METRO - LINK EXPRESS FOR GANDHINAGAR AND AHMEDABAD
(A Government of Gujarat Undertaking)

METRO-LINK EXPRESS FOR GANDHINAGAR AND AHMEDABAD (MEGA) COMPANY LIMITED

ENVIRONMENTAL IMPACT ASSESSMENT STUDY FOR AHMEDABAD METRO RAIL PROJECT (PHASE-1)

DRAFT REPORT

OCTOBER 2014

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CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDIXES

ABBREVIATIONS AND ACRONYMS

AMC	:	Ahmedabad Municipal Corporation
BIS	:	Bureau of Indian Standards
BOD	:	Biochemical Oxygen Demand
CO	:	Carbon Mono Oxides
COD	:	Chemical Oxygen Demand
CPCB	:	Central Pollution Control Board
CTE	:	Consent to Establish
cum	:	Cubic Meter
dB	:	Decibel
^{o}C	:	Degree Centigrade
DMRC	:	Delhi Metro Rail Corporation
DPR	:	Detail Project Report
EIA	:	Environmental Impact Assessment
EMP	:	Environmental Management Plan
EPA	:	Environmental Protection Agency
ETP	:	Effluent Treatment Plant
GIS	:	Geographical Information System
gm	:	Grams
Ha	:	Hectare
HC	:	Hydro Carbon
Hz	:	Hertz
IMD	:	India Meteorological Department
IS	:	Indian Standards
JICA	:	Japan International Cooperation Agency
Kg	:	Kilogram
KLD	:	Kilo Liter per Day
km	:	Kilo Meter
km/h, Kmph	:	Kilo Meter per Hour
KV	:	Kilo Volt
KWh	:	Kilo Watt Hour
m	:	Meter
mg	:	Milligram
mg/l	:	Milligram per Liter
mm	:	Millimeter
mm/s	:	Millimeter per Second
μm^3	:	Micro Cubic Meter
MoEF	:	Ministry of Environment and Forest
MRTS	:	Mass Rapid Transit System
MSL	:	Mean Sea Level
MT	:	Metric Ton
NATM	:	New Austrian Tunnelling method
mg/m^3	:	Milligrame per cubic Meter
NO_x	:	Nitrous Oxides
OP	:	Operation Policy
%	:	Percentage
PHPDT	:	Peak Hour Peak Direction Traffic
PIA	:	Project Implementation Agency
PiP	:	Pipe in Pipe
PM	:	Particulate Matter
PMC	:	Project Management Consultant

PSD	:	Power Spectral Density
RO	:	Reverse Osmosis
ROW	:	Right of Way
SO_2	:	Sulfur di Oxide
SPCB	:	State Pollution Control Board
SPM	:	Suspended Particulate Matter
sq.	:	Square
TBM	:	Tunnel Boring Machine

CHAPTER - 1
INTRODUCTION

1.1 INTRODUCTION

The historic city of Ahmedabad is amongst the major metropolitan cities in India. It is the sixth largest in India and is known for its old architecture and the textile industry. Ahmedabad became capital of the newly formed Gujarat State in the year 1960 but a new capital was established at Gandhinagar in 1970. Gandhinagar is a carefully planned city on the lines of Chandigarh. A new Division of Western Railway has recently been formed at Ahmedabad due to the increasing share of rail traffic in the area with development of private ports in Gujarat. The city is also a tourist place and gateway to Saurashtra and Kuchchh region.

Ahmadabad is the principal administrative, commercial and distribution center of the State. Ahmadabad has witnessed enormous growth during the last 10 years. The growth is mainly the result of immigration as the city provided better employment opportunities. Ahmadabad is fast developing as educational hub of Gujarat. Rapid urbanization in the recent past has put the city's travel infrastructure to stress. With the increasing opportunities for trade and commerce and as a center for higher education, the population of the city is already touching 6 million and this heavy growth continues. Being thickly populated area, Ahmadabad's traffic needs cannot be met by only road-based system. As per the Draft Development Plan and Integrated Mobility Plan for Greater Ahmedabad Region, the future growth in this area is expected to intensify between Ahmedabad and Gandhinagar. Road-based travel has already come under stress leading to longer travel time, increased air pollution and rise in number of road accidents. With projected increase in the population of the city, strengthening and augmenting of transport infrastructure has assumed urgency. For this purpose provision of rail-based Metro system in the city has been considered.

To decongest the existing public transport systems and increase mobility across the Region, DMRC prepared in 2010 a Detailed Project Report (DPR) for Ahmedabad Metro which was subsequently updated in 2013-14. Metro-Link Express for Gandhinagar and Ahmedabad (MEGA) Company Ltd intends to implement Phase 1 of the Ahmedabad Metro Rail Project with international/multilateral funding from lending agencies like JICA. Phase 1 comprises of the revised North-South corridor from APMC to Motera along existing railway line and the East-West corridor from Thaltej to Vastral. The East-West corridor provides connectivity between residential areas in the western part of Ahmedabad and Industrial areas in the eastern part and passes through old city and Ashram Road. The project alignment is shown in **Figure 1.1**.

1.2 OBJECTIVES AND SCOPE OF STUDY

The objective of the study is to facilitate the Metro Link Express for Gandhinagar and Ahmedabad (MEGA) in preparation of EIA report as per the requirement of regulatory agencies and funding agency JICA. The scope of EIA includes the impacts resulting from pre-construction, construction and operation phases of E-W & N-S corridor, Depot and sub-stations. The brief objective of the study as per the Terms of Reference is as follows:

- To supplement the collection of earlier secondary data and primary data on social and environmental baseline information, that may affect environmental and social components of the aligned area;
- To supplement assessment and calculate potential impacts on social and natural environment and pollution caused by the proposed alignment.
- To supplement the Environmental Management Plan and to prepare Monitoring Plan for the necessary actions to minimize potential environmental and social impacts as well as to propose proper mitigation measures.
- To disseminate the information of EIA study.

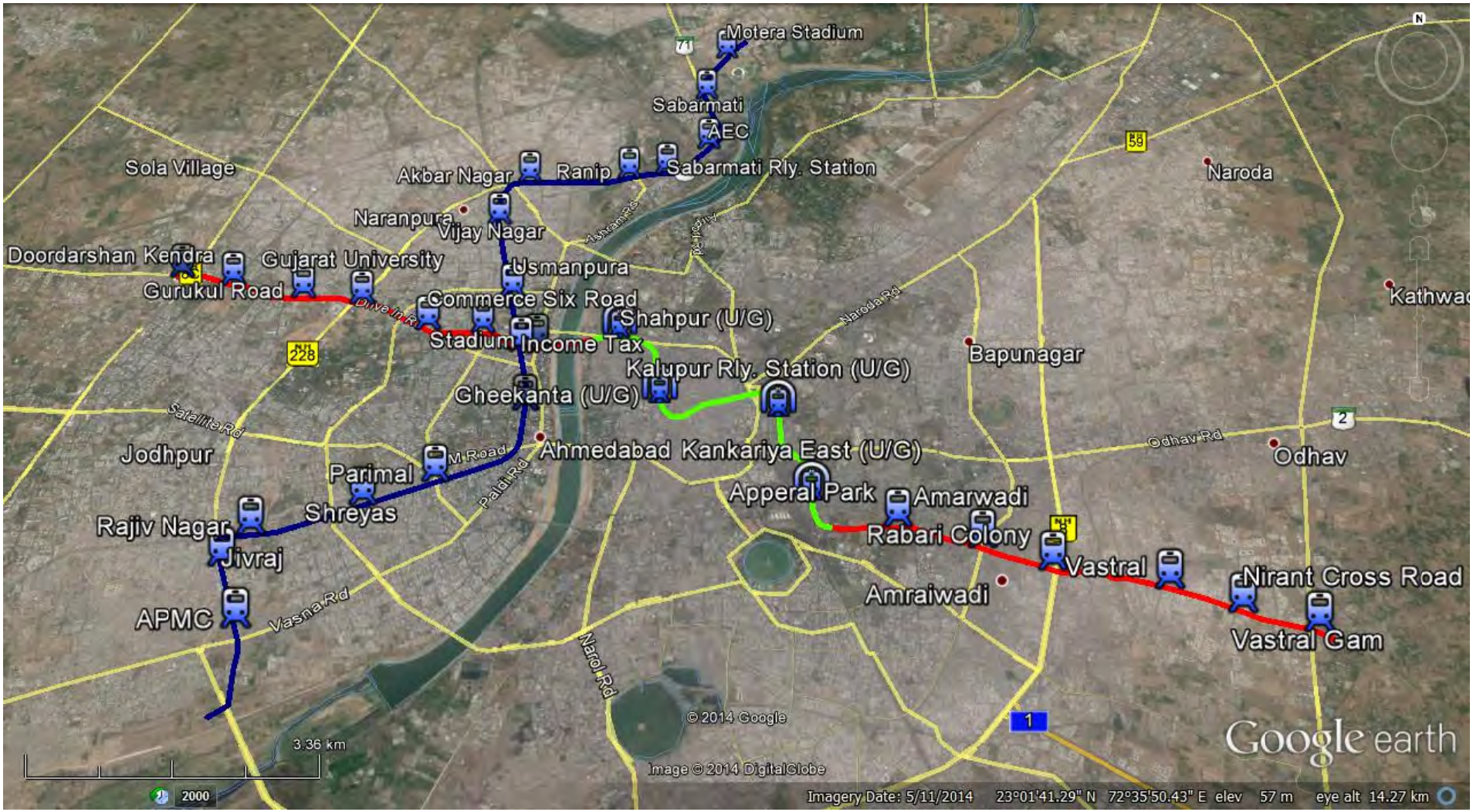
The MoEF, Government of India, Notification of 14th September 2006 and its amendment enlist projects in Schedule that require environmental clearance. However as per the said notification a metro project does not require environmental clearance from MoEF.

The scope of the study is framed as per JICA guidelines for Environmental and Social considerations. The objectives of the JICA guidelines are to encourage Project proponents to have appropriate consideration for environmental and social impacts, as well as to ensure that JICA's support for examination of environmental and social considerations are conducted accordingly.

1.3 JICA REQUIREMENT

In its confirmation of environmental and social considerations, JICA places importance on dialogue with all involved partners (e.g. the host country, local governments, borrowers and project proponents) regarding environmental and social considerations. Transparent and accountable processes, as well as active participation of key stakeholders (e.g. local residents and local NGOs) in all stages of the project are highly considered. JICA make clear in their "Guidelines for Environmental and Social Considerations" that these are mandatory to receive JBIC's funding. JICA guidelines are formulated based on the World Bank Operational Policy (OP 4.01). The project has been classified according to its impacts on the environment.

FIGURE 1.1
PROPOSED E-W & N-S AHMEDABAD METRO CORRIDOR



BOX 1.1 EIA CATEGORIZATION SYSTEM IN JICA

Category A Projects are likely to have significant adverse impacts on the environment and society. It includes projects in sensitive sectors or with sensitive characteristics and projects located in or near sensitive areas.

Category B Projects are ones with potential adverse impacts on the environment and society less adverse than those of Category A projects.

Category C Projects have minimal or little adverse impacts on the environment and society.

1.4 LEGAL, POLICY AND INSTITUTIONAL FRAME WORK

Since the adoption of The Kyoto Protocol in December 1997 which was entered into force on 16 February 2005, that developing countries are principally responsible for the current high level of GHG emission into the atmosphere due to industrial activities. This protocol commits the developed countries to reduce 5 percent pollution against 1990 level over the five years period 2008-12.

The need for a well-developed legal mechanism is to conserve resources, protect the environment and ensures the health and well being of the people in India was felt. Keeping the pace with international laws, the Ministry of Environment and Forest enacted Environmental Protection Act in 1986. Over the years, the Government of India has framed several policies and promulgated number of Acts, Rules and Notifications aimed at management and protection of the environment. During last three decades an extensive network of environmental legislation has grown and presently it has a fairly complex body of environmental legislation aimed at ensuring that the development process meets the overall objective of promoting sustainability in the long run. The available legal Acts and Legislation referred during the study are:

- The Water (Prevention and Control of Pollution) Act, 1974 (Amendment 1988).
- The Water (Prevention and Control of Pollution) Cess Act 1977, (Amendment 2003),
- The Water (Prevention and Control of Pollution) Cess Rules, 1978, 1991.
- The Air (Prevention and Control of Pollution) Act 1981 (Amended 1987).
- Noise Pollution (Regulation and Control) Rules, 2000 (Amendment 2002, 2006).
- Municipal Solid Waste Rules, 2000
- The Environment (Protection) Act, 1986, amended 1991.
- The Environment (Protection) Rules, 1986.
- The Indian Forest Act, 1927.

- Forest (Conservation) Act, 1980, amended 1988.
- Forest (Conservation) Rules, 2003.
- The Wild Life (Protection) Act 1972, Amendment, 2002
- The Metro Railway (Amendment) Act 2009
- Metro Railway (Construction of Works) Act, 1978
- Delhi Metro Railway (Operation and Maintenance) Act, 2002
- The Ancient Monuments and Archaeological sites and Remains (Amendment and Validation Act),2010

The EIA is conducted as per "Guidelines for Environmental and Social considerations" of JICA. These guidelines are formulated based on the World Bank Operation Policy (OP – 4.01)

The Environmental Impact Assessment covers the proposed on-site activities as well as the transportation of the generated waste to the waste disposal sites.

1.4.1 Water and Water Pollution

The use of water resources and also the discharge of polluted water (sewerage) are primarily regulated by the Water (Prevention and Control of Pollution) Act, 1974 amended in 1988. The Water Cess Act, 1977 amended in 1992 and 2003, including Rules 1978 and 1991 provides for levy and collection of Cess on water consumed with a view to generate resources for prevention and control of water pollution. The Act assigns functions and powers to the Central Pollution Control Board (CPCB) and State Pollution Control Board (SPCBs) for prevention and control of water pollution.

The Environment (Protection) Act 1986 amended in 1991 and Rules also lays down specific standards for quality of water effluents to be discharged into different type of water bodies (sewers, surface water bodies). Additionally, the water supplied to users for drinking shall also conform to the National Drinking Water Standard, IS-10500 **(Appendix 1.1)**. **Appendix 1.2** summarizes the general standards for discharge effluent in Inland Surface Water Bodies. To ascertain and categorize the existing water quality, the results of the analysis of water quality need to be compared with the water quality standards given in **Appendix 1.3.**

Off late, with rapid depletion of groundwater resources in several areas of the country, efforts have been initiated to regulate the use of groundwater resources. The focus of such acts and rules is to provide for mechanisms that would lead to replenishment of groundwater reserves through techniques like rain water harvesting. The Central Ground Water Board, (CGWB) the statutory authority set up by the Central Government has also restricted the drilling of tube wells and bore wells in certain water scarce areas in the country.

1.4.2 Air Quality

The Air (Prevention and Control of Pollution) Act, 1981 and amended in 1987 including Rules 1982 and 1983 was enacted to prevent, control and reduce air pollution. According to Section 21 of the Act, no person shall establish or operate any activity, which can cause air pollution without obtaining Consent to Establish (CTE) as per the Air Act. The Act also lays down National Ambient Air Quality Standards for pollutants like $PM_{2.5}$, PM_{10}, Sulphur dioxide, Oxides of Nitrogen, Carbon monoxide, Lead, Ozone, Ammonia, Benzene and Benzo pyrene with the intent of managing air quality for different category of areas (residential, industrial and sensitive). Ambient Air Quality Standards have been notified by the CPCB vide Gazette Notification dated 16th November 2009, refer **Appendix 1.4.**

The Extended Producer Responsibility (EPR) also specifies source emission standards determined on the basis of the impact of pollutants on human health, vegetation and property for activities, which can pollute the air. The SPCBs, on a case to case basis, can also make the emission standards more stringent on the considerations of the carrying capacity of a specific air shed and the existing pollution levels of ambient air quality.

1.4.3 Noise Quality

With the objective of regulating ambient noise quality in the environment, the Central Government has notified the Noise Pollution (Regulation and Control) Rules, 2000 amended in 2002 and 2006 under the EPA. The noise standards for different category of areas are based on the weighted equivalent noise level (L_{eq}). The EPR also lays down equipment noise standards for DG sets, Air conditioners and Construction Equipment, which would be in use for the project. Ambient Noise level standards have been notified by the MoEF vide Gazette Notification dated 26th December 1989 and also in the Schedule III of the Environmental (Protection) Rules 1986. It is based on the 'A' weighted equivalent noise level (L_{eq}). These are presented in **Appendix 1.5.**

1.4.4 Solid Waste Management

Project construction and operation generates solid waste at site. The MEGA would be responsible for collection and handling of solid waste as per the provisions of the Municipal Solid Waste Rules, 2000. The Hazardous Waste (Management and Handling) Rules, 2000 require facilities to classify wastes into categories, manage them as per the prescribed guidelines and obtain prior authorization from the SPCB for handling, treatment, storage and disposal of Hazardous Wastes.

1.4.5 The Ancient Monuments And Archaeological Sites And Remains (Amendment And Validation) Act, 2010

The Ancient Monuments and Archaeological Sites and Remains (Amendment and Validation) Act, 2010 has been enacted to amend the Ancient Monuments and Archaeological Sites and Remains Act, 1958 and to make provision for validation of certain actions taken by the Central Government under the said Act. The act has come into force on January 23, 2010.

The act states that the limits of prohibited area and regulated area around the monuments, archaeological sites and remains declared by the Central Government as protected have been specified in the principle Act as 100 m and 200m respectively. The limits so fixed may be further extended on the basis of gradation and classification of the monuments, archaeological sites and remains to be done by the National Monuments Authority, which is to be constituted by the Central Government by virtue of the Amendment in the principle Act. The Act defines regulated area and prohibited area as follows:

Prohibited Area: It is the areas of the protected monuments or protected areas, declared as of national importance, which has been defined as every area, beginning at the limit of the protected area or the protected monument, as the case may be, and extending to a distance of 100 m in all directions. There is also a provision in t he Act to further extend the prohibited area beyond 100 m having regard to the classification of any protected monument or protected area on the recommendation of National Monument Authority by the Central Government.

Regulated Area: It is the area beginning at the limit of the prohibited area in respect of every ancient monument and archaeological site and remains and extending to a distance of two hundred meters in all directions. This two hundred meters regulated area could further be extended having regard to the classification of any protected monument or protected area on the recommendation of National Monument Authority by the Central Government. The regulated area has extent not only horizontally but also vertically and covers even below the surface.

The amendment act provides that none other than an archaeological officer can carry out any construction in any prohibited area. The acts provides that no permission, including carrying out any public work or project essential to the public or other constructions, shall be granted in any prohibited area on and after the date on which the Ancient Monuments and Archaeological Sites and Remains (Amendment and Validation) Act, 2010 comes in to force.

This provision does not include cleansing of drains and drainage works and of public latrines, urinals and similar conveniences, or, the construction and maintenance of works

meant for providing supply of water for public, or the construction or maintenance, extension, management for supply and distribution of electricity to the public or provision for similar facilities for public.

This provision has barred all construction activities in the prohibited area to be taken up by all public bodies even if the purpose is related to public works or project essential to the public. *There is no provision for grant of any relaxation in this regard by any authority.*

Every person intending to undertake any construction or mining operation in a regulated area shall apply to the Director-General in Form VII at least three months before the date of commencement of such operation or construction.

1.5 INSTITUTIONAL FRAMEWORK

The Ministry of Environment and Forests (MoEF) is the nodal agency in the administrative structure of the central government for planning, promotions, co-ordination and overseeing the implementation of India's environmental and forestry policies and programs. The major responsibilities of MoEF include:

- Environmental resource conservation and protection, including environmental impact assessment, clearance of developmental projects;
- Co-ordination with the other ministries and agencies, voluntary organizations and professional bodies for environmental action plans;
- Promotion of research and development, manpower planning and training and creation of environmental awareness;
- Liaison and coordination with international agencies involved in environmental matters.

1.5.1. Central and State Pollution Control Boards

The Central Pollution Control Board is responsible for pollution control throughout the country. In addition to the control of air, noise and water pollution it is also responsible to ensure effective control of disposal of hazardous wastes and storage and handling of hazardous chemicals and substances. With the enactment of air and water pollution laws, states have set-up their own State Pollution Control Boards (SPCBs) to monitor industrial emissions and effluents and to approve the operation of new industries after careful scrutiny. The functions of the SPCBs include:

- The planning of comprehensive state programs for the prevention and control of air and water pollution and to ensure the implementation thereof;
- Inspection of pollution control equipment/ plants for monitoring of their efficiency

The SPCB in consultation with the Central Pollution Control Board may establish norms for air quality, gaseous emission and noise level etc.

1.6 APPROACH AND METHODOLOGY

An Environmental Impact Assessment study is proposed to be conducted as per the TOR by the MEGA and EIA & EMP guidelines by the JICA. The approach is to follow the sequence of steps adopted in an EIA study. The study should ascertain the existing baseline conditions and assess the impacts as a result of construction and operation of the project. The changes likely to occur in different components of the environment viz. physical, biological and socio-economic etc. shall be studied, analyzed and quantified, wherever possible. The accurate analysis of assessment depends upon the reliable data generated/available on environment. The consultant have been documented the baseline data for various parameters of ecology (Flora & Fauna), environmental pollution (air, water, noise and solid waste) and socio-economic (public health, education and economics).

The standard methodology for the data collection, impact assessment and formulation of management plans is adopted. The National Acts, Legislation and Laws along with JICA are consulted with a view to ensure compliance with various requirements. The consultant is collected and compiled the environmental baseline data for environmental attributes from primary and secondary sources. The primary sources include site visits, visual inspection, field studies, monitoring and analysis. The secondary sources include the books, reports, maps and documents from various government and non-government organizations on subject matter. The methodology adopted for data collection, impact analysis, preparation of environmental management and monitoring plans is highlighted in brief, in the following paragraphs. However, more elaborate methodology is presented in the main text in the relevant sections.

The following Acts, legislation and laws will be consulted with a view to ensure compliance with various requirements.

- The Wildlife (Protection) Act, Rules and Amendments, 1972, 1973, 1991
- The Forest (Conservation) Act and Rules, 1980, 1981 amended in 1989.
- Air (Prevention & Control of Pollution) Act, 1981
- Water (Prevention & Control of Pollution) Act, 1974 with Amendment 1991
- Environment (Protection) Act, 1986
- EIA Guidelines, MoEF, Govt. of India Notification, 2006
- JICA guidelines 2010
- Noise Pollution (Regulation and Control) Rules, 2000 amendment in 2010
- Hazardous Wastes (Management, Handling and Trans boundary Movement) Rules, 2008
- Municipal Solid Waste Rules, 2000

Data Collection

The existing **land-use** pattern of the area has been identified mainly as urban human settlements, roads, Trees and water bodies. Physical and chemical parameters of **soils**

along the project corridor are studied from the available data in the DPR. Based on this data, impact on soil has been predicted.

The **water** samples are collected from surface water sources (rivers/canals) and ground water source (wells/hand pumps/bore wells) for analysis as per IS: 10500-2012. The secondary data, if any, has been studied and compiled. The impact on water quality due to the proposed project activities has been evaluated.

Air and Noise quality is an important consideration during construction and operation phases. Ambient air quality and noise levels are monitored in and around project area to develop present baseline levels in the area. Location of Air & Noise monitoring have been identified on the basis of landuse at East-West and North-South corridor.

Vibration: Vibration levels are measured along the project corridor along the sensitive identified locations with the objective to establish the baseline data and assess the impacts of vibration at sensitive receptors (nine listed heritage structures) and at other selected locations.

Terrestrial **ecology** was studied along the proposed metro corridors. The vegetation types will be documented through the visual inspection, past research and field investigations. A survey was carried out in the project area to find the existing flora and fauna. The list of birds, animals, aquatic ecology etc. of the area is compiled along with the existence of any rare and endangered species.

Meteorological data for temperature, relative humidity, wind speed, wind direction, wind rose, rainfall and cloud cover are obtained from the nearest Meteorological station.

Based on project particulars and the existing environmental conditions, potential impacts are identified that are expected to be affected as a result of the proposed project and wherever possible, these are quantified. Both positive and negative impacts are evaluated to have an idea about resultant impacts. These impacts are assessed for various phases of project cycle namely, location & design, construction and operation. The standard methodology is adopted for impact prediction and assessment. The issues in each phase are considered as follows;

- Impacts due to project location & design,
  - Change in land use,
  - loss of forest, if any
  - Encroachment into natural reserves, if any
  - loss of historical and cultural monuments,
  - Impact on surface water (rivers/canals) and ground water resources,
  - Risk due to earthquake.
  - Drainage problem,

- Impacts due to project construction
  - Soil pollution at construction sites,
  - Pollution by construction spoils,
  - Air and noise pollution
  - Vibration
  - Water pollution
  - Health risks and Cultural hazards,

- Impacts due to project operation.

  Positive Impacts
  - Employment opportunities
  - Improved infrastructure
  - Reduction in Air and Noise Pollution
  - Reduction in Travel time
  - Reduction in Traffic on road
  - Better connectivity
  - Aesthetic Improvement,
  - Improvement in overall productivity

  Negative Impacts
  - Change in water quality and extraction of ground water,
  - Disposal of Solid Waste
  - Impact on soil at Depot

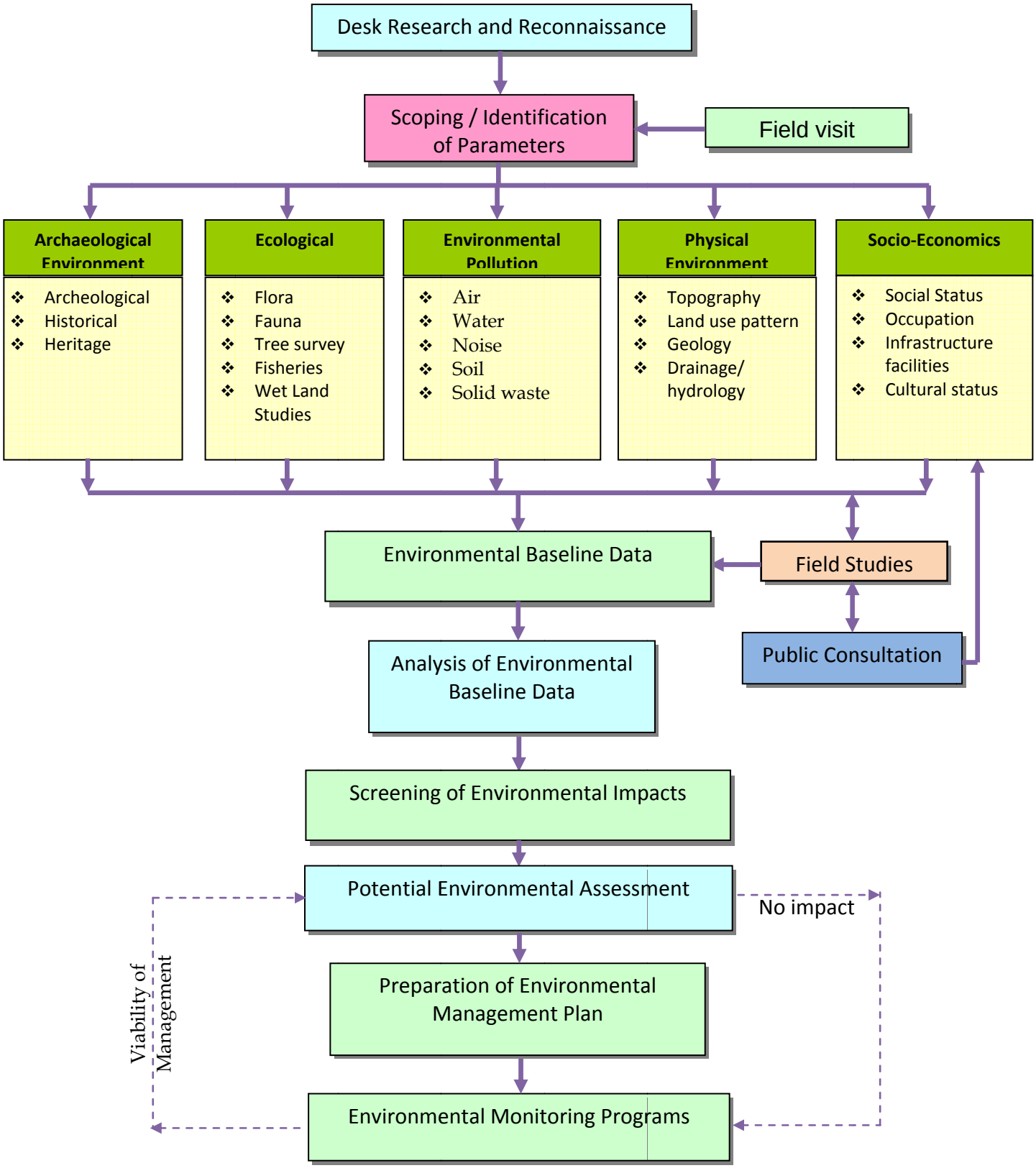
An environmental management strategy is developed to mitigate the adverse impacts during construction and operation phases of the project. The strategy includes evaluation of alternative methods to reduce or eliminate adverse impacts of the most critical areas likely to contribute to the most significant environmental burdens. The Environmental Action Plan (EAP) would specifically highlight the proposed mitigation measures to be implemented during project construction phase like compensatory afforestation plan, infrastructure facilities like sanitation, labour camps, and refuse disposal etc. Cost estimates for each of the proposed mitigation measures are given.

Consultation and communication with stakeholders during the project preparation is an integral part of the process of gathering relevant data for impact assessment, and facilitates the development of appropriate options for the affected population. In addition, informal consultations were organized with individuals and nearby people, in order to present the project and collect their views on the perceived positive and negative impacts on the environment on account of this new development.

It is necessary to monitor the environmental attributes during construction and operation. Monitoring indicates any environmental problems. This will facilitate to assess the effectiveness of management / mitigation measures. The post project environmental monitoring program is designed for implementation along with the cost. The Budget estimates and equipments necessary for the effective implementation of the Environmental Management Plan and environmental monitoring are worked out. The approach for the study is presented in **Figure 1.2.**

For the preparation of this EIA, the project team and environmental experts have liaised with the MEGA in order to discuss the proposed scope of the EIA, available data in the specific area on environmental attributes and general comments / observations that these authorities may have on the project and its environs.

FIGURE 1.2
APPROACH FOR ENVIRONMENTAL IMPACT ASSESSMENT



1.7 FORMAT OF THE REPORT

The main elements of the study are as follows: In **Chapter-2** briefs about the proposed project description & alternatives. **Chapter-3** summarises environmental baseline conditions including physical, biological and socio-economic parameters and pre-project environmental constraint such as air pollution, problems related to public health and traffic congestion. Potential negative and positive impacts are presented in **Chapters-4 and 5** respectively. These include issues such as loss of land, rehabilitation and resettlement, disposal of soil, loss of trees, noise and vibration, disruption of utilities/ facilities, socio-economic and other problems due to the development of proposed Ahmedabad Metro. Based on the anticipated negative impacts, the project may bring about an environmental management strategy, which has been outlined in **Chapter-6.** The detail of Public Consultation for the proposed project has been given in **Chapter-7.**

Chapter-8 includes post project environmental monitoring programmes. This programme aims at signalling any potential environmental problem during construction and operation of the project and it should allow for timely implementation of corrective measures. The costs of the environmental management and monitoring programmes are presented in **Chapter-9.** The conclusion of the EIA study conducted has been presented in **Chapter-10**.

The literature, books, reports referred, is detailed in References. Where applicable, more detailed information on methods used is included in concerning paragraphs. The issue related to rehabilitation and resettlement and rehabilitation plan are available in separate report**.**

1.7

Appendix-1.1

DRINKING WATER QUALITY STANDARDS (IS 10500:2012)

S. No.	Substance or Characteristic	Requirement (Desirable Limit)	Undesirable Effect outside the Desirable limit	Permissible limit in the absence of alternate source
Essential Characteristics				
1	Colour, Hazen units, Max	5	Above 5, consumer acceptance decreases	15
2	Odour	Agreeable	-	Agreeable
3	Taste	Agreeable	-	Agreeable
4	Turbidity NTU, max	1	Above 5, consumer acceptance decreases	5
5	pH Value	6.5 to 8.5	Beyond this range the water will affect the mucous membrane and/or water supply system	No relaxation
6	Total Hardness (as $CaCO_3$) mg/l, Max	200	Encrustation in water supply strucute and adverse effects on domestic use	600
7	Iron (as Fe) mg/l, max	0.3	Beyond this limit taste/appearance are affected, has adverse affect on domestic uses and water supply structures and promotes iron bacteria	No relaxation
8	Chloride (as Cl) mg/l, Max	250	Beyond this limit, test, corrosion and palatability are affected	1000
9	Free Residual free Chlorine, mg/l, Min	0.2	-	1.0
10	Fluoride (as F) mg/l, Max	1.0	Fluoride may be kept as low as possible. High fluoride may cause florosis	1.5
11	Dissolved solids mg/l, Max	500	Beyond this palatability decreases and may cause gastro intestinal irrigation	2000
12	Calcium (as Ca) mg/l, Max	75	Encrustation in water supply structure and adverse effects on domestic use	200
13	Magnesium (as Mg) mg/l, Max	30	Encrustation in water supply structure and	100

S. No.	Substance or Characteristic	Requirement (Desirable Limit)	Undesirable Effect outside the Desirable limit	Permissible limit in the absence of alternate source
Essential Characteristics				
			adverse effects on domestic use	
14	Copper (as Cu) mg/l, Max	0.05	Astringent taste, discoloration and corrosion of pipes fitting and utensils will be caused beyond this	1.5
15	Manganese (as Mn) mg/l, Max	0.1	Beyond this limit taste/appearance are affected, has adverse effect on domestic uses and water supply structures	0.3
16	Sulphate (as SO_4) mg/l, Max	200	Beyond this causes gastro intestinal irritation when magnesium or sodium are present	400
17	Nitrate (as NO_3) mg/l, Max	45	Beyond this methaemoglobinemia takes place	No relaxation
18	Phenolic compounds (as C_6H_5OH) mg/l, Max	0.001	Beyond this, it may cause objectionable taste and odour	0.002
19	Mercury (as Hg) mg/l, Max	0.001	Beyond this, the water become toxic	No relaxation
20	Cadmium (as Cd), mg/l, Max	0.003	Beyond this the water become toxic	No relaxation
21	Selenium (as Se), mg/l, Max	0.01	Beyond this the water become toxic	No relaxation
22	Arsenic (as As), mg/l, Max	0.01	Beyond this the water become toxic	0.05
23	Cyanide (as CN), mg/l, Max	0.05	Beyond this the water become toxic	No relaxation
24	Lead (as Pb), mg/l, Max	0.01	Beyond this the water become toxic	No relaxation
25	Zinc (as zn), mg/l, Max	5	Beyond this limit it can cause astringent taste and an opalescene in water	15
26	Anionic detergents (as MBAS), mg/l, Max	0.2	Beyond this limit it can cause a light froth in water	1.0
27	Total Chromium (as Cr) mg/l, Max	0.05	May be carcinogenic above this limit	No relaxation

S. No.	Substance or Characteristic	Requirement (Desirable Limit)	Undesirable Effect outside the Desirable limit	Permissible limit in the absence of alternate source
Essential Characteristics				
28	Polynuclear aromatic hydrocarbons (as PAH) mg/l, Max	0.0001	May be carcinogenic	No relaxation
29	Mineral oil mg/l Max	0.01	Beyond this undesirable and odour chlorination place	0.03
30	Pesticides mg/l Max	Absent	Toxic	0.001
31	Radioactive materials a) Alpha emitters Bq/l max b) Beta emitters pci/l, Max	 0.1 1.0	 - -	 No relaxation No relaxation
32	Total Alkalinity (as CaCo3)mg/l Max	200	Beyond this limit taste becomes unpleasant	600
33	Aluminium (as Al), mg/l Max	0.03	Cumulative effect is report to cause demntia	0.2
34	Boron (as B), mg/l, Max	0.5	-	1.0
35	Ammonia (as total ammonia-N) mg/l, Max	0.5		No relaxation

Appendix-1.2

EFFLUENT DISCHARGE STANDARDS (INLAND SURFACE WATER)

S.No.	Parameter	Unit	Standards
1	Colour & Odor	--	All efforts should be made to remove colour and unpleasant odor as far as practicable.
2	Suspended Solids Max.	mg/l	100
3	Particle size of Suspended Solids	--	Shall pass 850 micron IS Sieve
4	pH value	--	5.5 to 9.0
5	Temperature, Max.	^{o}C	Shall not exceed 5°C above the receiving water temp.
6	Oil and grease, Max.	mg/l	10
7	Total residual Chlorine, Max.	mg/l	1.0
8	Ammonical Nitrogen (as N), Max.	mg/l	50
9	Total Kjeldah Nitrogen (as N), Max.	mg/l	100
10	Free Ammonia (as NH_3), Max.	mg/l	5
11	Biochemical Oxygen Demand (5 days at 20°C), Max.	mg/l	30
12	Chemical Oxygen Demand Max.	mg/l	250
13	Arsenic (as As), Max.	mg/l	0.2
14	Mercury (as Hg), Max.	mg/l	0.01
15	Lead (as Pb), Max.	mg/l	0.1
16	Cadmium (as Cd), Max.	mg/l	2.0
17	Hexavalent Chromium (as Cr^{+6}), Max.	mg/l	0.1
18	Total Chromium (as Cr) Max.	mg/l	2.0
19	Copper (as Cu), Max.	mg/l	3.0
20	Zinc (as Zn), Max.	mg/l	5.0
21	Selenium (as Se), Max.	mg/l	0.05
22	Nickel (as Ni), Max.	mg/l	3.0
23	Cyanide (as CN), Max.	mg/l	0.2
24	Fluorides (as F), Max.	mg/l	2.0
25	Dissolved phosphates (as P), Max.	mg/l	5.0
26	Sulphides (as S), Max.	mg/l	2.0
27	Phenolic compounds (as C_6H_5OH), Max.	mg/l	1.0
28	Radioactive Materials α Emitters, μcurie/ml, Max. β Emitters, μcurie/ml, Max.	mg/l	 10^{-7} 10^{-6}
29	Bio-assay test	mg/l	90% survival of fish after 96 hours in 100% effluent
30	Manganese (as Mn)	mg/l	2.0
31	Iron (as Fe)	mg/l	3.0
32	Vanadium (as V)	mg/l	0.2
33	Nitrate Nitrogen	mg/l	10.0

TOLERANCE LIMITS FOR INLAND SURFACE WATER QUALITY

Characteristic	Designated Use Class of Inland Waters				
	A	B	C	D	E
pH value	6.5 to 8.5	6.5 to 8.5	6.5 to 8.5	6.5 to 8.5	6.0 to 8.5
Dissolved Oxygen, mg/l, Min.	6	5	4	4	-
Biochemical Oxygen Demand (5 days at 20^0C), mg/l	2	3	3	-	-
Total coliform organisms, MPN/100 ml. Max.	50	500	5000	-	-
Colour Hazen units	10	300	300	-	-
Chlorides (as Cl), mg/l Max.	250	-	600	-	600
Sodium Adsorption ratio Max.	-	-	-	-	26
Boron (as B), mg/l. Max.	-	-	-	-	2
Sulphates (as SO_4), mg/ l	400	-	400	-	1000
Nitrates (as NO), mg/l Max.	20	-	50	-	-
Free Ammonia (as NH_3), mg/l	-	-	-	1.2	-
Conductivity at 25^o C microhm / cm Max.	-	-	-	1000	2250
Arsenic (as As), mg/l. Max.	0.05	0.2	0.2	-	-
Iron (as Fe), mg/l	0.3	-	50	-	-
Fluorides (as F), mg/l	1.5	1.5	1.5	-	-
Lead (as Pb), mg/l. Max.	0.1	-	0.1	-	-
Copper (as Cu), mg/l	1.5	-	1.5	-	-
Zinc (as Zn) mg/l/ Max.	1.5	-	1.5	-	-
Manganese (as Mn), mg/l	0.5	-	-	-	-
Total Dissolved Solids, mg/l	500	-	1500	-	2100
Total Hardness ($CaCO_3$), mg/l	300	-	-	-	-
Magnesium (as Mg), mg/l	100	-	-	-	-
Chlorides (as Cl), mg/l	250	600	-	-	600
Cyanides (as CN), mg/l	0.05	0.05	0.05	-	-

Source: *Central Pollution Control Board*

A: Drinking Water Source without conventional treatment but after disinfections;
B: Outdoor bathing organized;
C: drinking water source with conventional treatment followed by disinfections;
D: propagation of wildlife and fisheries;
E: irrigation, industrial cooling, controlled waste disposal.

NATIONAL AMBIENT AIR QUALITY STANDARDS

Pollutant	Time Weighted Average	Industrial, Residential, Rural & Other Area	Ecologically Sensitive Area (notified by Central Government
Sulphur Dioxide (SO_2), $\mu g/m^3$	Annual 24 Hours**	50 80	20 80
Nitrogen Dioxide as NO_2, $\mu g/m^3$	Annual 24 Hours**	40 80	30 80
Particulate Matter (size less than 10µm) or PM_{10} $\mu g/m^3$	Annual 24 Hours**	60 100	60 100
Particulate Matter (size less than 2.5µm) or PM2.5 $\mu g/m^3$	Annual * 24 Hours**	40 60	40 60
Ozone (O_3) $\mu g/m^3$	8 hours** 1 Hours**	100 180	100 180
Lead (Pb) $\mu g/m^3$	Annual * 24 Hours**	0.50 1.0	0.50 1.0
Carbon Monoxide (CO) mg/m^3	8 Hours** 1 Hour**	02 04	02 04
Ammonia (NH_3) $\mu g/m^3$	Annual * 24 Hours**	100 400	100 400
Benzene (C_6H_6) $\mu g/m^3$	Annual *	05	05
Benzo (a) pyrene (BaP) particulate phase only ng/m^3	Annual *	01	01
Arsenic (AS) ng/m^3	Annual *	06	06
Nickle (Ni) ng/m^3	Annual *	20	20

Source: *Central Pollution Control Board Notification dated* 18th November 2009

** Annual arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week hourly at uniform intervals*

*** 24 hourly or 08 hourly or 01 hourly monitored values, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.*

Appendix-1.5

NATIONAL AMBIENT NOISE STANDARDS

Category of Zones	Leq in dB (A)	
	Day *	Night
Industrial	75	70
Commercial	65	55
Residential	55	45
Silence Zone **	50	40

Source: *Central Pollution Control Board*

* *Day Time is from 6.00 AM to 9.00 PM.*

** ***Silence Zone*** *is defined as an area up to 100m around premises of Hospitals, Educational Institutions and Courts. Use of vehicle horn, loudspeaker and bursting of crackers is banned in these zones.*

CHAPTER - 2
PROJECT DESCRIPTION

2.1 EXISTING SYSTEMS

The transportation system in Ahmedabad and Gandhinagar is predominantly dependent on roadway systems. The major road network in the study area is around 3045 km in length, of which 78% of which are managed by AMC, 15% by GUDA and others by AUDA. The proposed Metro Rail project is in Ahmedabad where vehicular traffic consists of two wheelers, auto rickshaw, cars, taxis, buses, commercial vehicles and others.

2.2 PROPOSED METRO SYSTEM IN AHMEDABAD

There is no existing metro system in Ahmedabad. Phase 1 of the Ahmedabad Metro Rail Project has been planned with international/multilateral funding from lending agencies like JICA. Phase 1 comprises of the East-West corridor from Thaltej to Vastral and the North-South corridor from APMC to Motera. East-West corridor provides connectivity to east-west and passes through important nodes of Kalupur, Ashram road, Thaltej and Industrial areas on the east of Ahmedabad. The proposed metro alignment provides north-south connectivity in Ahmedabad city from Visat to APMC running along the Ashram road on most of the sections. The details of proposed Metro components are given in following **Table 2.1**. All the components of project description for proposed Metro Corridors in respect of Depot planning, alignment details, rolling stock, power supply, traction system and signalling are summarised in DPR and reproduced in this chapter.

TABLE 2.1
DETAILS OF PROPOSED METRO COMPONENTS

Corridors	Length (kms)			Number of Stations		
	Underground	Elevated	Total	Underground	Elevated	Total
East-West	6.335	14.201	20.536	4	13	17
North-South	Nil	19.110	19.110	Nil	15	15
Total:	**6.335**	**33.311**	**39.646**	**4**	**28**	**32**

2.3 ANALYSIS OF ALTERNATIVES

2.3.1 Alignment Planning

Selection of an optional alignment is a multi-disciplinary decision, with objectives which may conflict with one another. The principal objectives which were considered while selecting the metro-alignment are minimization of the impact on the environment & social, minimum land acquisition, optimization of the functionality of the alignment, minimization of construction time, minimization of construction and operational cost and maximization of the results of the economic investment. Minimization of construction time and construction and operational cost are amongst the criteria with the highest weighting

factors in selecting the optimal alignment. While selecting the alignment of Ahmedabad Metro Rail corridors spread over total length of 35.956 km. Following parameters are taken into consideration:

- Catchment area,
- Integration with other mass transit corridors,
- Construction feasibility, and
- Environment and social aspects.

Alternative Options till Year 2010

Detailed Project Report was prepared by DMRC for Gandhinager-Ahmedabad Metro rail in the year 2005. The alignment is shown in **Figure 2.1**. In the year 2009, Central Road Research Institute (CRRI) based on Traffic study and subsequent revision of traffic estimates proposes Gandhinagar-Ahmedabad metro as shown in **Figure 2.2**. The above studies were commissioned by Gujarat Infrastructure Development Board (GIDB).

FIGURE 2.1
ALIGNMENT DETAILS IN 2005 (DMRC)

FIGURE 2.2
ALIGNMENT DETAILS IN 2009 (CRRI)

The alignment proposed by DMRC (2005) did not consider BRTS and its impact. Besides recommending 43.46 km long north ï south and - east ï west network, also suggested 53.47 km long regional rail network. The entire DMRC network, except 3 km near Kalupur railway station, was envisaged to be elevated. DMRC ï DPR provides ridership estimates with as well as without regional rail.

