U.P. Expressways Industrial Development Authority
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UTTAR PRADESH EXPRESSWAYS INDUSTRIAL DEVELOPMENT AUTHORITY (UPEIDA)

Government of Uttar Pradesh

Development of Purvanchal Expressway (Package-IV)

From Sidhi Ganeshpur (Dist. Sultanpur) to Sansarpur (Dist. Sultanpur) (Km 121+600 to Km 164+300) in the State of Uttar Pradesh on EPC Basis

MAIN REPORT

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EXECUTIVE SUMMARY

1. Project Rationale

Yamuna Expressway

Govt. of Uttar Pradesh (GoUP) has successfully developed 165 km Noida to Agra 6 Lane Access Controlled Expressway (Yamuna Expressway). Rigid pavement has been constructed for the entire length of the expressway. The project was developed on Public Private Partnership (PPP) mode and is in operation since August 2012.

Agra – Lucknow Expressway

The work of linking the Yamuna Expressway with capital city of Lucknow through a green-field fully high-speed access-controlled road infrastructure namely "Agra to Lucknow Access Controlled Expressway (Green Field) Project" has been completed and the Toll operations started in January 2018.

The entire length of the Agra-Lucknow Expressway is of flexible pavement type and is being developed on EPC mode with Government funding. The Agra-Lucknow Expressway network starting from Noida area to Lucknow city will provide seamless travel between State Capital and National Capital.

The Purvanchal Expressway (The Project):

Now to transfer this benefit to Eastern region of the State, GoUP through UPEIDA is developing this project, a new green-field expressway project connecting Lucknow with Haidariya (Ghazipur Dist.) via Azamgarh. This proposed Expressway project shall create immense opportunities to the people of eastern region of the State and over all development of the State by providing safer & faster connectivity of East to West borders of the State and with National Capital. The regional setting of the proposed expressway with other expressways in the State of Uttar Pradesh is presented below:

The Expressway will serve traffic of eastern part of UP and will connect western part of UP, which are at present taking longer routes through existing NHs, SHs and MDRs. The different Expressway alignments studied under this project aim to connect the common nodal points in future. On implementation of the project, apart from faster connectivity, it will provide economic and social benefits in the region.

The proposed expressway start chainage is Km (-)0+270 at Village Chand Sarai (Dist. Lucknow) from on National Highway NH-56 (chainage Km Km 20/960 on NH56 Lucknow-Sultanpur Road; 1.7 Kms before Gosainganj) and traverses towards south east direction and bypasses Azamgarh city before terminating at Haidariya (Dist. Ghazipur); end chainage of the Purvanchal Expressway is Km 340+500.

Important places and districts along the project stretch are Lucknow, Barabanki, Amethi, Faizabad, Sultanpur, Ambedkar Nagar, Azamgarh, Mau and Ghazipur.

The Purvanchal Expressway is packaged into 8 stretches and the chainages of the Packages is as presented below:

Package No.	Package Names	From Chainage	To Chainage	Length (Km)
I	From Chand Sarai (Dist. Lucknow) to Sansara (Dist. Barabanki)	-0+270	40+200	40.470
II	From Sansara (Dist. Barabanki) to Jaraikala (Dist. Amethi)	40+200	79+900	39.700
III	From Jaraikala (Dist. Amethi) to Sidhi Ganeshpur (Dist. Sultanpur)	79+900	121+600	41.700
IV	From Sidhi Ganeshpur (Dist. Sultanpur) to Sansarpur (Dist. Sultanpur)	121+600	164+300	42.700
V	From Sansarpur (Dist. Sultanpur) to Gobindpur (Dist. Azamgarh)	164+300	218+300	54.000
VI	From Gobindpur (Dist. Azamgarh) to Mojrapur (Dist. Azamgarh)	218+300	246+500	28.200
VII	From Mojrapur (Dist. Azamgarh) to Bijaura (Dist. Ghazipur)	246+500	292+530	46.030
VIII	From Bijaura (Dist. Ghazipur) to Haidariya (Dist. Ghazipur)	292+530	340+500	47.970

The Consultants have undertaken requisite surveys & studies for the project which includes costing to assess technical, environmental and social assessment studies, their analysis etc. As a part of the study to establish the viability, this Project Report has been prepared after carrying out engineering surveys and appropriate assessment of a preliminary design considering the engineering conditions, the present traffic and its growth, the environmental impact assessment as well as the social aspects along with cost assessment. This report among other aspects covers the details on finalization of alignment, grade separator interchanges and structures along the proposed Expressway, marking on the Khasra maps of ROW and marking of alignment on revenue maps, identification of Tourist spots, eco-friendly structures, water bodies etc. along the expressway.

2. Structure of the Project Report

The Project Report shall contain the following Chapters:

- ✓ Executive Summary
- ✓ Chapter 1: Description of Package-I of the Expressway
- ✓ Chapter 2: Methodology and Design Standards
- ✓ Chapter 3: Project Proposals
- ✓ Chapter 4: Traffic, Toll & Financial Studies
- ✓ Chapter 5: Cost Estimates
- ✓ Chapter 6: Economic Studies
- ✓ Chapter 7: Environmental Screening & Preliminary Assessment
- ✓ Chapter 8: Social Screening & Preliminary Assessment

3. Package-IV of the Purvanchal Expressway

The stretch of green-field alignment from Sidhi Ganeshpur (Km 121+600) (Dist. Sultanpur) to Sanasarpur (Km 164+300) (Dist. Sultanpur) has been classified as Package-IV of the Purvanchal Expressway. This Main Report here pertains to the Package-IV of the Purvanchal Expressway.

4. Key Traffic Study Findings

Various traffic surveys and analysis have been carried out for addressing the objectives of the project stretch. The surveys conducted for whole stretch of expressway include 7 days traffic volume count at 8 locations, 3 days traffic volume count at 4 locations, and 1 day origin – destination and commodity movement survey at 8 locations etc. The study aims at obtaining the existing traffic and travel characteristics on the project corridor and forecasting for project horizon year considering various constituent streams and for various scenarios. The results of analysis will form inputs for designing the pavement, decisions regarding grade separators, pedestrian facilities, and wayside amenities along with design of intersections along the project road.

Type Of Survey	Name of Road	Chainage	Location Name/Land Mark
7 Days Classified Volume Count	NH-2	KM 482	Rooma Village
	NH-28	KM 39	Lakshvar Village
	NH-56	KM 81+800	Mahanpur Village
	NH-56	KM 211(NH-731)	Sekhapur Village
	NH-28	KM 143	Lolpur Village
	NH-29	KM 84	Ghusurupur Village
	NH-233	KM 130+100	Hasanpur Village
	SH-13(BIHAR)	KM 13	Chausa Village
Origin - Destination Survey	NH-2	KM 482	Rooma Village
	NH-28	KM 39	Lakshvar Village
	NH-56	KM 81+800	Mahanpur Village
	NH-56	KM 211 (NH-731)	Sekhapur Village
	NH-28	KM 143	Lolpur Village
	NH-29	KM 84	Ghusurupur Village
	NH-233	KM 130+100	Hasanpur Village
	SH-13 (BIHAR)	KM 13	Chausa Village
Axle Load	NH-2	KM 482	Rooma Village
	NH-28	KM 39	Lakshvar Village
	NH-28	KM 143	Lolpur Village
3 Days Classified Volume Count	SH-36/ NH-24B	KM 39	Lalpur Village
	NH-29	Koperganj Village	Koperganj Village
	NH-56	KM 110	Kasthuni Purab Village
	SH-9A/ NH-232	KM 33+200	Baharpur Village
One Day Classified Volume Count	NH-56	KM 142+500	Kamrauli Village
	SH-9 / NH-96	Paroma Village	Paroma Village
	SH-67	Kusadhana Or Kusarna Village	Kusadhana Village
	NH-19	Bhawarkol Village	Bhawarkol Village
	SH-34	Haldarpur Village	Haldarpur Village

The expressway is a new alignment so the survey locations have been selected at the connecting highway to the project road. The project road is connecting to NH-56, SH-13, SH-15, SH-9A/NH-232, SH-5, NH-233, NH-29 and NH-19. Based on the traffic study, the potentially divertible traffic from the neighboring highways has been worked out on the project road.

The average daily traffic (ADT) has been converted to average annual daily traffic (AADT) using seasonal correction factor. The AADT is the input for various analyses like traffic forecast, capacity augmentation, pavement design, etc. The summary of AADT is given in Table E.1 in base year 2015-16.

Table E.1: Summary of AADT (2015-2016)

Section	AADT (Nos.)	AADT (PCUs)
Km. 121+600 to Km 164+300	4823	10795

Traffic Forecast

Traffic demand plays the most important factor in deciding the type of facility (infrastructure) to be provided. This in turn determines likely benefits and costs to develop the same. A highway project of this nature calls for significant investment. Prediction of traffic demand becomes an important task and has to be carried out accurately. For the design of pavement and to plan for the future maintenance program, it is necessary to have realistic estimate of the size of traffic in the design period of 30 years.

Traffic forecasting is made by determining the past trend of traffic flow along the corridor and by use of economic models developed to co-relate past vehicle registration data and economic indices such as per capital income (PCI), net state domestic product (NSDP) and gross domestic product (GDP). By using the elasticity values obtained from the economic models and the likely rate of growth of indicators, the mode wise growth rates are obtained. By applying this growth rates, future traffic volume is estimated.

The project road facilities have been designed for level of service 'B' for a period of 30 years. For more details please refer to the Chapter 3 (Traffic Survey and Analysis).

5. Key Engineering Survey Findings

The detailed reconnaissance survey has been carried out to identify and plan various surveys and investigations. Topographic survey has been carried out using differential global positioning system (DGPS), total station and digital level as per standards prescribed.

The material investigations have been carried out and various quarries / borrow areas have been identified and tested. The soaked CBR values of borrow areas vary from 8.0% to 8.59%. For pavement design purposes we have adopted 6% as design CBR (effective). A detailed Geo-Technical investigation works have been carried out to know about the subsurface features and soil profiles and relevant soil and rock properties in order to design the founding structures for the proposed structures along the expressway.

Pavement design has been carried out based on design life, projected traffic, VDF, MSA and CBR values.

6. Design Proposals

Preliminary design

- Geometric design: The horizontal and vertical design has been carried out for the project as per the Guidelines for Expressway published by Ministry of Road Transport and Highways (MoRT&H)

- Alignment proposal: Field investigations and reconnaissance survey along the approved alignment as given in the Inception report was carried out. The proposed alignment has been arrived by the Consultants in consultation with UPEIDA.

- Typical Cross Section: Based on the traffic considerations, geometric standards and existing site conditions, typical cross sectional elements are framed for project expressway.

Service Roads

Single Lane service roads of 3.75 m width on one side in staggered manner have been proposed throughout the length of the proposed expressway. The service roads have been discontinued at ROBs and major bridge locations.

The service roads have been proposed 7 m wide in a length of 200 m in both side of approaches of the minor bridges. At the Interchange locations, from the Interchange to the nearest Underpass; service road has been proposed 7 m wide.

There is a section of 3.2 Km proposed in this Package to serve as Expressway and Aircraft Landing Strip for Indian Air Force (IAF) operations.

Pavement Design

Flexible pavement has been adopted for new carriageways throughout the project length except at toll plaza locations. In the toll plaza area, rigid pavement has been adopted.

New Flexible Pavement Design

The pavement design basically aims at determining the total thickness of the pavement structure as well as thickness of individual structural components. The following assumptions are considered for the preliminary pavement design. The basic assumptions considered while designing are as follows:

- Design life of 20 (after construction period) years has been considered for flexible pavement design.
- Sub grade Effective CBR (for design) has been taken as 6%.
- Design life for Cement Concrete pavement has been assumed as 30 years.

The pavement has been designed for stage construction. The design life of 20 years for granular sub base and base layers and 15 years for bituminous layers with design CBR of 6% has been adopted. Accordingly the corresponding proposed crust composition and design MSA is mentioned in Table E.2.

Table E.2: Proposed Crust Composition for New Construction

Section	Design Life (Years)	Design MSA Granular	Design MSA Bituminous	Design CBR (%)	New Crust Composition (mm)				
					BC	DBM	WMM	GSB	Total Thickness
121+600 to 164+300	20/15	88	61	6	50	160	100	200	510

Service roads have been designed for 5 MSA with design CBR of 6%. The crust composition of service roads is given in Table E.3.

Table E.3: Proposed Crust Composition for Service Roads

Design MSA	Design CBR (%)	New Crust Composition (mm)				
		SDBC	DBM	WMM	GSB	Total Thickness
5	6	25	75	100	200	400

Rigid Pavement Design

Rigid Pavement has been proposed at the toll plaza location. 30 years design life and 8% design CBR has been assumed for finding out the pavement composition at toll plaza location. The proposed composition of rigid pavement is given in Table E.4.

Table E.4: Proposed Crust Composition for Rigid Pavement

Proposed Rigid Pavement Composition			
GSB (mm)	**DLC (mm)**	**PQC (mm)**	**Total Thickness (mm)**
150	150	280	580

Proposal for Structures

There are 1 major bridge, 13 minor bridges, no ROB, 6 VUPs, 3 Flyovers, 12LVUs, 11 PUPs, 45 box culverts on main carriageway and 2 Hume Pipe Culverts & 14 minor bridges , 59 box culverts on service road & 10 box culverts on loops of Interchange proposed along the project stretch.

7. Initial Environmental Impact Assessment

The Environmental Impact Assessment (EIA) is aimed at determining the environmental impacts due to the construction and operation of the project road. The major environmental disciplines in the EIA study include topography and land use, soil and agriculture, geology and seismicity, water quality, climate and meteorology, air quality, noise level, terrestrial and aquatic ecology.

Project specific environmental management plan is being prepared for ensuring the implementation of the proposed measures during construction phase of the project.

The UPEIDA has certain organizational and institutional capacity for satisfactory implementation of the EMP.

8. Social Assessment

The main objective of conducting social screening is to provide inputs of social concerns to be detailed in project design and to avoid or minimize the adverse social impacts with the best possible engineering solutions at minimum cost in close coordination between engineering, environmental and social experts during the entire design process. The social screening exercise is intended to assess the negative impacts (direct, indirect or cumulative) and to suggest mitigating measures to avoid or at least minimize the adverse impacts on nearby communities and natural environment, peoples and properties falling on the direct path of road development, people indirectly affected by the way of disruption of livelihood, breakage in community linkages, impacts arising from land acquisition and resettlement, on indigenous people (SC, ST etc.) and on human safety etc.

9. Cost Estimation

This being a Project Report, cost estimate is carried out based on preliminary design. Estimation of preliminary cost has been carried out for construction of new bridges, cross drainage structures, longitudinal drains, junction improvements, road furniture, bus bays, way side amenities, toll plaza, etc. and the same is presented in Table E.5.

Table E.5: Project Cost

Sr. No.	Particulars	Amount
1	Bill No. 1: Site clearance and Dismantling	3.49
2	Bill No. 2 : Earth Work	242.18
3	Bill No. 3 : Grannular Sub Base Courses and Base Courses (Non-Bituminous)	196.36
4	Bill No. 4 : Bituminous Courses	236.59
5	Bill No. 5 : Box Culverts	55.33
6A	Bill No. 6A : Minor Bridges	197.43
6B	Bil No. 6B : Major Bridges	25.94
6C	Bill No. 6C : VUP/LVU/PUP	74.47
6D	Bill No. 6D : ROB	0.00
6E	Bill No. 6E : Flyover and NH & SH Crossing	96.03
6F	Bill No. 6F : Interchange and Junctions	63.39
6G	Bill No. 6G : Retaining Wall	13.77
7	Bill No. 7 : Drainage & Protective Works	77.23
8	Bill No. 8 : Traffic signs, Road markings and other road appurtenances (1/3 rd Cost of Anti Glare Screen approved by EFC)	75.74
9	Bill No. 9: Toll Plaza	32.79
10	Bill No. 10: Approach to Wayside Amenities, Toilet block & Median Opening	8.06
11	Bill No. 11 : Environmental Cost (Civil Works)	11.03
12	Bill No. 12 : Miscellaneous Works	17.79
13	Bill No. 13 : Additional Service Cost & Median Opening	0.00
15	Bill No. 15 : Airstrip	184.69
	Civil Cost	**1612.32**
	Project cost including Labour cess	**1628.44**

The above project cost is exclusive of Goods and Services Tax

Chapter-1

DESCRIPTION OF PACKAGE-IV OF PURVANCHAL EXPRESSWAY

1 Introduction

This Main Report here pertains to the Package-IV of the Purvanchal Expressway.

1.1 Package-IV from Sidhi Ganeshpur (Dist. Sultanpur) to Sansarpur (Dist. Sultanpur) (Km 121+600 to Km 164+300)

The stretch of green-field alignment from Sidhi Ganeshpur (Dist. Sultanpur) to Sansarpur (Dist. Sultanpur) (Km 121+600 to Km 164+300) has been classified as Package-IV of the Purvanchal Expressway.

1.1.1 Terrain and Land Use

The terrain of this stretch can be termed as plain and flat throughout.

1.1.2 Alignment

The proposed alignment of the Expressway is a Greenfield alignment.

1.1.3 Major Intersections

Proposed alignment intersects one major road along the project stretch (Package-III) across the following location:

- SH 9 at Km 121+870 - Trumpet Type Interchange
- SH 9A at Km 138+155 - Trumpet Type Interchange
- Samadhi at Km 160+375 – Flyover

1.1.4 Right of Way (ROW)

The ROW has been taken as 120m for the proposed expressway except at interchange locations, way side amenities, toilet block locations and at locations for training the course of nalah/drain, where the ROW varies.

1.1.5 Bridges and Cross Drainage Structures

One major bridge, 13 minor bridges, no ROB, 6 VUPs, 3 Flyovers, 12 LVUs, 11 PUPs, 45 box culverts on main carriageway and 2 Hume Pipe Culverts & 14 minor bridges, 59 box culverts on service road & 10 box culverts on loops of Interchange have been proposed along the project stretch. The detailed list of structures is given in Chapter 3 of this report.

1.1.6 Utilities

As the proposed expressway alignment traverses through agricultural land, hence chances of having underground utilities are very less and most of the stretch is remote. There are a few existing electrical and telephone poles, Transformer, HT Pylons and hand pumps along the green field section which would require relocation. Details of the different identified utilities along the alignment are given in Table 1.2.

Table 1.2: Summary of the Utilities along the Alignment.

Type of Utility	LHS	RHS	Total Numbers
Electric Pole	60	59	119
Transformer	Nil	Nil	Nil
Telephone Pole	Nil	Nil	Nil
HT Tower	3	1	4
Hand Pump	8	4	12

1.2 Existing Project Facilities

Proposed Expressway alignment is a Green field alignment with majority length passing through agricultural/rural land; hence there are no existing facilities at present.

Chapter-2

METHODOLOGY & DESIGN STANDARDS

2 General

All the services are carried out strictly as per ToR. The Guidelines for Expressway published by Ministry of Road Trans-port and Highways (MoRT&H) have been followed for preparing this Project Report. Specific Codes and Guidelines of the IRC and publications of the MoRT&H including circulars & general/special publications, technical Specifications & Standards have also been considered. All the field activities have been completed as discussed in detail with Authority.

For Topographic survey latest electronic instruments like Differential Global Positioning System (DGPS), RTK GPS and Total Station were used. Data was collected as per formats and procedures approved by the MoRT&H and analyzed using in-house developed software. MX Roads software for the highway designs and STADD-proV8i for the structure designs are used. For the pavement designs standard software/programs developed in-house have been used.

In depth consultation process with UPEIDA was held on a regular basis to enhance the progress of the work. As time and quality are the essence of the project, before any analysis and designs, all the parameters to be used were got approved by the Client during preparation of draft reports so there is minimum changes later on, i.e. minimum time requirement in the finalization of final reports without compromising quality.

The idea is to seek prior approval from client through meeting/discussion on Inception, alignment finalization, bid evaluation, pre-bid conference etc. Similarly various traffic scenarios will be developed and presented to client for discussion and approval.

2.1 Design Basis

The broad methodology has been developed keeping standard practices / IRC guidelines, with certain additions and modifications as felt necessary and as discussed with Uttar Pradesh Expressway and Industrial Development Authority (UPEIDA) during various review meetings.

2.2 Review of Earlier Reports

The Consultants have collected and reviewed the relative study reports to have a better understanding of the project & also for getting some inputs as a part of the services. The study reports thus considered for review are:

1. Concept Report for Development of Agra–Lucknow Access Controlled Express-way (Green Field) Project.
2. Road development plan in the region by UPEIDA.
3. Master Plan reports within Project Influence Area especially for Agra and Lucknow districts.

Any useful details relevant for the project available with the Client/ Other agencies have been collected. Other details are also collected and collated to form recommendations by considering the following inputs:

- Material details
- Soil Test results
- Geo-technical investigation reports
- Topographic survey details / Bench mark details and other survey information
- Utility Services/Utility Relocation Plans
- Traffic Studies

- Tree plantation records
- Hydrological and Hydraulic details
- Development Plans for major towns and areas along the project road
- Availability of construction materials and unit rates for work items
- Recent acquisition rates for different types of land/immovable properties
- Right of Way Details from Revenue maps

2.3 Socio-Economic Profile

Socio-economic profile of the influence area is prepared, after study of data on growth of population and density, human settlement pattern, land use, sub-profiles of agriculture and industries, economic base, trends in socio-economic indicators, development scenarios for various sectors, transport infrastructure and its uses such as use of waterways & rail transport etc.

