearest hand-hole at the shoulder where branch connection of cable is possible. The TMCS camera shall be connected to the nearest Wireless Access-point through repeater / access point / transceiver appropriately.

6. Acceptance test

- a. Camera, camera housing, pan-tilt head, TMCS camera station, Solar power system, and TMCS camera system central equipment shall be subjected to test at all stages of Acceptance tests i.e. Factory Acceptance Test, during installation work and upon completion depending on the test item. Three types of test i.e. function, performance test and general test shall be conducted.
- b. Details of the test item, test procedure and criteria to judge test result shall be proposed by the Contractor/Contractor subject to the approval by the ITS Engineer / NHAI.
- c. In principle, function and performance requirement stated above shall be tested. More specifically, the following tests shall be conducted as minimum:
 - 1) Resolution
 - 2) Colour
 - 3) Wiper control
 - 4) Maximum pan and tilt angle and speed
 - 5) Control desk and remote controlVideo switching function
 - 6) Video recording
 - 7) Solar Power system charging and backup performance

Section - Video Incident Detection System (VIDS)

1. General

Video Incident Detection System (VIDS) will be installed at the accident-prone and other essential areas identified by the enforcement agency and other vulnerable locations. The images taken by VIDS camera shall be transmitted to the Traffic Management Centre (TMC) / sub- centres through Optic Fibre cable in real time. In the TMC, images are selectively shown on the monitor display of VIDS workstation and VIDS monitor screen. If an incident occurs within the coverage area of camera, operator shall be able to control VIDS camera remotely and check the status visually. At the same time, images from all cameras shall be recorded on the storage device in specified period.

2. System Configuration

- a. The VIDS system shall consist of the following components:
 - 1) VIDS image sensor and LPU at roadside.
 - 2) Network equipment.
- b. No periodical manual adjustment shall be required in camera and local processing unit.
- c. The VIDS application shall be provided to the Traffic Management Centre and Sub-centres for receiving pre-processed data from VIDS LPU on the Project. The data collection interval shall not be more than 60 seconds.

3. Equipment Location

- a. VIDS shall be installed at the location to identified by the Contractor/Contractor and approved by the ITS Engineer. The VIDS shall be installed at a suitable location from the connecting / merging road to monitor the sectional traffic volume on the main carriageway and at every 5km interval along the main road. The exact location of VIDS shall be finalized in consultation with IE/NHAI.
- b. The Contractor/Contractor shall examine and select the VIDS location and obtain the approval from the ITS Engineer.
- c. The VIDS shall be installed on a dedicated pole to be provided by the Contractor/Contractor. The clearance of 8 meter shall be secured.
- d. The VIDS shall be supplied power from the solar panel attached to Camera Pole. The UPS and Lithium-ion battery bank shall be able to provide the power backup for minimum of 72 hours.

4. System Function

VIDS system shall be provided with the functions described below.

4.1 Monitoring function

- a. The road and traffic condition video and images taken by VIDS cameras on the project shall be transmitted as video signal to the Traffic Management Centre through the communication network. The ATMs Software shall be capable of selecting video signal from any VIDS camera to be displayed on the monitor and graphics display.
- b. Sequential display function shall be provided to the ATMS Software. The sequential display function shall allow the video image from the multiple cameras to be sequentially displayed at a pre-set interval. It shall be possible to select the cameras

for sequential display and to set the display time of the image from each camera.

- c. The VIDS console and graphics display shall have multiple screen capability and shall display either one image or four images at a time. The image on the Graphics Display shall be controlled by the ATMS Software.

4.2 Incident detection

- a. The VIDS system shall have an incident detection function and automatically detect incident occurred within its viewing area when the camera is set at home position. Incident refers to those occurrences of slow-moving vehicle, stopped vehicle, reverse traffic, fallen object, poor visibility, vehicle running in opposite direction, etc.
- b. If an incident is detected, ATMS Software shall issue an alarm and incident image shall be automatically displayed on the VIDS operator console monitor display and Graphics Display. The GIS Map shall show the location of the incident with a red dot and popup of the video.
- c. The Contractor/Contractor shall describe the incident detection mechanism in the Technical proposal that the Contractor/Contractor proposes together with its limitation.

4.3 Image recording and retrieval

All images shall be automatically recorded in the VRS at TMC/Sub-centre with camera ID and time stamp. Frame rate of the video signal can be configured to one frame to 60 frames per second to optimise the storage capacity as per the site requirements. Images shall be stored for minimum 60 days.

4.4 Diagnosis

- a. The VIDS system shall have a diagnosis function. The ATMS Software shall check the connection with the VIDS camera and the status of VIDS camera by sending the diagnosis signal every five (5) minutes. If VIDS camera fault signal is received or there is no response from the VIDS camera, the ATMS Software shall issue an alarm on the Graphics display and operator console. The fault shall also be recorded in the log.
- b. The Contractor/Contractor shall state in his Technical Proposal, the types of error and malfunction of the VIDS System that can be diagnosed from the ATMS Software.

5. Camera

5.1 General

- a. The IP camera shall be POE powered bullet type with inbuilt IR of 120 meters.
- b. The Camera shall have inbuilt SD card slot and shall be provided with at least 128 GB class 10 SD card.
- c. The shutter speed of the camera shall be 1/3 second to 1/100000 seconds for capturing the motion detection even during low light condition and provide proper image.
- d. The face detection function shall be activated as soon as the motion detection is triggered.
- e. The camera shall detect any object addition, object removal, and line crossing.
- f. Whenever any event is triggered, the camera shall record the event on SD card also.

5.1.1 Lens

2 MP Full HD motorized varifocal lens with minimum 6-90 mm motorized auto-focus function having optical defog feature and auto focus covering suitable range of focal length shall be provided and mounted on the camera. The range of the camera shall be minimum 150 meters. The resolution shall be full HD at 60 FPS.

5.1.2 Night vision capability

Cameras shall have inbuilt IR illuminator of 120 meters for night vision functionality. External IR illuminator shall be acceptable in case of box cameras, however inbuilt IR shall be preferred. The minimum illumination shall be of 0.005 lux for colour image with automatic gain control on in auto/ manual mode. The camera shall be capable of recording black and white video even in 0 lux with IR up to a distance of 120 meters.

5.1.3 Image enhancement capability

Camera shall have hue light compensation, back light compensation, and three-dimensional digital noise reduction features. The camera shall support true wide dynamic range of minimum 120 dB.

5.1.4 Camera Housing

The camera shall be housed in a suitable housing to protect them from solar radiation, UV, dust and rain. The field of view of the camera shall not be obstructed by the housing. Picture quality or optical performance shall not be degraded by the housing. The Housing shall have IP-66 or higher rating for Weather-proof, and NEMA 4X-rating or IK10 or higher rating for Vandal-proof.

5.2 VIDS LPU

VIDS LPU (Local Processing Unit) shall be housed in a cabinet together with power supply and network equipment. The cabinet shall be electrically and mechanically isolated and shall have a degree of protection of IP 55 or higher specified in IEC 60529. If necessary, the cabinet may be provided with a ventilation fan for controlling internal temperature, but the protection code requirements shall be met. A right hinged door shall be provided on the front to realize easy maintenance work. The turning direction of the handle shall be counter clockwise. The power supply unit shall be provided with a circuit breaker. The anti-lightning and surge protection complying with the IEC 61643-1 shall be provided. The cabinet shall be finished with the anticorrosive treatment. The Contractor/Contractor shall state the details of the anticorrosive treatment and painting. The Cabinet shall have door open alert feature and alarm.

5.3 Local warning flashing lights and Alarm

The local VIDS controller shall be enabled to provide appropriate local warnings (in the interest of road safety) to vehicles on the main carriageway on detection of incidents like reverse traffic (along with warning to the Traffic Management Control Centre).

- a. Pole mounted flashing lights of minimum 300mm diameter with a visibility of at least 500m shall be used for local warning.
- b. There shall be at least five such warning lights each mounted typically at a distance of 100 meters and 200 meters before the incidence monitoring point when seen from the direction of travel. The above distances shall be suitably

- optimized during detailed engineering. Two warning lights shall be installed in the median and three on the shoulder side.
- c. The lights shall be powered by a local solar PV based power supply within built Li-ion battery and shall be interconnected with the incident detection system either by cable or by wireless (GSM based).
 - d. During periods of poor visibility, as detected by the VIDS or TMC / Sub-centre operator, the lights shall go into a flashing mode until visibility improves to a level for adequate incident detection. The TMC / Sub-centre operator shall have the option to turn on/off the lights remotely.
 - e. The above lights shall stop flashing either on the event of the disappearance of the detected incident(s) or on the occurrence of a reset from the TMC / Sub-centre operator.
 - f. In case of failure of the VIDS LPU the above lights shall, by default, switch to the flashing mode.

5.4 Solar powered Amber Flasher Light

Apart from the local warning flashing light mentioned above, a set of two standalone Solar powered Amber Flasher Lights (FL) / Solar Blinkers of 300 mm Dia with at least 96 hours power backup shall be provided at each location mentioned in the equipment location list. The FL shall be installed such that it is visible to the merging traffic as well as the traffic plying on the main carriageway. The set of FL shall be installed at each median opening (also at the location even if the median opening has been closed, as these are the points where two-wheelers, pedestrians etc. frequently use for road crossing and may be potential accident prone areas even after the closure of the median opening), junctions, merging / diverging points near the flyovers, major bridges, railway over bridges, villages, accident prone areas, location identified as frequent animal crossing etc.

The Solar panel and Lithium-ion battery (in lockable and theft proof housing/ enclosure) shall be installed on the top of the FL pole, at a suitable height to prevent theft.

5.5 Motion Detection surveillance camera, hooter alarm with beacon, and all-in-one solar streetlight

- a. A surveillance camera of 2MP at 25 FPS shall be provided at each equipment location along with hooter alarm and beacon. The IP camera shall be POE powered bullet type with inbuilt IR of 50 meters with illumination at 0.1 lux for colour image and black& white at 0 lux with IR. The lens shall be of 2.8-12 mm motorised varifocal with true WDR, 3D DNR, BLC, AGC and dual streaming. The Camera shall have inbuilt SD card slot and shall be provided with at least 128 GB class 10 SD card. The shutter speed of the camera shall be 1/3 second to 1/100000 seconds for capturing the motion detection even during low light condition and provide proper image. The housing shall be IP 67 rated with IK10 protection against vandalism. The camera shall support one alarm I/O port for activation of Hooter and beacon.
- b. The function of this camera is to monitor the cabinet and pole surrounding for pilferage and vandalism attempts. The motion detection feature shall raise the alert in the control centre as soon as any movement is detected nearby the cabinet and camera pole to alert the control centre operators regarding any possibility of pilferage and vandalism attempt.

- c. Hooter shall be controlled locally by the camera and shall sound when the motion detection period is greater than 5 seconds. The alert in the TMC/Sub-centre shall be raised by VMS/ATMS software as soon as hooter is activated.
- d. The face detection function shall be activated as soon as the motion detection is triggered.
- e. The camera shall also detect any object addition, object removal, and line crossing.
- f. Whenever any event is triggered, the camera shall record the event on SD card also.
- g. The camera and hooter beacon alarm shall be installed at height of 8 meters to prevent vandalism.
- h. The camera shall be mounted on 1-meter cantilever arm attached to the pole.
- i. All-in-one solar streetlight of 15W 2000 Lumens with inbuilt motion detection sensor and auto on-off and auto dimming function shall be installed at each location at a suitable height.

6. Quality

- a. The system shall operate on a 24x7 basis. The VIDS shall be capable of taking clear images of road and traffic conditions under any brightness conditions during the daytime and night- time.
- b. It shall be the responsibility of the Contractor/Contractor to furnish and install all necessary hardware, software, and database, integrate all system components and deliver a complete operational VID.

7. Power Supply

- a. A solar power supply system consisting of a solar panel, a controller, a UPS and Lithium- ion battery bank shall be provided at each location that operates on solar power. Solar power equipment except solar panel shall be accommodated in the same stainless-steel cabinet as controller or in a separate stainless-steel cabinet. The solar panel shall have sufficient size to generate the power required. The Contractor/Contractor shall provide the support for solar panel and connection between the panel and the controller, which shall not be exposed. A mechanism shall be provided to adjust the angle of solar panel to the solar panel support and prevent pilferage. The solar panel shall be installed at the minimum height of 8 meters.
- b. The Lithium-ion battery shall provide power for Camera at least for 3 days even if solar power cannot be generated due to the weather condition. The Contractor/Contractor shall present the calculation of power consumption and capacity of solar power supply system to be used for the system. The Contractor/Contractor shall also consider the power requirement of network devices, wireless access points, PoE switch, SPD etc. suitably during the calculation.
 - a. Proper earthing shall be provided at each equipment location.
 - b. Power consumption of all types of VIDS shall be 100VA or less regardless of the type of power supply.

8. Installation

- a. VIDS Camera device shall be installed on the top of individual supporting tilt pole. The supporting structure with enough length must be provided to keep good visibility.
- b. VIDS camera station (local control electronics) shall be installed in VIDS cabinet at the bottom of supporting pole for VIDS camera. VIDS cabinet is a shelter made of

stainless steel or aluminium.

Section - Variable Message Sign (VMS)

1. General

- a. Variable Message Sign (VMS) is intended to provide the road and traffic condition information to the commuters. It will help users travel on the project smoothly without much stress. In case of incident like congestion drivers can judge whether to take detour or not, or make other decision based on the information provided through VMS. VMS system shall be provided at all entry/exit locations, exact locations shall be finalized in consultation with IE/NHAI.
- b. The Contractor/Contractor shall supply and construct a VMS system that can achieve the purpose of the system mentioned above. The Contractor/Contractor shall be responsible for the detailed design, procurement, software development, installation, adjustment, and commissioning of the VMS. Portable VMS is mounted on the trolley towable by the patrol vehicle to display the maintenance/ incident related information on it.
- c. The VMS shall be capable of playing videos, messages in all font size, graphics, etc, and shall be configurable to divide the single screen into multiple sections to display multiple contents at the same time in each section.

2. System Configurations

The VMS system will consist of the following equipment.

- 1) Full matrix outdoor LED panel and control unit in VMS with supporting structure (gantry type) at roadside.
- 2) VMS centre controller with application software installed in Traffic Management Centre.
- 3) Power supply equipment and peripheral.

2.1 Outdoor LED Panel

- a. High intensity LED (light emitting diode) shall be used as light source for VMS. At least three colour elements, blue, red and green, shall be provided and a total of seven (7) colours including white, yellow, green, red and blue shall be displayed. Brightness and colour shall be uniform throughout the surface.
- b. The panel shall have 6 mm $\pm 10\%$ pixel pitch, suitable for outdoor operations. The Pixel density shall not be less than 22,000 pixels per square meter.
- c. The VMS shall have automatic brightness sensors and shall have minimum brightness of 5500 cd/sqm and refresh rate shall be more than 1920 Hz.
- d. The thickness of the panel shall not be more than 150mm and shall be light weight.
- e. Life of LED unit shall be long enough to withstand the severe environmental conditions in which the signboard operates. The Contractor/Contractor shall submit the results of high temperature high moisture biased test of LED to be used to the satisfaction of the ITS Engineer.
- f. Display panel of VMS shall be of unit/ modular construction using LED matrix. The size of the LED matrix unit shall be as per the manufacturer's design. The unit shall be easily replaceable from backside or front without affecting other units. Display unit shall be capable of detecting open circuit condition of each LED.
- g. Malfunction of an LED, a pixel, and a display unit shall not affect the normal operation of other LEDs, pixels and display units.

- h. VMS designs, components, and enclosures primarily designed for commercial, advertising, billboard or other display purposes shall not be accepted.
- i. VMS should be CE certified as per EN 12966 by EU approved notified body only.
- j. VMS should be BIS certified.
- k. Message / video shall be sufficiently bright and directed to indicate to a motorist approaching the VMS, at a distance of 300m on a bright cloud free day.
- l. The enclosure shall be made from a corrosion resistant material. The enclosure shall have an IP65 rating for front and IP 54 rating for back.
- m. The LED chip used for the display shall be from internationally acceptable OEM only. Post supply the LED chip shall be verified by the ITS Engineer with the manufacturer at the cost of the Contractor/Contractor, in order to confirm the genuineness of the LED chip used in the VMS LED Panel.
- n. The Contractor/Contractor shall submit the EN 12966 and BIS certifications of the VMS in the Technical Proposal.

2.2 Type of LED Signboard

Three (3) types of variable message signboard, Types L, M, and Portable shall be provided depending on the location where VMS is installed and VMS display size. Different support structures shall be suitably adopted. However, they shall be identical in terms of VMS function

Type	Support Type	Message Input	Installed Location
Type L	Gantry type	Remotely	Locate on the main carriageway (only 6/8 lane highway and expressway projects)
Type M			- Locate on the main carriageway (2/4 lane highway projects) - Service/ approach roads / ramps/ connecting roads etc. (6/8 lane highways and expressway projects)
Portable	Mounted on Trolley	On the vehicle, manually as well as remotely	Portable mounted on the trolley and moved by the patrol vehicle.

2.3 VMS Controller

VMS controller will have the following functions:

- 1) Communication control
- 2) Display control
- 3) Monitoring
- 4) Local operation

The VMS control unit will communicate with the VMS centre controller in the TMC through the fibre optic network using TCPIP or GPRS or other equivalent international protocols. It will receive display data from the VMS centre controller and send back the operating status data to the centre controller.