CRRI, besides undertaking fresh traffic studies/modeling, considered addition of one line ï GIFT city, 8.62 km. However, it did not consider regional rail, implying that regional rail, by 2009, had receded into background. CRRI took into account BRTS plan for Ahmedabad.

Alternative Options Post 2010

Special Studies on East-West connectivity carried out by Barsyl in July, 2011 and Memco-Vadaj connectivity carried out by Lead Rail in July, 2031. In addition, the traffic studies and modeling to forecast ridership were carried out by Prozeal keeping in view the alignment proposed in 2012 and sequent change in it till mid ï 2013. They were intended to estimate ridership on proposed alignment rather than to delineate optimum alignment.

The exercises enumerated above drove route planning. The plan has evolved during last two and a half years. The subject was dealt with in relevant parts from time to time. The following is a synopsis of major developments and underlying considerations from time to time. The High Level Committee meetings held time to time was made necessary modifications while finalizing the alignment. These are discussed in subsequent section:

Due to constraint an unavoidable 3 km stretch to reach Kalupur station and at requirement of interchange station at Income Tax junction, Barsyl was asked to suggest alternative east-west connectivity. Barsyl was submitted an alternative connectivity route in July 2012 as shown in **Figure 2.3**.

The alternative of Motera Stadium route along Sabarmati River to reach airport was proposed in year 2011.

Also metro route traversing along Gheekanta road was considered which was dropped due to presence of ASI monument, unavailability of sufficient RoW and discontinuity in the road.

It was suggested at the meeting chaired by the Honorable Chief Minister on December 28, 2011 not to lay metro on Ashram road and to examine various routes for eastern Ahmedabad.

Following the visit of group of ministers in July, 2013 on it was decided to work it out, depending on technical feasibility July 17, 2013. Lead Rail carried out technical feasibility soon thereafter and recommended underground line.

FIGURE 2.3
METRO RAIL ROUTE ALTERNATIVE IN YEAR 2012

It was then decided to reverse the phasing-Ahmedabad. Region to become Phase I and Gandhinagar Region to become Phase II.

Post September 2013

North – South Corridor: This corridor almost resembles to the DMRC 2003 corridor which starts from APMC in the south and ends at Motera Stadium (instead of extending the corridor till Akshradham, Gandhinagar). Moreover to that, due to ASI monument at Vasna, the corridor deviates from the road to keep the prohibited 100m distance at bay.

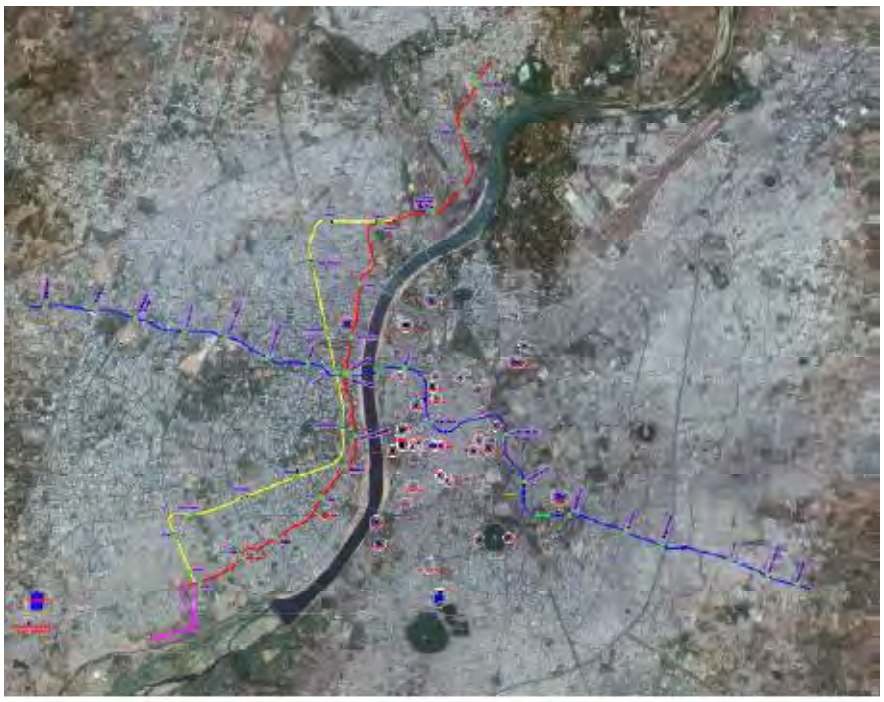
- APMC to Motera Stadim : ~16.1 km
- No. of Stations : 13
- Completely elevated
- Depot at Gyaspur (Near APMC)

East – West Corridor: Majority of this corridor also resembles to the previous DMRC 2003 corridor but it extends at both the ends of the corridor. At eastern part, the new corridor extends till Vastral Gaam instead of Kalupur Railway Station with keeping in mind the potential ridership and catchment area. The route alignment showing N-S and E-W corridor is given in **Figure 2.4.**

Thaltej Gaam to Vastral Gaam: 18.2km

- Elevated corridor: 11.5km (13 Stations)
- UG Corridor: 6.7km (4 stations)
- Depot at Apparel Park, Amraiwadi

FIGURE 2.4
ALIGNMENT SHOWING N-S AND E-W CORRIDOR



Post June 2014

The proposed alignment is parallel to the existing Meter Gauge line. This is the reason which prevents most of its ridership from the western Ahmedabad. In addition to that, North ï South line of January 2014 alignment needs extra care for the underground utilities and barricading/hindrance for the mix traffic till the construction activity lasts. So, the new alignment proposed on the existing Meter Gauge line within its Right of Way for the construction of the new North ï South corridor. The depot will be the same with the end station as APMC but then after the corridor will go through Shyamal RoB and joins the Indian Railway RoW till Vijay Nagar and joins road at Vadaj and merge with the original alignment from Ranip onwards. (Refer Figure 2.4)

- APMC to Motera Stadium: 17.2 kms
- Stations : 15

2.3.2 Proposed Alignment

The alignment as discussed above was studied and reviewed. Two Corridors have been identified for implementation in Ahmadabad Metro Rail Project network (Phase 1) which is depicted in subsequent para.

East-West Corridor: The East-West corridor alignment covers Thaltej to Vastral which provides east to west connectivity and passes through important nodes of Kalupur, Ashram road, Thaltej and Industrial areas on the east of Ahmedabad.

North-South Corridor: The proposed metro alignment provides north-south connectivity in Ahmedabad city from Visat to APMC running along the Ashram road on most of the sections.

TABLE 2.2
PROPOSED ROUTE ALIGNMENT

S.No	Corridors	Total (Km)
1	North-South Corridor: APMC-Motera	19.110
2	East-West Corridor: Thaltej to Vastral Gam	20.536
	Total	**39.646**

A total of 32 stations have been proposed across both the corridors. These are mostly elevated stations located at a clear height of 5.5m above the road. The stations shall be accessible from both sides of the road in order to better serve the catchment area. Two side platforms are planned on this type of station. Approximately 6 km of alignment in the E-W corridor is located underground. This alignment will include four underground stations. These underground stations will be island types in configuration.

TABLE 2.3
PROPOSED STATIONS ON EAST-WEST CORRIDOR

S. No	Type	Name of Station	Interchange Facility
1	Terminal	Thaltej	
2	Elevated	Doordarshan Kendra	
3	Elevated	Gurukul Road	
4	Elevated	Gujarat University	BRTS
5	Elevated	Commerce Six Road	
6	Elevated	Stadium	
7	Interchange	Ashram Road	Metro Corridor
8	U/G	Shahpur	
9	U/G	Ghee Kanta	
10	U/G	Kalupur Rly. Station	Indian Railway
11	U/G	Kankaria East	
12	Elevated	Apparel Park	
13	Elevated	Amraiwadi	

S. No	Type	Name of Station	Interchange Facility
14	Elevated	Rabri Colony	BRTS
15	Elevated	Vastral	
16	Elevated	Nirant Cross road	
17	Terminal	Vastral Gam	

TABLE 2.4
PROPOSED STATIONS ON NORTH-SOUTH CORRIDOR

S. No	Type	Name of Station	Interchange Facility
1	Terminal	APMC	
2	Elevated	Jivraj	
3	Elevated	Rajiv Nagar	
4	Elevated	Shreyas	
5	Elevated	Parimal	
6	Elevated	Gandhigram	Indian Railway
7	Interchange	Income Tax	Metro Corridor
8	U/G	Usmanpura	
9	U/G	Vijay Nagar	
10	U/G	Akbar Nagar	
11	U/G	Ranip	GSRTC, BRTS
12	Elevated	Sabarmati Rly. Station	Indian Railway
13	Elevated	AEC	BRTS
14	Elevated	Sabarmati	BRTS
15	Terminal	Motera Stadium	

2.4 Depot Planning

The proposed corridor would require a dedicated depot for the maintenance of the rakes. The inspection, overhauling and all maintenance facilities for P Way, S & T, OHE etc will also be provided at the depot cum maintenance workshop. Depot cum workshop shall have necessary facilities viz stabling lines, schedule inspection lines, workshop for overhaul, unscheduled maintenance including major repairs, wheel profiling, and heavy interior/under frame/roof cleaning etc.

In addition, the Depot will also house for operation control centre (OCC), administrative building, maintenance facilities for civil-track, water supply; electrical-traction, E&M; signalling & telecomm; etc.

2.4.1 Proposed sites for Depot

It is proposed to establish one depot- cum- workshop at Gyaspur (25.2 Hac) for North South Corridor and one depot- cum- workshop at Apparel Park (19.5 Hac) for East West Corridor with following functions:

a) Depot- cum- workshop at Giyaspur for North South Corridor

(i) Major overhauls of all the trains of N- S Corridor.

(ii) All minor schedules and repairs of N- S Corridor.

(iii) Lifting for replacement of heavy equipment and testing thereafter of N- S Corridor.

(iv) Repair of heavy equipments of N- S Corridor.

b) Depot- cum- workshop at Apparel Park for East West Corridor

(i) Major overhauls of all the trains of E-W Corridor.

(ii) All minor schedules and repairs of E-W Corridor.

(iii) Lifting for replacement of heavy equipment and testing thereafter of E-W Corridor.

(iv) Repair of heavy equipments of E-W Corridor.

The Depot planning at Giyaspur for North South Corridor and at Apparel Park for East West Corridor is based on following assumptions:

(i) Enough space should be available at Giyaspur for North South Corridor and at Apparel Park for East West Corridor for establishment of a Depot- Cum- workshop

FIGURE 2.5
APPAREL PARK DEPOT

FIGURE 2.6
GIYASPUR DEPOT

(ii) All inspection, workshop lines and stabling lines are designed to accommodate two trainsets of 3- car each.

(iii) All stabling lines are planned in the proposed depot-cum-workshop assuming adequate space availability. In case of space constraints, if any, stabling facilities may need to be created at terminal stations or elsewhere to cater to the required stability facilities.

(iv) Provision of transfer line from one corridor to another corridor.

2.5 RIDERSHIP ON PROPOSED METRO CORRIDOR

Daily ridership on the Ahmedabad metro rail network in 2018 is expected to be 4.6 lakh passengers. Corridor wise total daily ridership for the years 2021, 2031 and 2043 and PHPDT are shown in **Table 2.5**.

TABLE 2.5
MAXIMUM PHPDT AND DAILY RIDERSHIP

Daily Ridership				
Corridor/Year	**2018**	**2021**	**2031**	**2043**
East-West Corridor	246743	361780	493781	619118
North-South Corridor	210928	299824	429074	624492
PHPDT				
Corridor/Year	**2018**	**2021**	**2031**	**2043**
East-West Corridor	10593	15659	19251	22944
North-South Corridor	8476	12097	17778	26484

2.6 ROLLING STOCK, TRACTION AND SIGNALLING

The required transport demand forecast is the governing factor for the choice of the Rolling Stock. The forecasted Peak Hour Peak Direction Traffic calls for a Medium Rail Transit System (MRTS).

- A short train consisting of 3 cars which can be increased for increasing the Passenger Carrying Capacity of Trains with the consideration of matching the growing traffic demand.

- The rolling stock shall be Standard 1435 mm track gauge Section having maximum width of 2.9 m, Axle load of 16 tonnes and capacity of 3 coach unit as 764 passengers. Seating arrangement will be longitudinal and AC class accommodation will be provided.

- 4.74 MVA and 6.38 MVA Power demand for Traction system is proposed to fulfil the power demand of N-S & E-W corridors in 2018 respectively. Two receiving stations for each corridor have been proposed at Gyaspur, Sabarmati, Thaltej and Apparel Park Depot.

- The system, under normal operating conditions, will be an automatically operated system utilizing Automatic Train Control and Automatic Train Protection (ATP) under the overall control of a train driver and OCC operators.

- Computer Based Interlocking (CBI) signalling and continuous automatic train control with Automatic Train Protection (ATP) is proposed., while telecommunication system is integrated with Optical Fiber Cable, LED/LCD based boards, Mobile Radio, Mobile system etc.

- Fare collection system is provided with automation in association with Contactless Smart Card and Retractable Flap Type Control Gates, Ticket Office Machine, TR, PTD etc.

2.7 PASSENGER CARRYING CAPACITY

In order to maximise the passenger carrying capacity, longitudinal seating arrangement shall be adopted. Criteria for the calculation of standing passengers are 3 persons per square metre of floor area in normal state and 6 persons in crush state of peak hour. Therefore, for the Medium Rail Vehicles (MRV) with 2.9 m maximum width and longitudinal seat arrangement, conceptually the crush capacity of 43 seated, 204 standing thus a total of 247 passengers for a Driving motor car, and 50 seated, 220 standing thus a total of 270 for a trailer/motor car is envisaged. These are shown in **Table 2.6**.

TABLE 2.6
CARRYING CAPACITY A CAR

DESCRIPTION	DRIVING MOTOR CAR		TRAILER CAR		3 CAR TRAIN	
	Normal	Crush	Normal	Crush	Normal	Crush
Seated	43	43	50	50	136	136
Standing	102	204	110	220	314	628
Total	**145**	**247**	**160**	**270**	**450**	**764**

2.8 MAINTENANCE DEPOTS

The maintenance depot along with full workshop facilities have been proposed at Arey Milk Colony for the proposed metro corridor. The facilities include for the maintenance of the Rakes, Track, Electrical ï Traction (OHE), E & M, Signalling & Telecom, Automatic Fare Collection etc. It will house Operation Control Centre (OCC) and Administrative Building.

2.9 POWER REQUIREMENTS

Power supply is required for the operation of Metro system for running of trains, station services, workshop, depot and other maintenance works within the premises of metro system. The power requirement is for peak hour demand for traction and auxiliary application. Some of assumptions to estimate the power supply are

- Specific energy consumption of rolling stock : 75 KWh per 1000 GTKM
- Underground station : Design Load 2000 kW
- Depot auxiliary : Design load 2000 kW

Keeping in view the above norms, designed load and power requirement projected are depicted in **Table 2.7**

TABLE 2.7
POWER DEMAND IN MVA

Corridor		2018	2021	2031	2043
North-South	Traction	4.74	6.38	8.14	11.43
	Auxiliary	6.79	6.92	8.03	10.01
	Sub Total	**11.53**	**13.30**	**16.17**	**21.44**
East-West	Traction	6.38	8.47	12.04	12.26
	Auxiliary	17.05	17.66	19.76	22.73
	Sub Total	**23.43**	**26.13**	**31.80**	**34.99**

Keeping in view the reliability requirements, Four Receiving Sub-stations (two for N-S line and Two for E-W line) are proposed to be set up. This is an economical solution without compromising reliability. It is proposed to avail power supply for traction as well as auxiliary services from M/s Torrent AEC Ltd from its 132 kv sub-station.

2.10 SUB STATIONS

As per power supply network of Ahmedabad city, the city has 220 KV, 132 kV, 66 kV network to cater to various types of demand in the vicinity of proposed corridor. Out of these, 33 kV network are highly reliable and stable to meet the power requirement of the proposed corridor. The power requirement will be met from the M/s Torrent Power AEC Ltd. Keeping in view the reliability requirements and considering the complete corridor of 35.956 m length with all underground stations; four receiving Sub-stations are proposed to avail power supply for traction as well as auxulliary services cable feeders for metro Corridor. Sources of Power Supply are depicted as in **Table 2.8.**

TABLE 2.8
SOURCES OF POWER SUPPLY

Corridor	GRID SUB-STATION	Location of RSS of Metro	Approx. Length (132 or 66 kV cables)
North-South	Pirana Grid Sub-station (132kV)	Gyaspur Depot	5 km Transmission line
	Sabarmati Grid sub-station (132kV)	Sabarmati	1 km
East-West	Thaltej Grid sub-station (132kV)	Thaltej	1 km
	Grid sub-station at Apparel Park	Apparel Park Depot	To be identified

2.11 CONSTRUCTION METHODOLOGY

Elevated viaduct consisting prestressed concrete ñBoxò shaped Girders will be constructed on Single pier with pile / Open foundations. The underground section alignment will be Tunnel Boring and underground station will be either cut and cover or NATM method depending upon the availability of space.

2.11.1 Construction Strategy

Design and build contacts will be adopted for proposed corridor. There will be three major contracts 1. Civil Works, 2. System Contract and 3. Depot Contract. Under civil contact, Architectural finishes, fire fighting and general electrification will be included along with the civil construction works. System contract will be on the basis of design, construct and installation which will include Traction and Power Supply, Signal and Telecommunication, Lifts, Escalators, Fare collection, Rolling Stock, Track and Signages. Layout, design and construction and general electrification comes under the Depot contract.

2.11.2 Construction Period

It is proposed to complete the project in a time period of 60 months.

2.12 COST ESTIMATES

The completion cost of the project with all taxes, escalation & land comes to Rs 10675.00 Crore.

CHAPTER - 3
ENVIRONMENTAL BASELINE DATA

3.1. ENVIRONMENTAL SCOPINGS

This chapter describes the existing environmental settings in the study area. Baseline description, which involves collecting data on the existing status of the environment, helps in identification and assessment of impacts as a result of the proposed metro project. The objective of Environmental Impact Assessment (EIA) is to ascertain the baseline environmental conditions and then assess the impacts as a result of the proposed project during various phases of the project cycle. The environmental baseline data has been compiled for:

- Land Environment (Physiography, Geology, Soils and Minerals)
- Water Environment (Water resources, water use and quality)
- Air Environment (Meteorology and Air Quality)
- Noise Environment (Noise levels and Vibration)
- Ecological Environment (Flora and Fauna)
- Socio-Economic environment (Demography and Socio-Economics, etc)

The environmental baseline data includes inventorisation of physical, chemical, biological and socio-economics. The data collection was carried out in the months of August - September 2014. A scoping matrix was formulated to identify the attributes likely to be affected due to the development of proposed project and is presented in **Table 3.1**. Data on land environment has been collected and compiled from various published sources and field focused surveys. Information about geology, hydrology, prevailing natural hazards like earthquakes, etc have been collected from literature reviews and authenticated information made available by government departments. Attributes of water and ambient environment in the surrounding area were assessed, primarily through field studies, and by undertaking monitoring and analysis of samples collected from field. Meteorological data was collected from Indian Meteorological Department (IMD). The methodology adopted for data collection is highlighted wherever necessary. The general environmental attributes pertaining to the proposed metro project along with parameters to be collected and its frequency are presented in **Table 3.2**.

TABLE 3.1
SCOPING MATRIX FOR THE PROJECT

ASPECT OF ENVIRONMENT	LIKELY IMPACTS
A. Land Environment	
Construction Phase	Increased soil erosion
	Pollution by construction spoils
	Solid waste from worker colonies, construction sites
B. Water Resources & Water Quality	
Construction Phase	Water quality impacts due to disposal of wastewater from worker camps and construction sites, spoils.
	Depletion of groundwater resources
Operation Phase	Drainage, Water requirement, and Disposal of waste water
C. Air Pollution	
Construction Phase	Impacts due to emissions generated by construction machinery

ASPECT OF ENVIRONMENT	LIKELY IMPACTS
	Fugitive emissions from various sources
D. Noise Pollution	
Construction Phase	Noise due to operation of various equipment
	Noise due to increased vehicular movement
	Noise due to DG sets
Operation Phase	Noise from Metro operation
	Noise due to DG sets
E. Ecology	
Construction Phase	Removal of vegetation cover/loss of biomass
F. Socio-Economics	
Construction Phase	Improved employment potential during project construction phase
	Development of allied sectors leading to greater employment
	Pressure on existing infrastructure facilities
Operation Phase	Increase in Employment Opportunities in direct and indirect sectors
	Increased revenue from business development

TABLE 3.2
ENVIRONMENTAL ATTRIBUTES AND FREQUENCY OF MONITORING

S. NO	ATTRIBUTE	PARAMETER	FREQUENCY	SOURCE
LAND ENVIRONMENT				
1	Soil	Soil Characteristics	Once	Literature review and Secondary data
2	Geology	Geological History	---	Literature review
3	Seismology	Seismic Hazard	---	Literature review
WATER ENVIRONMENT				
4	Water Quality	Physical, Chemical and Biological parameters	One Season	Field studies/literature review
AMBIENT ENVIRONMENT				
5	Ambient Air Quality	$PM_{2.5}$, PM_{10}, SO_2,,NO_2, CO, HC, O_3, Pb, and NH_3	One Seasons	Field Studies
6	Meteorology	Temperature, Relative humidity, Rainfall, wind direction and speed	Data	India Meteorological Department/literature review
7	Noise	Noise levels in dB (A)	One Seasons	Field studies
8	Vibration	Peak Particle Velocity (VdB) in mm per second	Once	Field monitoring & modeling
SCIO-ECONOMIC				
9	Socio-economic aspects	Socio-economic characteristics	Once	Field Studies, Literature review.
ECOLOGY				
10	Ecology	Flora & Fauna	Data Collection	Literature and Field observations

3.2. LAND ENVIRONMENT

The land environment primarily consists of physiography, geology & minerals, soil and land use parameters.

3.2.1. Physiography

The Project area is situated in Ahmedabad, which is the largest city and former capital of the Gujarat State and is located on the banks of the River Sabarmati. Ahmedabad is situated on both sides of river Sabarmati. It lies between 22°55' & 23°08' North latitude and 72°30' & 72°42' East longitudes with an elevation of 53 m above msl. The sea is at a distance of about 105 km at Gulf of Khambhat. Sabarmati River is one of the longest rivers of Gujarat State, bifurcates the Ahmedabad city into eastern and western parts. The state of Gujarat can be broadly classified into following three physiographic regions[1]:

Mainland of Gujarat: Mainland Gujarat extends from Umbergaon (Maharashtra border) in the south to Mt. Abu (Rajasthan) in the north, and from hill ranges with forests in the east to the Arabian Sea, Gulf of Cambay, Saurashtra and Rann in the west.

Peninsular Gujarat: Saurashtra (earlier known as Kathiawar), the Peninsular Gujarat, is bounded on three sides by waters of sea, viz. In the north by the Gulf of Kutch with some part by the Little Rann, in the west and south by the Arabian Sea, and in the Southeast by the Gulf of Cambay; while in the east is the alluvial tract of the Mainland of Gujarat.

Kutch Area of Gujarat: The region of Kutch in the north-eastern part of Gujarat State forms an independent geographical and geological unit. It has an international border in the north with Pakistan, making it strategically important. The area covered by Kutch is 44,203 sq km.

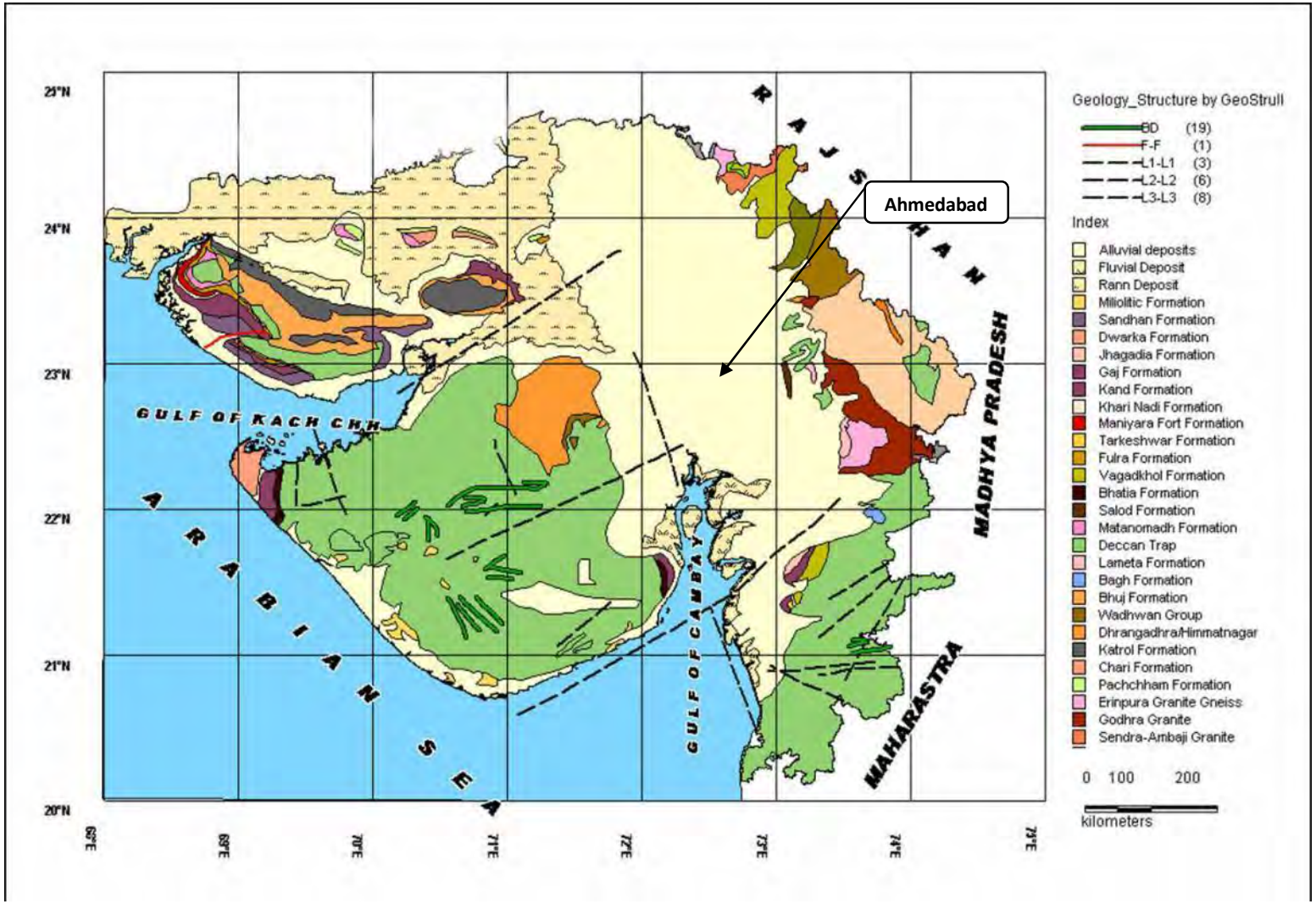
The district of Ahmedabad and the project area falls in Mainland Gujarat. Physiographically, the Mainland Gujarat comprises a vast alluvial plain covering nearly 83,528 sq. km with a hilly terrain in the east. This alluvial plain is mainly formed by the rivers Indus, Sabarmati, Mahi, Narmada and Tapi.

3.2.2. Geology and Soils

Geologically Gujarat provides a wide spectrum of rock types of different ages. Whereas the Aravallies in the NE is as old as 2500 million years, the unconsolidated alluvium and beach material in its Central and Western parts, date back to a few thousand years only. All the important lithological types Ignious, Sedimentry and Metamorphic occur within the state. The Gujarat state exposes rocks belonging to the Pre-cambrian, Mesozoic and Cenozoic era. The hard rocks cover about 49% of the total area of Gujarat,the rest being occupied by sediments of Quaternary period. The hard rock comprises Pre cambrian metamorphosed and associated intrusives, sedi- mantry rocks of Mesozoic and Cenozoic eras and the traps/flows constituting Deccan volcanic of Cretaceous Eocene age[2]. The different geological formations occurring in various parts of Gujarat are shown in **Figure 3.1**.

[1] Physical Geology of Gujarat by V N Kulkarni, Sr. Geologist, ERI, PWD, Gujarat State
[2] Narmada, water resources, water supply and Kalpsar Department

FIGURE 3.1
GEOLOGICAL MAP OF GUJARAT



The major portion of the district is covered by recent and sub-recent formations. The area is almost flat, covered by brown sandy and clayey soil and has a gentle southerly and south westerly slope. It forms part of Camby Basin. The sub surface stratigraphy along with average thickness of different formations and general lithology of the Tertiary sediments met with in the district are given in **Table 3.3** based on electrology and rock cuttings and core data[3]. The geotechnical investigation of study shows that, the project site area is covered with deep layers recently placed alluvial sands.

TABLE 3.3
GEOLOGICAL FORMATIONS OF AHMEDABAD DISTRICT

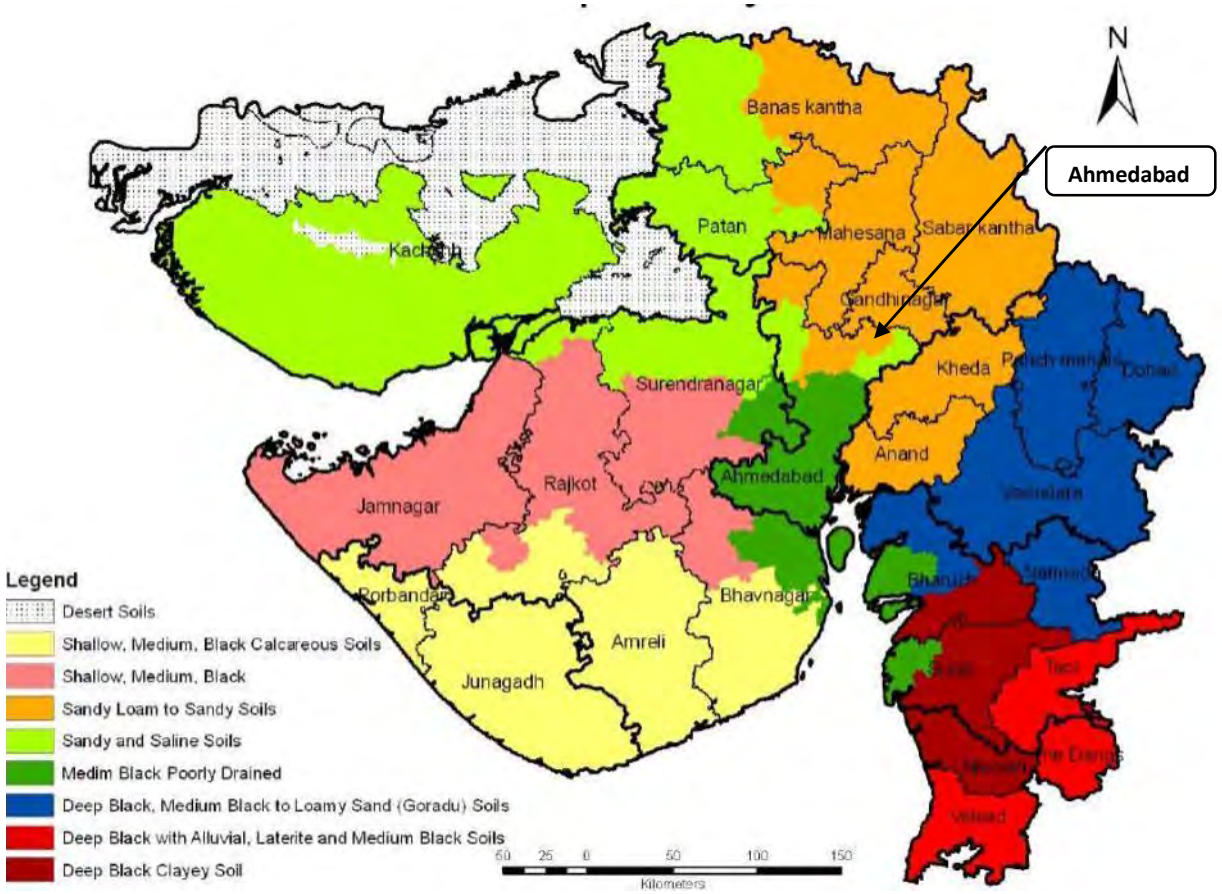
Age	Formation	Thickness in M	Lithology
Holocene	Alluvium		Soil, Alluvium and Brown Sand
Post Miocene	Gujarat Alluvium	100	Unconsolidated coarse sand, pebbly with kankar and minor clays
	Jambusar	100	Sand, coarse grained, occasional gravels and clays
	Broach (Bharuch)	125	Greenish brown clays and sand clay alternations with variegated clay stone
	Jhagadia	300	Greenish grey to variegated clay stone with coarse to medium to fine grained sands
Miocene	Kand	200	Greenish grey clay stone with occasional, banks of medium to fine grained sands
	Babaguru	125	Alternate bands of clay stone and shale with minor sand stone beds
	Tarkeswar	125	Shale with minor clay stones with coarse to medium grained sands
Oligocene to upper Eocene	Tarapur shale	175	Grey to greenish grey shale with argillaceous sandstone in the basal part
Upper Eocene to middle Eocene	Kalol	250	Grey to dark grey shale with siltysand stone, silt stone and coal beds with minor sidreitic clay stone and oolite with sideritic matric in Bavla and Ambliara areas
Lower Eocene	Cambay Shale Vagadkhol	1500	Dark grey to black fissible, Pyritic, carbonaceous shale with occasional silt stone bands towards bottom and reddish brown shale. The Cambay shale facies changes towards the basin margin to Vagadkhol formation with the lithology of Trapconglomerate, trapwash and brown clay/clay stone.

3.2.3. Soils

Deep black and coastal alluvium soils are predominant in South Gujarat; Medium black is prevalent in Middle Gujarat; grey brown and coastal alluvium soils are in North and North ï east while the Saurastra Peninsula has calcareous medium black and to some extent coastal alluvial soils. The proposed project area falls in North Gujarat Region of very deep soil to moderately deep soil. The nature of the soil in Ahmedabad district is brown sandy and clayey soil. A major texture of the soil in the region is 'Loamy'. Soil map of Gujarat state is shown in **Figure 3.2**. Soil details of the Ahmedabad district are given in **Table 3.4**.

[3] Gazetteer of India, Gujarat State, Ahmadabad District

FIGURE 3.2
SOIL MAP OF GUJARAT



Source: Based on data provided by Department of Agriculture, Gujarat

TABLE 3.4
SOIL DETAILS OF AHMEDABAD DISTRICT

S. No	Type of Soil	Area (lakh ha)	% of Total
1.	Black Soil	84.0	15.64
2.	Medium Black	284.9	52.91
3.	Sandy Loam	159.0	29.59
4.	Sandy	10.0	1.86
	Total	**537.9**	**100**

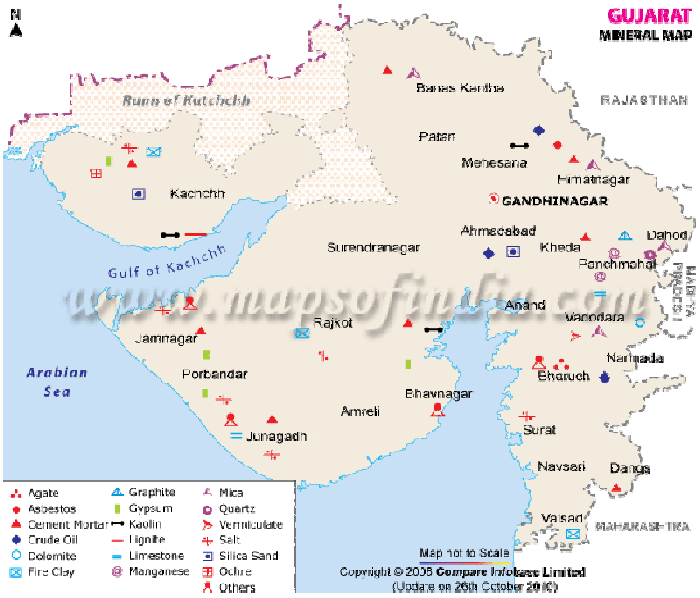
Source: Department of Agriculture & Cooperation, Ministry of Agriculture: http://agricoop.nic.in/

3.2.4. Minerals

The state of Gujarat is endowed with a number of mineral deposits viz., bauxite, bentonite, base metals, fireclay, fluorite, fuller's earth, limestone, chalk, glass sand, manganese, graphite, lignite, petroleum and natural gas, building and dimension stones. Mineral map of Gujarat state is shown in **Figure 3.3**.

Ahmedabad district is not much important in respect of mineral resources except oil and gas. However the important economic minerals available in the district are sand, kankar, gravel, brick earth and limestone. The Sabarmati River is the main source for the production of sand, kankar and gravel.

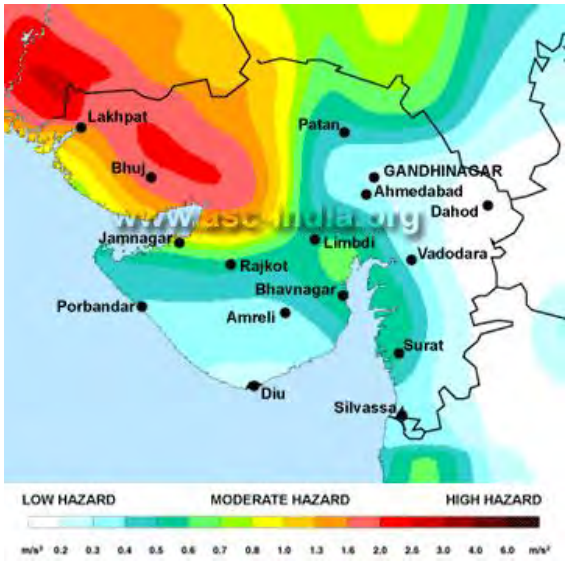
FIGURE 3.3
MINERAL MAP OF GUJARAT



3.2.5. Seismicity

The state of Gujarat falls in a region of moderate to high seismic hazard as per Global Seismic Hazard Assessment Program (GSHAP) data. Seismic hazard map of Gujarat state is shown in **Figure 3.4** and Earthquakes of magnitude more than 5 occurred in the region are given in **Table 3.5**[4]. An unprecedented devastating earthquake of the magnitude 7.7 occurred at 08.46 hrs on January 26, 2001 at Bhuj area of Gujarat. It was one of the worst calamities in the history of Gujarat. As per the revised seismic zoning map of India (IS-1893: Part-I: 2002); the state of Gujarat falls in zone II, III, IV and V; and the project area of the proposed metro falls in Zone III of the classification. Seismic zoning map of Gujarat state is shown in **Figure 3.5**.

FIGURE 3.4
SEISMIC HAZARD MAP OF GUJARAT STATE



[4] http://asc-india.org

TABLE 3.5
IMPORTANT EARTHQUAKES IN THE REGION

S. No	DATE	LOCATION	MAGNITUDE	LATITUDE	LONGITUDE
1.	16-Jun-1819	Rann of Kachchh, Gujarat	8.2	23.60 N	69.60 E
2.	14-Jan-1903	Kunria area, Gujarat	6.0	24.000 N	70.000 E
3.	15-Aug-1906	North of Bakhasar, Rajasthan	6.2	27.500 N	70.250 E
4.	12-Jul-1907	Tharpakar, Pakistan	5.6	25.000 N	70.000 E
5.	1940	Umia-Luna area, Gujarat	5.8	23.700 N	69.100 E
6.	27-Nov-1945	Off the Makran coast, Pakistan	8.0	24.500 N	63.000 E
7.	14-Jun-1950	Tharad-Jhajham area, Gujarat	5.6	24.000 N	71.200 E
8.	21-Jul-1956	Bhadreshwar-Anjar area, Gujarat	6.0	23.000 N	70.000 E
9.	01-Sep-1962	Khed Brahma-Vadali area, Gujarat	5.0	23.000 N	73.000 E
10.	23-Mar-1970	Ankleshwar-Bharuch area, Gujarat	5.4	21.600 N	72.960 E
11.	26-Jan-2001	Bhachau-Chobari (Bhuj) area, Gujarat	7.7	23.442 N	70.310 E
12.	28-Jan-2001	Suvi-Rapar area, Gujarat	5.8	23.532 N	70.598 E
13.	08-Feb-2001	Suvi-Chobari area, Gujarat	5.1	23.693 N	70.400 E
14.	05-Aug-2003	Suvi area, Gujarat	5.0	23.640 N	70.230 E
15.	07-Mar-2006	Mouna area, Gujarat	5.5	23.768 N	70.853 E
16.	06-Apr-2006	Vondh area, Gujarat	5.5	23.308 N	70.444 E
17.	20-Oct-2011	Sasan Gir region, Gujarat	5.0	21.181 N	70.540 E

3.3. WATER ENVIRONMENT

Water environment consists of water resources and its quality. Its study is important from the point of view to assess the sufficiency of water resources for needs of the project in its various stages and the impact of the project on water environment. In the proposed project area, surface and ground water quality have been tested to evaluate its suitability for the intended purpose.

3.3.1. Water Resources

The most important surface water body in the Ahmedabad area is the river Sabarmati. The Khari River runs almost parallel to the Sabarmati towards east, beyond the city limits. One of the oldest irrigation schemes of Gujarat ô Kharicut canal schemeô passes through eastern part of Ahmedabad City, which also serve as ôStorm Water Drainageô during monsoon. The Kankaria and the Chandola are two important ponds in the Ahmedabad city area.

3.3.2. Drainage

The drainage system of the district is controlled by the topography. Rivers, streams and ponds are the important drainage basins of the district. River basin map of Gujarat state is shown in **Figure 3.6**. The rivers in the district are Sabarmati, Khari, Meshvo, Bhogavo, Omkar, Bhadar, Nalika, Utavli, and Rodh. The drainage of the district is towards south.

FIGURE 3.5
SEISMIC ZONING MAP OF GUJARAT STATE

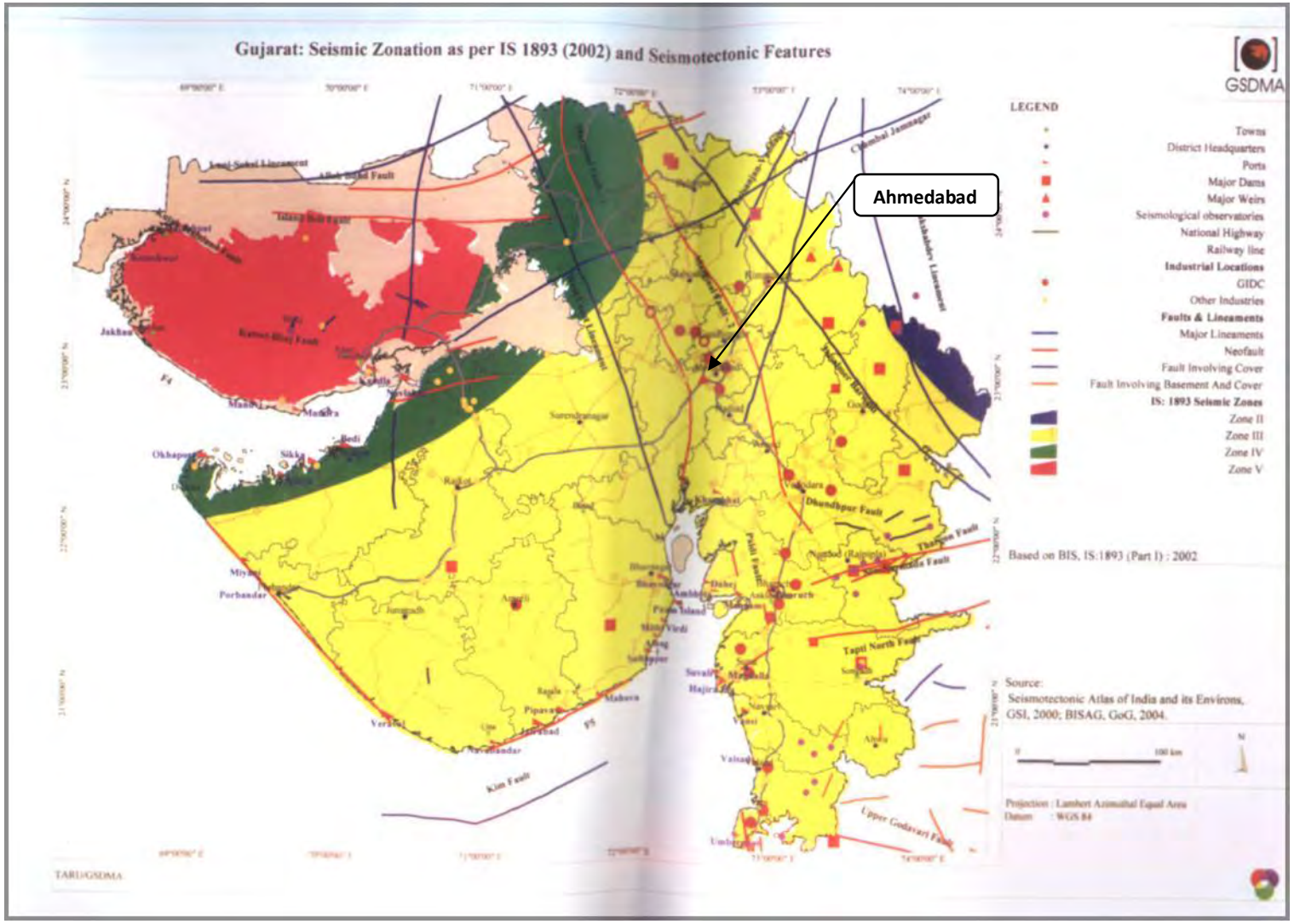
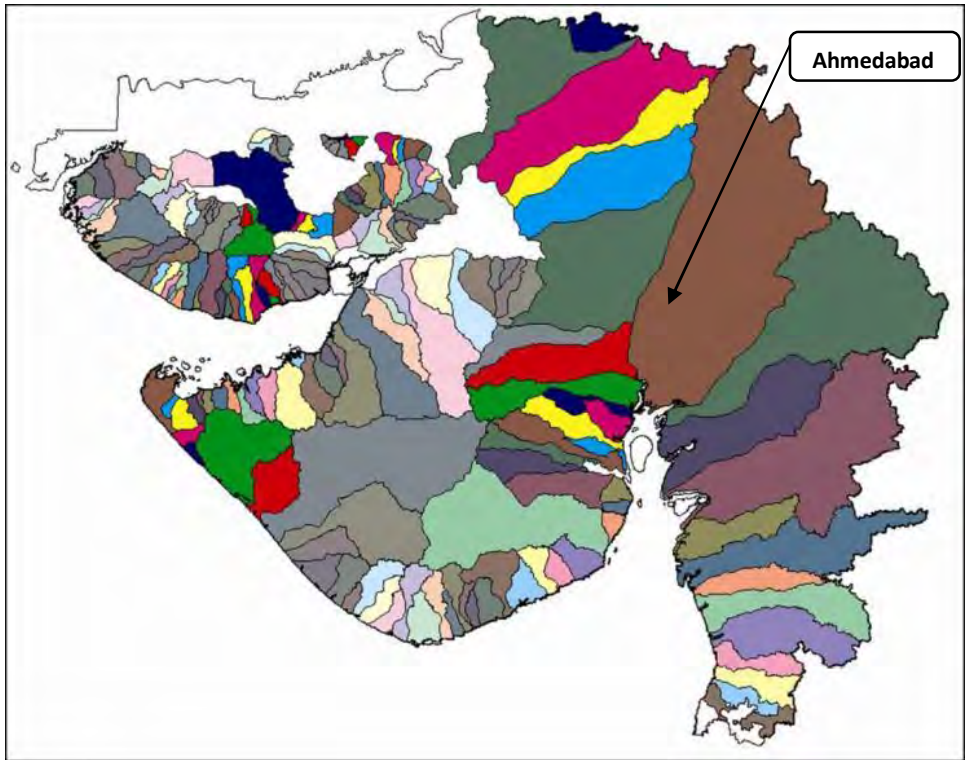


FIGURE 3.6
RIVER BASIN MAP OF GUJARAT STATE



3.3.3. Water Quality of the Project Area

In order to assess the baseline water quality status of the study area, 8 samples (5 samples on E-W corridor and 3 samples on N-S corridor) were collected in the project area. The sample locations are shown in **Figure 3.7** and description of water quality monitoring locations are given in **Table 3.6**. The samples were analyzed for physical and chemical constituents for the purpose of domestic and irrigation use. The results of water analysis are compared with CPHEEO manual for Drinking Water Specifications. The results of analysis are presented in **Table 3.7**.

