13.2 EXISTING ENVIRONMENTAL STATUS

13.2.1 Natural Environment

This section describes the existing environmental setting in the study area for the project. This study area extends up to a distance of 1 km on either side of the alignment for conducting detailed studies and 10 km on either side of the alignment for collecting data from secondary sources.

Reconnaissance survey of the study area was carried out in the first week of May, 1999 for the selection and finalization of the sampling locations. Field studies were conducted to determine ambient air quality, ambient noise levels, water quality, soil characteristics, ecology, and meteorology conditions. Data from secondary sources was also collected for different environmental attributes. The baseline environmental status of the area has thus been determined from the field surveys as well as the secondary data collection.

1. Meteorology

The micro-meteorological parameters regulate the transport and diffusion of pollutants released into the atmosphere. The principal variables, which affect the micro-meteorology, are wind speed, wind direction, atmospheric stability, inversion conditions and topography of the area.

Data Collection from Secondary Sources

The climate in the project area is characterized by extreme temperatures with mean maximum temperature of 40.6^{0}C.during summer and mean minimum temperature as low as 7.5^{0}C during winter. The average annual rainfall in the study area varies from 535 mm to 810 mm in last 12 years.

The meteorological data for the period 1981-1992 has been collected for Safdarjung Airport which is located at a distance of approximately 25-km in South-West direction from Nandgram where continuous monitoring station was installed for this study. The secondary data collected has been compiled in the report 'Environmental Impact Assessment for Construction of Expressways in the National Capital Region in India'.

According to the secondary data collected, the predominant wind direction during the day time is West with wind speed in the range 5.0-11.0 km/hr. The calm condition ranges from 13.0%-40.0%. During the nighttime the predominant wind direction is North-West with wind speed in the range 12.0-19.0 km/h. The calm condition ranges from 3.0%-42.0%.

Meteorological Survey at Site

The methodology adopted for monitoring surface observations was as per the standard norms laid down by the Bureau of India Standards (BIS) and Indian Meteorological Department (IMD). Meteorological data was recorded at Nandgram for a period of 7th May 1999 to 27th June 1999 for various meteorological parameters listed in Table-13.2.1.

Table-13.2.1: Meteorology Parameters Monitored at Site

No.	Parameters	Instruments	Frequency
1.	Wind Velocity	Anemometer	Every hour / Continuous
2.	Wind Direction	Wind Vane	Every hour / Continuous
3.	Temperature	Min./Max. Thermometer	At 0830 and 1730 Hours
4.	Relative humidity	Dry/Wet Bulb Thermometer	At 0830 and 1730 Hours

Observations

The meteorological data on temperature and relative humidity generated during study period has been analyzed for maximum, minimum's and averages and is presented in Table-13.2.2. The temperature recorded on site compared vis-a-vis the 12 years IMD data show slight variations (1°C to 2°C) in temperature levels.

Table-13.2.2: Summary of the meteorological data generated at site (Nandgram)

No.	Parameters	Maximum	Minimum	Average
1.	Temperature (°C)	41.0	26.0	35.4
2.	Relative Humidity (%)	86.0	34.0	64.0

Hourly wind speed and direction was recorded at the meteorological station at the site. In order to compare with secondary data (i.e. IMD, Safdarjung data) wind roses for the period 0830 Hours and 1730 Hours have been drawn (Appendix-13.2.1 and Appendix-13.2.2). A review of the wind rose diagrams shows that the predominant wind direction is ESE (17.39%) at 0830 Hours. Similarly at 1730 Hours the predominant wind direction is E (17.38%) for the month of May. For the month of June, the predominant wind direction is W.(17.46%) at 0830 Hours. The predominant wind direction at 1730 Hours was also West (16.67%). The wind speeds was in the category of 5.0-11.0 km/h.

2. Air quality

The study area represents mostly rural environment with predominantly agricultural fields. The sources of air pollution in the region are mainly the dust arising from unpaved village roads, burning of domestic fuel and emissions from vehicular traffic. The prime objective of baseline air quality survey is to assess the existing air quality of the area. This will be useful for comparison with the prescribed standards; with 'no project' scenario and also for assessing the ambient air quality during the operation of the road with respect to the standards.

Selection of Sampling Locations

The baseline status of the ambient quality has been assessed through ambient air quality monitoring stations. The design of monitoring network in the air quality surveillance program has been based on the Meteorological conditions, Topography, Land Use, Sensitive receptors, if any; and Anticipated Impact Areas.

Meteorology data (wind direction) recorded at Safdarjung Airport over past 12 years was used to locate monitoring stations to represent upwind and downwind air quality status with respect to the roads. Locations were selected either to represent highest impact area due to road traffic or to represent background concentrations. The location selected and the sampling criteria chosen are detailed out in Appendix 13.2.3

Ambient Air Quality Monitoring (AAQM) stations were set up at eight locations along Ghaziabad-Meerut route and at seven locations along Kundli-Meerut route for sampling of SPM, RPM, SO_2, and NO_x at twenty four hourly intervals. Hourly HC and CO sampling was done by taking grab samples. Lead (Pb) was analyzed from the samples of particulate matter. The locations of the selected AAQM stations and their environmental setting are given in the Figure-13.2.1.

Sampling and Analytical Techniques

Respirable Dust Samplers have been used to collect samples for SPM and RPM in ambient air. A blower sucks the ambient air through the cyclone and filter paper. Samples of gases are drawn at a flow rate of 0.2 liters per minute and are analyzed in the laboratory located at Delhi. SPM has been estimated by gravimetric method. Jacobs-Hochheiser method (IS-5182 Part VI, 1975) has been adopted for the measurement of NO_x. Modified West and Gaeke (IS-5182 Part II, 1969) has been adopted for measurement of SO_2. Mylar bags with pulse pumps were deployed for collection of hourly samples of Carbon monoxide (CO) and hydrocarbon (HC). The CO and HC levels were analyzed by Gas

Chromatography. Lead was analyzed from the filter papers collected from dust samplers by the method of Atomic Absorption Spectroscopy (AAS).

Traffic data giving details like category and number of vehicles observed during the survey was also used to correlate with the air monitoring results.

Observations

The results for ambient air quality monitoring are presented in Appendix where ranges for various pollutants (SPM, RPM, SO_2, NO_x, Pb, HC and CO) are given. The sampling locations in residential areas at about 200 - 800 m away from the proposed expressway indicate concentrations for SPM in the range of 47.2 to 521.7 $\mu g/m^3$, RPM in the range of 20.9 to 248.5 $\mu g/m^3$, SO_2 in the range 6.0 to 29.8 $\mu g/m^3$, and NO_x in the range of 3.0 to 27.3 $\mu g/m^3$. Similarly, concentrations for hydrocarbon are in the range of below detectable limit to 0.82 ppm, CO in the range of below detectable limit to 1212 $\mu g/m^3$, and Pb in the range of 0.004 to 0.116 $\mu g/m^3$.

To conclude, the ambient air quality levels observed in the study are found to be well within the standards prescribed by CPCB for residential and rural zones except for few occasions where SPM concentrations is exceeded. This is in case of Bhuapur where high traffic volume on unpaved roads and the brick kilns lead to airborne dust. High values of SPM can also be attributed to occasional high speed winds. In case of Duhai, Modinagar, Khekra, and Preetampur (near NH-1) relatively high levels of gaseous pollutant (especially SO_2 and NO_x) are observed due to their proximity to highways. Overall in the study area the values of CO, SO_2, and NO_x are much below the stipulated Indian standards.

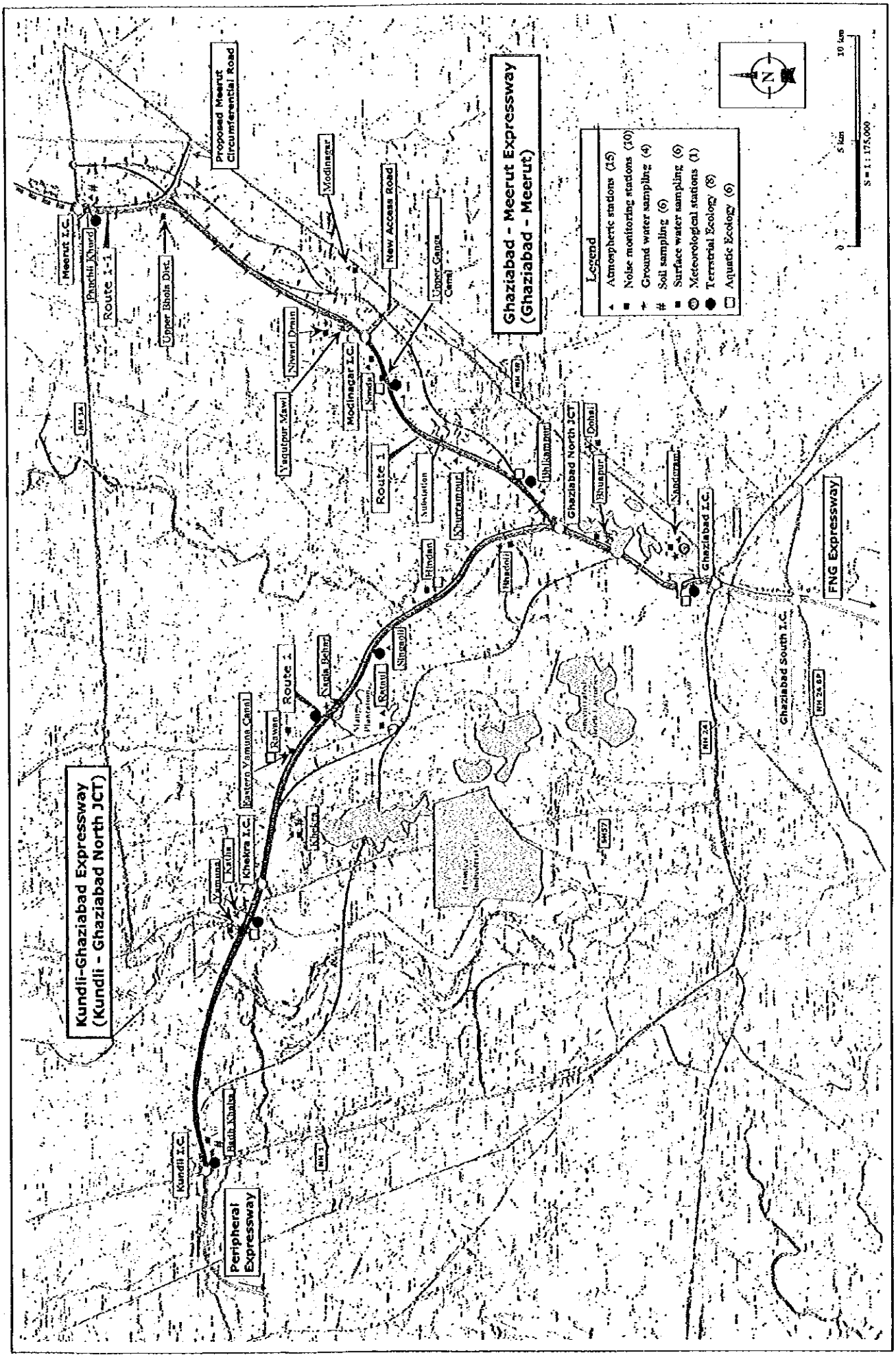


Figure 13.2.1 Location of Monitoring Stations

Table-13.2.3: Ambient Air Quality Monitoring Results

Code	Location	SPM (µg/m^3)	RPM (µg/m^3)	SO_2 (µg/m^3)	NO_x µg/m^3)	Pb(µg/m^3)	CO(µg/m^3)	HC(ppm)
A1	Nandgram	71.3-158.1	20.9-61.6	6.0-10.7	6.5-13.7	0.032-0.104	263.4-1110.6	0.27-0.82
A2	Bhuapur	232.1-521.7	165.0-248.5	10.1-21.2	12.3-26.2	0.026-0.116	251.9-1110.6	0.22-0.82
A3	Bhikanpur	47.2-79.3	16.7-33.1	6.0	3.0	0.004-0.022	ND-309.2	ND-0.22
A4	Khurrampur	77.3-147.3	23.8-76.2	6.0-7.8	3.0-10.4	0.010-0.032	ND-274.8	ND-0.18
A5	Sonda	92.4-189.3	32.5-87.3	6.0-8.5	3.0-11.7	0.012-0.022	ND-320.6	ND-0.09
A6	Panchli Khurd	82.2-165.2	21.2-62.7	6.0-8.6	4.8-12.3	0.016-0.104	ND-458.0	ND-0.78
A7	Duhai	117.4-208.5	38.3-81.6	14.5-24.5	22.3-34.5	0.032-0.122	240.5-1110.6	0.27-0.98
A8	Modinagar	134.5-208.2	33.7-92.3	14.8-34.5	24.7-38.7	0.032-0.126	251.9-1110.6	0.27-0.82
A9	Bhadoli	131.2-196.8	38.4-86.2	6.0-15.4	5.8-25.0	0.011-0.024	22.9-274.8	0.06-0.14
A10	Singaoli	113.7-178.0	31.4-95.4	6.0-29.8	3.0-25.0	0.013-0.019	ND-217.6	ND-0.22
A11	Rataul	128.7-195.6	37.2-76.1	6.0-17.5	5.5-29.8	0.016-0.096	240.5-1110.6	0.10-0.82
A12	Khekra	116.8-211.4	53.4-95.2	6.0-13.0	4.2-48.7	0.016-0.104	160.3-938.9	0.07-0.82
A13	Katha	121.4-201.0	31.6-83.6	6.0-15.1	3.0-27.3	0.004-0.016	ND-549.6	ND-0.32
A14	Near NH-1 (Preetampur)	165.0-264.8	36.0-95.8	6.0-17.9	3.0-33.0	0.012-0.088	206.1-1110.6	0.27-0.82
A15	Badh Khalsa	134.7-208.9	48.4-95.7	6.0-17.0	3.0-14.3	0.016-0.104	0.18-0.97	0.27-0.82

NS: Not Specified ND: Not Detected

3. Noise Levels

The main objective of noise monitoring in the study area was to establish the baseline noise levels and assess the impact of the total noise expected to be generated by the proposed expressway.