The relevant data is collected from the following sources:

- State Statistical Abstracts
- State Year Books

Census Publications – Districts and State

- Hand Books of Statistics of Districts in the area of influence
- Economic Surveys of the State constituting the zone of influence
- The Bureau of Economics & Statistics of Uttar Pradesh

2.4 Traffic Survey, Analysis and Projections

Traffic surveys include (only those surveys would be carried out which are required for correctly forecasting the traffic along the proposed road):

- Classified Traffic Volume Counts
- Origin – Destination and commodity Movement Surveys

Standard procedures given in IRC Codes have been followed for carrying out Traffic Surveys. The data arrived from the Surveys has been analyzed to determine ADT of surrounding roads of the proposed project road and travel characteristics.

Growth of traffic in project road influence area and also on the project road is regarded as the most important aspect since the whole project design is based on this. To establish the realistic growth rates, road transport data, population growth rates and socio-economic parameters have been studied and analyzed. The growth rates for passenger vehicles have been worked out on the basis of annual growth rate of population and per capita income while the growth rates of freight vehicles have been based on the rate of growth in agricultural, industrial and tourism sectors and historical traffic data. These growth rates have been used to arrive at the traffic projections for the design period. After the development of project corridor to six lane standard configuration, greater amount of traffic is expected to be diverted from the peripheral road network. Appropriate traffic diversion models have been used for assessment of diverted traffic to this road. Details on traffic data & projections have been discussed in Chapter 5 of this Report.

2.5 Engineering Surveys and Investigations

2.5.1 Reconnaissance Survey of the Project Road

Reconnaissance survey has been carried out immediately before the kick off meeting to examine the general characteristics of the Project Corridor. Consultants have undertaken a site visit along with the experts in the field of Highway, Pavement and Bridge Engineering. This has helped in the detailed appreciation of the project corridor in terms of traffic and other engineering measures and judicious assessment of the following salient factors have generally been made:

- Topography of the area
- Terrain and soil conditions
- Climate and Rainfall
- Drainage Characteristics
- Traffic patterns and preliminary identification of traffic homogeneous sections of road.
- Railway lines and other critical utilities/services having impact on road alignment
- Land use (agricultural, build-up, forest land, etc.,)
- Environmental factors
- Availability of materials
- Any other useful information

The findings are described in the following paragraphs;

2.5.2 Topographic Surveys

Topographic survey has been carried out along the proposed alignment to know the topography, natural and manmade features present within the proposed ROW and to assess the existing geometric deficiencies along with land use plan. The survey has been carried out only after establishing horizontal and vertical control grids. Horizontal grid has been established through DGPS points and been erected at every 5 km interval. For vertical grid, bench mark has been erected at every 250m interval and connecting these to the nearest BM of Survey of India.

Selection of primary Control Points and Observations is as detailed below:

- These are located on the edge of the proposed right of way (ROW) at inter-visible locations at every 5 km.
- These are, as far as possible, on either side of 5 km stone so that it can be identified easily in the field and an arrow has been painted on the existing road indicating their location. They are recorded in separate field with their three dimensional locations.
- The stations selected are free from obstruction towards sky at an angle of 15° with horizontal plane.
- The horizontal control station is established on nail fixed in centre of RCC (M15) pillar of size 15 cm x 15 cm x 45 cm embedded in concrete M10 (5 cm all around) up to a depth of 30 cm and the balance 15 cm above the ground painted yellow.
- The Primary Control Stations are fixed using DGPS Trimble make instrument. The time of observations at Base Stations is observed for a minimum of 30 minutes and at Reference Stations for 20 minutes or longer if instrument signal is not indicating sufficient data received, to eliminate the possible projection and time errors in the signals received from various satellites being observed at respective locations in order to ensure high accuracy in the positioning of control stations within + 20 mm.
- Minimum of 6 satellites are available during observation to ensure high accuracy

Secondary control stations are established at 2 km intervals using Total Station and through closed traverse distributed linearly running between two nearest Primary Control Stations ensuring accuracy in the order of $12\sqrt{K}$ in mm, where 'K' is the distance in kilometers between two primary control stations. Any errors within permissible limits are distributed in rational manner to establish the accurate and effective horizontal control grid. These are established on reference pillars having configuration similar to primary control station with an arrow painted on the surface of existing road indicating their location.

2.5.2.1 Pillar Construction

Benchmark pillars at every 1000m along the route within the ROW have been constructed. All these pillars will have to be furnished with X, Y, Z co-ordinates. The pillars are of size 150 x 150 x 600mm long. The pillar is concreted and embedded in a manner that 150mm is

remain above ground. A steel rod has been fixed in the centre for punching the point and finally these are to be painted yellow.

2.5.2.2 Total Station Traverse

A closed traverse is run for a loop length of 5 km. While traversing, station is established 200 to 250mts apart. The pillars constructed along the route are connected. These points are further used for detailed survey. The minimum accuracy of this survey is 1:10,000.

2.5.2.3 Bench mark

These are located, as far as possible, along the proposed right of way (ROW) boundaries at an interval of 250 m with BM No. marked on it with red paint.

- Bench Mark pillar is of size 15 cm x 15 cm x 45 cm cast in RCC M15 with a nail fixed in the centre of the top surface and embedded in concrete M10 (5cm all around) up to a depth of 30 cm. The balance 15 cm above the ground is painted yellow.
- An arrow indicating the location of the BM is painted on the road with the permanent yellow paint and recorded in separate field books with its three dimensional location.

The Bench Mark is established using high accuracy Digital Level and Bar coded staff by way of double run leveling in small circuits of 3 km length ensuring an accuracy in the order of $12\sqrt{k}$ mm, where 'K' is the distance in Kilometers between two Bench Marks avail-able in the project area, and error, if any, within permissible limits is distributed in rational manner to establish the accurate and effective vertical control grid.

The topographic survey has been extending up to the proposed Right of Way (ROW). Wherever necessary, the survey corridor width is further increased to accommodate situations arising out of encroachments and any other contingencies. The survey areas at the locations of intersections cover up to a minimum of 500m on the either side of the centre-line and have sufficient width to accommodate improvement measures. Necessary surveys are also carried out for determining the requirements of service roads for local traffic, where appropriate.

2.5.2.4 Detailed Survey

Using the horizontal and vertical control points established accurate data in the digital format in terms of Northing (Y). Easting (X) and Elevation (Z) co-ordinates for all breaks in terrain such as ridges and ditches are collected perpendicular to the centre line at 50m intervals in tangent sections and 20-25m in curve sections using Total Stations. Cross sections are taken for the specified corridor width of 110m; however this corridor width is increased to 150m on the inside of sharp curves to account for minor adjustments.

All natural and man-made features such as buildings, irrigation channels, drainage structures, temples, mosques, trees and utility installations etc. are captured during the survey. Spot level on the existing carriageway are captured at five points namely at centerline, mid points of both lanes of traffic movement and pavement edges at both ends to calculate the profile corrective courses more realistically. Trees with girth wise are captured with areas of plantation. Wherever there are groups of trees/plantations, they are picked with the areas of plantation. Boundaries of Agricultural Land area have been surveyed to demarcate the cultivation land limit.

Where existing major roads cross the alignment, the survey has been extended to a maximum of 500m on either side of the road centerline to allow improvements including grade separated intersections to be designed. Apart from this, the survey has covered a maximum of 1000m and 500m on either side of centerline in cases of major and minor bridges respectively.

2.5.2.5 Data Processing

The field survey data are processed in the office to provide a digital output file for the design engineers. The data is structured so that the existing vertical profile along the proposed alignment can be produced automatically. The format of the resulting data readily promotes the calculations of earthworks and other quantities required for the evaluation of cost estimates.

Roadway plans have been produced from the survey data, which identify the available Right of Way (ROW) along the existing road corridors. In addition, the plans identify all existing utilities /installations within the corridor/ROW that require re-location by the new road design. Action Plans for covering the relocation of these obstructing installations and public utilities are to be prepared on a km to km basis.

2.5.2.6 Material Investigations

The Material Investigation for road construction has been carried out to identify the potential sources of construction materials and to assess their general availability, mechanical properties and quantities. This is one of the most important factors for stable, economic and successful implementation of the road program within the stipulated time for improvement work as well as for new carriageway, the list of materials includes the following:

a) Granular material for lower sub-base works.
b) Crushed stone aggregates for upper sub-base, base, surfacing and cement concrete works.
c) Sand for filter material and cement, concrete works, sub-base and filling material.
d) Borrow material for embankment, sub-grade and filling.
e) Manufactured material like cement, steel, bitumen, geo-textiles etc. for other related works.

The Information on material sources has been carried out with the following basic objectives:

- Source location, indicating places, kilometer age, availability and the status whether in operation or new source.
- Access to source, indicating the direction and nature of the access road i.e. left / right of project road, approximate lead distance from the gravity centre and type of access road.
- Ownership of land / quarries, either government or private.
- Probable uses indicating the likely use of materials at various stages of construction work i.e. fill materials, sub-grade, sub-base, base and wearing course and cross drainage structures.

During the process of investigation, due consideration has been given to the locally available materials for reducing the cost of construction.

The samples have been collected as described below:

- From quarry sites for aggregate characteristics like, aggregate impact value, gradation, soundness, flakiness index and elongation, stripping value and water absorption etc.
- From random pits (farmland) along the proposed alignment for availability of suitable embankment and sub grade material, and identification of the borrow areas and tested in line with relevant IRC code.

2.5.2.7 Geotechnical Investigations

Sufficient information about the arrangement & behavior of the underlying materials and their physical properties for adopting and designing the structural foundation is essential. Soil exploration through field investigation and laboratory testing of the substrata are helpful in arriving at required parameters for designing of safe and economical

foundations. The data obtained from these investigations has been analyzed for safe design of the foundation. In the geotechnical report's recommendations has been made for type of foundations and its safe bearing capacity/load carrying capacity required for the structure design.

2.5.2.8 Hydrological Investigations

Hydrological investigations have been carried out for the entire project. It has been ensured that majority of the cross drainage structures are hierologically adequate to carry the discharge of the river / streams.

2.6 Traffic Design

2.6.1 General

The capacity standards for expressway have been adopted as per the "Guidelines for Expressways". Capacity analysis is fundamental to the planning, design and operation of roads and provides, among other things, the basis for determining the carriageway width to be provided at any point in a road network with respect to the volume and composition of traffic. Moreover it is a valuable tool for evaluation of the investments needed for future road constructions and improvements.

2.6.1.1 Equivalency Factors

The need of expressing capacity in passenger car units has triggered off many studies for establishing appropriate passenger car equivalency (PCE) values for different types of vehicles. Notable among the studies carried out in India are the road user cost studies (RUCS) by CRRI and the MoRT&H. It has been recognized that the PCE values vary under different traffic, roadway conditions and composition for any given type of vehicle.

Equivalency Factor is a factor to convert the mixed flow of traffic in to single unit to express the capacity of road. The unit generally employed is the passenger car unit (PCU). The equivalency factors for conversion of different types of vehicles in to equivalent passenger car units based on their relative interference value are given in Table 2.1 (as per IRC: 64 – 1990).

Table 2.1: PCU Factor for Various types of Vehicles on Rural Roads

S. No.	Vehicle Type	Equivalency Factors
Fast moving vehicles		
1	Motor cycle or scooter	0.50
2	Passenger car, pick up van or auto-rickshaw	1.00
3	Agricultural tractor, light commercial vehicle	1.50
4	Truck or bus	3.00
5	Truck – trailer, agricultural tractor – trailer	4.50
Slow moving vehicles		
1	Cycle	0.50
2	Cycle rickshaw	2.00
3	Hand cart	3.00
4	Horse drawn vehicle	4.00
5	Bullock cart	8.00

2.6.2 Capacity Analysis for 6-Lane Expressway

As per the Guidelines for Expressways Volume-I: Planning, the capacity of an expressway is sensitive to the traffic flow characteristics on divided highways.

2.6.2.1 Free Flow Speed

An important element of the speed – flow curves of the project roads is the free flow speed. It is the speed at which driver feel comfortable travelling under the physical,

environmental and traffic control conditions on a non-congested section of a multi lane highway, - HCM (2000). All recent studies suggest that speed on project road is insensitive to flow over a broad range of flows. Thus free-flow speed can be established on an existing facility by measuring in the field, the average speed of vehicles when flow rates do not exceed 1300 passenger car per hour per lane (PCPHPL) (HCM 1994). In the absence of traffic flow speed data on highway in India, the free flow speed is required to be assumed.

2.6.2.2 Factors affecting the Free Flow Speed (FFS):

The FFS of an expressway depends on the traffic and roadway conditions described below:

- Lane width
- Lateral Clearance
- Number of Lanes
- Interchange Density
- Geometric design

The basic equation used to calculate the FFS is as given below:

$$FFS = BFFS - f_{LW} - f_{LC} - f_N - f_{ID} \quad \text{----Eq(1)}$$

Where,
BFFS=base free flow speed, kmph
f_{LW} = adjustment factor for lane width
f_{LC} = adjustment factor for right shoulder lateral clearance
f_N = adjustment factor for number of lanes
f_{ID} = adjustment factor for interchange density

Base Free Flow Speed BFFS is set at 120 kmph for rural facilities.

Adjustment factor for Lane width (f_{LW}) is given in Table 2.2.

Table 2.2: Adjustment Factor for Lane Width

Lane Width (m)	Reduction in FFS (kmph)
3.6	0.0
3.5	1.0
3.4	2.1
3.3	3.1
3.2	5.6
3.1	8.1
3.0	10.6

For the project road, the lane width considered is 3.75, hence, the reduction in FFS =0.0

Adjustment factor for left shoulder clearance (f_{LC}) is given in Table 2.3.

Table 2.3: Adjustment Factors for Left Shoulder Clearance.

Left Shoulder width(m)	Reduction in FFS (Kmph; fLC)			
	Number of Lanes in One Direction			
	2	3	4	>=5
>=1.8	0.0	0.0	0.0	0.0
1.5	1.0	0.6	0.3	0.2
1.2	2.0	1.3	0.6	0.3

For the project road, the left shoulder width is greater than 1.8, hence adjustment factor is 0.0.

Adjustment factor for Number of Lanes (fN):
For rural facilities f***N*** is set as 0.
Adjustment factor for Interchange density (fID)
Since the minimum interchange spacing more than 4 kms, the adjustment factor for interchange density is set as 0.

The using Equation (1) we get
FFS=120-0-0-0-0
FFS = 120kmph

Calculation of Base Capacity (Base Cap)
The base capacity (pcphpl) of an expressway facility is given by
Base Capacity = 1700+10FFS; for FFS<=112 ----------Eq(2)
Base Capacity = 2400; for FFS>112 ----------Eq(3)

Since, the FFS is (120kmph)>112kmph, base capacity =2400pcphpl

Determination of Peak Capacity (Peak Cap)
The peak capacity is given by,
Peak Cap = Base Cap*PHF*N*f_{HV}*f_P

Where,
Peak Capacity = Peak capacity, vehicles per hour (all lanes, one direction)
PHF = Peak Hour Factor; *0 .88 so as to maintain LOS B always on Expressway*
N = Number of lanes in one direction (3 for 6-lane); *3 for one direction flow on Expressway*
f_{HV} = Adjustment factor for heavy vehicles; *0.8253 for expressway as calculated below*
f_P = Adjustment factor for driver population; *0.975 for rural expressways*

Assign a final PHF is given in **Table 2.4.:**

Table 2.4: Peak Hour Factor

Area Type	V/C Ratio	PHF
Rural	<0.7744 0.7744<=v/c<=0.9025 >0.9025	0.88 Equation(4.04) 0.95
Urban	<0.8100 0.8100<=v/c<=0.9025 >0.9025	0.90 Equation(4.04) 0.95

For the project road the PHF of 0.88 has been considered.
Adjustment factor for Heavy Vehicles (fHV)
The adjustment factor for heavy vehicles is based on calculating passenger car equivalents for trucks and buses.

f_{HV} = 1/(1+PT(ET-1))

Where,
PT= Proportion of trucks and buses in the traffic stream; 42% as per traffic projections
ET=Passenger car Equivalents; 1.5 for rural expressways in level terrain.

The f_{HV} factor for the expressway using the above equation is 0.8253

Adjustment factor for Driver Population (f_P)
On rural expressways, the factor is set to 0.975 but has been considered as 1.0 for the project road.

Thus, the peak capacity for the 6-lane expressway

Peak Capacity = 2400*0.88*3*0.8253*.975

= 5089 pcphpl *(for 3-lane in one direction)*

= 5089*2/0.08 = 127225 PCUs per day *(for 6-lane carriageway with depressed median)*

The peak capacity of the Purvanchal Expressway shall be 127225 PCUs per day

2.6.3 Recommended Design Service Volume for Six Lane Expressway

Assuming a V/C ratio of 0.77 lesser than 0.7744 corresponding to PHF of 0.88 to maintain a Level of Service B, the Design Service Volume for 6-Lane Expressway with depressed median shall be 98000 PCU per day for peak hour flow of 8%

= 127225 * 0.77 = 97963, say 98000 PCUs per day

2.7 Engineering Design

2.7.1 Geometric Design of the Alignment

The Preliminary Design has been carried out on the selected alignment so as to have optimum Construction, Operation & maintenance cost and Vehicle Operation Cost; minimum Social Impacts and Social Costs and Environmental Impacts and Environmental Mitigation Costs.

The preferred alignment would definitely have minimum Rehabilitation and Resettlement i.e. it would utilize to the maximum possible barren / agriculture / government land to minimize Land Acquisition in villages / habited areas. A thorough consultation with stakeholders including industries, relevant government agencies, NGOs, project affected persons (including farmers & people having property) and other consultants working in the region will be made.

Geometric Design Control

The detailed design for geometric elements covers, but is not limited to the following major aspects:

- Horizontal alignment
- Longitudinal profile
- Cross-sectional elements
- Junctions, intersections and Interchanges
- Service road along the alignment

Different options for providing grade separated interchanges were examined and the geometric design of interchanges has taken into account the site conditions, turning movement characteristics, level of service, overall economy and operational safety.

Indicative Design Standards

The indicative design standards for geometric design of road are illustrated in for main carriageway, geometric standards for Interchange elements and Length of speed change

lanes. Ruling design speed is adopted for designing the Project Highway in conformity with the provisions of the Guidelines for Expressway Manual.

Table 2.5: Indicative Design Standards

S. No.	Description		Details for Project road
1	Design Speed		120 Kmph
2	Lane width		3.75 m
3	Raised Median (including shyness)		5.50m
4	Median side paved strip (Shy distance)		0.75 m
5	3-Lane carriageway		11.25m
6	Paved Shoulder		3.00m
7	Earthen Shoulder		2.00m
8	Camber/Cross-fall	C/W & PS	2.50%
		Earthen shoulder	3.00%
9	Width of Service Road		3.75 m/7.00m
10	Utility Corridor		2.00m
11	Maximum super-elevation	For below 1000m radius	7.00%
		For above 1000m radius	5.00%
12	Minimum Stopping Sight Distance (SSD)		250 m
13	Minimum Intermediate Sight Distance (ISD)		360 m
14	Minimum radius of horizontal curve		670 m
15	Minimum radius curve without transition		4000 m
16	Minimum vertical Gradient		0.375 %
17	Min. vertical gradient for Drain	Unlined	1%
		Lined	0.375%
18	Absolute maximum vertical gradient		3%
19	Maximum grade change not requiring vertical curve		0.50%
20	Minimum length of vertical curve		100m
21	Minimum Height of Embankment		Bottom of Sub-grade is at least 1.5 m above the High Flood Level/Water Table/Pond Level.
22	Vertical clearance for PUP		3.0 m
	Vertical clearance for LVU		3.5/4.3 m
	Vertical clearance for VUP		5.5 m
	Vertical clearance for ROB		6.83 m
24	K-Value for Sag-curve		50-73
	K-Value for Hog-curve		102-202

Design Speed

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

In general, the ruling design speed is adopted for geometric design of the highway. Only in exceptional circumstances, minimum design speed may be adopted where site conditions are extremely restrictive and adequate land width is not available.

2.7.2 Cross Sectional Elements

Right of Way (ROW)

As per Guidelines for Expressway the minimum right of way (ROW) for up to 6 lanes expressways is 90m for plain and rolling terrain. The minimum ROW of 120 m has been adopted for the proposed expressway in rural section (open areas i.e. green field section). The ROW at toll plaza locations, ROBs and flyovers/interchange sections may vary depending on their respective layout and requirement. A 2m wide utility corridor outside the boundary fencing has been taken into account within the proposed ROW width.

Table 2.6: Right of Way in Plain/Rolling Terrain

Section	Right Of Way Width* (ROW)
Rural Section	90 m – 120 m
Rural Section passing through semi-urban areas	120 m#

* The ROW width includes 2 m wide strip on either side reserved for placement of utilities outside fencing.

In case an elevated expressway on viaduct is proposed, the width of ROW may be reduced as per site conditions and availability of land

Lane Width

As per Guidelines for Expressway the width of a lane in Plain and Rolling terrains has been taken as 3.75 m. The kerb shyness of 0.75 m shyness on median side has been provided.

Median width of Carriageway

The median shall be raised of 5.5m including shyness. The width of median is the distance between inside edges of carriageways.

The raised median shall have suitably designed drainage system so that water does not stagnate in the median.

An edge strip of 0.75 m width of depressed median adjacent to carriageway in either direction shall be paved with same specifications as of the adjoining carriageway.

As far as possible, the median shall be of uniform width in a particular section of the Project Expressway. However, where changes are unavoidable, a transition of 1 in 50 shall be provided.

Median barriers shall be provided as specified in Manual. In the case of flush type medians, suitable antiglare measures such as metal/plastic screens shall be provided to reduce headlight glare from opposite traffic. The total height of screen including the height of the barrier shall be 1 .5 m.