TABLE 3.6
DESCRIPTION OF WATER QUALITY MONITORING LOCATIONS

S. No	Location	Alignment	Chainage in km	Environmental Setting
1.	Thaltej	E-W	-0.400	Ground Water from Bore Well
2.	Gurukul	E-W	3.000	Ground Water from Bore Well
3.	Sabarmati River	E-W	7.500	Surface Water from River
4.	Apparel Park	E-W	13.900	Tap Water
5.	Vastral Gam	E-W	19.900	Ground Water from Bore Well
6.	Ayojan Nagar	N-S	5.150	Ground Water from Bore Well
7.	AEC	N-S		Ground Water from Bore Well
8.	Motera Stadium	N-S		Ground Water from Bore Well

The results of analysis of water samples indicates that all the parameters are within the permissible limits except Hardness for sample locations 5, 6, 7 and 8; Calcium at location 2; Magnesium at locations 2 and 6; TDS, chloride and Alkalinity at locations 2, 5, 6, 7 and 8; and Coliform at locations 3, 4 and 5. Water from these sources should be treated before using it for drinking purposes.

FIGURE 3.7
ENVIRONMENTAL MONITORING LOCATIONS

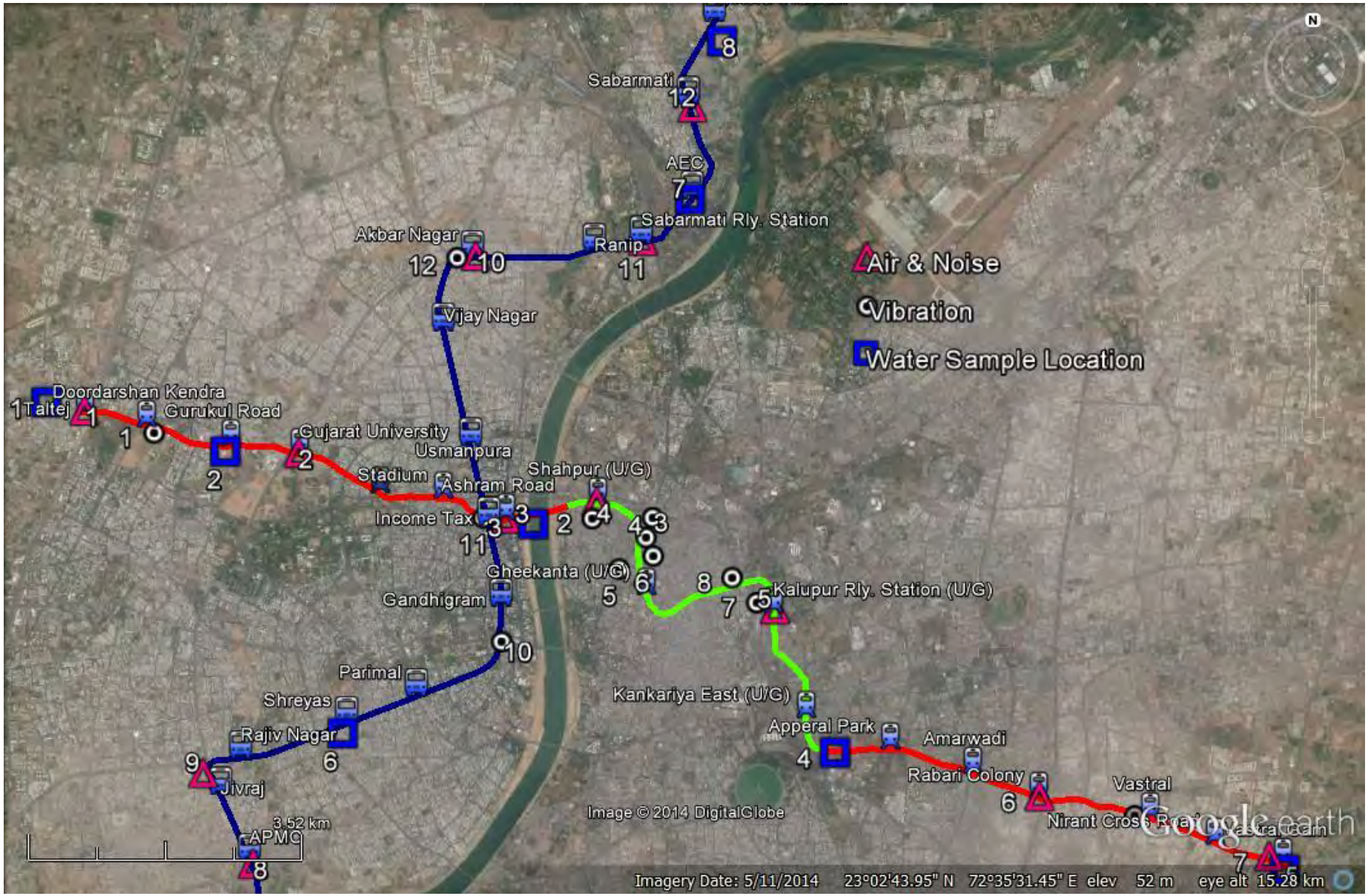


TABLE 3.7
PHYSICO-CHEMICAL ANALYSIS OF WATER SAMPLES IN PROJECT AREA

S. No	PARAMETER	UNITS	1	2	3	4	5	6	7	8	Acceptable/Permissible Limits
1.	pH at $25^{O}C$	-	7.91	7.32	7.23	7.72	7.56	8.19	8.20	8.23	6.5-8.5/No relaxation
2.	Total Hardness as $CaCO_3$	mg/l	106.7	363.8	117.6	106.7	208.6	247.5	257.4	356.4	200/600
3.	Calcium as Ca	mg/l	27.2	93.3	27.2	27.2	52.5	47.6	55.6	59.5	75/200
4.	Magnesium as Mg	mg/l	9.4	32.0	11.8	9.4	19.0	31.3	29.0	50.6	30/100
5.	Total Dissolved Solids	mg/l	182.0	1344.0	294.0	318.0	1092	1296	1554	2154	500/2000
6.	Chloride as Cl	mg/l	19.4	398.2	21.9	19.4	252.5	306.0	340.0	684.8	250/1000
7.	Fluoride as F	mg/l	<1.0	>1.0	<1.0	<1.0	<1.0	>1.0	>1.0	>1.0	1.0/1.5
8.	Sulphate as SO4	mg/l	7.4	68.5	9.3	10.0	57.0	69.2	156.0	106.6	200/400
9.	Total Alkalinity as $CaCO_3$	mg/l	112.2	438.6	117.3	117.3	510	295.8	448.8	387.6	200/600
10.	Nitrate as NO3	mg/l	BDL	4.0	BDL	BDL	BDL	BDL	BDL	BDL	45/No relaxation
11.	Aluminium as Al	mg/l	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.03/0.2
12.	Arsenic as As	mg/l	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.01/0.05
13.	Cadmium as Cd	mg/l	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.003/ No relaxation
14.	Copper as Cu	mg/l	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.05/1.5
15.	Lead as Pb	mg/l	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.01/ No relaxation
16.	Mercury as Hg	mg/l	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.001/ No relaxation
17.	Nickel as Ni	mg/l	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.02/ No relaxation
18.	Zinc as Zn	mg/l	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	5.0/15
19.	Iron as Fe	mg/l	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.3/ No relaxation
20.	Total Chromium as Cr	mg/l	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.05/ No relaxation
21.	Manganese as Mn	mg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1/0.3
22.	Phenolic Compounds as C_6H_5OH	mg/l	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.001/0.002
23.	Total Phosphate as PO_4	mg/l	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	-
24.	Sodium as Na	mg/l	11.9	320.0	13.7	13.6	320.0	302.5	360.0	610.0	-
25.	Potassium as K	mg/l	0.71	2.5	1.0	0.81	2.0	1.04	1.87	1.36	-
26.	Chemical Oxygen Demand	mg/l	8.0	89.0	35.0	19.0	3.9	16.0	8.0	8.0	-
27.	Biochemical Oxygen Demand	mg/l	3.0	26.0	12.0	8.0	1.0	5.0	2.0	2.1	-
28.	Total Suspended Solids	mg/l	7.0	9.0	18.0	7.0	8.0	10.0	8.0	6.0	-
29.	Dissolved Oxygen	mg/l	6.4	5.1	5.9	6.1	6.5	5.6	6.3	6.2	-
30.	Total Coliform		Absent	Absent	Present	Present	Present	Absent	Absent	Absent	Shall not be detected in any 100 ml sample

1. Thaltej Gam GW 2. Gurukul GW 3. Sabarmati River SW 4. Apparel Park TW 5. Vastral Gam GW 6. Ayojan Nagar GW 7. AEC GW
8. Motera Stadium GW

GW - Ground Water SW - Surface Water TW - Tap Water

3.4. AMBIENT ENVIRONMENT

The ambient environment is responsible for the health of human beings, animals, wildlife and vegetation. The ambient environment covers climate, atmospheric pollution and noise pollution. All air pollutants emitted by point and non-point sources are transported, dispersed or concentrated by meteorological and topographical conditions. The meteorological parameters regulate the transport and diffusion of pollutants into the atmosphere. In order to assess the impact on existing ambient environment due to the project, it is necessary to have baseline status of ambient environmental parameters. Meteorological data on rainfall, wind, humidity, and temperature was collected from secondary sources. The ambient environmental status existing in the project area is discussed in different paragraphs as under.

3.4.1. Meteorology

Ahmedabad district falls in North Gujarat region of Agro Climatic Region as shown in **Figure 3.8**. The district has arid to semi-arid climate with an average annual rainfall of about 756 millimeters. There are three main seasons: summer, monsoon and winter. Aside from the monsoon season, the climate is extremely dry. The weather is hot through the months of March to June; the average summer maximum is 41 °C and the average minimum is 27 °C. From November to February, the average maximum temperature is 30 °C and the average minimum is 15 °C; and the climate is extremely dry. Cold northerly winds are responsible for a mild chill in January. The southwest monsoon brings a humid climate from mid-June to mid-September.

FIGURE 3.8
AGRO CLIMATIC ZONES OF GUJARAT STATE

Meteorological data like rainfall normal of the district for a period of 1941 - 1990 and normals of other parameters for a period of 1971 - 2000 are given in **Table 3.8**. From the table, the temperature of the district varies from 23.7 - 41.6^{O}C in summer to a minimum of around 12.0 -16.6^{O}C in winter and Relative humidity varies from 35-80%.

TABLE 3.8
METEOROLOGICAL DATA

MONTH	RAINFALL IN MM	TEMPERATURE IN ^{o}C			RELATIVE HUMIDITY IN %	WIND SPEED IN KM/HR	CLOUD IN OCTAS
		Mean	Max	Min			
JAN	1.8	20.1	28.2	12.0	49.3	7.5	1.4
FEB	0.6	22.3	30.6	14.0	41.9	8.1	1.4
MAR	0.6	27.5	35.8	19.2	35.6	9.0	1.6
APR	1.7	31.8	39.8	23.7	38.7	10.1	1.5
MAY	6.6	34.1	41.6	26.6	46.0	12.4	1.7
JUN	81.1	32.9	38.5	27.3	66.3	12.1	4.5
JUL	249.3	29.6	33.5	25.8	77.1	10.4	6.4
AUG	209.7	28.5	32.0	24.9	79.7	9.0	6.5
SEPT	119.2	29.1	33.8	24.4	70.9	8.0	4.2
OCT	13.6	28.6	35.9	21.3	53.1	5.3	1.9
NOV	8.3	24.8	33.0	16.6	46.6	5.6	1.5
DEC	2.4	21.4	29.6	13.1	48.8	6.6	1.6

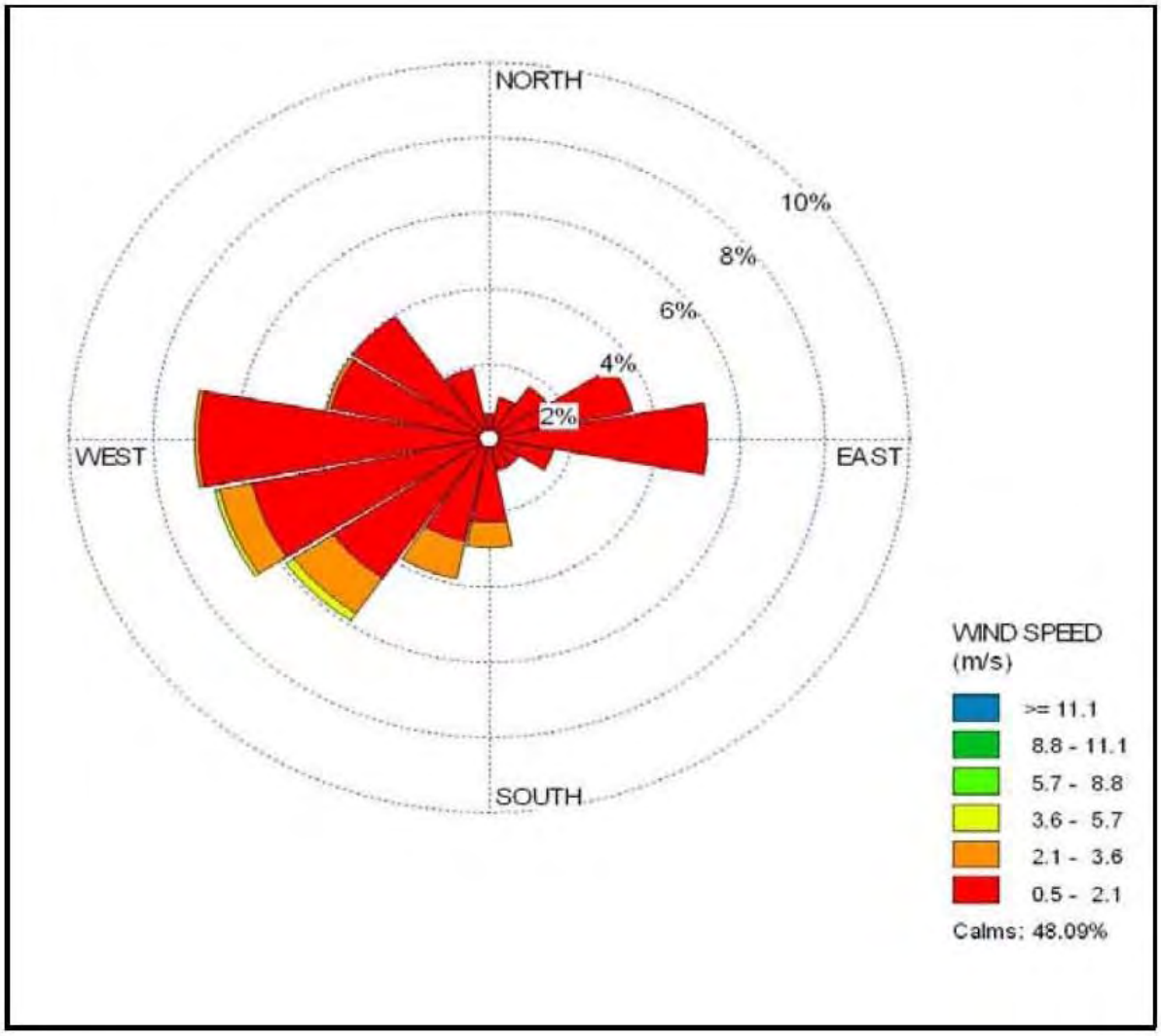
Source: Indian Meteorological Department, Pune

From DPR of the proposed metro project, the temperature and rainfall data of years 1901 to 2000 are given in **Table 3.9** and wind rose diagram for the year 2012 is given in **Figure 3.9**. From the figure, the predominant wind direction is West and WSW.

TABLE 3.9
MONTHLY MEAN MAXIMUM & MINIMUM TEMPERATURE AND TOTAL RAINFALL

Month	Max. Mean Temperature ^{o}C	Min. Mean Temperature ^{o}C	Mean Rainfall, mm
January	28.7	13.1	2.1
February	31.0	14.8	1.2
March	35.9	19.4	1.1
April	39.5	23.5	1.9
May	41.4	26.3	9.1
June	38.5	27.2	97.4
July	33.5	25.7	309.8
August	32.0	24.9	213.8
September	33.5	24.4	126.6
October	35.8	21.9	13.5
November	33.2	17.5	6.1
December	29.9	14.1	1.7

FIGURE 3.9
WINDROSE DIAGRAM FOR YEAR 2012



3.4.2. Air Quality

The prime objective of baseline air quality survey was to assess the air quality of the area; it would also be useful in assessing the conformity to standards of the ambient air quality. The sources of air pollution during the construction phase would be due to the site clearance & preparation activities, material handling activities, emissions from construction equipment & vehicular movement, and operation of diesel generators.

Air quality monitoring was carried out at 12 locations along the project alignments (E-W and N-E corridor) for one day. The sample locations are shown in **Figure 3.7** and description of Air quality monitoring locations are given in **Table 3.10**. Nine major air pollutants viz. particulate matter (PM_{10} & $PM_{2.5}$), Sulphur Dioxide (SO_2), Nitrogen Dioxide (NO_2), Carbon Monoxide (CO), Lead (Pb), Hydro Carbons (HC), Ammonia (NH_3) and Ozone (O_3) representing the air quality was monitored. Air quality monitoring was carried out by collecting 24 hourly samples for 1 day at 12 locations for parameters PM_{10}, $PM_{2.5}$, SO_2, NO_2, NH_3, Pb, and HC; and 8 hourly samples for 1 day at 12 locations for Parameters CO and O_3. Results of the monitoring are tabulated in **Table 3.11**.

TABLE 3.10
DESCRIPTION OF AIR QUALITY MONITORING LOCATIONS

S. No	Location	Alignment	Chainage in km	Environmental Setting
East - West Alignment				
1.	Thaltej	E-W	1.04	Residential/Commercial
2.	Gujarat University	E-W	3.97	Residential/Commercial
3.	Ashram Road	E-W	6.87	Residential/Commercial
4.	Shahpur	E-W	8.12	Residential/Commercial
5.	Kalupur Rly. Stn	E-W	11.78	Residential/Commercial
6.	Rabari colony	E-W	16.56	Residential/Commercial
7.	Vastral Gam	E-W	20.00	Residential/Commercial
North - South Alignment				
8.	APMC	N-S	2.10	Residential/Commercial
9.	Shyamprasad ROB	N-S	3.40	Residential/Commercial
10.	Akbar Nagar	N-S	12.95	Residential/Commercial
11.	Sabarmait Rly. Stn	N-S		Residential/Commercial
12.	Sabarmati	N-S		Residential/Commercial

TABLE 3.11
AMBIENT AIR QUALITY MONITORING RESULTS

LOCATION	DATE	CONCENTRATION*								
		PM_{10}	$PM_{2.5}$	SO_2	NO_2	Pb	HC	NH_3	CO	O_3
East - West Alignment										
Thaltej	28/09/14 to 29/096/14	189	97	7.6	34.2	ND	4.2	9.4	1.21	13.10
Gujarat University	28/09/14 to 29/096/14	178	92	<5.0	25.7	ND	4.8	5.9	1.18	13.73
Ashram Road	24/09/14 to 25/096/14	128	72	<5.0	28.2	ND	3.6	5.8	1.18	16.13
Shahpur	25/09/14 to 26/096/14	214	92	<5.0	30.2	0.32	6.8	7.3	1.20	19.83
Kalupur Rly. Stn	26/09/14 to 27/096/14	221	98	<5.0	32.8	0.47	7.5	8.3	1.25	18.93
Rabari colony	26/09/14 to 27/096/14	172	85	<5.0	26.7	ND	5.2	6.9	1.16	16.27
Vastral Gam	26/09/14 to 27/096/14	139	73	<5.0	23.8	ND	4.6	6.8	1.13	14.63
North - South Alignment										
APMC	27/09/14 to 28/096/14	176	84	<5.0	24.2	ND	4.6	7.4	1.14	14.40
Shyamprasad ROB	27/09/14 to 28/096/14	157	78	19.3	25.8	ND	5.3	7.4	1.05	11.90
Akbar Nagar	28/09/14 to 29/096/14	187	81	<5.0	27.8	ND	4.3	6.8	1.25	15.27
Sabarmait Rly. Stn	27/09/14 to 28/096/14	211	97	8.3	28.5	0.42	6.2	7.4	1.21	14.50
Sabarmati	28/09/14 to 29/096/14	191	89	<5.0	26.3	ND	4.8	6.3	1.18	14.70

* **All units are in $\mu g/m^3$ except CO which is in mg/m^3**

The air quality monitoring results indicates that all parameters were noted within the limits for residential areas except PM10 and PM2.5 because of the road traffic. The ambient air quality criteria laid down by CPCB has been given in Appendix 1.4 of Chapter - 1.

3.5. Noise Environment

Noise beyond tolerance limit can lead to effects such as noise induced hearing loss and annoyance depending upon the loudness of noise levels. The environmental impacts of noise from the proposed construction activity and traffic movement are required to be assessed on factors like potential damage to hearings, psychological responses and annoyances. Noise is of concern during construction phase of the project. The impacts of noise sources on surrounding community depend upon:

- Characteristics of noise sources (instantaneous, intermittent or continuous in nature). It can be observed that steady noise is not as annoying as one, which is continuously varying in loudness.
- Time of day at which noise occurs, for example high noise levels at night in residential areas are not acceptable because of sleep disturbance.
- Location of noise source, with respect to noise sensitive land use, which determines the loudness and period of exposure.

Noise level survey was conducted at the project site with an objective to establish the baseline noise levels and assess the impacts of the noise expected due to the proposed development. Noise levels were recorded on hourly basis for 24 hours in order to have an assessment of the Day and Night time noise levels. The sample locations are shown in **Figure 3.7** and description of Noise monitoring locations are given in **Table 3.12**. The average noise levels so obtained are summarized in **Table 3.13**. The ambient noise quality criteria laid down by CPCB has been given in Appendix 1.5 of Chapter - 1.

TABLE 3.12
DESCRIPTION OF NOISE QUALITY MONITORING LOCATIONS

S. No	Location	Alignment	Chainage in km	Environmental Setting
East - West Alignment				
1.	Thaltej	E-W	1.04	Residential/Commercial
2.	Gujarat University	E-W	3.97	Residential/Commercial
3.	Ashram Road	E-W	6.87	Residential/Commercial
4.	Shahpur	E-W	8.12	Residential/Commercial
5.	Kalupur Rly. Stn	E-W	11.78	Residential/Commercial
6.	Rabari colony	E-W	16.56	Residential/Commercial
7.	Vastral Gam	E-W	20.00	Residential/Commercial
North - South Alignment				
8.	APMC	N-S	2.10	Residential/Commercial
9.	Shyamprasad ROB	N-S	3.40	Residential/Commercial
10.	Akbar Nagar	N-S	12.95	Residential/Commercial
11.	Sabarmait Rly. Stn	N-S		Residential/Commercial
12.	Sabarmati	N-S		Residential/Commercial

TABLE 3.13
NOISE LEVELS IN THE PROJECT AREA

LOCATION	Date	Leq	Leq (day)	Leq (night)	Ldn	Lmax	Lmin	L_{90}	L_{50}	L_{10}
East - West Alignment										
Thaltej	28/09/14 to 29/096/14	63.4	65.0	51.7	64.2	68.8	44.3	64.0	66.2	68.3
Gujarat University	28/09/14 to 29/096/14	63.6	65.3	49.9	64.1	69.9	45.3	64.1	66.4	69.0
Ashram Road	24/09/14 to 25/096/14	59.7	61.3	49.5	60.8	64.4	44.6	60.2	62.3	63.8
Shahpur	25/09/14 to 26/096/14	64.1	65.7	52.5	64.9	68.8	45.6	64.6	66.8	68.6

LOCATION	Date	Leq	Leq (day)	Leq (night)	Ldn	Lmax	Lmin	L_{90}	L_{50}	L_{10}
Kalupur Rly. Stn	26/09/14 to 27/096/14	66.8	68.5	55.0	67.6	73.4	50.1	67.4	69.6	72.6
Rabari colony	26/09/14 to 27/096/14	61.8	63.4	52.7	63.2	67.2	46.2	62.4	64.4	66.4
Vastral Gam	26/09/14 to 27/096/14	58.9	60.6	46.9	59.7	63.3	43.6	59.5	61.7	62.9
North - South Alignment										
APMC	27/09/14 to 28/096/14	60.9	62.5	49.3	61.7	66.3	45.2	61.4	63.7	65.7
Shyamprasad ROB	27/09/14 to 28/096/14	57.7	59.3	47.1	58.7	62.6	44.3	58.2	60.4	61.9
Akbar Nagar	28/09/14 to 29/096/14	60.7	62.3	51.1	62.0	66.7	45.7	61.3	63.4	65.6
Sabarmait Rly. Stn	27/09/14 to 28/096/14	65.8	67.3	58.4	67.7	71.2	48.5	66.4	68.3	70.3
Sabarmati	28/09/14 to 29/096/14	64.0	65.6	53.9	65.1	71.3	47.3	64.6	66.8	70.3

From the table, Leq for day and night at Sabarmati railway station exceeds the National Ambient Noise Standards for Commercial Zone and Leq for day time at Gujarat University, Shahpur, Kalupur Railway Station and Sabarmati exceeds the standards for commercial zone. The main source of noise in the project area is the traffic movement on the road.

3.6. Vibration

The sources of the vibration and noise are due to operation of Tunnel Boring Machine (TBM) during construction of tunnel. Vibration induced by the metro train during operation is mainly due to the rolling stock, track and the interaction between them. Continuous effect of vibration on the buildings can cause damage to buildings. Building subjected to the vibration effect with more than 50 mm/s would receive structural damage. Historic buildings are more susceptible to vibration effect due to type of building material and design. The vibration induced by the operation of train first causes the vibration of track structure as well as tunnel structure, and then, propagate through the strata to the surrounding environment.

Human response to vibration is subjective and will be different for different people. When the vibrations reach the floors and walls it may result in perceptible vibration depending on the amplitude and frequency of the vibrations. Rattling of windows, dishes, and similar parts may also result in audible noise which is called ground-borne noise. People may be more annoyed if they are exposed to both noise and vibration compared to when only vibration is felt. According to the U.S. Department of Transportation, (1998) the perception threshold of humans for peak particle velocity is about 0.04 mm/s (65VdB with reference 1e-6 inch/sec).

Vibration monitoring was carried out at 12 locations for E-W corridor and N-S corridor in September 2014 by selecting the historical monuments near to the alignment and structures falling near to the proposed metro line alignment. The vibration monitoring locations are shown in **Figure 3.10** details are given in **Table 3.14**.

FIGURE 3.10
VIBRATION MONITORING LOCATIONS

TABLE 3.14
VIBRATION MONITORING LOCATIONS

S. No	Location	Latitude	Longitude	Aerial Distance From Alignment Edge
1.	Doordarshan Tower at Doordarshan Kendra	23° 02' 50.50" N	72° 31' 30.75" E	62.9
2.	Shahpur Kazi Md Chisti Mosque	23° 02' 15.58" N	72° 34' 49.56" E	159.13
3.	Delhi Darwaja	23° 02' 15.93" N	72° 35' 16.88" E	254.28
4.	Qutubiddin Shah Mosque	23° 02' 7.74" N	72° 35' 13.85" E	119.97
5.	Muhafiz Khan Mosque	23° 01' 59.91" N	72° 35' 17.08" E	211.41
6.	Rani Rupamati Mosque	23° 01' 54.51" N	72° 35' 1.68" E	210.18
7.	Kalupur Darwaja	23° 01' 50.84" N	72° 35' 52.83" E	109.34
8.	Brick Minar	23° 01' 40.45" N	72° 36' 4.03" E	184.59
9.	Vastral	23° 00' 11.53" N	72° 38' 55.06" E	11.2
10.	The Silver Arc apartment near Ellis Bridge	23° 01ô24.23òN	72° 34ô08.47òE	24
11.	Navrangpura, Ashram Road	23° 02ô15.82òN	72° 34ô00.08òE	23
12.	Akhbar Nagar	23° 04ô04.22òN	72° 33ô48.38òE	5

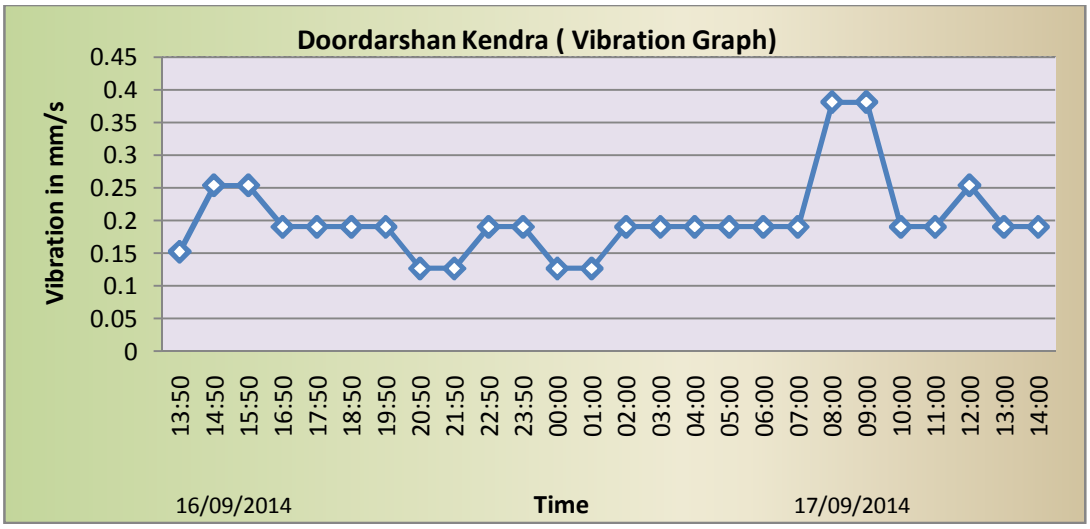
The monitoring was carried out using the Nomis Seismographer equipment which can measure the radial, transverse and vertical vibration of ground borne vibration. The vibration studies have been conducted to know the existing vibration on the above structures due to the road traffic. The study has been conducted for 24 hours at each location. The detail description of vibration analysis of each monitoring location is as follows:

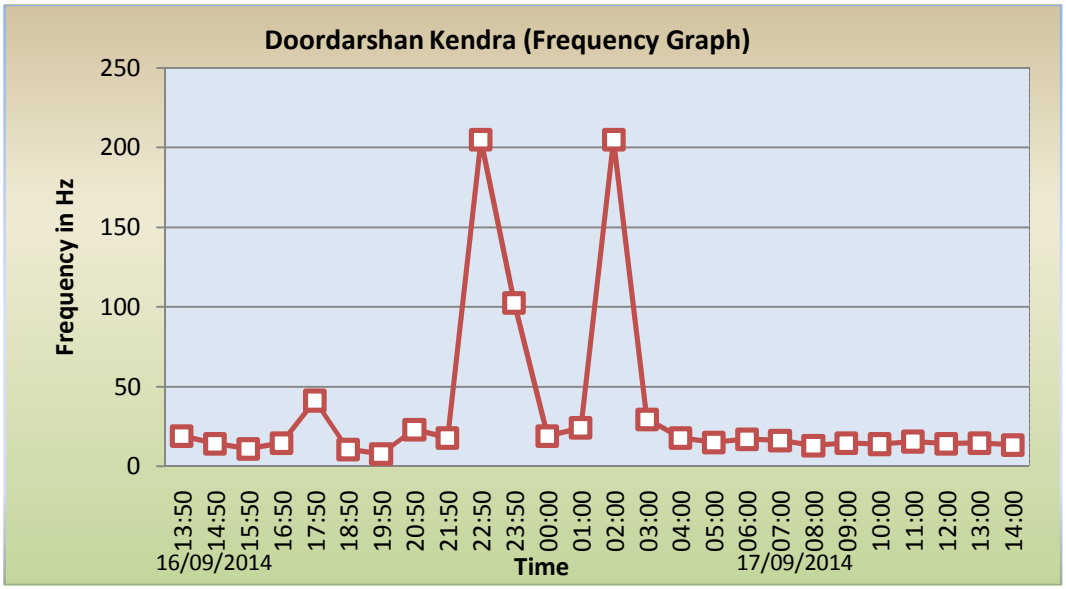
A. Doordarshan Kendra

Doordarshan Kendra was set up in 1993 and the height of the tower is 160m built with RCC and steel structure. The vibration monitoring was carried out at the first floor of the tower for 24 hr on 16/09/2014 to 17/09/2014. The first floor of the tower is at a height 30 m. The vibration monitoring location and results at Doordarshan Kendra are shown in **Figure 3.11**.

The vibration graph shows that, the average vibration is about 0.2 mm/s, which is within limits and do not have any effect on surrounding structures. From the frequency graph, it was observed that, sometime during night the frequency has increased to about 200 Hz, however when compared to vibration at same time, there was no increase in vibration levels.

FIGURE 3.11
VIBRATION MONITORING LOCATION AND RESULTS AT DOORDARSHAN KENDRA



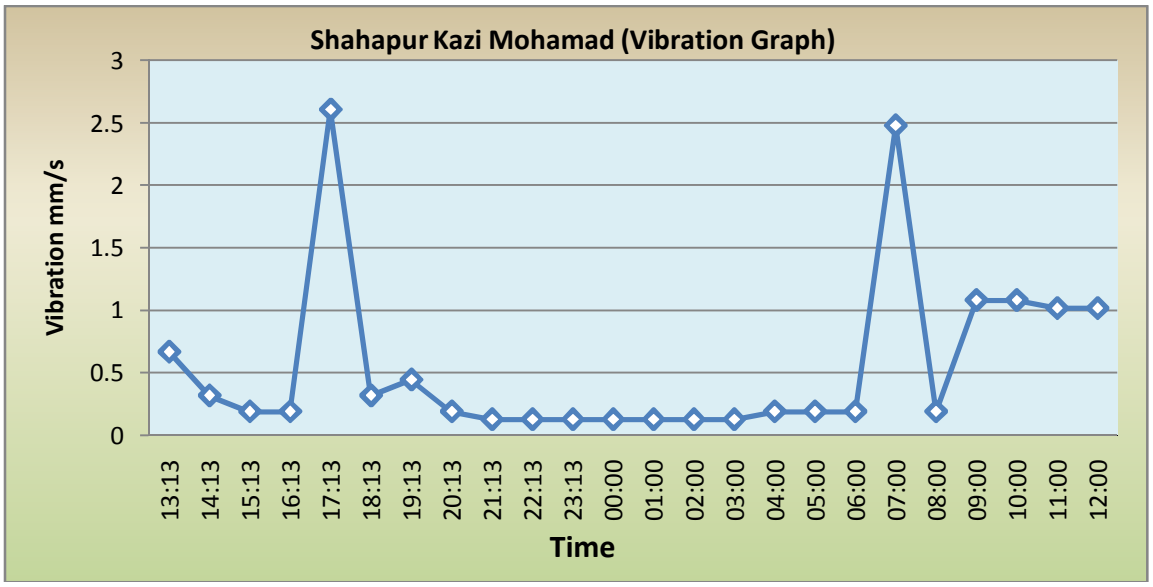


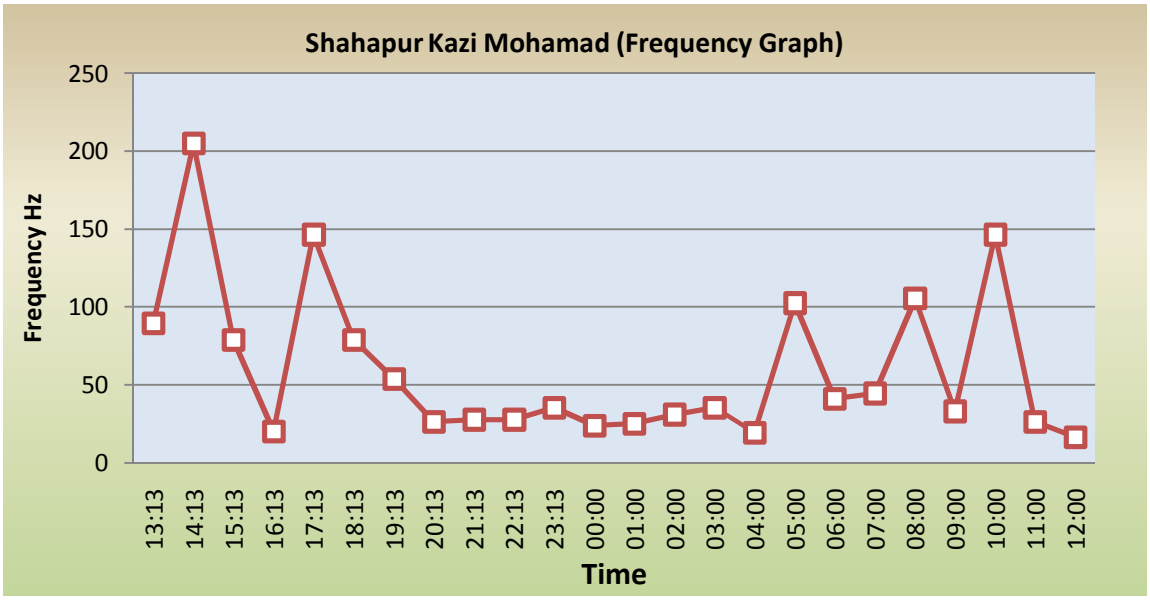
B. Shahpur Kazi Md Chisti Mosque

The Shahpur Kazi Mohamad Chisti Mosque was constructed 1510 AD. The Shahpur Kazi mosque is located in a densely populated area of Shahpur. This mosque was built with hard rocks and bricks and it is height of 15m. The proposed underground metro line is passing at a distance of 160 m from Shahpur Kazi Mohamad Chisti Mosque. The vibration monitoring was conducted within the Mosque for 24 hr on 24/09/2014 to 25/09/2014. The vibration monitoring location and results at Shahpur Kazi Mohamad Chisti Mosque are shown in **Figure 3.12**. There is no higher traffic flow near this mosque; however there are very narrow roads near this mosque.

The vibration graph shows that, the average vibration is about 0.5 mm/s. Sometimes, the peak vibration is more than 2 mm/s; this is due to dumping of material at a construction site near by the Mosque. From the frequency graph, it was observed that, the frequency is found to be high up to 200Hz at the beginning of monitoring. The average frequency is below 50 Hz.

FIGURE 3.12
VIBRATION MONITORING LOCATION AND RESULTS AT SHAHPUR KAZI MD CHISTI MOSQUE



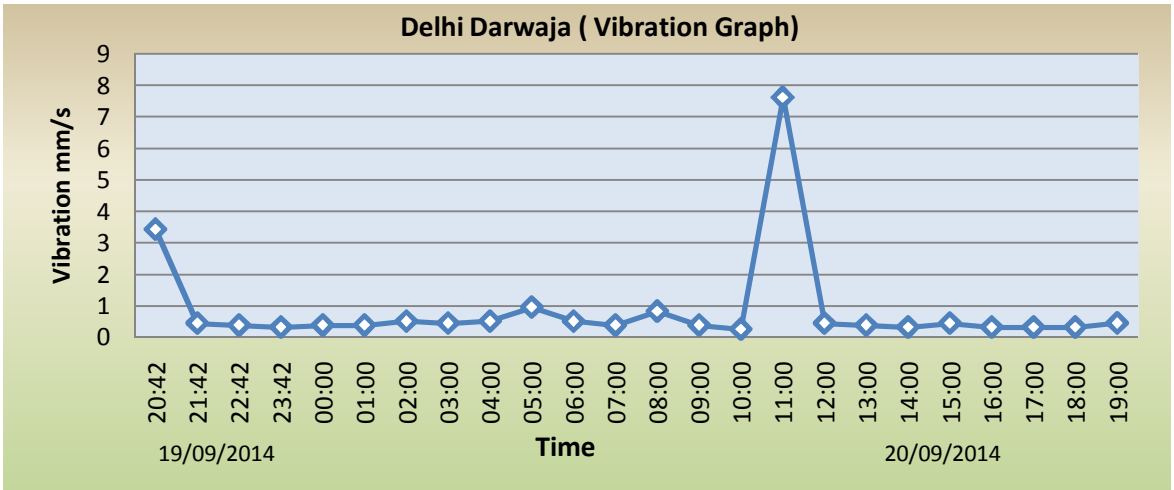


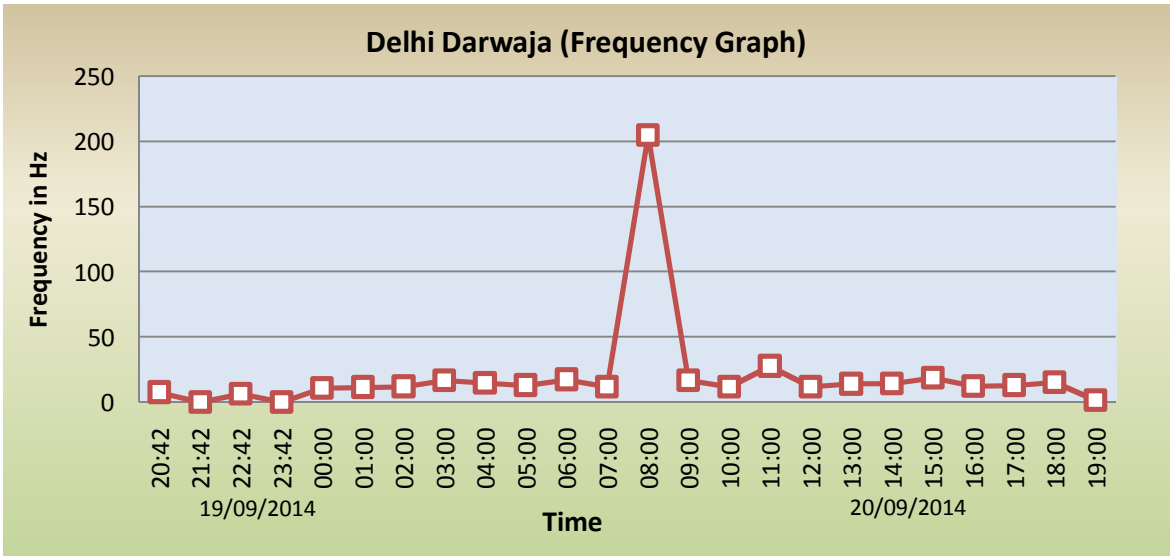
C. Delhi Darwaja

Delhi darwaja was constructed 1450 AD. Delhi Darwaja was built with bricks and stone with a height of 45 feet. The proposed underground metro line is passing at a distance of 254 m away from the Delhi darwaja. In order to know whether there could be any effect of vibration on Delhi darwaja, vibration monitoring was carried out for about 24 hr on 19/09/2014 to 20/09/2014. The vibration monitoring location and results at Delhi darwaja are shown in **Figure 3.13**.

Delhi Darwaja is located at busy traffic junction area; all types of vehicles (light to heavy) are passing through this location. The vibration graph shows that, the average vibration level are less than 1 mm/s, however at one time it is showing about 7.5mm/s which may be due to passage of heavy vehicle. The Delhi Darwaja structure is built with hard stone blocks and can withstand with vibration up to 10mm/s. From the frequency graph, it was observed that, the average frequency at Delhi darwaja is less than 30 Hz. The sudden rise in frequency at 8:0ohr is due to some sudden shock wave because of heavy vehicle.