The assessment of impact of noise sources on surrounding community depends on:

- Characteristics of noise sources (instantaneous, intermittent, or continuous)
- Time of day (same noise levels at nighttime will be more annoying as compared to daytime in residential areas),
- Location of the noise source with respect to noise sensitive land use, which determines the loudness and period of exposure.

Selection of Sampling Locations

Noise monitoring has been conducted to determine noise levels at ten locations in the study area. These levels were recorded for a continuous 24 hours period. The locations and the sampling criteria are described in Appendix 13.2.4 and are depicted in Figure-13.2.1.

Method of Monitoring

Sound pressure level (SPL) measurements were automatically recorded with help of an Integrated Sound Level Meter (CEL 383 model, Lucas Inc., England) to give the equivalent noise level for every hour continuously for 24 hours in a day. The day noise levels were estimated between the period 6 a.m. to 9 p.m. and night levels between the period from 9 p.m. to 6 a.m. Noise monitoring was done for weekdays as well as weekends at all locations.

The ambient noise levels are presented in Table-13.2.4. The table indicates equivalent noise levels *viz.*, L_{day} and L_{night}, along both sections.

Table-13.2.4: Ambient Noise Level Monitoring Results

Code	Location	$L_{eq(day)}$ (dBA) (6.00 a.m. to 9.00 p.m.)	$L_{eq(night)}$ (dBA) (9.00 p.m. to 6.00 a.m.)
N1	Nandgram	64.2	61.0
N2	Bhuapur	65.9	60.9
N3	Sonda	65.1	57.4
N4	Duhai	79.6	83.4
N5	Modinagar	80.2	88.2
N6	Bhadoli	55.9	50.2
N7	Rataul	59.0	51.8
N8	Khekra	66.0	54.3
N9	Ravana	54.8	51.1
N10	Badh Khalsa	60.7	51.8

Observations

Residential zone: The day time as well as night time noise levels exceeds the prescribed limit of 55 dB(A) and 45 dB(A), respectively. The daytime noise level at Sonda recorded the highest level at 65.1 dB(A) whereas Ravana records the lowest as 54.8 dB(A). The night time noise level at Sonda recorded the highest level at 57.4 dB(A) whereas the lowest noise level of 50.2 dB(A) was recorded at Ravana. Though both are residential areas, high noise levels at Sonda during both daytime and nighttime is attributed to local activities as well as regular traffic. In case of Ravana, the area is not prone to regular traffic, hence the noise levels recorded are less.

Commercial zone: The day time noise levels at commercial locations prone to traffic is observed to exceed the prescribed limit of 65 dB(A). Duhai recorded the highest level of 79.6 dB(A) due to high traffic and commercial activities along NH-58. The nighttime noise levels at commercial locations prone to traffic is observed to be as high as 83.4 dB(A) which exceeds the limits of 55 dB(A). The higher level of noise during nighttime can be attributed to plying of more heavy vehicles (>25%) during that time.

Industrial zone: The daytime noise levels at commercial and industrial locations prone to traffic was observed to exceed the prescribed limit of 75 dB(A). Modinagar recorded the highest level of 80.2 dB(A). The nighttime noise levels are also observed to be as high as 88.2 dB(A), which exceeds the limits of 70 dB(A). The higher nighttime noise level is due to higher proportion of heavy vehicles in the traffic during that time.

4. Water Quality

Water quality parameters for surface and ground water resources along the proposed expressway have been studied for assessing the water environment and evaluate anticipated impact of the proposed project. The two major rivers in the study area are Hindon and Yamuna. The major canals in the area are Eastern Yamuna Canal and Upper Ganga Canal. Understanding the water quality is essential in preparation of Environmental Impact Assessment and to identify critical issues with a view to suggest appropriate mitigation measures for implementation of the project.

The purposes of this study is to assess the critical parameters and the impact on water quality by the construction of road and related activities. The secondary data has been complied in the report 'Environmental Impact Assessment for Construction of Expressways in the National Capital Region in India'.

Selection of Sampling Locations

Reconnaissance survey was undertaken and the monitoring locations were finalized based on the alignment of expressway, the location of water bodies, the location of residential areas representing different activities/likely impact areas, and areas which can represent baseline conditions. Six sampling locations for surface water and four for ground water were selected for the survey as shown in Figure-13.2.1.

Methodology for Sample Collection

Water sampling was done in the months of May and October representing pre-monsoon and post-monsoon periods respectively. This was done to study the variation in water quality during the two seasons. The samples were collected and analyzed as per the procedures specified in 'Standard Methods for the Examination of Water and Wastewater' published by American Public Health Association (APHA). Samples for chemical analysis were collected in polyethylene carboys. Samples for bacteriological analysis were collected in sterilized glass bottles. Selected physico-chemical and bacteriological parameters have been analyzed for estimating the existing water quality status in the study area.

The results of surface water are compared with Class 'C' water quality (fit for drinking after conventional treatment) as per IS:2296-1982 "Tolerance Limits for Inland Surface Waters subject to Pollution". The ground water results are compared with standards for drinking water as per IS:10500-1983 "Specifications for Drinking Water". The results of surface and ground water analyses in the pre-monsoon and the post monsoon period are given in Appendix 13.2.5 (A to D).

Observations

The pre monsoon and post monsoon data was analysed for all the sampling locations. The analysis results indicated pH in the range of 7.70 -8.34 during pre-monsoon and 8.33-8.59 during post-monsoon season. The total dissolved solid (TDS) ranges from 120 -280 mg/l during pre-monsoon and 136-276 mg/l during post-monsoon season. BOD ranged from 2.0-6.0 mg/l during pre-monsoon and 4.0-9.0 mg/l during post-monsoon season. During pre-monsoon nitrates ranged from 1.6 -3.4 mg/l and 1.72-3.78 mg/l during post-monsoon season. Heavy metals are observed to be either absent or below detection limits. It can be seen from above comparison that there is very slight variation in the water quality in both the seasons. All tested parameters except for BOD were found well within the permissible limits as per IS:2296 and thereby indicating the good quality of surface water at all sampling locations.

The physicochemical characteristics of ground water samples collected from selected locations show conformity with IS: 10500 specifications except for hardness and TDS which exceeded desirable limits in some samples but are well within the extended limits. The hardness varies from 288-380 mg/l for pre-monsoon season whereas it ranged from 242-324 mg/l during post-monsoon season. TDS were observed to be in the range of 428-537 mg/l in pre-monsoon season and 400-496 mg/l during post-monsoon season. Slightly high level of hardness and TDS in ground water can be related to the local geology of this area, which governs the factors such as recharge of aquifer and chemical composition of the water. Heavy metals are either below detection limit and/or well within the prescribed limit.

5. Soil Quality

The project area is characterized by flat terrain with an average elevation of 200 MSL. The project lies largely within the flood plains of Yamuna and Hindon rivers. The flood plain varies from 2 to 3 km in the project area. The soil generally consists of two types. The upper stratum (from 10 to 20 m below ground level) consists of non-plastic fine silty sand. The lower stratum (from 20 to 45 m) consists of low plasticity inorganic silt with fine sand. The land near the riverbanks in the flood plain and adjacent to landfall sites is fertile and can support a variety of vegetation suitable for extreme type of climate. The area adjoining the proposed alignment of expressway is mostly under cultivation. The soil analysis has been carried out to assess the agricultural and afforestation potential of the soil.

Soil Sampling

Soil samples have been collected from six locations, which include three each on Ghaziabad-Meerut section and Kundli-Ghaziabad section. Details of sampling locations are presented in Appendix-13.2.6. Soil sampling locations are as shown in Figure 13.2.1. Soil characteristics at six locations along the proposed project road were assessed for the physical and chemical properties. Soil sampling locations were selected based on distance from proposed alignment and the land Use Pattern.

Table-13.2.7 shows standard soil classification and Appendix-13.2.7 presents soil analysis results for the study area

Table-13.2.7: Standard Soil Classification

No.	Parameter	Classification
1	Organic Carbon (%)	Up to 0.4: Less; 0.41-0.5: Medium; 0.61-1.0: Sufficient
2	Nitrogen (kg/ha)	Up to 100: Less, 101-300: Good; >300: Sufficient
3	Phosphorus (kg/ha)	Up to 30: Less; 31-50: Good; >50: Sufficient
4	Potassium (kg/ha)	Up to 180: Less; 181-300: Good; >300: Sufficient

Observations

Soil color is observed to be varying between whitish black to brownish. The texture is observed to be predominantly clayey. The soils in the area are observed to be moderately alkaline in nature. While both nitrogen and phosphorus fall under the category of "more than sufficient". Potassium levels fall under the category of " low to medium". The levels of organic matter in the soils fall under the category of "medium to average sufficient".

It can be seen from the soil analysis results that the soil in the area is very fertile with high agricultural productivity, hence steps should be taken to prevent the soil from erosion and any land use change should be avoided as much as possible.

6. Geology and Hydrology

Geology

Geological formation of National Capital Region (NCR) consists of quartzite, girt and schist rock. The Alwar series of the Delhi System is represented by quartzite and mica schist with pegmatite intrusive. This series is predominated by the quartzite and forms the high concentration in the N - NE and S - SW. The prominent joint directions are NNE - SSW, NNW - SSE and E - W and dipping at various angles right up to 90 degree. The

deposition character of the quartzite are close textures, thickly beeded and is devoid of interstitial spaces. The Quartzite are white, pale gray or pale pinkish purple with red and brown shades depending upon the amount of iron oxides coating over constituent grains.

Quaternary Alluvium and pre-Cambrian meta-sediments of Delhi System occupy the geological formation of the Haryana and Rajasthan sub-region. The former includes the recent to sub-recent alluvium and post Delhi intrusive - pegmatite, quartz and granite etc. The later (Delhi system) includes the Alwar series, Ajabgarh series, and Khulgash limestone.

The geological substratum of the U.P. Sub-Region is of thick Alluvium tract because the presence of perennial flows of the two mighty rivers of Ganga and Yamuna with a definite divide formed by the Delhi ridge. Pre-tertiary river bound debris from the peninsula, the latter supplemented by the upper and post-tertiary Himalayan debris, yet under intense compaction, constitute the alluvial deposition.

The sub-region does not reveal anything striking, Kankar and Reh are only found, of which the latter is in little amount. Sand is another material, which needs to be mentioned due to its easy accessibility for construction purposes. The geological map of the study area is given in Figure-13.2.2

Hydrology

Yamuna and Hindon are the two major rivers passing through the study area. Besides these rivers, there are several distributaries, canals and drains. The important ones in the Ghaziabad-Meerut section include Upper Ganga canal, Niwari drain, Sultanpur and Sheikhpur minor, Tikri distributory, and Left Bhola distributary. In Kundli-Meerut section it is mainly Khekra distributary, Eastern Yamuna Canal, Sonda drain, and Bhikanpur drain. It has been observed that flow rate of these rivers is in the range of 2.5-3.5 m/sec during high flood levels and 0.20-0.25 m/sec during lean seasons.

7. Ecological Studies

The ecological studies have been carried out to understand the present status of terrestrial and aquatic ecosystem within one-kilometer distance, on either side, from the Right of Way of the proposed expressway.