Paved Shoulder

Paved shoulders shall be designed as an integral part of the pavement for the main carriageway. Width of these shoulders has been taken as 3 m. This will provide for better traffic operation conditions, lower maintenance and facility of directly using these as part of carriageway when the road is subsequently widened on these sides.

The Composition and specification of the paved shoulder shall be as that of the main carriageway.

Earthen Shoulder

The earthen shoulder has been proposed with good borrowed earth having a width of 2m on the outer side.

Sight Distance

The Safe stopping sight distance and desirable minimum sight distance for divided carriageway for various design speed given in Table 2.8. The desirable values of the sight distance shall be adopted unless there are sight constraints. A minimum of Safe stopping sight distance shall be available throughout.

Table 2.8: Safe Sight Distance

Design Speed (km/hr)	Safe Stopping Sight Distance (m)	Desirable minimum Sight Distance (m) (Intermediate Sight Distance)
120	250	500
100	180	360

At critical locations decision or decision points where changes in cross sections occurs such as Toll Plazas and Interchanges, the sight distance shall be not be less than decision sight distance given in Table 2.9. The criteria for measuring sight distance are same as for the stopping sight distance.

Table 2.9: Decision of Sight Distance

Design Speed (km/hr)	Decision Sight Distance (m)
120	360
100	315

Horizontal Alignment

The horizontal curves on the project road are designed for maximum radii (where feasible) as per Guidelines of Expressway manual and IRC:SP:99-2013, absolute minimum radius has been used at couple of locations.

The Alignment shall be fluent and blend with the topography. The horizontal curve shall be designed to have largest practical radius and shall consist of circular portion flanked by spiral transitions at both the ends.

Super – Elevation

Super-Elevation shall be limited to 7%, if radius of curve is less than desirable minimum radius. It shall be limited to 5% if radius is more than or equal to desirable minimum. Super elevation shall be not be less than the minimum specified Cross fall.

The super elevation at curves is arrived at as per the following equation:

$(e + f) = v2/127R$

Where,

v = Vehicle speed in Km/hr.

e = Super elevation ratio in meter per meter

f = Coefficient of side friction between vehicle tyre and pavement (0.1)

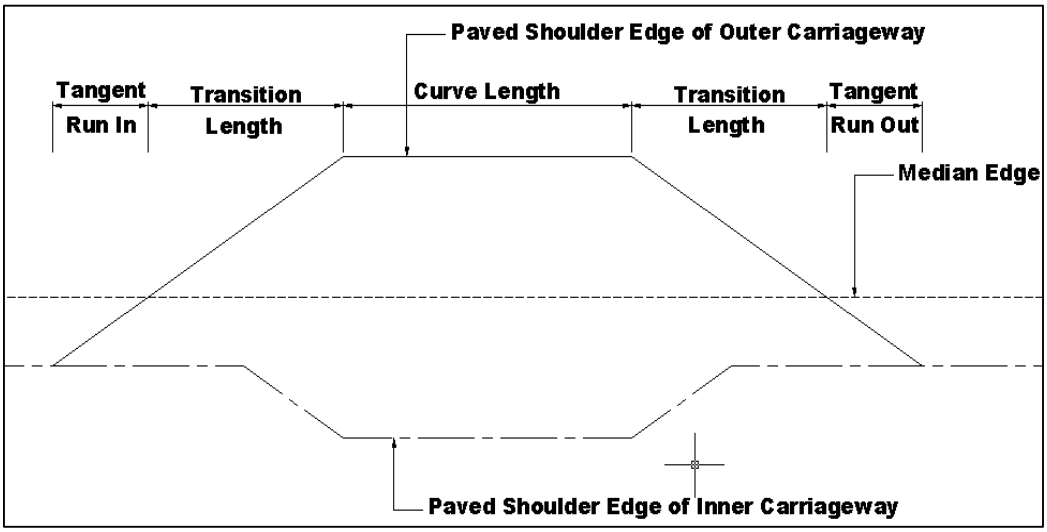
R = Radius in meters.

The super elevation is calculated keeping in view the horizontal radii and gradient at curves at different locations.

2.7.3 Method for attaining super-elevation

Dual – inner edge pivot of both carriageways at different chainage is used for attaining super-elevation. This method pivots the dual carriageway about the inner edge strings of both carriageways using different chainage, so that the central reservation levels are not changed. The application of super-elevation to the left and the right carriageways will start (or end) at different chainage, to ensure that the rate of change remains the same for both. The method is explained in Figure 2.1:

Figure 2.1: Method for attaining Super-Elevation



2.7.4 Transition Curves

The following three formulae are used for calculating the transition lengths and the maximum value is being adopted for design:
Rate of change of centrifugal acceleration
Ls = 0.0215 V3/ CR

Where,
R – Radius of curve in meters
V – Vehicle speed in Km / hour
Ls – Length of transition in meters
C – Rate of change of acceleration.

C = 80/(75+V)
Subject to maximum of 0.6 & minimum of 0.4

b) Rate of change of super elevation or runoff.

The rate of change of super elevation is being considered not steeper than 1 in 200 for roads in plain and rolling terrain and 1 in 150 for roads in Mountainous terrain.

c) Three seconds time for manipulating the steering. The minimum length of transition curves for this criteria is as in Table 2.10.

Table 2.10: Minimum Length of Transition Curve

Design Speed (km/hr)	Minimum length of transition curve (m)
120	100
100	85

2.7.5 Vertical Alignment

General

The vertical alignment of the carriageway is generally compatible with the guidelines given in the Guidelines of Expressway manual as well as IRC: SP: 99-2013.
At locations of grade break of 0.5%, vertical curves are being provided.

- There shall be no change in grade within a distance of 150m
- The length of vertical curve will not be less than 0.6V (kmph)

- Number of vertical intersection point shall not be more than 4 per km.
- At locations of sight deficiency, at least stopping sight distance (SSD) is being provided.

The aspect of efficient drainage shall be kept into consideration while designing the vertical profile and cross sections of the Project Expressway as stipulated in IRC:SP:42 and IRC:SP:50.
The vertical alignment shall be coordinated with the horizontal alignment

Gradients
The ruling and limiting gradients are given in Table 2.11.

Table 2.11: Gradients

Terrain	Ruling Gradient	Limiting Gradient
Plain	2.5%	3.0%
Rolling	3.0%	4.0%

The ruling gradient shall be adopted as far as possible. Limiting gradient shall be adopted only in very difficult situation and for short lengths.
In cut sections, minimum gradient for drainage considerations is 0.5% (1 in 200) if the side drains are lined; and 1.0% (1 in 100) if these are unlined.

Vertical Curves
Long sweeping vertical curves shall be provided at all grade changes. Summit curves and valley curves shall be designed as square parabolas. The length of the vertical curves is controlled by sight distance requirements, but desirably curves with the longer length shall be provided from aesthetic considerations. The minimum grade changes requiring vertical curve and the minimum length of vertical curve shall be as given in Table 2.12. More liberal values are adopted wherever this is economically feasible. Valley curves are designed for headlight sight distance.

Table 2.12: Minimum Length of Transition Curve

Design Speed (km/hr)	Minimum Grade Change requiring Vertical curve	Minimum length of Vertical Curve(m)
120	0.5%	100
100	0.5%	85

Lateral and Vertical Clearance at Underpasses

Lateral Clearance
Minimum clearance at under passes shall be as follows:

i) For Vehicular Underpass, the lateral clearance shall not be less than 12m (7m carriageway + 2X2.5 m Shoulder width on either side).
ii) For Light Vehicular Underpass, the lateral clearance shall not be less than 10.5m including 1.5m wide raised footpaths on either side.
iii) For Pedestrian and Cattle Underpasses the lateral clearance shall not be less than 7m.
iv) Crash barrier shall be provided for protection of vehicles from colliding with abutments and piers and the deck of the super structures.

Vertical Clearance
The vertical clearances at underpasses shall not be less than the values given in Table 2.13.

Table 2.13: Vertical Clearance

Vehicular Underpass	5.5m
Light Vehicular Underpass	4.3m / 3.5m
Pedestrian, Cattle Underpass	3.0m

Lateral and Vertical Clearance at Overpasses

Lateral Clearance
Shall be provided as a full roadway width as specified in Schedule of Contract Agreement.

Vertical Clearance
A minimum of 5.5m Vertical Clearance shall be provided from all points of the Carriageway of the Project Expressway.

2.7.6 Cross-Fall

The crossfall on each sections of the expressway carriageway shall be as given in Table 2.14. Each carriageway shall have unidirectional cross fall.

Table 2.14: Crossfall on different surfaces

Cross-Sectional Element	**Annual Rainfall**	
Carriageway, Paved shoulders, Edge Strip, Flush Median.	**1000mm or more**	**Less than 1000mm**
	2.5 %	2.0 %

The crossfall for earthen/granular shoulders on straight portions shall be at least 0.5% steeper than the values given in Table above. On Super Elevated sections, the earthen portion of the shoulder on the outer side of the curve would be provided with reverse crossfall so that the earth does not drain on the carriageway and the storm water drains out with minimum travel path.

2.8 Design OF Horizontal and Vertical Alignment

The general principles and design criteria laid down in MoRTH Guidelines for Expressways shall be followed except as otherwise indicated in this Manual.

Culverts
The culverts are proposed to be built to the full formation width of the road and have been designed accordingly.

Highway Signs and Marking
The road signs conforming to latest IRC: 67 have been proposed. Location of route marker signs are as per the latest IRC: 2; the provision for hectometer stones, 5th kilometer stone, Kilometer and 200 m stones are as per latest IRC: 8 and latest IRC: 26 respectively. The boundary stones are as per latest IRC: 25. Road Delineators are as per latest IRC: 79.

All road signs are considered as retro-reflective sheet of high intensity grade with encapsulated lens fixed over aluminium substratum and conforming to MoRT&H Specifications for road and bridge works. Provisions for Road markings have been considered as latest IRC: 35.

2.9 Access Control

Project Expressway shall be designed for fast motorized traffic with full control of access. Access to the Expressway shall be provided with grade separators at location of intersections. Parking/standing, loading/unloading of goods and passengers and pedestrians/animals shall not be permitted on the Expressway.

Location of interchange – The locations of individual interchanges are determined primarily to reduce detour considering regional network and nearness to places of importance. Location of interchange is guided by the following situations:

i) At crossing or nearest points of other Expressways, National Highways, State Highways and important arterial roads.
ii) At crossing or nearest points of major roads to important ports, airports, material transport facilities, commercial and industrial areas, and places of tourist interest.

The interchanges shall be provided at the locations specified in Schedule-B of the Contract Agreement.

2.10 Connecting roads

Connecting roads where required to maintain proper circulation of local traffic, continuity of travel and to facilitate crossing over to the other side of the Project Expressway through an under/overpass shall be constructed on the land acquired within the ROW of the Project Expressway. These shall be provided outside the fencing. The location, length, other details and specifications of connecting roads, to be constructed by the Contractor shall be specified in Schedule-B of the Contractor Agreement. The width of the connecting road shall be 7.0 m. The construction and maintenance of connecting roads shall be part of the Project Expressway

2.11 Pavement Design

Type of Pavement – The Authority may require provision of specific type (flexible/rigid) of pavement depending upon specific site conditions. Such requirements shall be as specified in Schedule-B of the Contract Agreement. Unless otherwise specified in Schedule-B, the Contractor may adopt any type (flexible/rigid) of pavement structure for new construction.

Flexible pavement is designed by using IRC: 37-2012 and rigid pavement is designed as per the provisions contained in latest IRC: 58. Besides the above, designs for service roads, toll plaza, parking bays have been carried out.

Design of flexible pavement – The pavement shall be designed to ensure the specified performance for the projected traffic needs, climate and type of soils in the given area. The Contractor is expected to use a design procedure that is appropriate to produce a cost-effective structure meeting the performance requirements and long term durability. The Contractor may use IRC:37 "Tentative Guidelines for the Design of Flexible Pavements" or it may use any internationally accepted design procedure that is based on past performance and research. It will be the Contractor's responsibility to provide a pavement structure that fully meets the prescribed performance requirements throughout the operation period.
Design of rigid pavement – Jointed rigid pavement shall be designed in accordance with the method prescribed in IRC:58 "Guidelines for the Design of Plain Jointed Rigid Pavements for Highways". Continuously Reinforced Concrete Pavements (CRCP) shall be designed as per any recognised international guidelines which shall be subject to approval by the Independent Engineer.

Design Life

The bituminous pavement with design life of 15 years has been considered for the flexible pavement design. For rigid pavement a design life of 30 years has been considered.

Design Traffic

The Design traffic has been estimated in terms of cumulative number of standard axles (8160kgs) to be carried by the Pavement during the design period.

Any likely change in traffic due to proposed improvement of the facility and/or future development plans, land use, shall be duly considered in estimating the Design Traffic. The Growth rates mentioned in the Traffic Studies chapter has been considered while

calculating the Million Standard Axle loads. The project road is a green field highway and there is no existing carriageway, therefore, the VDF has been calculated based on the Axle Load Surveys conducted on alternate roads and the values of VDF has been presented in Section 3.3.3 of this report.

Rigid Pavement Design

Design of Concrete Slab

Once the parameters are decided, actual stresses developed in the concrete slab due to design wheel load is computed by the Westergaard's Equation modified by Teller and Sutherland. The maximum stress occurs in the corner and the minimum in the interior. The edge load condition gives an intermediate value.

Temperature stresses at the edge are calculated by using Bradbury's formula. The temperature stresses in the corner region is negligible as the corners are relatively free to wrap and may be ignored.

The design wheel load stress and the temperature stress at the edge are then added up together and this summation shall be less than 28 days flexural strength of concrete for the assumed thickness to be adequate from design point of view.

Once the assumed slab thickness is found adequate for the combined stresses developed due to temperature and design wheel load, its adequacy needs to be checked from the view point of its consumption of fatigue resistance. In this case also, edge stresses are computed as discussed earlier for various axle load classes. Then stress ratio (SR) is calculated as ratio of stress due to wheel load and the 28 days flexural strength of concrete for all axle load class. Consumption of fatigue resistance is computed for this stress ratio for each axle load class. Summation of this consumption of fatigue resistance should not exceed the allowable limit for the assumed thickness to be adequate from the view point of fatigue consideration.

Design of Joints

Once the concrete slab thickness is designed based on particular spacing and location of joints, the remaining job is the design of dowel bars and tie bars with the provision of adequate sealants.

Dowel Bars

The design of dowel bar at joints is carried out on the basis of its load transfer capacity. It is recommended that 40% of wheel load can be transferred through dowel bar system. It is observed that failure of dowel bar occurs due to the crushing of concrete below the dowel bar and hence bearing stress shall be considered for its design.

Generally 500 mm long 32 mm diameter M.S. bar at a spacing of 250 – 300 mm is used as dowel bar for concrete slab of 200 -350 mm thick. No dowel bar is required for slab thickness less than 150 mm. However separate calculation has been made for present situation for dowel bar design.

Tie Bar

Tie bars are provided to prevent the adjoining slabs from separating. Longitudinal joints are provided with tie bars. It does not increase the structural capacity of the slab and are not designed as load transferred devices.

2.12 Hydrological Design

Design Standards

The hydrological & hydraulic design for cross drainage structure shall conform to the following codes and reports:

IRC: SP-13 – Guidelines for the design of small bridges and culverts

IRC: 5 – Code of practice for Road Bridges, Section I (General features of Design)
IRC: 78 – Code of Practice for Road Bridges, Section VII (Design of Foundation and Substructure)
IRC: SP-87 – Manual of Specifications and Standards for Six-Laning of Highways through Public Private Partnership

Design Approach
The hydrological & hydraulic design of bridges is an important aspect to determine the minimum required waterway; design highest flood level (HFL) and minimum scour levels of piers & abutments of the bridges proposed on the new alignments. The various design standards (latest) which have been adopted for the hydrological & hydraulic design of bridges are given below. Approach slabs shall be provided for all bridges and grade separated structures as per Clause 217 of IRC:6 and Section 2700 of MORTH Specifications.

Design Parameters –
Area of catchment & length of longest stream have been obtained from topographical sheets of Survey of India (SOI).
The Cross Section of stream at 500 m U/S and 500 m D/S depending upon catchment area along with longitudinal gradient has been obtained to evaluate design discharge .The various method such as area velocity , unit hydrograph Rankins method has been considered for obtaining of design discharge .

Scour Depth
Scour depth can be calculated as per Clause 703.2 of latest IRC: 78 and as explained in latest IRC: SP 13. The mean depth of scour, dsm below the highest flood level is given by the following equation:
dsm = 1.34 (Db2/Ksf)1/3

Where, Db = the design discharge for foundation in cumec per meter width. The value of Db shall be the total design discharge divided by the effective linear waterway width between abutments.

"Silt Factor" (Ksf) have been assumed based on the silt factor values of the Agra to Etawah project. As per latest IRC: 78, for the design of piers and abutments located in a straight reach and having individual foundations without any floor protection works, the maximum depth of scour from the highest flood level is given by:

For piers: dmax = 2 x dsm
For abutments: dmax = 1.27 x dsm (having retained approach)

Minimum Founding Level: The foundation has been taken to a level to safeguard against scour. In case of bridges, where the mean scour depth dsm is calculated by using the equation given in Clause 703.2 of latest IRC-78, the depth of foundation has not been taken less than that of existing structures in the vicinity.

2.12.1 Drainage and Protection Works

The drainage requirements for the project road and adjoining areas are assessed through the DTM prepared from topographical survey data. Pavement internal and external drainage is ensured by providing drainage layer and camber respectively. Longitudinal slopes in roadside ditches and central drain are generally equal to generate self cleaning velocity at the time of storm.

Small catchment analysis with project specific unit hydrograph is undertaken for the hydraulic design of the drain channel. The shape of the channels is fixed to facilitate easy and economical construction and easy maintenance. Suitable drainage system is planned

for the high embankment, super-elevated carriageway and other key areas, with a view to en sure easy collection and disposal of storm water. A network has been conceptualized from runoff till final disposal and its continuity is ensured at each critical point.

2.13 Structural Design

2.13.1 General

This section deals with the standards to be adopted in design of vis-à-vis ROBs, flyovers, bridges, underpasses and culverts. It also provides for the type of materials and their specifications that had been adopted for the above structures, the loads and forces to be considered. The project road is 6 lane and the structures are also designed for 6 lanes.

2.13.2 Cross-sectional Elements

a) Structural width for bridges / flyovers / road over rail bridges

The overall deck width for all bridges, underpasses & ROBs has been kept same 21.25 m (including 0.5m crash barrier on either side) in each direction of traffic. Please refer for structure drawing and GADs of each major/minor structures.

b) Median width

A median width of 3.0 m is maintained between two outer faces of RCC crash barriers.

c) Reinforced Earth Retaining Structures –

The design and construction of reinforced earth structures shall conform to section 3100 of MORTH Specifications. Reinforced earth retaining structures shall not be provided near water bodies. Such structures should be given special attention in design, construction, ground improvement where necessary, maintenance and selection of System/System design. Local and global stability of the structure shall be ensured.

d) Road over bridge (road over railway line)

i) If the alignment of road at the existing railway crossing has skew angle more than 45°, the alignment of road or of pier/abutment shall be suitably designed to reduce skew angle up to 45°.

ii) Railways normally do not allow construction of solid embankment in their right of way. The horizontal and vertical clearances to be provided on the railway land shall be as per requirement of the Railway authorities.

iii) In case the Authority has obtained approval of General Arrangement Drawings, the same shall be appended with the Request for Proposal. The Contractor shall have option of adopting the same span arrangement or have his revised proposal for GAD approved from the Railways. In case the total length of stilt portion is not reduced, it will not be considered as change of scope. However, before submitting the revised proposal to the Railways, prior consent of the Authority shall be required.

iv) The Contractor shall be required to obtain approvals of all designs and drawings from the concerned Railway authorities.

v) The construction of ROB within the railway boundary shall be under the supervision of the Railway authorities.

vi) The approach gradient shall not be steeper than 1 in 40.

vii) Outside the railway boundary, one span of 12 m conforming to the requirements of Vehicular Underpass shall be provided on either side of ROB to cater for the local traffic, inspection, and pedestrian movement.

2.13.3 Specification for Material

a) Concrete: The grades of concrete are either equal to or higher than those pre-scribed in latest IRC: 112. Grade of concrete in various structural elements is for moderate conditions of exposure.

Superstructure
PSC Members : M 45
RCC T-Girder and Deck Slab : M 35
RCC Solid Slab : M 35
RCC Box cell : M 35
RCC Crash Barriers: M 40

Substructure
RCC substructures and foundations: M 35
All PCC structural members: M 20
All PCC non structural members: M 15

Pedestals for bearings
Pot/PTFE : M 40
Elastomeric: M 40

b) **Steel:** This conforms to the provisions given in IS: 1786, IS: 432 (Part I).
Reinforcement steel:

- High yield strength deformed bars conforming to Fe 500 / TMT.
- Mild steel not to be used.
- Pre-stressing steel

These conform to IS: 14268-1995
System : 19 K13 or 12 T13 low relaxation multiple strands system
Cables :19 K13 or 12 T13 systems with strands of 12.7 mm nominal diameters.
Sheathing : 90 mm / 75mm Corrugated HDPE sheathing duct.

c) **Bearings**
All bearings shall be easily accessible for inspection, maintenance and replacement. Suitable permanent arrangements shall be made for inspection of bearings from bridge deck. Design and specifications of bearings shall be as per IRC:83 (Part I, II and III). Spherical bearings shall conform to the requirements of BS:5400 and materials of such bearings may conform to the relevant BIS codes nearest to the specifications given in BS:5400. The drawing of bearings shall include the layout plan showing exact location on top of pier and abutment cap and the type of bearings i.e. fixed/free/rotational at each location along with notes for proper installation. The bearing should cater for rotation and movement in both longitudinal and lateral direction. Elastomeric bearing has been provided under RCC T-beams and RCC solid slabs type superstructures as per latest IRC: 83 (Part II) and shall conform to clause 2005 of MoRT&H specification for Road and Bridge Works.