FIGURE 3.13
VIBRATION MONITORING LOCATION AND RESULTS AT DELHI DARWAJA



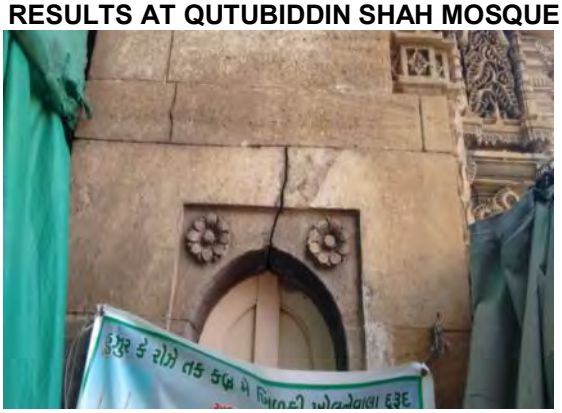


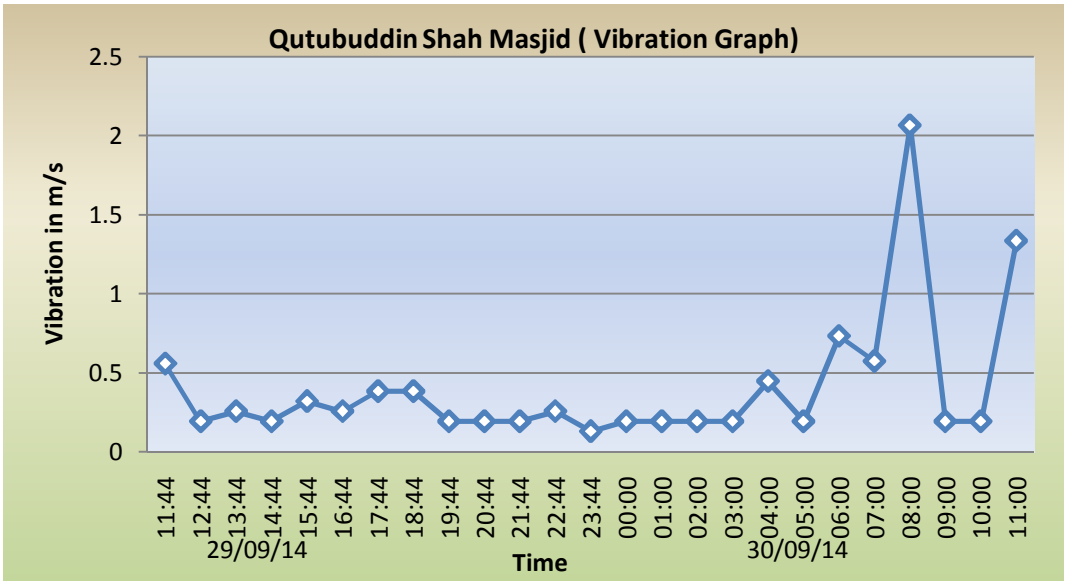
D. Qutubiddin Shah Mosque

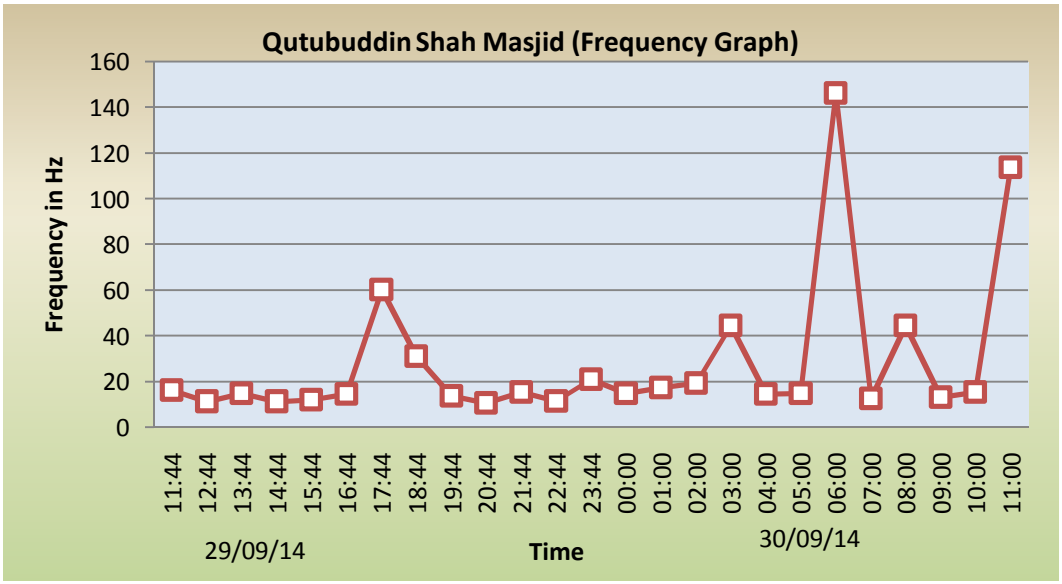
Qutubiddin Shah Mosque was constructed 1449 AD. Qutubiddin Shah Mosque was built with bricks and stone with a height of 15 m. The proposed underground metro line is passing at a distance of about 120 meters from Qutubiddin Shah Mosque. In order to know the vibration levels at this location, vibration monitoring was conducted inside the Mosque. Vibration monitoring was carried out for about 24 hr on 29 /09/2014 to 30/09/2014. During the study, it is observed that the Mosque has many cracks that were developed due to Earth Quick in 2001, some of the beams are in very critical condition and subjected to get damaged. The vibration monitoring location and results at Qutubiddin Shah Mosque are shown in **Figure 3.14**.

The existing vibration was monitored at the Qutubiddin Shah Mosque and the vibration graphs were developed. The vibration graph shows that, the average vibration is found to be between 0.3 to 0.5 mm/s. Some time the maximum vibration is 2mm/s which is due to heavy vehicle passing from nearby road. From the frequency graph, it was observed that, most of the time the frequency is below 20 Hz, however at some time due to sudden passage of heavy vehicles, the frequency is high up to 140 Hz.

FIGURE 3.14
VIBRATION MONITORING LOCATION AND RESULTS AT QUTUBIDDIN SHAH MOSQUE





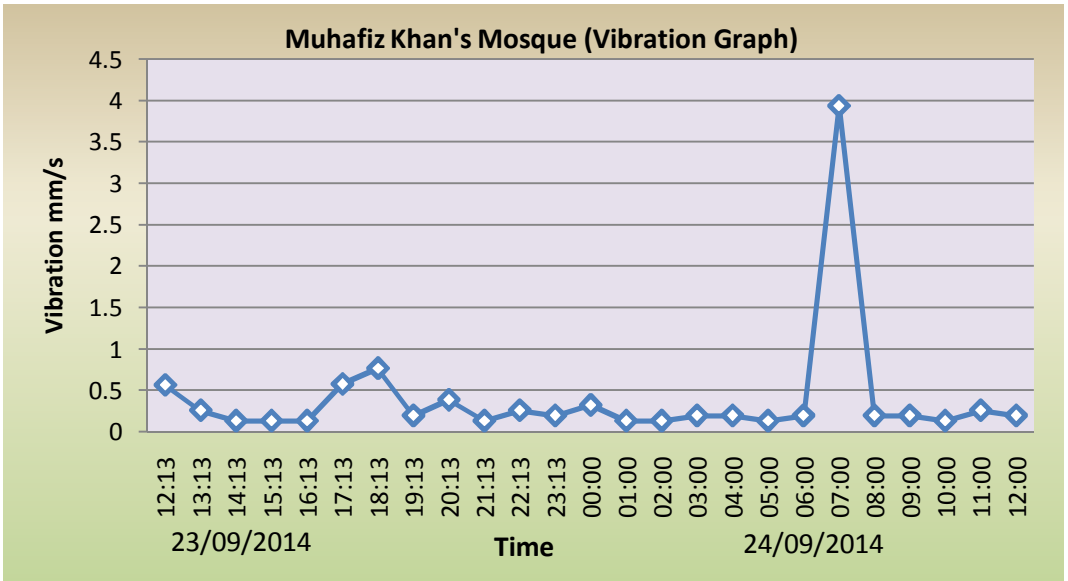


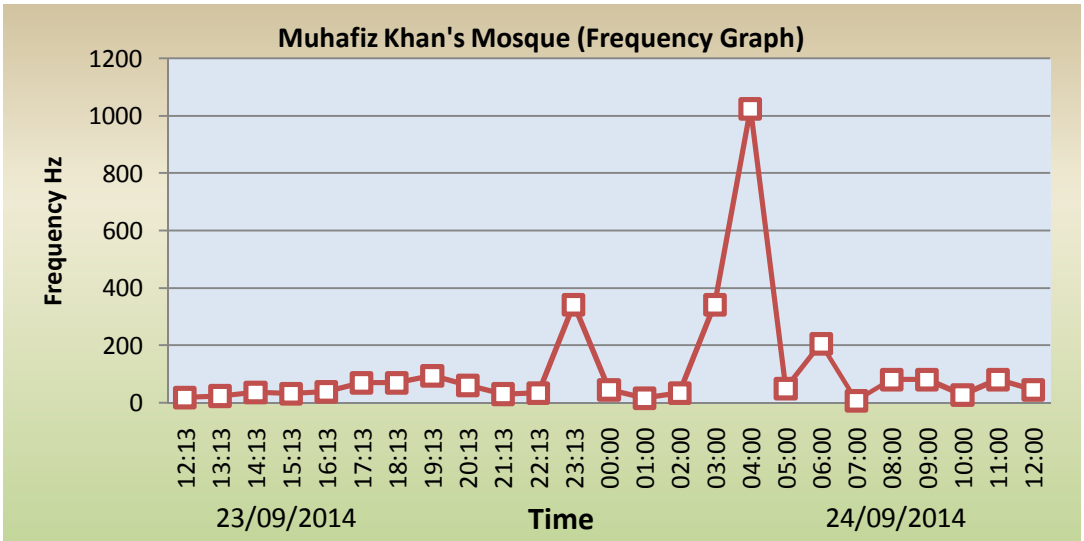
E. Muhafiz Khan Mosque

The Muhafiz Khan's Mosque was constructed in 1450 AD. It was built with bricks and stone for a height of 15 m. The proposed underground metro line is passing at a distance of 211 m from the mosque. In order to know the existing vibration levels at this location, vibration monitoring was conducted in side mosque for about 24 hr on 23/09/2014 to 24/09/2014. The vibration monitoring location and results at Muhafiz Khan Mosque are shown in **Figure 3.15**.

The vibration graph shows that, the average vibration at mosque is 0.25 mm/s. Once during the monitoring period, the vibration level is showing about 4 mm/s second which may be due to passage of a heavy vehicle from nearby road. From the frequency graph, it was observed that, the frequency is below 20 Hz, however there was sudden rise in frequency at around 4:00 hr, this may to be due to disturb in the transducers of vibration instrument.

FIGURE 3.15
VIBRATION MONITORING LOCATION AND RESULTS AT MUHAFIZ KHAN MOSQUE



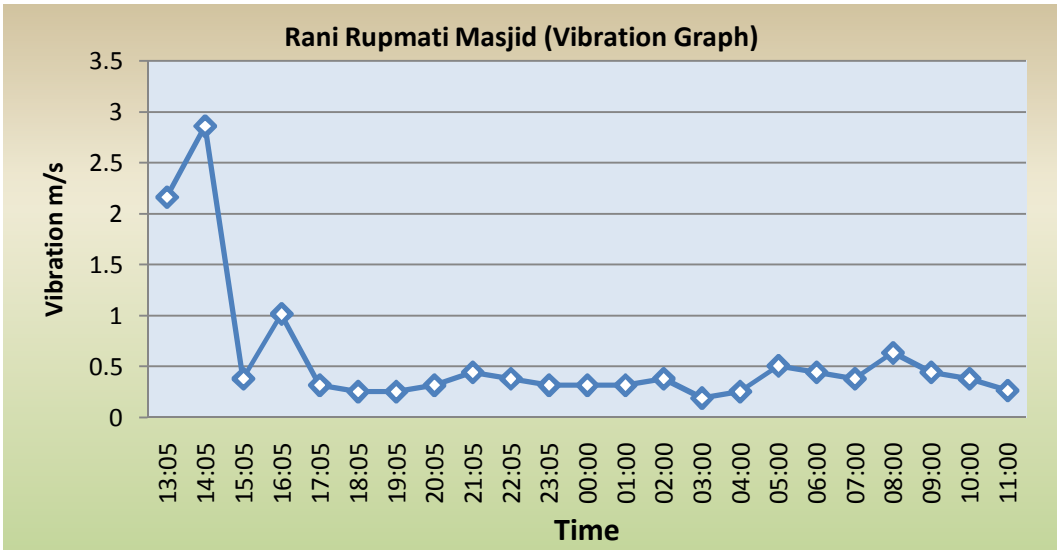


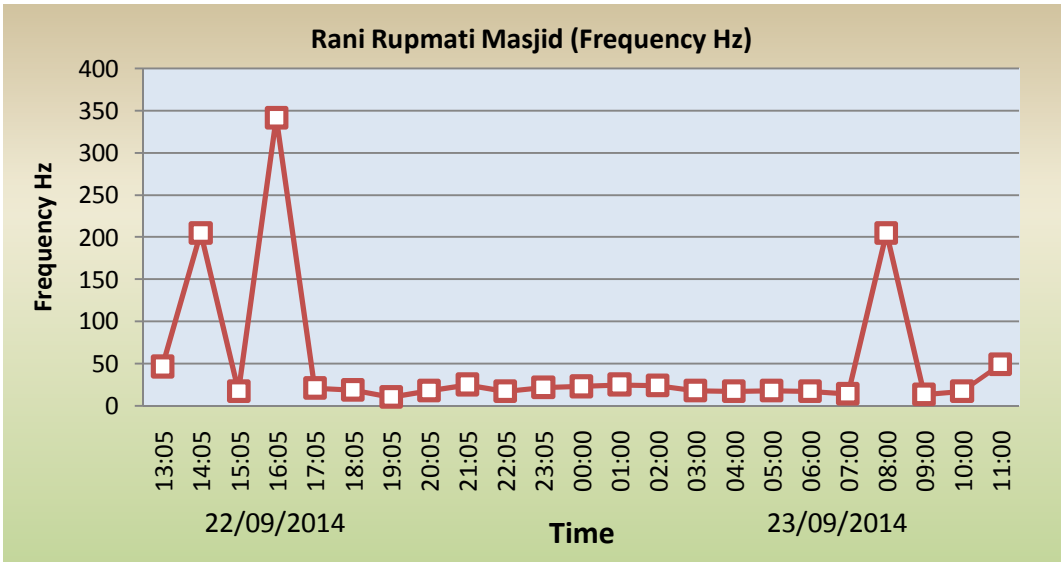
F. Rani Rupamati Mosque

The Rani Rupamati Mosque was constructed early 16th century. Rani Rupamati Mosque was built with bricks and stone for a height of about 15 m. The proposed underground metro line is passing at a distance of 210 m from the mosque. In order to know the existing vibration levels at this location, vibration monitoring was conducted in front of Rani Rupmati Mosque near to road. The vibration monitoring was carried out for about 24 hrs on 22/09/2014 to 23/09/2014. The vibration monitoring location and results at Rani Rupamati Mosque are shown in **Figure 3.16**.

Rani Rupamati Mosque is closely located to a road which has heavy traffic. The mosque is built with hard stones and bricks and the foundation level of mosque is at a height of about 3 m from the existing road level. The vibration graph shows that, the maximum vibration is about 3mm/s which may be due to passage of heavy vehicle. The average existing vibration is less than 0.5 mm/s. The frequency graph shows that the peak frequency of about 350 Hz, this was for shorter duration due to passage of heavy vehicle. Most of the time, the existing frequency is found to be less than 50 Hz.

FIGURE 3.16
VIBRATION MONITORING LOCATION AND RESULTS AT RANI RUPAMATI MOSQUE



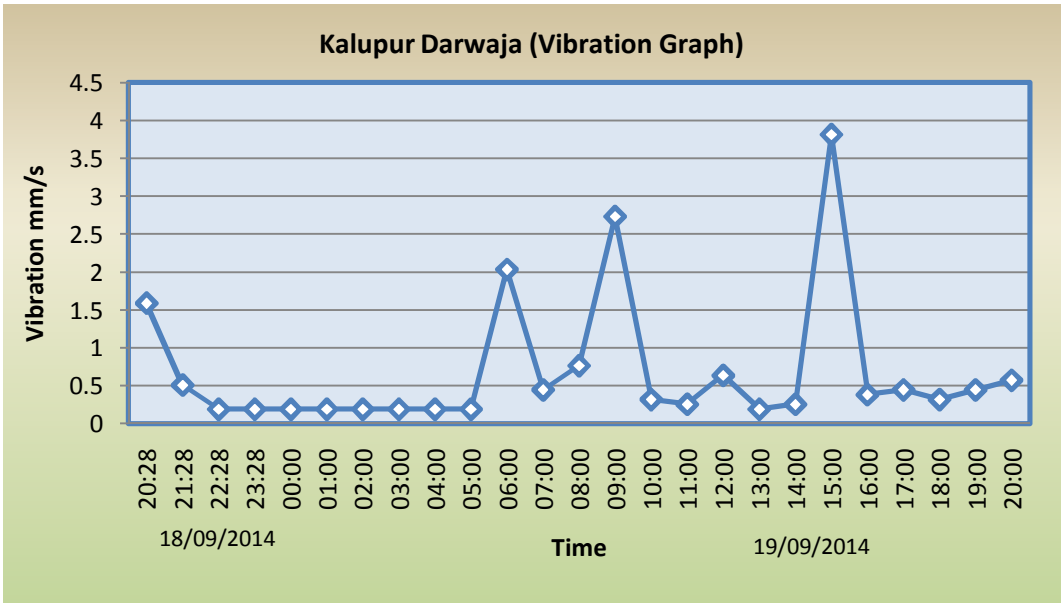


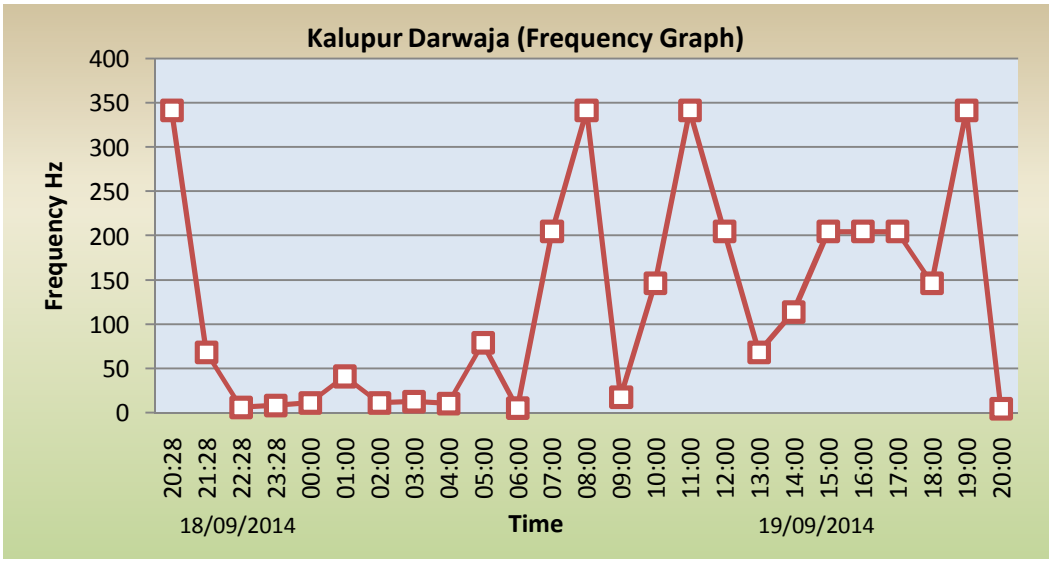
G. Kalupur Darwaja

The Kalupur darwaja is located at the eastern side of walled city and it was constructed in 1450 AD. Kalupur Darwaza was built with bricks and stone with a height of 45 feet. The proposed underground metro line is passing at a distance of 109m from Kalupur darwaja. The area is densely populated with structures. Vibration monitoring was carried out for about 24 hrs on 18/09/2014 to 19/09/2014. The vibration monitoring location and results at Kalupur darwaja are shown in **Figure 3.17**.

The vibration graph shows that, the average vibration is below 0.5 mm/s. During monitoring it was observed that there was a sudden rise in the vertical vibration of about 4 mm/s. This could be because of the vibration caused due to passing of heavy vehicle from the road. From the frequency graph, It was observed that there was sudden rise in frequency up to 350 Hz due to heavy vehicle passage. The vibration during this peak frequency has increased to 2.5 mm/s. The Kalupur Darwaza structure is made of hard stone blocks and there would not be any damage due to existing vibration.

FIGURE 3.17
VIBRATION MONITORING LOCATION AND RESULTS AT KALUPUR DARWAJA



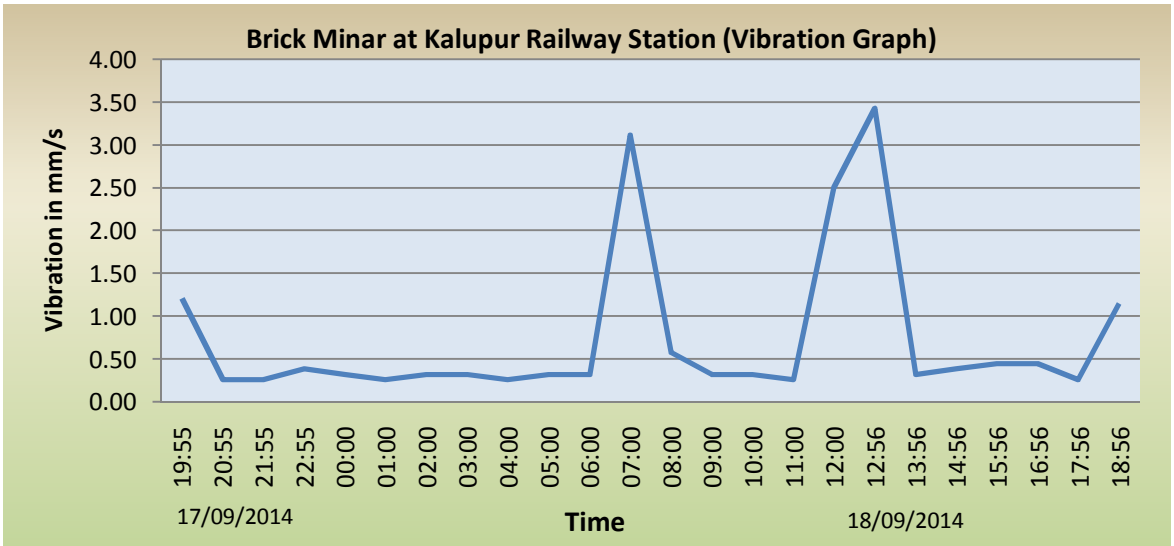


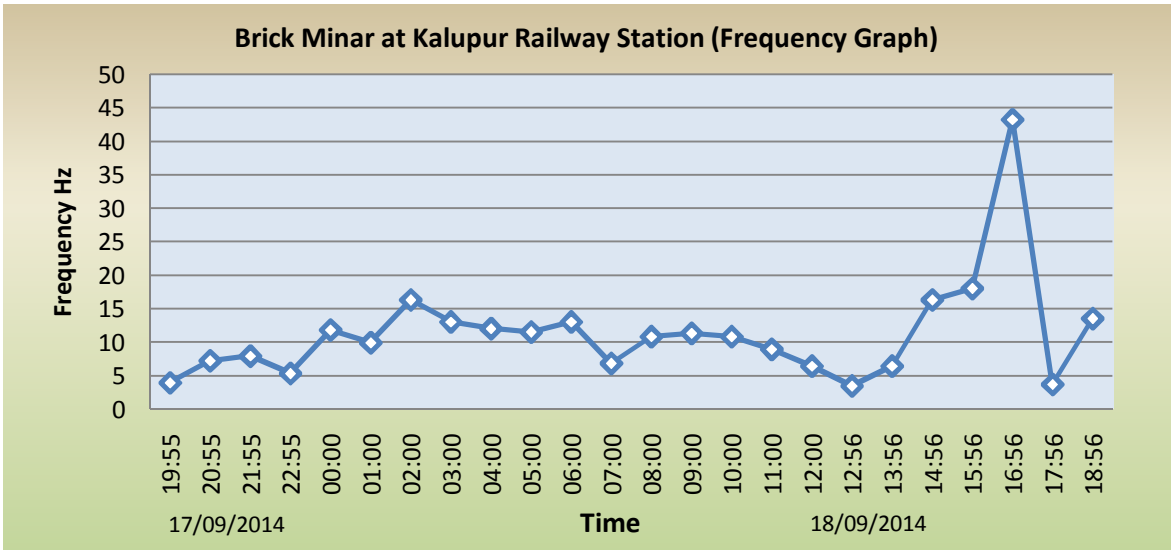
H. Brick Minar

Brick Minars are two minars, were constructed with bricks nearly 30.48 M high at Kalapur Railway station and is at a distance of 10m from the railway track . These minars were constructed early sixteenth century A.D. The proposed underground metro line is passing near to the Brick Minars at a distance of 185m. In order to know the vibration levels at this location, vibration monitoring was conducted by placing seismographer between the two minars. Vibration monitoring was carried out for about 24 hr from 17/09/2014 to 18/09/2014. The vibration monitoring location and results at Brick Minar are shown in **Figure 3.18**.

The vibration graph shows that, the peak vibration is above 3mm/s due to train passage from nearest track, which may cause damage to structure. The average vibration is around o.4 mm/s. The frequency graph shows that most of the time the frequency is in the range of 5 to 15 Hz, comparing to vibration levels of same time, the average vibration is 0.2 mm/s, which is in safe to the structure.

FIGURE 3.18
VIBRATION MONITORING LOCATION AND RESULTS AT BRICK MINAR



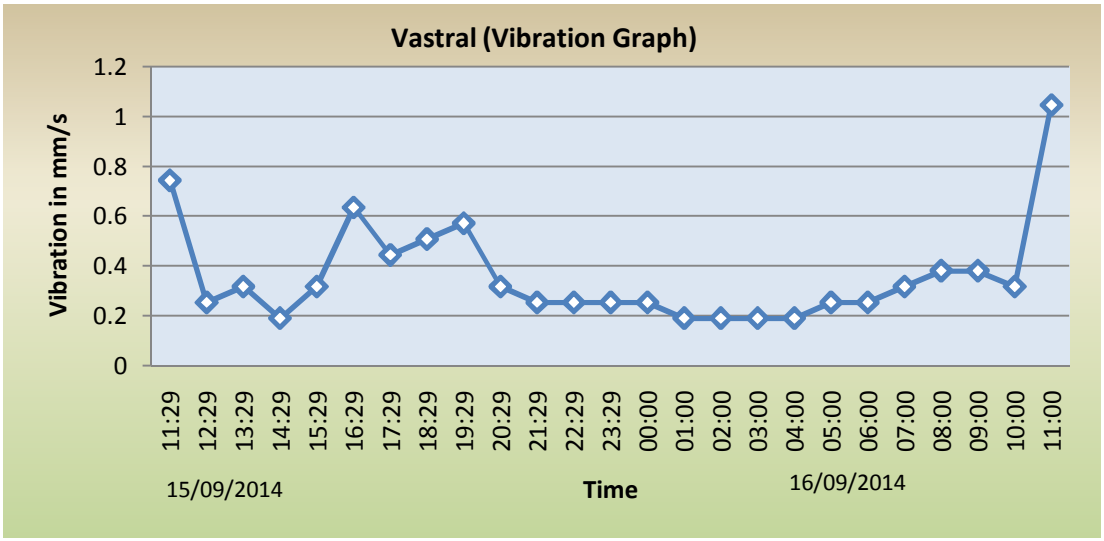


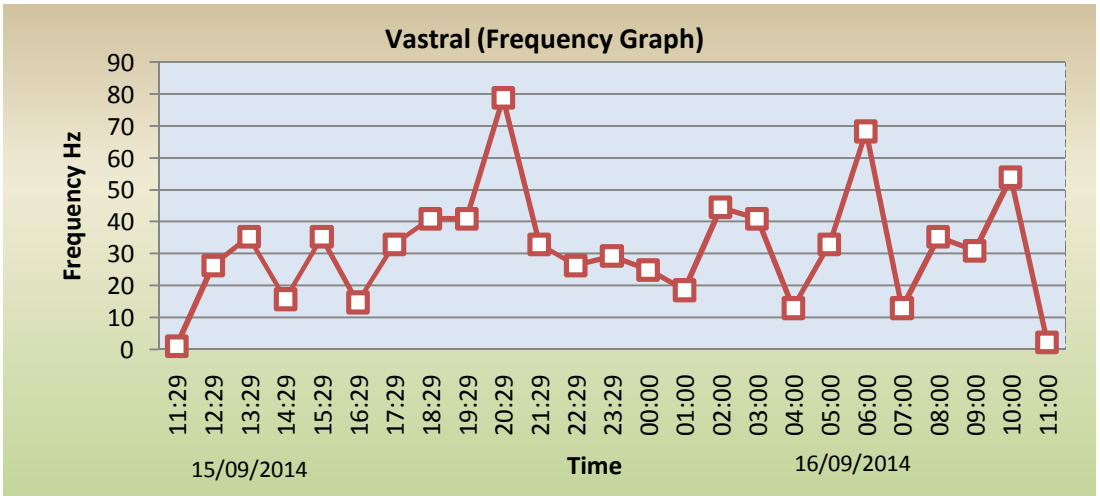
I. Vastral

At Vastral, vibration monitoring was carried out on top of the existing building. This building falls very close to the proposed metro rail alignment. Vibration was monitored 24 hr from 15/09/2014 to 16/ 09/2014. The vibration monitoring location and results at Vastral are shown in **Figure 3.19**.

The results of the monitoring show that, the average vertical vibration is between 0.2 to 0.4 mm/s which are quite normal vibration due to road traffic. During monitoring it was observed that there was a sudden rise in the vertical vibration of about 1.2 mm/s at a frequency 60 Hz. This could be because of the vibration caused by heavy vehicle. The highest frequency observed is 80 Hz which was around 20:29hrs.

FIGURE 3.19
VIBRATION MONITORING LOCATION AND RESULTS AT VASTRAL



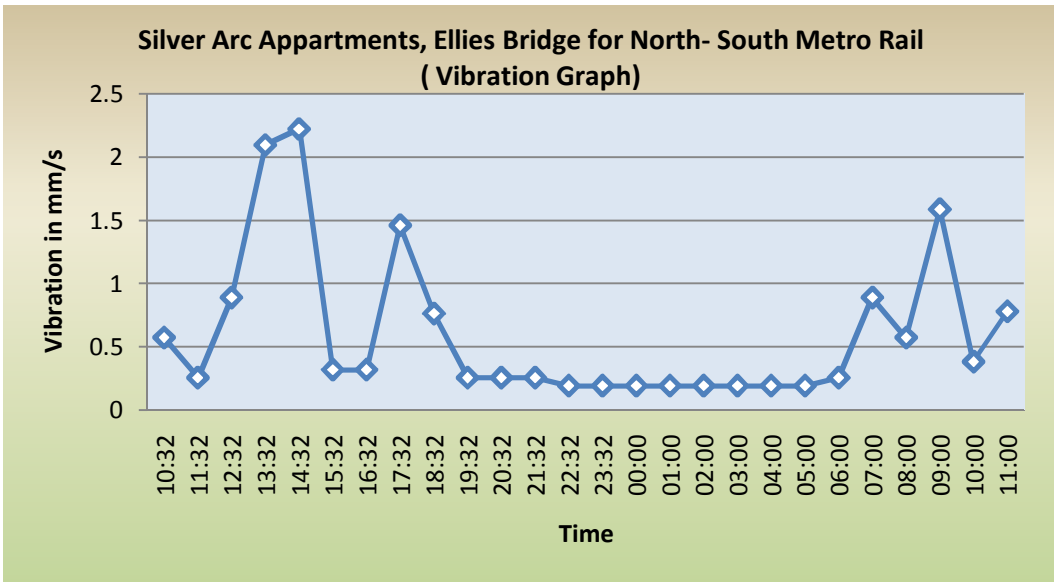


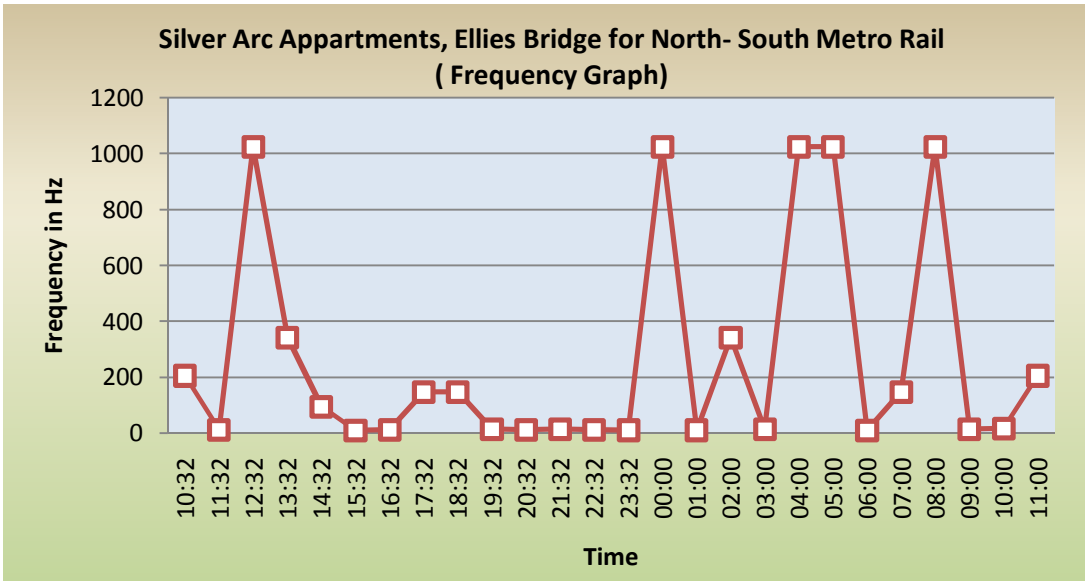
J. Silver Arc apartment near Ellis Bridge

The Silver Arc apartment is selected for monitoring existing vibration at Ellis Bridge as the apartment is very close to the proposed N-S metro rail alignment and Ellis Bridge. The monitoring location is about 24 m from the center of the proposed metro rail and about 15m from the Ellis Bridge. Ellis Bridge is one of the busiest traffic roads in Ahmadabad. The vibration monitoring was conducted for out 24 hr from 28/09/2014 to 29/ 09/2014. The vibration monitoring location and results at Silver Arc Apartment are shown in **Figure 3.20**.

The result of the monitoring shows that, the peak vibration is about 2 mm/s which are due to the existing train passage and road traffic from Ellis Bridge. The frequency graph shows higher peak values during different times due to road traffic from the Ellis Bridge.

FIGURE 3.20
VIBRATION MONITORING LOCATION AT SILVER ARC APARTMENT NEAR ELLIS BRIDGE



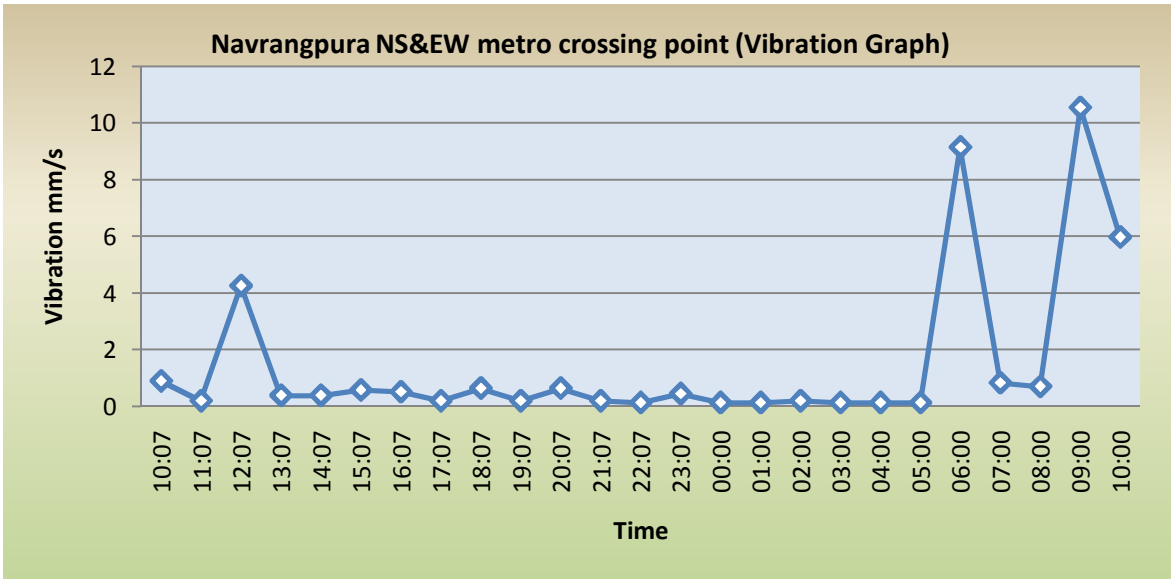


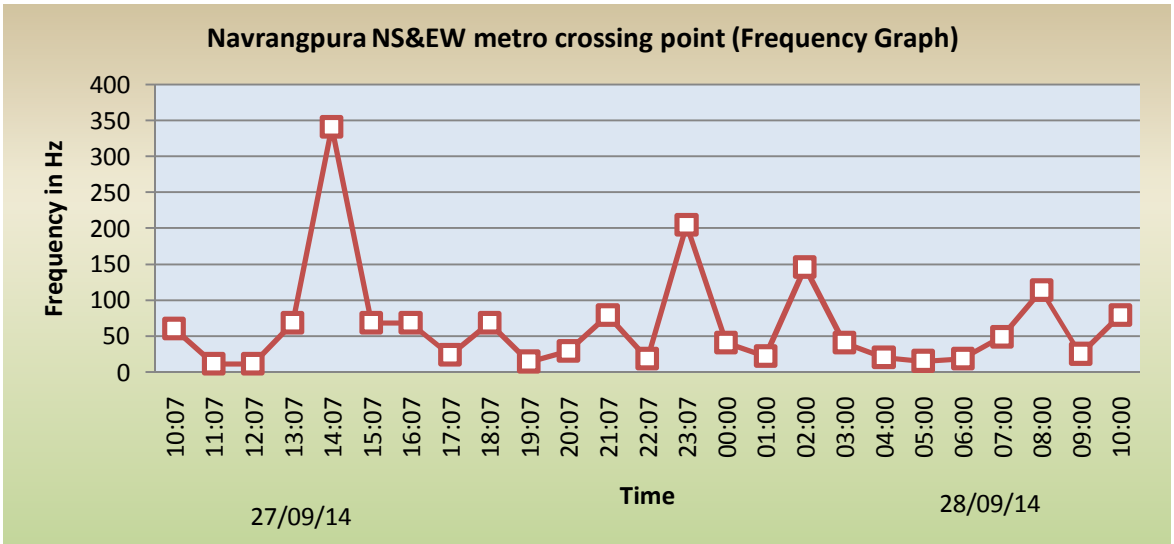
K. Navrangpura, Ashram Road

The vibration monitoring was carried out at Navrangpura, where two metro rail corridors (N-S and E-W metro rail corridor) cross each other. Vibration monitoring was conducted at a distance of 23 m from the proposed metro rail alignment. The Vibration monitoring was conducted for out 24 hr from 27/09/2014 to 28/ 09/2014. The vibration monitoring location and results at Navrangpura are shown in **Figure 3.21.**

The result of the monitoring shows that, the peak vibration is at three times which is about 10 mm/s. This is because of train passage on existing meter gauge track. The existing frequencies shows peak values during monitoring because of passing of heavy vehicles on nearby road and it is also due to existing train passage.

FIGURE 3.21
VIBRATION MONITORING LOCATION AND RESULTS AT NAVRANGPURA, ASHRAM ROAD



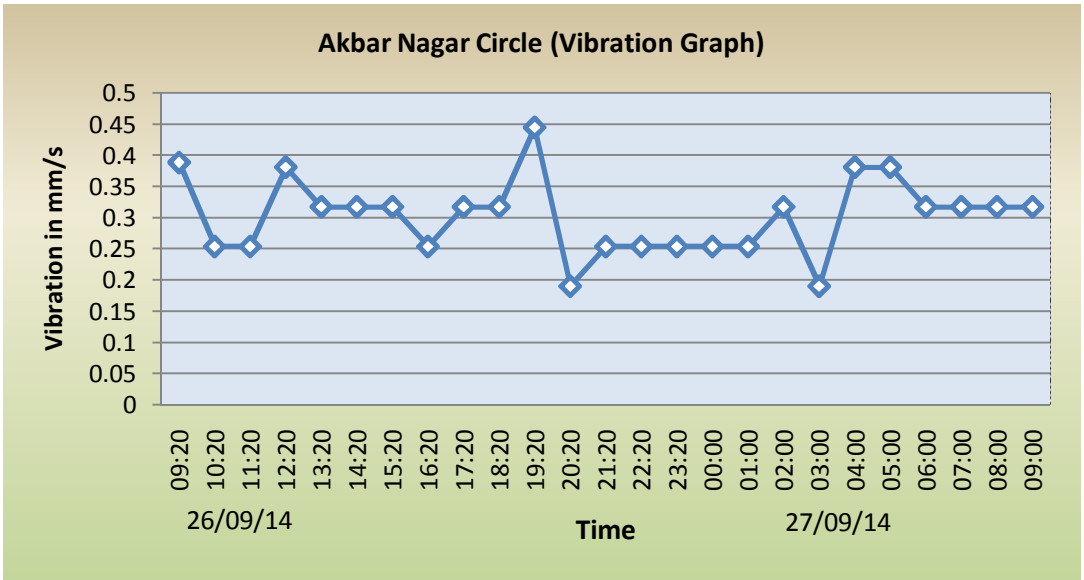


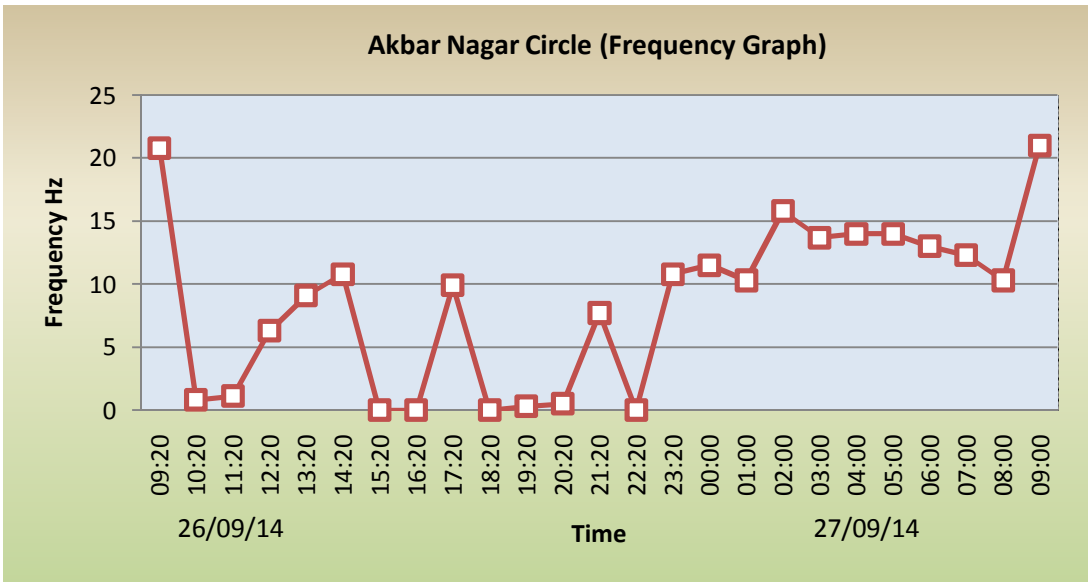
L. Akhbar Nagar

The vibration monitoring was carried out at Akbar nagar circle, near to the proposed N-S metro rail alignment. At this location proposed metro rail alignment is taking turn towards RTO. Due to centrifugal forces due to the curve, the vibration at location can cause more effect towards outer side of curve. Therefore, the vibration monitoring point is selected at the outer side of the curve at the Akbar nagar circle. The existing road is a major road with heavy traffic. Vibration monitoring location is about 25 m from the center of the road. Vibration monitoring was conducted for out 24 hr from 26/09/2014 to 27/ 09/2014. The vibration monitoring location and results at Akhbar Nagar are shown in **Figure 3.22.**

The result of the monitoring shows that, the vibration level is between 0.2 to 0.4 mm/s which is higher than the threshold of human perception for vibration (0.1mm/s). The existing frequency is varying with time because of passage of different type of vehicles. Overall the average frequency can be considered as more than 10 Hz. The above two graphs shows that there is already high vibration at this location due to road traffic.

FIGURE 3.22
VIBRATION MONITORING LOCATION AT AKHBAR NAGAR





3.7. ECOLOGICAL ENVIRONMENT

An ecological study of the ecosystem is essential to understand the impact due to project development activities on the existing flora and fauna of the area. The present study was undertaken to predict changes as a result of project activities and to suggest measures for maintaining the conditions to the maximum possible extent. This section describes the ecology of the area based on field study and information compiled from secondary data available for the study/project area.

3.7.1. Forest

Forest in the state is 21,664.99 sq.km forming 11.05% of the state geographical area of the state, out of which Ahmedabad district forest area is 106.82 sq.km forming 1.32% of the district geographical area[12]. Type of Forest area in the Ahmedabad district is given in **Table 3.15**. The forest in the district is of inferior dry scrub type and is un-productive. The areas planted with fast growing trees along the roads and canal banks have been

[12] Gujarat Forest statistics 2012-13

declared as forests under section 29 of the Indian forests Act[13]. The forest map of the Gujarat state is shown in **Figure 3.23**. No forest area exists near to the proposed metro alignments.