Display data received from the VMS centre controller will be stored in the buffer until all the data have been correctly received without error. Upon confirmation of correctness of data, display will be changed to the new message. Changeover shall be fast, and no

irregular display shall be shown during the transition. Under any circumstances, the changeover of message shall be completed within 3 -5 seconds after the system operator in the TMC has issued a message changeover command.

Several test patterns will be provided to the VMS control unit, with which defect of LED can be tested by indicating one of them sequentially.

Operating condition of the VMS will be monitored regularly by VMS itself and the control unit. If any abnormality is detected, error signal will be issued to the VMS centre controller together with the type of error.

It will be possible to operate the control unit and the VMS board manually at the site. The manual control panel will be provided to the VMS control unit. Alternatively, manual control will be made with a notebook computer connected to the VMS control unit through serial port or network port.

2.4 VMS Application

VMS central application will have following minimum functions.

- 1) To compose message by three method, manual input, combination of pre-set words, and selection of pre-set message.
- 2) To have interface with operator through data input device.
- 3) To convert text and symbol message to be displayed on VMS into dot image data to control LED display matrix.
- 4) Shall display time at the top right corner of the display in HH:MM:SS (24 hour) format at all the times, even if no message is being displayed on the VMS.
- 5) To communicate with VMS controller unit at roadside for message data and operating status data transmission.
- 6) To display and store operating status and issue alarm in case of abnormal condition; and
- 7) To record operation log.

The VMS centre controller and operation console shall be standard models manufactured by organizations of international repute.

3. Motion Detection surveillance camera, hooter alarm with beacon, and all-in-one solar streetlight

- a. A surveillance camera of 2MP at 25 FPS shall be provided at each equipment location along with hooter alarm and beacon. The IP camera shall be POE powered bullet type with inbuild IR of 50 meters with illumination at 0.1 lux for colour image and black& white at 0 lux with IR. The lens shall be of 2.8-12 mm motorised varifocal with true WDR, 3D DNR, BLC, AGC and dual streaming. The Camera shall have inbuild SD card slot and shall be provided with at least 128 GB class 10 SD card. The shutter speed of the camera shall be 1/3 second to 1/100000 seconds for capturing the motion detection even during low light condition and provide proper image. The housing shall be IP 67 rated with IK10 protection against vandalism. The camera shall support one alarm I/O port for activation of Hooter and beacon.
- b. The function of this camera is to monitor the cabinet and pole surrounding for pilferage and vandalism attempts. The motion detection feature shall raise the alert in the control centre as soon as any movement is detected nearby the cabinet and the Gantry to alert the control centre operators regarding any possibility of pilferage

- and vandalism attempt.
- c. Hooter shall be controlled locally by the camera and shall sound when the motion detection period is greater than 5 seconds. The alert in the TMC/Sub-centre shall be raised by VMS/ATMS software as soon as hooter is activated.
 - d. The face detection function shall be activated as soon as the motion detection is triggered.
 - e. The camera shall also detect any object addition, object removal, and line crossing.
 - f. Whenever any event is triggered, the camera shall record the event on SD card also.
 - g. The camera and hooter beacon alarm shall be installed at the gantry to prevent vandalism.
 - h. The camera shall be mounted on at a suitable location on the Gantry such that it focuses on the enclosure / cabinet housing the LPU and Li-ion battery bank.
 - i. All-in-one solar streetlight of 15W 2000 Lumens with inbuilt motion detection sensor and auto on-off and auto dimming function shall be installed at each location at a suitable height.

4. Equipment Location

- a. The location of M and S type of VMS shall be proposed by the Contractor/Contractor and approved by the ITS Engineer.
- b. Portable VMS is installed on the trolley and moved by the patrol vehicle at the incident location.

5. System Function

5.1 General

5.1.1 Power Supply

- a. The power supply shall be connected from communication rack using the POE or Adaptor.
- b. A solar power supply system consisting of a solar panel, a controller, a UPS and Lithium- ion battery bank shall be provided at each location that operates on solar power. Solar power equipment except solar panel shall be accommodated in the same stainless-steel cabinet as controller or in a separate stainless-steel cabinet. The solar panel shall have sufficient size to generate the power required. The Contractor/Contractor shall provide the support for solar panel and connection between the panel and the controller, which shall not be exposed. A mechanism shall be provided to adjust the angle of solar panel to the solar panel support and prevent pilferage.
- c. The Lithium-ion battery shall provide power for at least for 3 days even if solar power cannot be generated due to the weather condition. The Contractor/Contractor shall present the calculation of power consumption and capacity of solar power supply system to be used for the system. The Contractor/Contractor shall also consider the power requirement of network devices, wireless access points, PoE switch, SPD etc. suitably during the calculation.
- d. Proper earthing shall be provided at each equipment location.

5.1.2 Communication

The data transmission of the VMS system will be made through the fibre optic and GSM.

5.2 Message Indication Function

- a. Message to be displayed on the VMS shall be concise and clear as drivers driving a vehicle have to read and understand the message in a short time. Messages shall have uniform structure and simple words shall be used. Messages on the VMS shall be expressed in English, Hindi and Regional. Messages in different language will be separately managed and automatic translation is not required.
- b. In principle, a message to be displayed on the variable message signboard shall be composed of three parts, “location”, “event”, and “instruction or regulation”.
- c. Location
- d. Location indicates the relationship between the VMS location and the event location. They can be expressed as section (between Interchange A to Interchange B), distance (ahead, xx km ahead), or specific location (near Interchange A).
- e. Event
- f. Event is a thing that has happened or taken place. It includes traffic conditions (accident, congestion, car on fire), traffic regulation (lane closure, road maintenance work), road condition (wet road surface, fallen object, damaged pavement), and weather condition (fog, rain, strong wind).
- g. Instruction / Regulation
- h. The instruction is the action to be taken by the project users such as “slow down”, “cautious”, “exit here”, “exit at next interchange”, and “use right/left lane”. The regulation is the traffic regulation being enforced like “lane closure” or “Highway closed”.
- i. The three components are not necessarily required all the time. Messages consisting of one or two components described above or simple message will also be displayed.

5.2.1 Message Creation and Editing Function

Three message composition methods shall be provided: (1) manual input, (2) combination of pre-defined phrase, and (3) selection of ready-made message. The functions specified herein shall be possible in three languages. In addition, a set of graphic symbols shall be provided to complement the text message.

5.2.2 Manual composition

In the manual input, it shall be possible to display on the VMS any text message input by the system operator through the keyboard of the VMS operator console. There shall be no restriction as to the contents of the message, but the length of message is limited to the display capacity of the variable message signboard. If manual composition mode is selected, the VMS Server shall show the image of the signboard and the message as it is input by the system operator.

5.2.3 Combination of pre-defined phrase

In the case of combination of pre-defined phrase, frequently used words or phrases such as “accident”, “congestion”, “construction work”, “slow down” and so on are used to compose a message. It shall be possible to insert a word into the message composed by combination method. There shall be sets of pre-defined words. They shall contain

words indicating location, event and instruction or regulation. Each set shall have a capacity of 100 words in each language. In this mode, the VMS operator console shall show the categories and the words or phrases in each category for the system operator to select. It shall be possible to alter the pre-defined words by the system operator.

5.2.4 Ready-made message

Ready-made message selection method shall allow the system operator to choose one of the ready-made messages. If the ready-made message mode is selected, the VMS Server shall indicate the list of ready-made messages grouped into categories for the system operator to select. Message set shall have the capacity of 100 messages in each language.

5.2.5 Video and Graphic symbols

Video and Graphic symbols that show typical incidents such as highway closure, construction work, and rain graphically shall be provided to complement the text message. The sample graphic symbols are provided in these RFP for reference. The design of graphic symbols shall be subject to the NHAI's approval.

5.2.6 Dot matrix pattern

The VMS system shall be provided with a function to create a display pattern by specifying the on/off status and colour of each pixel comprising the display area of the signboard. It shall be possible to mix the dot matrix pattern and character message on the signboard.

5.2.7 Automatic message creation from incident information

If an incident is detected through other system, the system shall send an alarm to the VMS system. VMS system shall then create a warning message indicating the location, type of incident and action to be taken. The message thus created shall not be displayed automatically on the signboard. Instead, a recommendation shall be displayed on the VMS operator console indicating the contents of the message and the location of VMS for which message is recommended. Upon confirmation of the recommendation, the message will be displayed on the specified message.

The VMS centre controller console will be provided with updating and editing functions of pre-defined word, phrase, message and symbol mark. Editing of symbol mark will be possible on a pixel basis.

The console will communicate with the operator through monitor and keyboard for message composition and operation monitoring. Message composition will be made interactively with one of the methods described above. Graphic user interface will be adopted in the interface as much as possible for user friendly operation and fail-safe mechanism will be incorporated to prevent VMS system from showing inadequate message. The system will be equipped with a text input method in Hindi and Regional languages commonly used in the Project area through the standard keyboard.

The VMS system will be provided with an automatic message selection function based on the priority or severity of the events and coefficient that represents the importance of event to each VMS as described in the following tables. The function will select and

recommend the message to be shown separately for each VMS when there are two or more incidents to be informed to the road users.

Each message being displayed on the VMS will be assigned with a time-to-live (TTL) value, during which message is displayed, to prevent inadvertently displaying false message after incident has been removed. Upon expiration of TTL, message will be automatically extinguished, if no response is made to the warning within the pre-set time limit. A warning will be issued to the operator console before TTL expires for operator to choose extension of TTL or termination of the display as scheduled.

The VMS system will have an alternate display function, in which a maximum of two sets of messages can be displayed alternately. The function is intended to display a message in three different languages (Hindi, English and Regional) but not necessarily limited to the same message.

5.3 Data Transmitting Function

Text and symbol mark messages to be displayed will be converted to pixel image data to control display unit before transmitting to the variable message sign.

The VMS centre controller will communicate with the VMS control unit at roadside through the fibre optic network. It will send out message converted to dot pattern for display. It will also send out command data to control the VMS control unit and to confirm normal operation of the VMS board. In return, the centre controller shall receive status data from the control unit.

5.4 Operation Monitoring and Logging Function

Operating status of the VMS will be checked periodically. Status (message on, no message, fault, local control, test and switch off) will be collected from the VMS control unit at roadside. If any abnormality is reported, an alarm will be issued. The collected operation monitoring data will be recorded as part of operation log. It will be possible for the VMS centre controller console to send a command to the control unit and collect the dot pattern data being displayed on the VMS board upon system operator's initiative.

Message displayed together with the starting and ending time will be recorded as operation log. Status or malfunction of the VMS and the control unit will also be recorded. Data retrieval software will be provided, and operation log can be retrieved for display on monitor and as printed report.

5.5 Data Storage Function

All data transmitted from the VMS roadside equipment and processed data in the TMC will be recorded and stored in the VMS centre controller for analysis and future usage. Data retrieval and presentation software will be provided that can easily retrieve and show the recommended message automatically generated against event and message indicating on each VMS of the specified roadside equipment location at the hour or day.

Status of roadside equipment (normal or malfunctioned) will be recorded in the VMS centre controller as operation log and for future reliability analysis together with error code and date & timestamp.

Data Sub-system	Storage Data	Type	Storage Period
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VMS system	Recommended message automatically generated against event	Raw data	2 years
	Manual input operation record	Raw data	
	Equipment operational status	Raw data	
	Current message indicating on each VMS	Processed data	

5.6 Display and Reporting Function

The VMS center controller will be capable of showing the following screens.

Item	Contents
Route map	Schematic road map of project and access road Detailed VMS location map Name and station number of interchanges and toll barrier
Equipment location and status	Location of VMS and their condition (message / no message and normal / error)
Message	Message being displayed at selected VMS with starting time and scheduled end time Pre-defined words and phrases Pre-defined messages Graphic symbol marks
Operation	List of VMS currently not in operation Operation log and error record
Date and Time	Current date and time

The VMS centre controller will produce the reports listed below. The reports will be output according to the schedule or upon the system operator's request. It will be possible to output the report as a file in portable document file format.

Item	Contents
VMS operation	Daily report summarizing VMS location, message displayed, start time, end time
Error log	List of VMS currently not in operation Error record

6. Specifications

VMS must have LED pixel failure detection, door open sensor and temperature & humidity sensors.

6.1 VMS board (Type-L)

- I. The L-VMS board size shall be 10,000 mm (W) x 2,000 mm (H) ± 50 mm
- II. The LED configuration shall be 3 in 1 SMD and the pixel pitch shall be 6mm outdoor or better. Lower pixel pitch shall be considered better.
- III. The VMS board shall have the capacity to display any content, graphics, videos, symbols, text in full matrix, with multiple font size and character height, and multiple

languages.

- IV. The brightness of the board shall not be less the 5500 mcd with option to adjust the brightness manually as well as auto brightness adjustment feature.

6.2 VMS board (Type-M)

- I. The M-VMS board size shall be 5,000 mm (W) x 2,000 mm (H) ± 50 mm
- II. The LED configuration shall be 3 in 1 SMD and the pixel pitch shall be 6 mm outdoor or better. Lower pixel pitch shall be considered better.
- III. The VMS board shall have the capacity to display any content, graphics, videos, symbols, text in full matrix, with multiple font size and character height, and multiple languages.
- IV. The brightness of the board shall not be less the 5500 mcd with option to adjust the brightness manually as well as auto brightness adjustment feature.

6.3 Portable VMS

- I. The Portable-VMS board size shall be 1,650 mm (W) x 1000 mm (H) ± 100 mm
- II. The LED configuration shall be 3 in 1 SMD and the pixel pitch shall be 6mm outdoor or better. Lower pixel pitch shall be considered better. The pixel density shall be more than 2500 pixels per square meters.
- III. The VMS board shall have the capacity to display any content, graphics, videos, symbols, text in full matrix, with multiple font size and character height, and multiple languages.
- IV. The brightness of the board shall not be less the 5500 mcd with option to adjust the brightness manually as well as auto brightness adjustment feature.
- V. The DC power supply with suitable power backup shall be provided.

6.4 Movable Trolley (for Portable VMS)

Portable VMS shall be mounted on this trolley. It is used for security measurement to display maintenance information on the portable VMS while maintenance of the system equipment's.

This trolley shall be moved by the vehicle which will be used to patrol on the highway to locate damage, to implement countermeasures such as highway closure or lane closure, and to undertake emergency action such as removing obstacle on the Highway/Expressway. As such, the vehicle must have high driving performance, short stopping distance, high safety features, large loading capacity and environmentally friendly features. It shall be equipped with an on-board signboard specified elsewhere in these specifications on the rooftop. The body of the trolley shall have sufficient strength and durability as signboard or other objects will be loaded on the trolley.

9. 6.4.1 Warning light with Siren

A yellow / Red warning light and siren system shall be provided to the trolley and placed firmly on the roof. It shall be LED type and shall be ECE R65 Compliant.

6.5 VMS Controller

- a. VMS controller will have the following functions:
 - 1) Communication control
 - 2) Display control
 - 3) Monitoring

- 4) Local operation
- b. The VMS control unit will communicate with the VMS centre controller in the TMC through the fibre optic network using NTCIP / GPRS / TCPIP or other equivalent international protocols. It will receive display data from the VMS centre controller and send back the operating status data to the centre controller.
- c. Display data received from the VMS centre controller will be stored in the buffer until all the data have been correctly received without error. Upon confirmation of correctness of data, display will be changed to the new message. Changeover shall be fast, and no irregular display shall be shown during the transition. Under any circumstances, the changeover of message shall be completed within 3 seconds after the system operator in the TMC has issued a message changeover command.
- d. Several test patterns will be provided to the VMS control unit, with which defect of LED can be tested by indicating one of them sequentially.
- e. Operating condition of the VMS will be monitored regularly by VMS itself and the control unit. If any abnormality is detected, error signal will be issued to the VMS centre controller together with the type of error.
- f. It shall be possible to operate the control unit and the VMS board manually at the site. The manual control panel will be provided to the VMS control unit. Alternatively, manual control will be made with a notebook computer connected to the VMS control unit through serial port or network port.

7. Supporting Structure

- a. The VMS board will be fixed on gantry type supporting structure. A mechanism to adjust the tilting angle of VMS will be provided to the VMS housing or fixture used to attach the VMS to the support. It shall be possible to adjust the tilting between 0 degree (vertical) and 10 degree (tilted forward).
- b. There shall be proper and safe walkway provision at the rear side so that the maintenance engineer can easily walk and sit behind the board for maintenance and repair works. the width of the walkway shall be minimum 3 feet or at least 1 foot more than the width of the backdoor of the VMS board. The floor of the walkway shall be designed suitably so that no tool or equipment part may fall on the road.
- c. The walkway shall be rugged and shall bearing capacity of at least 4-5 persons.

8. TMC Equipment

8.1 VMS Application

VMS central application will have following minimum functions.

- 1) To compose message by three methods - manual input, combination of pre-set words, and selection of pre-set message.
- 2) To have interface with operator through data input device.
- 3) To convert text and symbol message to be displayed on VMS into dot image data to control LED display matrix.
- 4) To communicate with VMS controller unit at roadside for message data and operating status data transmission.
- 5) To display and store operating status and issue alarm in case of abnormal condition; and
- 6) To record operation log.

8.2 Installation

- a. VMS sign on the Highway/Expressway shall be mounted on a Gantry installed between the median and shoulder. Clearance of minimum 6 meters above the ground level shall be secured. Gallery shall be provided to the support / walkway at the back of signboard for maintenance purpose.
- b. Face of VMS shall be slightly rotated inner side so that the line perpendicular to VMS front panel shall extend toward a point on the carriageway about 120 meters from the VMS location. The face shall also be tilt down slightly for better recognition of message.
- c. Foundation and other civil works required for the VMS installation shall be completely in the scope of the Contractor/Contractor.
- d. Communication cable shall be extended from the nearest hand-hole at to the VMS through the conduit to be installed by the Contractor/Contractor. No aerial cable shall be allowed.