Terrestrial Ecosystem Studies

To have a fair understanding of the nature of terrestrial ecosystem the sampling was done at the eight sites which were distributed along the 80 km stretch of the proposed

expressway as mentioned in Appendix 7.2.8. At each site, sampling was done randomly at ten locations. Since the area does not show presence of any zonal biome it was not necessary to carryout phytosociological study of woody vegetation. The woody plants were restricted to zonal biomes like field bunds, roadsides, canal banks etc. and hence they were just listed. The phytosociological analysis of herbs was carried out by taking ten quadrants of 1 m^2 and the assessment was based on their relative frequency, density and abundance. Again in case of herbaceous vegetation there was no natural flora and it was restricted mainly to field bunds and agricultural fallow. Since the flora has been subjected to severe biotic interference there was no need to estimate dominance and hence Importance Value Index (IVI). The overall floral study was based on both actual field studies and the data from the forest records.

The terrestrial fauna was studied at the same sites as that of flora. The list of birds, mammals, reptiles and amphibians was made based on actual field survey interrogation of local people and secondary data obtained from the forest records.

Floral Analysis

The terrestrial ecosystem does not show much of variation. It is exclusively dominated by agrarian ecosystem with Sugarcane (*Saccharum officinalis*), Wheat (*Triticum* sp.), Pearl millet (*Pennisetum glaucum*), Paddy (*Oryza sativa*), Jowar (*Sorghum bicolour*), Harhar (*Cajanus cajan*) as prominent food crops, several kinds of vegetables, Mustard (*Brassica juncea*) as main oilseed crop and Cotton (*Gossypium herbaceum*). The wild vegetation is restricted mainly to field bunds, agricultural fallow, banks of rivers and canals and roadsides. Agricultural weeds dominate the herbaceous vegetation. At few places sivicultural plantations of Poplar and Eucalyptus and pomoculture of mainly Mango are seen. There is patch of reserve forest near Nagla Baheri village.

The flora in this region is represented by 305 species of plants of which herbs, shrubs and trees constitute 95, 97 and 113 respectively. Among herbs grasses dominated. Since there are no natural forests in the study area, the terrestrial ecosystem is represented by zonal biome. The trees are restricted mainly to field bunds, roadsides and canal banks. Herbs are mainly agricultural weeds. The phytosociological study was restricted to herbaceous vegetation around the agricultural fields. The plants were studied with respect to their relative frequency, frequency class, density and abundance. The detailed phytoplankton study is shown in the report 'Environmental Impact Assessment for Construction of Expressways in the National Capital Region in India'.

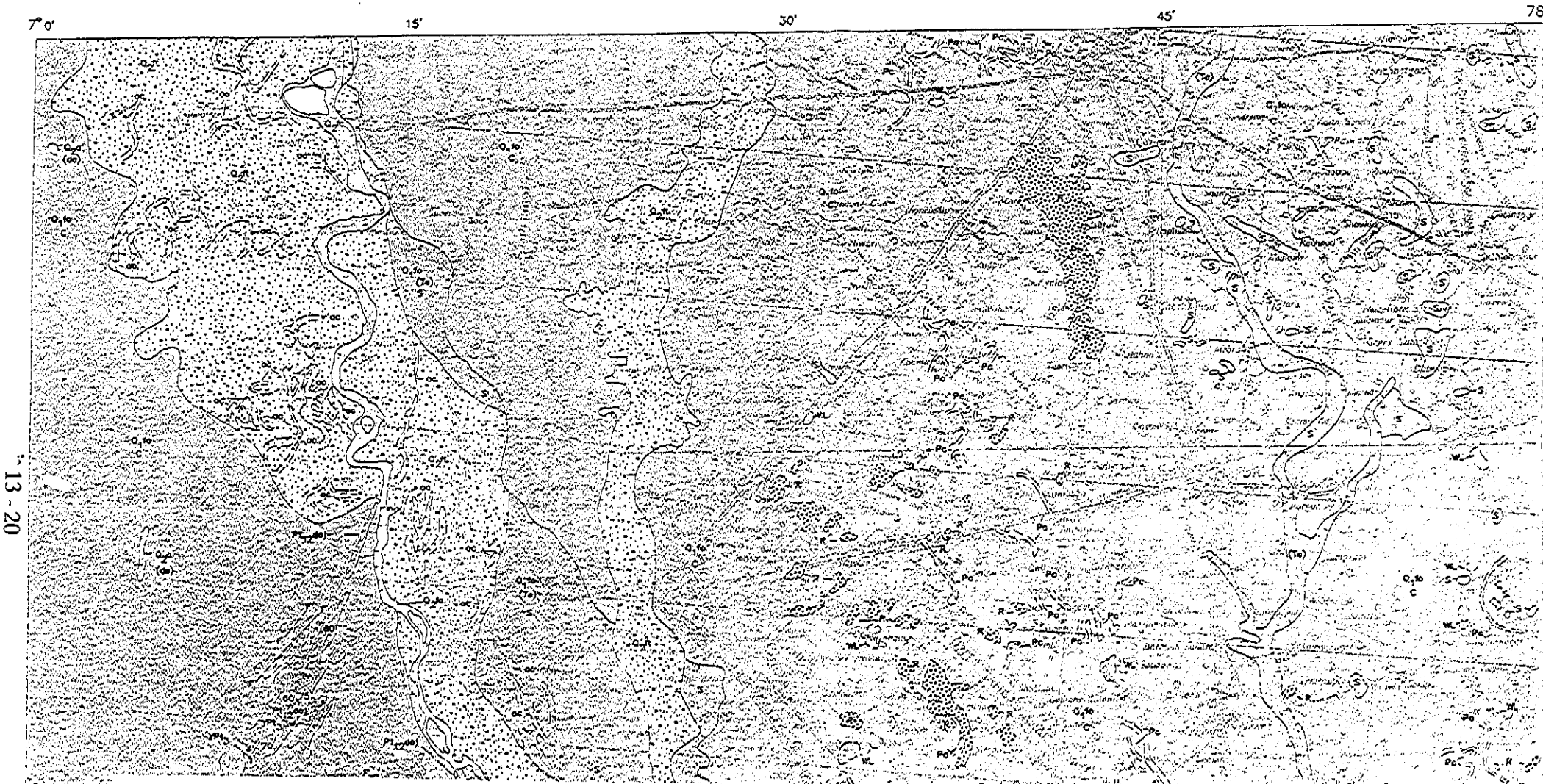


Figure-13.2.2: Geological Map of the Study Area

The State Governments of Uttar Pradesh and Haryana have declared some natural and man made features like rivers, canals, railway lines and roads as reserved or protected forests. Acoording to the Forest (Conservation) Act, 1980 all forest land needed for non-forest purpose would require prior approval of the Government. A secondary survey which included surveys of Government Officials was done to determine such forest land in the project area. Some of them have been listed below in Table-13.2.8.

Table 13.2.8: Reserved or Protected Forest Land in the Project Area

State	Reserved or Protected Forests
Uttar Pradesh	1. National Highway 24 2. Upper Ganga Canal 3. State Highway 14 4. State Highway H 57 5. Eastern Yamuna Canal
Haryana	1. National Highway 1 2. Yamuna River 3. All tarred roads

Faunal Analysis

The faunal studies were restricted to making check list of mammals, birds, reptiles, amphibians from secondary data obtained from forest department and actual field surveys conducted at eight terrestrial locations distributed along the eighty kilometer long stretch of proposed express way. In all 16 mammals, which included Nilgai and Indian fox, which are rare species, 29 reptiles that included snakes, geckos, lizards, skink and turtles, three species of amphibians and 89 terrestrial birds have been reported. Among birds 12 species were of migratory nature. The fauna Checklist and their detailed description at different locations is given in the report 'Environmental Impact Assessment for Construction of Expressways in the National Capital Region in India'.

In all 17 species of fishes, 26 aquatic birds have been reported. The fauna Checklist and their detailed description at different locations is given in the report 'Environmental Impact Assessment for Construction of Expressways in the National Capital Region in India'.

The network of canals and two rivers, Yamuna and Hindon form the major sources of fish fauna in this region. There is large scale fishing activity in the rivers Yamuna and Hindon.

Aquatic ecosystem studies

The aquatic ecosystem was studied by selecting six aquatic sampling sites. These sites represented all kinds of water bodies that are found within the study area. The avifauna was studied by actual field observations. The planktons were studied by using 25 µm plankton net. The analysis was carried out by simple drop method using compound microscope. Mainly two rivers Yamuna and Hindon represent the aquatic eco-system. Out of these water bodies typical riparian vegetation mainly composed of *Saccharum spontaneum* and few reeds belonging to family cyperaceae was observed on the banks of Yamuna river. Sampling locations that were considered for ecological studies are listed in Appendix 13.2.8 and Figure 13.2.1.

Plankton studies

The plankton studies to understand the status of water bodies within the study area was carried out at six aquatic sampling sites. These sites are listed in Appendix 13.2.8. The detailed analysis of the Plankton Study is available in the report 'Environmental Impact Assessment for Construction of Expressways in the National Capital Region in India'.

The rapid analysis for indicator parameters such as Dissolved oxygen, chlorides and hardness indicate that the quality of water fluctuates depending upon the inflow of waste, various human uses such as washing of cloth, cattle and agricultural licheates. The pH of water is on alkaline side. The DO range was from 9.9 to 0.81 ppm indicating clean to organically rich water. The level of DO usually is on higher side even for organically polluted water due to fact that the algae growth contributes DO which many a times is on higher side during daytime.

This stands clearly when one compares algae/phytoplankton analysis. Almost all sites except (A2) Hindon upstream of Sarfabad shows lower Palmer's index indicating clean water with only diatom growth. This diatom growth can be attributed to the high turbidity and availability of silicates. While remaining five stations showed Palmer's Index from 11 to 21 indicating moderate organic pollution. The types of algae that were found in such locations such *as Ankistrodesmus, Euglena, Phacus, Scenedesmus, Melosira, Chlamydomonas* etc are known to tolerate organic pollution and used as pollution indicators. The Nandgram and Yamuna river near Mavikalan showed highest Shannon's index of diversity among all the sites.

Endangered Species

Within the study area no plant, which has been categorized as a threatened species according to red data book of plants published by Botanical Survey of India, Ministry of Environment and Forests, has been observed.

Among fauna there were four animals which have been recorded as endangered species by Zoological Survey of India, MoEF, these were Indian Fox (*Vulpes bengalensis*) among mammals Yellow monitor lizard (*Varanus flavescens*) & Python (*Python molurus*) among reptiles and Indian Peafowl (Pavo *cristatus*) among birds.

13.2.2 Socio-Economic Profile

This section describes the socio-economic aspects of the project. The information on socio-economic aspects has been compiled from secondary sources (mainly Census Hand Book, 1991). Sociological aspects include demographic aspects, socio-economic aspects and infrastructure facilities available in the study area. The economic aspects include occupational structure of the people. The social survey locations are shown in Figure-13.2.3.

Social Profile

The following sections describes the socio-economic profile of the study area villages. A detailed description of these villages is given in the report

i) Settlement Pattern: The study area comprises of four districts namely Ghaziabad, Meerut, Baghpat and Sonipat. The details regarding the geographical area and number of villages are given below:

Table 13.2.9: Settlement Pattern

District	Geographical Area		Number of settlements		
	Area (ha)	Percentage (%)	Inhabited	Uninhabited	Total
Ghaziabad	7519	41.6	27	-	27
Meerut	2529	14.0	5	-	5
Baghpat	4993	27.6	11	2	13
Sonipat	3020	16.7	5	-	5

ii) Demography: The details regarding the demographic aspects as well as households in the study area are given below:

Table 13.2.10: Demography

District	Population			No. of Household
	Male	Female	Total	
Ghaziabad	18,363	14,961	33,324	4,672
Meerut	9,538	8,057	17,595	2,363
Baghpat	9,934	8,741	18,675	2,904
Sonipat	8,244	6,700	14,944	2,081

iii) Density of population: The density of population in the study area is given below:

Table 13.2.11: Density of Population

District	Density of population (Person/ha)
Ghaziabad	4.43
Meerut	6.95
Baghpat	3.74
Sonipat	4.95

iv) Availability of Infrastructure: All the villages in the study area are supplied with electricity. The main source of drinking water is groundwater (from wells and hand pumps). The facilities like education and health are given in table below. Medical facilities are very poor as represented by low number of health centers in the villages. Most of the people have to rely on district center hospitals for their medical treatment.

Table 13.2.12: Availability of Infrastructure

District	Educational facilities			Health Center
	Primary	Middle	Secondary	
Ghaziabad	18	6	4	0
Meerut(*)	1	1	1	0
Baghpat	8	4	1	2
Sonipat	1	2	-	1

(*) : Complete data couldn't be collected due to elections.