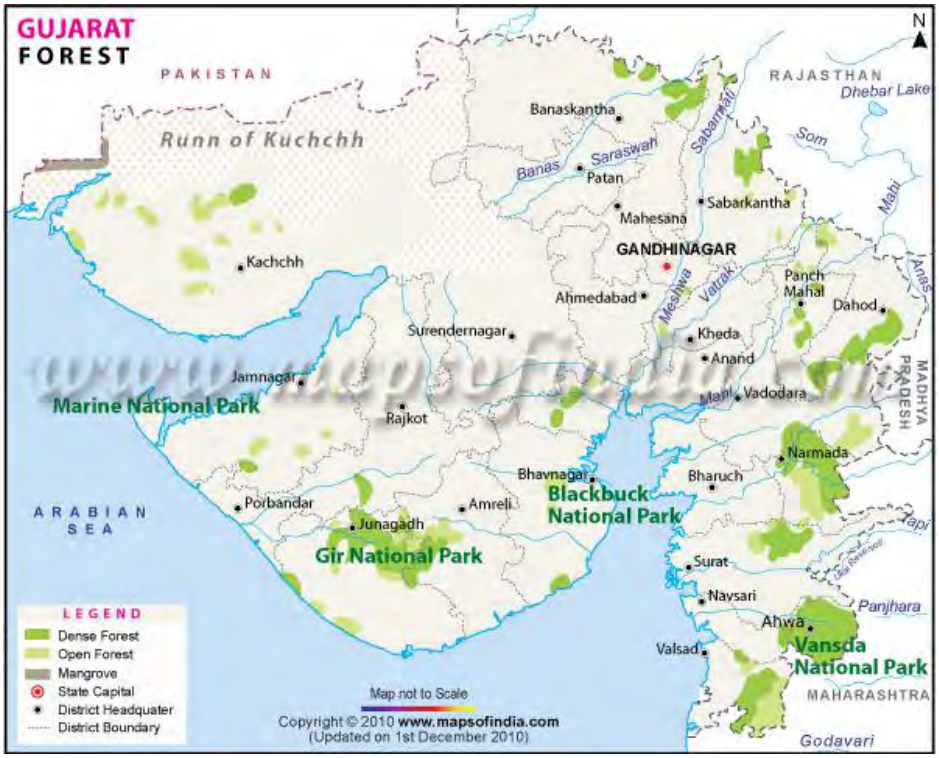
TABLE 3.15
FOREST AREA OF AHMEDABAD DISTRICT

Type	Area in Sq. Km	
	District Data	State Data
Reserved Forest	45.80	14387.16
Protected Forest	1.09	2888.85
Unclassed Forest	59.93	4388.98
Total Forest Area	**106.82**	**21664.99**
Geographical Area	8087.00	196024.00

3.7.2. Flora

Natural growth in reserved and protected forest of Ahmedabad district consists of Baval, Awal, Khijda, Cassia, piluri and Xerophilous plants. Trees survey was carried out along the proposed E-W and N-S alignments and at station locations and the details are given in Table 3.16 along with their scientific names. About 501 trees have been observed along the E-W alignment and at Apparel Park depot; and about 1137 trees have been observed along the N-S alignment and at Giyaspur depot. The Tree inventory summary of E-W and N-S alignments is given at **Table 3.17** and details are given at **Appendix 3.1 and 3.2**.

FIGURE 3.23
FOREST MAP OF GUJARAT STATE



[13] Gazetteer of India, Gujarat State, Ahmadabad District

TABLE 3.16
TREE DETAILS ALONG THE METRO ALIGNMENTS (E-W AND N-S)

S. No	Local Name	Scientific Name		S. No	Local Name	Scientific Name
1.	Ashoka	Saraca asoca		2.	Karanj	Pongamia pinnata Linn
3.	Babool	Acacia Nilotica		4.	Kavath	*Limonia acidissima*
5.	Badam	Prunus dulcis		6.	Malberry	Morinda tinctoria
7.	Baniyan	Ficus benghalensis		8.	Mango	Mangifera indica
9.	Bargad	Ficus benghalensis		10.	Moringa	Moringa oleifera
11.	Ber	Ziziphus mauritiana		12.	Neem	Azadirachta indica
13.	Booganbel	Bougainvillea Glabra		14.	Nerium	Nerium oleander
15.	Bombax	Bombax ceiba		16.	Nilgiri	Eucalyptus L Herit
17.	Caesalpinia	*Caesalpinia* pulcherrima		18.	Pakad	Ficus virens
19.	Cassia	Cinnamomum cassia		20.	Pipal	Ficus religiosa
21.	Champa	*Plumeria* sp.		22.	Khair Champa	Plumeria obtusa
23.	Delonix	Delonix regia		24.	Pongam	*Millettia pinnata*
25.	Eucalyptus	Eucalyptus tereticornis		26.	Keekar	Prosopis Juliflora
27.	Gulmohar	Delonix religa (Boj)		28.	Ritha	Sapindus mukorossi
29.	Guava	Psidium guajava		30.	Shisam	Dalbergia sissoo
31.	Jamun	Eugenia jambolana		32.	Tamarind	Tamarindus indica
33.	Jangal Jalebi	ithecellobium Dulce		34.	Umbar	Ficus racemosa

TABLE 3.17
SUMMARY OF TREE INVENTORY ALONG E-W AND N-S CORRIDORS

S. No	Description	Number of Trees
East West Alignment		
1	Alignment	279
2	Apparel park depot	222
	Sub-Total	**501**
North South		
3	Alignment	1112
4	Giyaspur Depot	25
	Sub-Total	**1137**
	Total Trees	**1638**

3.7.3. Fauna

The air-fauna of the district is rich and varied; the mammalian fauna is possibly the poorest in the state because of the fact that much of the area is now under intense agriculture and settlements. Common birds observed in the project area are pelican, pigeons, crows, and doves. On consultation with the local people in the vicinity of the project area, it is learnt that no birds are observed in the project area. The domestic animals in the project area consist of cows, bullocks, sheep, goats and dogs. No rare and endangered species have been recorded in the project area.

3.7.4. Protected Areas of Gujarat

The protected area network of the Gujarat State comprises of 26 protected areas including 22 sanctuaries (with an area of 16440.91 sq.km) and 4 national parks (with an

area of 479.67 sq.km). Gujarat is a unique state that has many kinds of habitats. These varied landforms include dry deciduous forests, majestic grasslands, wetlands, marine ecosystems and rich moist deciduous forests. These habitats are home to some extremely rare wildlife. The Asiatic Lion is found only in Gir. The Wild Ass in the Rann of Kutch, the rare great Indian bustard in the bird reserves, the world's only four-horned antelope and the Black Buck are some other valued species protected in Gujarat. The dugong and the rare boralia species also find a safe haven here. National Park and sanctuaries details of the Gujarat state are shown in **Figure 3.24** and details are given in **Appendix 3.3**.

FIGURE 3.24
NATIONAL PARK AND SANCTUARIES OF GUJARAT STATE

3.8. ARCHAEOLOGICAL MONUMENTS

The city of Ahmedabad has plenty of archaeological and historical monuments, which serve as the main tourist attraction destinations of the city. The architectural design of the Ahmedabad monuments represents a blend of Hindu and Islamic styles. The origin of most of the historical monuments of Ahmedabad, Gujarat can be traced back to the 15th century.

As per The Ancient Monuments and Archaeological Sites and Remains (Amendment and Validation) Act, 2010; prohibited area is an area beginning at the limit of the protected area or the protected monument, and extending to a distance of 100 m in all directions; and regulated area is the area beginning at the limit of the prohibited area in respect of every ancient monument and archaeological site and remains and extending to a distance of two hundred meters in all directions.

The Ancient Monuments and Archaeological Sites and Remains Act, 2010 has barred all construction activities in the prohibited area to be taken up by all public bodies even if the purpose is related to public works or project essential to the public. *There is no provision for grant of any relaxation in this regard by any authority.*

The proposed East West metro alignment is passing closer to seven historical monuments which are listed in the **Table 3.18**. The locations of these monuments from the alignment along with the photographs are shown in **Figure 3.25**.

TABLE 3.18
ARCHAEOLOGICAL MONUMENTS ALONG THE ALIGNMENT

S. No	Historical Monuments	Distance From Edge of Metro Alignment in m
1.	Shahpur Kazi Md Chisti Mosque	159.13
2.	Delhi Darwaja	254.28
3.	Qutubiddin Shah Mosque	119.97
4.	Muhafiz Khan Mosque	211.41
5.	Rani Rupamati Mosque	210.18
6.	Kalupur Darwaja	109.34
7.	Brick Minar	184.59

Source: Archaeological Survey of India

The proposed East West alignment is not passing within the 100m of prohibited area; however the alignment is passing within the 200m of regulated area around these monuments. Nearest archaeological monument from the proposed E-W alignment is Kalupur Darwaza with a distance of 109.34m at chainage 10.95km. Regulated Area of Archaeological Monuments along E-W Alignment is showing in **Figure 3.26**. **Prior approval is required for construction activities in a regulated area of these monuments from Director – General of Archaeological Survey of India.**

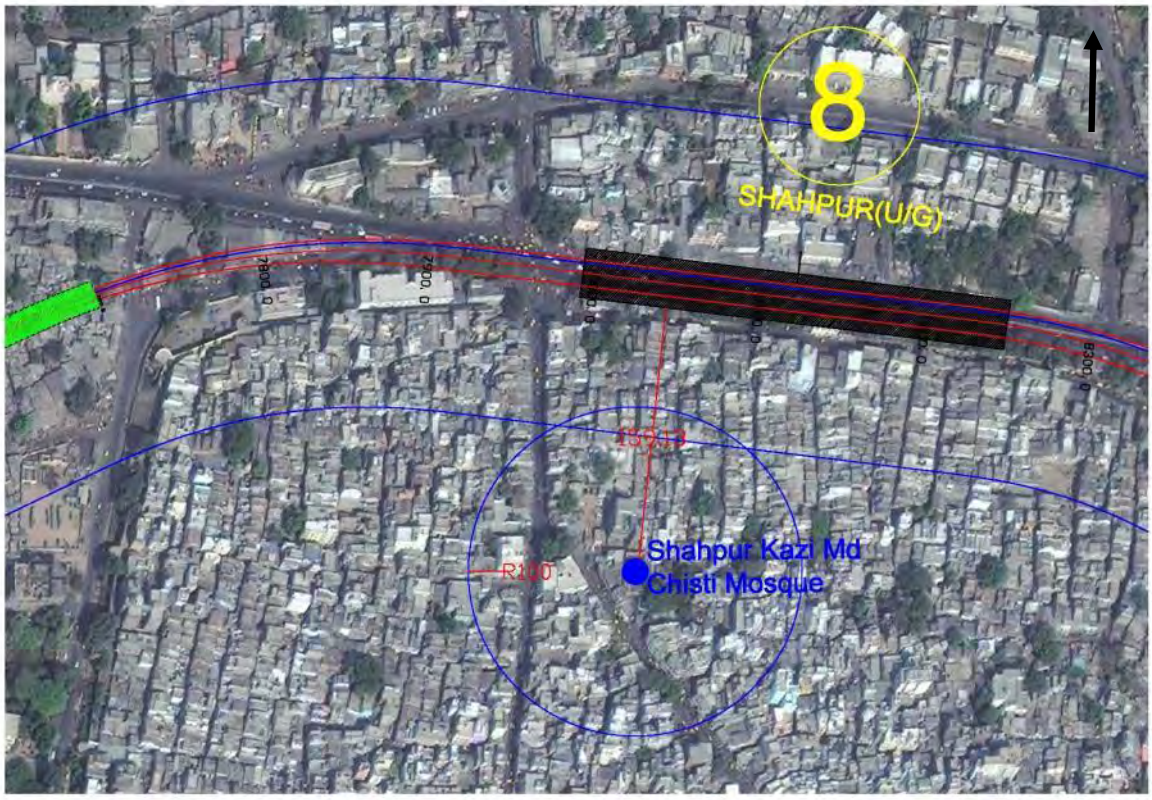
3.9. SENSITIVE RECEPTOR

A drawing showing sensitive receptor like school, colleges, hospitals, place of worship within 100 m on either side of E-W and N-S alignment is prepared and enclosed at the end of the report. The list of sensitive receptor is tabulated in **Table 3.19.**

TABLE 3.19
LIST OF SENSITIVE RECEPTORS ALONG E-W AND N-S CORRIDORS

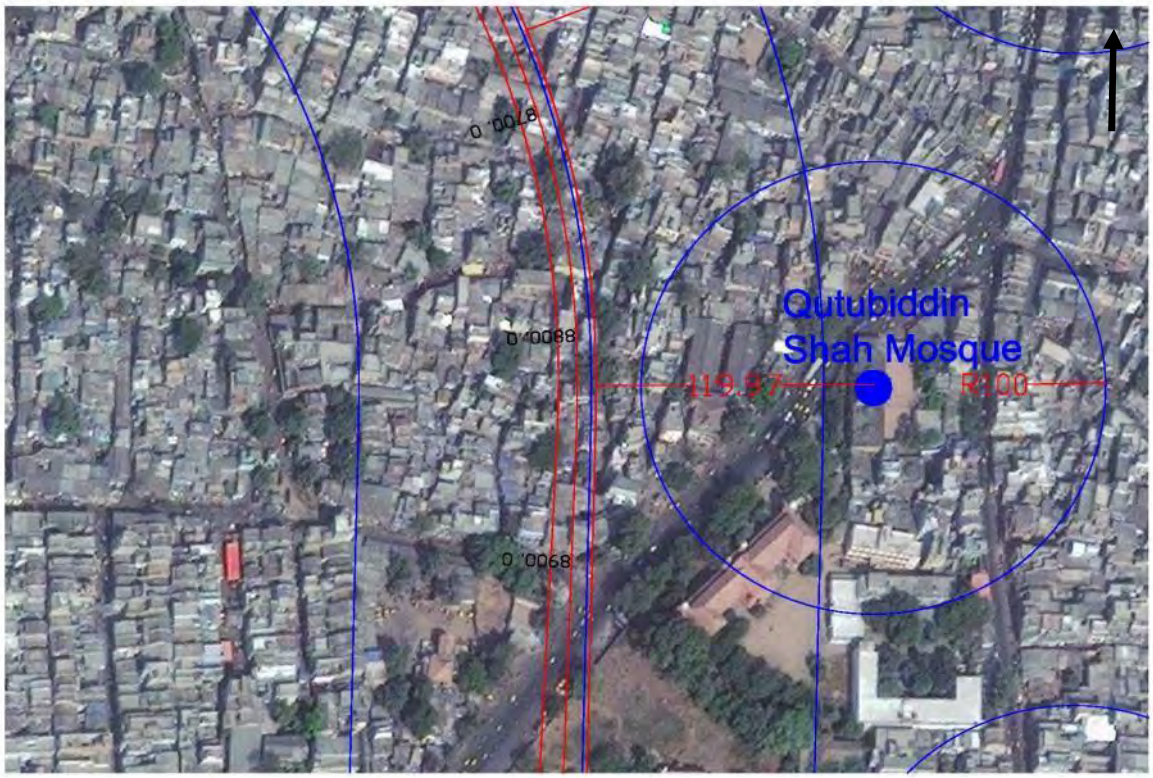
S. No	Description	Within 100 m on Either side of Corridor	
		East West	North South
1	School	15	1
2	Hospital	22	6
3	Temple/ Mosque /Church	56	35
	Total	**93**	**42**

FIGURE 3.25
ARCHAEOLOGICAL MONUMENTS ALONG THE ALIGNMENT



Shahpur Kazi Md Chisti Mosque

Delhi Darwaja

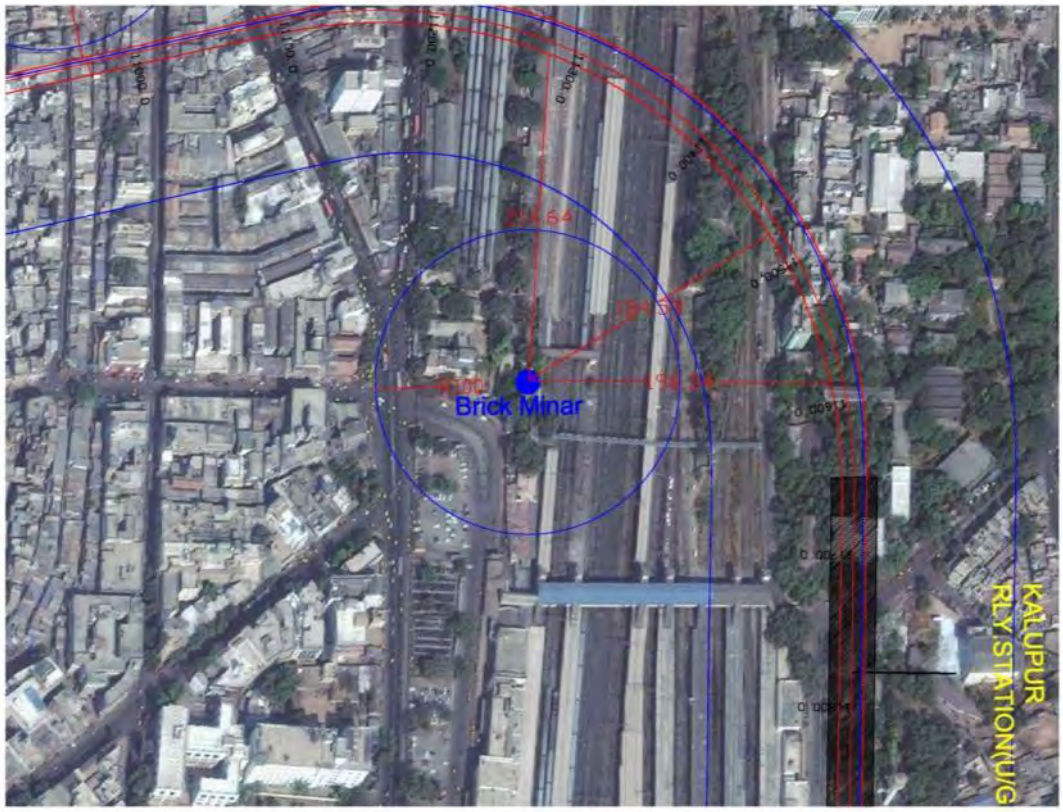


Qutubiddin Shah Mosque

Muhafiz Khan Mosque

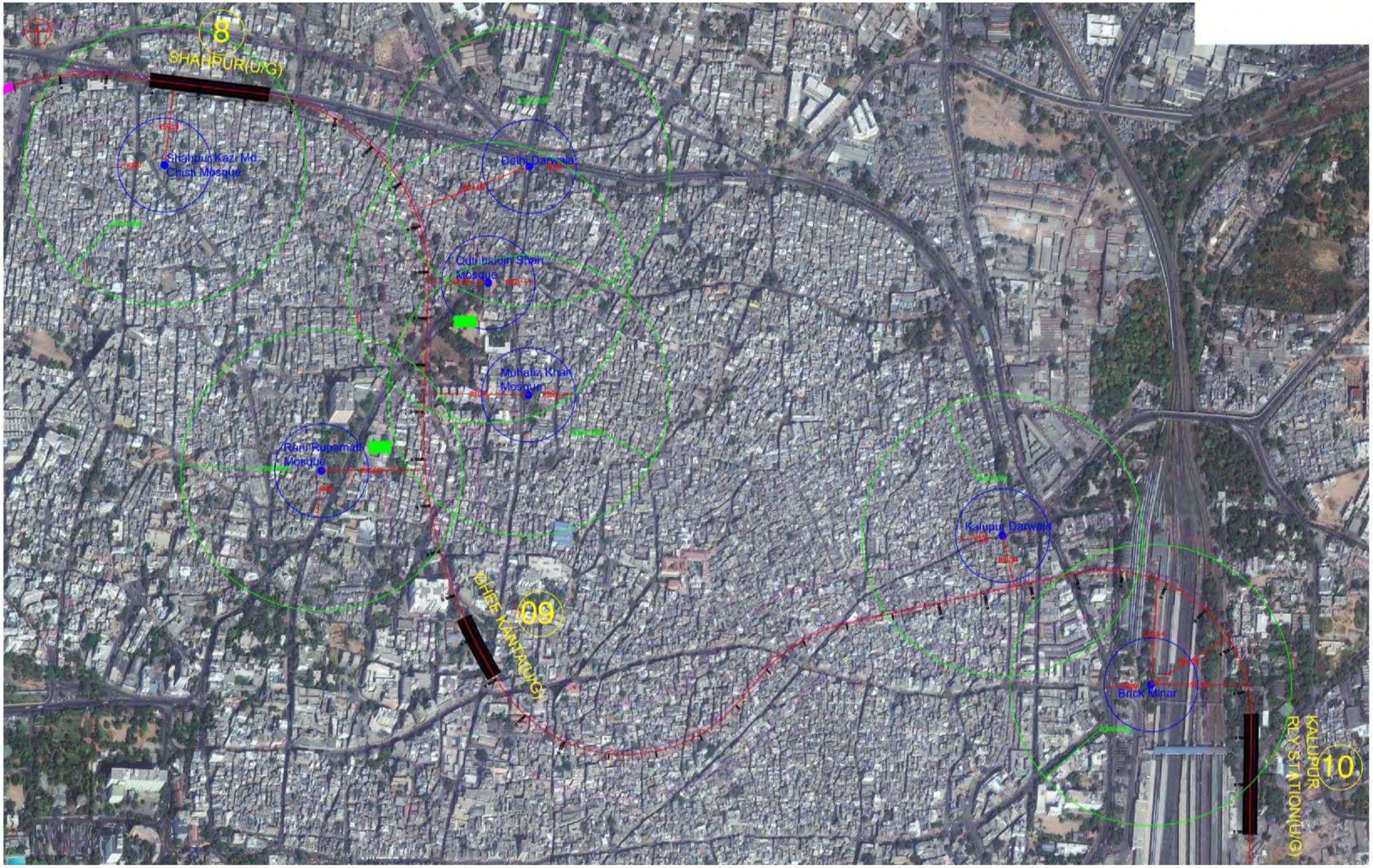
Rani Rupamati Mosque

Kalupur Darwaja



Brick Minar

FIGURE 3.26
REGULATED AREA OF ARCHAEOLOGICAL MONUMENTS ALONG THE E-W ALIGNMENT



APPENDIX 3.1

Tree Inventory for East - West Corridor													
S. No	Location name	Chainage	Description				Ht. in mtr	Range of Girth in Centimeter					
			Left	Center	Right	Species		20-30	30-40	40– 60	60 - 100	100- 200	200 - 300	300-400
1	Thaltel station	1114												
2	Thaltel station to Doordarshan Kendra	1114-1900			2	Gulmohar	10			2				
			2			Neem	10				2			
			1			Neem	10				1			
3	Doordarshan Kendra Station	1961	4			Pongam/ Karanj	10				4			
			2			Neem	10				1			
						Neem	10					1		
			2			Gulmohar	11					1		
						Gulmohar	12					1		
					1	neem	10			1				
					1	neem	11				1			
					1	neem	12				1			
					1	neem	11					1		
					1	Pongam/ Karanj	10				1			
					1	gulmohar	10					1		
					1	tamarind	12					1		
4	Doordarshan Kendra Station- Gurukul Road Station	2050-3000		1		neem	12					1		
					1	neem	8				1			
				1		Gulmohar	5		1					
			2			Gulmohar	10				2			
			1			neem	8				1			
5	Gurukul road station	3082			1	Gulmohar	10				1			
					1	Cassia	10					1		

Tree Inventory for East - West Corridor														
S. No	Location name	Chainage	Description				Ht. in mtr	Range of Girth in Centimeter						
			Left	Center	Right	Species		20-30	30-40	40– 60	60 - 100	100- 200	200 - 300	300-400
					1	champa	10					1		
					3	neem	10				3			
					1	neem	12					1		
6	Gurukul road-Guj university	3150-3900			1	Gulmohar	12					1		
					5	Gulmohar	10				5			
7	Gujrat university	3989	6			pongam	10				6			
			4			pongam	10					4		
			2			pongam	8			2				
					5	cassia	10				5			
					8	pongam	10			8				
					4	pongam	10				4			
					2	Gulmohar	10			2				
8	Guj university - commerce six	4050-4980		4		gulmohar	10		4					
9	Commece six road station	5053	3			pongam	8				3			
			2			pongam	10			2				
					1	tamrind	10					1		
					3	gulmohar	10				3			
					2	bargad	12					2		
					2	neem	10					2		
10	commerce six road -stadium	5125-5870	1			pongam	10				1			
			1			pongam	10					1		
					1	pongam	3		1					
					1	neem	8			1				
					2	gulmohar	10			2				
			4			gulmohar	10				4			

Tree Inventory for East - West Corridor														
S. No	Location name	Chainage	Description				Ht. in mtr	Range of Girth in Centimeter						
			Left	Center	Right	Species		20-30	30-40	40– 60	60 - 100	100- 200	200 - 300	300-400
			1			pongam	10					1		
11	stadium station	5945	2			pongam	10				2			
			4			ashoka	10			4				
			1			ashoka	12				1			
			1			neem	10					1		
					2	neem	10			2				
					3	neem	10				3			
					5	ashoka	12				5			
					2	pongam	10			2				
					1	pongam	8				1			
					4	pongam	10			4				
					2	gulmohar	10				2			
					1	gulmohar	12					1		
12	stadium - ashram road	6020-6800			3	ashoka	10			3				
					1	gulmohar	10			1				
					1	neem	10			1				
			1			neem	10					1		
			2			gulmohar	10				2			
			1			ashoka	10			1				
					2	neem	10					2		
					1	pongam	10				1			
					1	gulmohar	10				1			
13	ashram road station	6600	2			neem	15					2		
					1	pongam	15				1			
					1	gulmohar	10			1				
					1	gulmohar	10			1				

Tree Inventory for East - West Corridor														
S. No	Location name	Chainage	Description				Ht. in mtr	Range of Girth in Centimeter						
			Left	Center	Right	Species		20-30	30-40	40– 60	60 - 100	100- 200	200 - 300	300-400
					1	neem	10			1				
					1	neem	6			1				
14	ashram road to river bed	6650-7100	1			gulmohar	15			1				
			1			neem	10			1				
					2	neem	12			2				
					3	pongam	12			3				
15	underground ramp starts	7450-7575			1	bargad	12						1	
					1	neem	10					1		
					1	pongam	10				1			
					1	pipal	12						1	
16	Shahpur station	8124		4		pongam	10						4	
				4		pongam	12					4		
				2		neem	10				2			
				1		neem	10			1				
				2		neem	12						2	
				2		gulmohar	10							2
				1		gulmohar	12					1		
				1		gulmohar	10					1		
				1		gulmohar	12						1	
17	shahpur to gheekanta	8124-9624												
18	gheekanta station	9624												
19	gheekanta to kalupur	9624-11779												

Tree Inventory for East - West Corridor													
S. No	Location name	Chainage	Description				Ht. in mtr	Range of Girth in Centimeter					
			Left	Center	Right	Species		20-30	30-40	40– 60	60 - 100	100- 200	200 - 300	300-400
20	kalupur railway station	11779		3		neem	10						3	
				2		neem	12							2
				5		neem	10					5		
				2		badam	10						2	
				1		badam	12				1			
				2		jamun	10						2	
				12		ashoka	12					12		
				10		ashoka	10						10	
				3		nilgiri	10				3			
				2		pongam	10						2	
				6		pongam	8					6		
				5		gulmohar	10					5		
				3		pipal	10				3			
				1		pipal	12							1
				2		bakaneem	10							2
				2		bargad	12							2
				2		umbar	10							2
21	kalupur - kankariya	11779-13096												
22	kankariya east station	13096	2			neem	10					2		
			1			pipal	12				1			
					1	bargad	10							1
					2	neem	12						2	
23	kankariya East to apparel park ramp	13096-13992												
24	appreal park	13992-	2			neem	12				2			

Tree Inventory for East - West Corridor													
S. No	Location name	Chainage	Description				Ht. in mtr	Range of Girth in Centimeter					
			Left	Center	Right	Species		20-30	30-40	40– 60	60 - 100	100- 200	200 - 300	300-400
	ramp	14157												
			2			pipal	10				2			
25	appareal park station	14654	2			pongam	8			2				
			1			neem	5		1					
			1			neem				1				
26	appreal park to amaraiwadi	14720-15750	1			peepal	15					1		
			3			neem	15					3		
					4	neem	10				4			
27	amaraiwadi station	15839	4			neem	10			4				
28	amaraiwadi to rabari colony	15910-16490			1	gulmohar	10			1				
			1			peepal	15					1		
29	rabari colony station	16560												
30	rabari colony to vastral	16660-17775	1			neem	15				1			
31	vastral station	17845												
32	vastral to nirant cross road	17920-19010												
33	nirant cross road station	19086												
34	nirant cross to vastral gam	19150-19925												
35	vastral gam station	20000	1			neem	10							1
			1			neem	7					1		

Tree Inventory for East - West Corridor														
S. No	Location name	Chainage	Description				Ht. in mtr	Range of Girth in Centimeter						
			Left	Center	Right	Species		20-30	30-40	40– 60	60 - 100	100- 200	200 - 300	300-400
			1			neem	7				1			
			2			pongam	8					2		
			1			pongam	8		1					
			2			bargad	8					2		
			2			neem	8					2		
			1			neem	8				1			
			1			cassia				1				
		Total	**87**	**87**	**105**				**8**	**59**	**91**	**78**	**30**	**13**
			279					**279**						
	DEPOT													
36	apparel park depot	13800-14600	5			tamarind	12						5	
			9			bakaneem	10							9
			6			bakaneem	12						6	
			2			bakaneem	8				2			
			3			bakaneem	10					3		
			4			pipal	12							4
			5			pongam	10						5	
			2			bargad	12							2
				12		bakaneem	12						12	
				13		bakaneem	10							13
				15		pipal	12							15
				5		pipal	10						5	
				5		pipal	8					5		
				5		baniyan	12							5
				8		gulmohar	10					8		
				5		moringa	10				5			
				5		badam	10				5			
				4		umbar	10					4		

Tree Inventory for East - West Corridor													
S. No	Location name	Chainage	Description				Ht. in mtr	Range of Girth in Centimeter					
			Left	Center	Right	Species		20-30	30-40	40– 60	60 - 100	100- 200	200 - 300	300-400
				1		neem	7			1				
				1		neem	12							1
					10	neem	12						10	
					16	pipal	14					16		
					6	bakaneem	10						6	
					4	bakaneem	12							4
					6	jangal jalebi	10						6	
					15	bargad	12					15		
					3	badam	8						3	
					5	moringa	10				5			
					10	gulmohar	10					10		
					5	jamun	12							5
					5	jamun	10						5	
					5	eucalyptus	12					5		
					5	eucalyptus	10						5	
					9	pongam						9		
					3	caesalpinia								3
		Total	**36**	**79**	**107**			**0**	**0**	**1**	**17**	**75**	**68**	**61**
			222					**222**						
Grand Total			**123**	**166**	**212**			**0**	**8**	**60**	**108**	**153**	**98**	**74**
			501					**501**						

APPENDIX 3.2

Tree Inventory for North - South Corridor														
S. No	Location name	Chainage	Description				Ht. in mtr	Range of Girth in Centi meter						
			Left	Center	Right	Species		20-30	30-40	40-60	60-100	100-200	200-300	300-400
1	start of the alignment to NH 8A Road	0.00-1.000			28	prosopis	3	28						
					1	prosopis	8	1						
				50		prosopis	3	50						
					1	pongam	12				1			
					2	delonix	5	2						
					1	neem	6	1						
					1	neem	10	1						
2	NH 8A road to APMC	1.000-1.900			2	neem	10				2			
					1	neem	10					1		
					3	prosopis	10			3				
				1		neem					1			
			2			bakaneem	10					2		
				1		bakaneem	10					1		
				2		neem	10				2			
				1		neem	10					1		
				1		acacia	10					1		
			1			neem	7			1				
					1	pongam	7		1					
					1	pongam	10					1		
					1	acacia	9					1		
					1	acacia	10					1		
					2	nilgiri	10					2		
					1	Subabul	10						1	
3	APMC station	2.05			4	neem	4	4						
					1	neem	8				1			
					2	pongam	5	2						

Tree Inventory for North - South Corridor														
S. No	Location name	Chainage	Description				Ht. in mtr	Range of Girth in Centi meter						
			Left	Center	Right	Species		20-30	30-40	40-60	60-100	100-200	200-300	300-400
				2		pongam	4	2						
4	APMC to Jivraj station	2.15-2.925												
5	Jivraj station	2.800-2.980			1	gulmohar	5		1					
					1	gulmohar	8			1				
					1	pongam	8		1					
6	jivraj station - Rajiv Nagar	3.075-3.8	1			neem	10					1		
			1			gulmohar	5		1					
			1			neem	10			1				
			1			pongam	10			1				
			1			cassia	10					1		
				5		delonix	10					5		
				18		delonix	8			18				
				24		nerium	5	24						
7	rajiv nagar station	3.85			1	babool	8				1			
					1	gulmohar	8			1				
					5	badam	10			5				
					20	gulmohar	10		5	5	10			
					2	cassia	10				2			
					1	cassia	12				1			
					2	pongam	8			2				
8	Rajiv Nagar Stn to Shreyas	3.925-5.2		1		Neem	10				1			
				1		gulmohar	10					1		
				2		Neem	8		2					
				1		gangli	10					1		
				1		gulmohar	10				1			
				1		Neem	8	1						

Tree Inventory for North - South Corridor														
S. No	Location name	Chainage	Description				Ht. in mtr	Range of Girth in Centi meter						
			Left	Center	Right	Species		20-30	30-40	40-60	60-100	100-200	200-300	300-400
				1		peepal	8					1		
				1		gulmohar	8					1		
				1		Neem	8				1			
				1		gulmohar	8				1			
				1		Neem	8			1				
				2		bargad	8					2		
				1		Neem	5		1					
				1		bargad	8					1		
				1		peepal	10					1		
				5		gulmohar	10			5				
				2		pongam	5			2				
				3		pongam	10				3			
				1		bargad	10				1			
9	Shreyas Station	5.25			3	pongam	8			3				
					2	gulmohar	8			2				
					1	peepal	8			1				
					2	Neem	8			2				
					1	subabul	10				1			
					4	pongam	8	4						
					4	pongam	10				4			
					1	bargad	10		1					
10	Shreyas to Parimal Station	5.35-6.2			1	prosopis	7			1				
				1		neem	10				1			
					1	delonix	7	1						
					1	pipal	7	1						
					1	subabul	8		1					
					1	pongam	5	1						

Tree Inventory for North - South Corridor														
S. No	Location name	Chainage	Description				Ht. in mtr	Range of Girth in Centi meter						
			Left	Center	Right	Species		20-30	30-40	40-60	60-100	100-200	200-300	300-400
					1	neem	7		1					
					2	pipala	7			2				
					1	pipala	7				1			
					1	bundi	7	1						
					1	delonix	5	1						
				3		neem	10			3				
				2		neem	5	2						
					1	champa	5		1					
					1	karanj	8		1					
					2	pipal	8				2			
					1	bargad	6		1					
					1	neem	10			1				
					1	pongam	7		1					
				2		pipal	10					2		
				1		neem	12					1		
				1		neem	12						1	
					1	bakaneem	12						1	
				2		neem	12					2		
					1	chinchbilai	12				1			
					1	pongam	10				1			
					1	malberry	7	1						
					1	bargad	10		1					
					1	bakaneem	15						1	
					1	pipal	10				1			
					1	neem	10						1	
11	parimal station	6.25			1	pipal	10				1			
			1			cassia	7				1			

Tree Inventory for North - South Corridor													
S. No	Location name	Chainage	Description				Ht. in mtr	Range of Girth in Centi meter					
			Left	Center	Right	Species		20-30	30-40	40-60	60-100	100-200	200-300	300-400
			1			neem	12				1			
					1	neem	12						1	
			1			delonix	10				1			
					1	pongam	12				1			
					1	pongam	15					1		
				1		bakaneem	10				1			
12	Parimal Station to Gandhigram	6.35-8.00			3	bakaneem	10		3					
					4	bakaneem	12			4				
					1	subabul	8			1				
					1	subabul	8				1			
				1		pipal	15						1	
					1	pipal	10						1	
					1	champa	10				1			
					1	subabul	7				1			
					1	neem	10				1			
					2	subabul	10				2			
					1	bakaneem	12				1			
					1	coconut	10		1					
				1		jamun	15						1	
				1		pongam	10				1			
					1	pongam	15				1			
				1		pipal	10		1					
				1		pipal	10			1				
				2		neem	12						2	
					2	ashoka	15				2			
				3		pongam	15						3	
					1	bakaneem	15						1	

Tree Inventory for North - South Corridor														
S. No	Location name	Chainage	Description				Ht. in mtr	Range of Girth in Centi meter						
			Left	Center	Right	Species		20-30	30-40	40-60	60-100	100-200	200-300	300-400
				4		neem	5	4						
				1		prosopis	5	1						
				1		cassia	5	1						
					1	neem	15			1				
					1	neem	10					1		
					1	pongam	15				1			
					1	neem	10					1		
					1	neem	10			1				
					1	babool	10		1					
					1	peepal	15					1		
13	Gandhgigram railway station	8.05			1	badam	10				1			
					1	neem	10				1			
					1	peepal	10				1			
					1	neem	15					1		
					3	bargad	10				3			
					1	neem	10					1		
14	Ghandhigram station to Income Tax Station	8.150-9.05			1	mango	10				1			
					1	ashoka	10			1				
					1	neem	8			1				
					1	gulmohar	10				1			
					3	neem	10				3			
					1	neem	10					1		
					4	bargad	5				4			
					1	tamarind	10				1			
					1	tamarind	15					1		
					1	gulmohar	20					1		
					1	bargad	5				1			

Tree Inventory for North - South Corridor														
S. No	Location name	Chainage	Description				Ht. in mtr	Range of Girth in Centi meter						
			Left	Center	Right	Species		20-30	30-40	40-60	60-100	100-200	200-300	300-400
					1	gulmohar	10					1		
					1	pongam	10				1			
					1	gulmohar	15					1		
					1	babool	10			1				
					10	gulmohar	10				10			
					2	neem	10				2			
					1	gulmohar	10				1			
					1	pongam	10				1			
15	Incometax	9.15		1		gulmohar	5			1				
			1			neem	12						1	
			1			neem	12				1			
			1			jamun	8		1					
			1			neem	10			1				
			1			badam	10				1			
			2			bargad	6	2						
			1			neem	6		1					
			1			neem	10				1			
			1			subabul	10			1				
			1			cassia	10				1			
			1			delonix	10				1			
			1			bargad	8		1					
				1		tamarind	12				1			
				1		mulberry	6	1						
				2		neem	12				2			
					1	neem	10				1			
					1	subabul	10			1				
					1	neem	10	1						

Tree Inventory for North - South Corridor													
S. No	Location name	Chainage	Description				Ht. in mtr	Range of Girth in Centi meter					
			Left	Center	Right	Species		20-30	30-40	40-60	60-100	100-200	200-300	300-400
					1	pipal	12				1			
					1	neem	12				1			
					1	delonix	10			1				
					1	bakaneem	10		1					
					1	ber	10			1				
					1	delonix	12					1		
16	Incometax to Usmanpura Station	9.20-10.100			1	neem	10				1			
					1	bakaneem	15						1	
					1	neem	10				1			
					1	cassia	10			1				
					1	pongam	6			1				
					1	delonix	8			1				
					1	neem	8	1						
			1			mulberry	6	1						
					1	neem	8		1					
			1			pongam	12				1			
					7	neem	10			7				
					1	neem	12						1	
					1	neem	12					1		
					1	delonix	8		1					
					1	neem	10		1					
					2	neem	12					2		
					1	neem	6	1						
				1		pongam	8		1					
				1		babul	12				1			
				1		pongam	12					1		
				1		pipal	12				1			

Tree Inventory for North - South Corridor													
S. No	Location name	Chainage	Description				Ht. in mtr	Range of Girth in Centi meter					
			Left	Center	Right	Species		20-30	30-40	40-60	60-100	100-200	200-300	300-400
				1		subabul	10				1			
					1	pongam	15				1			
					1	umbar	15					1		
					1	neem	15						1	
			1			sona	8			1				
				1		neem	5						1	
					2	pongam	15						2	
					1	neem	15						1	
					1	jamun	15						1	
					8	bakaneem	15			8				
					1	bakaneem	15					1		
			2			bakaneem	15				2			
			2			neem	10			2				
			6			bakaneem	10				6			
			2			subabul	6			2				
				5		bakaneem	15				5			
				1		cassia	10				1			
				1		neem	8		1					
			2			neem	15					2		
			5			bakaneem	15					5		
			1			subabul	10				1			
					1	neem	10				1			
			9			bakaneem	15					9		
					1	neem	10				1			
				1		neem	15				1			
				1		bakaneem	15			1				
				1		bargad	15				1			

Tree Inventory for North - South Corridor													
S. No	Location name	Chainage	Description				Ht. in mtr	Range of Girth in Centi meter					
			Left	Center	Right	Species		20-30	30-40	40-60	60-100	100-200	200-300	300-400
				1		bargad	15			1				
			1			umbar	10			1				
				1		neem	8		1					
				2		bakaneem	10				2			
				5		pongam	10				5			
				1		bargad	10				1			
				1		umbar	10						1	
				1		neem	10			1				
				2		bargad	10			2				
				1		neem	10			1				
				1		neem	10				1			
					1	bargad	10			1				
					2	pipal	10			2				
					1	neem	6			1				
					1	delonix	10			1				
					1	neem	12		1					
					1	plumeria	6			1				
					1	plumeria	8			1				
					1	subabul	10			1				
					2	pipal	7	2						
					1	neem	10			1				
					4	umbar	10			4				
					3	subabul	10			3				
					1	neem	10				1			
17	usmanpura station	10.110-10.210			2	neem	10			2				
					6	umbar	10			6				
					1	neem	10			1				

Tree Inventory for North - South Corridor														
S. No	Location name	Chainage	Description				Ht. in mtr	Range of Girth in Centi meter						
			Left	Center	Right	Species		20-30	30-40	40-60	60-100	100-200	200-300	300-400
					1	pongam	10					1		
					3	umbar	10	3						
					2	delonix	10			2				
					2	cassia	8			2				
					2	cassia	10				2			
					1	pongam	12					1		
					1	pongam	10				1			
					1	delonix	10				1			
				1		neem	10			1				
				1		pongam	10					1		
				1		cassia	10			1				
				2		cassia	12				2			
				2		neem	10			2				
				1		badam	8		1					
				2		cassia	10				2			
				2		neem	10			2				
				1		babul	10				1			
18	Usmanpura to Vijaynagar Station	10.250-11.650		2		neem	12			2				
					1	subabul	10			1				
					1	pongam	12				1			
					3	pongam	12			3				
					1	pipal	10					1		
					1	pongam	8			1				
					1	pongam	8				1			
				3		neem	10				3			
					1	neem	10					1		
					1	bargad	13					1		

Tree Inventory for North - South Corridor														
S. No	Location name	Chainage	Description				Ht. in mtr	Range of Girth in Centi meter						
			Left	Center	Right	Species		20-30	30-40	40-60	60-100	100-200	200-300	300-400
					1	subabul	12				1			
					1	umbar	6	1						
					1	moringa	12					1		
					1	cassia	8			1				
					1	delonix	10			1				
					1	neem	12					1		
			10			subabul	12				10			
			7			subabul	10				7			
			12			delonix	12				12			
				1		pongam	12				1			
				1		ritha	10			1				
				1		delonix	10			1				
				1		neem	10			1				
				1		neem	10		1					
			1			champa	10			1				
					1	neem	8		1					
					1	neem	10				1			
					1	pongam	10			1				
					1	bargad	8		1					
					1	subabul	10				1			
					1	pongam	15				1			
					2	subabul	12			2				
					2	subabul	12				2			
					1	champa	10			1				
					1	neem	10				1			
					2	delonix	12				2			
					1	pongam	10		1					

Tree Inventory for North - South Corridor														
S. No	Location name	Chainage	Description				Ht. in mtr	Range of Girth in Centi meter						
			Left	Center	Right	Species		20-30	30-40	40-60	60-100	100-200	200-300	300-400
					1	moringa	10				1			
					1	cassia	10				1			
					1	neem	12				1			
					1	babul	10				1			
					1	neem	10			1				
					1	neem	10				1			
					1	ashoka	5	1						
					1	subabul	12		1					
					1	neem	10				1			
					1	neem	5				1			
					1	pongam	5	1						
				1		neem	5	1						
					1	subabul	10			1				
					3	subabul	10				3			
			1			pongam	8		1					
			1			guvava	8		1					
					2	neem	10			2				
			1			pongam	10			1				
			1			pongam	10		1					
					1	champa	10			1				
					2	subabul	10			2				
					1	neem	10			1				
				1		delonix	10			1				
					1	neem	10				1			
				1		pipal	8	1						
				1		neem	10			1				
				1		cassia	12				1			

Tree Inventory for North - South Corridor													
S. No	Location name	Chainage	Description				Ht. in mtr	Range of Girth in Centi meter					
			Left	Center	Right	Species		20-30	30-40	40-60	60-100	100-200	200-300	300-400
				1		pipal	12				1			
				1		champa	10				1			
			2			neem	10			2				
			1			neem	10				1			
			1			prosopis	8			1				
			1			neem	8		1					
			1			champa	10			1				
				2		babul	10				2			
			2			subabul	10					2		
			2			neem	10			2				
					1	neem	10				1			
					1	pipal (sacred)	15					1		
					1	neem	10				1			
				1		pongam	12				1			
					2	neem	10			2				
					1	neem	10				1			
					2	neem	15				2			
					1	umbar	10				1			
			1			pipal	15				1			
				1		subabul	15					1		
					1	neem	15				1			
				4		neem	12				4			
				1		subabul	12				1			
				1		bargad	10				1			
				3		umbar	12					3		
				1		umbar	10				1			
					3	neem	12					3		

Tree Inventory for North - South Corridor														
S. No	Location name	Chainage	Description				Ht. in mtr	Range of Girth in Centi meter						
			Left	Center	Right	Species		20-30	30-40	40-60	60-100	100-200	200-300	300-400
					1	pongam	12					1		
					1	umbar	12				1			
					1	subabul	12				1			
					1	umbar	12				1			
					2	bakaneem	12						2	
					1	bakaneem	12					1		
					1	bargad	10				1			
					2	neem	10				2			
					1	neem	10					1		
					1	neem	10		1					
					2	subabul	10				2			
				5		neem	12				5			
				5		neem	15						5	
				4		subabul	12			4				
			8			neem	12			8				
					20	neem					20			
					1	neem	15				1			
				10		subabul	10			10				
					1	neem	15				1			
			1			sona	8			1				
					1	pongam	8				1			
					1	cassia	10				1			
					1	umbar	10				1			
				1		delonix	12				1			
					2	bombax	15				2			
				1		delonix	10			1				
				1		umbar	10				1			