9. Design Principle of VMS Foundation

9.1 Design Strength

The VMS foundation shall be of reinforced concrete with the concrete having the compressive strength of $2,500 \text{ N/cm}^2$ (250kg/cm^2) after 28 days (cylinder type), or when made with a high rapid strength Portland Cement, it shall acquire the same strength after 7 days.

9.1.1 Contractor/Contractor's Detailed Survey and Design

Before commencing the actual work, Contractor/Contractor shall carry out the field detailed survey/design of the VMS facilities. The detailed drawings including the calculation data based on the survey/design shall be prepared and shall be submitted to NHAI for approval.

9.2 Construction of VMS Foundation

9.2.1 VMS Location

The VMS foundation shall be constructed at locations specification in the general layout of ATMS location or construction drawings to be approved by NHAI and/ or other location as dictated by The ITS Engineer.

9.2.2 VMS Foundation

- a. Contractor/Contractor shall comply with the following specifications for preparing and mixing concrete.
- b. All VMS foundations shall be constructed with a ready-mixed or site-mixed, M20 Grade

Or if made manually then the concrete, when made with a normal Portland Cement, shall attain a minimum compressive strength of $2,500\text{N/cm}^2$ (250kg/cm^2) in 28 days (cylinder type) , or when made with a high rapid strength Portland Cement, it shall acquire the same strength in 7 days (Test to be performed on cylindrical type concrete specimen of size 150mm x 300mm).

- c. The slump range for the concrete used in the construction of foundation shall be between 8 and 15cm.

- d. NHAI may order three (3) test pieces (cylinder type) from any batch of the concrete to be taken and properly marked for the laboratory test as required.
- e. The concrete shall be slowly poured around the moulds or forms up to adequate level evenly and tamped into all parts of the moulds or forms by using a vibrator until a densely solid mass without cavities is obtained.
- f. The concrete, once mixed, shall be used within 60 minutes. After one hour, any remaining concrete shall be removed and shall not be used.
- g. Cement mortar shall consist of one (1) measure of Portland Cement and two (2) measures of sand.
- h. The concrete shall be covered with saturated sackcloth or similar materials and shall be sprinkled water to keep the sufficient moisture, adequate times a day for 7 days.

9.2.3 Excavation for VMS Foundation

- a. The Contractor/Contractor shall take all countermeasures necessary for safety of the public and for protecting and preserving any and all temporary or permanent utilities.
- b. Contractor/Contractor shall obtain all permissions, right-of-way and/or permits necessary for the execution. The permissions shall include property owners' approvals for necessary work on their properties.
- c. Contractor/Contractor shall obtain all permissions, right-of-way and/or permits necessary for the execution. The permissions shall include property owners' approvals for necessary work on their properties.
- d. Contractor/Contractor shall be directly responsible for all damages to existing utilities and shall restore these services immediately at his own expense.

9.2.4 Backfilling

- a. Backfilling shall commence after notifying The Engineer.
- b. Upon completion of the backfilling, all remaining soil shall be removed and the road surface, pavement and the area concerned shall be immediately cleaned.
- c. Before backfilling, all foreign objects shall be removed from the excavation.

9.3 Material for VMS Foundation

9.3.1 Cement

- a. All cement used in underground construction shall be Portland Cement and in accordance with BS 12 or equivalent.
- b. The cement shall be stockpiled in such a manner as to afford easy access for inspection. Cement shall be kept dry at all times prior to use in order to prevent deterioration. Open air storage of cement shall not be permitted.
- c. Deteriorated cement, such as cement containing lumps that are too difficult to powder by hand, shall not be used.

9.3.2 Water

- a. All water used for mixing and curing of concrete shall be supplied by the waterworks.
- b. Water from other sources may be used only if authorized by NHAI after tests have shown the quality to be better than that supplied by the waterworks.

- c. Water from any source which has been contaminated with dirt, oil, salt or other foreign substances shall not be used.

9.3.3 Fine Aggregate

- a. The fine aggregate for concrete shall consist of natural river sand or equivalent material.
- b. The fine aggregate shall be uniformly graded and shall meet the grading requirements as follows:

Sieve Designation	Percentage by Weight Passing square mesh sieve
(10.0mm)	100
No.4 (5.0mm)	95 to 100
No.16 (1.2mm)	45 to 80
No.50 (0.3mm)	10 to 30
No.100 (0.15mm)	2 to 10

- c. The fine aggregate shall be stored in such a manner as to prevent mixture with other aggregate prior to the use and also to prevent inclusion of foreign materials.

9.3.4 Coarse Aggregate

- a. The coarse aggregate for concrete shall consist of crushed stones having hard, strong and durable pieces free from adherent coatings such as mud or other foreign materials. The coarse aggregate shall be graded between a maximum size of 25mm and a minimum size corresponding to No.4 sieve size. It must be free from dirt, flourey stone dust, earth or any similar materials.
- b. The coarse aggregate shall be stored in such a manner as to prevent mixture with other aggregate prior to the use and also to prevent inclusion of foreign materials.

9.3.5 Reinforcing Bar

Reinforcing bars shall be deformed steel bars. The bars shall be free from dirt, oil, paint, grease, thick rust and other defects and shall conform to the following requirements:

Item	Unit	Specific Value
Tensile Stress at Minimum	N/mm ²	500 (49 kg/mm ²)
Yield Point at Minimum	N/mm ²	300 (30kg/mm ²)
Elongation at Minimum	%	14
Design Stress	N/cm ²	160 (1,600kg/mm ²)

10. Acceptance test

VMS, VMS local controller, VMS central controller, and operator console shall be subjected to the test. Tests shall be conducted at the factory (before Site Acceptance test), during installation work and upon completion depending on the test item. Two types of test, function and performance test and general test shall be conducted.

Details of the test item, test procedure and criteria to judge test result shall be proposed by the Contractor/Contractor subject to the approval by the NHAI.

10.1 Function and performance test

In principle, function and performance requirement stated above shall be tested. More specifically, the following tests shall be conducted as minimum:

- 1) Message composition
- 2) Data exchange
- 3) Central control
- 4) Local control
- 5) Colour and brightness
- 6) Response time
- 7) Display off function
- 8) Error detection

10.2 General test

The following tests shall be conducted as minimum:

- 1) Appearance
- 2) Power supply fluctuation
- 3) Instantaneous power interruption
- 4) Insulation resistance
- 5) Dielectric strength
- 6) Temperature variation
- 7) Waterproof test (field equipment)
- 8) Amount of zinc coating (field equipment and support)

Section - 7 Vehicle Speed Detection System (VSDS)

1. General

The Contractor/Contractor shall install the ANPR camera-based solution for over speed detection and enforcement, and radar sensor-based speed detection system for speed display on LED panel. The ANPR system should correctly link the vehicle number plate with the vehicle speed.

The ANPR camera shall be mounted permanently to monitor a single lane of a highway. Multiple ANPR cameras shall be placed on an overhead gantry to get the complete picture of traffic flow for each lane including hard & earthen shoulder in the location.

The ANPR system shall be capable of detection both spot over speeding as well as section based over speeding.

The ATMS Software shall be capable of generating e-challan automatically and integrated with the Vaahan database and NPCI FASTag mapper for obtaining the vehicle registration details for e-challaning and cross-verification of the vehicle class. The Contractor/Contractor shall be responsible for integration of AMTS software with the Vaahan Database and NPCI FASTag Mapper as part of this Contract.

In addition to ANPR based VSDS, 2D radar triggered Vehicle Actuated Speed Display (VASD) shall be installed in each lane. The purpose of the VASD is to display the speed of the vehicle to the driver and alert about his speed and prevent him/her from over-speeding, hence shall act as speed calming device.

2. System Configuration

The Radar Speed Sensor can be used in traffic monitoring situation to give input to the VADS for vehicle speed display in real-time. The ANPR camera shall be used to capture the vehicle speed and estimate of vehicle length to identify vehicle class, reverse vehicle detection, and wrong lane driving (on the bases of the vehicle classification, e.g. Bus/truck driving in the car/overtaking lane, car driving in over taking lane, etc.). both VSDS and VASD systems shall work independent to each other.

The 2D radar shall be capable for monitoring three lanes lane including hard & earthen shoulder simultaneously and send the command to each VASD display for displaying the real-time speed of the vehicle in each lane. Precise tracking and video overlaying in difficult situations like

- Multiple car tailgating Parallel motion,
- High occlusion target scenarios – e.g. small car or bike next to a large truck

The system shall be capable of capturing all type and classes of vehicles, including but not limited to 2-wheelers, three wheelers, tractor, etc.

The Contractor/Contractor shall be responsible for Integration of ATMS system and sub-systems with the NHAI Mobile App for the road users as per the requirement raised from time to time by the Electronics/ IT department of NHAI or its authorized agency.

3. Location

VSDS and VASD shall be installed at suitable locations as identified during the survey by the Contractor/Contractor and approved by the ITS Engineer in consultation with IE/NHAI. The VSDS

and VASD shall be installed in the section where the over speeding chances are higher, such that at least one set is installed at suitable location at every 10 Kms. Minimum of 3 sets in each direction on the project stretch for obtaining sufficient data for section-based speeding, ATCC, and TTMS functionalities.

Both the system shall be installed in both the directions (LHS & RHS) of the road at each location

4. Roadside Equipment

- a. ANPR Camera
- b. LPU
- c. Vehicle Actuated Speed Display integrated with Speed Radar
- d. Motion Detection surveillance camera, hooter alarm with beacon, and all-in-one solar streetlight

5. TMC Equipment

Speed Enforcement Application module (part of the ATMS software) and console.

6. System Function

6.1 Radar System

- a) The radar Sensor must have the high accuracy and detection range. The operational range should be 100 meters.
- b) The Sensor shall be Capable for the tracking up to 32 vehicles simultaneously.
- c) The accuracy of speed detection shall be more than 97% at a speed range of 0.5 to 200 km/hr.
- d) Inbuilt radar in VASD shall also be acceptable if the accuracy level and speed range of 0.5 to 200 km/hr can be achieved by the inbuilt radar and displayed on the VASD in real-time with read range of 100 meters.
- e) The radar shall be calibrated and tested by the third-party for speed detection. Test and calibration certificates shall be submitted by the Contractor/ Contractor along with the Technical Proposal and commissioning. The commissioning certificate shall only be issued after authentication of the test reports and calibration certificates.

6.2 ANPR Camera

- a) The ANPR camera shall be installed at site independent of the radar system.
- b) Success rate of number plate recognition and associating with transaction shall not be less than 90% during night-time. The vehicle image capturing, and processing zone shall be within 40 meters for higher accuracy.
- c) The night vision should not affect the accuracy.
- d) The camera shall capture the image of each over speeding vehicle for spot speeding and each vehicle for section speeding and send to the control room. In case the ANPR/OCR is unable to read/recognize the number plate, the system shall create an incident and send an alert to the operator. The operator shall be able to zoom the vehicle image to read the registration number plate and manually enter the vehicle number in the system for further processing. The Contractor/Contractor shall be responsible to propose the system capable of processing all over speeding vehicles, irrespective of the accuracy, read rate of the ANPR.
- e) The video recording of each ANPR camera shall be stored for a period of 60 days in N.264/N.265 format and the video clip of over speeding vehicles shall be stored

for the entire period of the Contract i.e. for minimum of 5 years. The length of the video clip shall be proposed by the Contractor/Contractor such that the same can be produced to the enforcement agency as and when required as an evidence of speed violation. It shall be solely the responsibility of the Contractor/Contractor to prove the evidence and provide required support to the Authority and enforcement agency for justifying the speed violation.

- f) The software and cameras shall be calibrated on monthly basis and the certified test report shall be submitted to the Authority and ITS Engineer. In addition to the monthly testing and calibration, the Authority or Enforcement agency may instruct the Contractor/Contractor so test the cameras and software at any time to ascertain the accuracy of the cameras, software and radars.
- g) The ANPR Cameras and VSDS Software shall be calibrated and tested by the third-party for speed detection. Test and calibration certificates shall be submitted by the Contractor/Contractor along with the Technical Proposal and commissioning. The commissioning certificate shall only be issued after authentication of the test reports and calibration certificates.

6.3 Specifications

- a. The system shall perform during day and night as well as in adverse weather conditions.
- b. It shall have built in diagnostic functions to quickly assess the validity of speed calibration.

6.3.1 General

- a. The IP camera shall be POE powered box type with inbuilt IR of 100 meters.
- b. The Camera shall have inbuilt SD card slot and shall be provided with at least 128 GB class 10 SD card.
- c. The shutter speed of the camera shall be 1 second to 1/100000 seconds for capturing the motion detection even during low light condition and provide proper image.
- d. The Camera shall have Ethernet port, RS-485, and RS-232 interface.

6.3.2 Lens

2 MP Full HD manual varifocal lens with minimum 5-50 mm C/CS mount DC drive. The range of the camera shall be up to 100 meters. The resolution shall be full HD at 60 FPS.

6.3.3 Night vision capability

Cameras shall have inbuilt IR illuminator of 100 meters for night vision functionality. External IR illuminator shall be acceptable, however inbuilt IR shall be preferred. The minimum illumination shall be of 0.005 lux for colour image with automatic gain control on in auto/ manual mode. The camera shall be capable of recording black and white video even in 0 lux with IR up to a distance of 100 meters.

6.3.4 Image enhancement capability

Camera shall have hue light compensation, back light compensation, hue light compensation, defog, and three-dimensional digital noise reduction features. The camera shall support true wide dynamic range of minimum 140 dB.

6.3.5 Camera Housing

The camera shall be housed in a suitable housing to protect them from solar radiation, UV, dust and rain. The field of view of the camera shall not be obstructed by the housing. Picture quality or optical performance shall not be degraded by the housing. The Housing shall have IP-67/IP-68 rating for Weather-proof with better dust & dirt protection, and NEMA 4X-rating or IK10 or higher rating for Vandal-proof. The housing shall have built-in heater and blower.

6.4 VSDS LPU

VIDS LPU (Local Processing unit) shall be housed in a cabinet together with power supply and network equipment. The cabinet shall be electrically and mechanically isolated and shall have a degree of protection of IP 55 or higher specified in IEC 60529. If necessary, the cabinet may be provided with a ventilation fan for controlling internal temperature, but the protection code requirements shall be met. A right hinged door shall be provided on the front to realize easy maintenance work. The turning direction of the handle shall be counter clockwise. The power supply unit shall be provided with a circuit breaker. The anti-lightning and surge protection complying with the IEC 61643-1 shall be provided. The cabinet shall be finished with the anticorrosive treatment. The Contractor/Contractor shall state the details of the anticorrosive treatment and painting. The Cabinet shall have door open alert feature and alarm.

6.5 Vehicle Actuated Speed Display (VASD)

6.5.1 Function

The speed display shall display the speed of the vehicle in real-time and provide textual or graphical warning to the vehicles exceeding the pre-set speed limit. The speed shall be displayed in green colour if the speed is within the permissible limit for the vehicle class, orange colour if the speed is matching the speed limit, and red if the vehicle is over-speeding. The display shall blink continuously if the speed of vehicle is more than 120% of the permissible speed limit, along with the message “Over-Speed – Slow down” in the first row of the display. One speed display shall be installed for each lane on both the sides of the road.

Time shall be displayed at the top section of the display in HH:MM:SS (24 hour) format at all the times, even if no speed is being displayed on the VASD. The font size shall be suitable and visible from 100 meters distance. The time on all the displayed shall be synced with the central server.

6.5.2 Specifications

- a. The system shall perform during day and night as well as in adverse weather conditions.
- b. It shall have built in diagnostic functions to quickly assess the validity of speed calibration.
- c. It shall adjust display intensity automatically to suit the ambient light conditions.
- d. It shall be modular in construction for ease of maintenance.
- e. It shall display numeric speed data as well as graphical (standard IRC road warning sign) (preferably) / textual warning.
- f. Measurement:
 - i. Speed range: 0.5 km/h to 200 km/h
 - ii. Maximum Measuring errors: Up to 100 km/h $\pm$ 3 km/h, Above 100 km/h $\pm$ 5 km/h
 - iii. Minimum Monitored section length: 100m
- g. It shall have the facility to log vehicle speed of over- speeding vehicles and

- transfer them to the ATMS control centre.
- h. The speed display shall be formed using individual modules.
 - i. Speed display must be constructed using corrosion resistant panel with LED pixels in row: column matrix.
 - j. Scanning/Multiplexing ratio shall be 1/8 or better.
 - k. The LED Cluster shall consist of individual LED's rated for out-door use.
 - l. Shall support an industry standard communication interface such as TCP/IP on copper, Wi-Fi, and/or fibre optic to help setting the pre-set speed and retrieve log data.
 - m. Shall maintain time stamped record (speed and vehicle image) of each case of over speeding in a log file that can be retrieved over the connected network or using a locally connected laptop.
 - n. It shall optionally be possible to configure the display to send real time violation event record (speed, and time stamp) over the connected network while recording the same
 - o. It shall be possible to control the brightness of displays automatically using built-in light sensors.
 - p. All PCB's shall be of FR4 material, 1.6mm thick and LED matrix PCB shall be 2.4mm thick. PCBs shall be of the quality suitable for use in environment conditions specified.
 - q. The equipment shall allow local diagnostics via laptop connected to its communication port.
 - r. Display size shall be suitable to display both the speed of the vehicle and warning message simultaneously in two rows.
 - s. Brightness intensity shall be 7500 cd per sq.m.
 - t. Fault diagnostics shall be provided to include the following as a minimum:

i. Radar Failure

ii. LED Failure

7. Motion Detection surveillance camera, hooter alarm with beacon, and all-in-one solar streetlight

- a. A surveillance camera of 2MP at 25 FPS shall be provided at each equipment location along with hooter alarm and beacon. The IP camera shall be POE powered bullet type with inbuilt IR of 50 meters with illumination at 0.1 lux for colour image and black& white at 0 lux with IR. The lens shall be of 2.8-12 mm motorised varifocal with true WDR, 3D DNR, BLC, AGC and dual streaming. The Camera shall have inbuilt SD card slot and shall be provided with at least 128 GB class 10 SD card. The shutter speed of the camera shall be 1/3 second to 1/100000 seconds for capturing the motion detection even during low light condition and provide proper image. The housing shall be IP 67 rated with IK10 protection against vandalism. The camera shall support one alarm I/O port for activation of Hooter and beacon.
- b. The function of this camera is to monitor the cabinet and pole surrounding for pilferage and vandalism attempts. The motion detection feature shall raise the alert in the control centre as soon as any movement is detected nearby the cabinet and the Gantry to alert the control centre operators regarding any possibility of pilferage and vandalism attempt.