POT cum PTFE bearing has been provided for span more than 25m where we have to cater for large loads and conforming to latest IRC: 83 (Part III) and clause 2006 of MoRT&H specifications for Road & Bridge works.

d) **Expansion Joints**
All Structures shall have minimum number of expansion joints. This may be achieved by adopting longer spans, making the superstructure continuous or by adopting integrated structures. Expansion joints shall conform to IRC:SP:69. In any case, the number of expansion joints shall not be more than 1 for each 100 m length of the bridge or part thereof. For avoidance of doubt, the structures upto 100 m length shall have only one joint at one side abutment, the structures over 100 m and upto 200 m length may have two joints and structures over 200 m and upto 300 m length may have maximum 3 expansion joints. Elastomeric strip seal type expansion joints are provided on all the bridges and ROBs as per Clause No. 2607 of MoRT&H

specification for road and bridge works and interim specifications for expansion joints issued subsequently vide MoRT&H letter no. RW/NH-34059/1/96-S&R dated 25.01.2001 and addendum there to circulated vide letter of even no; dated 30.11.2001. In case of bridges with smaller spans slab seal type expansion joints are provided.

2.13.4 Loads and Forces to be considered in Design

Vertical Loads

a) Dead Loads

Following unit weights are assumed in the design as per latest IRC Codes.
Pre-stressed Concrete: 2.5 t / m3
Reinforced Concrete : 2.5 t / m3
Plain Cement Concrete : 2.2 t / m3
Structural steel : 7.85 t / m3
Dry Density of Backfill Soil : 2.0 t / m3
Saturated Density of Backfill Soil : 2.0 t / m3

b) Superimposed Dead Loads

Wearing Coat: 65mm thick with 40mm bituminous concrete overlaid + 25mm thick bituminous mastic layer
Crash barriers: 1.0 t / m / side

c) Live Loads

Carriageway live loads: The following load combinations are considered in the analysis and whichever produces the worst effect is considered.

Five Lanes of IRC Class A
One Lane of 70R (wheeled) with Three lanes of IRC Class A.

Resultant live load stresses are reduced by 20% in case all the five lanes are loaded. Impact factor is as per latest IRC: 6 for the relevant load combinations. For simplicity in design, Impact factor for continuous structures is calculated for the smallest span of each module and used for all the spans of that module.

d) Horizontal Forces

(i) Longitudinal Forces due to live load

Following effects are considered in the design

- Braking forces as per the provision of latest IRC: 6
- Distribution of longitudinal forces due to horizontal deformation of bearings/frictional resistance offered to the movement of free bearings as per latest IRC: 6

(ii) Horizontal forces due to water currents

The portion of bridge, which may be submerged in running water, is designed to sustain safely the horizontal pressure due to force of water current as per the stipulations of latest IRC:6

(iii) Earth load

Earth forces are calculated as per the provisions of latest IRC:6 assuming the following soil properties:

a. Type of soil assumed for backfilling : As per latest IRC: 112
Angle of Internal Friction : $\Phi = 30^{O}$
Angle of Wall Friction : $\delta = 20^{O}$
Coefficient of Friction 'μ'at base : tan (2/3 Φ), while Φ is the angle of internal friction of substrata immediately under the foundations.

b. ii. Live load surcharge are considered as per the provisions of latest IRC: 6.

e) Centrifugal forces

Centrifugal forces are calculated as per the provisions of latest IRC: 6 for a design speed applicable at horizontal curves.

f) Wind effect

Structures are designed for wind effects as stipulated in latest IRC: 6. The wind forces are considered in the following two ways and the one producing the worst effect shall govern design.

g) Seismic Effect

The road stretch is located in Seismic Zone-III as per the revised seismic map of India (IS: 1893-2002). The seismic forces will be coefficient method as suggested by the modified clause for the interim measures for seismic provisions in latest IRC: 6.

h) Other Forces / Effects

Temperature effects: The bridge structure / components i.e. bearings and expansion joints, are designed for a temperature variation of + 250 C considering extreme cli-mate. The superstructures are also designed for effects of distribution of temperature across the deck depth as given in latest IRC: 6, suitably modified for the surfacing thickness.

Temperature effects considered are as follows:

- Effects of non-linear profile of temperature combined with 50% live load and full value of 'E' is considered.
- Effects of global rise and fall of temperature combined with 100% live load and full value of 'E' is considered.

Differential shrinkage effects: A minimum reinforcement of 0.2% of cross sectional area in the longitudinal direction of the cast-in-situ slab is provided to cater for differential shrinkage stresses in superstructures with cast-in-situ slab over precast girders as per Clause 605.2 of latest IRC: 22.

However, effects due to differential shrinkage and / or differential creep are duly accounted for in the design.

Construction stage loadings / effects: A uniformly distributed load of 3.6 KN /m2 of the form area is considered to account for construction stage loadings in the design of superstructure elements, wherever applicable, as per Cl. 4.2.2.2.2 of IRC: 87 – 1984.

Buoyancy: 100% buoyancy is considered while checking stability of foundations 31um-spective of their resting on soil/weathered rock / or hard rock.

i) Load Combinations to be considered in Design

All members are designed to sustain safely the most critical combination of various loads and forces that can coexist. Various load combinations as relevant with increase in permissible stresses considered in the design are as per latest IRC: 6.

In addition, the stability of bridge supporting two superstructures (with an expansion joint) is checked under one span dislodged condition also.

j) Exposure Condition

Moderate exposure conditions are considered while designing various components of the bridge.

k) Design Codes

The main design criteria adopted is to evolve design of a safe structure having good durability conforming to the various technical specifications and sound engineering practices.

l) Load combinations

The various load combinations considered are as per provisions of latest IRC: 6

ROB

The design of ROB will be based on the guidelines of Ministry of Railways. As per the latest Railways Guidelines, a vertical clearance of 6.625m is being imposed for electrified track.

CD structures & HO/Grade separators

The GAD of CD structures is based on hydraulic and hydrological studies.
The GAD of flyovers/Grade separator is based on the traffic surveys and guidelines as contained in relevant IRC codes.

Codes and Publications

The following codes and publications (latest editions) shall be used for the design of approach road and bridge components:

- Specifications For Road and Bridge Works (4th Revision, 2000)
- IRC: 5-1998 For General Features of Design
- IRC: 6-2000 For Loads and Stresses
- IRC: 18-2000 For Pre-stressed Concrete Road Bridges
- IRC: 21-2000 For Reinforced Concrete Design
- IRC: 78-2000 For Substructure and Foundations
- IRC: 83-1999 (Part I) For Metallic Bearings
- IRC: 83-1987 (Part II) For Elastomeric Bearings
- IRC: 83-1987 (Part III) For Pot cum PTFE Bearings

2.14 Environmental and Social Screening

2.14.1 Environmental Screening

An Environmental screening study has been undertaken. The preliminary environmental study focused on identifying the key areas, the need for assessment of key impacts, issues, including information necessary for proposed development. The following issues were identified:

- The important environmental issues and concerns;
- The significant effects and factors; and
- The appropriate content and boundaries of an EIA study.

The programme included:

- Field surveys;
- Consultation exercises; identifying existing relevant baseline data;
- Identifying the scope of baseline surveys required;
- Identifying key issues to be addressed within the EIA; and
- Providing a technical brief for the EIA.

To identify any potential environmental conflicts arising out from the construction of the road, information was collected to arrive at the environmental constraints for the proposed scheme. The main issues included as appropriate, local settlements and communities,

traffic, agriculture, ecology, land-use and soils, water, archaeological heritage, cultural and religious sites and planning issues.

This part of the study was undertaken in parallel with the economic and engineering analyses in order to determine any significant social or environmental issues, which require further detailed study. The approach and methodology to be adopted for environmental assessment conforms to the requirement of the Environmental Impact Assessment Notification, MoEF, 2006 & its amendment.

2.14.1.1 Secondary data collection

Secondary data collection including relevant maps for all the corridors was made available from various government agencies regarding:

(i) Flora and fauna
(ii) Critical natural habitats
(iii) Built-up areas
(iv) Water bodies
(v) Other critical environmental indicators
(vi) Policy, legal and administrative framework etc.

The available data has been used for environmental screening. The results of the preliminary screening lead to identification of the nature and extent of environmental issues needing more detailed examination, which may be dealt as a full EIA.

2.14.2 Social Screening

The overall objective of the study is to assess the likely impact on persons/families in the process of land acquisition needed in the process of construction of project road.

Social assessment would be conducted to broadly assess the extent of impacts due to the project on persons and properties within the corridor of impact. Both desk research and identification of major settlements within project area through field survey are conducted.

Social assessment study also aims at identifying the project affected people (PAP) and project affected families (PAF) analysing their socio-economic status, assessing losses due to project implementation. Remedial measures are proposed in the RAP to ensure that the income levels of PAPs, after the project implementation, are improved or at least restored to the pre-project level.

2.14.2.1 Secondary data collection

Available information is collected from various agencies that have worked in the state. The information includes constitutional provisions, status of social related legislation and policies of the central government and the state of Uttar Pradesh, guidelines for entitlement framework and community, social, ethnic and economic indicators of the population.

2.14.3 Social Impact Screening

During this preliminary screening stage, the consultants made an initial visit to the site in order to develop a clear understanding of the proposed road changes that may be undertaken and to identify the impact on housing, business and agricultural activities expected to arise out of the changes to be adopted. The social impact screening concentrated on the areas where there is likely to be the greatest impact on the population.

The data is analysed and screening is done initially, through a reconnaissance survey.
The various indicators considered are:

- Community life and economic activities
- Severance of community
- Encroachment on local community facilities
- Encroachment on local economic activities
- Encroachment on the access to and rights of resources
- Cultural heritage / property
- Social structure, institution and customs
- Cultural shock
- Road safety
- Public health
- Waste

Land acquisition and resettlement

- Expropriation of resources
- Involuntary resettlement
- Conflict between target population and host population
- Indigenous or traditional population

The results of the screening are plotted on maps and tabulated to identify any major conflicts and extent of conflicts.

2.15 Schemes for Development and Assessment

From the existing field data a few alternatives are evolved. This task made use of available data, site reconnaissance desk studies and preliminary findings. The standards, codes of practice and other relevant controlling documents are listed thereby establishing the procedures, design controls and general engineering practice required.

In the review of project alignment due considerations are given to the environmental implications, land acquisition and impact on project affected people, using information, provided in the discipline desk study reports undertaken earlier.

2.16 Preliminary Cost Estimates

The rates of materials adopted in the preliminary cost estimate are based on the SoR from respective districts of the Uttar Pradesh. The basis of rate analysis is the MoRT&H Stan-dard Data Book. For the working out of preliminary cost estimate, work items are split into the following sub-heads:

- Site Clearance and earthworks
- Granular Pavement Courses
- Bituminous Courses
- Bridges, Culverts, Retaining Walls and other structures
- Kerbs, Drainage and other Protective works
- Road Junctions, Service Roads, Bus Stops, Truck Lay-byes
- Toll Plaza
- Road Furniture and Road Safety Works
- Traffic Management and maintenance during construction

Chapter – 3

PROJECT PROPOSALS

3 Features of Project

The project is a Greenfield project with a total length of 42.700 Kms, which starts from Km 121+600 at Sidhi Ganeshpur (Dist. Sultanpur) and ends at Sansarpur (Dist. Sultanpur) Km 164+300.

3.1 Terrain of the Project Road

The entire project road passes through plain terrain. The majority of the length of the project road passes through agricultural land.

3.2 Sections Passing Through Rural Areas

The project road is passing through following rural areas/ built-up areas as most of the alignment is Greenfield and uses mostly barren and low fertility/unused land. As much as possible the alignment avoids crossing any village and it is proposed to provide proper service roads. Inhabited sections which are heavily congested (towns and villages), identified along the project corridor are given in Table 3.1

Table 3.1: Rural areas along the Purvanchal Expressway (Package-IV)

Sr. No.	District	Tehsil	Village Name in Package III
1	Sultanpur	Kadipur	Kaithwan, Dhanaupur, Dewapur, Badhauli, Pratap Pur, Madanpur Khurd, Sansarpur.
		Jaisinghpur	Dakhinwara, Jafarpur, Karote Khurd, Arwal Kiri Karawat, Gaura, Kharsauma, Fulauna, Akodi, Bhagwanpur, Dalhupur, Sarang Pur, Sakradepur, Belgara, Parsa, Ramnathpur, Khapra Dih, Dev Parapar, Chandpur, Mahmamud Pur Semri, Sabai, Moke Dih, Chorma, Nidura, Birsinghpur, Saray Nauranga, Chaure, Govindpur, Byaspur, Mahuwari Ashapur, Sarai Sahawan, Gose Singhpur, Sher Khanpur, Sailkha, Alah Dadpur, Khalispur Durg, Vishunpur Chitepatti.
		Sultanpur	Sidhi Ganeshpur, Chak Churabanpur, Madhopur Shukul, Seur Chamurkha.
2	Ambedkar Nagar	Akbarpur	Ahetha, Umarpur, Revra, Rasoolpur Diyara

3.3 Pavement Design

3.3.1 Flexible Pavement Design for Main Carriageway

Flexible pavement has been proposed for main carriageway, IRC:37–2012, "Tentative Guidelines for the Design of Flexible Pavements" have been followed for the flexible pavement design and checked the design by IIT-Pave.

Flexible pavement has been proposed with bituminous and granular base and sub-base for new alignment and service road consisting of various layers such as Granular Sub base

(GSB), Wet Mix Macadam (WMM), Bituminous Surfacing comprising Dense Bituminous Macadam (DBM) and Bituminous Concrete (BC/SDBC up to 5 MSA).

3.3.2 Material Investigations

3.3.2.1 Existing Ground Soil Testing

The soil investigations along the proposed alignment for the green field project have been carried out. The soil samples have been collected and testing of the collected samples has been completed and the summary of test results is given in Table 3.2.

Table 3.2: Test Results of the Existing Soil along the Proposed Alignment

Chainage	Type of soil	% passing through I.S.Sieve				% Sand Content	L.L.	P.L.	P.I.	Classification as per I.S.-1498-1970		FreeSwelling Index (%)	Field Moisture (%)	M.D.D.(gm/cc)	O.M.C. (%)	C.B.R. (%) In soaked condition (Actual)
		4.75 mm	2.00 mm	425 mic.	75 mic					Symbol	Typical Name					
120+000	Fine Grained	100	99.92	99.728	80.564	19.44	21.8	19.2	2.6	ML	Clayey Silt with none to low plasticity	10	13.95	1.94	11.40	6.41
125+000	Fine Grained	100.00	99.53	98.19	97.24	2.76	40.8	21.2	19.6	CI	Silty Clay	60	8.04	1.84	14.49	4.76
130+000	Fine Grained	98.06	95.89	94.66	75.30	22.77	20.8	17.58	3.22	ML	Clayey Silt	11.11	6.80	1.91	11.50	7.18
135+000	Fine Grained	100.00	99.87	99.12	95.62	4.38	29.9	23.2	6.7	ML-CL	Mixture of Silt & Clay with low to medium plasticity	33.33	4.50	1.85	14.20	5.89
140+000	Fine Grained	97.90	96.90	95.25	91.40	6.50	28.5	24.14	4.36	ML-CL	Mixture of Silt & Clay with low to medium plasticity	22.22	7.30	1.86	13.40	6.22

145+000	Fine Grained	99.456	95.28	92.08	87.216	12.24	29.8	23.1	6.7	ML-CL	Mixture of Silt & Clay with low to medium plasticity	33.33	14.46	1.93	12.70	6.16
150+000	Fine Grained	100	99.884	98.692	89.176	10.82	29.7	19.7	10	CL	Silty Clay	44.44	10.26	1.88	14.20	6.16
155+000	Fine Grained	100.00	100.00	98.11	92.45	7.55	32.9	24.9	8	CL	Silty Clay	40	14.57	1.88	13.20	5.92
160+000	Fine Grained	98.352	95.264	91.492	73.892	24.46	27.8	25.6	2.2	ML	Clayey Silt with none to low plasticity	10	6.30	1.87	13.80	6.22
165+000	Fine Grained	99.908	99.372	98.208	87.552	12.36	27.8	23.7	4.1	ML-CL	Mixture of Silt & Clay with low to medium plasticity	20	8.10	1.81	15.20	6.16

3.3.2.2 Borrow Area Soil for Sub-grade Material

Borrow area locations have been identified for the sub-grade material and testing of the collected samples from trail pits have been completed.

The borrow area material test results indicates that the available CBR is in the range of 8.0 % to 8.59 %. A design sub-grade CBR (effective) of 6% has been adopted for the pavement design. The details of borrow area material and laboratory test results have been given in Table 3.3.

Table 3.3: Test Results of Borrow Area Soil Samples

Chainage	Type of soil	% passing through I.S.Sieve				% Sand Content	L.L.	P.L.	P.I.	Classification as per I.S.-1498-1970		FreeSwelling Index (%)	Field Moisture (%)	M.D.D.(gm/cc)	O.M.C. (%)	C.B.R. (%) In soaked condition (Actual)
		4.75 mm	2.00 mm	425 mic.	75 mic					Symbol	Typical Name					
BA-17	Fine Grained	100	100	99.2	94.676	5.32	29.3	23.6	5.7	ML-CL	Mixture of Silt & Clay with low to medium plasticity	33.33	14.57	1.84	13.4	8
BA-18	Fine Grained	99.912	99.584	97.048	67.432	32.48	NP	NP	NP	NP	NP	0	7	1.96	11.5	8.59
BA-19	Fine Grained	59.536	58.172	57.044	54.76	4.78	27.5	23.6	3.9	ML	Clayey Silt with none to low plasticity	11.11	8.7	1.95	11.4	8.32
BA-9A	Fine Grained	99.81	99.203	98.928	95.888	3.92	33.2	26.8	6.4	ML-CL	Mixture of silty clayey sand with none to low plasticity	33.33	7.60	1.92	9.4	8.16

3.3.3 Design Traffic Loading

Base year traffic in terms of AADT, design period, traffic growth rates, vehicle damage factors (VDFs) and lane distribution factors (LDFs) are required to estimate the design traffic loading in terms of equivalent standard axles.

Base Year Traffic (AADT)

The base year traffic has been assessed by carrying out traffic surveys. Since the project road is green field project, hence the traffic surveys have been carried out on the cross roads/connecting roads. The detailed traffic surveys and analysis for the project road have been given in Chapter 5.0 (Traffic Surveys & Analysis). For pavement design purpose, commercial vehicles of laden weight more than 3 tonnes has been considered. Such vehicles consisted of buses, LCVs, 2 Axle trucks, 3 Axle trucks and Multi Axle trucks. The summary of AADT of commercial vehicles considered for pavement design is given in Table 3.4.

Table 3.4: Commercial Vehicles (AADT) for the Pavement Design

Sections	Length (kms)	Commercial Vehicles (AADT – 2015)					
		Bus	LCV	2- Axle	3 – Axle	MAV	Total
121+600 to 164+300	42.700	296	458	314	1077	770	2915

Traffic Growth Rates

Traffic growth rates have been estimated based on elasticity method and the summary of obtained growth rates are given in Table 3.5. The detailed traffic growth calculations have been given in Chapter 4 (Traffic Surveys and Analysis).

Table 3.5: Adopted Traffic Growth Rates

Year	Car	Minibus	Bus	Mini LCV	LCV	2 Axle Truck	3 Axle MAV	4- to 6 Axle MAV
2015-20	11.07%	6.67%	6.67%	9.80%	9.80%	8.06%	10.17%	10.70%
2021-30	9.97%	5.86%	5.86%	9.14%	9.14%	7.34%	9.51%	10.03%
2031-40	7.22%	3.83%	3.83%	7.50%	7.50%	5.55%	7.86%	8.35%

Vehicle Damage Factors

The vehicle damage factor (VDF) is a multiplier to convert the number of commercial vehicles of different axle loads and axle configuration to the number of standard axle load repetitions. It is defined as the equivalent number of standard axles per commercial vehicle. Universally accepted standard axle load weighs 8,160 Kg. ESAL is determined by the relationships recommended in IRC: 37-2012 'Tentative guidelines for the design of Flexible Pavements'.

The project road is a green field highway and there is no existing carriageway, therefore, the VDF has been calculated based on the Axle Load Surveys conducted on alternate roads. VDF values adopted for design is as per Axle Load surveys as tabulated below:

Vehicle Type	Bus	LCV	2 Axle	3 Axle	MAV
VDF	0.93	0.41	4.36	6.98	3.53

Design Life

Pavement design life is the period for which the initial design of pavement crust layers shall be carried out. Design life should not be referred as terminal stage of crust beyond which crust becomes unusable.

The flexible pavement design is to be carried out in accordance with IRC: 37-2012, with stage construction, hence a design life of 15 years has been considered for design purpose.

Design Traffic Loading (Cumulative Million Standard Axles)

For flexible pavement design traffic loading in million standard axles (MSA) has been estimated for a design life of 15 years (post construction). The design traffic is considered in terms of the cumulative number of standard axles to be carried during the design life of the road. The summary of MSA obtained and adopted is given in **Table 3.6.**

Table 3.6: Obtained and Adopted MSA for the Pavement Design

Section	Design Life 20 Years	Design Life 15 Years
Km 121+600 to Km 164+300	MSA Granular	MSA Bituminous
	88	61

3.3.4 Flexible Pavement Design for Main Carriageway (New Construction)

The IRC method for pavement design is based on limiting the vertical compressive strain on top of sub-grade which results in permanent deformation of the pavement and the horizontal tensile strain at the bottom of the bituminous layer which results in cracking of the pavement.