Economic Profile

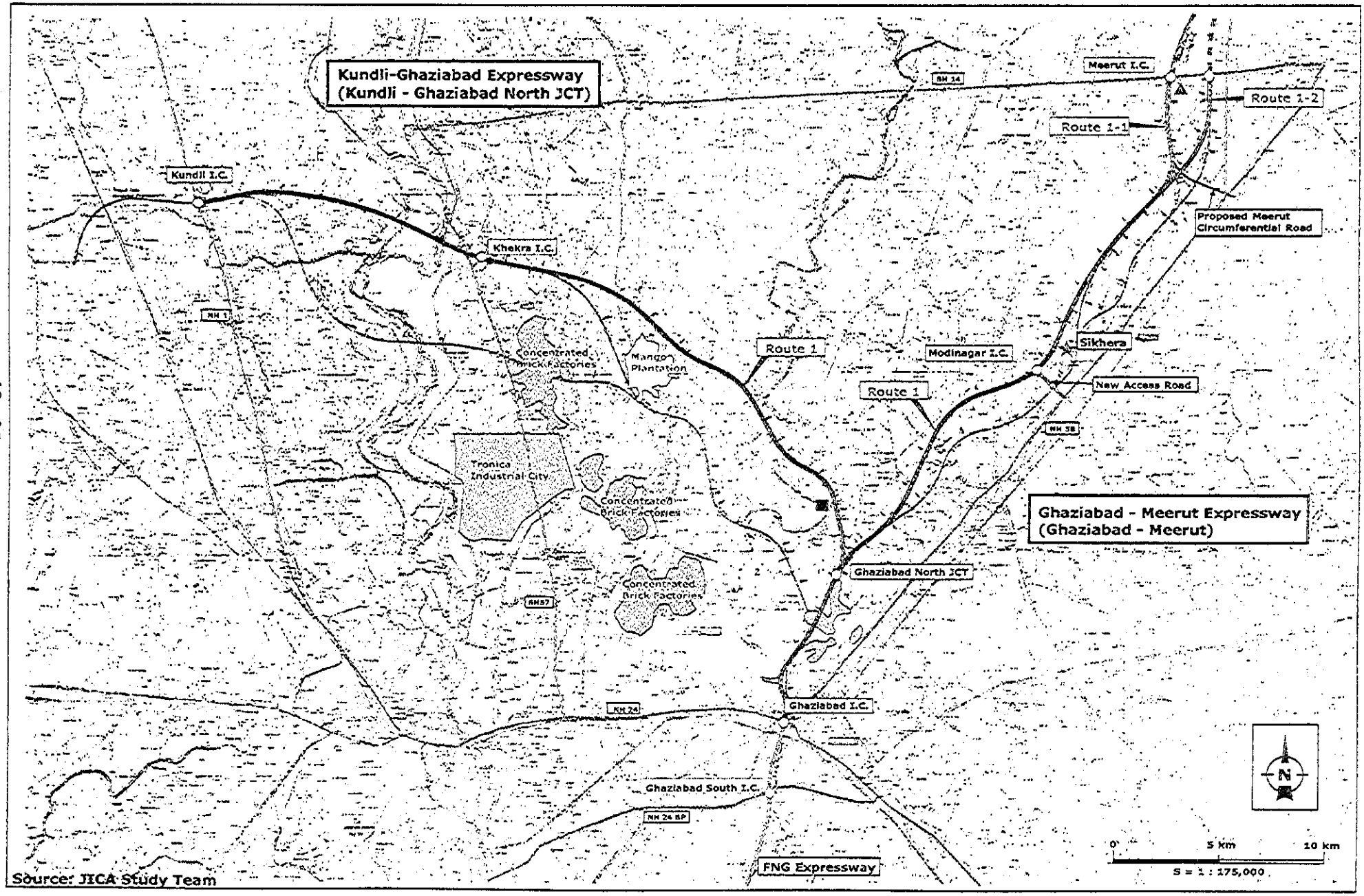
This section deals with the economic aspects of the study area which basically include the occupational structure of inhabitants.

i) Occupational Structure: Agriculture is mostly mechanised hence deployment of manpower is low. Apart from agriculture being the main occupation, people also work in nearby industries as is reflected in large number of main workers. District wise occupational structure is given in table below:

Table 13.2.13: Occupational Structure

District	Occupational Structure			Percentage to total population
	Agriculture Laborers	Cultivators	Main Workers	
Ghaziabad	2,676	4,744	12,549	59.9
Meerut	1,690	1,533	4,704	45.1
Baghpat	1,666	3,658	7,897	70.8
Sonipat	507	1,521	3,928	39.9

Figure-13.2.3: Socio-Economic Map of Study Area



13.3 Environmental Impact Assessment

The present section identifies and appraises various impacts from the proposed project based on environmental baseline conditions and analysis of the field data as discussed in the earlier chapter and future simulations.

The environmental impacts are categorised as either primary (direct) or secondary (indirect). Primary impacts are those which are attributed directly by the project whereas secondary impacts are those which are indirectly induced and typically include the associated investment and changing patterns of social and economic activities due to the proposed action. The typical potential direct and indirect impacts of such expressway projects are summarised in Table-13.3.1.

Table-13.3.1: Potential Environmental Impacts of Expressway Projects

POTENTIAL IMPACTS OF THE PROPOSED EXPRESSWAY
DIRECT IMPACTS
Air pollution
Noise
Surface and Ground water hydrology and quality
Terrestrial and aquatic flora and fauna
Removal of Vegetative cover
Soil contamination
Erosion of lands
Sedimentation in rivers/ponds due to erosion
Landscape
Hazardous materials spillage
Sanitation and solid waste disposal
Dust and Roadside litter
Aesthetics
Dislocation /resettlement of people
INDIRECT IMPACTS
Induced development/land use patterns
Increased transportation
Illegal /Unplanned Timber Cutting
Illegal /Unplanned Land clearing

13.3.1 Construction Phase

(1) Impact on Air Quality

The construction phase air quality impacts of the project, although transitory, could also be significant. The regions downwind to the construction yards are likely to be most vulnerable areas in this respect.

Burning of diesel fuel will be the principal cause of air pollution during the construction phase. The vehicular movement due to project is not expected to cause a significant rise in existing traffic on any of the haul routes passing through the inhabited areas because of their low volume. The air quality impacts due to gaseous emission from transport of construction material therefore are insignificant. During the period of construction activities the approximate fuel consumption at a construction yard is expected to be about 200 L diesel per hour.

The concentration of gaseous pollutants due to fuel burning needs to be monitored and restriction on working hours should be suggested based on actual observations during construction phase.

There will also be a rise in Suspended Particulate Matter (SPM) levels due to the construction activities. Since the emission will be fugitive in nature it is difficult to quantify and SPM standards are even expected to be exceeded as the background values are high at many places. However, particulate materials tend to settle during the low wind and stable conditions. Therefore, even if it is exceeded it will be for very short period.

There will be some increase in levels of gaseous pollutants.

(2) Impact on Noise Levels

During the construction, the major sources of noise pollution are movement of vehicles transporting the construction material to the construction yard and the noise generating activities at the yard. Concreting, mixing, casting, and material movement are primary noise generating activities in the yard and will be about uniformly distributed over the entire construction period. Construction activities are expected to produce noise levels in the range of 80 - 95 dB(A). The major work is expected to be carried out during the day time. The noise produced during the construction will however not have a significant impact on the existing ambient noise levels near villages (where the existing ambient noise levels for residential zone are already being exceeded) because as

already discussed the predominant land use along the most part of alignment is agricultural and open fields. Therefore, there will be very limited presence of population being exposed to noise levels.

The construction equipment will have high noise levels that can affect the personnel operating the machines. Use of proper personal protective equipment will mitigate any adverse impact of the noise generated by such equipment.

The noise levels in the working environment are compared with the standards prescribed by Occupational Safety and Health Administration (OSHA-USA) which in-turn are being enforced by Government of India through Model rules framed under the Factories Act. The acceptable limits for each shift being of 8 hour duration, the equivalent noise level exposure during the shift is 90 dB(A). Hence noise generated due to various activities in the construction camps may affect workers, if equivalent 8 hour exposure is more than the safety limit. ACGIH (American Conference of Government Industrial Hygienists) proposed an 8 hour L_{eq} limit of 85 dB(A). Exposure to impulses or impact noise should not exceed 140 dB(A) (Peak acoustic pressure). Exposure to 10,000 impulses of 120 dB(A) are permissible per day.

The noise likely to be generated during excavation, loading and transportation of material near the borrow areas will be in the range of 90 to 105 dB(A) and this will occur only when all the equipment operate together and simultaneously. This will be a highly improbable. The workers in general are likely to be exposed to an equivalent noise level of 80-90 dB(A) in an 8 hour shift for which all statutory precautions as per bye laws should be taken into consideration.

Also these levels can be reduced by careful planning of machinery operations and scheduling of operations.

13.3.2 Operation Phase

(1) Impact on Air Quality

Vehicular emissions are one of the major sources for air pollution. By virtue of being a road project that facilitates efficient travel between two nodes, the project will have beneficial air quality impacts during its operation when thought of complete area. However, when viewed with respect to the existing ambient air quality or with respect to compliance of ambient air quality standards during the operation phase of the project, the air quality along a narrow corridor of the roadway is likely to be lower due to the increase in the traffic volumes.

During the operation phase of the project the primary air quality impacts will be due to the flow of the traffic on the project road. The extent of these impacts, at any given time, will depend upon (i) the rate of vehicular emission within a given stretch of the road and (ii) the prevailing meteorological conditions. The impacts will have strong temporal dependence as both of these factors vary with time. The temporal dependence would have diurnal, seasonal as well as long term components.

The air quality predictions have been carried out by using the air quality model CALINE4 developed by California Department of Transportation. The model is based on Gaussian diffusion equation and uses a mixing zone concept to characterise pollutant dispersion over the roadway. The model has been extensively tested for its predictive capability for traffic related air quality impacts. Given source strength, meteorology, site geometry and site characteristics the model can reliably predict pollutant concentrations for receptors located within 500 meters of the roadway, the most important region for estimating the impacts of road project due to the low elevation emissions. Conveniently divided links are divided into a series of elements and sub-elements from which incremental concentrations are computed and then summed to form a total concentrations for a particular receptor location. Each element is modelled as an "Equivalent Finite Line Source" positioned normal to wind direction.

The long term variations in air quality scenarios during the project life are expected due to the change in traffic on the project road with time. The traffic volumes for the year 2006, 2016, and 2026 have been considered to simulate future air quality scenarios to provide an indication of the long term variations in air quality. A longer time horizon has not been considered because of uncertainty in ascertaining the emission factors for various categories of vehicles beyond the year 2026 due to the probable change in technology and fuel use.

To account for the effect of the diurnal variations in model inputs (vehicular emissions and meteorological conditions), the averaging time for model predictions has been restricted to 1 hour. The averaging time is so selected because the primary meteorological factors that influence the air quality predictions i.e. wind speeds and directions do not remain steady for longer time periods. Also, during the peak traffic hours, traffic volumes typically show significant variations over periods longer than one hour.

A. Emission Factors

The speed corrected emissions factors are presented in Table-13.3.2.

Table-13.3.2: Speed Corrected Emission Factors

Values are in gm/km per vehicle

Diesel Vehicle (Trucks)							
Pollutant	Speed (km/h)						
	10	20	30	40	50	60	70
CO	37.60	18.80	12.53	9.40	7.52	6.27	5.37
NO_x	66.83	33.42	22.28	16.71	13.37	11.14	9.55

Petrol Vehicles (Independent of speed)			
Pollutant	Cars	2 Wheelers	3 Wheelers
CO	2.72	2.0	4.0
NO_x	0.58	0.05	0.05

B. Model Inputs Parameters

The input parameters are chosen to suit the local conditions. The traffic data and speed used is Peak Hour Traffic. Some of the important model input parameters are as follows:

- Road stretch (representative) 1000 m
- Road wide 20-40 m
- Averaging time 1 hour
- Temperature 10 °C
- Wind speed site specific 2.0 m/s
- Wind direction 15°
- Mixing Height 100 m

This scenario has been taken to have conservative estimates of concentrations.

HC and SPM, although contributed by the vehicular movement, were not modelled. For HC, the Environment (Protection) Act, 1986 does not specify the ambient standards and therefore it would have not been possible to interpret the modelling results meaningfully. SPM contributions are dominated by background concentrations as well as traffic induced resuspension, both of which are difficult to quantify hence modeling is not relevant.

Carbon Monoxide Levels:

The source emission levels for CO were estimated by using the peak hourly traffic volumes for vehicles of five categories i.e., trucks and buses, LCVs, cars, two wheelers, and three wheelers. The traffic volumes for these categories of vehicles were obtained by distributing the total daily predicted traffic volumes for respective vehicle types for the years 2006, 2016, and 2026 over the 24 hours according to the hourly proportions

observed during the traffic count in 1999. As far as the ratio for the proposed expressway was concerned, the traffic pattern was assumed to be the same as adjacent state and national highways and the peak traffic was considered for the purpose of modeling.