- c. Hooter shall be controlled locally by the camera and shall sound when the motion detection period is greater than 5 seconds. The alert in the TMC/Sub-centre shall be raised by VMS/ATMS software as soon as hooter is activated.
- d. The face detection function shall be activated as soon as the motion detection is triggered.
- e. The camera shall also detect any object addition, object removal, and line crossing.
- f. Whenever any event is triggered, the camera shall record the event on SD card also.
- g. The camera and hooter beacon alarm shall be installed at the gantry to prevent vandalism.
- h. The camera shall be mounted on at a suitable location on the Gantry such that it focuses on the enclosure / cabinet housing the LPU and Li-ion battery bank.
- i. All-in-one solar streetlight of 15W 2000 Lumens with inbuilt motion detection sensor and auto on-off and auto dimming function shall be installed at each location at a suitable height.

8. Power Supply

- a. The power supply shall be connected from communication rack using the POE or Adaptor.
- b. A solar power supply system consisting of a solar panel, a controller, a UPS and Lithium- ion battery bank shall be provided at each location that operates on solar power. Solar power equipment except solar panel shall be accommodated in the same stainless-steel cabinet as controller or in a separate stainless-steel cabinet. The solar panel shall have sufficient size to generate the power required. The Contractor/Contractor shall provide the support for solar panel and connection between the panel and the controller, which shall not be exposed. A mechanism shall be provided to adjust the angle of solar panel to the solar panel support and prevent pilferage.
- c. The Lithium-ion battery shall provide power for at least for 3 days even if solar power cannot be generated due to the weather condition. The Contractor/Contractor shall present the calculation of power consumption and capacity of solar power supply system to be used for the system. The Contractor/Contractor shall also consider the power requirement of network devices, wireless access points, PoE switch, SPD etc. suitably during the calculation.
- d. Proper earthing shall be provided at each equipment location.

9. Installation

The system will be installed on the gantry at specified locations.

10. Acceptance test

Acceptance test shall be conducted for speed system at the factory (before Site Acceptance test), during installation work and upon completion depending on the test item. Test will be classified into two types, functional and performance test, in addition, trial operation shall be conducted after the Acceptance test.

Section - Digital Transmission System and Communication Cable

1. Digital transmission system

The field / roadside equipment deployed under the scope of this Contract shall be connected with the central equipment at the Traffic Management Centre and sub-centres and data and voice are exchanged between them. Digital transmission system is required to perform the service of data and voice communication. IP based digital transmission system over optical fibre cable shall be provided for this purpose.

The Contractor/Contractor shall design, supply, install and test a digital transmission system that satisfies the needs of the component systems in terms of speed, bandwidth and reliability.

2. System configuration

Digital transmission system shall consist of local line transmission system and access line transmission system. The former connects between nodes established along the Highway/ Expressway and uses optical fibre cable while the latter connects roadside facility to the node using optical or metallic cable.

It is specifically noted that when the Highway / Expressway is extended, trunk line transmission system will be introduced for long distance data transmission between the Traffic Management Centre and the offices on the highway / expressway. Digital transmission equipment for trunk line transmission system will not be installed under this project. The local line transmission system to be provided shall be compatible with the standard digital transmission system commonly used in trunk line transmission. The optical fibre cable to be installed along the Project shall have minimum 48 cores to accommodate trunk line system.

All transmission cables shall be optical fibre cable having suitable number of cores except the metallic cable to be used to connect roadside emergency telephones to the nearest exchange or line concentrators.

3. System design

The Contractor/Contractor shall undertake the detailed design of the digital transmission system. The design work shall include but not be limited to transmission protocol, network and transmission equipment, type and size of cable, cable splicing, conduit and cable installation work, manhole, hand-hole and pull box at bridge and earth sections.

Digital transmission system shall adopt IP. Suitable media and transmission protocol at Layers 1 and 2 shall be decided type of digital station equipment shall be selected. In developing the design, various factors such as amount and type of data, transmission distance, quality of service (QoS), reliability, latency, and changeover time to backup route shall be considered. Type of optical fibre cable shall also be considered in the design. Packet based transmission system will be preferred than circuit-based transmission system such as Gigabit Ethernet.

Loop topology based on resilient packet ring (RPR) shall be adopted for local line transmission system for redundant operation. A cut of communication at a point in the loop shall not affect the normal operation of the communication system.

Physically separate optical fibre cables shall be used to for a ring topology and for back up route in the future trunk line transmission system. Compressed image data and data from other devices must be separately allocated to the optical fibre core.

Layer 3 switch will be used at each node to connect local network or device to the local line network. Layer 2 switch will also be used to connect devices to the local network.

In addition to the equipment listed above, the system requires fibre distribution frame and main distribution frame for cable termination, surge arrester or similar surge protection device to protect the equipment from the lightening, and accessories necessary for cable installation. The Contractor/Contractor shall supply and install these devices and accessories.

4. Reliability

Digital transmission system shall have high reliability to ensure continuous operation of the system. Bit error rate for the end to end data communication must be 1×10^{-6} or better.

5. Capacity and quality of service

The digital transmission shall have a sufficient capacity in terms of speed and bandwidth to meet the demands to be decided based on the estimated amount of data including digitized voice data at each facility such as Traffic Management Centre, Toll Plazas, sub-centres and service area/wayside amenities. Video signal from the TMCS camera shall be transmitted in H.264/H.265 format and the digital transmission system shall provide sufficient capacity for it. The Contractor/Contractor shall estimate the type, amount and location of data transmission need and design the system, equipment and cables that satisfy the demand.

Quality of service (QoS) capability shall be provided to the digital transmission system to ensure smooth and uninterrupted delivery of data for voice and video image transmission required for VIDS, VSIDS, and TMCS camera system.

6. System supervision

The digital transmission system shall be equipped with a supervisory function which continuously monitors the system operation and issues an alarm in case malfunction is found. The supervisory shall have the following functions:

- Management of occurrence and recovery of malfunction
- Registration and modification of system configuration
- Registration and modification of network configuration
- Testing of equipment and circuit
- Logging of equipment operation and cable
- Changeover between primary and backup routes

7. Communication Cable

7.1 General

The type of cable for digital transmission system shall be as stipulated below. The cable having suitable number of cores for optical cable and pairs for metallic cable shall be selected.

Two types of cable, optical fibre cable and metallic cable shall be used for digital transmission system along the Highway/ Expressway. In addition, power cable will be installed to provide power to the roadside equipment.

Application	Cable type
Outdoor cable	
Trunk line system	Optical fibre cable

Local line system	Optical fibre cable
Access line system	CCP cable (colour coded polyethylene cable)
Indoor cable	
Data / voice	PVC, SWVP or Ethernet cable

7.2 Specification

Optical fibre cable (OFC) to be installed along the Highway/ expressway (main duct route) shall have a minimum of 48 cores. Branching of optical fibre cable shall be made in such a way that only the cores connected to the facility are taken into the facility and other cores will be bypassed. Splicing of optical fibre cable shall be made with the method that allows re-opening of splicing housing and change of connection. The connection of core shall be made with fusion splicing.

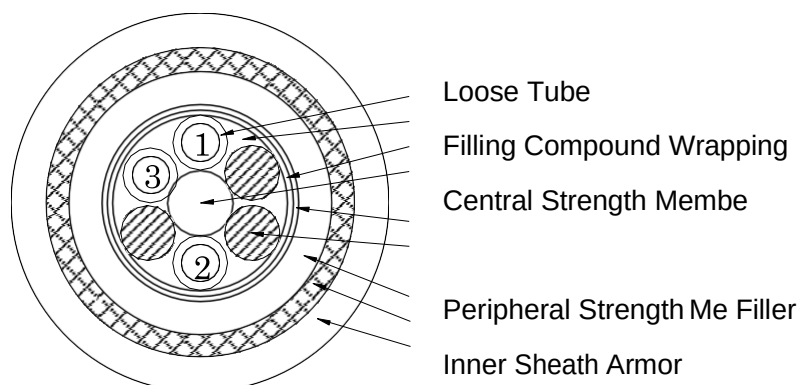
Other materials not specified in this Part shall be based on the Contractor/Contractor's own technical specifications, subject to the approval of ITS Engineer. In this connection, Contractor/Contractor shall submit, together with Technical Proposal, the technical specifications of main and other materials.

7.2.1 OFC Specification

The optical fibre cable to be supplied and installed under the Contractor/ Contractor shall be single-mode fibre optic cable having characteristics meet ITU-T G.652B, or equivalent and specification as below.

No.	Item	Specifications
1.	Cable type	OF-SM 48C OF-SM 8C
2.	Number of cores	OF-SM 48C: 48 cores OF-SM 8C: 8 cores
3.	Mode	Single mode
4.	Cladding diameter	125.0 $\mu\text{m} \pm 1.0$
5.	Coated fibre diameter	245 $\mu\text{m} \pm 10$
6.	Core/cladding concentricity error	$\leq 0.8\mu\text{m}$
7.	Coating/cladding concentricity error	$\leq 12\mu\text{m}$
8.	Cladding non-circularity	$\leq 1.0 \%$
9.	Mode Field Diameter	9.3 $\mu\text{m} \pm 0.5$ at 1310nm
10.	Attenuation (cable)	0.36dB/Km at 1310nm 0.25dB/Km at 1550nm,
11.	Zero-Dispersion Wavelength	1300 to 1322 nm
12.	Zero-Dispersion Slope	$\leq 0.092 \text{ ps/Sq. Nm .km}$
13.	Cut-off Wavelength	$\leq 1260 \text{ nm}$
14.	Polarization Mode Dispersion Coefficient	≤ 0.2 at 1310nm
15.	Fibre macro bend loss	$\leq 0.05\text{dB}$ at 1550 nm with 75 mm dia, 100 turns
16.	Fibre macro bend loss	$\leq 0.5\text{dB}$ at 1550 nm with 32 mm dia, 1 turn
17.	Coating Strip Force	$1.3 \leq F \leq 8.9$

18.	Minimum Proof Strength	0.70 (100kpsi) Gpa
19.	Strain	1 %



Specifications for Fiber Optic Armoured Cable

7.3 Packing and Delivery

- Packing and delivery of fibre optic cables shall conform to the following:
- Each length of cable shall be coiled on a substantial wooden or steel drum. Standard cable peice length shall be 1000 to 3000 meters.
- After completion of the optical tests, both ends of the cable shall be sealed by a suitable method to prevent the entrance of moisture.
- The starting end of the cable shall be secured on the inside of the drum flange.
- Due care shall be taken during the transportation of the cable drum so as not to cause damage the cable.

7.4 Metallic Cable

The size of CCP cable shall be 0.65 mm or larger. The number of pairs shall be decided taking the future demand after 10 year into consideration. Al least spare capacity of 100 % shall be reserved for future use. The minimum number of pairs shall be 50 pairs for the cable to be installed along the Highway/expressway and 10 pairs for the cable other than the above. In case of metallic cable, all pairs shall be connected to the MDF at each facility.

8. Conduit and Cable Work

8.1 General

- Conduit work includes underground conduit, conduit attached to bridge and culvert, handhole, manhole, cable rack and associated accessories necessary for cable installation.
- The Contractor/Contractor shall undertake the detailed design of conduit and cable work including preparation of plain plan of conduit and cable route showing type and length of conduit, number of conduits, type and length of cable, and type of handhole, manhole. The detailed design shall be submitted to the ITS Engineer for his approval.
- For the section where electromagnetic induction or electrostatic induction caused by high power transmission line is expected, countermeasures such as use of steel conduit or used of aluminium sheath shall be taken.

8.2 Conduit Works

Scope of work shall cover the following.

Installation of conduit (HDPE PLB duct $\Phi 40\text{mm} \times 2$), Excavation and back filling, onstruction of cable trench, Construction of manhole (as required), Temporary reinstatement of road surface, Safety measures and warning signs during installation works, Power cable duct to be included, Site clean-up and disposal of excess materials.

8.2.1 Installation of Cables

Scope of cable installation work shall cover the following.

installation of cable rack (vertical part of inside building) and ODF (Optical Distribution Frame).

laying of cable into HDPE pipe, splicing of optical fibres and jointing of cables, splicing of metallic cables and jointing of cables, termination of optical fibre cable and metallic cable, testing of optical fibre cable and metallic cable, preparation of as-built documents, site clean-up and disposal of excess materials, safety precaution where necessary, preparation of as-built documents, Acceptance test.

8.3 Cable Works

Conduit works facilities built under this Project shall have satisfied to conduit works acceptance before cable are pulling in, specially to cable test piece for conduit (ducts). Conduits shall be rodded by an acceptable method and cleaned before cables are pulled in.

Duct assignment shall be always done carefully to avoid crossing of cables between the duct entrance and cable bearer, and blockage of future access to vacant duct. In general, placing shall start at the bottom row and handhole/ manhole wall side of the duct arrangement.

Splicing shall be carried out as soon as possible after placing of the cables.

The extension of fibre optic cable shall be carried out at a constant speed and suitable back tension shall be applied to the drum to prevent hunching.

While under tension, a minimum bend radius of 20 times the outside cable diameter shall be maintained through the use of pulleys and sheaves where required. After pulling, no bend may have a radius, at rest, of less than 10 times the outside cable diameter.

At the splicing point, slack of minimum 3 meter shall be kept on each side of splicing kit. The slack shall be neatly arranged and the requirement for the minimum radius shall be met.

8.3.1 Type and Size of Conduit

Main materials to be supplied by the Contractor/Contractor for the implementation of the duct installation shall be in accordance with, or better in quality than, the specification stipulated hereinafter.

8.3.2 Application of Conduit

In general, HDPE (high density polyethylene) pipe having nominal inside diameter of 40mm shall be used. Galvanized steel pipe shall be used in the following cases and in accordance with Contractor/Contractor's own specification subject to the approval of ITS Engineer.

Bridge Attachment, b) Culvert Crossing, c) Highway/Expressway road crossing and d) etc.

8.3.3 Warning Tape

“CAUTION: NHAI F.O CABLE BELLOW” caution marks in English and Hindi should be printed in every two meters of the yellow warning tape to be placed in the cable trench (100mm width and 0.15mm thickness).

8.3.4 Cable Tag

Cable tag (plastic plate) describing the name of the cable and the origin of cable (cable name, type of cable, interchange name & etc.) shall be attached to the cable

All other materials not specified in this Functional and Technical Specifications shall be in conformity with the Contractor/Contractor's own technical specification, subject to the approval of the ITS Engineer.

8.3.5 Depth of Conduit

The covering depth from the top of HDPE pipes and GI pipes to the surface of ground shall be as follows:

Location	Depth
Side-shoulder	165cm
Carriageway	100cm or more
Highway road crossing, Main road crossing and Interchange area	120cm or more

However, in special case, the depth shall be determined in consultation with ITS Engineer, as per the site conditions and soil type.

8.4 Installation and Construction

Conduit installation works shall be performed in accordance with the specification stipulated hereinafter.

Other installation and/or construction works, the detail of which is not specified in this section, shall be based on this specification and/or the Contractor/Contractor's own Technical Specifications, subject to the approval by ITS Engineer.

NHAI / ITS Engineer shall, at any time when deemed necessary during the construction period, carry out inspection and/or tests on the facility under construction and/or the portions of facilities completed by the Contractor/Contractor.

Upon completion of conduit section, loose materials such as concrete, mud, dirt, sand, etc. shall be cleaned out from new ducts before testing. 6.0 m cable test piece may be used for main duct sections (cable test piece diameter 35mm) with sharp curve under the condition of the prior approval of the ITS Engineer.

The Contractor/Contractor shall apply the Area Log Book in order to facilitate a full supervision on the construction work.

8.5 Handhole and Manhole

The internal sizes of the standard type of Handhole and Manhole shall be as follows:

Type	Number of Ducts	Length (m)	Width (m)	Depth (m)	Cable Bracket
Handhole					
HH-1	1-8	1.20	0.60	0.85	One side
Manhole					
MH-1	1-9	1.80	1.00	1.50	One side

Handhole and Manhole shall be equipped with covers, duct plug, ladders, steps, cable bearers, cable brackets, name plates and pulling irons according to detailed drawings.

8.6 Excavation for Handhole, Manhole and/or Conduit

All excavation shall be done in a thorough and workmanlike manner in accordance with the detailed drawings and the Specifications.

The Contractor/Contractor shall obtain all pertinent records from the Electric, Water Supply, and Sewage pipe and other organizations for underground utilities in order to proceed his work and safeguard to other utilities.