The flexible pavement design has been carried out by using the procedure given in IRC: 37-2012, thereby ensuring requisite structural layers. By considering all inputs given above the proposed flexible pavement design for the main carriageway (new construction) is given in Table 3.7.

Table 3.7: Flexible Pavement Design for Main Carriageway (New Construction)

Section	Design Life (Years)	Design MSA Granular	Design MSA Bituminous	Design CBR (%)	New Crust Composition (mm)				
					BC	DBM	WMM	GSB	Total Thickness
121+600 to 164+300	20/15	88	61	6	50	160	100	200	510

Sub-grade of 500 mm thickness of CBR value not less 8% and sub-base material of CBR not less than 30% shall be used.

Paved shoulder

The pavement composition of paved shoulders has been kept with the same specifications as those of the main carriageway.

3.3.5 Service Roads

The Service roads are proposed to be provided at locations of the project road where it is passing through urban areas. Service roads have been designed for 5 MSA for 6% CBR. The crust composition of service roads is given in Table 3.8.

Table 3.8: Flexible Pavement Design for Service Road (New Construction)

Design MSA	Design CBR (%)	New Crust Composition (mm)				
		SDBC	DBM	WMM	GSB	Total Thickness
5	6	25	75	100	200	400

3.3.6 Rigid Pavement Design for Toll Plaza Locations

Rigid pavement is proposed at toll plaza locations, as it has longer life and can resist the wear and tear caused by braking forces exerted by heavy vehicles. Since the project road is a green field project and the axle load spectrum is not available. In the absence of the axle load spectrum, the rigid pavement design has been carried out by considering the similar kind of six lining project.

The rigid pavement design has been carried out as per IRC: 58-2011 (Guidelines for the Design of Plain Jointed Rigid Pavements for Highways). The design period for the rigid pavement design has been considered is 30 years. The CBR of sub-grade has been adopted is 8%. The rigid pavement design has been carried out for the concrete pavement with tied concrete shoulder with doweled transverse joints. The proposed composition of rigid pavement is as given below in Table 3.9.

Table 3.9: Rigid Pavement Design for Proposed Toll Plaza Location

Proposed Rigid Pavement Composition			
GSB (mm)	**DLC (mm)**	**PQC (mm)**	**Total Thickness (mm)**
150	150	280	580

3.4 Geometric Design

3.4.1 Horizontal Curves

The horizontal geometry varies along the entire stretch however all the curves satisfy the highway requirements.

3.4.2 Vertical curves

The vertical geometry varies along the entire stretch however all the curves satisfy the highway requirements.

3.4.3 GTS BM, DGPS and UTM Coordinates

Table 3.10: GTS Bench mark has been taken as mentioned below:

Sl. No.	GTS BM No.	Reduced Level (RL)	Location	Remarks
1	Sl. No. (3); 63B	111.220	GTS BM on stone at N.end of second step just N. of GPO , Hajratganj, Civil lines, Lucknow	GTS BM Value taken from this and connected to GPS 42

Differential Global Positioning System (DGPS) and Universal Transverse Mercator (UTM) coordinates along the project road are given in Table 3.11.

Table 3.11: DGPS and UTM Coordinates along the Project Corridor

SL. No.	Point ID	EASTING	NORTHING	RL	Location
1	GPS2	610675.310	2920354.886	97.924	Near at Ch. 120+600 at LHS side near Kurebhar Railway station
2	GPS1A	611883.125	2919567.965	98.878	Near at Ch. 121+800 on Sultanpur cross Road at RHS side
3	GPS1	611903.984	2919647.502	99.110	Near at Ch. 121+880 on Sultanpur cross Road at RHS side
4	GPS43	611964.240	2920240.795	99.539	Near at Ch. 121+900 on Ayodha cross Road at LHS side
5	GPS43A	611932.871	2920226.548	98.938	Near at Ch. 121+870 on Ayodha cross Road at LHS side
6	GPS44	615273.942	2918541.257	97.222	Near at Ch. 125+570 on Karuta cross Road at RHS side
7	GPS44A	615305.530	2918526.020	97.461	Near at Ch. 125+630 on Karuta cross Road at RHS side
8	GPS45	618457.326	2918484.796	97.375	Near at Ch. 128+780 on Culvert Top of Canal at LHS side
9	GPS45A	618395.316	2918474.656	96.655	Near at Ch. 128+700 at LHS side
10	GPS46	621407.244	2918028.924	95.632	Near at Ch. 131+750 on Sarangpur cross road at LHS side
11	GPS46A	621357.763	2918024.941	95.576	Near at Ch. 131+700 on Sarangpur cross road at LHS side
12	GPS47	624218.874	2917366.757	94.952	Near at Ch. 134+660 on Para cross road at RHS side
13	GPS47A	624239.483	2917399.748	94.909	Near at Ch. 134+660 on Ramnathpur cross road at LHS side
14	GPS48	627992.189	2915548.920	94.806	Near at Ch. 138+150 on Devparapar cross road (SH-9A) at LHS side
15	GPS48A	628048.270	2915568.781	94.428	Near at Ch. 138+150 on Devparapar cross road (SH-9A) at LHS side
16	GPS49	631339.285	2914238.404	94.025	Near at Ch. 142+800 at LHS side
17	GPS49A	631319.524	2914263.991	93.996	Near at Ch. 142+800 at LHS side
18	GPS50	633327.013	2912915.534	92.419	Near at Ch. 146+100 at LHS side
19	GPS50A	633399.688	2912959.804	93.103	Near at Ch. 146+100 at LHS side
20	GPS51	635890.524	2912124.315	92.120	Near at Ch. 148+930 at LHS side
21	GPS51A	635916.901	2912157.587	92.084	Near at Ch. 148+930 at LHS side
22	GPS52	638516.494	2911389.846	91.179	Near at Ch. 151+800 on Shekhanpur cross Road at LHS side
23	GPS52A	638523.912	2911417.036	90.851	Near at Ch. 151+800 on Shekhanpur cross Road at LHS side
24	GPS53	641742.699	2910164.560	90.892	Near at Ch. 155+200 on cross Road at RHS side
25	GPS53A	641695.853	2910189.220	90.812	Near at Ch. 155+150 on cross Road at RHS side
26	GPS54	643913.226	2909400.333	89.121	Near at Ch. 157+460 at LHS side
27	GPS54A	643827.895	2909382.775	88.776	Near at Ch. 157+410 at LHS side
28	GPS55	647201.658	2907815.741	88.510	Near at Ch. 161+180 on cross Road at LHS side
29	GPS55A	647218.277	2907866.718	88.561	Near at Ch. 161+180 on cross Road at LHS side
30	GPS56	649941.942	2906859.143	90.106	Near at Ch. 164+100 on Sansarpur cross Road at RHS side
31	GPS56A	649893.739	2906872.904	89.983	Near at Ch. 164+040 on Sansarpur cross Road at RHS side

3.5 Airstrip

The section of the Expressway of length 3.2 Km from 124+750 to 129+450 has been proposed to serve as Expressway and Aircraft Landing Strip for Indian Air Force (IAF) operations.

The Expressway sections of 750 m in both sides preceding and succeeding the Landing Strip has been proposed to serve as Clear Zone for the Landing Strip.

3.6 Structures

The type of foundation, span arrangement and the type of superstructure are based on preliminary design only. The indicative GADs has been taken for costing purposes and actual design will be carried out by EPC contractor.

3.6.1 Major Bridges

1 (one) bridge has been proposed within ROW of the project stretch.

Table 3.12. Major Bridge Proposals

Sr. No.	Chainage	Proposed Span Arrangement (m)	Remark
1	149+130	2 x 32.0	Nallah

3.6.2 Minor Bridges

There are 13(thirteen) number of minor bridges proposed within the ROW of the project stretch and the same is given in Table: 3.13.

Table 3.13: Minor Bridges on Expressway and service Road

Sr. No.	Proposed Chainage	Total Right Length (m)	Skew	Total Width on Expressway	Total Width on service Road
1	125+235	11.5	44	2 x 21.250 m	10.000 m
2	126+885	9	56	2 x 21.250 m	10.000 m
3	127+070	25	40	2 x 21.250 m	10.000 m
4	128+805*	50	10	2 x 21.250 m	10.000 m
5	129+619	16	0	2 x 21.250 m	10.000 m
6	133+495	10	34	2 x 21.250 m	10.000 m#
7	135+660	12	0	2 x 21.250 m	10.000 m
8	138+385*	**18**	18	2 x 21.250 m	10.000 m
9	143+340	12	20	2 x 21.250 m	10.000 m
10	149+890*	25	0	2 x 21.250 m	10.000 m
11	156+210	25	0	2 x 21.250 m	10.000 m
12	158+535	25	0	2 x 21.250 m	10.000 m
13	161+525	32	0	2 x 21.250 m	10.000 m

An additional Minor Bridge on the Cross Road is to be constructed due to training of nala as per following:

Sr. No.	Proposed Chainage (Km)	Total Right Length (m)	Skew	Total Width on Cross Road	Remarks
1	146+850	12.43	39	10.500 m	Bridge on Cross Road

Note: 1- Deck Level for bridges on main carriageway should not be less than as given in Road Profile; if required from hydraulic considerations it may be increased. The same deck level as provided for bridges on main carriageway, shall be provided for bridges on service road also (except bridges over canal on service road).

2- For Bridges over canals on main carriageway, the length of bridge will constitute of canal section, it's inspection road on one side and spoil bank on other side. The face of abutment shall be beyond the toe of canal embankment as shown in the standard x-section of the canal or as per site condition, whichever is more. Minimum 5.5m vertical clearance shall be provided for canal's inspection road.

3- For Bridges over canals on service road, the service road and canal's inspection road will intersect each other at the same level. Deck level and Span of bridge shall be fixed as per hydraulic considerations subject to concurrence from the concerned department.

4-* the structures at these minor bridge locations includes an underpass (min. 7.0m wide and 5.5m vertical clearance) to serve as an nala/drain inspection road

5-# the structures at these locations include minor bridges on service roads on both sides.

6- All structures having skew angle less than 10 degree shall be provided with "Strip Seal Expansion Joints with sinus plate".

7- The work of major/minor bridge is inclusive of all protection works and guide bunds (if required).

3.6.3 Vehicular Underpass

6 (six) numbers of vehicular underpasses and 12 (Twelve) numbers of light vehicular underpasses have been proposed within the ROW of the project Stretch and the same are given in **Table 3.14.**

Table 3.14: Proposed Vehicular Underpasses & Light Vehicular Underpasses within ROW of the Project Stretch

Proposed Vehicular Underpass (VUP)

Sr. No.	Chainage	Proposed Span Arrangement	Remark
1	123+150	2 x 12.0 x 5.50	Madhopurshukul (Due to Interchange)
2	131+800	1 x 12.0 x 5.50	Dhundhu – Sarangpur Road
3	135+920	2 x 12.0 x 5.50	Ramnathpur (Due to Interchange)
4	145+315	1 x 12.0 x 5.50	Birsinghpur – Sapahi Road
5	161+085	2 x 12.0 x 5.50	MDR Road-117E
6	163+970	2 x 12.0 x 5.50	Dewapur – Sansarpur Road

Proposed Light Vehicular Underpass (LVU)

Sr. No.	Chainage	Proposed Span Arrangement	Remark
1	123+895	1 x 10.5 x 4.30	Madhavpur – Shukulpur
2	125+400	1 x 10.5 x 4.30	Kundaran – Kalibaha – Sudnapur Road
3	129+780	1 x 10.5 x 4.30	Baroula – Dhundhu Road
4	133+765	1 x 10.5 x 3.50	Balgara – Sarangpur Road
5	139+415	1 x 10.5 x 4.30	Devparapur Road
6	141+650	1 x 10.5 x 4.30	Jayainghpur – Moukedih Road
7	143+900	1 x 10.5 x 4.30	Siyaraphari – Mattakpati Road
8	146+795	1 x 10.5 x 4.30	Birsinghpur Road
9	149+185	1 x 10.5 x 4.30	Shekhanpur – Saraynaurang Road
10	151+575	1 x 10.5 x 4.30	Shekhanpur Road
11	155+100	1 x 10.5 x 4.30	Khalispurdogra Road
12	157+085	1 x 10.5 x 4.30	Dhanaupur – Bishunpur Chhotepatti Road

3.6.4 Pedestrian Underpass

11(eleven) PUPs have been proposed within the ROW of the project stretch to meet the requirement as given in Guidelines for Expressways. The consultant ensured that the location of proposed PUPs suits the agrarian traffic requirements. The list of proposed PUPs within the ROW of the project stretch is given in Table: 3.15.

Table 3.15: Proposed Pedestrian Underpasses within ROW of the Project Stretch

Sr. No.	Chainage	Proposed Span Arrangement	Remark
1	134+655	1 x 7.0 x 3.0	Ramnathpur – Para Road
2	136+690	1 x 7.0 x 3.0	Khapra Dih Road
3	137+375	1 x 7.0 x 3.0	Dev Parapar Road
4	140+385	1 x 7.0 x 3.0	Sabai Road
5	143+065	1 x 7.0 x 3.0	Chorma Road
6	148+735	1 x 7.0 x 3.0	Mahuari Ashapur Road
7	153+940	1 x 7.0 x 3.0	Khalispur Durg
8	154+680	1 x 7.0 x 3.0	Khalispur Durg
9	158+770	1 x 7.0 x 3.0	Umarpur Road
10	159+585	1 x 7.0 x 3.0	Revra
11	162+795	1 x 7.0 x 3.0	Badhauli Road

3.6.5 ROB

There is no ROB proposed along the project stretch as given in Table: 3.16.

Table 3.16: Proposed Rail Over Bridge (ROBs) within ROW of the Project Stretch

Sr. No.	Chainage	Proposed Span Arrangement	Remark
Nil			

3.6.6 Flyovers and Interchange

There are 3 (three) flyovers proposed within the ROW of the project stretch as given in Table: 3.17.

Table 3.17: Proposed Flyover & Interchange

Sr. No.	Chainage	Type of Interchange	Remark
1	121+870	Trumpet Type Interchange	SH – 9 crossing
2	138+155	Trumpet Type Interchange	SH-9A crossing
3	160+375	Flyover	Samadhi / Kabarstan

3.6.7 Culverts

There are 45 (forty five) Box Culverts proposed on main carriageway as well as on service road within the ROW of the project stretch:

Table 3.18: Proposed Box Culverts on Main Carriageway & Service Road

Sr. No.	Chainage	Proposed Span Arrangement
1	122+450	1 x 2.0 x 2.0
2	124+190	1 x 2.0 x 2.0
3	124+625	1 x 3.0 x 3.0

Sr. No.	Chainage	Proposed Span Arrangement
4	129+210	1 x 2.0 x 2.0
5	130+170	1 x 2.0 x 2.0
6	130+615	1 x 3.0 x 3.0
7	131+060	1 x 2.0 x 2.0
8	132+000	1 x 2.0 x 2.0
9	132+500	1 x 2.0 x 2.0
10	133+080	1 x 3.0 x 3.0
11	134+240	1 x 2.0 x 2.0
12	134+815	1 x 2.0 x 2.0
13	135+180	1 x 3.0 x 3.0
14	135+955	1 x 3.0 x 3.0
15	136+865	1 x 3.0 x 3.0
16	138+730	1 x 3.0 x 3.0
17	139+080	1 x 2.0 x 2.0
18	139+910	1 x 2.0 x 2.0
19	140+870	1 x 2.0 x 2.0
20	141+295	1 x 3.0 x 3.0
21	142+470	1 x 2.0 x 2.0
22	143+610	1 x 3.0 x 3.0
23	144+850	1 x 3.0 x 3.0
24	146+150	1 x 3.0 x 3.0
25	147+750	1 x 2.0 x 2.0
26	148+230	1 x 2.0 x 2.0
27	150+440	1 x 3.0 x 3.0
28	150+850	1 x 2.0 x 2.0
29	151+270	1 x 2.0 x 2.0
30	152+180	1 x 2.0 x 2.0
31	152+680	1 x 3.0 x 3.0
32	153+180	1 x 2.0 x 2.0
33	153+680	1 x 2.0 x 2.0
34	155+550	1 x 2.0 x 2.0
35	155+920	1 x 3.0 x 3.0
36	156+730	1 x 3.0 x 3.0
37	157+650	1 x 2.0 x 2.0
38	158+130	1 x 3.0 x 3.0
39	159+060	1 x 2.0 x 2.0
40	160+695	1 x 3.0 x 3.0
41	161+380	1 x 2.0 x 2.0
42	162+140	1 x 3.0 x 3.0
43	162+520	1 x 2.0 x 2.0
44	163+300	1 x 2.0 x 2.0
45	163+625	1 x 3.0 x 3.0

Table 3.20: Proposed Hume Pipe Culverts on Main Carriageway & Service Road

Sr. No.	Chainage	Type of H. P. Culvert
1	125+985	1 x 1.2 H. P. Culvert
2	128+500	2 x 1.2 H. P. Culvert

Chapter – 4

TRAFFIC, TOLL AND FINANCIAL STUDIES

4 Traffic, Toll and Financial Studies is given in a separate report.

Chapter – 5

COST ESTIMATES

5 General

The cost estimates for the project are extremely important as its entire viability and implementation depends on the project cost. Therefore, cost estimates and rate analysis of the items have been carried out with due care. The project cost estimates have been prepared considering various items of works associated with the identified proposals.

5.1 Methodology

The process involved in the preliminary cost estimation has been described under the following sections.

5.1.1 Basic rates

The basic rates for each construction items were analyzed on the basis of MoRT&H Standard Data Book and Uttar Pradesh PWD (National Highway) Standard Schedule of Rates (2017-2018) for material and Labour. The basic rates for each construction items are analyzed on the basis of material study under taken the prices of construction materials collected from various sources and on the anticipated distance of source to the site of work.

For items where these rates are not available, the rates were taken from DSR and further rates which are not available in DSR are adopted from market rates.

5.1.2 Quantification of Items / Quantities

The construction items covered in cost estimates are: site clearance, earthwork in new embankment sub-grade, pavement in carriageways and shoulders, culverts, bridges, drainage and protection works, parking and lay-byes, resettlements, land acquisition, environmental protection, flyovers, electrification, toll plazas and miscellaneous items which includes pavement markings, signs, guard rails, etc. Special consideration was given for the stretches passing through hazardous conditions.

For estimation of quantities & costs, various work items have been grouped in Table 5.1.

Item	Detailed Description
Site Clearance & Earthwork	Clearing and Grubbing, Removal of stumps of felled trees Earth excavation Fill by excavated earth Sub-grade Earthen Shoulder
Sub-base & Base Course	Granular Sub-base Wet Mix Macadam
Bituminous Courses	Prime coat Tack Coat Dense Bituminous macadam Bituminous concrete
Bridges/FO/VUP/PUP/ROB	Structures on Main Expressway with Service Road and Link Road
Cross Drainage Structures	RCC Box Culverts

Drainage & Protective Works	Open Drain along with Expressway and Service Road
Road furniture and safety works	Km stone, Hectometer stone Guard Stone Gantry Signs & Markings Lamp Posts
Toll Plaza	Toll Plaza
Miscellaneous	Photographic records, Vehicles, wireless systems
Environmental Plan	Including plantation on median

The quantities for the respective cost estimates have been computed as detailed below:

The earthwork quantities like roadway excavation and embankment have been calculated by Bentley's MX Road design software

The quantities for road pavement, base, sub-base etc. for main carriageway and service roads have been calculated through applicable typical cross section.

5.1.3 Centages

Besides the cost estimates, the following percentages have been added.

Labour Cess – 1%
Contingencies – 2.8%
Utility Shifting – 1%
Establishment – 0.5%
Agency Charges – 3%
Quality Control charges – 0.25%
Road Safety Audit charges – 0.25%
Supervision – 3%
Maintenance Cost for 5 years – 8%
Escalation for First Year – (2.5% x20%)
Escalation for Second Year – (7.5% x 40%)
Escalation for Third Year – (12.5% x 40%)

5.2 Specifications

The Specifications for various items of work have been assumed to follow the Guidelines for Expressway (2010) and Manual of Specifications and Standards for Expressways (IRC:SP:99-2013) published by IRC, Government of India.

5.3 Cost Estimates

The Cost Estimates have been estimated for the project expressway (Package-IV). Cost estimate includes cost for 6(six) lanes expressway and the cost of structures has been adopted for 8(eight) lanes. The summary of cost estimates for Package-IV of the project road is given in Table 5.2.

Table E.5: Project Cost

Sr. No.	Particulars	Amount
1	Bill No. 1: Site clearance and Dismantling	3.49
2	Bill No. 2 : Earth Work	242.18
3	Bill No. 3 : Grannular Sub Base Courses and Base Courses (Non-Bituminous)	196.36
4	Bill No. 4 : Bituminous Courses	236.59
5	Bill No. 5 : Box Culverts	55.33
6A	Bill No. 6A : Minor Bridges	197.43
6B	Bil No. 6B : Major Bridges	25.94
6C	Bill No. 6C : VUP/LVU/PUP	74.47
6D	Bill No. 6D : ROB	0.00
6E	Bill No. 6E : Flyover and NH & SH Crossing	96.03
6F	Bill No. 6F : Interchange and Junctions	63.39
6G	Bill No. 6G : Retaining Wall	13.77
7	Bill No. 7 : Drainage & Protective Works	77.23
8	Bill No. 8 : Traffic signs, Road markings and other road appurtenances (1/3 rd Cost of Anti Glare Screen approved by EFC)	75.74
9	Bill No. 9: Toll Plaza	32.79
10	Bill No. 10: Approach to Wayside Amenities, Toilet block & Median Opening	8.06
11	Bill No. 11 : Environmental Cost (Civil Works)	11.03
12	Bill No. 12 : Miscellaneous Works	17.79
13	Bill No. 13 : Additional Service Cost & Median Opening	0.00
15	Bill No. 15 : Airstrip	184.69
	Civil Cost	**1612.32**
	Project cost including Labour cess	**1628.44**

The above project cost is exclusive of Goods and Services Tax

Chapter – 6
ECONOMIC STUDIES

Economic Studies is given a separate report.