Tree Inventory for North - South Corridor													
S. No	Location name	Chainage	Description				Ht. in mtr	Range of Girth in Centi meter					
			Left	Center	Right	Species		20-30	30-40	40-60	60-100	100-200	200-300	300-400
				1		champa	8	1						
				2		bombax	10			2				
				1		bargad	10				1			
				1		neem	10				1			
				1		pongam	10			1				
				1		delonix	10				1			
				1		subabul	10				1			
				1		pongam	10				1			
				1		pipal	15					1		
					1	sona	10				1			
				2		bargad	12					2		
					1	sona	12				1			
				1		pipal	15					1		
			2			neem	12				2			
			1			subabul	10				1			
			1			pongam	10				1			
			1			ashoka	10			1				
			1			pipal	15						1	
				1		neem	15				1			
					4	neem	12					4		
					1	umbar	10						1	
					1	ber	12					1		
					2	bargad	12				2			
19	vijay nagar station	11.7	5			cassia	15				5			
			2			pongam	10				2			
			1			delonix	10					1		
			1			subabul	10					1		

Tree Inventory for North - South Corridor													
S. No	Location name	Chainage	Description				Ht. in mtr	Range of Girth in Centi meter					
			Left	Center	Right	Species		20-30	30-40	40-60	60-100	100-200	200-300	300-400
			1			cassia	15				1			
			2			neem	12				2			
			2			sona	12				2			
			1			bargad	12				1			
				1		ber	12				1			
			1			neem	12				1			
			1			neem	5				1			
			1			pongam	8	1						
			1			neem	12				1			
					3	ber	12				3			
					4	sona	12				4			
					3	neem	12					3		
					1	pipal	12				1			
					1	Neem	12				1			
20	Vijay Nagar Station to Akhbar Nagar Station	11.80-12.850		1		pakad	12					1		
				1		neem	8		1					
				2		cassia	10				2			
				1		pongam	10				1			
					1	pipal	15					1		
					2	pongam	10				2			
					1	cassia	10			1				
			2			delonix	10			2				
				3		neem	10				3			
			1			ashoka	10				1			
			1			pongam	10				1			
			2			neem	12					2		
				2		subabul	10			2				

Tree Inventory for North - South Corridor														
S. No	Location name	Chainage	Description				Ht. in mtr	Range of Girth in Centi meter						
			Left	Center	Right	Species		20-30	30-40	40-60	60-100	100-200	200-300	300-400
				1		bargad	5			1				
				1		ber	10			1				
				1		neem	10				1			
				1		pongam	10				1			
				1		neem	10			1				
				1		pongam	10			1				
				2		ber	10				2			
				2		neem	15						2	
				4		neem	15					4		
				1		pipal	12				1			
				1		subabul	12				1			
				1		pongam	12				1			
					4	ashoka	10			4				
					1	babul	10			1				
					1	pongam	10				1			
					1	subabul	10			1				
					4	cassia	10	4						
					1	neem	5	1						
				3		neem	10				3			
				1		cassia	5	1						
				1		pongam	5	1						
				1		moringa	12				1			
				1		neem	15						1	
					3	ber	12				3			
				1		champa	10			1				
				1		pakad	15					1		
				1		subabul	10					1		

Tree Inventory for North - South Corridor														
S. No	Location name	Chainage	Description				Ht. in mtr	Range of Girth in Centi meter						
			Left	Center	Right	Species		20-30	30-40	40-60	60-100	100-200	200-300	300-400
				1		pongam	10				1			
				1		mulberry	8			1				
				2		ashoka	8		2					
				1		ashoka	6	1						
				1		pakad	10				1			
				1		boganvilia	15				1			
				2		neem	10			2				
				1		cassia	10			1				
				1		kavath	12				1			
				2		neem	10			2				
				1		ashoka	15				1			
				1		pongam	15					1		
				1		umbar	10				1			
				1		malbery	10				1			
				2		subabul	10				2			
				2		pongam	10				2			
				1		pakad	10				1			
				1		pakad	10				1			
				1		subabul	10				1			
				1		pongam	10				1			
				1		pongam	8				1			
				2		pongam	15					2		
				1		neem	10				1			
				1		bargad	12				1			
				1		pakad	8			1				
				1		pongam	8			1				
				1		neem	10			1				

Tree Inventory for North - South Corridor													
S. No	Location name	Chainage	Description				Ht. in mtr	Range of Girth in Centi meter					
			Left	Center	Right	Species		20-30	30-40	40-60	60-100	100-200	200-300	300-400
				1		cassia	10	1						
					1	bad	10				1			
					1	neem	10			1				
				1		champa	10					1		
				2		pongam	10					2		
				1		bakaneem	10					1		
21	akbar nagar station	12.95		6		neem	10				6			
				8		pongam	10			8				
				1		pipal	10			1				
					1	boganvilia	8			1				
					1	bargad	10				1			
					5	Neem	10			5				
					10	gulmohar	10				10			
22	Akbar Nagar to Ranip	13.025-14.200			3	pipal	10				3			
					1	pongam	8	1						
					1	mango	10			1				
					3	ashoka	10				3			
					1	neem	10				1			
					1	pipal	10				1			
					1	pipal	10					1		
				2		cassia	10				2			
				3		subabul	10				3			
				1		ber	10			1				
				1		champa	10				1			
				2		subabul	10					2		
				1		subabul	10			1				
				1		neem	10			1				

Tree Inventory for North - South Corridor													
S. No	Location name	Chainage	Description				Ht. in mtr	Range of Girth in Centi meter					
			Left	Center	Right	Species		20-30	30-40	40-60	60-100	100-200	200-300	300-400
				1		pipal	10			1				
				1		subabul	10			1				
				1		neem	10			1				
				1		subabul	10				1			
				1		mango	8			1				
				1		neem	10				1			
				1		pipal	10				1			
23	ranip station	14.3	1			prosopis	8	1						
			1			neem	10			1				
24	ranip station to Sabarmati Rly Stn				1	neem	10				1			
				1		ber	10			1				
				1		babul	10			1				
				1		tamarind	10					1		
					1	pongam	12				1			
					1	pipal	12				1			
					1	kavit	10				1			
				1		pipal	10					1		
			2			subabul	10			2				
			1			neem	10				1			
			2			neem	10					2		
25	sabaramati rly stn		1			pipal	10				1			
			2			pipal	10					2		
			1			neem	10			1				
			2			neem	10				2			
			1			delonix	10			1				
			1			pongam	10				1			
26	Sabarmati Rly stn to			1		champa	10					1		

Tree Inventory for North - South Corridor													
S. No	Location name	Chainage	Description				Ht. in mtr	Range of Girth in Centi meter					
			Left	Center	Right	Species		20-30	30-40	40-60	60-100	100-200	200-300	300-400
	AEC			1		pongam	10			1				
				1		neem	12				1			
				1		subabul	10				1			
				1		pipal	10				1			
			2			neem	12					2		
			1			bakaneem	15						1	
27	AEC station		1			pipal	10			1				
			1			neem	10				1			
			2			pipal	10				2			
			1			moringa	10				1			
			1			subabul	10				1			
28	AEC to Sabarmati		1			pipal	10				1			
			1			bakaneem	15						1	
			1			neem	15						1	
			1			ashoka	15				1			
29			1			neem	10				1			
				1		bakaneem	12					1		
				2		pipal	10					2		
					1	neem	12					1		
					1	neem	10					1		
					1	champa	10				1			
				1		neem	12					1		
					1	pipal	12					1		
					2	pipal	12					2		
					1	subabul	10				1			
					1	umbar	10					1		
			2			eucalyptus	15					2		

Tree Inventory for North - South Corridor														
S. No	Location name	Chainage	Description				Ht. in mtr	Range of Girth in Centi meter						
			Left	Center	Right	Species		20-30	30-40	40-60	60-100	100-200	200-300	300-400
				1		champa	12					1		
					1	ashoka	12				1			
30	sabarmati		1			neem	12				1			
					1	pipal	10					1		
					1	pipal	12				1			
31	Sabarmati to Motera		4			neem	12					4		
					1	neem	10					1		
					1	badam	10				1			
					1	peepal	10				1			
			1			neem	10				1			
					1	badam	10			1				
					1	neem	10				1			
					4	neem	10				4			
					1	badam	10				1			
			1			ashoka	15					1		
			4			neem	12					4		
			1			neem	10			1				
			1			pipal	8			1				
			1			babul	10			1				
32	motera stadium		4			neem	12				4			
			2			neem	10			2				
			1			neem	8		1					
			1			pongam	10				1			
			1			pipla	12				1			
					1	subabul	10				1			
					1	pipla	10			1				
					1	pongam	10				1			

Tree Inventory for North - South Corridor														
S. No	Location name	Chainage	Description				Ht. in mtr	Range of Girth in Centi meter						
			Left	Center	Right	Species		20-30	30-40	40-60	60-100	100-200	200-300	300-400
					1	pongam	12					1		
					1	bakaneem	12				1			
33	Motera stadium to end of the alignment	18.800-19.300	1			neem	10				1			
			1			badam	10				1			
			1			umbar	10					1		
					1	pongam	10				1			
Total			**199**	**407**	**507**			**164**	**52**	**272**	**430**	**155**	**40**	
			1113					**1113**						
Depot														
34	Giyaspur depot				2	neem	8		2					
					1	neem	8					1		
					1	neem	8				1			
					5	prosopis	6		5					
				1		ricinus	6		1					
				8		neem	8		8					
				1		shisam	6			1				
				1		neem	6		1					
				1		babul	15				1			
			1			neem	10			1				
			1			neem	10				1			
			1			neem	6		1					
			1			bakaneem	15					1		
Total			**4**	**12**	**9**			**0**	**18**	**2**	**3**	**2**	**0**	
			25					**25**						
Grand Total			**203**	**419**	**516**			**164**	**70**	**274**	**433**	**157**	**40**	
			1138					**1138**						

APPENDIX 3.3

DETAILS OF NATIONAL PARK AND SANCTUARIES OF GUJARAT STATE

S. No	Name of Park / Sanctuary	Year	Area in Sq. km	Location	Major Species
National Parks					
1.	Gir National Park	1975	258.71	Sasan Gir Dist : Junagadh	Lion, Leopard, Chital, Chausinga, Hyena, Sambar, Chinkara, Herpetofauna, Crocodiles and birds.
2.	Black National Park	1976	34.08	Velavader Dist : Bhavnagar	Blackbuck, Wolf, Houbara bustard, Harrieres, Leser florican, Herpetoufaua
3.	Vansda National Park	1979	23.99	Vansda Dist: Navasari	Leopard, Hyena Chital, Chausinga, Birds, Herpetofauna
4.	Marine National Park	1982	162.89	Gulf of Kachchh Dist : Jamnagar	Sponges, Corals, Jelly fish, Sea horse, Octopus, Oyster, Pearl oyster, Starfish, Lobster, Dolphin, Dugon, Waterfowls.
Sanctuaries					
5.	Gir Wild Life Sanctuary	1965	1153.42	Sasan Gir Dist: Junagadh, Amreli	Lion, Leopard, Chausinga, Chital, Hyena, Sambar, Chinkara, Herpetofauna, Crocodiles and birds
6.	Wild Ass Sanctuary	1973	4953.70	Little Rann of Kachchh	Wild Ass, Chinkara, Blue bull, Houbara bustard, Wolf, Waterfowls, Herpetofauna
7.	Nal Sarovar Birds Sanctuary	1969	120.82	Nal Sarovar Dist:Amdavad & Surendranagar	Flamingos, Pelicans, Coot, ducks, waders, storks, Herons and other spp. of waterfowls, Herpetofauna
8.	Jessore Sloth BearSanctuary	1978	180.66	Jessore hill Dis: Banaskantha	Sloth Bear, Leopard, Hyena, Birds, Herpetofauna
9.	Barda Wild Life Sanctuary	1979	192.31	Hingolgadh Dist:Rajkot	Leopard, Blue bull, Hyena, wild boar, Jackal, Birds, Herpetofauna
10.	Hingolgadh Sanctuary	1980	6.54	Hingolgadh Dist: Rajkot	Chinkara, Blue bull, Wolf, Hyena, Fox, Birds, Herpetofauna
11.	Marine Sanctuary	1980	295.03	Gulf of Kachchh Dist: Jamnagar	Sponges, Corals, Jellyfish, Sea horse, Octopus,Oyster, Pearloyster, Starfish, Lobster, Dolphin, Dugong, waterfowls
12.	Narayan Sarovar Sanctuary	1981	444.23	Narayan Sarovar Dist: Kachchh	Chinkara, Caracal, Desert Cat, Hyena, Desert Fox,Jackal, Birds, Herpetofauna
13.	Khijadia Bird Sanctuary	1981	6.05	Khijadia Dist: Jamnagar	Indian Skimmer, Ibises, Painted stork, Cormorants, etc. App. 220 spp. of birds, Herpetofauna
14.	Ratanmahal Sanctuary	1982	55.65	Ratanmahal Dist: Dahod	Sloth bear, Leopard, Hyena, Jackal, Chausinga, Civet Cat, Jungle cat, Birds, Herpetofauna
15.	Kutch Desert Sanctuary	1986	7506.22	Great Rann of Kachchh	Chinkara, Hyena, Fox, Flamingo, Pelicans & other waterfowls, Herpetofauna
16.	Gaga Wild Life Sanctuary	1988	3.33	Gaga Dis: Jamnagar	Great Indian Bustard, Wolf, Jackal, Birds, Herpetofauna
17.	Rampara Sanctuary	1988	15.01	Rampara Dist: Rajkot	Blue bull, Chinkara, Wolf, Fox, Jackal, Birds, Herpetofauna
18.	Thol Lake Bird Sanctuary	1988	6.99	Thol Dist: Mahesana	Cranes, Geese, Famingos, Sarus and app. 125 spp. of other

S. No	Name of Park / Sanctuary	Year	Area in Sq. km	Location	Major Species
					waterfowls
19.	Shoolpaneshwar Sanctuary	1982	607.70	Dist: Narmada	Sloth bear, Leopard, Rhesus macaque, Chausinga, Barking deer, Pangolin, Herpetofauna, birds including Alexandrian parakeet
20.	Porbandar Birds Sanctuary	1988	0.09	Porbandar Dist: Porbandar	Flamingos, Pelicans, Spoonbill and various bird spp.
21.	Pania Wild Life Sanctuary	1989	39.63	Dist: Amreli	Lion, Chinkara, Leopard, Chital, Hyena, wild board, four horned antelope, pangolin, Blue bull, birds
22.	Balaram Ambaji Sanctuary	1989	542.08	Dist: Banaskantha	Sloth bear, Leopard, Blue bull, Hyena, Wolf, Jungle cat, Birds, Herpetofauna
23.	Jambuhoda Sanctuary	1990	130.38	Jambughoda Dist: Panchmahal	Sloth bear, Leopard, Jungle cat, Hyena, Wolf, Four Horned Antelope, Herpetofauna, Birds
24.	Purna Wild Life Sanctuary	1990	160.84	Dist: Dangs	Leopard, Barking deer, macaques, Four horned antelope, Sambhar, Hyena, Herpetofauna, birds
25.	Kutch Bustard Sanctuary	1992	2.03	Near Naliya Dist: Kachchh	Great Indian Bustard, Lesser Florican, Houbara bustard, Chinkara, Blue bull, Herpetofauna
26.	Mitiyala Wildlife Sanctuary	2004	18:22	Mitiyala Dist: Amerli	Lion, Leopard, Chital, Blue bull, Pangolin, Sambar,Chinkara, Herpetofauna, Birds

CHAPTER–4
NEGATIVE ENVIRONMENTAL IMPACTS

4.1 GENERAL

The primary function of an environmental impact assessment study is to predict and quantify the magnitude of impacts, evaluate and assess the importance of the identified changes and formulate plans to monitor and mitigate the actual changes. Environmental impacts could be positive or negative, direct or indirect, local, regional or global, reversible or irreversible. The process begins by identifying the development and operational activities resulting from the proposed project as contained in **Chapter-2** and **Chapter-3** is dedicated for providing information on the baseline environmental conditions for various parameters. Attempts have been made to predict the impacts due to proposed project. The pollutants generated due to the proposed project premises during construction and operation phases are solid, liquid and gaseous in nature. This section identifies and appraises the negative impacts on various aspects of the environment likely to result from the proposed development.

- Land Environment,
- Water Environment,
- Air Environment,
- Noise Environment,
- Biological Environment and
- Socio-Economic Environment

The impacts on the above environmental components have been assessed during various phases of project cycle namely project Location, design, construction and operation.

4.2 IMPACTS DUE TO PROJECT LOCATION

During this phase, those impacts, which are likely to take place due to the layout of the project, have been assessed. These impacts are:

- Project Affected People (PAPs)
- Change of Land use;
- Loss of trees/forest;
- Utility/Drainage Problems,
- Impact on Historical and Cultural Monuments, and
- Impact on Local Transport Facilities

4.2.1 Project Affected People (PAPs)

The proposed Ahmedabad metro rail project shall cause involuntary displacement of people along the alignment, which shall include both title holder and non-titled holder land owners. The issue of Rehabilitation and Resettlement (R&R) is addressed in a separate SIA report**.**

4.2.2 Change of Land Use

Development of proposed Ahmedabad Metro involves acquisition of land for stations, Depot, TSS, Cut & Cover station and for other facilities. The details of land requirement for different components of the project of East-West corridor are given in **Table 4.1**. Acquisition of the private land may cause social disruption and economic loss for the project affected families/people. While implementing the project, there is a need to take into account these disturbances and losses due to the project, their impact on socio-economic condition of the people and plan for their mitigation measures to minimise any negative impacts.

TABLE 4.1
EAST-WEST CORRIDOR LAND REQUIREMENT (Sq.m)

S.NO	PARTICULARS	East-West Corridor		North-South Corridor		Total
		PERMANENT LAND REQUIREMENT		PERMANENT LAND REQUIREMENT		
		GOVERNMENT	PRIVATE	GOVERNMENT	PRIVATE	
1	Depot	190936	--	250,000	-	440,936
2	Stations	5,020	9,840	1,400	11,200	27,460
3	Running Section	197,672	22,073	127,500*	8,500	355,745
4	Staff Quarter, office complex & OCC	50,000	-	0.82	-	50,000
5	Receiving Substation	11,200	-	11,200	-	22,400
6	Mid Shaft	1,650	-	-	-	1,650
	Total	**456,478**	**31,913**	**390,100**	**19,700**	**898,191**

*** Railway Land**

From the data it could be concluded that out of total permanent land requirement about 93 % land to be acquired is from Government and 7 % from private sector for East-West corridor. The compensation for land is included in Social Impact Assessment Study Report.

4.2.3 Loss of Trees/Forests

The proposed alignment of metro rail is in urban/ city area and not passing through any forest. Hence no loss of forest is anticipated. The trees are getting affected along alignment, stations and at depots location. There are 279 trees observed along the East-West alignment and 222 trees are at depot (**Refer Section 3.7.1)**. Hence the total number of trees observed on East-West corridor is 501. 1137 trees observed

along the North-South corridor in which 1112 along the alignment and 25 number of trees at Depot location. Hence total number of trees on both the alignment is 1638.

It is observed from the tree survey (Annexure 3.1) that, out of total on East-West corridor 35% (i.e 176) and along North-South corridor 83% (i.e 941) of the tree have girth below 1 metre. These trees which are having girth below 1 metre will be transplanted and remaining trees from both corridors (i.e 521) of the trees needs to be cut. With removal of these trees the process of CO_2 absorption and O_2 production will get affected and the losses are reported in **TABLE 4.2**.

TABLE 4.2
OXYGEN DEFICIT DUE TO TREE LOSS

S. No	DESCRIPTION	QUANTITY
1.	Total no. of Trees to be cut	521
2.	Increase in CO_2 @ 21.8 Kg/year/ tree	11538 kg
3.	Decrease in Oxygen production @ 49 Kg/year/ tree	25529 kg

According to Clean Development Mechanism one tonne of CO_2 increase will yield one Carbon credit and 6 Euros (1Euro = Rs.69.00) is earned by one carbon credit. Total loss of carbon credit is 11.53 ton per year due to cutting of 521 trees. About 25,529 kg of Oxygen production will get reduced because of tree loss and loss of Rs. 14.18 lakh (25,529 (kg of O_2) X 55.55 (Rs./Kg of O_2) is anticipated.

4.2.4 Utility/Drainage Problems

Large number of sub-surface, surface and over head utility services viz. sewers, water mains, storm water drains, telephone cables, O.H electrical transmission lines, electric poles, traffic signals, etc. are existing along the proposed alignment. These utility services are essential and have to be maintained in working order during different stages of construction, by temporary/permanent diversions or by supporting in position. Since these may affect construction and project implementation time schedule/costs, for which necessary planning/action needs to be initiated in advance. The list of utility affected chainage wise is given in DPR (Chapter-5).

4.2.5 Impact on Historical and Cultural Monuments

The proposed metro rail project will affect residential and commercial structures at some of the portion of alignment and metro stations where construction be made by cut and cover method. No Archeological Monuments are directly affected. Some of the Archeological Monuments are close to the proposed metro alignment near underground section as depicted in **Table 3.18**. Utmost care needs be taken so that no significant impact is anticipated on the historical structures due to project activities during construction and operation.

4.2.6 Impact on Local Transport Facilities

The metro rail has been proposed to cater the additional demand of present and future traffic requirement. Hence, no loss of job to the existing transport facilities is anticipated. The drivers of local transport facilities like buses, taxis, autos and rickshaws may be utilized to cater the requirement of transport from metro stations to work place and vice-versa. Additional employment opportunities are also anticipated due to the proposed metro.

4.3 IMPACTS DUE TO PROJECT DESIGN

Considered impacts, due to project designs are:

- Platform inlets and outlets,
- Ventilation and lighting,
- Metro station refuse, and
- Risk due to earthquake.

4.3.1 Platforms Inlets and Outlets

The platform level has adequate assembly space for passengers for both normal operating conditions and a recognized abnormal scenario. The platform level at elevated stations is determined by a critical clearance of 5.50 m under the concourse and above the road intersection, allowing 3.00 m for the concourse height, about 2-m for concourse floor and 2.00 m for structure of tracks above the concourse. Further, the platforms are 1.09 m above the tracks. This would make the platforms in an elevated situation at least 14.0 m above ground. Tunnel Ventilation fans and ASS in underground stations are provided at platform level/ concourse level depending on availability of land for locating vent shafts.

Provision has been made for escalators to connect concourse to platforms. Passenger handling facilities comprise of stairs/escalators, lifts and ticket gates required to process the peak traffic from street to platform and vice-versa (these facilities must also enable evacuation of the station under emergency conditions, within a set safe time limit). The escalators will be heavy duty ñPublicò service escalators capable of operating safely, smoothly and continuously in either direction, for a period of not less than 20 hours per day, seven days per week within the environmental conditions. The escalators will be equipped with energy saving system with protection barriers. Also the design of the escalators will be such that they can be used as fixed staircases under a condition of power failure or activation by safety/protection devices. When the escalators are stationed, no slipping, jerking, sliding and vibration should occur. One lift has been provided on platform to provide access for elderly and disabled. Additional staircases have been provided for the fire

escape at the two ends of platform. For emergency evacuation purposes, the maximum distance to an exit route on the platform shall be 50 metre.

Platform roofs that can invariably make a structure look heavy; have been proposed to be of steel frame with aluminium cladding to achieve a light look. Platforms would be protected from the elements by providing an overhang of the roof and sidewalls would be avoided, thereby enhancing the transparent character of the station building. In order to allow unhindered traffic movement below the stations, cantilevers across the road have been proposed in the concourse part, over which the station structure would rest. The station structure is supported on a single column, which lies unobtrusively on the central verge.

The typical underground station is a two level station with platforms at the lower level and concourse on the upper level. Concourses are provided at the ends in such a manner that the total depth of the underground station and cost is kept to the minimum. Two emergency staircases are also being planned in the traffic islands.

The Entry/exit structures to proposed stations have been planned to be located on footpaths to the extent possible. However, where this is not possible, land acquisition would be inevitable.

Hence, it can be concluded that all stations have necessary provision for space at inlet, outlet, elevators and platforms to accommodate people in normal as well as in emergency situation. Hence no hazard is anticipated due to the proposed sizes of inlets and outlets.

4.3.2 Ventilation and Lighting

The underground stations are built in a confined space. A large number of passengers occupy concourse halls and the platforms, especially at the peak hours. The platform and concourse areas have a limited access from outside and do not have natural ventilation. It is therefore, essential to provide forced ventilation in the stations and inside the tunnel for the purpose of:

- Supplying fresh air for the physiological needs of passengers and the staff;
- Removing body heat, obnoxious odours and harmful gases like carbon dioxide exhaled during breathing;
- Preventing concentration of moisture generated by body sweat and seepage of water in the sub-way;
- Removing large quantity of heat dissipated by the train equipment like traction motors, braking units, compressors mounted below the under-frame, lights and fans inside the coaches, A/c units etc.;

- Removing vapour and fumes from the battery and heat emitted by light fittings, water coolers, Escalators, Fare Gates etc. working in the stations;
- Removing heat from air conditioning plant and sub-station and other equipment, if provided inside the underground station.

This large quantity of heat generated in underground stations cannot be extracted by simple ventilation. It is, therefore, essential to provide mechanical cooling in order to remove the heat to the maximum possible extent. As the passengers stay in the stations only for short periods, a fair degree of comfort conditions, just short of discomfort are considered appropriate. In winter months it may not be necessary to cool the ventilating air as the heat generated within the station premises would be sufficient to maintain the comfort requirement.

The underground stations of the corridors are built in a confined space. A large number of passengers occupy concourse halls and the platforms, especially at the peak hours. The platform and concourse areas have a limited access from outside and do not have natural ventilation. It is therefore, essential to provide forced ventilation in the stations and inside the tunnel for the purpose of supply of fresh air, preventing concentration of moisture, removing heat from battery, light fittings and air conditioning plant.

With the hot and humid ambient conditions of Ahmedabad during the summer and monsoon months, it is essential to maintain appropriate conditions in the underground stations in order to provide a ñcomfort-likeò and pollution free environment. The plant capacity and design of VAC system needs to be optimized for the ñDesigned inside Conditionsò

The purpose of ventilation system is to provide pollution free comfort environment inside the tunnel (Underground station). Provision of ventilation system leads to air exhaust into the outside environment which has no significant impact on the environment.

In emergency situation, the tunnel ventilation system would be set to operate to control the movement of smoke and provide a smoke free path for evacuation of the passengers and for the fire fighting purposes. The proposed VAC system design has been guided by codes and standards like Subway Environment Design Handbook (SEDH), ASHRAE Handbook and NFPA-130, 2003 edition.

The platforms, concourse, staircase and escalator areas for underground stations will have adequate and uniform fluorescent lighting to provide pleasant and cheerful environment. The lighting system adopted in other metro system in India will guide the design of this system. An Illumination adopted at different locations such as Entrance to stations, Booking/Concourse, Platforms, Passenger staircase and escalator areas, Offices and Tunnels should be in the range of 100 to 250 LUX.

4.3.3 Metro Station Refuse

The collection and removal of refuse from railway stations in a sanitary manner is of great importance for effective vector control, nuisance abatement, aesthetic improvement and fire protection. The refuse from railway station includes;

- Garbage,
- Rubbish, and
- Floor Sweepings.

As per the available data from Delhi Metro Phase I and II, the solid waste generation is about 0.8 ï 1.2 cum/day at elevated stations and 0.5-1.0 cum/day at underground stations. At elevated stations, the solid waste generation is more due to airborne dust. Thus about 19.6 cum of solid waste will be generated from all metro stations per day at East-West corridor. About 18 cum of solid waste will be generated from all metro stations per day at North-South corridor. Thus about 37.6 cum/day solid waste will be generated from both the corridors. The maintenance of adequate sanitary facilities for temporarily storing refuse on the premises is considered a responsibility of the MEGA project authorities. The storage containers for this purpose need to be designed. However it is suggested that the capacity of these containers should not exceed 50 litres and these should be equipped with side handles to facilitate handling. To avoid odour and the accumulation of fly-supporting materials, garbage containers should be washed at frequent intervals.

4.3.4 Risk Due to Earthquake

The project area lies in Zone III of Bureau of Indian Standards (BIS) Seismic Zoning Map. Seismic factor proposed by India Meteorological Department (IMD) for the purpose of design of Civil Engineering structures shall be incorporated suitably while designing the structures.

4.4 IMPACT DUE TO PROJECT CONSTRUCTION

The environmental hazards related to construction works are mostly of temporary nature. Appropriate measures should be included in the work plan and budgeted for. The most likely negative impacts related to the construction works are: -

- Soil erosion,
- Traffic diversion
- Muck disposal,

- Dust Generation,
- Increased water demand,
- Impact due to labour camp
- Impact due to construction of Tunnel,
- Impact due to Land subsidence/Landslides,
- Impact due to Supply of Construction Material,
- Loss of Historical and Cultural Monuments,
- Impact due to Construction near Archeological Structures,
- Impact on Ground and Surface Water,
- Air Pollution,
- Noise Pollution,
- Impact due to Vibration,
- Health risk at construction site,
- Impact on Sensitive Receptors, and
- Impact due to blasting.

4.4.1 Soil Erosion,

Though the project may not have significant impact on soil erosion, however, minor impact on soil erosion due to runoff from unprotected excavated areas may result in soil erosion, especially when erodibility of soil is high. Problems could arise from dumping of construction soils (concrete, bricks), waste materials (from contractorôs camp) etc. causing surface and ground water pollution. Mitigation measures include careful planning, timing of cut-and-fill operations and re-vegetation. It is also proposed to have Ready Mix Concrete (RMC) directly from batching plant for use at site. The construction material such as steel, bricks, etc. will be housed in a fenced stored yard. The balance material from store yards will be removed for use/disposal at the end of work.

4.4.2 Traffic Diversions

During construction period, partial traffic diversions on road will be required, as most of the construction is to be carried out on the middle of the road. Central two lanes including median will be required for construction activities. Most of the roads where alignment is passing are double lane. During piling and open foundation work, a width of about 9 m will be required for construction and the same will be barricaded. It is proposed that two lanes are provided for traffic on either side during construction by widening of roads, if necessary. In certain cases, one way traffic may be resorted to.

For underground section, construction activities are for the entry and exit blocks on the edges of road. Advance traffic updates/information on communication systems will be an advantage to users of affected roads. Traffic Diversion Plans are required in order to look for options and remedial measures so as to mitigate any traffic

congestion situations arising out due to acquisition of road space during Metro construction of various corridors under Metro Rail Project network.

4.4.3 Muck Disposal

The proposed metro route is underground for 6.335 km including 4 stations. The construction activity involves tunnelling, cut and cover, foundation, fill and embankment. All these activities will generate about 16,03,000 m^3 of muck. On land disposal, 40 Ha of area will be required taking an average depth of filling as 4 metre. Owing to paucity of space in busy cities and for safety reasons, elaborate measures need to be adopted for collection, storage, transfer and disposal of soil. To avoid impact on land due to muck disposal, project proponent has identified options for disposal of muck by utilizing the muck for various purposes as described in chapter-6.

4.4.4 Dust Generation

Protective measures shall be undertaken during construction phase for transportation of earth and establishment of the material due to use of heavy machinery like compactors, rollers, water tankers, and dumpers. This activity is machinery intensive resulting in dust generation. However, this activity will be only short-term. The total 16,03,000 m^3 of muck has to be transported through trucks. The muck will be transported by trucks up to nearest proposed option. The truck movement required for transporting the muck/ earth will be about 60 truck trips per day for the entire underground length. On an average a truck is anticipated to move about 30 km per trip. Hence total distance travelled would be 1800 km per day. Being the good road condition in Ahmedabad, the dust generation due to transportation of muck will be insignificant.

4.4.5 Increased Water Demand

The water demand will increase during construction phase. The water requirement estimated for the proposed Metro rail project during construction will be about 244 KLD[1]. Sufficient water for construction purpose is made available by digging borehole / borewell within the vicinity of the project site during the construction phase. Hence proper care shall be taken while deciding the location of these activities or drawing water from public facilities.

4.4.6 Impact due to Labour Camp

About 5,000 persons are likely to work during peak construction activity. The skilled workers associated with tunneling and fabrication work are supposed to stay at

[1] DPR for Ahmedabad Metro Rail Project.

labour camp while the local workers will be employed for other associated work like earthwork and concreting. About 500 skilled workers will stay at labour camp. Four labour camps will be proposed at appropriate and suitable locations. Considering that 80% of labourers are married, in 80% of married families both husband and wife will be working and taking average family size as 4, total workforce in the labour camps will be about 900. The water requirement at camp and construction site will be about 63 KLD and 20.5 KLD respectively. Hence the total water requirement will be 83.5 KLD & breakup is given in **Table 4.3**. Waste water generation will be 66.8 KLD.

TABLE 4.3
WATER REQUIREMENT DURING CONSTRUCTION

S. No	Water Requirement	Quantity
1	At Labour Camps	63 KLD
2	At Construction site for drinking	20.5 KLD
3	Construction activities	244 KLD
	Total	**327.50 KLD**

Municipal solid waste generation will be 315 Kg per day. Construction workers are more prone to infectious diseases like HIV/AIDS due to migration and lack of education. The three main transmission routes of HIV are sexual contact, exposure to infected body fluids or tissues and from mother to foetus or child during prenatal period. Training and awareness programme will be conducted during construction to avoid the spread of infected diseases and maintain good sanitation in labour camp. After construction, operation of metro does not give significant impact on spreading of infectious diseases.

4.4.7 Impact due to Construction of Tunnel

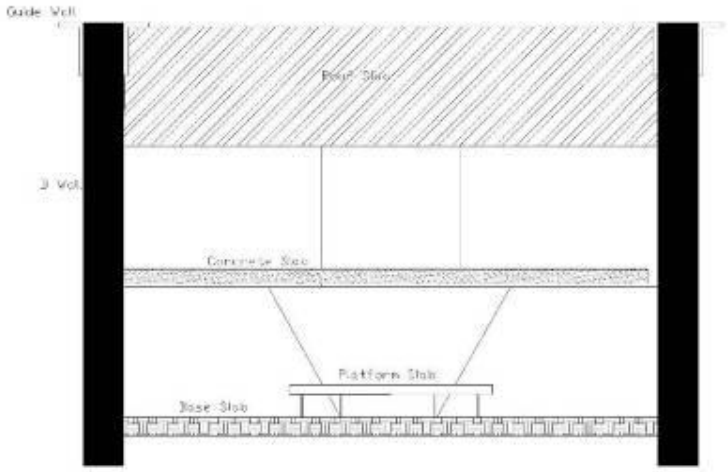
Ground water contamination can take place only if chemical substances get leached by precipitation of water and percolate to the ground water table. This is not the case with the present project, as the activity does not use any harmful ingredients, which could leach down to water table. The tunneling is to be done in hard strata by Tunnel Boring Machine (TBM), which is widely used throughout the world. The tunneling underground portion of proposed project alignment will be done through hard strata hence no major impact on flow of water, surface and ground water quality is anticipated. However, care shall be taken that construction activities are not carried out during the monsoon period.

4.4.8 Impact due to Land Subsidence/Landslides

Land subsidence during construction of tunneling may be anticipated at the station locations where cut and cover method would be adopted. In a cut and cover method a trench is excavated with necessary ground support. The construction will be in situ concrete, precast concrete and corrugated steel. Use of permanent Diaphragm wall

helps to maintain retention of the surrounding soil and ground water. The D-wall method is useful where ground water is high. The D-walls for underground station construction would be 80 to 100 cm thick and will function as a permanent side wall of the station. It is rigid type of support system and therefore ensures the maximum safety against settlement to the adjacent structures. Typical section of D-wall is shown below.

However, state of the art technology like Tunnel Boring Machine (TBM), NATM etc will be adopted during construction to prevent the possible landslides.



The other support walls which can be used depending on the site conditions are as follows:

Sheet Piles: Sheet piles can be used as temporary support wall. This can be advantageous where it is possible to re-use the sheet pile again and again and therefore, economy can be achieved. However the main concern remains, driving of sheet piles causes vibrations/noise to the adjacent buildings. This may sometimes lead to damage to the building and most of the time causes inconvenience to the occupants of the building. Situation becomes more critical if sensitive buildings are adjacent to the alignment like hospitals, schools, laboratories, etc. Silent pile driving equipments however are now available and can be used where such problems are anticipated.

Retaining Casing Piles: This is suitable for situation where the cut and cover is to be done in partly soil and partly rock. The top soil retaining structure can be done with the help ofCasing pile which is then grouted with cement slurry. This is considered suitable in case of shallow level, non-uniform, uneven nature of rock head surface which render the construction of sheet piles/diaphragm wall impracticable. These are suitable up to 7-meter depth. The common diameter used for such casing pile is 2.00-2.50 m dia.

Soldier Piles and Lagging: Steel piles (H Section or I section) are driven into the ground at suitable interval (normally 1-1.5 m) centre-to-centre depending on the

section and depth of excavation. The gap between two piles is covered with suitable lagging of timber planks/shot-creting /steel sheets/GI sheets during the process of excavation.

Secant Piles: are cast-in-situ bored piles constructed contiguously to each other so that it forms a rigid continuous wall. This is considered an alternative to diaphragm wall where due to soil conditions it is not advisable to construct diaphragm wall from the consideration of settlement during the trenching operation. 800 to 1000 mm dia piles are commonly used. Two alternate soft piles are driven and cast in such a way that the new pile partly cuts into earlier constructed piles. This new pile is constructed with suitable reinforcement. With this, alternate soft and hard pile is constructed. This has got all the advantages of diaphragm wall. However, this wall cannot be used as part of permanent structure and permanent structure has to be constructed in- side of this temporary wall.

4.4.9 Impact due to Supply of Construction Material

Metro construction is a material intensive activity. Quarry operations are independently regulated activities and outside the purview of the project proponent. It is nonetheless, appropriate to give consideration to the environmental implications in selection of quarry sources since poorly run operations create dust problems, contribute noise pollution, ignore safety of their employees, or cause the loss of natural resources. About 10-15% of the construction material such as waste material from contractor camps is left behind by the contractor as construction waste/spoils. Dumping of construction waste/spoil in haphazard manner may cause surface and ground water pollution near the construction sites.

4.4.10 Loss of Historical and Cultural Monuments

No historical/cultural monuments will be affected/ damaged as a result of the proposed development.

4.4.11 Impact due to Construction near Archaeological Structures

As per section 4.2.5 of the report, No Archeological Monuments are directly affected. Some of the Archeological Monuments are close to the proposed metro alignment near underground section. The Archaeological Monuments at underground section of the corridor are outside prohibited area of 100 meter but passing within 200 meter of regulated area. The details showing locations of Archaeological Monuments from proposed alignment is given in Section 3.8.

However the tunnel will be constructed by State of Art Technology i.e Tunnel Boring Machine (TBM) which gives negligible vibration and does not affect the surrounding structures. Stations/entry/exit area will be constructed by Cut and Cover method

which is widely accepted and the safest technique being adopted by metro in India and abroad.

4.4.12 Impact on Ground and Surface Water

Insignificant impact will be anticipated on surface water for the elevated section of the Metro. For underground section, as a precautionary measure, detailed hydrological investigation will be undertaken prior to the construction of tunnel to locate the ground water aquifer falling in the alignment of metro tunnel and to safeguard the ground water flow wherever feasible. This will prevent generation of turbid water during construction in the tunnel. No ground water is used by inhabitants staying nearby proposed tunnel since adequate water supply is available.

4.4.13 Air Pollution

Construction work of the metro rail has impact on the air quality at station, alignment and at depot locations. In the previous chapter, the existing conditions of air quality along the alignment are described. The monitoring results of pollutants such as NO_2, SO_2 and CO are much below the national standards (NAAQS, CPCB), the dust concentrations monitored are 1.3 ï 2.2 times higher than the standard value. Hence, dust could be the problem when the project is under construction. Any development can have associated health impact that can result directly from changes to the biophysical environment or indirectly as the result of other changes caused by the project. The air pollutants such as particulate matter, sulphur dioxides and nitrogen oxide have adverse impact on human health. The impact of air pollution aggravates bronchitis, respiratory diseases, emphysema, cardiovascular diseases and eye irritation. However, the air pollution during construction is localized and only around the station construction sites only.

4.4.14 Noise Pollution

The major sources of noise pollution during construction are movement of vehicles for transportation of construction material and the construction machinery/equipment at the construction site. Noise levels at source have been forecasted at various distances as reproduced in **Table 4.4.** As seen from the table, construction activities are expected to produce noise levels in the range of 104 - 109 dB (A) at source which decreases with increase in distance.

TABLE 4.4
FORECASTED NOISE LEVELS

S No	Machine	Noise Levels in dB(A) without Noise Controls		
		At Source**	At 50 feet*	At 150 feet**
1	1.5 cum capacity Excavator / Loader	109	85	65
2	8.33 cum capacity rear end dumper	108	84	64
3	Crawler Dozer	109	85	65
4	Heavy Duty jack Hammer	109	85	65

5	Compressor	104	80	60
6	Crane	107	83	63
7	Generator	105	81	61
8	Rock Drill	122	98	78

* Data taken from ñconstruction equipment noise levels and ranges reportò of Federal Highway Administration, ** Calculated using logarithmic equation.

Exposure to noise may lead to complete hearing loss, tension, fatigue, fast pulse/ respiration rates, dizziness & loss of balance, anger, irritation & in extreme case nervousness. Construction of noise barriers, such as temporary walls between noisy activities and receivers reduces noise by up to 15 dB (A). Vegetation cover also reduces the noise level.

Careful planning of machinery operation and scheduling of operations can however reduce the noise levels. The overall noise during construction will be for short-term (for day time only) and can be mitigated as mentioned in Chapter - 6.

4.4.15 Vibration Impact

The whole North-South alignment of the Ahmedabad metro is elevated however, out of 20.536 KM; 6.335 KM of East-West alignment is underground. This underground section will be carried out by Tunnel Boring Machine (TBM). TBM is the worldwide accepted machine having less impact of vibration. Human response to ground-borne vibration is influenced by amplitude, duration and frequency and is subjective in nature. According to the U.S. Department of Transportation, (1998) the perception threshold of humans for particle velocity is about 0.04 mm/s (65 VdB with reference 1e-6 inch/sec). For a person in their residence, the lower threshold for annoyance is 72 VdB (FTA 2006). The vibration affects human health by causing fatigue, increased pulse & respiration rates, dizziness & loss of balance, anger and irritation.

4.4.15.1 Vibration due to Tunnel Boring Machine (TBM)

TBM typically consist of a large rotating cutting wheel in front of large metal cylinder(s) known as shields as well as trailing control and ancillary mechanisms. Behind the cutting wheel is a chamber where the spoil is removed using conveyors to the rear of the machine. The cutting wheel is moved forward by hydraulic jacks supported off the finished tunnel walls. When the cutting wheel has reached maximum extension the TBM head is braced against the tunnel walls and the rear section of the TBM is dragged forward.
Continuous effect of vibration on the buildings can cause damage to the buildings. Building subjected to the vibration effect with more than 50 mm/s would receive structural damage. Historic buildings are more susceptible to vibration effect due to type of building material and design. Old structures generally lose structure strength over the period. Therefore, it is more important to study the effect of vibration on the historic buildings especially the structures that comes under heritage category.

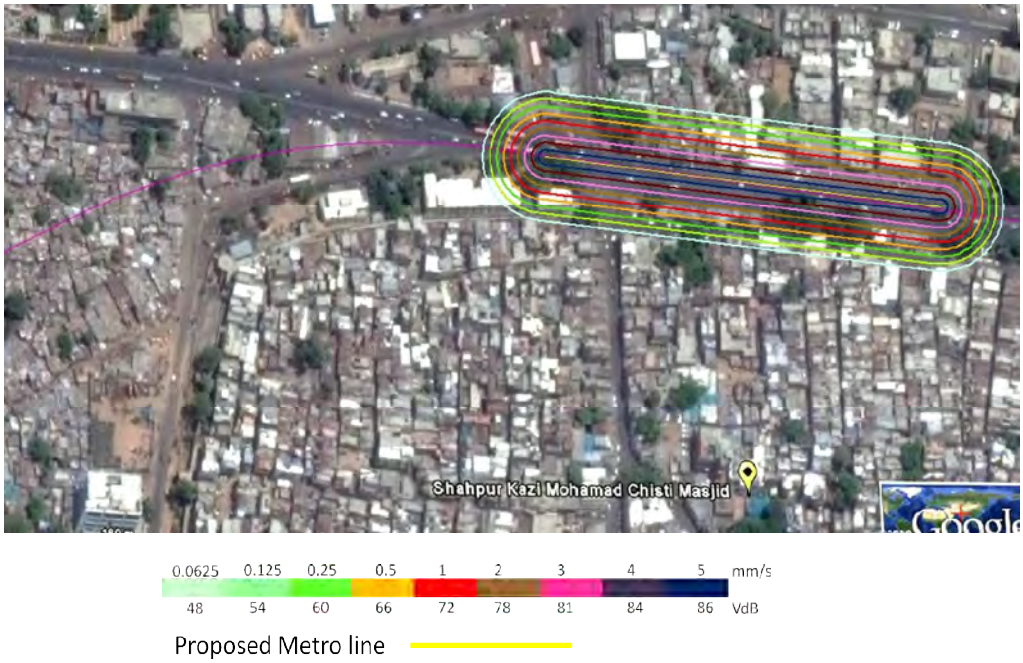
The vibration that could be generated due to TBM has been calculated at each monitoring location as presented in Chapter-3 using the standard equation. The diameter of the TBM blades is assumed as 10 m with the operating speed of 1 m/ Hr. The TBM operation is considered at a depth of å 14 m below ground level. The geotechnical investigation of study shows that, the project site area is covered with deep layers recently placed alluvial sands. Hence the vibration at the ground surface and at the bottom of the building foundation would be low. The vibration contours has been drawn using GIS software on the satellite image of study location. Vibration is generated at source from 14 m below the ground level and dissipates in all direction.