During the execution of the work, existing underground facilities are damaged, or any part thereof is disturbed, the Contractor/Contractor shall immediately notify of the facts to NHAI and owner of the utility and shall be responsible for the rectification of the damaged utility at its own cost. The Contractor/Contractor shall indemnify the NHAI and its representatives from any loss or damaged caused by the Contractor/Contractor during execution of the works. The Contractor/Contractor shall cart away all excavated materials except that to be used for backfilling.

9. Inspection and Acceptance test

Site inspection specified herein shall be performed throughout installations and constructions of the various type of conduit facilities.

Should any errors in construction, faulty materials or other evidence of unsatisfactory construction and installation are found in the course of test, the Contractor/Contractor shall immediately repair, replace and/or remedy such unsatisfactory items.

The Contractor/Contractor shall perform the conduit facility inspection by himself every time to see if the work meets the requirement before the Acceptance test.

Acceptance test specified shall be performed by the Contractor/Contractor under the supervision of the ITS Engineer. Necessary equipment and materials for the site inspection and the Acceptance tests shall be provided by the Contractor/Contractor at his own expense. Written report including the test results shall be prepared by the Contractor/Contractor and verified by the ITS Engineer.

During interim inspection, at least the following test and inspection items shall be performed: Visual inspection of location, dimension, accessories and workmanship of handhole/manhole, Number and type of conduit, Cable test piece passage test, Check of new conduit, Backfilling and temporary reinstatement Acceptance test.

During Acceptance test, at least the following test and inspection item shall be performed: Acceptance test item for handhole, manhole, conduit and optical fibre cable on-site inspection are as follows:

No.	Item	Contents
1	Visual Check	Handhole, Manhole & Conduit Construction/Cable Installation Workmanship/ Installation Practice Compliance to Drawings
2	Optical Line Performance Test	Optical Fibre Attenuation Test (Transmission Loss Measurement by Laser Source & Power meter)/ OTDR (Optical Time Domain

		Reflectometer) Test (OTDR Measurement both direction and Splice Loss)
3.	As-built Drawings	Verification

Section - Power and Other Cables, Power conditioning equipment**1. Power Cable****1.1 Type of Power Cable**

The types of cables shall be as follows:

No.	Item	Specifications
1.	Outdoor Power Cable	Minimum 1.5 square mm - 22 square mm, 3 cores

1.2 Specification of Outdoor Power Cable

Outdoor power cable shall meet the following specifications:

- 1) Bright annealed, 99.97% electrolytic grade
- 2) Copper conductor (solid/stranded),
- 3) Voltage grade 1100 V,
- 4) Single or multi core cable,
- 5) Flame retardant low smoke (FRLS),
- 6) PVC / XLPE insulated,
- 7) With high oxygen and temperature index
- 8) Armored,
- 9) IS 8130, IS 5831, IS 3975, IS 1554 (Part I) / IS 7098 (Part I) or BS 6346/ IEC 60502

2. Power Conditioning Equipment System**2.1.1 General**

- a. This specification lays down the general, functional and technical requirements of the power conditioning equipment.
- b. Power supply rated at 440V, 3 phases will be made available at the Essential Supply Board of the TMC and Sub Centre Building. This supply will be backed up by standby generators to be provided by others; should there be an absence of electrical power.
- c. A power distribution board (PDB) as detailed in the drawing shall be supplied and installed under this Contract. The Contractor/Contractor shall provide power distribution board at other locations where necessary and the cost of such power distribution board shall be considered included in the Contract Price.
- d. The Contractor/Contractor shall supply and install UPS systems indicated below. All equipment except the equipment with solar power supply shall be provided power through this UPS to make sure that the power is continuously available to all equipment during the interruption of commercial power.

2.1.2 System Configuration

The UPS system shall consist of the following components:

- 1) UPS at TMC, Sub Centres and all Road-side equipment
- 2) Power distribution board at TMC centre, sub centres and all Road-side equipment

3. Type of UPS

- a. Rating of UPS Type for TMC and Sub-Centres shall be 10KVA, 15KVA or 20KVA.
- b. The suggested rating of the UPS at each location shall be submitted in the proposed design and BOQ. The Contractor/Contractor shall make his own calculation of the

rating based on the power requirement of the equipment he supplies and the sound engineering practice. The Contractor/Contractor shall submit the calculation and the rating to the ITS Engineer for his approval before the supply of the UPS.

3.1 Installation Location

1. All UPS provided shall be online type UPS only with minimum 4 hour back for TMC and sub- centres and 72 hours for roadside equipment. The minimum UPS rating for each system and sub-system shall be as shown in the table below:

No.	Position	For ATMS		Remarks
		UPS Rating (minimum)	Quantity	
	For Server Rack	10 KVA	4	1 at TMC and 1 at each Sub- centre (4 hours backup each)
2	TMC	20 KVA	2	In Parallel Hot Standby configuration (4 hours backup combined)
3	Sub Centres	10 KVA	6	In Parallel Hot Standby configuration (4 hours backup combined)
4	Road-Side Equipment	ATMS Contractor to Propose	1 at each location	With solar panel
				Minimum 72 hours backup

2. The Contractor/Contractor shall be responsible to calculate the UPS rating required for each location in the configuration mentioned in the table above based on the load of the equipment being proposed. The load calculation for each location shall be submitted in the tender document.

4. Cabinet

4.1 Fabrication

Panel or distribution board shall be wall mounted. It shall be fabricated or readymade with 14/16SWG CRCA Sheet, compartmentalized, double door hinged type. Gasket shall be provided to prevent the ingress of dust and vermin conforming to degree of protection IP- 54 (panel) and IP- 43 (distribution board), IP-65 (outdoor) with suitable space & direction for cable entry. Distribution board shall be cleaned with 7 Tank process, powder coated with primer and epoxy paint as per IS 2174/1962 as amended.

4.2 Switchgears & Meters

All switchgears (MCCB / MCB / fuses/ measuring instruments / meters/ indicating lamps / relays / switches) rating, capacity, make, kA rating, dimension shall be as per the type of DB with quick make & break type operating mechanism suitable for rotary operation with suitable extended operating handles with capacity and position marking on door, flush mounted, with suitable spreaders / links for cable connection as per IS 1248, 2208, 4237, 8623, 10118 (Parts I to IV).

4.3 Wiring

All power wiring within panel and distribution board shall be with suitable size flexible copper wire of 1.1kV grade, C.T. & control wiring with 2.5 square mm and 1.5 square mm, respectively with 1.1kV grade with proper lugging, ferruling, and connection with SS Nut - Bolt with adjustable and fixed washer.

4.4 Indication and Marking

All distribution board and panel shall have suitable main name plate, feeder name plate, danger board plate engraved or anodized aluminium type as per IS 2551. All panels and distribution boards shall have earthing node, point or strip similar to busbar as per IS 3043.

4.5 UPS Specification

The UPS system to be provided under the Contract shall comply with the specifications below.

No.	Item	Specifications
1.	Rating in KVA	10KVA, 15KVA or 20KVA
2.	Rectifier design	IGBT charger - Advanced rectifier
3.	Nominal voltage	440 VAC (-20% to +15%) 3 Phase and neutral
4.	Nominal Frequency	50 Hz (+/- 6%) (60 Hz optional)
5.	Waveform	True Sine Wave
6.	Total Harmonic Distortion	<2% on linear load and <5% on non-Linear load (Reference IEC 62040-3)
7.	Crest Factor	3:1

5. Cable Installation Work

5.1 Cable Pulling

- a. Sufficient care shall be taken, and measures shall be applied during the loading, transportation and unloading of cable drum so as to avoid shock and damage to the cable.
- b. Appropriate surplus of cable shall be required at inside of handhole/ manhole.
- c. Cable shall be connected only inside the handhole/ manhole.
- d. Cable tag (plastic plate) describing the name of the cable (power cable or earthing cable) and the origin of cable (cable name, type of cable, interchange name & etc.) shall be attached to the cable.
- e. During the installation of cable, the following constraints shall be observed:
- f. The maximum tension allowed.
- g. The minimum curvature radius allowed: When installing cable at the handhole/ manhole, curvature radius shall be more than 6 times of the diameter of the cable being laid at all times. After cable laying work, minimum radius of more than 20 time of the diameter shall be ensured.
- h. Extension speed of laying:
- i. Towing cable shall be made smoothly without any excessive tension intermittently at the time of laying, and calibration of appropriate apparatus for setting up allowable tension shall be required.
- j. The extension of cable shall be carried out at a constant speed and it shall apply the suitable back tension for a drum to avoid hunching.
- k. Cable in the point in a handhole/ manhole shall have at least 3 m margin complied

with curvature radius at every handhole/ manhole and the point of handhole/ manhole terminal equipment shall have the 3 m margin at both sides of branch.

- l. Winding up of Insulating tape for the connecting point of electric wire shall be required.
- m. Connection between electric wire and terminal equipment shall be connected using terminal lug or a screw.

6. Inspection and Acceptance test

Acceptance test specified shall be performed by the Contractor/Contractor under the supervision of ITS Engineer.

Necessary equipment and materials for the site inspection and the Acceptance tests shall be provided by the Contractor/Contractor at his own expense. Written report including the test results shall be prepared by the Contractor/Contractor and verified by the ITS Engineer.

6.1 Interim Inspection

- a. During interim inspection, at least the following test and inspection items shall be performed:
- b. Visual inspection of cable route, cable location, dimension, accessories, cable terminations and cable joints.

6.2 Acceptance test

During Acceptance test, at least the following test and inspection item shall be performed: Acceptance test item for power cable on-site inspection are as follows:

No.	Item	Contents
1	Visual Check	Cable Installation/Workmanship/ Installation Practice Compliance to Drawings
2	Power Cable Performance Test	insulation resistance test, Inductance Capacitance
3	As-built Drawings	Verification

Details of the test item, test procedure and criteria to judge test results shall be proposed by the Contractor/Contractor subject to the approval by the Engineer.

Section - Facility Monitoring System

1. Function

Facility monitoring system shall be provided to monitor the operation of facilities on the Highway/ Expressway. The system shall monitor the operation of the following component systems:

- 1) Traffic Monitor Camera System (TMCS)
- 2) Video Incident Detection System (VIDS)
- 3) Probe Data System
- 4) Central processing System
- 5) Variable Message Sign (VMS)
- 6) Vehicle Speed Detection System (VSDS)
- 7) Adaptive Traffic Signal Control System (ATSC)
- 8) Digital Transmission System
- 9) Power supply system (at building and field)

The functions of facility monitoring system may not be integrated in a single system. They may be achieved by the operation monitoring function of the component systems. The role of the facility monitoring system is to consolidate the monitoring function undertaken by component system, present the system status in a concise manner to the operator and keep the record of system operation. In case any abnormality or malfunction is detected, the system shall issue an alarm together with the information regarding type and location of the trouble so that remedial action can be taken swiftly.

The Contractor/Contractor shall design, procure, manufacture, install, test and commission the facility monitoring system that meets the concept and functions stated herein.

2. Operating Status

- a. Items to be monitored and its content differ from one system to another system to be monitored. In general, the condition of the system and device such as 'Normal', 'Error' and 'No Reply' shall be classified in detail.
- b. The system shall have a function to test itself without affecting normal operation of the system being monitored by the system.
- c. Each error or malfunctioned status shall be assigned with severity level for each system. Depending on the severity level, different action shall be taken by the system. For minor errors such as abnormal data from vehicle detector for one interval, error is recorded in the log and no alarm will be issued. For severe errors such as interruption of communication circuit, alarm signal shall be automatically displayed on the system supervisory server overwriting the display being shown.

3. Monitoring

The manner of monitoring shall differ depending on the system and device to be monitored. In general, normal operation shall be confirmed periodically by the monitoring system by sending inquiry command. The time interval of inquiry shall be adjustable for each component system and its devices. But alarm signal shall be issued immediately by the component system and their devices comprising it to minimize delay.

4. Recording and logging

The facility monitoring system shall keep record of its operation and status of the various systems and devices in a unified manner in the database. All incident and events shall be recorded. Data

retrieval software shall be provided to retrieve and display the operating history of the specified systems and devices. The database thus stored will be used to calculate the reliability indicators of the system and device including MTBF (mean time between failures) and MTTR (mean time to repair).

Availability calculation shall be reported in a quarter.

The Formula of calculation of availability is shown as follows. $\text{Availability} = \{1 - [(A)/(B-C)] * 100\}$

Where

A= Time for which system is down B = Total Time

C= Scheduled downtime

5. Monitoring signal interface

- a. The Contractor/Contractor shall provide necessary number of monitoring signal interface units to receive operating condition and alarm signal from the system or device to be monitored. The interface shall be provided with sufficient number of analog, digital and pulse interfaces. It shall be capable of receiving operating condition signals through interface and sending them to the Traffic Management Centre using FTP, SNMP or DATEX-ASN protocol.
- b. The interface shall be provided with an optical hub or switcher and can be connected to optical fibre cable directly.
- c. The interface shall be equipped with a clock and the clock shall be adjusted using network time protocol (NTP) or simple network time protocol (SNTP).
- d. Some of the monitoring signal interface shall be installed outdoor. The device to be used outdoor shall be capable of withstanding the environmental conditions for outdoor equipment.

Section - Adaptive Traffic Signal Control System

1. General

ATSC system shall be deployed at intersection/ crossing / junction locations along the Highway stretch, such as junctions formed under the flyover, VUP, and underpasses. The locations shall be identified during the site survey by the Contractor/Contractor.

ATSC shall be provided at every junction under the VUP and Flyover where signalling system is not available and required by the Traffic Police. In case Traffic signals are available and doesn't require replacement, only RLVD and Automatic pedestrian Detection system shall be deployed.

The quantity provided in the BOQ/indicative list of equipment is tentative and the final quantity shall be derived as per the actual project requirement during the site survey and Detail Design phase and the quantity shall be reduced or increased accordingly.

The primary purpose of these signals will be to provide traffic and transit management services in support of improving congestion and reducing delays at the intersections.

The proposed system shall comply with the functional requirement stipulated in IRC:SP:110:2017.

Training shall be provided to all the concerned stakeholders such as traffic police, NHAI representatives, etc. as per the requirement. The training schedule and procedure shall be finalized in consultant with the ITS Engineer and Traffic Police.

2. ATSC Components

The ATSC to be provided as part of this contract encompass the following components:

1. Traffic Signaling System
2. Red light violation detection system (RLVD)
3. Automatic Pedestrian Detection system (APDS)
4. Traffic Signal System monitoring, control, analytics and management module at TMC integrated with ATMS Software
5. Traffic Signal Controller Cabinets to accommodate traffic signal hardware or red-light enforcement, surveillance cameras, switches, emergency preemption equipment, etc.
6. Vehicular and pedestrian signal heads at every signalized intersection.
7. Traffic Signal Poles – high poles, cantilever poles (mast arms) and gantries
8. Camera based Traffic Detectors
9. Digital Communication System
10. Solar based Power supply with 72-hour backup
11. SPD, Lighting protection, etc.
12. Foundation, conducting, etc.
13. Integration with NMS and FMS
14. Integrate with Smart City ITS Control Rooms/ ICCC, as applicable.
15. Automatic generation of e-challan and SMS service, same as in case of violation detection from VSDS and VIDS system.

Dismantling of existing equipment and installation of new ATSC system shall be in the scope of the Contractor/Contractor and no additional cost shall be payable for any dismantling of existing equipment is required at any intersection / location.

3. Operations & Maintenance of ATSC

The Contract shall perform following tasks during the O&M phase:

- a. Finalize the Maintenance SOP developed as part of the proposal using stakeholders' inputs.
- b. provide comprehensive maintenance of the System as mentioned in the Maintenance SOP including cleaning of the Solar panels regularly.
- c. provide comprehensive maintenance of the System as mentioned in the Maintenance SOP including cleaning of the Solar panels regularly.
- d. monitor & evaluate the efficiency of the adaptive control system on a regular basis and developing strategies for enhanced operation.
- e. monitor the ATSC system performance with respect to the entire stretch and traffic management module targets.

4. System Design

The Contractor/Contractor shall submit the detail design of following components during the detail design phase for the approval of the ITS Engineer. The design of each component shall be on the bases of the system required for each type of junction / intersection.

- a. Traffic signal design
- b. Traffic signal poles, mast arms and gantries
- c. Traffic signal Heads – vehicular and pedestrian
- d. Traffic Signal Cabinet Assembly
- e. Detection system
- f. TMC Controlled Adaptive Software
- g. Conduits and Junction Boxes

The system shall be designed and installed in accordance with relevant National (Indian) and International technical, safety and environmental standards, specifications and type approvals, including but not limited to current versions of the following documents:

1. Guidelines on Design and Installation of Road Traffic Signals – The Indian Roads Congress, (IRC: 93-1986).
2. Guidelines for Pedestrian Facilities – The Indian Roads Congress, (IRC: 103-2012)

The proposed system shall be fully compatible and seamlessly integrate with the current ATSC and RLVD system being deployed in the concerned smart city or city ITS project or traffic police project, as applicable.

4.1 Design Drawings

The traffic signal design drawings shall specify the location of the following component for every junction:

1. Traffic signal heads
2. Traffic signal cabinet
3. Traffic signal poles
4. Traffic signal conduits and pull boxes
5. Detection system (RLVD, APDS, etc.)
6. Other installed intersection technologies

Following minimum information shall be provided in the traffic signal design drawings:

1. Electrical circuit schedule/table
2. Pole schedule/table
3. Detector assignment schedule/table
4. Phasing Diagram
5. Pole foundation
6. Traffic controller foundation
7. Conduit and pull boxes installation

Traffic signal drawings shall be supplemented with any necessary documents to comply with requirements of the project and prevailing standards.