Chapter - 7

ENVIRONMENTAL SCREENING AND PRELIMINARY ASSESSMENT

7.1 Background

The Uttar Pradesh Expressway Industrial Development Authority (Government of UP) has been entrusted to develop the access controlled Purvanchal Expressway, which traverses entire state to integrate creation of World Class infrastructure with industrial and economic development, IIDC Limited has been engaged by UPEIDA to provide technical support in the project preparation of the proposed Purvanchal Expressway. Agra Lucknow section of this expressway is already under construction and remaining portion of this expressway from Chand sarai in District Lucknow to Haidariya in District Ghazipur (about 340.956 Kms) is being proposed to develop on EPC mode. The proposed expressway will also have economic and industrial corridors along the link expressway which will be connected to the proposed expressway. This proposed Expressway project shall create immense employment opportunities to the local people of eastern region of the State because of induced economic and industrial development. The proposed expressway has been divided in 8 packages and the chainages of Package - IV is as presented in Table below.

Table 7.1: Chainage-wise details of Package - IV

Package	From	To	Chainage	Length (Kms)
I	Sidhi Ganeshpur (Sultanpur)	Sansarpur (Sultanpur)	121+600 to 164+300	42.700

The present environmental screening has been carried out for Package–IV which is from Sidhi Ganeshpur in Dist. Sultanpur (Km 121+600) to Sansarpur in Dist. Sultanpur (164+300). Environmental screening study has been carried out to identify critical issues and areas that would be studied in detail for impact assessment, mitigation measures and management plan. Further details will be taken up during subsequent stages of the project preparation. This report has been prepared based mainly on field survey and collection of secondary data.

In the screening stage, existing environmental set-up of the study corridor in general i.e., the Corridor of Impact (CoI) and the existing Right of Way (RoW) in particular were studied and is described in subsequent sections. The entire EIA study was carried out within existing policy, legal and administrative framework considering the applicable environmental legislation, regulations and guidelines.

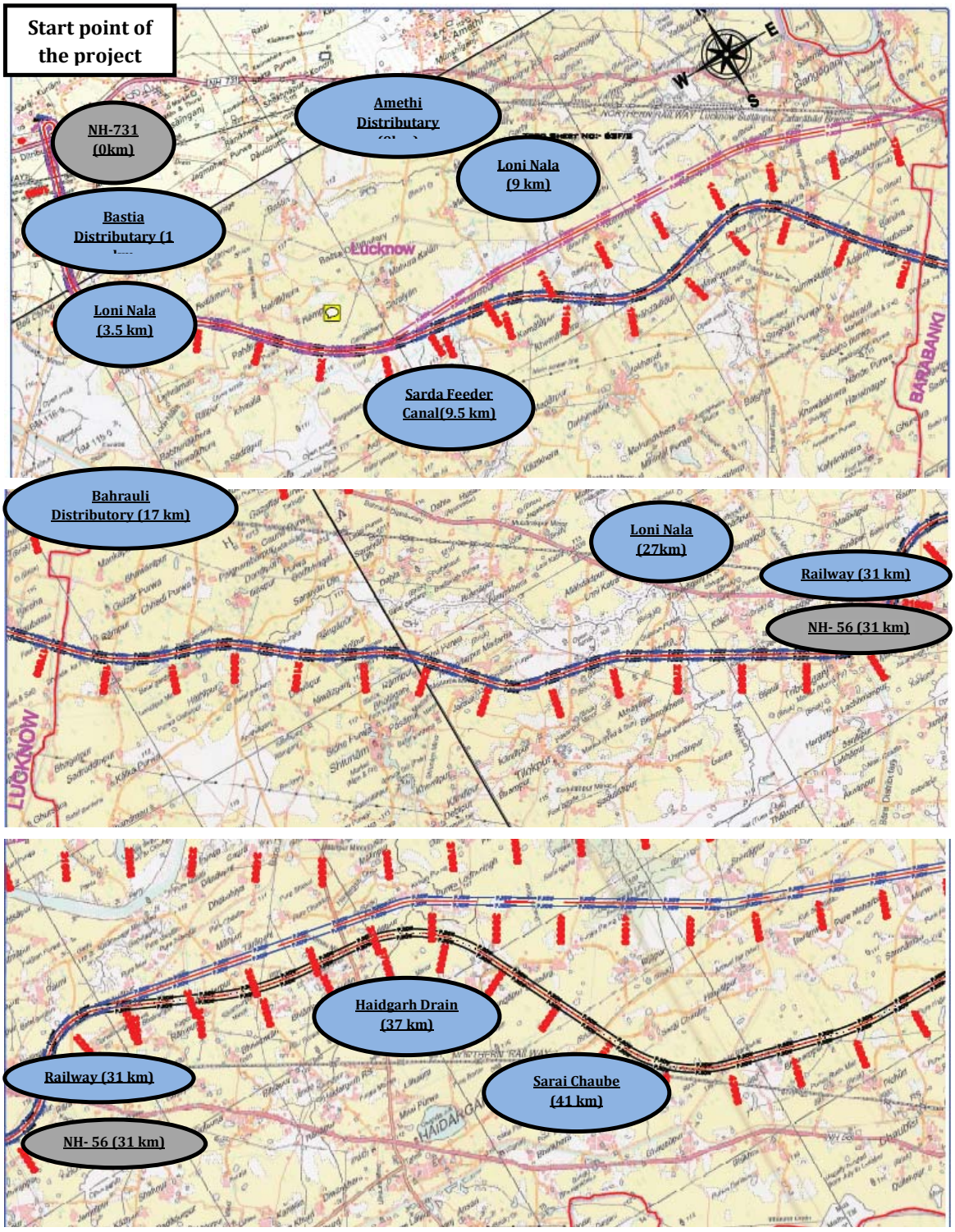
The Right of Way (RoW) of the proposed expressway is 120 meter. The proposed expressway will have 6-Lane access controlled expressway and service roads on one side of expressway. The connectivity to the proposed expressway will be through grade-separator such as clover leaf, underpasses and overpasses at pre-defined locations. Flexible pavements are proposed for main carriage way and service roads throughout the expressway except at toll plaza where rigid pavements are being proposed. All geometric design has been carried out as per the IRC and MoRT&H standards and specifications. The design speed has been kept quite uniform, and design speed even at curves is 120 kmph.

7.2 Description of the Project Area

The project districts are located in middle Gangetic Plains. The entire project area is is alluvial plain formed by Ganga and its tributaries. The climate of project area is predominantly subtropical & is characterized by hot summer and cool winter. Most of

the rainfall occurs during the southwest Monsoon, (June to September). However winter rainfalls (about 5 cm) takes place in the month of December and January. The area experiences a dry period from February to June. There are three distinct seasons 1. Monsoon 2. Winter, 3. Summer.

Environmental features along the alignment



(i) Forest Area: The Project Road from Chand Sarai (Dist. Lucknow) to Sansara (Dist. Barabanki) traverses through the plain agricultural field. However, there are National Highways, State Highways, railways and Canal crossings in the proposed Expressways. The plantation area other than main carriageways is declared as protected forest in Uttar Pradesh. List of such protected forest is presented in the Table below. This is to be noted that the proposed expressways is not passing through any wildlife sanctuaries, National Park or any other Eco sensitive areas.

Table 7.2: List of Forest Length along the Project Road

Chainage	Protected / Reserved Forest	Districts
121.870	Protected	Sultanpur
125.234	Protected	Sultanpur
126.856	Protected	Sultanpur
127.070	Protected	Sultanpur
128.803	Protected	Sultanpur
129.619	Protected	Sultanpur
133.494	Protected	Sultanpur
135.661	Protected	Sultanpur
138.155	Protected	Sultanpur
138.155	Protected	Sultanpur
141.373	Protected	Sultanpur
143.341	Protected	Sultanpur
146.582	Protected	Sultanpur
150.054	Protected	Sultanpur
161.185	Protected	Sultanpur

(ii) Junctions: The project road traverses through various habitations and towns as discussed earlier. Also, many cross roads join the project road at different locations. A list of the entire cross roads is presented here below:

Table 7.3: List of Major/Minor Junctions

Sl. No.	Chainage	Category	Surface Type	Remarks
1.	121+870	PWD	Bituminous	
2.	138+155	PWD	Bituminous	
3.	161+085	MDR	Bituminous	

7.3 Baseline Environment Status

The project districts are located in middle Gangetic Plains Region of Uttar Pradesh. It is a fertile alluvial plain drained by Gomti river and its tributaries. The average thickness of alluvium is about 1300-1400 meters. The project area is homogenous and featureless plain with very little difference of elevation. The climate of project area is predominantly subtropical & is characterized by hot summer and cool winter. About 90% of the rainfall occurs during the southwest Monsoon, lasting from about June to September. The area experiences a dry period from February to June. After February there is continuous increase in temperature till May which is generally the hottest month. There are three distinct seasons – Summer, Monsoon and Winter

Table 7.4: Climatic Conditions of a Representative Location in the Project

Months	Normal	Warmest	Coldest	Normal
January	15.9°C	23.1°C	8.7°C	2
February	18.4°C	26.2°C	10.7°C	2
March	24.5°C	33.1°C	15.9°C	1
April	30.7°C	39.3°C	22.1°C	1
May	34.0°C	41.6°C	26.3°C	2
June	33.6°C	39.5°C	27.8°C	5
July	29.9°C	33.8°C	26.1°C	16
August	29.2°C	32.8°C	25.7°C	13
September	28.7°C	32.9°C	24.4°C	10
October	26.4°C	32.7°C	20.2°C	2
November	21.7°C	29.4°C	14.0°C	0
December	17.3°C	24.7°C	9.8°C	1

(i) **Geology:** The geological formation of the project area is of Pleistocene and recent era because of deposition of alluvium in trough like depression between Himalaya and Peninsular pleateau. The plain is divided in Khadar and Bhanger area. The project area provides rich fertile soil for agricultural operations and support dense population.

(ii) **Soil Characteristics:** The soils in the project area are alluvium and loam soils which are generally light colored and fertile.

(iii) **Hydrology:** The project road crosses Loni near Lucknow and Gomti near Amethi. A large number of small rivers and canal also crosses the proposed expressways.

(iv) **Ambient Air Quality:** As the proposed expressways traverses through rural and agricultural area**,** the Ambient air quality of the project road is generally influenced by emissions from stationary sources like domestic sources from various settlements, stone crushers operating in the area and from mobile sources like the vehicles plying in the project area. Not many big industries are found along the proposed expressway except few Sugar mill industries. All these sources contribute to the local air pollution levels.

(v) **Water Quality:** Perennial water sources are River Gomti and Loni. Ground water is also available. It expected that all important parameters falling within the prescribed limit.

(vi) **Ambient Noise level:** Noise level in the project area is expected to be within limit as the project passess through rural area.

(vii) **Biological Environment:** The proposed road passes through agricultural areas. Important species are shissam, Teak, Mahaneem, Babul, Mahua, Sirash etc. The fauna reported along the project road are Jungle Cat, Monkey, Fox, Jakal, Blue Bull etc. however these are not going to be affected by the proposed work.

(viii) **Land Environment:** The main land use along the project road is agriculture, followed by commercial, residential and forest areas. The project road is passing mainly through agricultural area followed by commercial and forest areas. Other than agriculture, commercial and industrial areas, residential areas contribute a

significant percentage towards land use. Even though there are some small industries and institutions along the project stretch, its contribution is comparatively very low with the above mentioned land use pattern.

7.4 Scope of Work

The EIA has been included in project preparation to streamline environmental issues in project design, constructional and operational stages. The scope of the Environmental Impact Assessment as envisaged in the Terms of Reference (ToR) includes the delivery of a EIA Report, which assess the impact of the project highway as per provisions of the applicable laws and also identify a package of measures to reduce / eliminate the adverse impacts identified during the assessment. This chapter deals with environmental screening and preliminary environmental assessment for the feasibility report for the project. The primary baseline data are being generated for air, water, noise & soil.

7.5 Purpose / Objectives of the Environment Screening Exercise

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

As per EIA Notification, 2006 & its amendment a screening exercise shall be undertaken by the State level Expert Appraisal Committee (SEAC) based on the Form 1 to classify Category B projects further to determine the need for a detailed EIA.

This screening exercise is undertaken to identify environmental sensitive features and to attribute these in the Project report and the Form 1.

7.6 Expected Benefits from the Project

The major benefits of the project are:

- The project would provide high speed connectivity from Eastern part of State to the Western Part as well as to National Capital,
- This, in turn, would bring agricultural and industrial development in the region,
- The proposed project will create employment opportunity and occupational transformation from agricultural sector to secondary and tertiary sector.
- The Expressway is proposed to be linked through Link Expressways from existing and potential commercial/agriculture hubs and important cities, therefore the entire region will be developed.
- The proposed expressway will provide faster health services to otherwise less accessible medical facilities to rural population.
- Development of local industry like glass, perfume etc., agriculture and handicrafts.
- Development of tourism and pilgrimage
- Transportation, processing and marketing of agricultural products
- Better approach to medical & educational services and quick transportation of perishable goods like fruits, vegetables and dairy products
- Improved quality of life of people
- Aggressive a forestation policy leading to development of avenue plantation and thus overall green area.

7.7 Methodology

7.7.1 Steps in Screening Process

Screening process mainly consists of the following types of activities:

7.7.2 Study of Background information

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

Study of Laws and regulations: Laws and regulations enacted by Government of India and Uttar Pradesh state relevant to road construction and environment were studied.

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

7.7.3 Reconnaissance Survey

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

7.7.4 Analysis of data and screening exercise

The data collected through the above steps shall be compiled to develop the environmental scenario of the project area and the sensitive components within the project area. The full road length and COI shall be put under screening to identify the hot spot zones. The identification of hot spots in project area would help in further detailed study and preparation of Environmental Impact Assessment report and Environmental Management Plan for the project at later phase.

7.7.5 Types and Sources of Data Collection

7.7.5.1 Collection of Secondary Data

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

Table 7.5: Type of Information and Sources

Information	Source
Demography	Census of India, Government of Uttar Pradesh websites
Land use	Survey of India Topo sheets, Government of Uttar Pradesh websites
Meteorology	Primary Surveys, Meteorology Department, Government of Uttar Pradesh websites
Forest	Department of Forest, Government of Uttar Pradesh
District Profile	Government of Uttar Pradesh websites
Geological Data	Government of Uttar Pradesh websites

7.7.5.2 Field Study / Monitoring / Laboratory Analysis for Generation of Primary Data

Field study / monitoring shall be carried out to generate and collect primary data in the study corridor, which shall involve:

- Water quality monitoring at identified ground water and surface water locations
- Air quality monitoring at identified locations
- Ambient noise level monitoring at identified locations
- Enumeration of roadside trees
- Enumeration of flora and fauna found in COI

Presently Baseline Ambient Monitoring for air, water, noise & soil are in progress.

7.7.5.3 Rapid Assessment Survey

Rapid Assessment Survey (RAS) was undertaken to identify the Valued Ecosystem Components (VECs) in the project corridors. Screening study encompasses identification of "long list" of valued eco-system components (VECs) in the project study area.

Table 7.6: Valued Ecosystem Components

S.No.	Environmental Attributes	Valued Eco System Components
1	Topography	Terrain (Hilly to Plain)
2	Land use	Agriculture: (Irrigated, Un-irrigated); Settlements; Forest; Notified Industrial Area / Estate; Grazing; Fallow; No Development zone etc.
3	Water resources	Water bodies like rivers, canals, reservoirs, lakes and ponds – Crossings as well as water bodies with-in project area
4	Forests & Wild Life	• Designated Protected Areas like Biosphere Re-serves, Terrestrial or Marine National Parks, Sanctuaries, Tiger / Elephant Reserves, Coastal Regulation Zone etc.) within 15 Km (aerial dis-tances) from the proposed project location boundary • Migratory route / crossing of wild animals and birds crossing project road • Presence of RF, PF other forests within project area
5	Settlements	Towns and villages abutting the road corridor
6	Sensitive Receptors	Sensitive receptors such as educational and health facilities within COI
7	Drinking water sources	Total number of drinking water sources (wells, hand pumps, community water points / taps etc.) within COI
8	Religious Structures	Temples, shrines, mosque, church, gurudwara etc. within COI
	Road side Plantations	Green Tunnels, Strip Plantation
10	Cultural Properties	Number (total) of cultural properties (protected/ un-protected archaeological monuments) within 500m from the road
11	Market Places	Number (total) of weekly market places / *haats*; grain / fruit / vegetable / fish market; cattle market within COI
12	Common Property Re-sources	CPRs such as pastures / grazing lands; seating are-as of the community; cremation/burial grounds etc. within / along the RoW (All CPRs other than religious structures, drinking water sources and bus stops) within COI
13	Other features	Flood Plains; Soil Erosion; stone quarries etc.

7.7.5.4 Identification of valued eco-system components (VECs)

By combined local knowledge, scientific evidence and expert opinion, VECs that are termed as ecological, social, economic and cultural was identified. Degree of importance values varies with respect to significant environmental impacts. An approach of "component-impact" – wise ranking followed by a modified evaluation shall be adapted for VECs observed within the COI and project area.

After identification and compilation of VEC list, assessment to what extent proposed total road construction would affect each VEC has been made. To arrive at the nature and significant impacts, numerical values were assigned for each VEC and combined them all in a single overall measure of the impact. This is usually completed by a group of people who is well versed with environmental science. There are number of drawbacks in this procedure mainly due to over-simplification. However, this method gives an idea of wide range of environmental issues that need to be addressed.

7.7.5.5 Weight age / Ranking System

A weight-age and ranking system has been developed so as to rank / weigh the various VECs identified during the reconnaissance survey. The details are as below:

Table 7.7: Weight age and Ranking System Adopted

Environmental Attribute	Total Weight	Scoring Criteria		Score
Natural Environment				
Topography	4	Plains		1
		Rolling terrain		2
		Flood plains/ Coastal belt		3
		Hilly/Mountainous terrain		4
Vulnerability to natural hazards (such as floods, cyclones, cloud bursts. Landslide, subsidence, earthquake etc.)	4	Not prone at all		1
		Rare occurrence		2
		Prone to natural disasters/ risks		3
		Highly prone to natural disasters(regular occurrence)		4
Surface water resources	5	Number (average) of water bodies per km crossings as well as water bodies within 100 m on either side of the road	5 or less	1
			6 to 10	2
			11 to 15	3
			16 to 20	4
			21 or more	5
Drainage conditions	5	Over topping and/ or water logging within 100 m on either side of the road1	2 or less	1
			3 to 4	2
			5 to 6	3
			6 to 7	4
			7 or more	5
Ground water sources	4	Is ground water availability/ extraction an issue in project?	Yes (if the project falls partially or fully within dark or over exploited blocks)	4
Materials Availability	4	Availability of stone quarries	Within 50 km	1

Environmental Attribute	Total Weight	Scoring Criteria		Score
			50 to 100 km	2
			100 to 200 km	3
			More than 200 km	4
Soil Erosion	4	Is soil erosion an issue in/ along the sub project road	Not at all	1
			To some extent	2
			Critical	3
			Very critical	4
Sub Total	**30**	-	-	-
Biological Environment				
Designated Protected Areas	10	Presence of designated protected areas within 15 km from the proposed project location boundary	Yes	10
			No	0
Wildlife habitats	6	Occurrence outside designated protected areas from the proposed sub project location boundary	Within 5 km	6
			5 to 10 km	4
			10 km or more	2
Migratory route/ crossing of wild animals and birds	6	Crossing project road or within 500 m from the proposed project location boundary	Yes	6
			No	0
Reserved forests	5	Presence of RF within 100 m from either side of the existing central line	Yes	5
			No	0
Protected or Other Forests	5	Length of forests along the road within 100 m from either side of the existing Central line	Less than 5 km	1
			5 to 10 km	2
			10 to 15 km	3
			15 to 20 km	4
			20 km or more	5
Green Tunnels	4	Length of green tunnel/s within 30 m (on either side) along the road	2 km or less	1
			2 km to 5 km	2
			5 km to 10 km	3
			10 km or more	4
Road side trees (broad estimate, specific numbers, girth and species details etc. Shall be presented)	4	Number of trees likely to be affected	Upto 1000	1
			1000 to 2000	2
			2000 to 4000	3
			More than 4000	4
Total	40	-	-	-
Social Environment				
Settlements	5	Total length of settlement sections (both towns and villages) abutting the road corridor	10 km or less	1
			10 to 20 km	2
			20 to 30 km	3
			30 to 40 km	4
			40 km or more	5
Sensitive receptors	5	Number (total) of sensitive	10 or less	1

Environmental Attribute	Total Weight	Scoring Criteria		Score
		receptors within 50 m on either side of the road (such as educational and health facilities)	11 to 20	2
			21 to 30	3
			31 to 40	4
			41 or more	5
Drinking water sources	4	Total no. Of drinking water sources (wells, hand pumps, community water points/ taps etc.) within COI	10 or less	1
			11 to 20	2
			21 to 30	3
			31 or more	4
Religious structures	4	Number (total) of religious structure (temples, shrines, mosques, church, gurudwaras) within COI	10 or less	1
			11 to 20	2
			21 to 30	3
			31 or more	4
Cultural Properties	4	Number (total) of cultural properties (protected/ unprotected archaeological monuments) within 500 m from the road	2 or less	1
			3 to 5	2
			6 to 8	3
			More than 8	4
Market Places	4	Number (total) of weekly market places/haats; grain/fruit/vegetables/fish market; cattle market within COI	5 or less	1
			6 to 10	2
			11 to 15	3
			15 or more	4
Common Property Resources (All CPRs other than religious structures, drinking water sources and bus stops)	4	Number (total) of CPRs (such as pastures/grazing lands; seating areas of the community, cremation/ burial grounds etc.) within/ along the COI	5 or less	1
			6 to 10	2
			11 to 15	3
			15 or more	4
Total	**30**	-	-	-
Grand Total	**100**	-	-	-

The total score of the project shall be calculated & sensitivity identified

7.8 Proposed Environmental Action Plans

There are various activities, which are envisaged to be carried out by the consultants. Relevant environmental secondary data was collected to provide the overview and details of the study corridor. The secondary data will be appropriately supplemented with primary data collection and the required mitigation devised accordingly.