The vibration levels of TBM and train passby are predicted levels using the standard calculation models. These models provided the possible estimates of potential vibration impacts for preliminary assessment of vibration impact, these values cannot be taken for detail design. A detail investigation is required during construction and operation stage.

4.4.15.2 Vibration Impact Assessment at Shahpur Kazi Mohamad Chisti Masjid

The Figure 4.1 shows the predicted vibration contours that could cause due to operation of TBM. The contour in the figure shows the vibration level on the ground surface. As per the geotechnical report, the soil of the site is considered be soft alluvial. The least vibration of about 0.06 mm/s is at a distance of 150m from the Shahpur Kazi Masjid. Therefore there would not be any vibration effect on the Shahpur Kazi Masjid due to TBM operation.

FIGURE 4.1
VIBRATION CONTOURS DUE TO TBM AT SHAHPUR KAZI MOHAMAD CHISTI MASJID



4.4.15.3 Prediction of Vibration due to TBM at Delhi Darwaza

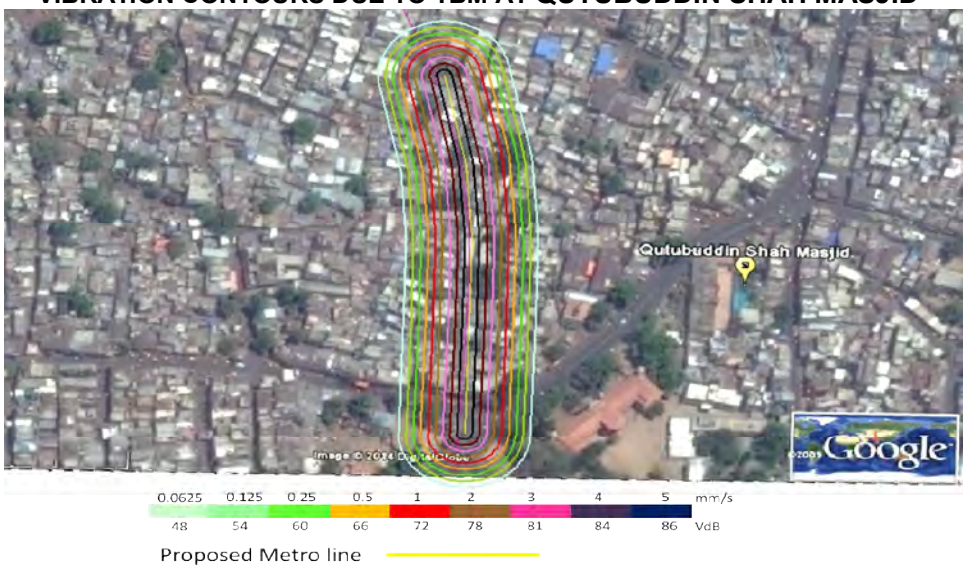
The predicted vibration contour that could cause from TBM at this location is shown in the **Figure 4.2**. As per the predicted vibration levels shown in the figure, there would not be any vibration effect on Delhi Darwaja due to TBM tunneling work.

FIGURE 4.2
VIBRATION CONTOURS DUE TO TBM AT DELHI DARWAZA

4.4.15.4 Prediction of Vibration due to TBM at Qutubuddin Shah Masjid

The **Figure 4.3** shows the predicted vibration contours that could cause from TBM. , There are many small houses which are densely located and they are very old structures.

FIGURE 4.3
VIBRATION CONTOURS DUE TO TBM AT QUTUBUDDIN SHAH MASJID

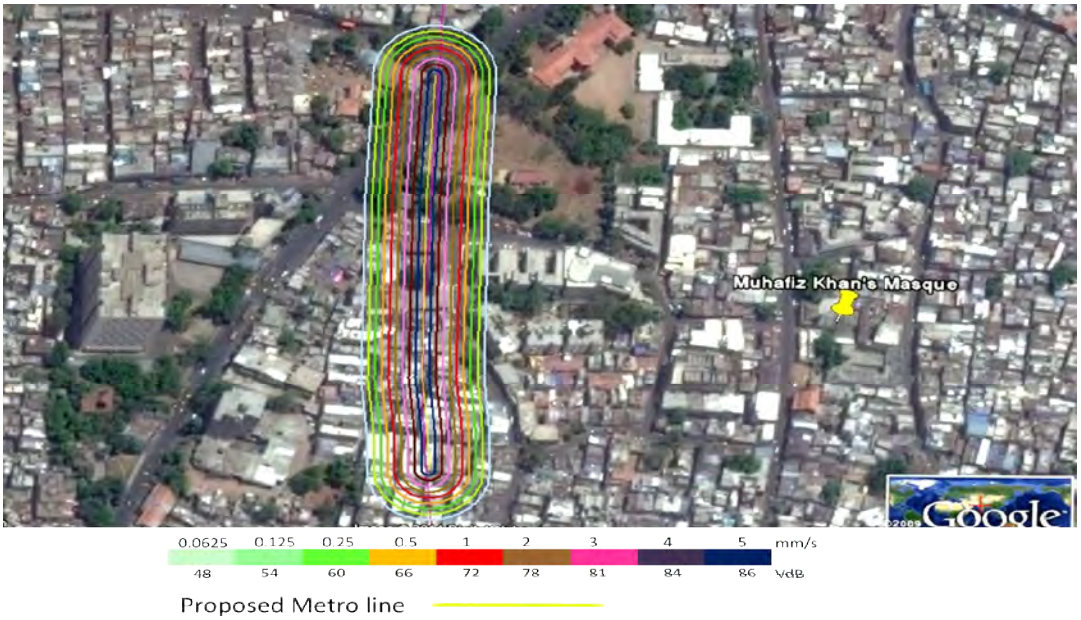


These structures can get damaged during TBM tunneling. The residents staying in the location has to be informed about the tunneling work, so that they can take measures. Special care should be taken during the TBM operation at this location. Geotechnical investigation is recommended at this location before going for TBM operation.

4.4.15.5 Prediction of Vibration due to TBM at Muhafiz Khan's Mosque

The **Figure 4.4** shows the predicted vibration contours that could cause from TBM operation. The contour shows that the vibration due to TBM would not cause any damage to Muhafiz Khanôs Masque as it is far from the proposed metro rail alignment.

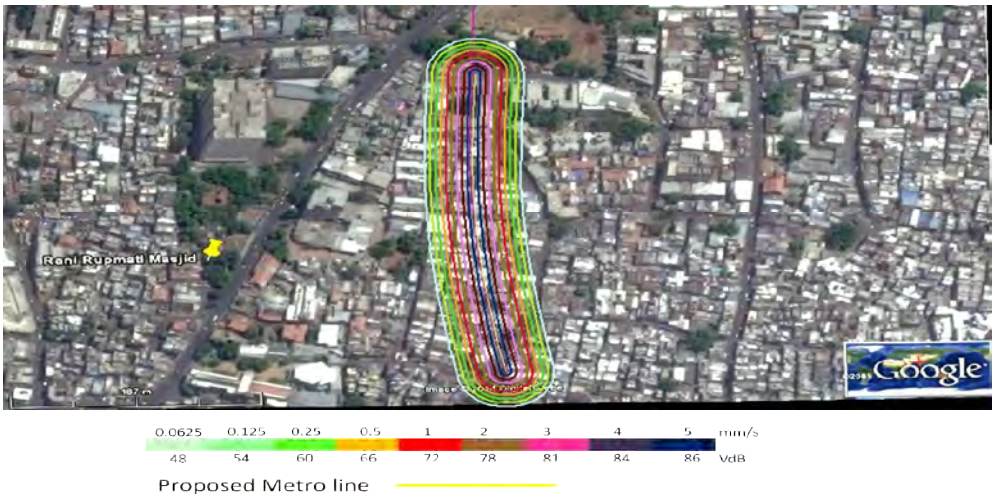
FIGURE 4.4
VIBRATION CONTOURS DUE TO TBM AT MUHAFIZ KHAN'S MOSQUE



4.4.15.6 Prediction of Vibration due to TBM at Rani Rupamati Masjid

The **Figure 4.5** shows the predicted vibration contours that could cause from TBM operation at this location. The predicted vibration contour, shows that the least vibration due to TBM is at a distance of 180 m form Rani Rupmati masjid and thus there would not be any effect of vibration from TBM on masjid. However, as can be seen from the figure, that there are many small buildings that can get damage during TBM operation.

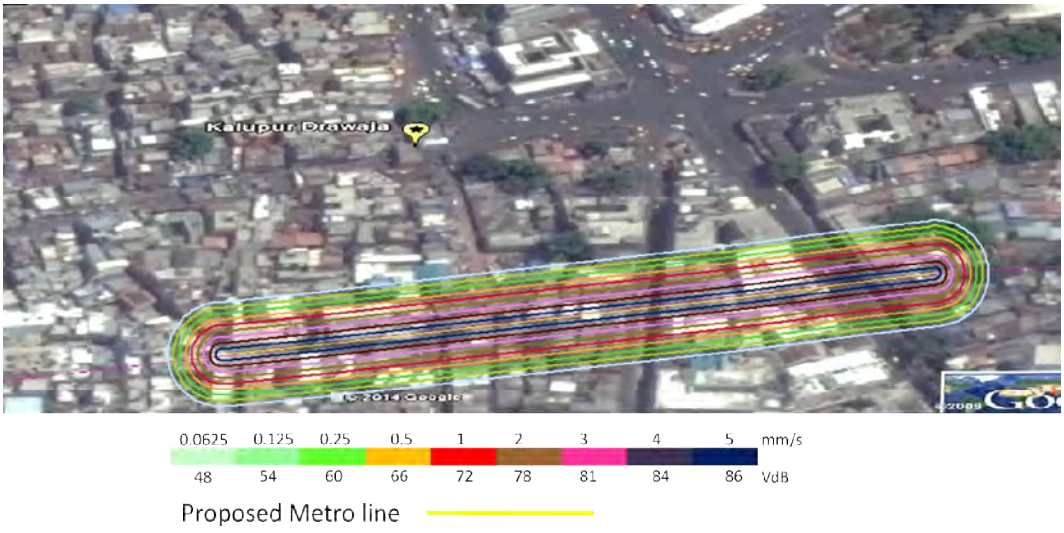
FIGURE 4.5
VIBRATION CONTOURS AT RANI RUPAMATI MASJID



4.4.15.7 Prediction of Vibration due to TBM at Kalupur Darwaja

The **Figure 4.6** shows the predicted vibration contours that could cause from TBM. The vibration due to TBM do not has much impact on Kalupur Darwaja, however it is observed that, there are many small and old buildings on the proposed metro rail alignment, these building could get damage during TBM tunneling, therefore appropriate measures shall be taken during tunneling. Geotechnical investigation is recommended at this location before going for TBM operation.

FIGURE 4.6
VIBRATION CONTOURS AT KALUPUR DARWAJA



4.4.15.8 Prediction of Vibration due to TBM at Brick Minar

The **Figure 4.7** shows the predicted vibration contours that could cause from TBM. The vibration contours shows that the least vibration that could cause by the TBM is about 0.625 mm/s (48 VdB) which is at a distance of about 190m from the brick minar. Hence there would be no vibration effect on brick minars due to TBM tunneling.

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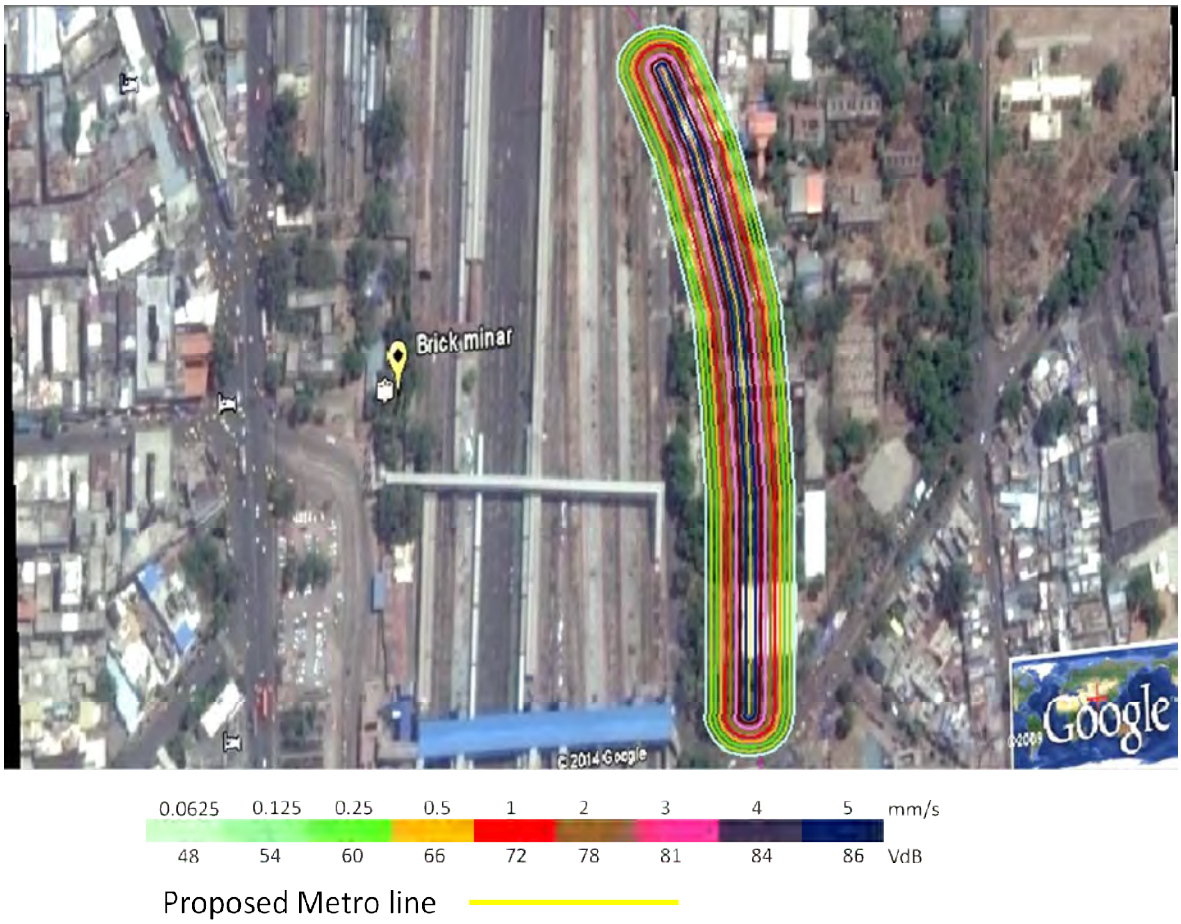
FIGURE 4.7
VIBRATION CONTOURS AT BRICK MINAR



4.4.16 Health risk at construction site

Health risks include accidents due to improper construction practice and hazard diseases due to lack of sanitation facilities (i.e., water supply and human waste disposal). Implementation of good construction practice may reduce the chance of accident at work place. Mitigation measures should include proper water supply, sanitation, drainage, health care and human waste disposal facilities at construction site. In addition to these, efforts need to be made to avoid water spills, adopting disease control measures, awareness programmes etc.

4.4.17 Impact on Sensitive Receptors

As discussed in section 3.9, there are 135 numbers of sensitive receptors identified within 100 m on either side of the both the alignment. No disturbance to facilities such as School, Hospital and Temple are anticipated as proposed alignment. The major impacts to the sensitive receptors are due to noise and vibration.

The major sources of noise pollution during construction activities would be during excavation, loading, transportation of materials and operation of construction

equipments and DG sets etc. Expected noise levels due to use of construction machineries at site are forecasted w.r.t distances are given in **Table 4.5**.

Construction activities have the potential to produce vibration levels that may be annoying or disturbing to humans living nearby. Federal Transit Administration (FTA) has recommended the typical levels of vibration for construction equipment which are summarized in **Table 4.5**. In the table the values at 25 feet are based on the FTA 1995. On the basis of reference values of vibration at 25 feet, an impact at 75 feet, 100 feet and 150 feet are calculated. The ground borne vibration impacts may be somewhat perceptible to people who are outdoors, it is almost never annoying and does not cause a strong adverse human reaction. According to the California Department of Transportation, (2004), the threshold of perception, or roughly 0.25 mm/s (108 VdB) may be considered annoying to people and the architectural damage criterion for continuous vibrations is 5 mm/s (134 VdB).

TABLE 4.5
TYPICAL LEVELS OF VIBRATION FOR CONSTRUCTION EQUIPMENTS

S. No	Construction Activity	VdB at 25 Feet	VdB at 75 Feet	VdB at 100 Feet	VdB PPV at 150 Feet
1	Rock drilling	115.9	101.6	97.9	94.3
2	Dump trucks	122.7	108.3	104.6	99.3
3	Bulldozer	124.0	109.7	106.0	100.7
4	Excavator 0.089, 106	124.0	109.7	106.0	100.7
5	Crane 0.808, 87	143.2	128.9	125.1	119.8

Source: *Transit Noise and Vibration Impact Assessment, Federal Transit Administration (FTA).*

4.4.18 Impact due to blasting

Controlled blasting will be required during construction of stations to remove hard rock if any. Blasting will generate ground vibration and noise of which intensity is depends upon the quantity of explosive charge.

Ground Vibration: The intensity of ground vibrations depends on several factors. The most important are how close the person or house is to a blast and how many kilogram of explosives are detonated per delay period. The magnitude of ground vibrations decreases as the distance from the blast increases. The most commonly accepted blast vibration prediction in use was developed by Lewis L. Oriard, a noted seismologist from Huntington Beach, California. The derived equation is:

$$V = K\,(R/Q^{½})^{B}$$

Where, V: Peak Particle Velocity (mm per second),
K = Site and Rock Factor Constant,
Q = maximum instantaneous charge per delay (Kg),
B = Constant related to the rock and site (usually-1.6),
R = Distance from charge (m)

Typical K Factors in Metric System are 500 for Under Confined hard or highly structured rock, 1140 for Free face average rock (Normal Confinement) and 5000 for heavily (Over) Confined rock.

Putting the value of R = 15 m, Q = 1 Kg (The quantum of explosive should be strictly restricted to 1 Kg per delay), K = 1140, in above equation, we get peak particle velocity of 14.96 mm per second. **Table 4.6**, indicates the average human response to vibration and air over pressures that may be anticipated when the person is at rest, situated in a quiet surrounding.

Comparing Peak Particle Velocity of 14.96 mm/second, it is observed from the Table, that the vibration will be strongly perceptible to mildly unpleasant and it will have no damage to the structure.

TABLE 4.6
HUMAN RESPONSE TO BLASTING GROUND VIBRATION

S. No	Average Human Response	PPV (mm/sec)	Air Blast (dB)
1	Barely to distinctly perceptible	0.508ï 2.54	50-70
2	Distinctly to strongly perceptible	2.54ï 12.7	70-90
3	Strongly perceptible to mildly unpleasant	12.7ï 25.4	90-120
4	Mildly to distinctly unpleasant	25.4ï 50.8	120-140
5	Distinctly unpleasant to intolerable	50.8ï 254	140-170

Source: Transportation- and Construction-Induced Vibration Guidance Manual, June 2004

The safe ground vibration level for structures for lowï frequency blast vibration is 19.05 mm/sec and 50.8 mm/sec for frequencies above 40 Hz. (United State Bureau of Mines, 656, RI 8507).

Noise and Air Blast

A simple estimate of air blast overpressure levels is given using the following cube root scaling formula from AS2187.2 for the estimated Maximum Instantaneous Charge (MIC) of 1 kg of explosive.

$P= K \{R/(Q)^{0.33}\}^{B}$

Where, P= Pressure (KPa)

K= Site constant (State of confinement, Typical K factors are 185 for unconfined, 3.3 for fully confined)

R=Distant from charge (m)

Q=Explosive charge mass per delay (kg)

B= Constant related to Rock & Site (usually K=-1.2)

Now, Take K = 5 (blasting inside and may be assumed as confined), R = 15 m, Q = 1

Kg and B= -1.2

P=0.127 kPa=196 Pa

Equivalent Noise Level would be 136 dB, which will be impacts mildly to distinctly unpleasant.

4.5 IMPACTS DUE TO PROJECT OPERATION

The negative impacts may cause during operation of the project due to increase in the number of passengers and trains at the stations:

- Noise pollution,
- Vibration Impact due to train,
- Water supply and sanitation at Stations,
- Refuse disposal and sanitation, and

4.5.1 Noise Pollution

During the operation phase the main source of noise will be from running of metro trains. Noise radiated from train operations and track structures generally constitute the major noise sources.

US data shows that the noise levels inside the rail transit cars ranges between 65 to 105 dB(A) during normal operation but it will depend on various factors like Train speed, type of way structure, sound insulations of car body, type & design of mechanical equipment, wheel and rail conditions. A study was conducted by National Physical Laboratory for Delhi metro for noise levels in elevated and underground metro stations. The Noise Level at 15 m from track Centre Line and at 25 km/h is 75.0± 10.0 while interior noise level is about 78.0±8.0. The noise generated due to metro is limited within the tunnel area and station and hence users only have impact of noise during operation. The cumulative noise due to Metro Rail and existing ambient noise is given in **Table 4.7**.

TABLE 4.7
CUMULATIVE NOISE DURING OPERATION PHASE

LOCATION	Cumulative Noise in dB (A)
East - West Alignment	
Thaltej	75.3
Gujarat University	75.3
Ashram Road	75.1
Shahpur	75.3
Kalupur Rly. Stn	75.6
Rabari colony	75.2
Vastral Gam	75.1
North - South Alignment	
APMC	75.2
Shyamprasad ROB	75.1
Akbar Nagar	75.2
Sabarmait Rly. Stn	75.5
Sabarmati	75.3

The cumulative noise on the elevated route alignment is due to the traffic and noise levels from the metro operations are more than the Noise Standards for Commercial

area. However, because of the metro wherever there is reduction of vehicular traffic, the road traffic noise will come down. Given the high ambient noise levels, it is imperative that the government enforces noise control measures (silence zone, no horns, traffic discipline etc.)

4.5.2 Vibration Impact due to train

The prediction of vibration is computed using the Pipe-in-Pipe (PiP) model using train traffic. PiP model has been developed by the team of experts and scientist from Nottingham University, UK. It is commonly used to simulate the vibration that is generated in the tunnel due to train passage. The vibration is calculated in Power Spectral Density. The prediction of vibration due to train passing is simulated and the results are shown in Power Spectral Density (PSD). The figures plotted shows the assumptions made for the prediction of vibrations. The maximum velocity of the train is considered as 40 km/hr at all locations. Due to limitation in the available modeling tools, the vibration simulation was carried out with single train passby, however there would be increase in vibration when two trains are in tunnel. The increase would be up to 3 VdB. The Power Spectral Density graph plotted in **Figure 4.7, 4.8, 4.9, 4.10, 4.11** & **4.12** are used to calculate the vibration at 12 locations during operation. The calculations are based on the input data as per site condition and operation of metro train.

4.5.2.1 At Shahpur Kazi Masjid Masjid

The result of the vibration prediction using PiP model is shown in **Figure 4.8**. The graph shows that the vertical Power Spectral Density (PSD) increases upto 75Hz. From the graph, it is clear that the vibration due to train passage is up to horizontal distance of 10m. There would not be any effect of vibration on Shahpur Kazi masjid due to metro train passage.

4.5.2.2 At Delhi Darwaja

The result of the vibration prediction using PiP model is shown in **Figure 4.9**. The graph shows that the vertical Power Spectral Density (PSD) is constant between 40 Hz to 80 Hz. The maximum speed of the train is assumed to be 80km/hr, however, as there is a curve at this location, the train speed is expected to be low. The prediction study shows that, Delhi Darwaja would not get affected with vibration due to metro rail passage.

FIGURE 4.8
VIBRATION DUETO TRAIN AT SHAHPUR KAZI MASJID MASJID USING PiP

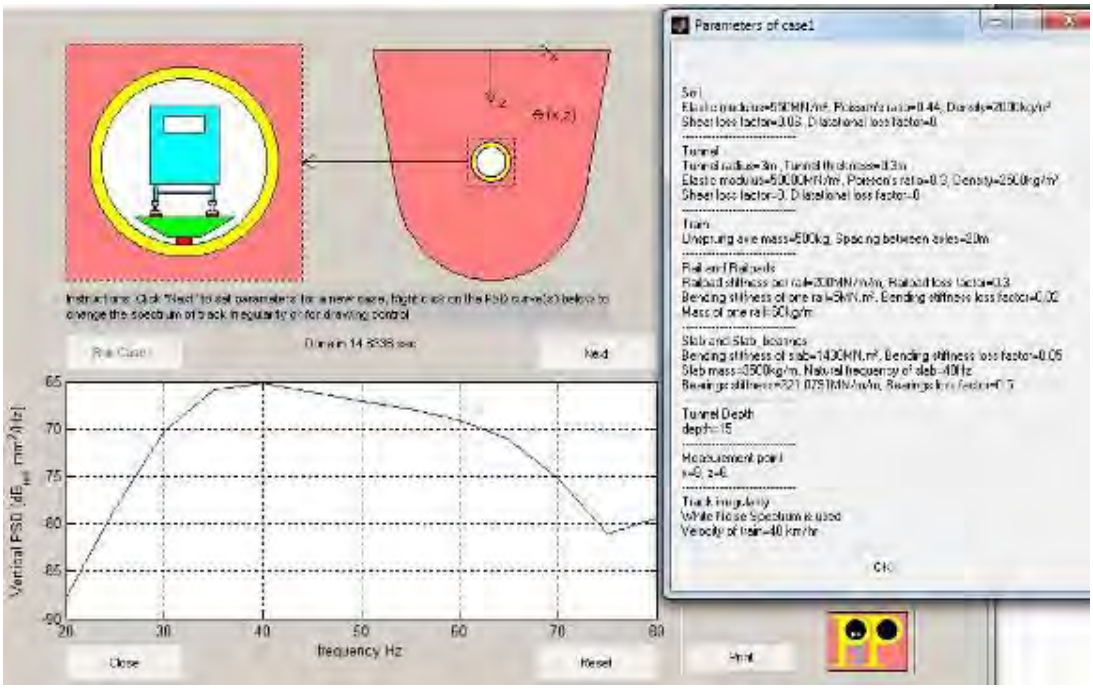
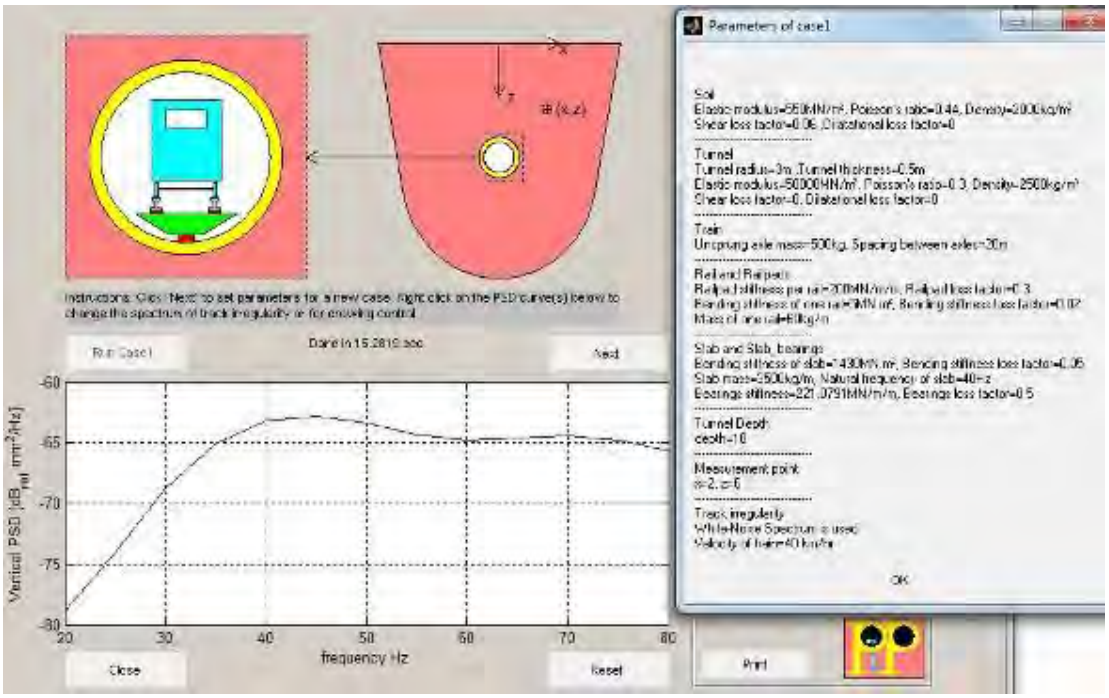


FIGURE 4.9
VIBRATION DUETO TRAIN AT DELHI DARWAJA USING PiP

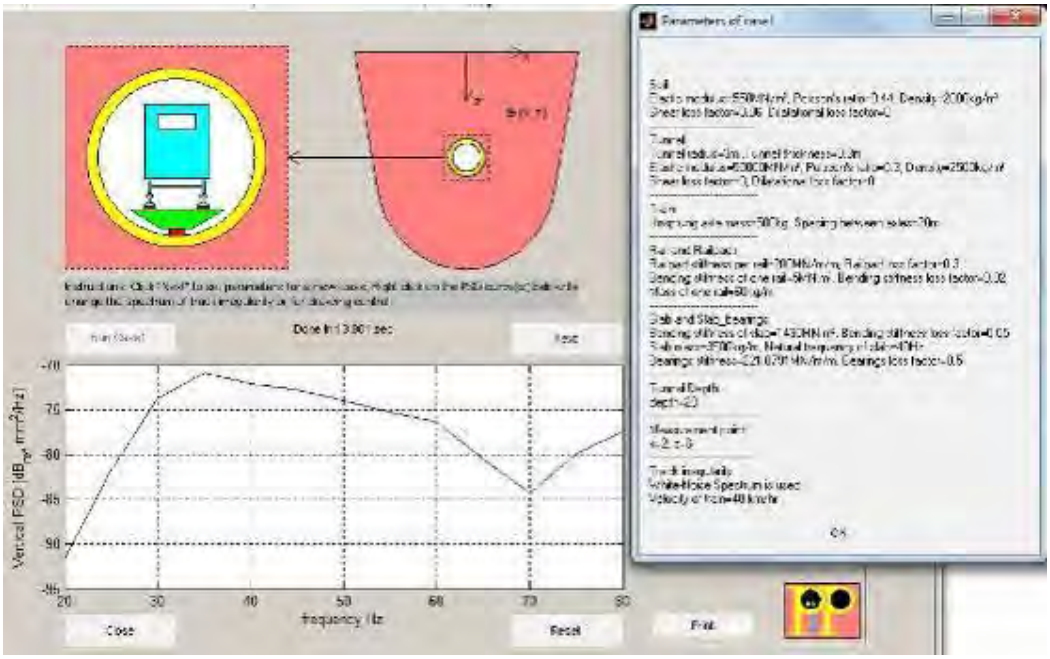


4.5.2.3 At Qutubuddin Shah Masjid

The result of the vibration prediction using PiP model is shown in **Figure 4.10**. The graph shows that the vertical Power Spectral Density (PSD) gradually increases between 40 Hz to 70 Hz. The graph shows that the vibration is high at 70 Hz and then decrease with increase of frequency. As the train alignment is far from the

Qutubuddin Shah Masjid, there would not be any effect of vibration of train passage on this structure.

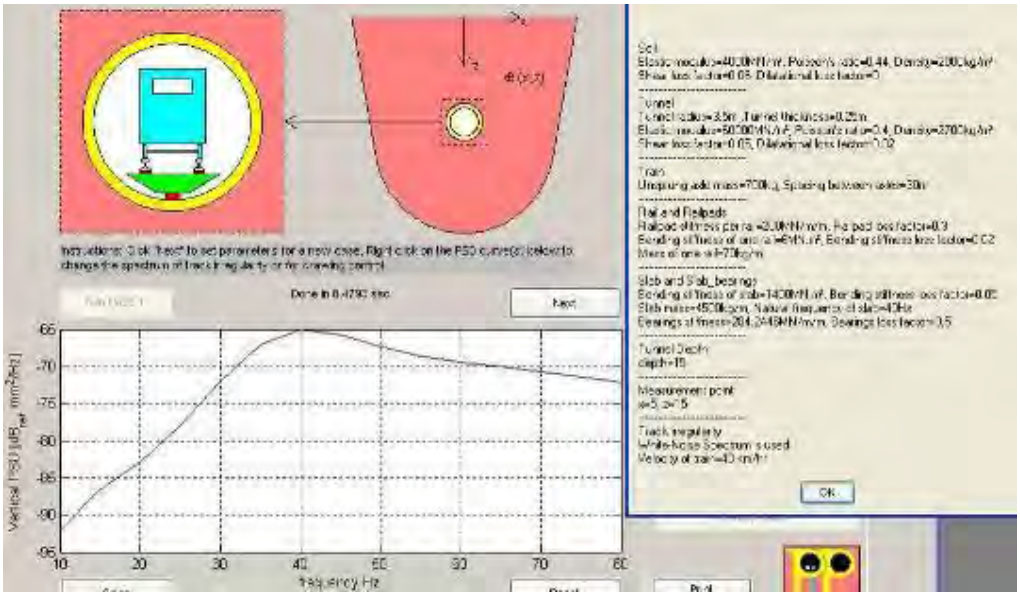
FIGURE 4.10
VIBRATION DUE TO TRAIN AT QUTUBUDDIN SHAH MASJID USING PiP.



4.5.2.4 At Muhafiz Khan's Mosque

The result of the vibration prediction using PiP model is shown in **Figure 4.11**. The graph shows that the vertical Power Spectral Density (PSD) increases up to 60 Hz The graph shows that the vibration is high at 60 Hz and then decrease with increase of frequency. As the train alignment is far from the Muhafiz Khan's Masque, there would not be any effect of vibration due to passage metro train on this structure.

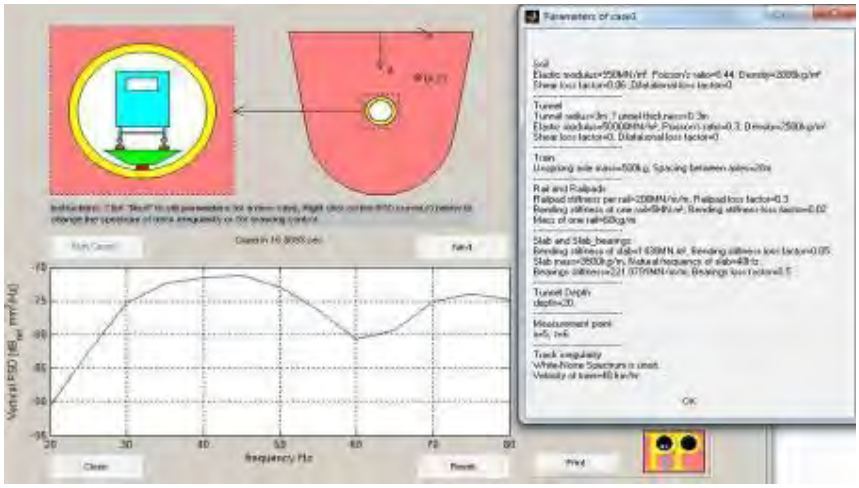
FIGURE 4.11
VIBRATION DUE TO TRAIN AT MUHAFIZ KHAN'S MOSQUE USING PiP



4.5.2.5 At Rani Rupmati Masjid

The result of the vibration prediction using PiP model is shown in **Figure 4.12**. The graph shows that the vertical Power Spectral Density (PSD) increases upto 60 Hz. From the graph, it is clear that the vibration due to train passage is up to horizontal distance of 10m from proposed underground metro alignment. Therefore there would not be any effect of vibration on Rani Rupmati Masjid due to train passage.

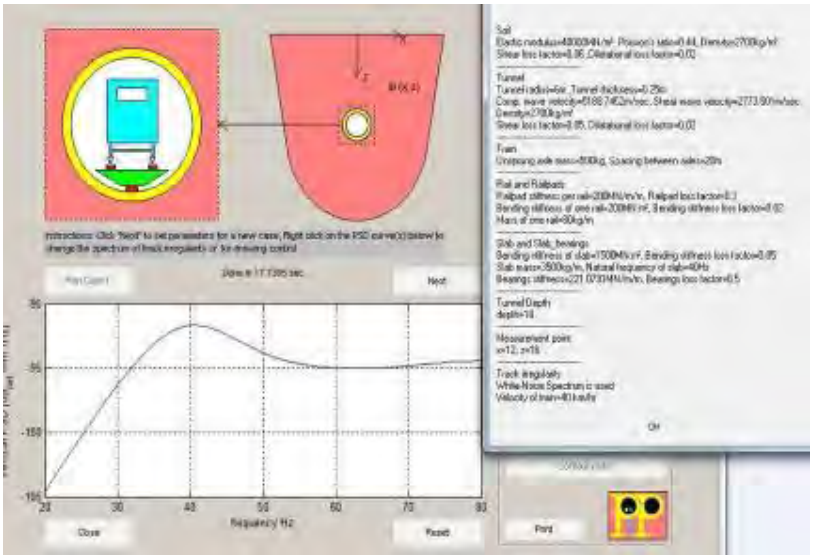
FIGURE 4.12
VIBRATION DUE TO TRAIN AT RANI RUPMATI MASJID USING PiP



4.5.2.6 At Kalupur Darwaja

The result of the vibration prediction using PiP model is shown in **Figure 4.13**. The figure 4.10 shows that the maximum vibration is about 85 to 90 VdB (5 to 6 mm/s) at the ground surface above the metro rail alignment, this reduces with distance, and at Kalupur Darwaja, the vibration due to train passage would be below limits and there would not be any vibration affect on the Kalupur Darwaja. However the building those are located on the metro rail alignment could get damage.

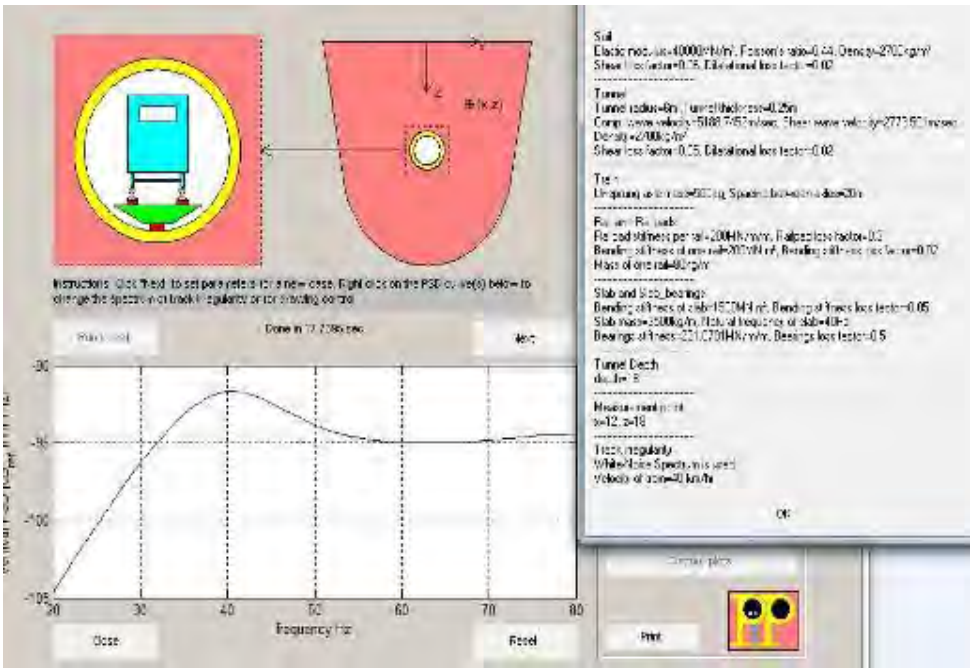
FIGURE 4.13
VIBRATION DUE TO TRAIN AT KALUPUR DARWAJA USING PiP



4.5.2.7 At Brick Minar

The result of the vibration prediction using PiP model is shown in **Figure 4.14**. The graph shows that the vertical Power Spectral Density (PSD) is increasing with the frequency and has become constant between 40 Hz to 80 Hz. However, as the metro station is nearby, the train speed would be less and the vibration due to metro train passage would be minimum. The brick minar would be safe due to metro train passage.

FIGURE 4.14
VIBRATION DUE TO TRAIN AT BRICK MINAR USING PiP



4.5.2.8 At Doordarshan Tower

The predicted vibration shows that the least vibration that would generate from metro train is about 0.625 mm/s which could be at a distance of 43 m from the Doordarshan tower, hence the tower and the structures of Doordarshan Kendra would be safe from the vibration due to metro train.

4.5.2.9 At Vastral

The vibration level due to train passage would be around 0.0626 mm/s at the buildings, which is in safe limit to the structure as well as to the people living in the building. However, it was observed that some to the buildings located close to the proposed metro rail alignment are very old and has many cracks and damages.

4.5.2.10 At Metro rail crossing

The metro train passage at this location is in two ways and cross each other. Bothe the metro rail are elevated. One would be at a distance of 8 m from the ground level and other would be 15m from the ground surface. This location would be a station point for change over. Therefore the speed of the train would be less at this crossing point. The vibrations that can be generated are calculated using the finite element

model. Vibration is calculated for the most critical condition that is passage of four trains with the speed of 80 km/h crossing each other on two elevated tracks. However, this condition would be expected during operation, this is only considered to predict maximum effect of vibration. The predicted vibration contours are mapped on satellite image using GIS software. The prediction vibration is shown in **figure 4.15**

FIGURE 4.15

VIBRATION DUE TO METRO TRAIN AT METRO RAIL CROSSING

As it can be seen from the vibration contours, the effect of vibration is upto a distance of about 15 meters from the center of piers of metro rail structure of each track. The building located very close can be affected due to vibration (only in the scenario where four trains cross each other). However this condition would not be there all the time. If the train speed is controlled, there would be no effect on be nearby structures.

4.5.2.11 At Silver Arc Apartment near Gandhi Gam station

The metro train passage at this location is in single way on a elevated structure. The metro rail cross over the existing Ellis Bridge, therefore the height of the proposed metro rail bridge would be more than 20 m. The vibrations that can be generated from the proposed metro rail are calculated using the finite element model and mapped on the GIS platform. The speed of the train is considered as 80 km/h. The prediction vibration is shown in **figure 4.16**.

As it can be seen from the vibration contours, the effect of vibration is upto a distance of about 10 meters from the center of pier of metro rail structure. There would be no vibration on the buildings located close to the proposed metro rail.

FIGURE 4.16
VIBRATION DUE TO METRO TRAIN AT SILVER ARC APARTMENT

4.5.2.12 At Akbar Nagar

The metro train passage is from an elevated structure which is above 8 m from the ground level. The vibration caused by the train pass through the piers of metro rail structure. Most of the vibration caused by the metro train passes deep into the ground, only the horizontal vibration can pass to nearby structures. The horizontal vibrations are calculated using the finite element model. The predicted vibration contours are mapped on satellite image using GIS software. The prediction vibration at Akbar Nagar circle is shown in **figure 4.17**.

As it can be seen from the vibration contours, the effect of vibration is upto a distance of about 10 meters from the center of piers of metro rail structure. The building located very close (< 10m distance) can get effected by vibration.

FIGURE 4.17
VIBRATION DUE TO METRO TRAIN AT AKBAR NAGAR CIRCLE

4.5.3 Overall Result of Vibration Impact

The vertical vibration above the tunnel during construction and due to train operation is also evaluated. The summary of Vertical vibration above the tunnel during construction and vibration due to metro train operation is presented in **Table 4.8**.

TABLE 4.8
SUMMARY OF VERTICAL VIBRATION ABOVE THE TUNNEL

Sl	Location	Vibration due to TBM Operation in mm/s	Vibration due to Metro Train Operation in mm/s	Standards of Vibration in mm/s for Frequency (8Hz to 25 Hz)	Remarks
1	Vastral	--	1.0	10.0	There would be no vibration impact on the surrounding structures due to metro rail operation
2	Doodashan Kendra Transmission tower	--	1.0	20.0	There would be no vibration impact on the surrounding structures due to metro rail operation
3	Brick Minar at Kalupur Railway Station	4.0	2.0	5	There would be no vibration impact on the surrounding structures due to metro rail

Sl	Location	Vibration due to TBM Operation in mm/s	Vibration due to Metro Train Operation in mm/s	Standards of Vibration in mm/s for Frequency (8Hz to 25 Hz)	Remarks
					operation
4	Kalupur Darwaza - Kalupur	5.0	4.0	5	The old building above the tunneling can get damage precautionary measures has to be taken
5	Delhi Darwaza ï Delhi Chakla	5.0	3.0	5	The old building above the tunneling can get damage precautionary measures has to be taken
6	Qutubuddin Shah Masjid, Walled city	5.0	4.0	5	The old building above the tunneling can get damage precautionary measures has to be taken
7	Muhafiz Khanês Mosque- Walled city	5.0	3.0	5	The old building above the tunneling can get damage precautionary measures has to be taken
8	Rani Rupmati Masjid ï Walled City	5.0	3.0	5	The old building above the tunneling can get damage precautionary measures has to be taken
9	Shahpur Kazi Mohamad Chisti Masjid	5.0	4.0	5	The old building above the tunneling can get damage precautionary measures has to be taken
10	Silver Arc Apartment near Gandhi Gam Railway Station	---	1.0	10	There would be no vibration impact on the surrounding structures due to metro rail operation
11	Junction point at Navrangpura	---	2	10	There would be no vibration impact on the surrounding structures due to metro rail operation
12	Akbar Nagar Circle	---	1.0	10	There would be no vibration impact on the surrounding structures due to metro rail operation

Permissible Limit of Ground Vibration in India is presented in **Table 4.9**. The result of the vibration impact on the surrounding due to TBM and underground train traffic has been tabulated in **Table 4.10**. The limit for vibration varies in different countries. The

limits for vibration is 65 VdB as per Federal Transit Administration (FTA) whereas 83 VdB is the maximum limit as per ISO -2361-2. Directorate General of Mines and Safety (DGMS) prescribed permissible limit of ground vibration (INDIA).