5. RLVD (Red Light Violation Detection) System

- a. System should be totally digital
- b. The system shall detect and capture vehicle details when: i) It violates the stop line/zebra crossing, ii) It violates the red-light signal
- c. System shall be Non-Intrusive. It shall have the option of working without integration with traffic controllers but Contractor/Contractors should also provide undertaking that their system also works with integration of controllers.
- d. Red light system shall be a completely fair system with all evidence captured before and after the red-light jumping infraction has happened.
- e. Each camera system shall cover road width of 3.5 meter or 7 meter or 10.5 meter and above.
- f. The Camera specifications shall be same as specified in the VIDS section for bullet/box camera and VSDS section for ANPR camera.
- g. Red light system should detect vehicle presence to act as input to control the Traffic Controller.
- h. System can be a composite unit with all components inside the IP66 box OR comprised of camera or other units mounted on poles or gantries with controller and processors at side poles to make sure all lanes of the road are covered.
- i. System should be able to recognize the entire event by which the same can be justified automatically by fetching the number plate of cars in violation.
- j. The system shall have alert generation feature as per the requirement of the Traffic Police, the same shall be finalized after discussion with the concerned enforcement agencies of the state in consultant with the ITS Engineer.
- k. Certification: UL (Underwriters Laboratories), BIS (Bureau of Indian Standards) and RoHS compliant certificate.

6. ATSC and RLVD Module in TMC

- a. The system should provide function to the Operator to manually check the entry in application and edit the numbers which may be wrongly OCR- read, before the numbers are fed to the e- Challan generating sub-system. An audit trail should be maintained to record such editing activities.
- b. No deletion or addition of data without validation, proper password protection. Deleted data if any to be inserted automatically in a separate table.
- c. The system should provide facilities to search for the cases of violations that occurred during any specific span of time and provide a statistical analysis of the number of such incidents occurring during various days of the month.
- d. A customized web-based dashboard to be developed for all types of master data

- entry and for customized reports with graphical analysis.
- e. System can be integrated with existing e-Challan generating systems with fine generated for each infraction with multiple images clearly showing color of red-light signal and violation (i.e. color image of context camera), date, time, vehicle registration number, classification of offence etc. Image having water mark of Date & time, Place, Latitude & Longitude to be uploaded.
 - f. Integration with RTO database, Vaahan databased, and police control rooms etc. to be integrated by the Contractor/Contractor.
 - g. It is desirable that the proposed solution should already be in use with enforcement authorities and is used for generating fines. End user certificates for proper working shall be submitted, if applicable.

Operation and Maintenance of ATMS

1. General

1.1 General Requirements

Operation and Maintenance of Advance Traffic Management System (ATMS) shall be executed in the manner originally intended, that is to collect road, traffic and weather condition data, process and analyse the data into useful information, disseminate the information to road users in accordance with the procedures as set forth herein and instructions given by the Engineer. The system shall be in operation for 24 hours a day and 7 days a week without interruption. The Contractor/Contractor shall not divert and modify the procedure without written approval by the NHAI.

The purpose of Operation and Maintenance of ATMS is to keep the traffic management system and related facilities in operation in the manner originally intended, that is to collect road, traffic and weather condition data, process and analyse the data into useful information, disseminate the information to road users and to prolong the life of the system and the equipment. Therefore, time is of essence. Repair must be done in a timely manner.

The specifications described herein shall be considered the minimum standards to be followed for the maintenance and repair of all equipment and software covered under the Contract. Unless otherwise specified, the standards for equipment and equipment performance shall be in accordance with the Technical Specification.

1.2 Scope of Work

Apart from installation of ATMS system, the scope of contract also includes Operation and Maintenance of ATMS for a period of 5 years from the date of Completion of ATMS system. Except otherwise specified in the Operation & Maintenance Specifications of NHAI's Requirements, it is the Contractor/Contractor's responsibility to provide sufficient manpower to implement flawless execution of ATMS in operation in the manner originally intended, that is to collect road, traffic and weather condition data, process and analyse the data into useful information, disseminate the information to road users and undertake the Services that are not specifically mentioned in these requirements but essential for the safe and efficient traffic operation on the Project. The Contractor/Contractor shall maintain qualified staff at the Traffic Management Centre (TMC), Sub Centre and other places wherever required necessary, tools, shop facilities, equipment, consumables, transportation and materials and perform all works necessary to maintain in good working manner all Advanced traffic management system and associated equipment.

The scope shall also include the following:

1. House Keeping of Traffic Management Centre and Sub Centre by a house keeping supervisor, housekeeper, security guard, cleaner, gardener and miscellaneous workers.
2. Administrative work such as purchases, account, human resource, public relation
3. Building maintenance and recurring charges such as electricity bills, water bill,

Operation & Maintenance services are required to cover the system of Traffic Management Centre, Sub Centre system and following sub system.

- 12) Traffic Monitor Camera System (TMCS)
- 13) Video Incident Detection System (VIDS)
- 14) Automatic Traffic Counter and Classifier (ATCC)
- 15) Travel Time Measurement System (TTMS)
- 16) Central Processing System
- 17) Variable Message Sign (VMS)
- 18) Vehicle Speed Detection System (VSD)
- 19) Adaptive Traffic Signal Control System (ATSC)
- 20) Digital Transmission System and Communication Cable
- 21) Power and Other Cables
- 22) Facility Monitoring System

Apart from above scope of operation and maintenance of ATMS, following works are out of scope from Operation and Maintenance of ATMS, but scope of NHAI and/or their Contractor/Contractor.

- 1) Operation and Maintenance of TMS (Toll Management System)
- 2) Traffic Management work on the road such as patrol by patrol-vehicle, maintenance of road, recovery of accident, cleaning of road.
- 3) Civil and Electrical work other than for ATMS TMC, Sub-centres, and field equipment.

2. Operation & Maintenance Service Proposal

The Contractor/Contractors shall describe the methodology and outline to execute proposed Services both Operation & Maintenance in sufficient detail in his Services Proposal to enable the NHAI to evaluate the technical capability and qualification of the Contractor/Contractor and to judge whether the proposal is adequately responsive or not.

The Contractor/Contractor shall update and furnish the Service Proposal two (2) months before expected starting date of Operation period for approval by NHAI.

The Services Proposal shall describe the operation and maintenance activities taking Manufacturer or OEM recommendations for all hardware and software into consideration and shall be written in the same sequence as the NHAI's Requirement. Where the supporting documents such as brochure, article, report, or paper are provided, they shall be attached at the end of the proposal or in a separate volume and a cross reference shall be prepared. The Services Proposal shall be written in English.

The Contractor/Contractor shall prepare a list of equipment to be covered by the maintenance based on the actual configuration and quantity of the equipment. If the Contractor/Contractor provides any additional equipment not specifically mentioned in the NHAI's Requirements to complete the Advanced traffic management system required under the Contract, they shall be included in the scope of maintenance work and the Contractor/Contractor shall prepare and submit to the Engineer the revised list for his approval.

This plan shall be updated as necessary during the O&M period so as to reflect the actual conditions of O&M.

2.1 Operation Service Proposal

The contents of the Services Proposal shall include but not limited to the following:

1. Scope of services to be rendered
2. System coverage area and list of equipment
3. Contractor/Contractor's general obligation
4. Organization of operation team
5. Operation procedure of sub-systems
6. Records and reports to be prepared by the Contractor/Contractor
7. Contractor/Contractor's personnel and personnel management
8. Operation manual
9. Training of Contractor/Contractor's personnel
10. Safety, security and protection of environment
11. Ability to track performance and operation activities
12. Inspection and evaluation

No cost information of the services and operation shall be included in the Services Proposal.

2.2 Maintenance Service Proposal

The contents of the Maintenance Services Proposal shall include but not limited to the following:

- 1 Scope of services to be rendered
- 2 System coverage area and list of equipment
- 3 Contractor/Contractor's general obligation
- 4 Organization of maintenance team
- 5 Maintenance manual
- 6 Checklist for Preventive Maintenance tasks on each device
- 7 Inventory of devices
- 8 Work order management capabilities
- 9 Level of Service and device inventory
- 10 Ability to track performance and maintenance activities
- 11 Establishing criteria for devices, equipment and systems regarding mean time failure
- 12 Equipment needed for performing diagnosis on ITS field devices
- 13 Schedule cross training activities to improve the overall skill level of ATMS technicians

3. Requirements for ATMS Operation Services

The various type of operation related services to be performed by the Contractor/Contractor shall include the following:

3.1 ATMS Operation

The ATMS Operation shall be executed in accordance with the procedures as set forth herein and instructions given by the NHAI. The system shall be in operation for 24 hours a day and 7 days a week without interruption. The Contractor/Contractor shall not divert and modify the procedure without written approval by the NHAI.

3.2 Briefing at shift change

Shift time of operators shall be arranged in such a way that there will be an overlapping period of at least 15 minutes. During the overlapped period, new operation team shall be briefed by the previous operation team as to the following:

- 1) General traffic condition
- 2) Weather condition
- 3) Existing incidents and accident being disposed of
- 4) On-going and scheduled work on the Project
- 5) On-going and scheduled event on the Project and radial roads connected with the Project interchange
- 6) Messages being displayed on VMS
- 7) Equipment malfunctioned and the status of maintenance work
- 8) Other matters that need attention of the operation team

3.2.1 Confirmation of equipment condition

At the start of a shift, operators shall confirm the condition of all equipment through operation or through the consoles. If there is a new failure that was not reported by the previous shift team, the operator shall record it and report it to the maintenance team for proper maintenance action.

During the operation of the system, if the operator detects any abnormality of the equipment, software, or database, he shall report it to the maintenance team for proper maintenance action. The operator shall refrain from manipulating equipment, modifying operating parameters, reloading software or other action without instruction by the maintenance staff when abnormal or defective behaviour of the equipment or software is found.

If the fault signal or no diagnosis signal response from roadside equipment is received at Traffic Management Centre, operator shall contact the maintenance team and report the location and status of equipment with failure.

3.3 Operation of Emergency Telephone (“1033”)

3.3.1 System Setup

The system shall be set to automatic recording mode and all calls shall be recorded automatically. No recorded conversation shall be deleted without the written consent of the NHAI.

3.3.2 Operation

3.3.2.1 Call reception

When operator receives a call from “1033”, he shall confirm the following information from the caller:

1. Caller’s ID
2. Type of incident (accident, break-down, puncture, out of fuel, fallen object, etc.)
3. Location (kilo post and direction)
4. Request for action

In the case of accident, the followings shall be confirmed in addition to items (1) through (4) above.

1. Type and severity of accident

2. Number of persons injured
3. Necessity of ambulance, wrecker and/or fire brigade
4. Possibility of drivability of vehicle involved in the accident

In the case of breakdown, the followings shall be confirmed in addition to items (1) through (4) above.

1. The lane where that broken-down vehicle is stopping
2. Vehicle type
3. Reason of breakdown
4. Necessity of wrecker or crane

The operator shall inform the caller to implement temporary safety measures such as placing safety triangle or waving flag to prevent secondary incident and advise the caller to stay at a safe place.

In the case of simple inquiry such as location of exit for specific destination, the operator shall provide necessary information to the caller.

3.3.1.2 Countermeasure

The operator shall inform the patrol team of the incident so that they can take proper actions at site. If a call involves request for assistance such as dispatching wrecker, the operator shall inform the relevant agencies and request appropriate action to be taken.

3.3.1.3 Message on variable message sign

If the incident reported is the type that affects traffic flow or traffic safety on the Project, the operator shall provide incident information and display the incident information on the VMS of suitable location as per the operating procedure of VMS.

3.3.1.4 Reporting

The operator shall fill up the prescribed incident form for every incident that requires actions to be taken by the NHAI, operator or other agencies.

When operator receive a call from patrol team or other related agencies regarding completion or clearing of incident, operator shall remove the incident message.

3.3.1.5 Mobile communication

The operating procedure from the mobile communication shall be same as that for “1033” emergency call system. If operator receives a call from a road user or patrol team through mobile phone, the operator shall act in a same manner as a call from “1033”.

3.4 Operation of Traffic Monitor Camera System (TMCS)

3.4.1 System Setup

Under normal condition of the Project, the TMCS system shall be set to sequential display mode in which video image from all TMCS cameras is sequentially displayed on the multiple video monitors. The number of monitors used and scanning interval of each video camera is user selectable.

Under normal condition of the Project, the TMCS cameras shall be set at home position to enable automatic incident detection.

Image recording function shall be set to ON and image from all TMCS cameras shall be recorded automatically.

3.4.2 Operation

3.4.2.1 Monitoring

The operator shall from time to time watch the TMCS monitor which sequentially displays video image from all cameras at pre-set interval to monitor and confirm normal traffic flow.

If any abnormality is found in the video image, the operator shall discontinue sequential changeover mode and select and fix the camera that captures the scene of incident and observe the incident. If the incident is the type that requires assistance, the operator shall inform relevant agencies of the incident and request appropriate action to be taken.

If a report of incident is received and incident location is within the coverage area of a TMCS camera, the operator shall select the TMCS camera of incident location, operate the camera and focus on the incident to monitor to get first-hand information of the incident.

3.4.2.2 Incident detection

If the Video Incident Detection System (VIDS) detects an incident such as a vehicle moving in reverse direction, VIDS console issues an alarm and incident image will be displayed on the VIDS console monitor and Graphics Display.

The operator shall request Mobile operator to contact the relevant agencies such as patrol team, traffic police, fire brigades, ambulance or wrecker service, explain briefly the incident, and request them to take necessary action immediately.

3.4.2.3 Variable message sign

If the incident detected and reported is the type that affects traffic flow or traffic safety on the Project, the operator shall operate VMS console and display the incident information on the VMS of suitable location as per the operating procedure of VMS.

3.5 Operation of Automatic Traffic Counter-cum-Classifer (ATCC) System and Travel Time Measuring System (TTMS)

3.5.1 System Setup

No specific system setup is required for ATCC and TTMS once its normal operation is confirmed at the time of system commissioning, as no additional hardware or filed equipment has been installed on the Project for ATCC and TTMS functionalities. The ATMS Software processes the data from ANPR and VIDS cameras for traffic counting and classification, and travel time estimation. However, threshold values that are used to detect abnormal traffic conditions shall be reviewed from time to time to confirm that the values are appropriate.

3.5.2 Operation

3.5.2.1 Monitoring

Operator shall from time to time but at least once an hour checks the ATCC and TTMS data for any abnormality. If abnormal data are found, the operator shall confirm whether

the actual traffic flow is different from the normal, or the data is erroneous. If the data is found erroneous, the operator shall inform the maintenance team for further investigation.

3.5.2.2 Abnormal traffic condition

If the ATCC and TTMS module detects a traffic flow parameter at a lane or section is lower or higher than the predetermined threshold, the ITS console issues an alarm to the monitor display as abnormal traffic condition.

If an alarm is issued, the operator shall capture the image of traffic by TMCS at the sensing area and confirm whether the abnormal data is caused by the abnormal traffic condition or by ANPR equipment failure.

If any incident is identified by the TMCS system and requires attention or help, the Traffic operator shall contact the relevant agencies such as patrol team, traffic police, fire brigades, ambulance etc. for their action.

After the contact with the relevant agencies, operator shall display adequate messages on the VMS at adequate location and direction.

When Traffic operator confirms that the traffic condition has become normal, operator to remove the messages or change the message with second priority. Operator shall also inform the relevant agencies of the termination of the incident.

3.5.2.3 Monthly review

At the end of every month, the operator shall go through the data collected by the ATCC and TTMS for any abnormality that could have been overlooked during daily operation. If an abnormal data is found, the operation shall further examine the data and determine whether the traffic condition became abnormal due to an incident or the ANPR equipment was defective. If any abnormality that is attributable to erroneous system operation is found, the operator shall inform the maintenance team for further investigation.

3.6 Operation of Variable Message Sign (VMS) System

3.6.1 Type of information provided

Different types of message will be displayed on the VMS. These types are summarized below. With regard to the message format, the sample messages presented in “IRC:SP: 85-2010, Guidelines for Variable Message Signs, Annex-B” can be referred.

Social messages shall not be displayed on the VMS at any time. Only the messages useful for the user to provide them the information / alert / warning for any incident, road closure, traffic jam, over-speeding alerts etc. or travel time shall be displayed on the VMS. Travel advisory or travel time shall be displayed when there is no alert / warning is required to be disseminated to the commuters.

3.6.2 Advance warning message

Advance warning message gives the road users running at upstream section an advance notice of the incident at downstream section. The incident includes traffic congestion, slow traffic, accident, stalled vehicle, lane closure, fallen object, work zone and weather conditions. The message is effective in reducing possibility of secondary incidents.

3.6.3 Advisory message

Advisory message provides the road users with useful information about a specific problem along their route. This information allows the road users to change their speed or lane in advance of the problem area, or the road users may elect to voluntarily take an alternative route to their destination.

3.6.4 Early notice

Early notice informs the road users of a planned event such as road work on the Project or the closure of an interchange. This type of message has lower priority than other types of message and will be displayed only when there is no real-time message to be shown.

3.6.5 Language used

Three languages, English, Hindi, and another one local language will be used for VMS. Thus, the VMS operator shall be fluent in these languages. Except short message, messages will be displayed in one of the three languages. Message shall carry the same meaning regardless of the language used. For short message that can be expressed in one line, the same message may be displayed simultaneously in three lines.