The ROW (Right Of Way) of the proposed expressway is 100 m. It is observed from the Figure-13.3.1 to Figure-13.3.6 that the predicted CO levels at 50 m from centreline of the road in the year 2006 range from 87-432 $\mu g/m^3$. The range is about 2 times higher for the year 2026 (119-726 $\mu g/m^3$) which is approximately the ratio of traffic volume in the years 2006 and 2026, respectively. On comparison with the hourly standard for CO of 4000 $\mu g/m^3$, it is seen that no violations of CO standard are expected due to the project even if we consider the existing concentration of CO (<1200 $\mu g/m^3$). The maximum concentration that is observed is expected to be 726 $\mu g/m^3$ for year 2026. Hence CO levels in fact will remain well below the standards all the time even at the edge of the ROW. The project therefore has insignificant negative impact on ambient air quality in terms of CO.

The prediction of CO for 'Without Project Scenario' is comparatively on the higher side at all distances considered from the centreline for the existing highways. This observation is attributable to the higher emission factors for lower traffic speed due to congestion and concentration of the all increased traffic to the existing highways for 'Without Project Scenario'. The concentrations, however, are estimated to be well below the specified one hourly standard for all predicted conditions.

It is observed that the CO levels will remain significantly below the 1 hourly standard of 4000 $\mu g/m^3$ for both With and Without project scenarios.

NO_x Levels:

Similar to emission factors for CO, values for NO_x were obtained from the standards proposed by IIP and corrected for the variations in vehicle speed using WHO guidelines. The emission factors thus derived are also presented in Table-13.3.2. One hourly simulations for NO_x were carried out on the lines similar to CO.

The results for 1 hour average values for NO_x for the years 1999, 2006, 2016, and 2026 are presented in Figure 13.3.7 to Figure 13.3.9. When compared to 24 hours standard of 80 $\mu g/m^3$, it is observed standard is violated up to a distance of about 100 m from the centreline. The prediction for the existing highways for 'With Project' scenario were observed to be lower than that of 'Without Project' scenario in all the years of prediction.

Considering the wind rose from secondary source (IMD, Safdarjung) for the last 10 years, it can be concluded that calm condition exists in the range of 7-42% of time during winter season. Regions of probable violation of Indian Standard of 80 $\mu g/m^3$ for 24 hour average levels could not be stated considering the fluctuation in the wind directions and variation in the traffic volume over a period of 24 hours during the winter, however, it is safe to assume that such violations will not be more than the violations of 1 hourly average standard of 400 $\mu g/m^3$.

When viewed with respect to the short term standard for NO_x, there are violations for year 2026. However, for this violation to continuously occur, the same conditions (wind speed, direction, and traffic volume) also need to occur simultaneously which is highly improbable. In view of this observation it may be concluded that the project would not lead to significant violations at least up to the year 2016. During later years it is expected that technology interventions may reduce the source NO_x levels, which result in limiting the excess.

However, no new developments up to 50 m from the centreline of the proposed expressway will be permitted under the existing rules. Therefore, the impact will be insignificant.

Figure 13.3.1: CO Concentration at NH-58

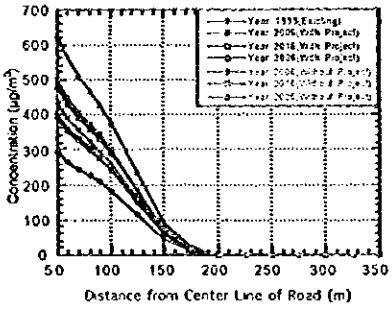


Figure 13.3.2: CO Concentration at SH-57

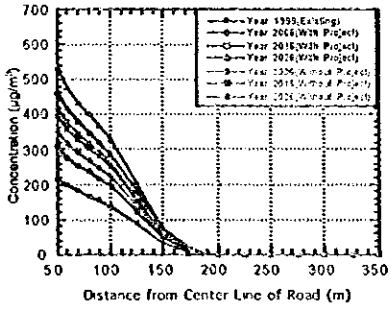


Figure 13.3.3: CO Concentration at SH-14

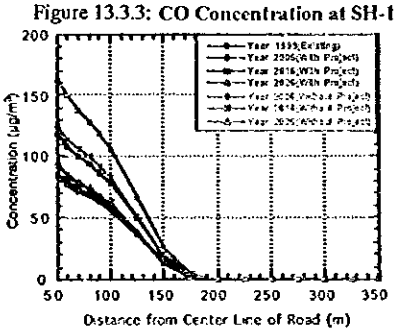


Figure 13.3.4: CO Concentration along Ghaziabad IC and Ghaziabad JCT

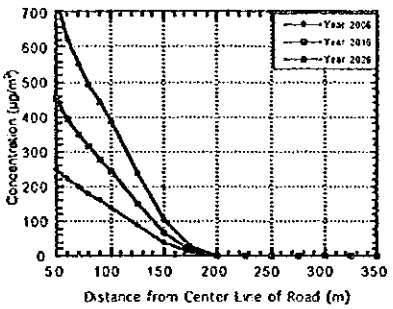


Figure 13.3.5: CO Concentration along Ghaziabad JCT and Modinagar IC

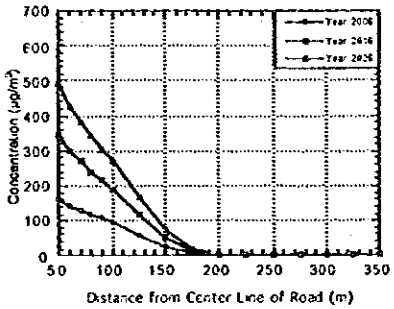


Figure 13.3.6: CO Concentration along Ghaziabad JCT and Khekra IC

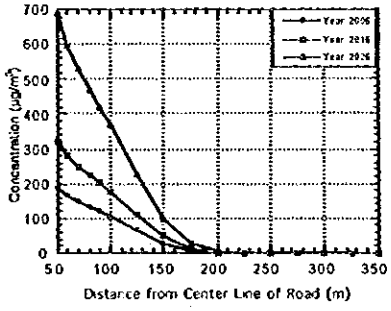


Figure 13.3.7: NO Concentration at NH-58

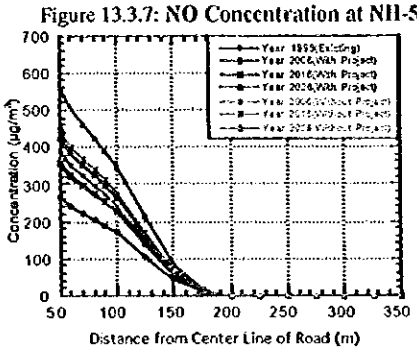


Figure 13.3.8: NO Concentration at SH-57

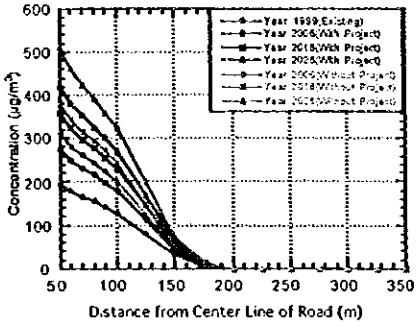


Figure 13.3.9: NO Concentration at SH-14

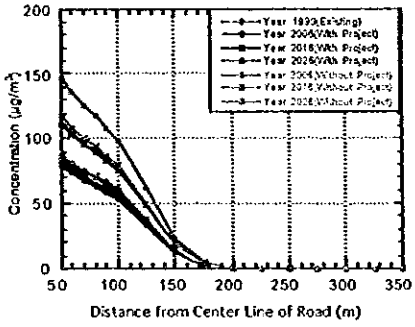


Figure 13.3.10: NO Concentration along Ghaziabad IC and Ghaziabad JCT

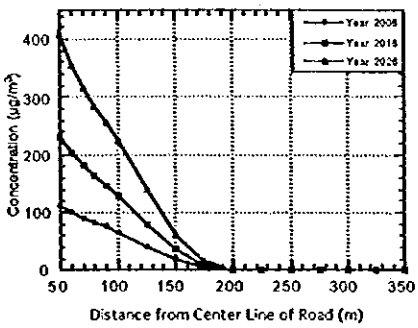


Figure 13.3.11: NO Concentration along Ghaziabad JCT and Modinagar IC

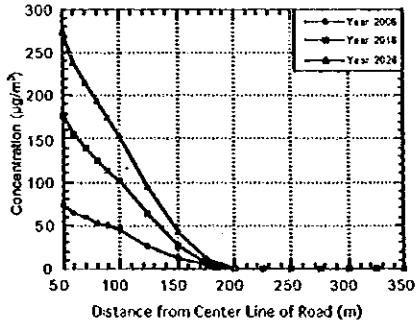
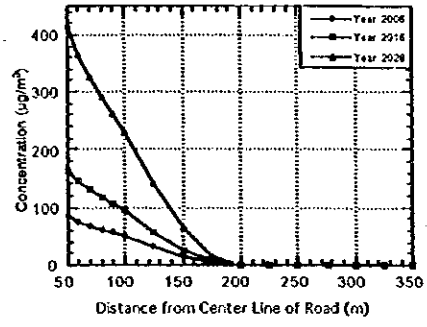


Figure 13.3.12: NO Concentration along Ghaziabad JCT and Khekra IC



(2) Impact on Noise Levels

Uninterrupted movement of heavy and light vehicles at high speeds will give rise to increase in ambient noise levels along the roadway. It may have negative environmental impacts on the sensitive receptors located within the zone of influence. In order to estimate the noise impacts with respect to existing situations, noise monitoring was undertaken at various locations near the proposed alignment in the different zones. It was observed that the daytime and nighttime equivalent noise levels were above the prescribed permissible limits most of time in these places.

The impact of noise levels from the proposed expressway on the neighboring communities is addressed by carrying out computations using *Highway Noise Model* developed based on the guidelines suggested by Federal Highway Administration (FHWA). The details of the model and the model computations are described below.

Noise Modeling

Details of Noise Model

The Sound Pressure Level (SPL) generated by noise sources decreases with increasing distance from the source due to wave divergence. An additional decrease in SPL with distance from the source is expected due to atmospheric effect or its interaction with objects in the transmission path.

Estimating highway/expressway noise impact involves complex process, which will require a large computer analysis to model in detail. However, the methodology presented below is a general highway noise model that predicts the equivalent noise level (L_{eq}) and is adequate for most noise assessment requirements. The advantage of the model that predicts L_{eq} is that L_{eq} is the *"Energy Average"* noise level and as such is not dependent on the statistics of the traffic flow. Further, the model presented below can be applied equally well to high and low traffic volume roadways.

The Highway Noise Model presented below is for calculating the one hour L_{eq}. The model is based upon calculating the hourly L_{eq} for vehicle types separately and then adding these logarithmically to obtain the overall hourly L_{eq} as follows:

- Traffic Volumes and Speed

To obtain the hourly traffic for the years 2006, 2016, and 2026 for various vehicles, the average daily traffic for each category of vehicles was distributed in to 24 hours based

on the hourly traffic distribution obtained during the traffic counts in 1999. Then, the ratio factors of hourly traffic to average daily traffic for each categories of vehicles obtained for the year 1999 have been used for the years 2006, 2016, and 2026 to estimate the corresponding projected hourly traffic of the respective vehicle types by considering the average traffic in the respective years. Cars and LCVs are grouped together under the same reference noise level.

- Estimation of Alpha Shielding Factor

In this study Alpha value of 0.0 and Shielding factor values of 0.0 are considered for the projected years for safety estimation.

- Simulation results

The noise levels predicted up to a distance of 500 m from the centreline of the road for the years 1999, 2006, 2016, and 2026 for 'Without and With' project scenario have been worked out with respect to the distance from the centreline of the road. The L_{eq} noise levels at various distances for each type of vehicle were computed on hourly basis. And the cumulative L_{eq} noise levels for day (6 am to 9 pm: L_{day}) and night time (9 pm to 6 am: L_{night}) were obtained and are given in Figure-13.3.13 to Figure-13.3.18.

The predicted noise levels at the some of the residential areas near to the proposed expressway are presented below in Table-13.3.3.

Table-13.3.3: Predicted Ambient Noise Level at Residential Area - dB(A) (Year 2016)

No.	Areas Along	Approx. Distance from Centreline (m)	Resultant Level	
	Expressway		L_{day}	L_{night}
1.	Badh Khalsa	200	68	67
2.	Bhikanpur	200	68	68
3.	Nandgram	500	65	65

The background ambient day noise limit of 55 dB(A) and the night time noise limit of 45 dB(A) is exceeding in most of the places for residential zone. The noise levels in the adjoining state and national highways is likely to decrease by about 2 dB(A) due to proposed expressway. In case of places near to the proposed expressway, there is very less increase in daytime noise levels as the background level are already high, but in case

of night time, there is significant increase in noise levels up to about 15 dB(A) at a distance of about 200 m from expressway (Badh Khalsa) and about 4 dB(A) in case of Nandgram which is at a distance of about 500 m.