7.9 Environmental Impact Assessment

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

- Alignment of the project road and topographical changes
- Nature and quantum of automobile emissions
- Water requirement during construction and sources
- Noise levels during operation and noise control measures
- Loss of trees and compensatory plantation & afforestation
- Noise level, dust concentration and water logging near construction sites

- Nature quantity and disposal of construction spoils
- Public health & sanitation and occupational health & safety of construction workers
- Population affected including weaker sections

7.10 Regulatory and Institutional Regime

This section elaborates on the various clearance requirements for the project from the State Government and MoEF, GoI. Regulations containing procedures and requirements that directly impact the project have also been assessed.

7.11 Environmental Legislations and their Implications / Application

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

Table 7.8: Relevant Environmental Laws & Regulations

Sl. No.	Law / Regulation / Guide-lines	Relevance	Applicable Yes / No	Reason for application	Implementing / Responsible Agency
1	The Environ-mental (Protection) Act. 1986, and the Environmental (Protection) Rules, 1987-2002 (various amendments)	Umbrella Act. Protection and improvement of the environment. Establishes the standards for emission of noise in the atmosphere.	Yes	All environ-mental notifications, rules and schedules are issued un-der the act	MoEF, State Department of Environment & Forest, CPCB and SPCB
2	The EIA Notification, 14th September 2006 & subsequent amendments	Identifies expansion of National highways greater than 30 Km involving additional ROW greater than 20m involving Land Acquisition and all new state highway projects & state highways expansion project in hilly terrain (above 1000 MSL) and or ecologically sensitive areas and (item 7 (f) of schedule) as one of the projects requiring prior clearance.	Yes	The project road is a new state highway project	MoEF / EC for EAC,GOI

Sl. No.	Law / Regulation / Guide-lines	Relevance	Applicable Yes / No	Reason for application	Implementing / Responsible Agency
3	Notification for use of Fly ash, 3rd November 2009	Reuse fly ash discharged from Thermal Power Station to summarize land use for dispersal and summarize borrow area material. The onus shall lie with the implementing authority to use fly ash unless it is not feasible as per IRC	Yes	Panki Thermal Power stations located in 100 Km radius of road	MoEF, SPCB
4	The Water (Prevention and Control of Pollution) Act, 1974	Central and State Pollution Control Board to establish/enforce water quality and effluent standards, monitor water quality, prosecute offenders, and issue licenses for construction/operation of certain facilities.	Yes	Consent required for not polluting ground and surface water during construction	State Pollution Control Board
5	The Air (Pre-vention and Control of Pollution) Act. 1981	Empowers SPCB to set and monitor air quality standards and to prose-cute offenders, excluding vehicular air and noise emission.	Yes	Consent required for establishing and operation of plants and crushers	SPCB, GoUP
6	Noise Pollution (Regulation And Control) Act, 1990	Standards for noise emission for various land uses	Yes	Construction machineries and vehicles to conform to the standards for construction	SPCB, GoUP
7	Forest (Conservation) Act, 1980	Conservation and definition of forest areas. Diversion of forest land follows the process as laid by the act	Yes	Involvement of forest land diversion for the project	Department of Forest, GoUP
8	Coastal Regulatory Zone Notification, 1991	Protect and manage coastal areas	No	The project area is not within designated coastal zone	NA

Sl. No.	Law / Regulation / Guide-lines	Relevance	Applicable Yes / No	Reason for application	Implementing / Responsible Agency
9	Wild Life Protection Act, 1972	Protection of wild life in sanctuaries and National Park	No	No sanctuaries / national park within 10 Km	State Forest Department, MoEF
10	Ancient Monuments and Archaeological sites and Remains Act , 1958	To protect and conserve cultural and historical re-mains found.	No	No Archaeological monument along the project road	NA
11	The Motor Vehicle Act. 1988	Empowers State Transport Authority to enforce standards for vehicular pollution. From August 1997 the "Pollution Under Control Certificate is issued to reduce vehicular emissions.	Yes	All vehicles used for construction will need to com-ply with the provisions of this act.	State Motor Vehicles Department
12	The Explosives Act (& Rules) 1884 (1983)	Sets out the regulations as to regards the use of ex-plosives and precautionary measures while blasting & quarrying.	Yes	If new quarrying operation is started by the concessionaire / con-tractor	Chief Controller of Explosives
13	Public Liability And Insurance Act,1991	Protection to the general public from accidents due to hazardous materials	Yes	Hazardous materials shall be used for road construction	State Pollution Control Board
14	Hazardous Wastes (Management and Handling) Rules, 1989	Protection to the general public against improper handling and disposal of hazardous wastes	Yes	Hazardous wastes shall be generated due to activities like of maintenance and repair work on vehicles	State Pollution Control Board
15	Chemical Accidents (Emergency Planning, Preparedness and Response) Rules, 1996	Protection against chemical accident while handling any hazardous chemicals resulting	Yes	Handling of hazardous (flammable, toxic and ex-plosive) chemicals during road construction	District & Lo-cal Crisis Group headed by the DM and SDM

Sl. No.	Law / Regulation / Guide-lines	Relevance	Applicable Yes / No	Reason for application	Implementing / Responsible Agency
16	The Building and Other Construction Workers (Regulation of Employment and Conditions of Service) Act, 1996	Employing Labour / workers	Yes	Employing Labour / workers	District Labour Commissioner

7.12 Environmental Categorisation

This project shall be considered as a new State Highway project which should generally fall under Category 'B' project as per the EIA Notification of September 2006 but the project ends within the 10 km radius of Bihar State, it has been categorized as category A project. , Therefore, EC shall be carried out from EAC, MoEF, Government of India.

7.13 Environmental Permits / Approvals Required

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

Table 7.9: Summary of Clearances & NOCs Applicable

Sl. No	Type of clearance	Statutory Authority	Applicability	Project stage	Time Summary	Responsibility
1	Prior Environmental Clearance	SEIAA	Is a category B project	Pre construction	7-12 months	UPEIDA
3	Diversion of Sanctuary land / Permission for road construction	Chief Wild Life Warden	Project road passes within 10 Km of xxx / any sanctuary	Pre construction	3-36 months	UPEIDA
4	Forest Clearance	State Department of Environment and Forest and MoEF	Applicable for diversion of forest land	Pre construction	6-8 months	UPEIDA
5	Tree felling permission	State Department of Environment and Forest	Felling of trees	Pre construction	15 days	Contractor
6	NOC And Consents Under Air , Water, EP Acts & Noise rules of SPCB	State Pollution Control Board	For establishing plants	Construction (Prior to work initiation)	2-3 months	Contractor

Sl. No	Type of clearance	Statutory Authority	Applicability	Project stage	Time Summary	Responsibility
7	NOC And Consents Under Air , Water, EP Acts & Noise rules of SPCB	State Pollution Control Board	For operating Hot mix plants, Crushers and batching plants	Construction (Prior to work initiation)	1-2 months	Contractor
8	Permission to store Hazardous Materials	State Pollution Control Board	Storage and Transportation Of Hazardous Materials and Explosives	Construction (Prior to work initiation)	2-3 months	Contractor
9	Explosive license	Chief controller of explosives	Storage of ex-plosive materials	Construction (Prior to work initiation)	2-3 months	Contractor
10	NOC under Hazardous Waste (Management and Handling) Rules, 1989	State Pollution Control Board	Disposal of bituminous wastes	Construction (Prior to work initiation)	2-3 months	Contractor
11	PUC certificate for use of vehicles for construction	Department of Transport	For all construction vehicles	Construction (Prior to work initiation	1-2 months	Contractor
12	Quarry lease deeds and license	Dept. of Geology and Mines	Quarrying and borrowing operations	Construction (Prior to work initiation)	2-3 months	Contractor
13	NOC for water extraction for construction and allied works	Ground Water Authority	Ground water extraction	Construction (Prior to work initiation)	2-3 months	Contractor

7.14 Existing Institutional Set-Up

The project has been initiated and is being carried out by the UPEIDA. The primary responsibility of the project rests with the UPEIDA in providing encumbrance free ROW to the EPC contractor who shall implement the project.

The main government agencies who uphold the implementation of the various environmental legislations are:

- Ministry of Environment and Forests, Government of India (MoEF), New Delhi formulates and regulates all country level legislations besides giving prior environmental clearances through a committee for category A projects, wild life clearances and forest diversion clearances
- Central Pollution Control Board (CPCB) monitors and implements pollution related legislations

- State Pollution Control Board monitors and implements pollution related legislations in the state besides giving NOC for establishing and operating plants under air and water acts
- State Department of Forests gives permission for forest diversion and felling of trees

7.15 Mitigation and Enhancement Measures

7.15.1 General

The negative impacts of road projects can be reduced or summarized only if proper safeguards are put in place during the design and construction stage itself. These can include reducing pollutant discharge from the harmful activities at source or protecting the sensitive receptor. An effective mitigation strategy will summarized a combination of both options to arrive at practically implementable measures. Conscious efforts shall be worked out to summarize any adverse impacts on the various environmental and social components. Where the impacts on various environmental components shall be unavoidable, suitable mitigation designs

Table 7.10: Summary of Mitigation

Sl. No	Potential impact	Mitigation / Enhancement
1	Change in Geology	• Quarry Development Plan shall be enforced.
2	Change in Seismology	• All structures to be checked and complied with the seismological settings of the region (Zone)
3	Loss of land	• Alignment selected to have maximum exposure of govt. & barren land
4	Generation of Debris	• Disposed properly to avoid contamination.
5	Soil Erosion	• Embankment protection through stone pitching & Turfing • Residual spoil need to be disposed properly • Silt Fencing need to be provided • Quarries need to be reclaimed
6	Contamination of Soil	• Hazardous Wastes (Management and Handling) Rules, 1989 to be enforced. • Oil Interceptor will be provided for accidental spill of oil and diesel • Rejected material will be laid as directed by engineer. • Septic tank will be constructed for waste disposal.
7	Soil quality monitoring	• Measures will be revised & improved to mitigate / enhance environment due to any unforeseen impact.
8	Scarified Bituminous Wastes	• No scarification involved. • In case contractor decides to scarify then the material to be reused in the GSB layer. • Non reusable Bituminous wastes to be dumped in 30cm thick clay lined pits with the top 30cm layer covered with good earth for sup-porting vegetation growth over a period only after obtaining permission of Independent Consultant
9	Scarified Non Bituminous Material	• Used in the normal GSB layer (not the drainage layer)
10	Cut material	• Reused as embankment, median & shoulder fill materials

Sl. No	Potential impact	Mitigation / Enhancement
		• Excess material to be used for filling up of borrow areas identified by the contractor and approved by the Independent Consult-ant/Authority Engineer
11	Construction debris generated from dismantling of structures	• Guidelines for Identification of Debris Disposal Sites & Precautions and Guidelines for Rehabilitation of Dumpsites, Quarries and Bor-row Areas shall be framed
12	Soil Contamination due to accident spills	• An emergency response team to be created. The team shall contain members of the district and police administration and also have specialist in remediation. Responsibility of Contractor to inform the team to take actions. The roles and responsibility of the members of the ram shall be framed in conjunction with all the parties to address the situation arising out of the accidental spills resulting in situation like water and soil contamination, health hazards in the vicinity of the accident spot, fire and explosions etc. • During construction, the contractor described previously. Fuel storage will be in proper bunded areas. • All spills and collected petroleum products to be disposed off in accordance with MoEF and SPCB guidelines and as per the directions of the Emergency Response team. • Fuel storage and fuelling areas will be located at least 300m from all cross drainage structures and significant water bodies.
13	Runoff and drainage	• Improvements of design shall lead to less accidents and hence less spillage of oil and grease • Silt fencing to be provided • Recharge well to be provided to compensate the loss of pervious surface
14	Operation of residential facilities for labour camps, Vehicle parking areas	• Vehicle parking area will be made impervious using 75 mm thick P.C.C. bed over 150 mm thick rammed brick bats. The ground will be uniformly sloped towards to adjacent edges towards the road. A drain will take all the spilled material to the oil interceptor
15	Meteorological factors and climate	• Comprehensive afforestation • Avenue plantation • Shrub plantation in the median / island
16	Dust generation	• Sprinkling of Water • Fine materials to be completely covered, during transport and stocking. • Plant to be installed in down wind direction from nearby settlement
17	Gaseous pollutants	• Air pollution Norms will be enforced. • Labourers will be provided mask. • Local people will be educated on safety and

Sl. No	Potential impact	Mitigation / Enhancement
		precaution on access roads, newly constructed embankment etc.
18	Air quality emissions	• Compliance with future statuary regulatory requirements
19	Air quality monitor-ing	• Measures will be revised & improved to mitigate enhance
20	Alteration of Cross Drainage	• Widening & construction of bridges, there will be an improvement in the drainage characteristics of the project area.
21	Water requirement for project	• Contractor needs to obtain approvals for taking adequate quantities of water from surface and ground water sources. • This is required to avoid depletion of water sources. • Water harvesting structures to be provided.
22	Increased sedimentation	• Silt fencing to be provided • Guidelines for Sediment Control to be framed
23	Contamination of Water	• Hazardous wastes (Management and Handling) Rules, 1989 to be enforced. • Oil Interceptor will be provided for accidental spill of oil and diesel. • Rejected material will be laid as directed by IC. • Septic tank will be construction for waste disposal.
24	Water quality monitoring	• Measures will be revised and improved to mitigate / enhance environment due to any unforeseen impact.
25	Noise mitigation for Sensitive receptors	• Options for Noise barriers to be analysed • No Horn Zone sign Post.
26	Noise Pollution (Pre-Construction Stage)	• Machinery to be checked and complied with noise pollution regulations. • Camps to be setup away from the settlements, in the down wind direction
27	Noise Pollution (Construction Stage)	• Camps to be setup away from the settlements, in the down wind direction. • Noise pollution regulation to be monitored and enforced. • Temporary as the work zones will be changing with completion of construction
28	Noise Pollution (Operation Stage)	• Will be compensated with the uninterrupted movement of vehicles
29	Noise Pollution Monitoring	• Measures will be revised and improved to mitigate/ enhance environment due to any unforeseen impact.
30	Forest area	• Minimum acquisition of land • Permission for acquisition from forest department as per Forest Act • Plantation of trees as per Forest Department
31	Trees Cutting	• Compulsory tree plantation in the ratio of 1:2. • Option of compensatory afforestation through Forest Department. • Identification of incidental spaces for plantation

Sl. No	Potential impact	Mitigation / Enhancement
		along corridor, where ever possible
32	Vegetation	• Clearing and grubbing will be summarize • Exposed surface like embankment slopes will be protected with stone pitching and turfing. • Open land in and around plant will be vegetated

7.16 Construction Related Activities

Most of the direct impacts of a road project occur during the construction stage. This stage is also important since the people living near the sites are inconvenienced without the collateral benefits of a functional road. Moreover, construction related activities are confined within an identifiable boundary and so is the affected population. It is also the stage of the project when the UPEIDA, can exercise maximum control to ensure that the environmental impacts are summarize.

Most of the mitigation measures can be incorporated as good engineering practice during the design phase itself thus ensuring the mainstreaming of environmental concerns early in the project. Adherence to design drawing and specifications will reduce the adverse impacts during construction to within acceptable levels. Moreover, continuous supervision of construction activity can also work as a deterrent to errant summarize. Therefore, incorporating environmental provisions within the construction contracts becomes vital to ensure effective implementation of mitigation measures during construction stage of the project it-self.

7.17 Road Transportation Issues

Issues related with transportation along improved roads are beyond the control of the proponent, in most cases. The predicted timeframes are quite long and the mitigation for most impacts is beyond UPEIDA jurisdiction. They require intervention from agencies such as the revenue authorities, the motor vehicles department and the police to mitigate encroachment, increased roadside pollution due to vehicular emissions and accidents etc. The UPEIDA can from its side carry out the maintenance of the roads at specified intervals and act as the co-ordination agency for road transportation related impacts.

7.18 Hotspot Mitigation

There are several locations where undesirable impacts of the project occur which can be easily distinguished due to their unique characteristics. These are termed as 'hotspots'. Targeted interventions can help reduce the undesirable impacts to within acceptable limits. These can either be built into designs for road construction as part of good engineering practice or specific mitigation measures can be detailed and separately implemented.

Though the former is always more desirable, it may be difficult to achieve during project preparation for a variety of reasons. Irrespective of the route adopted, hotspot mitigation is a definite value-addition to any project and should always form a basis for 'selling' the project to the host communities.

7.19 Land Acquisition- Mitigation Measures

Based on the preliminary survey conducted and information on RoW obtained so far, the land required for widening of the existing road and acquisition to provide a 120m wide RoW for the project shall include agricultural, barren / fallow lands & governmental lands. Care shall be taken to minimize land acquistion. In order to mitigate the ensuing negative impacts of the land acquisition a resettlement and rehabilitation (R&R) policy

shall be pre-pared based on the National Policy of R&R. The salient features of the mitigation measures are:

- Wherever possible, displacement shall be reduced or avoided altogether by sensitive design of civil works (e.g. alternative designs or modification to the design).
- Where displacement is unavoidable, those displaced will have their living standard improved.
- PAPs will be compensated, at replacement cost, for assets lost. Adequate social and physical infrastructure will be provided.
- PAPs and lost community would be encouraged to participate in the implementation of RAP.
- An entitlement policy shall be worked out as part of the RAP and will deliver a comprehensive package of compensation and assistance to entitled persons, families groups suffering losses as a result of the project.

7.20 Safety

The project design shall take care of safety measures for road users. Safety of pedestrians as well as of the vehicles plying on the road shall be given highest importance and adequate measures shall be incorporated in the design of the alignment. Beside the divided carriageway designed for the project, service roads are also proposed. Signboards indicating construction sites on the road and flags shall be erected. All the signboards giving caution and barricades for diverting the traffic shall be as per MoRT&H / IRC specifications.

7.21 Environmental Mitigation Measures

The following mitigation measures shall be considered at the detailed design stage:

- Up gradation of existing approach roads to the highway
- Adequate drainage facilities along the road
- Provision of service roads
- Appropriate noise barriers at sensitive locations
- Development of strip plantation on both sides and median shrubs
- Regular monitoring of ambient air quality, noise level and water quality during construction
- Grade separation at interchanges

7.22 Enhancement Opportunities

Enhancements specifically refer to these positive actions to be taken up during the implementation of the project for the benefit of the road users and the communities living close to project road alignment. The following enhancement opportunities shall be explored as part of the detailed project report:

- Day-tourism potential along roadsides
- Water storage capacity for settlements
- Bus bay and Truck lay bye
- Wayside amenities
- Road signs, illuminations and pavement markings
- Introduction of ambulance services to transport serious accident cases

The enhancements have been carried out with the following objectives:

- To enhance the appeal and environmental quality of the project road to the users;
- To enhance visual quality along the highway; and
- To generate goodwill amongst the local community towards the project, by the enhancement of common property resources

7.23 Landscaping and Arboriculture

A proper landscape shall be provided along the highway alignment to fit in with the surroundings for pleasing appearance reduce headlight glare and adverse environmental effects such as air pollution, noise pollution and visual intrusion. The proposal for future landscaping shall include the following:

- Treatment of embankment slopes as per IRC: 56 – 1974, depending upon soil type involved
- Turfing of slopes of high embankment for controlling rain and wind erosion
- Planting of low height shrubs on medians for reducing glare effect and visual intrusion
- Planting of trees along ROW as part of compensatory afforestation
- Grading of ground between the embankment toe and ROW and provision of surface drain along the ROW. This will help in physical delineation of the ROW and avoid encroachment at later date
- Unlined drain shall be provided taking in to account the ground water recharging arrangement at required locations
- Water harvesting structures shall be provided

7.24 Recommendations & Conclusion

The screening report is a step towards preparation of environmental impact assessment report. The screening process as described in previous sections has primarily tried to focus on the potential impacts due to the proposed project, identification of the hotspots and to propose mitigation measures at different phases of the project. Based on the findings during the screening study some measures have to be considered from the inception of the project, which will reduce the detrimental effects of project appreciably. These are:

The project is a Category A' project and hence Prior Environmental Clearance is required from EAC, GOI as per EIA notification of Sept 2006 and its subsequent amendments

- The project road doesn't falls within 10 Km of any Wild life sanctuary & hence shall not require any clearance / permissions from the Wild Life Authorities
- A number of trees need to be felled for the project
- There shall be some displacement of the local populace as land has to be acquired
- Some structures including houses and shops shall be affected due to the project
- Environmental considerations shall be included in the project activities from the design stage
- The proposed alignment has been designed considering the design criteria laid in IRC 38, 1988 & IRC SP 23, 1983
- The alignment tries to avoid schools, temples and other public utilities as far as possible. Provision of access roads, service roads and noise barrier in the form of compound walls and plantation to be carried out
- Arrangement for alternative public utilities would be done before impacting them during construction or operation and this shall be part of project planning
- Attempt shall be made to keep removal of trees to minimum. Re-plantation programme shall be designed before hand and compensatory afforestation would be simultaneously carried out
- Construction workers' camp utilities would be provided to avoid impact on local environment
- With the above approach to design, construction and operation the project will be environmentally feasible.