3.6.6 Message Layout

Standard layout shall be followed consistently to express information for easier understanding by the road users.

3.6.7 Message Composition Method

TCC operator can choose message creation from three (3) methods as indicated below.

1) Combination of pre-defined message

The word which are frequently used such as “accident”, “congestion”, “construction work”, “slow down” and so on are used to compose a message combination by selection at VMS console. They contain words indicating location, event and instruction.

2) Ready-made message

VMS operator may select one of the ready-made messages stored in VMS console.

3) Manual composition

Any message which VMS operator cannot select from VMS console; operator can create any message through keyboard.

4) Graphic symbols

VMS operator may provide a graphic symbol that graphically represent an incident and help Project road users to understand instantly without reading messages.

3.6.8 Message display

Upon reception of incident information from other operators or directly from other agencies, the VMS operator shall display proper message on the VMSs at adequate locations and direction without undue delay.

If the VMS on which new message is to be displayed is already showing a message, the operator shall evaluate the priority of the current and new incidents and decide whether the message being displayed is replaced with the new message or not.

The incident that exists at immediate downstream section shall have higher priority than the incident that is located more than one section away in general. If there are two incidents in a same section between two interchanges, incident of higher severity will take precedence over the incident with lower severity. If there are two incidents of same severity, incident nearer to the VMS shall be selected.

3.6.9 Message removal

Upon reception of the notice that an incident for which a message is displayed has been resolved, the operator shall remove the message or replace with another message immediately. The message of the incident that has been resolved shall not be displayed unnecessarily.

The operator shall check the effectiveness of all the messages being displayed at every 15 minutes and confirm the message needs to be continued or removed. The operator shall remove the message or replace with another message if the message being displayed is no longer applicable.

3.6.10 Message Providing Area

For an incident occurred, not all VMSs are required to display the message related to the incident. The message of an incident shall be displayed on one or more VMSs starting from the VMS located immediately upstream of the incident location. The higher severity of incident, the more VMSs will display the message about the incident. In other words, the number of VMSs on which message about an incident is displayed depends on the severity of incident and distance from the incident location to VMS location.

3.7 Security & related Incident Management Service

The ATMS Project shall be designed for an end-to-end multi-layer security blanket to protect applications, services, data and the infrastructure from malicious attacks or theft from external (through internet) and internal (through intranet) hackers. Using Firewalls and Intrusion detection systems such attacks and theft should be controlled and well supported (and implemented) with the security policy. The virus and worms attacks should be well defended with Gateway level Anti-virus system, along with console level Anti-virus mechanism. ATMS should be designed to make use of the Secure Socket Layer (SSL)/Virtual Private Network (VPN) technologies to have secured communication between Applications and its end users. Furthermore, all the system logs should be properly stored & archived for future analysis and forensics whenever desired.

These Service Levels would be calculated for each of the following types of incidences:

a) Virus Attack

Any virus infection and passing of malicious code shall be monitored at the gateway level or user complains of virus infection shall be logged at the help desk system and collated every quarter.

b) Denial of Service (DoS) Attack

Non-availability of any services shall be analysed and forensic evidence shall be examined to check whether it was due to external DoS attack.

c) Intrusion

Intrusion is an illegal act of entering, seizing, or taking [possession](#) of data hosted by ATMS. Compromise of any kind of data hosted by ATMS.

d) SPAM

SPAM is an unsolicited bulk messages, especially advertising, indiscriminately. SPAM statistics on monthly basis shall be monitored through reports generated by Anti-SPAM software.

3.8 Records and Reports

The Contractor/Contractor shall prepare and submit the various reports as stipulated herein in a form mutually agreed. Each report shall contain as a minimum the information listed.

For every incident reported, the operator in the TMC shall gather the information about the details of incident and site condition. List of Incident summarized the information to be collected for different type of incident shall be prepared by Contractor/Contractor.

Operator shall prepare the following reports:

a) Daily report

- 1) List of incidents responded by incident category
- 2) Contact summary (numbers by category) with Emergency caller, patrol team, traffic police and other relevant agencies

b) Monthly report

- 1) Number of contacts with Emergency caller, patrol, police, NHAI and others for each day.
- 2) Number of incidents occurred by category for each day
- 3) Number of road closure each day by reason for closure
- 4) Number of emergency contact call
- 5) Number of other contacts

Operators who responded to a call (such as emergency call) shall prepare the reports listed below. The report shall be compiled immediately after responding to the call and shall not be left unrecorded.

c) Emergency Response Report

- 1) Incident location
- 2) Weather
- 3) Road condition
- 4) Vehicle condition
- 5) Contact record
- 6) Dispatch record
- 7) Traffic regulation implemented

d) Call Record

- 1) Time
- 2) Party contacted
- 3) Incoming or outgoing
- 4) Call content

e) Clearing/Recovering Record of Object on Road

- 1) Time when information is received

- 2) Receiver
 - 3) Contact source
 - 4) Caller
 - 5) Type or kind and name of object
 - 6) Location and direction (clockwise/counter clockwise)
 - 7) Lane number
 - 8) Time cleaning is ordered
 - 9) Name of person instructed
 - 10) Contractor/Contractor to which clearing is requested
 - 11) Time of arrival at site
 - 12) Time of clearing work completion
- f) Record of Traffic Regulation
- 1) Time when information is received
 - 2) Location and direction (clockwise/counter clockwise)
 - 3) Lane number
 - 4) Regulation applied
 - 5) Time started and time restored
 - 6) Other information
- g) Ambulance Dispatching Report
- 1) Date and time
 - 2) Reason for dispatch
 - 3) Location and direction (clockwise/counter clockwise)
 - 4) ID of ambulance dispatched
 - 5) Service rendered
 - 6) Entry and exit interchange
- h) Fire Engine Dispatching Report
- 1) Date and time
 - 2) Reason for dispatch
 - 3) Location and direction (clockwise/counter clockwise)
 - 4) ID of fire engine dispatched
 - 5) Service rendered
 - 6) Entry and exit interchange

Operator at day shift shall hand over all reports to the night shift except daily report. When night shift finishes the duty, all reports shall be filed, and their copy shall be submitted to the NHAI.

The Contractor/Contractor shall also prepare and submit to the NHAI as minimum the following deployment reports:

- a) Duty plan of the operation team with the name of traffic management chief and operators on a weekly basis.
- b) Daily attendance record with In-time and Out-Time for all Contractor/Contractor's staff working at Traffic Control Centre.
- c) Daily report of operation as stipulated in the operation manual and as agreed with between NHAI and Contractor/Contractor.

The reports mentioned above are a minimum requirement. The NHAI reserves the right to reasonably demand more reports other than those listed above after the commencement of Services by the Contractor/Contractor

3.9 Customer Assistance and Close coordination with other organizations

ATMS operator shall provide such information as to the road condition, traffic condition, expected travel time, and route guidance to the Project user through Emergency call or mobile phone if requested by the Project user as part of customer service.

ATMS management (operation and maintenance) must be conducted with close coordination and cooperation with other agencies concerned. Liaison and coordination among related agencies such as traffic police, ambulance and fire brigades must be maintained all the time.

4 Contractor/Contractor's Personnel

4.1 Contractor/Contractor's Key Personnel

For the purpose of discharging its obligations under the Contract, the Contractor/Contractor shall recruit and deploy the specified number of key personnel of suitable qualification and experience. The Contractor/Contractor shall ensure that the key personnel deployed are of good health, of highest integrity, punctual, well dressed, well behaved and of qualification and experience prescribed hereunder.

The frequent replacement of key personnel is not desirable unless they are found involved in malpractices or non-compliances. However, a permission of replacement of key personnel shall be obtained from the ITS Engineer / NHAI in advance together with the request for approval of replacement. The ITS Engineer / NHAI, if satisfied with the reasons submitted to him, may allow such replacement after verifying the CVs strictly in accordance with the requirements.

4.2 Deployment of Personnel

The Contractor/Contractor shall recruit and deploy the suitable number of traffic management chief and operator. The minimum number of the staff that the Contractor/Contractor shall deploy is presented in the preceding section of these NHAI's Requirements.

The Contractor/Contractor shall furnish to the NHAI, in addition to the list of key personnel provided with the tender, a list of persons deployed for the purpose of discharging its obligations under the Contract, containing all the details like their educational qualifications, experience, training undergone, health condition, personal residential addresses and recent photograph.

The personnel to be appointed shall not have any previous criminal record. A certificate to this effect from concerned State Police Authorities shall be made obligatory for verification prior to appointment at Traffic Control Centre.

The NHAI reserves its right to object to the deployment of any personnel for any reason. In such case, the person or persons being objected to by the NHAI shall be removed by the Contractor/Contractor forthwith and replaced within a day from such removal.

The NHAI shall not be liable for any misconduct or misdeeds or any act or incident involving the Contractor/Contractor or any of its personnel in any criminal or civil case.

The Contractor/Contractor shall be responsible for consequences and if any such incident takes place, the Contractor/Contractor shall forthwith intimate the said incident to the NHAI.

4.3 Relationship between Contractor/Contractor's staff and NHAI

The Contractor/Contractor specifically agrees that the personnel deployed by it, will not in any way claim employment with the NHAI. The Contractor/Contractor shall be solely responsible for any dispute raised by the personnel deployed by him either during the term of the Contractor/Contractor or thereafter.

In all circumstances it is clearly understood by the parties that the personnel deployed by the Contractor/Contractor shall have no connection whatsoever with the NHAI and the relationship of NHAI and Employee shall be only between the Contractor/Contractor and the personnel deployed by it.

4.4 Welfare of Contractor/Contractor's Employee

The Contractor/Contractor shall be solely responsible and liable for complying with statutory liability for welfare of the employees such as ESI, EPF, workmen's compensation, wages, bonus medical leave, etc.

However, if considered necessary, the NHAI shall have every right to enquire and seek documentary evidence from the Contractor/Contractor to confirm, whether all the statutory dues like ESI, EPF, minimum wages, weekly offs, bonus, medical leave, workman compensation and any other entitlements, in accordance with the statutory dues applicable in the area are being paid.

4.5 Uniform and Name-plate

The Contractor/Contractor shall provide uniforms to the persons engaged in ATMS Operation Services at Traffic Control Centre as approved by NHAI. All staff personnel of the Contractor/Contractor shall wear the uniform and nameplate when on duty without exception. The nameplate shall bear the name and designation along with the name of toll collecting Contractor/Contractor.

4.6 Operation Manual

The Contractor/Contractor shall prepare and submit to the ITS Engineer / NHAI for approval, the following operation manuals for their staff two (2) months before the expected starting date of O/M period:

- 1) Emergency call /mobile operating manual
- 2) TMCS/VMS operating manual
- 3) Traffic/System operating manual
- 4) Control Room (TMC) and Sub-centre operating manual

The manual shall describe the organizational setup of the Contractor/ Contractor, the authority and responsibility of each position, person to report, operation procedure of equipment comprising ATMS, report to be prepared and other details that staff at each position must follow.

4.7 Training

The Contractor/Contractor shall conduct training of the staff as specified herein at the time of new recruitment and also from time to time to ensure high quality ATMS Operation

Services. The training shall consist of classroom lecture using manual and hands-on training using the Advanced Traffic Management System equipment.

The training shall include but not be limited to the following subjects:

- a) Basic of traffic engineering
- b) Standard incident disposal procedure
- c) System log-in, log-out procedure of ATMS
- d) Each console and console operation
- e) Printer operation
- f) Access Control System operations and maintenance
- g) Storage device operation
- h) Network equipment operation
- i) Power supply equipment operation

The Contractor/Contractor shall describe the contents and the expected duration (number of hours) of the training in his Service Proposal.

4.8 Safety, Security and Protection of Environment

4.8.1 Safety of Staff Deployed

Throughout the period of Contract, the Contractor/Contractor shall have full regard for safety of all persons entitled to be upon the Traffic Control Centre area and for the avoidance of danger to such persons specially from moving traffic.

All staff employed by the Contractor/Contractor shall receive the training on the work area safety before assigned to the position. The Contractor/Contractor shall provide all necessary safety equipment such as reflective vests, hardhats to the persons.

5. NHAI's Equipment and Property

5.1 Provision of Equipment and Property

In order to enable the Contractor/Contractor to discharge its duties of ATMS Operation Services efficiently and uninterruptedly, the NHAI shall provide such infrastructural facilities including Advanced Traffic Management System hardware and software as may be considered appropriate by the NHAI.

5.2 Care of Equipment

The Contractor/Contractor shall use the NHAI's equipment and property that the Contractor/Contractor is allowed to use with utmost care and attention. If the equipment or property under custody of the Contractor/Contractor becomes inoperative or defective due to the inappropriate operation or use of them by the Contractor/Contractor's staff, the Contractor/Contractor shall repair or replace them at his own cost after obtaining the instruction from the NHAI as to the remedial measure to be taken.

If any liability or obligation with regard to the repair or replacement of NHAI's equipment and property is remained unfulfilled by the Contractor/Contractor at the time of return upon termination of the Contract, the amount necessary for the repair or replacement shall be detected to the payment due to the Contractor/Contractor.

All consumables including but not limited to the printer paper and printer toner shall be arranged and purchased by the Contractor/Contractor at his own cost.

6. Inspection and Evaluation

6.1 Inspection

The NHAI / ITS Engineer reserves the right to conduct inspection of the Contractor/Contractor's work at any time without prior notice, to check, observe, and witness the activities of the Contractor/Contractor at Traffic Control Centre.

The Contractor/Contractor shall permit the NHAI's Representative at any time or times during the execution of the Contract to enter upon any place where the Contractor/Contractor is allowed to access within the NHAI's premises for the purpose of inspection or for any other legitimate purpose. The Contractor/ Contractor shall give all required information and inspection of records to the Engineer regarding the operation of the Advanced Traffic Management System, if asked for.

The purpose of the inspection is to monitor the Contractor/Contractor's activities and to ensure that all the activities required under the Contract are being carried out properly by the personnel deployed by the Contractor/Contractor.

The NHAI may exercise any check control to ensure discharge of various obligations by the Contractor/Contractor under the Contract including but not limited to following:

- a) Adherence to operation procedure stipulated in the operation manuals;
- b) Promptness and responsiveness to Emergency call;
- c) Promptness and adequateness to communicate with other organizations;
- d) Handling of the system and equipment;
- e) Adequateness and promptness of VMS message;
- f) Adequateness of record keeping;
- g) Cleanliness and tidiness of the Traffic Management Centre and the rooms that are used by the Contractor/Contractor's staff;
- h) Manner and politeness of Contractor/Contractor's operator toward Emergency callers and Project users;
- i) Traffic safety awareness; and
- j) Any other check or control as considered appropriate by the NHAI.

6.2 Evaluation by NHAI

The NHAI will conduct from time to time the evaluation of the ATMS Operation Service provided by the Contractor/Contractor under the Contract based on the performance of service level parameters specified in Service level Table.

7. Requirements for ATMS Maintenance Services

The various type of maintenance and repair works and related services to be performed by the Contractor/Contractor shall include the following:

7.1 Preventive Maintenance

The Contractor/Contractor shall perform the preventive maintenance of all equipment and software supplied under the Contract in accordance with the preventive maintenance schedule to be developed by the Contractor/ Contractor and approved by the Engineer.

7.1.1 Inspection Item for Preventive Maintenance

The Contractor/Contractor shall prepare and submit to the Engineer a list of inspection items for all preventive maintenance work under the Contract two (2) months before the expected starting date of O&M period. The inspection item list shall indicate the type of inspection to be performed daily/weekly, monthly, bi-annually and annually. The inspection item shall cover all the equipment to be supplied under the Contract.

7.1.2 Schedule for Preventive Maintenance

The Contractor/Contractor shall prepare and submit to the NHAI a schedule for all preventive maintenance work under the Contract two (2) months before the expected starting date of O&M period.

The schedule shall be in sufficient detail to indicate which part of the monthly inspections is to be performed in each week and which part of the bi-annual and annual inspections is to be performed in each month and the number of maintenance engineers and technicians to be assigned to the work.

The Contractor/Contractor will be required to revise the schedule if the workload and the manpower assignment are unbalanced or unrealistic. Failure to submit an acceptable schedule within the specified time shall be a sufficient cause for suspension of the Contract and / or withholding of payments due the Contractor/Contractor.

7.1.3 Check List

The Contractor/Contractor shall develop and prepare check lists to be used for preventive maintenance for each type of equipment and software and submit them for the Engineer for his approval. The checklists shall include the type of equipment, equipment ID, location, date of inspection, name of inspector, check item, and remarks.

The check list shall be used every time a periodical inspection of the equipment is made, and results of the inspection shall be recorded together with other details.

The Contractor/Contractor is required to submit a copy of all recorded check lists every month and as requested by the Engineer at any time. Failure to maintain or submit the check lists shall be a sufficient cause for suspension of the Contract and / or withholding of payments due the Contractor/Contractor.

7.1.4 Software Preventive Maintenance

The Contractor/Contractor shall perform preventive maintenance of the software to be provided under the Contract as part of the maintenance work. The Contractor shall exert the utmost care not to inadvertently damage the software and database and cause erroneous or abnormal operation of the Advanced traffic management system.

The items for software maintenance shall include but not be limited to the following:

- 1) Monitoring of CPU, memory and disk space utilization
- 2) Monitoring of system availability over TCP/IP
- 3) Monitoring of anti-virus and system security software operation
- 4) Backup of the system and restoration of the system when necessary.
- 5) Monitoring and review of system and event logs.
- 6) System modification

The work to be done consists of modifying the system, system parameter and other operating conditions and to improve the operation or to conform to new operational requirements. The work shall be done as directed by the Engineer.