The model results reveal that both L_{day} and L_{night} levels are observed to be exceeding the standard prescribed for residential zone in both the scenarios. It may be mentioned that modeling has been done without considering the attenuation factors which would decrease the noise levels by about 5 dB(A).

Noise levels recorded at monitoring exceed the L_{day} and L_{night} standards in most of the cases. Considering high background levels, the resultant noise levels with or without the project are expected to be higher than the standards. Since most of the villages along the highway are not situated within a reach of about 500 m from the proposed expressway, the impact due to proposed project is not expected to be high.

There will be an approximate increase of noise levels by 4 dB(A) during night time which can be reduced by taking proper mitigation measures.

The computations carried out gives an indication of noise levels in an worst case scenario, i.e. without taking into consideration the local features like landuse, barriers, attenuation ,etc. However, in reality, the noise levels are expected to be on lower side due to these considerations. Moreover the noise levels monitored in the villages *viz.*, during day and night were high. This is mainly due to local activities and high background levels.

The main source of vibration is caused by construction equipment and vehicles during construction phase and plying of vehicles during operation phase. The nearby buildings is likely to be affected if the intensity of vibration is high. Since the movements of vehicles and construction equipment will be away from settlements, the impact is likely to be insignificant. Also the vibrations produced by these sources are not expected to be high. Since there are no environmental standards for vibrations generated during construction and operation of expressway, hence, detailed studies have not been done.

Figure 13.3.13(A1): Noise Level at NH-58 During Daytime

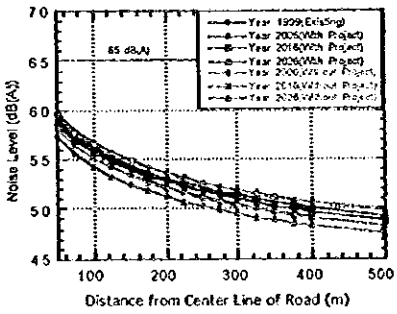


Figure 13.3.13(A2): Noise Level at NH-58 During Nighttime

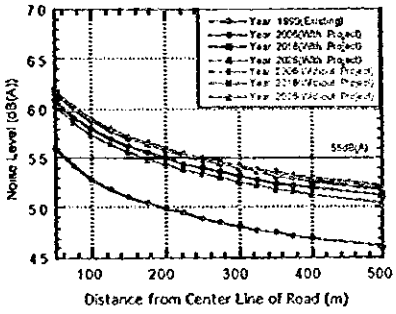


Figure 13.3.14(A1): Noise Level at SH-57 During Daytime

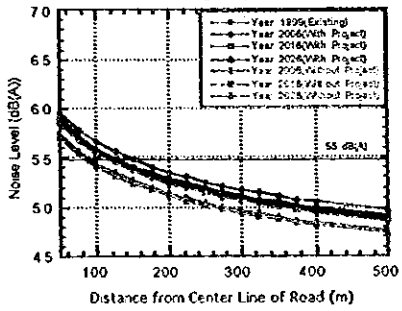


Figure 13.3.14(A2): Noise Level at SH-57 During Nighttime

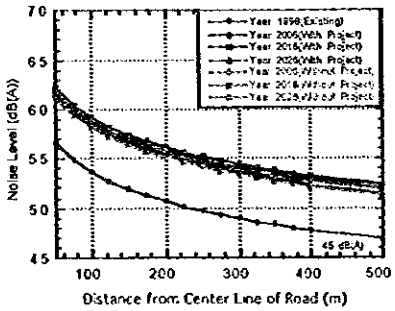


Figure 13.3.15(A1): Noise Level at SH-14 During Daytime

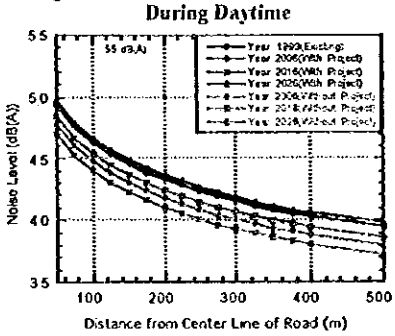


Figure 13.3.15(A2): Noise Level at SH-14 During Nighttime

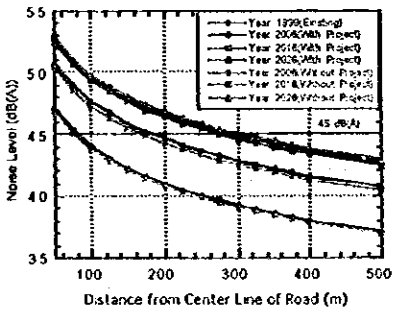


Figure 13.3.16(A1): Noise Level at Ghaziabad IC - Ghaziabad JCT During Daytime

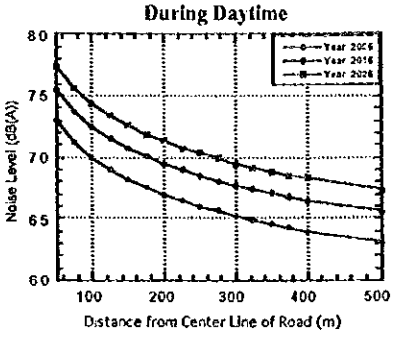


Figure 13.3.16(A2): Noise Level at Ghaziabad IC - Ghaziabad JCT During Nighttime

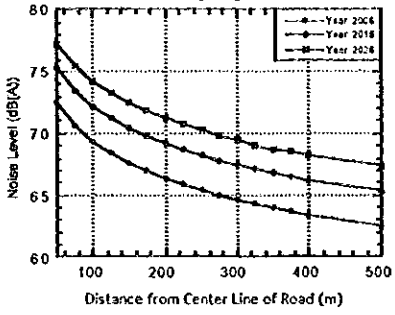


Figure 13.3.17(A1): Noise Level at Ghaziabad JCT - Modinagar During Daytime

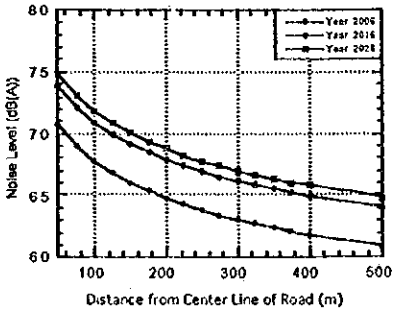


Figure 13.3.17(A2): Noise Level at Ghaziabad IC - Modinagar During Nighttime

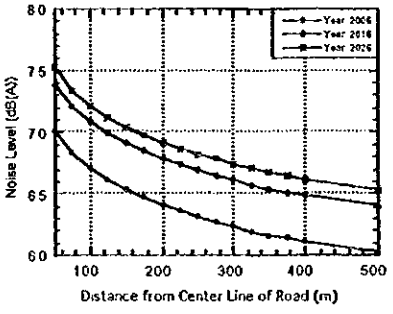


Figure 13.3.18(A1): Noise Level at Ghaziabad JCT - Khekra During Daytime

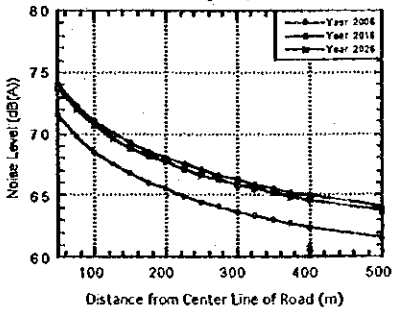
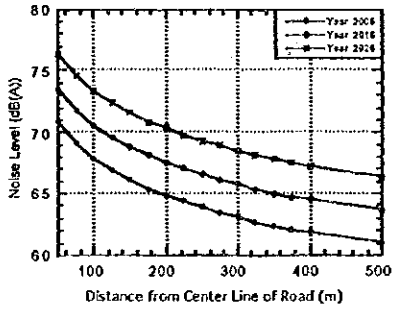


Figure 13.3.18(A2): Noise Level at Ghaziabad IC - Khekra During Nighttime



7.3.3 Impacts on other environmental parameters

(1) Impact on Water Quality

- Surface Water Quality

All tested parameters are found well within the permissible limits as per IS:2296 and thereby indicating the good quality of surface water at all sampling locations.

The construction and operation of the proposed highway project will not have any major impact on the surface and ground water quality in the area. Contamination to water bodies may result due to spilling of construction materials, oil, grease, fuel, and paint in the equipment yards and asphalt plants. But, the quantities of such spills are very negligible.

However, cares need to be taken to provide adequate sanitary facilities and drainage in the temporary colonies of the construction workers. Provision of adequate washing and toilet facilities with septic tanks and appropriate refuse collection and disposal system should be made obligatory.

An adequate foresight and creation of physical facilities will minimise the above problems. This should form an integral component in the planning stage before commencement of construction activity.

- Ground Water Quality

Ground water pollution can take place only, if a dump containing chemical substances get leached by precipitation of water and percolate to the ground water table. This is not the case with the present project as the activity does not contain any harmful substances which could leach down to water table. Hence impact on the ground water quality is not anticipated from the project during the construction and operation phase.

(2) Impact on Ecological Resources

There is no wildlife sanctuary in the close vicinity of the proposed expressway. The study area hosts small patches of reserved forest that mainly consists of few scrubs and trees. There are few endangered species in the study area. The ecological impacts are briefly described in the following sections.

- Terrestrial Ecology

The initial construction works at the project site involving land clearance, cutting, filling, and leveling may cause loss of potential agricultural productive land and loss of vegetation. The ROW requirements involve reserved/protected forest land and therefore project impacts in the form of loss of forest do exist for which detailed compensatory afforestation plan is required from project proponent. The total number of trees that will

be cleared along the alignment need to be identified and afforestation plan has to be given subsequently.

Inevitably, there will be a short-term impact on availability of nesting sites for the birds. However, since the area harbors mainly local grainivourous avian fauna, this should not affect their nesting requirements. There is no sensitive ecological area near the proposed expressway, so the impact will not be of significance. With the landscaping after the project, the number of trees are expected to be more than earlier numbers and will allow the short term impact to be reversed.

The removal of herbaceous vegetation from the soil and loosening of the top soil generally causes soil erosion. However, such impacts would be primarily confined to the project site during initial periods of the construction phase and would be minimised through adoption of mitigative measures like paving and surface treatment, water sprinkling, and appropriate plantation program. The project site will be landscaped with the development of green belt consisting of a variety of local trees that would enrich the ecology of the area and add to the aesthetics.

- Wild Life

Few endangered species have been reported from the area covered by the proposed alignment. No wild life travel routes of significance have been noted/recorded along the alignment. The wild life in the area do not confer any significant benefit on the local population.

The increased vehicular traffic coupled with higher noise levels due to various constructional activities may drive away the local fauna from the project site to the neighbouring area. As the project is devoid of forest and trees, it does not harbor any fauna of importance. Therefore, the impact of construction and operation activities on fauna will be insignificant.

- Aquatic Ecology

The proposed road would pass over two rivers *viz.* Hindon and Yamuna. River overbridges are planned over these rivers. No significant impacts on aquatic ecology of the area are perceived due to the construction of these bridges.

(3) Impact on Human Use Values

- Soils

The impact on soil due to this project is in terms of top soil erosion. Considerable care should be taken while locating the camps, borrow pits, quarries yards, spoil and disposal site which will minimise the soil erosion. The impact of construction would be minor as

the area that is susceptible to excessive soil erosion is very small. Soil pollution would take place to a negligible extent due to spillage of construction material, oil, fuel, grease, and asphalt around the construction yards.

- Land Use Development

The development in the project area will definitely bring substantial changes in the landuse pattern. In this process, areas presently under agriculture and vegetal cover will be diverted for development and other usage. The acquisition of less fertile fallow lands and its conversion for different developments is expected to lead to enriched land uses which include construction of residential area, offices, and other infrastructural facilities and these activities may occur in the immediate vicinity of the proposed project area.

The proposed project includes landscaping tree plantation all along the road alignment that will add to the quality of life and aesthetics of the area. Diversion of road sections away from the inhabited areas in major enroute towns and villages will also lead to the improvement of air quality and noise levels.

Another important factor could be the degradation of the borrow areas outside the construction zone if it left unattended after the construction. These borrow areas need to be reclaimed by filling up/levelling the trenches and development of greenbelt over them.