Chapter-8

SOCIAL SCREENING AND PRELIMINARY ASSESSMENT

8.1 Introduction

The Uttar Pradesh Expressway Industrial Development Authority (Government of UP) has been entrusted to develop the access controlled Purvanchal Expressway, which traverses entire state to integrate creation of World Class infrastructure with industrial and economic development. Important benefits of the project are (i) The project would provide high speed connectivity from Eastern part of State to the Western Part as well as to National Capital, (ii) This, in turn, would bring agricultural and industrial development in the region, (iii) The proposed project will create employment opportunity and occupational transformation from agricultural sector to secondary and tertiary sector, (iv) The Expressway is proposed to be linked through Link Expressways from existing and potential commercial/agriculture hubs and important cities, therefore the entire region will be developed, (v) The proposed expressway will provide faster health services to otherwise less accessible medical facilities to rural population.

The entire 340.956 Kms of Purvanchal expressway has been divided in 8 packages. This social screening report is prepared for Package–IV from Sidhi Ganeshpur (121+600) in Sultanpur District to Sansarpur (164+300) in Sultanpur District. Social screening study has been carried out to identify critical issues and areas that would be studied in detail for impact assessment, mitigation measures and management plan. Findings of the screening and preliminary assessment are presented in this report. Further details will be taken up during subsequent stages of the project preparation. This report has been prepared based mainly on field survey and collection of secondary data.

8.2 Description of the Project

The Right of Way (RoW) of the proposed expressway is 120 meter. The proposed expressway will have 6-Lane access controlled expressway and service roads on one side of expressway. The connectivity to the proposed expressway will be through grade-separator such as clover leaf, underpasses and overpasses at pre-defined locations. Flexible pavements are proposed for main carriage way and service roads throughout the expressway except at toll plaza where rigid pavements are being proposed. All geometric design has been carried out as per the IRC and MoRT&H standards and specifications. The design speed has been kept quite uniform, and design speed even at curves is 120 kmph.

8.3 The Project Area

The project districts are located in middle Gangetic Plains. The entire project area is alluvial plain formed by Ganga and its tributaries. The climate of project area is predominantly subtropical & is characterized by hot summer and cool winter. Most of the rainfall occurs during the southwest Monsoon, (June to September). However winter rainfalls (about 5 cm) takes place in the month of December and January The area experiences a dry period from February to June. There are three distinct seasons 1. Monsoon 2. Winter, 3. Summer.

Table 8.1 : Demographic Profile of the Project Districts

Sl. No.	From	Total Population		Area (in Sq. Km)	Literacy (in %)	
		Male	Female		Male	Female
1.	Sultanpur	1,914,586	1,882,531	4,436	80.19	58.28

As presented in Table 8.2, Total non-workers population in Amethi District is 3,25 lacs and in Sultanpur district is about 2,554 lacs.

Table 8.2: Details of District-wise Workers

District	Total Population		Workers	Main Worker	Marginal Worker	Non-Workers
	Urban	Rural				
Sultanpur	199,916	3,597,201	1,242,632	690,967	551,665	2,554,485

Villages: The project road from Sidhi Ganeshpur in Sultanpur to Sansarpur in Sultanpur traverses mainly through rural areas. Important urban settlements along the proposed expressways are there, which is District headquarters also, Sultanpur and Ambedkar Nagar. About 51 villages are along the proposed expressways. Detailed list of villages is presented in the Table below:

Table 8.3: Details of Village

Sr. No.	District	Tehsil	Village Name in Package III
1	Sultanpur	Kadipur	Kaithwan, Dhanaupur, Dewapur, Badhauli, Pratap Pur, Madanpur Khurd, Sansarpur.
		Jaisinghpur	Dakhinwara, Jafarpur, Karote Khurd, Arwal Kiri Karawat, Gaura, Kharsauma, Fulauna, Akodi, Bhagwanpur, Dalhupur, Sarang Pur, Sakradepur, Belgara, Parsa, Ramnathpur, Khapra Dih, Dev Parapar, Chandpur, Mahmamud Pur Semri, Sabai, Moke Dih, Chorma, Nidura, Birsinghpur, Saray Nauranga, Chaure, Govindpur, Byaspur, Mahuwari Ashapur, Sarai Sahawan, Gose Singhpur, Sher Khanpur, Sailkha, Alah Dadpur, Khalispur Durg, Vishunpur Chitepatti.
		Sultanpur	Sidhi Ganeshpur, Chak Churabanpur, Madhopur Shukul, Seur Chamurkha.
2	Ambedkar Nagar	Akbarpur	Ahetha, Umarpur, Revra, Rasoolpur Diyara

Table 8.4 : Important Demographic Indicators of the Project Districts

Item	Sultanpur
Actual Population	3,797,117
Male	1,914,586
Female	1,882,531
Population Growth	18.1
Area Sq. Km	4,436
Density/km2	856

Proportion to UP Population	1.9
Sex Ratio (Per 1000)	983
Child Sex Ratio (0-6 Age)	922
Average Literacy	69.3%
Male Literacy	80.2%
Female Literacy	58.3%
Total Child Population (0-6 Age)	563,373
Male Population (0-6 Age)	293,043
Female Population (0-6 Age)	270,330
Literates	2,239,902
Male Literates	1,300,248
Female Literates	939,654
Child Proportion (0-6 Age)	14.8
Boys Proportion (0-6 Age)	15.3
Girls Proportion (0-6 Age)	14.4

8.4 Methodology for Social Assessment

The methodology and approach which shall be adopted for the preparation of Social Impact Assessment (SIA) and Resettlement Plan has been summarized in Figure 8.2.

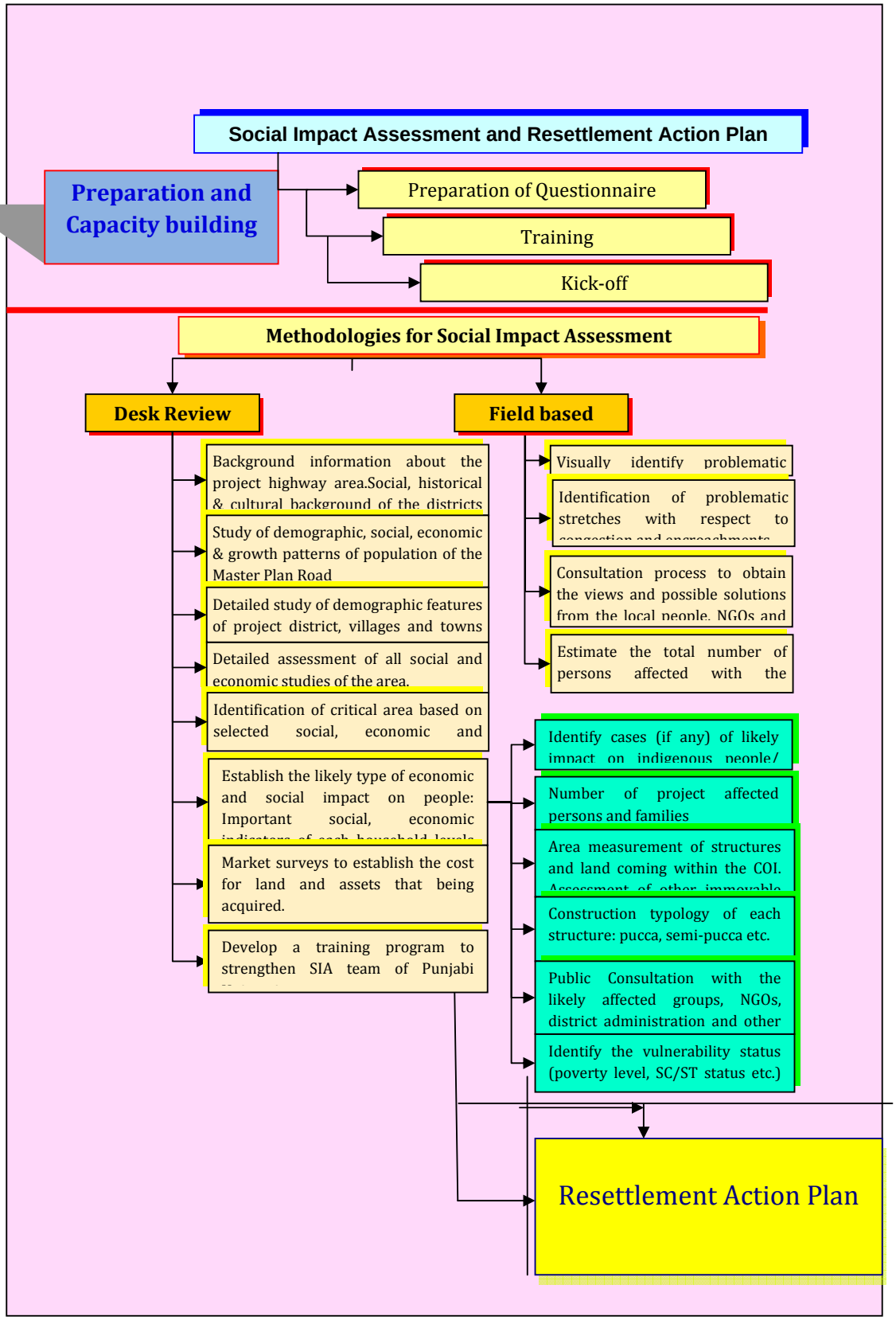


Fig. 8.2: Social Impact Assessment (SIA) and Resettlement Flow Chart

In order to assess the extent of losses, measurement and survey of structures and other assets shall be carried out. To quantify losses, designs shall super-imposed on revenue maps. Basic schedule of rate (BSR) and market values shall be collected and accounted in the valuation of assets and properties to finalize budgetary requirement for compensation. Consultation with key stakeholders including project functionaries at different levels has provided needed information to develop institutional mechanism for the preparation of RAP. Following section highlights data sources and activities to be carried out for the preparation of SIA Report.

8.5 Data Sources

Data from Secondary Sources

Following information shall be collected from the published documents to appreciate the project background, land ownership status, and statistical information required for baseline information.

- The Right to Fair Compensation and Transparency in Land Acquisition 2013,
- Primary Census Abstract, District Census Handbook 2011,
- Statistical Abstract GoUP,
- District wise Socio-Economic Indicators (Directorate of Economics & Statistics, GoUP),
- Acts and Policies of Government of India and Government of Uttar Pradesh related to R&R and Land acquisition, and

Data and information from Primary Sources

- Structured Survey - Baseline and Census survey in a prescribed format
- Public Consultation
- Consultation with key informant
- Interviews with important secondary stakeholders
- Public Hearing

8.6 Description of Methodologies: Following section describes steps taken to prepare SIA.

Step-I Desk Review:
This review has been carried out to understand the extent of land acquisition, applicable Government Acts and policies, socio-economic characteristics of the project area, categorization of socially and economically disadvantaged groups, technical considerations etc.

Step II: Training and Capacity Building
Field level Enumerators with sociological research background from University shall selected. Explanation of terms used in the questionnaires, methods of getting information from potential PAPs, mechanism of social behavior, Strategy of communication with respondents etc. shall part of the training program. During training sessions, enumerators shall exposed to role play of PAPs, to make them conversant with the situations in the field and approach required for collection of information through questionnaires, understanding and appreciating local situations etc. The survey team shall be mobilized in the field after testing of questionnaire in the project area on May 2016.

Step III: Preparation of Strip Maps
In order to assess impacts on local population resulting from the proposed project interventions, structures (if any) coming within the RoW shall be marked, measured and recorded on a strip map. The strip map shall be verified through Transact walk. Extent

of loss was determined by measuring the distance of the structure from the proposed centerline (Fig 8.3).

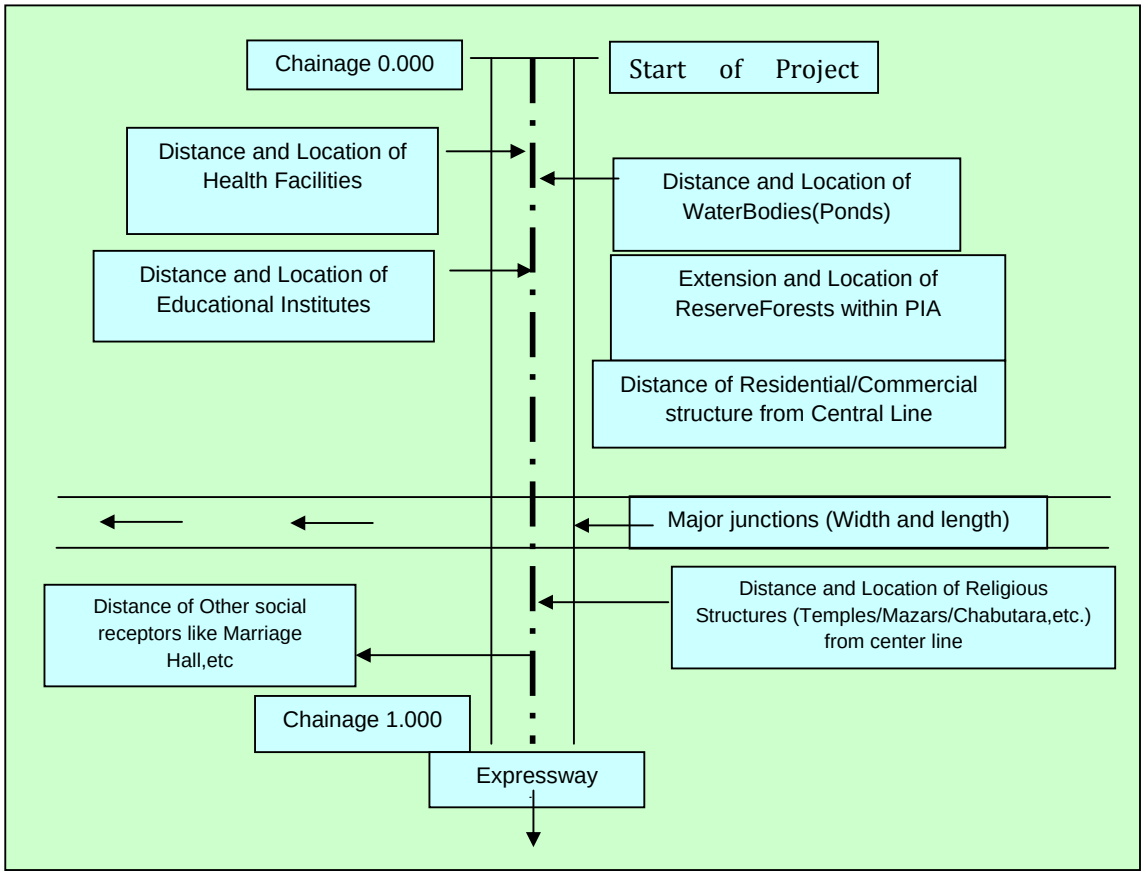


Fig. 8.3: Data Collection Format for Strip Map Preparation

Step IV: Identification of Affected Land

For identification of the affected lands and potential PAFs, Social teams shall visit to the Expressways alignment along with the drawings of the proposed expressways true to scale and Sajara (revenue) maps for site verification. The corridor of impact (proposed RoW(120 m) for road construction) shall be marked in the field at 100m intervals in straight portion and 50 meters interval at curves. Accordingly, proposed Corridor of Impact (CoI) shall be superimposed on Sajara map to assess the exact extent of land required to be acquired/appropriated. This included measurement of Center line from the fixed boundary stone of villages in the field and from the fixed location of boundary stone as shown in Sajara map (coordinates of village maps). On identification of affected plots of land and owner, the social teams will visit the household for survey.

Step V: Census and Baseline Survey

On identification of actual impacts and list of affected persons (titled and non- titled), questionnaires shall designed for the Census Survey and baseline socioeconomic survey. These formats shall be canvassed with the potentially affected people. The questionnaires included details regarding social and economic aspects of the affected persons such as demographic features (age sex composition, marital status etc) and economic information (occupation, sources of income, movable and immovable assets) of the households, expected losses(loss of residential/commercial or other properties as well as type of structure (such as pucca, semi pucca, kuccha) and options/preferences for their R&R (like cash in lieu of losses or site in lieu of losses).

While census survey has established actual impact on the project affected families in terms of severity, perception and R&R option for resettlement and rehabilitation, socio-economic survey helped in profiling socio-economic conditions of the PAFs .

Step VI: Stakeholders' Consultation

Stakeholders' consultation was initiated as soon as the assessment process commenced. Consultation shall be planned to understand peoples' perception and seek their opinion for the success of project execution. Consultation is also an important tool to gather qualitative data which helps in improving quality of planning. Following steps have been followed during stakeholders' consultations.

- Identification of key stakeholders
- Deciding on the level of consultation
- Identification of mechanism and tools of consultation
- Information dissemination through Pamphlet distribution
- Meetings with people in groups,, individual meetings/interviews
- Developing sense of ownership of project interventions among the stakeholders
- Planning for consultation and communication strategies
- Ensuring field offices as centers of information about the project during the preparation phase
- Properly documenting all consultations

Focused Group Discussions: Besides above mentioned consultation mechanism, the project will emphasize on issues based discussions with the stakeholders. Important issues discussed shall the specific needs of women and other vulnerable groups, policies and other interventions required for LA, strategies for developing harmonious relationship among various stakeholder including UPEIDA and project authorities.

Step VII Analysis of Data

The interview schedules filled up every day shall be scrutinized and verified on the spot (project corridor) and the data-sheets shall be coded. A coding manual shall be prepared for consistency in data entry. The MS-Excel and MS-Excess software package shall be used for the data feeding and its analysis. Wherever applicable, SPS package will also used to generate tables. As a measure of final confirmation about the correctness of the data, random manual calculations and checking shall also be done.

8.7 Land Acquisition

Since, the project is proposed to be a green field alignment with proposed RoW is 120 m. Total land required for the construction of Highways would be about 576.126 ha (for expressway, Junctions, way side amenities and toilet block).

8.8 Mitigation Measures

The negative impacts of road projects can be reduced or minimised only if proper safeguards are put in place during the design and construction stage itself. These can include reducing displacement from the project activities. An effective mitigation strategy will utilise a combination of both options to arrive at practically implementable measures. Conscious efforts shall be worked out to minimise any adverse impacts on the various Social components. Where the impacts on various Social components shall be unavoidable, suitable mitigation designs shall be worked out.

8.9 Construction related activities

Most of the direct impacts of a road project occur during the construction stage. This stage is also important since the people living near the sites are inconvenienced without the collateral benefits of a functional road. Moreover, construction related activities are confined within an identifiable boundary and so is the affected population. It is also the

stage of the project when the Authority, can exercise maximum control to ensure that the Social impacts are minimised.

Most of the mitigation measures can be incorporated as good engineering practice during the design phase itself thus ensuring the mainstreaming of Social concerns early in the project. Adherence to design drawing and specifications will reduce the adverse impacts during construction to within acceptable levels. Moreover, continuous supervision of construction activity can also work as a deterrent to errant behavior. Therefore, incorporating Social provisions within the construction contracts becomes vital to ensure effective implementation of mitigation measures during construction stage of the project itself.

8.10 Road Transportation Issues

Issues related with transportation along improved roads are beyond the control of the proponent, in most cases. The predicted timeframes are quite long and the mitigation for most impacts is beyond Authority jurisdiction. They require intervention from agencies such as the revenue authorities, the motor vehicles department and the police to mitigate encroachment, increased roadside pollution due to vehicular emissions and accidents etc. The Authority can from its side carry out the maintenance of the roads at specified intervals and act as the co-ordination agency for road transportation related impacts.

8.11 Land Acquisition- Mitigation Measures

Based on the preliminary survey conducted and information on RoW obtained so far, the land required for road and acquisition to provide a 120 m wide RoW for the project shall include agricultural, barren / fallow lands, forest & governmental lands. Care shall be taken to minimise land acquisition. In order to mitigate the ensuing negative impacts of the land acquisition a resettlement and rehabilitation (R&R) policy shall be prepared based on the LARR act 2013.

The salient features of the mitigation measures are:

- Wherever possible, displacement shall be reduced or avoided altogether by sensitive design of civil works (e.g. alternative designs or modification to the design).
- Where displacement is unavoidable, those displaced will have their living standard improved.
- PAPs will be compensated, at replacement cost, for assets lost. Adequate social and physical infrastructure will be provided.
- PAPs and lost community would be encouraged to participate in the implementation of RAP.
- An entitlement policy shall be worked out as part of the RAP and will deliver a comprehensive package of compensation and assistance to entitled persons, families groups suffering losses as a result of the project.

8.12 Conclusions

The initial social assessment report is a step towards preparation of the Social Impact Assessment and RAP. The initial assessment process as described in previous sections has primarily tried to focus on the relevant legislations, potential impacts due to the proposed project and to propose mitigation measures at different phases of the project. Based on the findings during the initial assessment study some measures have to be considered from the inception of the project, which will reduce the detrimental Effects of project appreciably.

- Alternative alignments shall be attempted in order to find a suitable alignment that would have minimum adverse impact on social aspects.
- An amicable solution with regard to shifting of religious structures (if required) shall be explored in consultation with community leaders, religious leaders and other prominent persons in the local area.
- It will be ensured that the likely affected common properties used by local people are suitably rehabilitated before the start of civil construction work and budgetary provision for the same shall be ma de in the project estimates.

With the above approach to design, construction and operation the project will be socially feasible.