7.2 Corrective Maintenance and Accident Repair

The Contractor/Contractor shall provide corrective maintenance and accident repair on a 24-hour a day, 7-day a week basis. Upon reception of a failure notice by the contact person, the Contractor/Contractor shall log the notice and determine the nature and severity of the failure, prepare the repair plan and dispatch the maintenance crew to the site. Immediate action shall be

If the fault cannot be permanently repaired immediately, a temporary repair or remedial measure sufficient to safeguard the operation of the Advanced traffic management system shall be affected by the Contractor/Contractor and the NHAI shall be so notified.

The cost of corrective maintenance of the failure that is not attributable to the Contractor/Contractor will be determined by mutual negotiation. The Contractor/Contractor shall assess the extent of the damage, prepare the remedial plan and estimate the cost.

7.2.1 Response Time and Resolution Time

For all cases, the failure shall be classified into three severity levels, critical, major and minor. The Contractor/Contractor shall satisfy the response time and resolution time specified for each type of failure as presented hereunder.

Severity	Response time	Resolution time
Critical failure	30 minutes	2 hours
Major failure	60 minutes	6 hours
Minor failure	2 hours	48 hours

Critical failure is defined as follows:

- 1) Halt of both active and backup server systems at TMC or sub-Centre.
- 2) Failure of Internet server.
- 3) Interruption of active or backup route of communication link to TMC system.
- 4) Failure of two or more console at TMC.
- 5) System failure of a server system of each sub-system
- 6) Failure of uninterruptible power supply. Major problem is defined as

follows:

- 1) Failure of a console at TMC.
- 2) Failure of large display at TMC.
- 3) Failure of two or more units of TMCS display monitor.
- 4) Loss of control of VMS.

Minor failure is defined as those failures other than critical and major failures listed above.

7.2.2 Inspection of Faulty Parts

The Contractor/Contractor shall inspect the faulty part retrieved from the equipment repaired and prepare and submit a report describing the nature of the failure to the Engineer together with his

opinion whether the failure is caused by defect, inadequate operation, act by the third party, normal wear and tear or other reasons.

7.2.3 Fault Report and Work Order

Each and every corrective maintenance and accident repair work shall be documented on the fault report form and work order form by the Contractor/Contractor. The Contractor/Contractor shall prepare and submit the form together with the list of inspection items for the approval of the Engineer. A copy of completed work order forms shall be submitted with the monthly invoice. No payment shall be made without submitting the completed work order forms. The Fault Reports shall be kept in a logbook and shall be made available to the Engineer upon request at any time.

7.2.4 Maintenance and repair records

The Contractor/Contractor shall maintain a comprehensive record of all maintenance and repair activities and spare parts consumptions and inventory. The records shall include as a minimum maintenance check lists, fault reports, spare parts receiving and consumption records, and work orders. These records shall be kept in a database and various operations including but not limited to search and retrieval of fault record by specified key, statistical processing of records into performance index, and calculation of MTBF, MTTR and other parameters shall be possible.

8. Reporting

The Contractor/Contractor shall prepare and submit a monthly report in the form and contents as specified herein and as agreed with the Engineer

9. Operation & Maintenance Personnel

The Contractor/Contractor shall employ traffic management chief and the suitable number of operators. It shall be noted that the number indicated in the table is the minimum requirements by NHAI and it is the Contractor/Contractor's responsibility to provide high quality service seamlessly and effective staff arrangement shall be recruited if necessary. International Staff shall carry out the technology transfer as an important aspect including Advance traffic management technology through operation and maintenance works to NHAI officers and Contractor/Contractor's local staffs.

The staff member shown in the table is the persons directly engaged in the ATMS Operation and Maintenance Services and the Contractor/Contractor shall recruit and deploy the necessary number of managers, operators and technicians.

The Contractor/Contractor shall provide all personnel necessary for performing the ATMS operation and maintenance by the personnel listed in Table. The Contractor/Contractor shall submit curriculum vitae of the candidate key person for the Engineer's approval two (2) months in advance of the start of operation and maintenance work. These engineers shall be involved in the installation, adjustment, test on completion and training of the NHAI's staff of the Advanced traffic management system to be supplied under the Contract.

The Contractor/Contractor shall submit the list of all ATMS Operation and maintenance staff with name, birth date and address together with copy of ID every month to the ITS Engineer. If there is any change in the composition of the operation and maintenance staff, it shall be reported immediately to the NHAI. The NHAI will issue an ID to each staff member. The Contractor/Contractor shall be responsible for the proper use of the ID to gain the access to the access- controlled places and system facilities and return it immediately if a staff member no longer works for the ATMS Operation and maintenance.

Three-shift (+1 backup) system shall be adopted for ATMS operation. The candidate shift is as shown below.

First shift: 05:45 -14:00 hours

Second shift: 13:45 - 22:00 hours

Third shift: 21:45 - 06:00 hours

9.1 Position and responsibility for position

1) The position, responsibility, and number are estimated by NHAI as follows;

S. No.	Position	Number	Responsibility
1	*Traffic Management Chief	1	Supervising and managing of highway traffic management with Traffic Management Chief
2	*Traffic Management Engineer	1 at TMC & 1 at each sub-centre	Technical aspect of Advanced traffic Management system
3	*Asst Manager – Operations	1 at TMC & 1 at each sub-centre	Management of Control room
4	Control Room Operator	5 at TMC & 3 at each sub-centre in each shift	Operating activity of the system (Three Shift)
5	*System Maintenance Engineer	1 for every 50 kms	Management of System maintenance
6	System IT Engineer	1 for every 50 kms	Management of IT System
7	System Maintenance Technicians	1 for every 50 kms in each shift	Actual Maintenance activity (Three Shift)
8	Support Staff	1 at TMC & 1 at each sub-centre	
9	Office Assistant	1 at TMC & 1 at each sub-centre in each shift	
10	Security Guard	1 at TMC & 1 at each sub-centre in each shift	
11	Maintenance Vehicle with Driver and helper	1 for every 50 kms	
12	Man-hoist vehicle with Driver and helper	1 for each project of up to 100 kms	Add 1 for every 2 nd sub-centre

Note; Position with asterisk (*) is identified as Key Staff

2) The minimum experience of each position is shown as follows;

Position	Minimum Experience
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*Traffic Management Chief	Total Professional experience ; 15 years Similar works [#] ; 7 years Manager of similar works ; 3 years
*Traffic Management Engineer (BE/B tech Only)	Total Professional experience ; 10 years Similar works [#] ; 5 years
*Asst Manager	Total Professional experience; 7 years Similar works [#] ; 5 years
Control Room Operator	Similar works [#] ; 2 years
*System Maintenance Engineer (BE/B tech Only)	Total Professional experience; 10 years Similar works [#] ; 7 years
*System IT Engineer (BE/B tech Only)	Similar works [#] ; 5 years
System Maintenance Technicians	Similar works [#] ; 2 years

Note; The position with asterisk (*) shall be at least a graduate in electronics, information technology, systems engineering, computer science, civil engineering, highway engineering or traffic engineering.

#Similar works shall mean that the candidate shall have working experience in ATMS/ ITS/ HTMS/ Traffic Management on a 4 lane/6 lane expressway/ highway project/ urban ITS project.

10. Maintenance Facilities

10.1 Maintenance Equipment and Tools

The Contractor/Contractor shall maintain required set of maintenance equipment and tool, and monitoring and testing software normally required for the maintenance of the electrical and server system. The maintenance equipment and tools shall be maintained in good workable condition so that they shall be available all the time. If periodical calibration is required, it shall be calibrated at the regular interval as specified by the supplier of the maintenance equipment. The maintenance staff shall be trained as to the use of the maintenance equipment and tools. The purchase or depreciation cost of the maintenance equipment and tools shall be deemed to be included in the appropriate cost item in the Tender and no separate payment shall be made.

10.2 Maintenance Office

The Contractor/Contractor will be allowed to occupy and use the maintenance room in the TMC/Sub centre free of charge for operation & maintenance purpose. The Contractor/Contractor shall observe the regulations regarding use of the maintenance office. Only persons authorized by the Engineer shall be allowed to use the office and the office shall be used solely for the operation & maintenance of the ATMS. The Contractor/Contractor shall prepare at his cost desks, chairs, shelves, cabinets, telephone, Internet access and other furniture and facilities necessary for the efficient maintenance operation.

10.3 Maintenance Vehicle

The Contractor/Contractor shall provide the suitable number of vehicles for their operation & maintenance use. The vehicle shall be of the type suitable for maintenance work in terms of the number of passengers and load carrying capacity. The vehicle shall meet the relevant government regulations and registered under the name of the Contractor/Contractor. The vehicles shall be maintained in good condition to run on the Project. The vehicle shall clearly indicate as maintenance vehicle on the side of the vehicle and a yellow flashing light shall be provided on the roof of the

vehicle. A set of traffic safety devices consisting of safety cones, stand-alone flashing light, and reflective guide and warning signs shall be provided to the maintenance vehicle. The cost of obtaining, operating and maintaining the maintenance vehicle shall be included in the contract and no separate payment shall be made.

11 Service Level Requirements (SLR)

Service level means the service delivery criteria established for the services specified in Service Level Table. The purpose of Service Levels specified in the Service Levels Tables is to clearly define the levels of service which shall be provided by the Contractor/Contractor to NHAI during O&M period i.e. Five Years from the date of Completion of ATMS. The service level parameters mentioned in the service level table shall be measured on a quarterly basis as per the individual service level parameter requirements, through appropriate service level measurement tool of Facility Monitoring System (FMS) and Network Management System (NMS). Measurement of service levels for systems shall be automatic using reports from appropriate management tool of FMS. Measurement of service levels for services, which are not delivered using a dedicated tool, will be carried out using appropriate and relevant reports from the Service Desk tool.

Measurement of Service Level parameters will be carried out on cumulative basis in a quarter. The Contractor/Contractor needs to try to ensure that the service levels as per service level table. Contractor/Contractor needs to submit service level report in a quarter

If the performance of the system/services is degraded significantly at any given point in time during the contract and if the immediate measures are not implemented and issues are not rectified to the complete satisfaction of NHAI, then NHAI will have the right to take appropriate corrective actions including termination of the Agreement.

The Contractor/Contractor and NHAI shall regularly review the performance of the services being provided by the Contractor/Contractor and the effectiveness of this Service Levels. The ATMS Contractor is responsible for development and implementation of appropriate management tools of FMS. which shall be basis for all project reviews.

For all cases, the failure shall be classified into three severity levels, critical, major and minor. The Contractor/Contractor shall satisfy the Service Levels specified for each type of service as presented in Service Levels table.

- 1) The Formula of calculation of availability is shown as follows.

$$\text{Availability} = \{1 - \{[(A)/(B-C)] * 100\}\}$$

Where

A= Time for which system is down B = Total Time and

C= Scheduled downtime

Note: Total Time shall measure on 24x7 basis

- 2) Service Level Requirement Table is shown below

No	Parameter	severity levels	Target
1. Traffic Management Centre Equipment & Sub-centre equipment			
1.1	Server Availability (TMC and internet servers including the OS, database and any other application running on it)	Critical	99%
1.2	Console Availability (TMCS)	Critical	99%

No	Parameter	severity levels	Target
1.3	Console Availability (TTMS, ATCC)	Major	97%
1.4	Console Availability (FMS)	Minor	95%
1.5	Console Availability (VMS, Internet)	Major	97%
1.6	Operational Availability (VIDS)	Critical	99%
1.7	Operational Availability (1033)	Critical	99%
1.8	Operational Availability (VSDS)	Minor	95%
1.9	Operational Availability (FMS)	Minor	95%
1.10	Storage Availability (Including power availability, network availability, availability of links to applications and databases)	Critical	99%
1.11	Graphic Display	Major	97%
1.12	Camera Monitor	Major	97%
1.13	Network Connectivity Between Main TCC – Sub centre – Roadside equipment	Critical	99%
2. Field Equipment			
2.1	Average Uptime Timeperiod of the TMCS Camera.	Major	97%
2.2	Average Uptime Time period of the VIDS Camera .	Major	97%
2.3	Average Uptime Timeperiod of the VMS	Major	97%
2.4	Average Uptime Timeperiod of the VSDS	Minor	95%
2.5	Average Uptime Timeperiod of the ATSC and RLVD	Minor	95%

11.1 Service Levels Review Process

- 1) Either NHA or Contractor/Contractor may raise an issue by documenting the business or technical problem, which presents a reasonably objective summary of both points of view and identifies specific points of disagreement with possible solutions.
- 2) A meeting or conference call will be conducted to resolve the issue in a timely manner. The documented issues will be distributed to the participants at least 24 hours prior to the discussion if the issue is not an emergency requiring immediate attention.
- 3) The NHA and the Contractor/Contractor shall develop an interim solution, if required, and subsequently the permanent solution for the problem at hand. The Contractor/Contractor will then communicate the resolution to all interested parties.
- 4) In case the issue is still unresolved, the arbitration procedures described in the “Draft format of Contract agreement” will be applicable.

12 Performance Damages / Penalty

The Service Provider would be penalized for non-compliance in meeting SLR for Operations as well as Maintenance of the Project. Any penalty levied by NHA or NHA's representative shall be applicable and deducted from the quarterly payable amount. The Service Provider should enable and facilitate continuous measurement of all-round performance of the ATMS System and not just event-based performance. The penalties are detailed here under:

- a. For non-compliance of SLR under maintenance requirement, penalty @ 120% of per day rate shall be imposed if the down time exceeds the maximum permissible on each instance.
- b. For non-compliance of SLR under operations requirement, the penalty of INR 10,000 per event shall be imposed.
- c. The amount against manpower will be payable only for the duration the O&M

personnel will be available at site. In case the required manpower is not available at any location for more than 15 days in a month, no payment shall be made against manpower (as quoted in the financial bid) for that location for whole month, apart from other deductions / penalties as applicable.

- d. Total cap on each of the Operations & Maintenance related penalties would each be 10% of the quarterly payment. NHAI may also consider termination of contract and forfeiture of performance bank guarantee if the number of non-compliance events exceeds 50 during any quarter, OR the total penalty exceeds the maximum penalty.

13. Spare Parts and Consumables

The Contractor/Contractor shall maintain required spare parts to maintain required service levels. An undertaking to be submitted along with technical bid that the Contractor/Contractor has the sufficient infrastructure and capability to keep/store spares required for maintenances and will at all times during the contract period maintain sufficient inventory of spares and consumables for operating and maintaining the ATMS and to meet the Service Level requirements.

Annex - III
(Schedule-D)

SPECIFICATIONS AND STANDARDS FOR DEVELOPMENT OF WAY SIDE AMENITIES

1. General: National Building Code of India -2005
2. Code for Structural design and details:

CODE OF PRACTICE FOR LOADS AND COMBINATIONS	
IS 875 Part I	Dead Loads - Unit weights of building Materials and stored materials.
IS 875 Part II	Imposed loads.
IS 875 Part III	Wind Loads.
IS 875 Part V	Special Loads and Combinations.
CODES OF DESIGN AND FABRICATION FOR PRE - ENGINEERED BUILDING	
IS 800 : 2007	General construction in steel
IS 808 : 1989	Dimensions for hot Rolled steel sections.
IS 801: 1975	Code of Practice for use of Cold Formed light gauge steel structural members in general building.
IS 811	Code of Practice for use of Cold Formed light gauge structural steel sections.
AISC : 2000	Design Code
IBC : 2002	Building Code
AISI : 2001	Purlin Code
ANS : 2006	Welding Code
SP-38 (S&T): 1987	Handbook of typified designs for structures with steel Roof trusses
IS 816 : 1969	Code of Practice for use of metal arc welding for general construction in mild steel
IS 456 : 2000	Plain and Reinforced Concrete Code of Practice.
IS 1893 : 2002	Criteria for Earthquake resistant design of structures
IS 6403: 1981	Code of Practice for determination of bearing capacity of shallow foundations
IS 1786: 2008	Specification for high strength deformed steel bars and wires for concrete reinforcement
IS 13920: 1983	Code of practice for ductile detailing of reinforced concrete Structures subjected to seismic forces.
SP - 16 (Design Aids for Reinforced Concrete) :1978	Design aids for reinforced concrete to IS 456.
SP - 34:1987	Hand book on concrete reinforcement and detailing

3. All relevant BIS Code of India for Civil, Electrical, Water Supply, Sanitary, HVAC and Solar Panels.
4. Energy Conservation Code - 2007.

5. Roads I Driveway I Parking: IRC 37-1984 I MORTH specifications.
6. Indian Electricity Rules I State Electricity Rules.
7. ASHRAE Standards.
8. All local bylaws.
9. Hand Book of Water Supply and Drainage, BIS, SP-35.
10. CPWD - Specifications published by Director General (Works) CPWD, New Delhi including subsequent amendments, upto date correction slips, revisions.
 - a. CPWD Specifications 2009 (Volume I & II)
 - b. CPWD General Specifications for Electrical Works Part IV Sub Station - 2013
 - c. CPWD General Specifications for Electrical Works Part IV Sub Station - 2013.
 - d. CPWD General Specifications for Electrical Works Part VII D.G. Sets - 2013.
 - e. General Specifications for Heating, Ventilation & Air-Conditioning (HVAC)- 2004
11. Specifications published by Director General (Works), MES, E-in-C branch, Kashmere House New Delhi, including subsequent amendments, up to date correction slips, revisions
 - a. MES SSR Part I 2009,
 - b. TI's issued by E-in-C branch for specified purpose from time to time

Note: Any reference to codes and standards shall be deemed to include all subsequent revisions, up to date corrections slips, updates, amendments etc.