- Land Acquisition and Transformation

The extent of area for land acquisition for the proposed project has been identified and does not involve any sensitive archeological monuments etc. The total area that are to be acquired are 916 ha of which 572 ha, 186 ha, and 158 ha are village area land, agricultural area, and vacant land, respectively. The villages that are likely to get affected are Bhikanpur, Badh Khalsa, and Manauli. Apart from that, brick kilns, orchards, temple and, schools are also to be relocated. The social impacts of land acquisition and adequate mitigation measures have been discussed in the Social Assessment report (JICA Study Team, 1999).

Construction of Roads and Bridges

This activity involves construction of the main expressway road, river overbridges, approach roads, and other supporting structures. This activity involves use of bulldozers, road rollers, water tankers etc. This activity is machinery intensive resulting in noise and dust generation. However, this activity will be a short-term effect. Protective measures should be undertaken during the construction phase.

The construction activity can provide ample employment opportunities for the residents of the nearby villages. The construction of proposed expressway would also promote

business avenues for the local people, better transportation facilities, and development of industrialization in the area.

- Construction of Site and Camp Buildings

This activity involves construction of buildings for site offices, construction camps, and habitation during the construction period.

This may result in clearing of vegetation and pose sanitary and health problems in the construction camps. Due care should be taken to maintain hygienic conditions at the sites.

(4) Other Issues

- Transport of Hazardous Material

After the implementation of the proposed road, increase in traffic is envisaged due to development of industries and other allied activities in the close vicinity. On the other side, congestion problems and probability of accidents will reduce considerably due to the better design service level.

The spillage materials on the road near the rivers/canals may cause loss of life, property and also adverse water quality impacts, if the materials find their way into surface or/and ground water bodies. Transport of the hazardous materials by road is regulated by Motor Vehicle Act 1989, which provides precautions to be followed by the consignor, owner of the goods carrier and its driver to minimise the risk of accidents and do the damage control in the event of mishap. As a precautionary measure, the nearest fire brigade stations should be upgraded adequately to handle the emergencies arising from accidents involving spillage of hazardous materials.

- Issues Related to Proposed Alignment

The proposed alignments have been recommended to minimise the social and environmental impacts by ruling out other options which would have otherwise resulted in the relocation of families, permanent and temporary structures and business, trees, place of worship and encroachment of surface water bodies.

- Natural Disaster

The study area lies in Zone-IV having basic horizontal seismic coefficient of 0.05. In the event of earthquake there will be considerable damage to poorly built structure in most of the villages in study area. There is also likelihood of many wells getting dried and recharge in other wells. It is normally recommended that masonry and plain concrete bridges of span more than 10 m should not be built in the area.

- Severance Issues

There are few utilities like telephone and electric poles that need to be relocated.

- Cross Drainage Works

The proposed project envisages construction of culverts and bridges across drains/rivers. Hence impact of cross drainage works is not considered to be of significance.

13.3.4 Summary of the Environmental Impact by the Project

The potential impacts of typical highway/expressway projects were given in Table 13.3.1. Table 13.3.4 summarise the impacts specific to this project considering the present environmental setting.

Table 13.3.4 Potential Environmental Impacts by the Proposed Expressway Project.

Environmental Parameters	Construction Phase	Operation Phase
Air quality	• Site clearance • Construction activities • Material transportation • Quarrying and Borrowing	• Vehicular traffic movement
Noise	• Site clearance • Construction activities • Material transportation • Quarrying and Borrowing	• Vehicular traffic movement
Vibration	• Site clearance • Construction activities • Material transportation • Quarrying and Borrowing	
Water quality	• Site clearance • Construction activities • Quarrying and Borrowing	
Ecology	• Site clearance • Construction activities • Quarrying and Borrowing	
Socio-economic	• Site clearance	

13.4 Environmental Management Plan

13.4.1 During Construction Phase

(1) Air Quality

Since the background concentrations of SPM are already exceeding the standard at some places violations in concentrations of SPM are expected during construction phase due to dust generation by plying of vehicles on unpaved haul roads.

Mitigation Measures

Mitigation Measures for Mobile Source Emissions:

- In order to curb the increased fugitive dust emissions in the area due to vehicular movement and raw material transport, sprinkling of water on all roads that do not have tar coating and dust covering of the material being transported by truck should be conducted;
- Idling of delivery trucks or other equipment should not be permitted while they are being unloaded or not in active use; and
- Low emission (diesel) construction vehicles and generators should be used whenever possible.

Mitigation Measures for Fixed Source Emissions:

- Air pollutants from the construction yards are expected to have some influence up to 1 km distance on the downwind side under adverse meteorological conditions. Therefore, it is desirable that construction yard is not located within 1 km of major villages;
- Within the construction yard the stationary equipment should be located as far as practicable from receptor locations in order to allow dispersion of emitted pollutants;
- Areas prone to fugitive dust emissions (such as demolition, excavation and grading sites) should be stabilized by using water;
- Proper care should be taken for storage of furnace oil, LDO etc.; and
- As soon as construction is over the surplus earth should be utilized to fill up low lands.

(2) Noise Levels

The prime sources of noise levels during the construction phase are the construction machinery and the vehicular noise due. Though the effect of noise would be insignificant

during daytime, the residential areas located in the near vicinity of the construction site may experience increase in the nighttime ambient noise levels.

Mitigation Measures

- Construction contracts should specify that the construction equipment should meet the noise and air emission levels as per EPA Rules, 1986.
- The siting of construction yards should be done leaving at least 1 km from major residential areas or sensitive receptors in order to attenuate noise level.
- The main stationary noise producing sources such as generators should be provided with noise shields around them.
- For protection of construction workers, earplugs should be provided to those working very close to the noise generating machinery.

(3) Water Quality

The proposed project will not alter the existing water quality on a permanent basis, but during the construction phase the extent of surface runoff and silt load may increase to give rise to a negative impact on receiving natural water bodies.

Mitigation Measures

- Runoffs from the construction site should be passed through silt traps, as required depending on the local topography.

(4) Sanitation at Workers Colony

Sewage and the domestic solid waste generated at the construction workers colony would have a negative impact on the aesthetics and environments of the surrounding area, if not treated in an appropriate manner.

Mitigation Measures

- The worker's camp must not be located within 1 km of the villages.
- The construction workers should be allotted a specified area of land on which the workers temporary colony should be built. Adequate sanitary facilities, drainage, washing and toilet facilities with septic tanks and garbage collection and disposal should be provided to the workers.

(5) Removal of Trees and Landscaping

Trees might be cut during the construction phase.

Mitigation Measures

- Landscaping should be done with a lag of few months from the start of the work on any section;
- Plant species suitable for the area like Eucalyptus, Acacia, Neem, Sirsa, Arjun, and Shisham should be planted at the onset of monsoon season.

13.4.2 During Operation Phase

(1) Air Quality

As the traffic increases, the ambient air quality levels will also change marginally. However, after the project implementation the ambient air quality levels in future years will be better with respect to without project scenario. The effect will be more pronounced during winter season when nighttime ground level inversion is observed in the area.

Mitigation Measures

- Use of fuel efficient engines, introduction of catalytic converters for petrol vehicles, and use of smoke traps for diesel vehicles could be effective;
- It should be made compulsory for all vehicles to adhere to the engine maintenance schedules and CPCB standards to reduce air pollution due to vehicular emissions;
- Along the expressway plantation of trees such as Eucalyptus, Acacia, Neem, Sirsa, Arjun, and Shisham that have known properties to absorb HC is recommended; and
- Future development along the road should follow correct land use norms so that sensitive receptors are not located along the road.

(2) Noise Levels

During the operation stage, there would be an increase in the ambient noise levels near the expressway due to continuous traffic movement. However, due to larger distance of expressway from the villages, there will very less population within the impacted zone.

Mitigation Measures

- Development of greenbelt along the main road can bring a considerable reduction in noise levels;
- Use of air horns should be minimized on the expressway during nighttime. During daytime use of horns should be restricted at sensitive locations; and

- Future development along the road should follow correct land use norms so that sensitive receptors are not located along the road.

13.4.3 Summary of Environmental Management Plan

Table-7.4.1 presents a summary of the Environmental Management Plan with the objective to minimize the negative environmental impacts of the project in the region. The table includes possible environmental issues and the necessary mitigative measures for the same.

13.4.4 Public information and consultation

The main purpose of these exercises is to know the people's reaction to the perceived impact of proposed project on the people at individual and settlement level. Visits should be made to know the villages and key persons in the villages. The meeting with key residents, opinion leaders of the villages, and local NGO's who are prominent, good, genuine, and committed to the task assigned should be organized.

Follow-up public information and consultation should be undertaken before mobilizing the project construction in the confidence presence of prominent NGO's.

13.4.5 Risk Assessment

The proposed project road will lead to continued and increased transportation of hazardous substances, even if they are expected to follow the Environmental Regulations regarding storage, handling, and transport, it is necessary to provide for some back-up facilities in the event of accidents. It is recommended that the following facilities be provided as a part of the project:

i. Ambulance stationed at the tollbooth;
ii. Tow truck for removing damaged vehicles;
iii. Communication facilities at each (and in between) end; and
iv. Access to local-fire fighting facilities (district).

13.4.6 Budgetary Cost Estimates for Environment Protection

The mitigation measures suggested in Table-13.4.1 and requires monitoring of ambient air quality, noise levels, provision of sanitation facilities, and landscaping along the proposed expressway. The cost estimates presented in this section (Table-13.4.2) are for the mitigation measures brought out in Table-13.4.1. These cost estimates give only an indication of likely cost (these will be confirmed before finalization/implementation phases).

Table-13.4.1: Environmental Management Plan

Kundli-Ghaziabad-Meerut Expressway

No.	Environmental Issues	Actions to be Taken
Construction Phase (Year 2002 – 2005)		
1.	Dust contamination at site and on haul roads	Construction sites and access roads passing through residential and commercial areas and unpaved haul roads to be watered twice each day.
2.	Air pollution	24 hourly monitoring at a frequency of two days a week during winter season in residential areas.
3.	Noise pollution	Provision of earplugs to heavy machinery operators. Construction of 3 m tall enclosures around generators when construction yards are within 100 m of residential areas.
4.	Disposal of construction debris	Daily inspection of the haul roads and sites for construction debris, and its collection and disposal to landfill sites.
5.	Transportation	All hauled material to be covered while being transported. Construction related transportation activity to be uniformly distributed during the night to minimize noise impacts. Routine check of vehicles used for transportation and their proper maintenance to minimize vehicular pollution.
6.	Domestic sewage and solid waste at workers colony	Provision of water supply and washing facilities. Provision of waste disposal facilities like septic tanks at the construction worker's colony. Provision of garbage cans at site and in worker's colony for collection of domestic garbage. Provision for composting of domestic garbage at construction workers colony.
7.	Removal of trees and landscaping	Landscaping plan to be asked with schedule of construction from contractor, it should be implemented concurrent to the road construction with a lag of few months.
8.	Resettlement	Advanced notification of enough time must be given to enable the relocatees to find a suitable place. Advance realistic payment should be available in some form for the relocatees to secure a new unit.
Operation Phase (Year 2006 onwards)		
1.	Air pollution	Provision of ambient air quality monitoring near the downwind direction of the expressway. Development of wide green belt all along the alignment.
2.	Noise pollution	Minimization of use of horns near sensitive locations and during nighttime with the help of signboards in proper positions.

TABLE-13.4.2: BUDGETARY COST ESTIMATES FOR ENVIRONMENT PROTECTION FOR EACH SECTION

No.	Item Particulars	Assumptions	Cost (Rs.)	Responsible Agency
Initial Investment (Fixed Cost)				
1.	Provision of domestic sewage and solid waste disposal at worker's colony	Lump sum	500,000	IA
2.	Landscaping	Initial cost of plantation @Rs.600,000/km x 40km	24,000,000	IA
Total Initial cost			**24,500,000**	
No.	**Item Particulars**	**Assumptions**	**Annual Cost (Rs.)**	**Responsible Agency**
Operational Cost (Variable Cost)				
1.	Dust suppression at the site and on haul roads	Rs. 500/trip x 10 trips/day x 340 days	1,700,000	IA
2.	Air pollution monitoring	Rs. 200,000/season x 4 seasons for fugitive sources (construction yard/nearby 2-3 villages)	800,000	MA through IA
3.	Noise monitoring	Fortnightly monitoring at 5 locations on hourly basis for 24 hour period	500,000	MA through IA
4.	Landscaping (annual maintenance)	Curbing, addition of manure including manure cost and gardeners @ Rs. 15,000/km x 40 x12 + cost of water @ Rs. 6,000/km-month x 40 km x 12	10,080,000	IA
Total annual operation cost			**13,080,000**	

IA: Implementing Agency
MA: Monitoring Agency

13.5 Land Acquisition and Resettlement

13.5.1 Issues and Problems in Land Acquisition

A large scale of land acquisition requires a lot of relocation and resettlement of the people who have lived historically in the locations. The acquiring process may create various impacts to the society, and it can sometimes be a problem in the region. These impacts are such as loss of assets including lands and houses, loss of livelihood or income opportunities, and loss of common property resources of social groups.

The loss of assets are to be covered by compensation. The Land Acquisition Act, 1894 refers to compensation for loss of assets. A recurrent flow in the policies of the Act is that compensation is available to individuals who lose land, housing or other property eligible for compensation. However, existing records of land transactions and other official documents pertaining to the value of various assets are generally not reliable as an indicator of the real value.

One of the problems in the experience in India is that the policies deal with only individual owners of the lands. The loss of land, however, will have a different impact on people belonging to different ethnic and economic groups. In the event of resettlement, certain groups suffer more than others because of the difficulties they face in gaining an access to alternative sources of livelihood. The landowners will be covered by legal compensation. However, those who have no titles but depend on the land for their livelihood, tenants or sharecroppers have no rights and are often pushed aside. The current laws and regulations do not fully recognize the historically established rights of the minority people to their livelihood including access to land, natural resources and knowledge. Indigenous people, ethnic minorities and other vulnerable groups of people that may have informal customary rights to the land or other resources taken for the project should also be provided with adequate forms of compensation. The absence of a formal legal title to the land should not be grounds for denying compensation and rehabilitation.

Women in society particularly face specific difficulties in re-establishing and earning a living in the new area after resettlement The current rehabilitation and resettlement policies do not consider women separately. The policy on land acquisition should address specifically the gender questions and enunciate the rights of women to treat the resettlement as an opportunity, a mandate for raising standard of living, restoring community and their relations, and minimizing conflict with the host community.

2.3 Mitigation Measures

2.3.1 Measures for Compensation

The Indian Land Acquisition Act stipulates that additional compensation known as solatium is to be paid on top of the registered value of land and other assets, in recognition of the involuntary nature of the acquisition. However, it may still be insufficient to reach real replacement cost, or it may overvalue assets unnecessarily. The project, therefore, should objectively establish the real replacement cost of assets. This should be done through conducting a detailed Land Market Value Survey at the time of final engineering design, and through compiling and comparing other available sources of information.

Experience shows that cash compensation carries a high risk in certain situations. It is normally inadequate in helping poor and vulnerable groups to re-establish their lost assets, particularly in the case of productive land, whereas more resourceful people may prefer cash compensation which in their cases does not entail a risk. The project, therefore, should provide an option of compensation in kind as well as other support mechanisms to those deemed as vulnerable or at risk. Replacement of land of equal or better productive value will have to be offered as an option to those losing substantial amounts of land (i.e. 25 % of their holdings or more), or where loss of land threatens the economic viability of the household.

2.3.2 Measures for Loss of Housing

People who will lose their home represent a particular challenge in the resettlement program. Every effort should be made by the project to ensure that new housing facilities are available before these people are required to relocate. If resettlement sites are developed as part of the project, which might be an option depending on the upcoming circumstances, the local "host population" should be consulted about their views and needs, and an appropriate support should be given to reduce any negative impact caused by an influx of the new people.

The resettlement policy should recognize the social and psychological trauma caused by the resettlement, and develop methods to compensate and relieve the distress. Wherever possible, the resettlement should be performed as a social unit---village or hamlet as a whole in an area that is comparable to their original social, cultural and ecological settings.

2.3.3 Measures for Loss of Livelihood or Income Opportunities

When resettlement causes loss of livelihood or income opportunities either temporarily or permanently, an assistance should be given to the affected people to re-establish their livelihood and income. The unit of entitlement eligible for support in such cases will be individuals of both men and women. All members of the affected households should be eligible for support.

If the project impact leads some people to an unable condition to continue with their previous occupation, the project should provide support and assistance through alternative employment strategies. This will be particularly the case for brick kilns and orchards to be acquired in this project. The affected people should be given a priority to employment opportunities created by the project, such as work with construction or operation and maintenance.

2.3.4 Measures for Losses to Vulnerable Groups

Through census, surveys and other studies, the project should determine who may be considered as vulnerable or at risk among the affected population, or who are likely to be excluded from the normal benefits of growth and development. Vulnerable groups should be able to receive targeted support and special attention from the project, and should be provided with more options and support mechanisms than those not considered vulnerable. These groups should be counseled so they are able to make informed choices among the provided options. The project should analyze each of the options and support mechanisms, and explain benefits and potential risks to the affected groups. By allowing those people to choose among different options, the project should seek an active participation in the development process so as to achieve greater acceptance of the resettlement efforts.

A social assessment should be undertaken for the project to support the participation and to realize the social factors affecting the development impacts and results. The assessment will identify stakeholders and key social issues, and formulate a participation and consultation strategy. It will specifically address the issue of how vulnerable groups may benefit from the project. The project should also establish a continuous monitoring and evaluation of the resettlement by an independent agency.

CHAPTER 14:

CONCLUSIONS AND RECOMMENDATIONS

14.1 Conclusions

14.1.1 Necessity of the Project

Kundli - Ghaziabad Expressway will form a part of circumferential expressway network outside of Delhi, and Ghaziabad - Meerut Expressway will form a radial expressway network to connect Meerut with the circumferential expressway. These routes will constitute part of "NCR Expressway Network" in the National Capital Region. These two expressway routes are expected to play the following important roles:

- To improve and strengthen the arterial road network in the NCR region to cope with the rapid increase in vehicle traffic demand and regional development which will support the balanced future transport network in the NCR;
- To solve traffic congestion on national/state highways in the northeastern part of the NCR which could become a major problem in the near future; and
- To contribute to sustained development of the NCR by contributing to the formulation of the full circumferential expressway network around Delhi.

14.1.2 Future Traffic Demand

The present traffic between Delhi and Ghaziabad shows the highest volumes in Delhi area. The result of the traffic counts shows NH24 and its bypass carries 85,000 vehicles/day. NH58 between Ghaziabad and Modinagar carries 21,000 vehicles/day.

The analysis of the socio-economic framework predicts that the NCR population in 2011 and 2021 will be 1.43 times and 1.71 times the 1999 population respectively, and the NCR economic growth in 2011 and 2021 will be 1.79 times and 2.87 times that of 1999. The total vehicular traffic demand will grow accordingly.

Under such circumstances, it is obvious that the existing national/state highways cannot efficiently accommodate the expected travel demand of the area without the projected expressway network.

Future traffic volume on K-G Expressway is forecast at 53,000 - 67,000 pcu/day in 2016 and 98,000 - 113,000 pcu/day in 2026, whereas that of G-M Expressway is forecast at 40,000 - 50,000 pcu/day in 2016 and 75,000 - 101,000 pcu/day in 2026.

14.1.3 Technical Aspects

(1) Route

A total of nine alternative route combinations was established, and these were examined from engineering and economic viewpoints. As a result of the comparison, it was concluded that a combination of Alternative 1 for K-G Expressway and Alternative 1-1 for G-M Expressway is superior to the other alternative combinations in all aspects of engineering, environmental impacts, regional development, and economic feasibility.

The total route length of K-G Expressway (Kundli IC - Ghaziabad IC) is 49.00 km, and G-M Expressway (Ghaziabad North Junction - Meerut IC) is 39.55 km.

(2) Major Design Features

a) 120 km/hr design speed was applied for entire expressway sections.

b) Based on the traffic demand forecast, initial 4-lane/ultimate 6 lane stage construction was applied for Kundli - Junction and Junction - Meerut sections. Initial 6-lane/ultimate 8 lane stage construction was applied for the common section (Ghaziabad - Junction).

c) A distance-based toll levy system was recommended for the expressways. Five interchanges, Kundli IC, Khekra IC, Meerut IC, Modinagar IC and Ghaziabad IC will be provided as either double trumpet or single trumpet type.

d) A throughway toll plaza will be provided at the north of Ghaziabad IC if Ghaziabad IC adopts the original partial cloverleaf type as in the FNG Feasibility Study. The toll plaza will not be necessary if Ghaziabad IC adopts the trumpet type as recommended in this study.

e) The total length of bridge and viaduct is 1.54 km taking up 1.9 % of the total length of the expressways. Precast PC I girders were recommended as the

general superstructure type because of the economy and ease of construction.

f) Most of the earth work section is embankment. Total volume of embankment with borrow material is estimated to be 12 million m^3.

g) Flexible pavement was recommended with a view to lower initial investment cost, which contributes to lower life cycle cost than rigid pavement.

14.1.4 Environmental Aspects

In the process of optimum route selection, a maximum attention was paid to minimize adverse environmental impacts, in particular, such social impacts as displacement of residents.

Environmental Impact Assessment was carried out to identify possible adverse impacts and examine their mitigation measures, and suggested that most of the possible adverse impacts can be mitigated if the design is carefully prepared and proper construction methods are taken. The most significant environmental problems will be displacement of residents and farms in the pre-construction phase, and noise/vibration/air quality impacts in the operation phase. Displaced families should be sufficiently compensated or resettled to suitable areas. Farms and factories acquired for the right of way should be sufficiently compensated. Noise/vibration/air quality problems are related to various factors, some of which can be mitigated by careful design for the roadside, and suitable construction metods. It is necessary to promote fundamental condition surveys and to establish a monitoring system for these problems.

14.1.5 Project Cost

The project cost (initial project cost) is Rp.11,349 million in 1999 prices as shown below:

Summary of Initial Project Cost

(Rs. million)

Construction Cost	7,323
Land Acquisition & Compensation Cost	1,649
Engineering Cost	897
Administration Cost	449
Contingency	1,031
Total	11,349

14.1.6 Results of Economic Analysis

The economic analysis was carried out by the conventional discounted cash flow method in determining the EIRR. The economic benefits quantified were the savings in vehicle operating cost, time costs and accident costs. The results indicated that the project is highly feasible from economic viewpoints.

	Length	EIRR
K- G and G-M	80.75 km	26.37 %
K-G Only	49.00 km	27.05 %
G-M Only	39.75 km	25.30 %

The sensitivity test shows that even the most severe case of -20 % benefit and +20 % cost still maintains an EIRR of 21.20 %.

14.1.7 Results of Financial Analysis and Implementation Study

The financial analysis was carried out by performing case studies for setting possible financial structures for the project. The pre-tax FIRR for K-G and G-M Expressways in constant price basis is 10.4 % which is much lower than acceptable commercial project implementation level. The result shows that 100 % private sector concessionaire approach cannot meet long-term debt-service during the first 5 operational years even with 100 % off-shore financing which could substantially reduce the financial cost than domestic financing.

The possible implementation scheme would be private or public sector dominated PPP approach, which should be able to reduce the project cost by risk sharing between private and public sectors, such as treating the land acquisition and compensation cost as "sunk" cost, or introducing ODA financing mechanism with some forms of government guarantee.

14.2 Recommendations

14.2.1 Implementation of the Project

The results of the Study indicate that the Projects are technically sound (no serious technical difficulty is anticipated for construction) and economically highly feasible. Taking into account the direct and enormous indirect benefits towards regional development other than the quantified savings in travel costs, the Projects should be implemented at the earliest opportunity.

However, when the estimated constant pre-tax FIRR is compared with the prevailing interest rates and financial environments in India or even with possible off-shore financing opportunities, the financial viability of the Projects is not satisfactory. It is necessary to consider the following measures and strategies toward implementation.

Recourse/Non-recourse Financing: A recourse financing approach would strengthen the confidence of private investors and considerably reduce the private sector risk. If recourse financing is not possible, however, the GOI/NCRPB should consider positively guaranteeing returns for financing institutions and private equity investors.

Equity Structure: If a public sector dominated PPP is established first, the shareholders of the Central and State Governments as well as NCRPB have to invest in the equity without expecting a high ROE to ensure a reasonable ROE to the private equity holders. In the case of private sector dominated PPP, the GOI/NCRPB may also need to assume measures to safeguard the ROE for the private investors

Debt Structure: India's financial market offers long-term funds at around 16 % interest for up to 10 to 12 years. This is an expensive money at an implied 8 % real interest rate. The GOI/NCRPB should consider obtaining ODA funds from international funding institutions. This would involve a sovereign guarantee to the lender and an assumption of exchange rate risk. It would however give a positive impact on private sector confidence and ease the burden on the Project's cash flow.

Toll Rate: The recommended toll rate of Rs.1.5/pcu-km should not exceed user benefits. However, the GOI/NCRPB should consider allowing periodic toll increase, perhaps in line with real per capita income increase, which would keep constant the toll impedance to expressway users in the real price.

14.2.2 Issues for Further Consideration

(1) Making A Success Story

It is seriously important to create a "success story" at the early stage of private sector led development. The GOI/NCRPB should do everything necessary to realize a success.

(2) Master Plan Formulation

The NCR needs an integrated transport sector master plan to establish an appropriate future modal share and network plan based on reliable traffic data. It is recommended that such study be performed as soon as possible.

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