TABLE 4.9
PERMISSIBLE LIMIT OF GROUND VIBRATION IN INDIA

Type of structures	Dominant excitation frequency, Hz		
	< 8Hz	8-25Hz	>25Hz
(A) Buildings/structures not belong to the owner			
1. Domestic houses/structures (Kuchcha, bricks & Cement)	5 mm/s	10 mm/s	15 mm/s
2. Industrial building	10 mm/s	20 mm/s	25 mm/s
3. Objects of historical importance & sensitive Structures	2 mm/s	5 mm/s	10 mm/s
(B) Buildings belonging to the owner with limited span of life			
1. Domestic houses/structures	10	15	20
2. Industrial buildings	15	25	50

TABLE 4.10
OVERALL RESULT OF VIBRATION IMPACT

SI	Location	Field Measured vertical vibration (mm/s)	Vibration due to TBM Operation(mm/s)	Vibration due to Metro Train Operation (mm/s)	Standards of Vibration in (mm/s) for frequency (8Hz to 25 Hz)
1	Vastral	0.6 mm/s	--	0.125	10
2	Doodashan Kendra Transmission tower	0.2	---	0.062	20
3	Brick Minar at Kalupur Railway Station	1.05	0.05	1.0	5
4	Kalupur Darwaza - Kalupur	2.0	0.05	0.5	5
5	Delhi Darwaza ï Delhi Chakla	1.0	0.05	0.5	5
6	Qutubuddin Shah Masjid, Walled city	0.5	0.05	1.0	5
7	Muhafiz Khanôs Mosque-Walled city	1.5	0.05	0.5	5
8	Rani Rupmati Masjid ï Walled City	0.5	0.05	1.0	5
9	Shahpur Kazi Mohamad Chisti Masjid	1.0	0.05	1.0	5
10	Akbar Nagar Circle	0.4		0.125	10
11	Junction point at Navrangpura	2.0		0.25	10
12	Silver Arc Apartment near Gandhi Gam Railway Station	1.0		0.25	10

As per the results of vibration study, the archeological structures are at safe distance and the there would be no vibration impact on these structures due to TBM tunneling and due to metro train operation.

4.5.4 Water Supply and Sanitation

Public Health facilities such as water supply and sanitation are very much needed at the stations. The water demands will be for drinking, toilet, cleaning and also for other purpose like AC, chiller etc. The demand is presented in **Table 4.11**. It is assumed that there would be similar water requirements in Ahmedabad Metro corridors also. The Water Demand of existing Delhi Metro corridors is considered for requirement of Ahmedabad metro. Water should be treated before use upto WHO drinking water standards. Municipal supply/Ground water shall be used for this purpose.

TABLE 4.11
WATER REQUIREMENT AT STATION

S.No.	Particular	Water Demand at Each Station (KLD)	Total Water Demand (KLD)
1	At Stations for Drinking Purpose	6	192
2	For AC, cleaning, chiller and other purposes	240-250	8000
		Total	**8192**

4.6 IMPACTS DUE TO DEPOT

The depot location at Apparel Park (19.5 hac) is planned for East-West corridor and at Giyaspur (25.2 hac) for North-South metro corridor. The area at depot is vegetated with no habitation. The depot will have following facilities:

- Washing Lines,
- Operation and Maintenance Lines,
- Workshop, and
- Offices.

These facilities could generate water and noise issues. The area will be levelled through cut and fill method within the depot and additional earth will be taken from tunnelling to raise the ground level. Problems anticipated at depot sites are:

- Water supply,
- Effluent Treatment,
- Oil Pollution
- Noise Pollution,
- Surface drainage,
- Solid Waste,

- Cutting of trees.

4.6.1 Water Supply

Water supply will be required for different purposes in the depots. The water requirement for train washing purpose will be 500 litres per day. About 123 KLD of fresh water will be required at Depot for different uses. Projected water demands are summarised in **Table 4.12.** Other water requirement for horticulture, flushing urinals/closet will be met from recycled water. The water after conventional treatment can be processed through Reverse Osmosis (RO) technology for specific use such as washing of equipment/ trains. This will reduce the fresh water requirement.

TABLE 4.12
WATER DEMAND AT DEPOTS

Corridor	DEPOT	PROJECTED NUMBER OF CARS	PROJECTED WATER REQUIREMENT PER DAY (LITRES)
East-West	Car Washing	96	48,000
	Floor Washing @ 0.5 lit/sqm	--	11,624
	Drinking Purpose: 35 person per Km=35x20.54. @ 5 lit per person per day	--	3595
	Sub Total		**63,219**
North-South	Car Washing	96	48,000
	Floor Washing @ 0.5 lit/sqm	--	11,624
	Drinking Purpose: 35 person per Km=35x19. @ 5 lit per person per day	--	669
	Sub Total		**60,292**
	Total		**1,23,511**

4.6.2 Effluent Treatment

About 48 KLD waste water will be generated at Apparel Park Depot and 46 KLD at Giyaspur Depot. Hence total waste water generation from both depots will be about 94 KLD, which will be treated at 100 KLD effluent treatment plant. About 12 m x6 m size Waste Water Treatment Plant for each Depot will be required to treat the waste water. The treated waste water will be tested for Inland Water Discharge Standard before release in to surface water body. The part of the water will be recycled to use at depot horticulture purpose.

The domestic waste /sewage generated at the Depot will be collected at one suitable point inside the depot. From here it will discharge to the nearest manhole of existing sewerage system of the corporation. It is estimated that the quantity of the sewage

generated will be only about 90 KLD[2]. Necessary permission/ approvals from the AMC are required for the discharge of wastewater in to the manhole of the existing AMC sewerage system. There will be minimal impact due to wastewater from the Depot.

4.6.3 Oil Pollution

Oil spillage during change of lubricants, cleaning and repair processes, in the maintenance Depot cum workshop for maintenance of rolling stock, is very common. The spilled oil should be trapped in oil and grease trap. The collected oil would be disposed off to authorised collectors, so as to avoid any underground/ surface water contamination.

4.6.4 Noise Pollution

The main source of noise from depot is during operation of workshop. The roughness of the contact surfaces of rail, wheel and train speed is the factors, which influence the magnitude of rail - wheel noise. The vibration of concrete structures also radiates noise. No impact on the ambient noise is anticipated due to mild activities.

4.6.5 Surface Drainage

Due to the filling of the low-lying area for the construction of depots, the surface drainage pattern will change. Suitable drainage measures will be adopted to drain off the area suitably.

4.6.6 Solid Waste

At per available data, it is estimated that about 1.8 Ton per month of solid waste will be generated from the Depot. Hence, solid waste generated from both the corridor will be 3.6 Ton per month.

4.6.7 Cutting of Trees

As already discussed in section 4.2.3, about 222 numbers of trees are observed at Apparel Park Depot and about 25 trees at Giyaspur Depot. The details of tree cut are mentioned in the section 3.7.2. The details of tree likely to be cut and transplanted are given in the Environmental Management Plan.

4.7 EPILOGUE

Based on above negative impacts, a checklist of impacts has been prepared along with positive impacts in **Chapter-5.** The net resultant impacts without management

[2] DPR

plans are also summarised. The management plans to mitigate the negative impacts are reported in **Chapter-6.**

CHAPTER-5
POSITIVE ENVIRONMENTAL IMPACTS

5.1 POSITIVE ENVIRONMENTAL IMPACTS

This chapter deals with the positive impacts of the project. The introduction of Metro Rail will also yield benefits from non-tangible parameters such as saving due to equivalent reduction in road construction and maintenance, vehicle operating costs, less atmospheric air pollutiom and socio-economic benefits of travel time, better accessibility, better comfort and quality of life. However, all benefits cannot be evaluated in financial terms due to non-availability of universally accepted norms. The parameters such as economic growth, improvement in quality of life, reduction in public health problems due to reduction in pollution, etc have not been quantified.

Various positive impacts have been listed under the following headings:

- Employment Opportunities,
- Benefit to Economy,
- Mobility,
- Safety,
- Traffic Congestion Reduction,
- Reduction in the number of Vehicle Trips on the road,
- Less Fuel Consumption,
- Reduced Air Pollution,
- Carbon Dioxide Reduction,
- Reduction in Number of Buses,
- Saving in Road Infrastructure, and
- Traffic Noise Reduction.

5.1.1 Employment Opportunities

The project is likely to be completed in a period of about 5 years. During this period manpower will be needed to take part in various activities. About 5,000 persons are likely to work during peak period of construction activities. In operation phase of the project about 35 persons per kilometre length of the corridor, ie (approx. 1,388 persons) will be employed for operation and maintenance of the proposed system. Thus the project would provide substantial direct employment; besides, more people would be indirectly employed in allied activities and trades.

5.1.2 Benefit to Economy

In the present context, the project will streamline and facilitate easy movement of public in Ahmedabad city. The metro rail will yield tangible and non-tangible saving due to equivalent reduction in road traffic and certain socio-economic benefits. Introduction of this metro rail project, in Ahmedabad city will result in the reduction in number of buses and private vehicles. This, in turn will result in significant social and economic benefits due to reduction in fuel consumption, vehicle operating cost and travel time of passengers. This will facilitate the movement of people fast. With the development of this corridor, it is likely that more people will be involved in trade, commerce and allied services.

5.1.3 Mobility

The proposed Ahmedabad Metro network is estimated to carry 9.22 lakh passengers per day, in the year 2031. The maximum PHPDT on any section will be more than 37,029 by 2031. The proposed development will reduce journey time significantly.

5.1.4 Safety

Substantial decrease in road accident has been noticed after 2007 with the implementation of Delhi Metro Phase I & II in Delhi. Hence, operation of Ahmedabad Metro Rail will also provide improved safety and lower the number of accidental deaths.

5.1.5 Saving in Road Infrastructure

An additional road infrastructure will be required in without metro scenario to cater the additional load. Road infrastructure will be saved due to implementation of proposed Metro.

5.1.6 Traffic Noise Reduction

Reduction in traffic volume affects the noise levels. A 50% reduction of the traffic volume may results in a 3 dB reduction in noise levels, regardless of the absolute number of vehicles. Reduction in traffic volume of 10% & 50% reduces noise at the tune of 0.5 dB & 3.0 dB respectively. An introduction of Ahmedabad Metro Rail substantially reduces the vehicular traffic which ultimately reduces noise level.

5.1.7 Traffic Congestion Reduction

To meet the forecast transport demand in the year 2043, it is estimated that the number of buses will have to be more. During this period personalised vehicles may also been grow. Together, they will compound the existing problems of congestion and delay. The proposed development will reduce journey time and hence congestion and delay.

5.1.8 Reduction in the number of Vehicle Trips on the road

Table 5.1 presents four scenario of the percent reduction in number of vehicle-kilometres achieved by implementing the proposed metro. The basis of reduction of vehicle is shift of ridership from road vehicle to the proposed system. The reduction in number of vehicles gives benefits to economy by reduction in Vehicle Operating Cost (VOC), Fuel Consumption, Pollution Load, Accidents and Travel Time etc.

TABLE 5.1
PERCENT REDUCTION IN NUMBER OF VEHICLE-KILOMETRES WITH METRO

Scenario	Year	% Savings in veh-kms		
		Two Wheelers	Cars	3 Wheelers
Business as usual	2018	4%	7%	4%
	2021	14%	14%	16%
	2031	28%	28%	29%
	2043	46%	46%	48%
Moderate speed of modal shift to Metro	2018	9%	12%	9%
	2021	18%	19%	20%
	2031	32%	31%	34%
	2043	47%	47%	49%
Rapid speed of modal shift to Metro	2018	13%	16%	14%
	2021	22%	23%	24%
	2031	35%	35%	38%
	2043	47%	48%	51%

Source: DPR

5.1.9 Less fuel Consumption Due to reduction in Vehicle

There will be a reduction in number of vehicle trips on implementation of this project. Therefore, it is estimated that both petrol and diesel consumption will also get reduced. There is an inter-fuel substitution of petrol and diesel to electricity that could result in savings of foreign exchange and a reduction of air pollution.

5.1.10 Reduced Air Pollution

Compared to other modes of transport, the metro is least polluting and can be classified as an environment friendly technology since no air emissions are involved in running and operating the metro trains. Reduction in traffic on Ahmedabad roads due to proposed metro rail could lead to reduce air pollution.

5.2 CARBON CREDITS

5.2.1 Introduction

The fact that the transport sector is growing quickly brings advantages, such as quick access to any geographical location on earth, but also disadvantages: noise, congestion and polluting emissions such as carbon dioxide (CO_2), the greenhouse gas (GHG) primarily responsible for global warming. In the effort to bring GHG emissions under control, improving results in the transport sector is a prime long-term objective.

TRANSPORT GREENHOUSE GAS EMISSIONS TRENDS & DATA 2010[14]

- Transport-sector CO_2 emissions represent 23% (globally) and 30% (OECD) of overall CO_2 emissions from Fossil fuel combustion. The sector accounts for approximately 15% of overall greenhouse gas emissions.

- Global CO_2 emissions from transport have grown by 45% from 1990 to 2007, led by emissions from the road sector in terms of volume and by shipping and aviation in terms of highest growth rates.

- Under ñbusiness-as-usualò, including many planned efficiency improvements, global CO_2 emissions from transport are expected to continue to grow by approximately 40% from 2007 to 2030 ï though this is lower than pre-crisis estimates.

- Road sector emissions dominate transport emissions with light-duty vehicles accounting for the bulk of emissions globally. In certain ITF member countries for which estimates can be made, road freight accounts for up to 30% to 40% of road sector CO_2 emissions though the breakdown amongst freight vehicle classes varies amongst countries. Emissions from global aviation and international shipping account for 2.5% and 3% of total CO_2 emissions in 2007.

- Some countries (e.g. France, Germany and Japan) stand out in that they have seen their road CO_2 emission stabilise or decrease even before the recession of 2008-2009 despite economic and road freight growth over the same period.

- The economic crisis of 2008 has led to a prolonged downturn in economic activity and has had to the sharpest drop in emissions in the past 40 years (estimates range from 3% to 10%). Depending on the strength of the economic recovery, may translate into approximately 5% to 8% decrease in 2020 emissions from their pre-crisis projected levels.
- The outcome of Copenhagen Climate Summit has not provided a strong signal supporting future emission reduction efforts for either developed or rapidly developing countries. Early analysis of both low and high ambition pledges by

[14] http://www.internationaltransportforum.org/Pub/pdf/10GHGTrends.pdf

countries following Copenhagen finds that mitigation action is unlikely to constrain global average temperatures to less than a 2 degree Celsius rise which is the threshold for dangerous climate change identified by the IPCC.

REDUCING EMISSIONS FROM TRANSPORTATION

There are a variety of opportunities to reduce greenhouse gas emissions associated with transportation. Carbon credit is one of them.

5.2.2 CARBON MARKET

The Basics of Carbon Offsetting

When companies or individuals go about their daily lives and conduct business they use energy. When this energy is derived from fossil fuels such as oil, coal and gas, it releases carbon and other greenhouse gases (GHGs) into the atmosphere. This is one of the key contributors to climate change. Carbon offsetting is the process by which businesses and households can compensate for the release of these GHG emissions by funding certified GHG emission reduction projects that destroy GHG emissions, prevent their release elsewhere or sequestrate the carbon dioxide.

A carbon credit, or carbon offset, is a financial unit of measurement that represents the removal of one tonne of carbon dioxide equivalent (tCO_2e) from the atmosphere.

Where Do Carbon Credits Come From?

Carbon credits come from GHG emission reduction projects that deliver measurable reductions in emissions by either:

- **Replacing** the use of dirty fossil fuels with renewable energy;
- **Reducing** the use of fossil fuels through energy efficiency; or
- **Capturing and storing** already released carbon in trees and other plants.

For example, wind farm project supplies power stations with renewable energy replacing the need for energy produced from fossil fuels such as coal. Energy efficiency projects reduce the direct release of GHGs into the atmosphere, e.g. a domestic project in Kenya that The Gold Standard is in the process of accrediting, distributes an engineering system for low-income families that treats contaminated water, reducing the direct release of GHGs into the atmosphere by avoiding the need to burn firewood to boil water. It is estimated that this project will generate more than 2-million emission reduction credits per year, the equivalent of taking nearly 350,000 cars off the road for one year.

Capturing and storing already released carbon in trees and other plants is known as carbon sequestration and requires the protection of existing forests or the planting of additional trees and plants.

The atmosphere has no national boarders and does not care where GHGs are emitted or prevented. The most important factor in terms of fighting climate change is reducing the total amount of emissions worldwide.

Type of Projects Eligible as Carbon Credit Projects

- **Renewable Energy –**such as solar, biomass, biogas and liquid bio-fuels (if they produce electricity), wind, geothermal, hydro.
- **Energy Efficiency –**industrial, domestic, transportation, public sector, agricultural sector and commercial sector.
- **Waste Handling and Disposal –**all waste handling activities that deliver an energy service or a usable product with sustainable development benefits (e.g. composting).
- **Land Use and Forests –**including New Forests & Agroforestry, Forest Management and Smart Agriculture.
- **Or** any other type of projects which reduces GHG into the atmosphere with reference to business as usual scenario

Classification of Carbon Markets

Climate change caused by greenhouse gas (GHG) emissions is a serious global problem. National and international attempts to mitigate the growth in atmospheric concentrations of GHGs have resulted in the formation of a carbon market. Currently the carbon market is comprised of:

- **The Compliance Market,** made up of emitters who are obligated to reduce their emissions and;
- **The Voluntary Market,** in which organizations voluntarily reduce their carbon emissions.

Most economists argue that an efficient, international carbon market will reduce GHG emissions at the lowest cost, allowing polluters that are unable to abate their own emissions cheaply to invest in projects globally that can.

A) The Compliance Carbon Market: In 1992, countries joined an international treaty, the United Nations Framework Convention on Climate Change, to cooperatively consider what they could do to limit average global temperature increases and the resulting climate change, and to cope with whatever impacts were, by then, inevitable.

The UNFCCC entered into force on 21 March 1994. Today, it has near-universal membership. The 195 countries that have ratified the Convention are called Parties to the Convention.

The UNFCCC is a ñRio Conventionò, one of three adopted at the ñRio Earth Summitò in 1992. Its sister Rio Conventions are the UN Convention on Biological Diversity and the Convention to Combat Desertification. The three are intrinsically linked. It is in this context that the Joint Liaison Group was set up to boost cooperation among the three Conventions, with the ultimate aim of developing synergies in their activities on issues of mutual concern. It now also incorporates the Ramsar Convention on Wetlands.

Preventing ñdangerousò human interference with the climate system is the ultimate aim of the UNFCCC.

The Kyoto Protocol: The Kyoto Protocol is an international agreement linked to the United Nations Framework Convention on Climate Change, which commits its Parties by setting internationally binding emission reduction targets.

Recognizing that developed countries are principally responsible for the current high levels of GHG emissions in the atmosphere as a result of more than 150 years of industrial activity, the Protocol places a heavier burden on developed nations under the principle of "common but differentiated responsibilities."

The Kyoto Protocol was adopted in Kyoto, Japan, on 11 December 1997 and entered into force on 16 February 2005. The detailed rules for the implementation of the Protocol were adopted at COP 7 in Marrakesh, Morocco, in 2001, and are referred to as the "Marrakesh Accords." Its first commitment period started in 2008 and ended in 2012.

This set legally binding targets for 37 industrialised countries to limit or reduce overall GHG emissions by at least 5% below 1990 levels during the period 2008-2012. Later in Doha, Qatar, on 8 December 2012, the "Doha Amendment to the Kyoto Protocol" was adopted. The amendment includes:

- New commitments for Annex I Parties to the Kyoto Protocol who agreed to take on commitments in a second commitment period from 1 January 2013 to 31 December 2020;
- A revised list of greenhouse gases (GHG) to be reported on by Parties in the second commitment period; and
- Amendments to several articles of the Kyoto Protocol which specifically referenced issues pertaining to the first commitment period and which needed to be updated for the second commitment period.

On 21 December 2012, the amendment was circulated by the Secretary-General of the United Nations, acting in his capacity as Depositary, to all Parties to the Kyoto Protocol in accordance with Articles 20 and 21 of the Protocol.

During the first commitment period, 37 industrialized countries and the European Community committed to reduce GHG emissions to an average of five percent against 1990 levels. During the second commitment period, Parties committed to reduce GHG emissions by at least 18 percent below 1990 levels in the eight-year period from 2013 to 2020; however, the composition of Parties in the second commitment period is different from the first.
Under the Protocol, countries must meet their targets primarily through national measures. However, the Protocol also offers them an additional means to meet their targets by way of three market-based mechanisms. The Kyoto mechanisms are:

- **International Emissions Trading -** the international transfer of emission allocations between industrialized (Annex 1) countries. E.g. a country that stays

within its target can sell the surplus allowances to another country that has exceeded its limit.

- **Clean Development Mechanism (CDM) -** creates carbon credits called Certified Emission Reductions (CERs) through emission reduction projects in developing countries, regulated by the United Nations. Emitters who have exceeded their emission allocations can purchase these CERs to make up the difference.
- **Joint implementation (JI) -** any Annex I country can invest in emission reduction projects in any other Annex I country as an alternative to reducing emissions domestically.

The mechanisms help to stimulate green investment and help Parties meet their emission targets in a cost-effective way.

The rationale behind such schemes is that climate change is a global problem and that the location of GHG emission reductions is irrelevant in scientific terms. This means that a tonne of carbon dioxide reduced in a cook stove project in Kenya has the same environmental value as a tonne of carbon dioxide reduced through a wind project in India or a clean energy project in the United States. The difference in these projects is the cost of implementation.

The emission reductions generated by these flexible mechanisms are collectively referred to as ócarbon creditsô A carbon credit is a financial instrument that represents a reduction or the avoidance of one tonne of carbon dioxide equivalent (tCO2e) from the atmosphere. These three mechanisms, along with the European Union Emissions Trading Scheme (EU ETS) put in place by the EU in order to meet its Kyoto target, make up the largest environmental market in the world for the trading of carbon credits.

Clean Development Mechanism (CDM)

The CDM allows emission-reduction projects in developing countries to earn certified emission reduction (CER) credits, each equivalent to one tonne of CO2. These CERs can be traded and sold, and used by industrialized countries to a meet a part of their emission reduction targets under the Kyoto Protocol.

The mechanism stimulates sustainable development and emission reductions, while giving industrialized countries some flexibility in how they meet their emission reduction limitation targets.

The CDM is the main source of income for the UNFCCC Adaptation Fund, which was established to finance adaptation projects and programmes in developing country Parties to the Kyoto Protocol that are particularly vulnerable to the adverse effects of climate change. The Adaptation Fund is financed by a 2% levy on CERs issued by the CDM.

CDM Benefits: The clean development mechanism was designed to meet a dual objective:

- to help developed countries fulfill their commitments to reduce emissions, and
- to assist developing countries in achieving sustainable development.

CDM projects earn tradable, saleable certified emission reduction (CER) credits that can be used by industrialized countries to meet a part of their emission reduction targets under the Kyoto Protocol.

Benefits of CDM projects include investment in climate change mitigation projects in developing countries, transfer or diffusion of technology in the host countries, as well as improvement in the livelihood of communities through the creation of employment or increased economic activity. This page serves to highlight where, how and what has been the impact of the CDM across the globe.

General eligibility requirements for CDM projects

The eligibility requirements are framed in the modalities and procedures as requirements for validation. These requirements are as follows:

- **CDM prior consideration:** The submission of the "prior consideration of the CDM" form within 6 months of the project start date is a mandatory requirement for all projects which have already started before a PDD has been published for public comments or a new methodology/revision of methodology has been proposed. This is considered an initial notification of the intention to seek CDM status in order to demonstrate that the benefits of the CDM were a decisive factor for taking up the project activity. It has to be submitted to the host countryÕs DNA and the UNFCCC secretariat within 6 months of the project start date, following the section IV.A. of the CDM Project Cycle Procedure. All submitted notifications are published on the CDM website.

- **Stakeholders have been consulted with:** Comments by local stakeholders have been invited, a summary of the comments received has been provided, and a report to the designated operational entity(DOE) on how due account was taken of any comments has been received.

- **The environmental impacts of the project have been considered:** Project participants have submitted to the DOE documentation on the analysis of the environmental impacts of the project activity, including trans-boundary impacts and, if those impacts are considered significant by the project participants or the Host Party, have undertaken an environmental impact assessment in accordance with procedures as required by the Host Party

- **Emission reductions are additional;** The project activity is expected to result in a reduction in anthropogenic emissions by sources of greenhouse gases that are additional to any that would occur in the absence of the proposed project activity,

- **Baseline and monitoring methodologies comply with requirements**: The baseline and monitoring methodologies comply with requirements pertaining to either Methodologies previously approved by the Executive Board; or Modalities and procedures for establishing a new methodology are used for approval of new methodology

- **The project complies with all other relevant requirements:** All permissions/NOCs related to project obtained and projectcontribute to sustainable development criteria of Host country. In India its environmental, social, economic and technological wellbeing.

- The CDM Project Cycle (Glimpse of the 7 steps of the Project Cycle) and CDM Pipeline is presented in **Figure 5.1.** The distribution of CERs issued by Host Party and Trend of Projects registered & registering by Host Party are presented in **Figure 5.2** & **Figure 5.3** respectively. The trend of types of projects registered and registering is given in **Figure 5.4**.

FIGURE 5.1
CDM PROJECT CYCLE

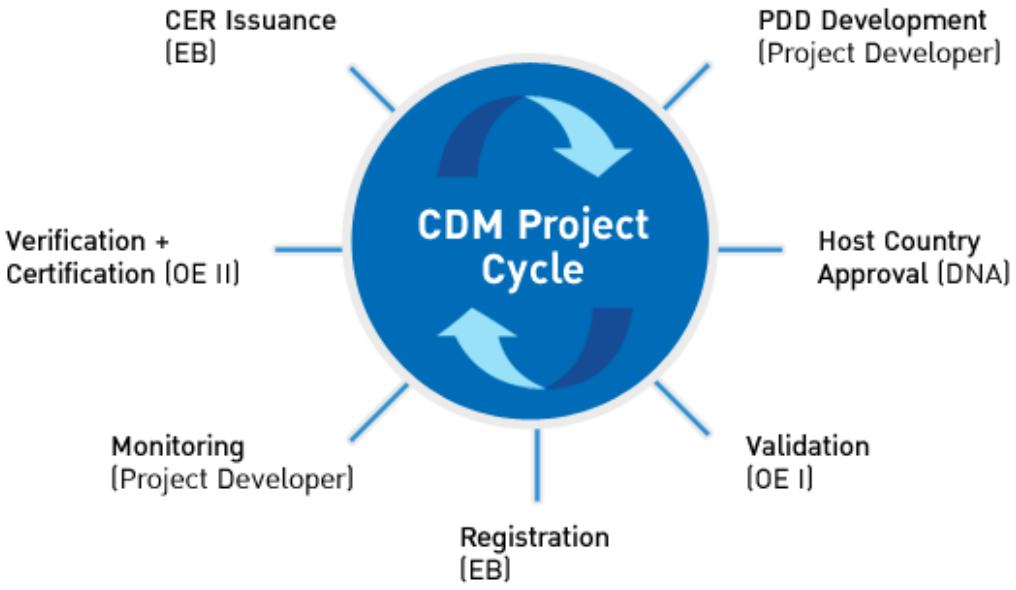


FIGURE 5.2
DISTRIBUTION OF CERS ISSUED BY HOST PARTY

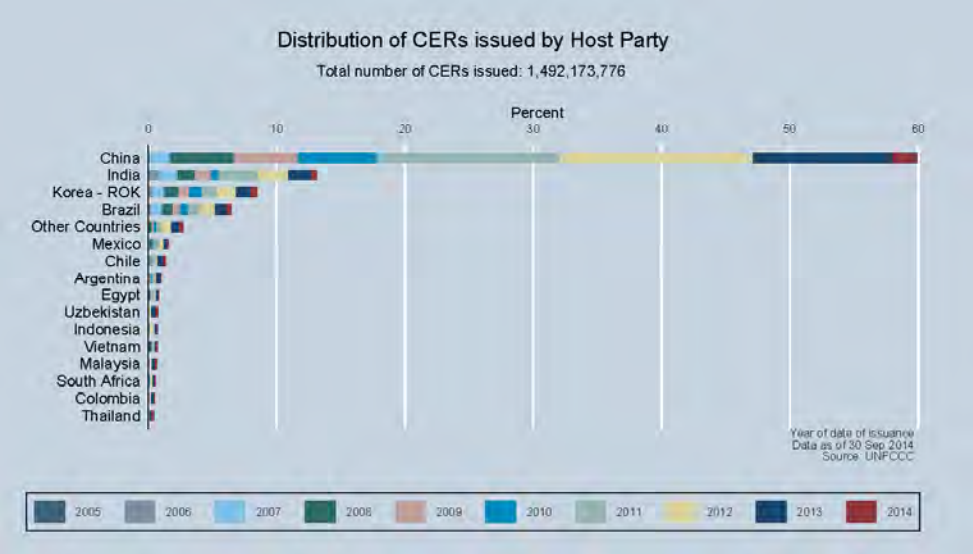


FIGURE 5.3
DISTRIBUTION OF CERs ISSUED BY HOST PARTY

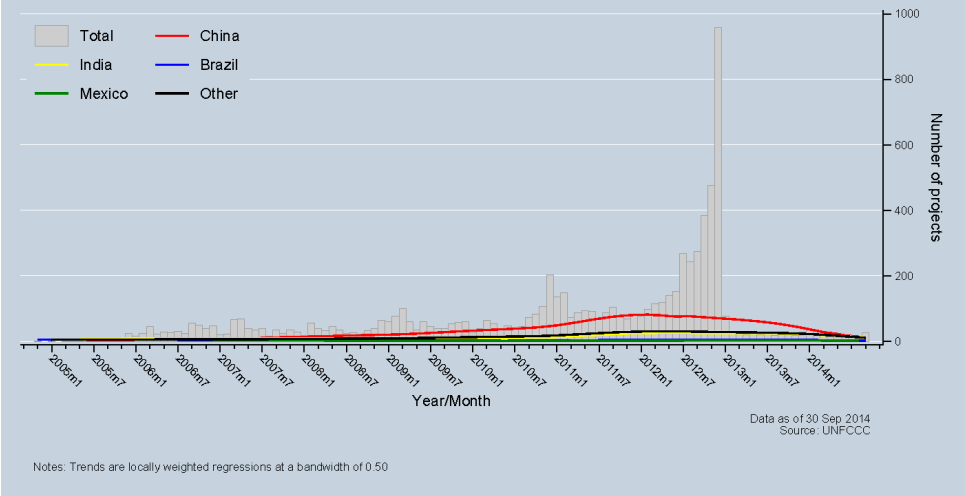
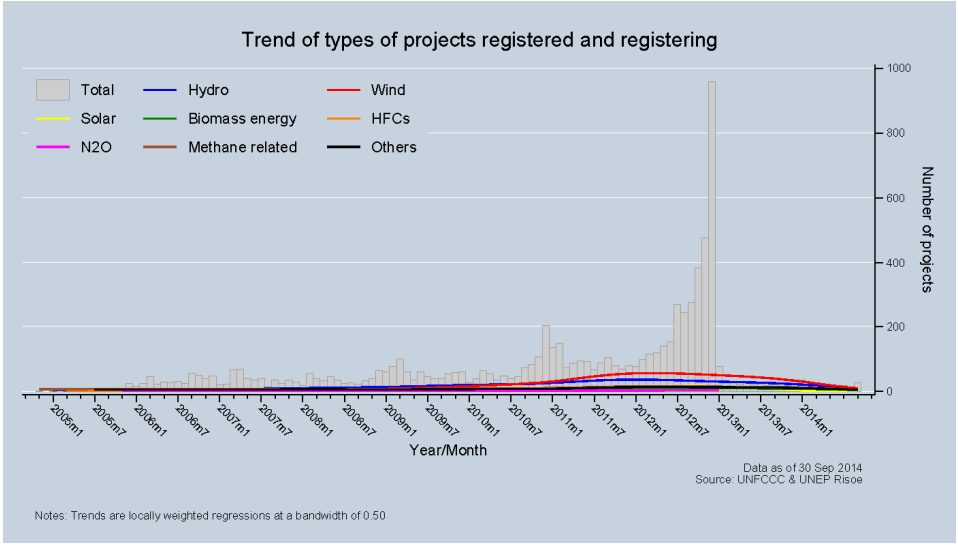


FIGURE 5.4
TREND OF TYPES OF PROJECTS REGISTERED AND REGISTERING



The road ahead: The Kyoto Protocol is seen as an important first step towards a truly global emission reduction regime that will stabilize GHG emissions, and can provide the architecture for the future international agreement on climate change.

In Durban, the Ad Hoc Working Group on the Durban Platform for Enhanced Action (ADP) was established to develop a protocol, another legal instrument or an agreed outcome with legal force under the Convention, applicable to all Parties. The ADP is to complete its work as early as possible, but no later than 2015, in order to adopt this protocol, legal instrument or agreed outcome with legal force at the twenty-first session of the Conference of the Parties and for it to come into effect and be implemented from 2020.

B) The Voluntary Carbon Market

In a voluntary carbon market, an entity (company, individual, or other ñemitterò) volunteers to offset its emissions by purchasing carbon credits that reduce the amount of carbon in the atmosphere. It is driven by a companyôs desire to demonstrate leadership and/or ódo the right thingôand has been around in different forms for many years. The wish to make voluntary commitments to reduce their impact on the environment pre-dates the Kyoto Protocol.

Reasons to engage in the voluntary carbon market could include:

- To save money/reduce operating costs
- Corporate Social Responsibility (CSR)
- Leading by example
- Demand from stakeholders
- Pre-compliance
- Green marketing / boosting green and socially responsible credentials
- Mitigating reputational and commercial risk

A Voluntary Greenhouse Gas (GHG) Program is the mechanism that new or existing projects must use to certify they are actively reducing emissions. While there are other voluntary GHG programs throughout the world, none are more widely used than the Voluntary Carbon Standard (**VCS)** Program and Gold Standard.

Voluntary Carbon Standard (VCS) Program

VCS is the worldôs largest voluntary greenhouse gas reduction program. We were founded in 2005 by a collection of business and environmental leaders who saw a need for greater quality assurance in voluntary carbon markets. Since that day, VCS projects all across the world have removed more than 125 million tonnes of CO_2e from the atmosphere.

There are more than a thousand individual VCS projects all across the world, focusing on everything from clean energy, to agriculture. In fact, VCS projects can be registered in any of 15 different categories.

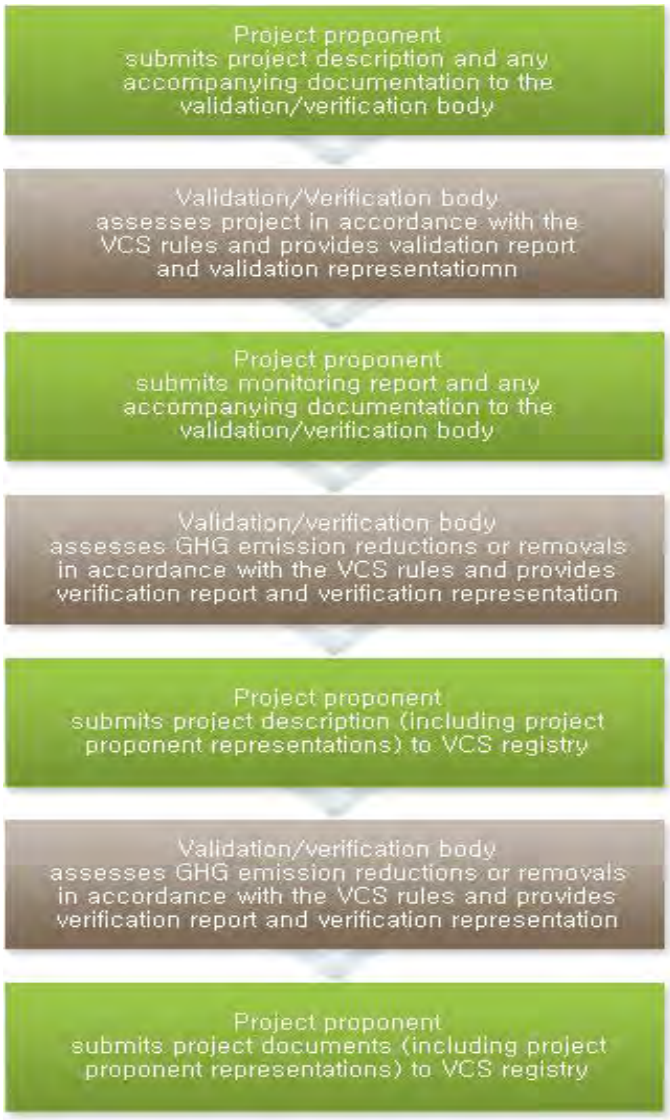
General eligibility requirements for the VCS Project:

To be eligible in the VCS program, your project should have been commissioned within two years from the date of application. Hence if you decide to enter the market in August 2010, then your project should have been commissioned on or after August 2008 only. When we say commissioning, we essentially look at the commissioning certificates of boilers or wind mills from official certifying agencies.

Instead of reinventing the wheel, the voluntary market follows the guidelines of the CDM market and you can follow any of the methods to do a carbon project as listed under the UNFCCC CDM guidelines.

VCS Project Cycle-Methodology

VCS projects are developed following a step-by-step process proven to result in the generation of quality-assured Verified Carbon Units (VCUs). More information on the following steps is provided in the Registration and Issuance Process:



Project Pipeline and VCU Summary

- VCUs issued - 156,430,749
- VCUs retired - 71,662,224
- Projects registered - 1,212
- Projects with VCUs issued - 923
- Projects without VCUs issued - 289

Voluntary Carbon Market

Companies, governments, organizations and individuals from around the world are increasingly acknowledging their climate impacts by supporting projects that reduce or remove the greenhouse gases (GHG) accelerating climate change. In 2012 alone, these voluntary actions avoided more than 100 million tons of GHG emissions ð equivalent to removing more than 20 million cars off the road ð and provided more than $500 million of support to implement innovative climate activities. This exchange of environmental services is known as the voluntary carbon market. Within the voluntary carbon market, VCS serves as the leading quality assurance standard; more than half of all transacted credits are issued through the VCS program, according to Ecosystem Marketplaceõs State of the Voluntary Carbon Markets.

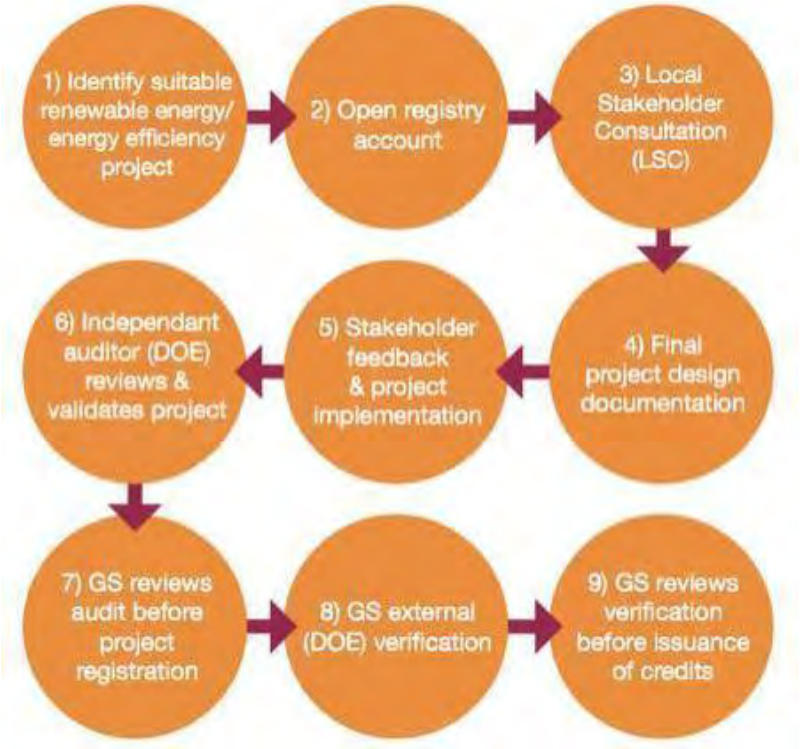
Gold Standard

The Gold Standard is an award winning certification standard for carbon mitigation projects, recognized internationally as the benchmark for quality in both the compliance and voluntary carbon markets. The Gold Standard is the standard of choice for multiple governments, multinationals and the United Nations and the only certification standard trusted and endorsed by more than 80 NGOs worldwide.

Established in 2003 by WWF to demonstrate that carbon markets could deliver capital efficiently to greenhouse gas mitigation projects, with substantial co-benefits, all Gold Standard projects demonstrate real and permanent GHG reductions and sustainable development benefits in local communities that are measured, reported and verified.

In the past decade more than 800 Gold Standard low carbon projects have been listed, predominantly in China, India, Turkey and Africa. In 2010 alone, 175 projects were added to the Gold Standard pipeline, a 40% increase from 2009. Each project represents a community that has benefited from The Gold Standardõs rigorous requirements. In total, over 6-million Gold Standard credits have been issued in the voluntary market (VERs) and almost 1-million have been labeled by The Gold Standard in the compliance market (CERs). This approach ensures Clean and Sustainable Development is genuinely achieved. Gold Standard Project Cycle CERTIFICATION PROCESS is presented in **Figure 5.5**:

FIGURE 5.5
GOLD STANDARD PROJECT CYCLE CERTIFICATION PROCESS



PROJECT REGISTRY/GS Pipeline

Currently, The Gold Standard focuses on Energy Efficiency, Renewable Energy, Waste Management and Land Use & Forest projects. The Gold Standard Project Pipeline is a summary of projects that are under development and lists information as to their stage of development. The total number of Gold Standard projects as of 1st December 2013:

- New Project Applicants ï 211
- Listed ï 354
- Validated ï 61
- Registered ï 223
- Issued ï 152
- 100+ project types (methodologies)
- 260+ project developers
- 1000+ projects in over 60 countries
- 65m+ GS tonnes CO2e issued and pending
- Approx 40:60 ratio of compliance to voluntary market projects

MAJOR EXCHANGES TRADING CERs

- European Climate Exchange (ECX)
- Nymex Green Exchange
- Nordpool
- Powernext
- OTC markets using bilateral trade agreements
- Bluenext

5.3 CARBON CREDIT OPPORTUNITIES IN TRANSPORT

Carbon Credit in Transport: Transport accounts for a significant share of energy-related overall CO2 emissions. Projections suggest that transport will comprise the most rapidly growing source of emissions over the next 30 years, especially in developing countries. Some forecasters predict the developing worldôs share of GHG emissions derived from transport will increase from about 35% in 2000 to 52%ï 63% by 2030[15]. Efforts are therefore required to reduce carbon dioxide and other GHG emissions in the sector. A number of options exist, such as the promotion of vehicles using cleaner technology and fuel, managing demand, more efficient public transport systems, and shifting to cleaner modes of transport.

Transport projects that contribute to reductions in GHG emissions, and have potential for Carbon finance, include improved public transport (bus rapid transit, metros, light rail transit), electric and hybrid vehicles (e.g., electric scooters), inter-urban rail infrastructure (including double-tracking, new freight lines, new passenger lines, or rapid passenger trains), technologies like regenerating breaking system which generate electricity while breaking and electrification railways projects (depending on whether the country uses fossil fuels to generate power or not). Of total registered CDM projects only 0.3% are in transport sector.

Basically, three ways exist to reduce GHG emission into transportation is:

- Reduce emissions per km
  - Fuel switch e.g. biofuels
  - Behavioral management change e.g fleet management, driver training
  - Technology vehicle change. i.e. Energy efficiency improvements, regenerating breaking system&electric vehicles
- Reduce emission per unit transported
  - Passenger transport e.g. urban planning modal shift, use of large units, Improved occupation rate
  - Fright transport
- Reduce distance or number of units
  - Urban planning to induce behavior change via government policies/measures

- Use of renewable energy and energy efficiency in stations and offices
  - Solar roof tops, led lighting, natural lighting, use of glare glasses, VAM etc.

[15] Price, L., S. de la Rue du Can, J. Sinton, E. Worrell, Z. Nan, J. Sathaye, and M. Levine. 2006. Sectoral trends in global energy use and greenhouse gas emissions LBNL-56144. Berkeley, CA. Ernest Orlando Berkeley National Laboratory, Environmental Energy Technologies Division.

Carbon Credit in Rail Metro Project:

Eligibility of measures to limit or reduce emissions from Ahmadabad Metro

The basket of measures for Ahmadabad Metro: The basket of measures was used to test the potential eligibility of metro projects under the under various schemes. The basket of measures was classified according to the following categories:

- Reduce emissions per km by use of regenerating breaking system & electric vehicles
- Reduce emission per unit transported modal shift from two, three and four wheelers
- Displacement of a more-GHG-intensive use of electricity by renewable energy and energy efficiency improvements

Assessment of potential eligibility under various scheme: The CDM, VCS and GS have a dual objective, reducing GHG emissions and contributing to sustainable development. Also project has to be ñadditionalò This implies that measures whose contribution to sustainable development cannot be proven will not be eligible. Also the measures for which it is not possible to prove ñadditionalityòshould also be excluded. The review of the measures provided in section 2.2.1 above, for eligibility, under the various schemes, identified the following potentially eligible measures:

Measure-1: Reduce emissions per km by use of regenerating breaking system & electric vehicles

- The project activity operates low GHG emitting rolling stocks having regenerative braking system in Ahmedabad Metro. The project activity replaces the conventional electro-dynamic rheostatic braking technology, with regenerative braking technology fitted rolling stocks. The regenerated electrical energy reduces the consumption of equivalent grid electrical energy required by the powering trains, thereby conserving electrical energy and subsequently leading to GHG emission reduction.

  Therefore the emission reductions are additional as the above project activity is expected to result in a reduction in anthropogenic emissions by sources of greenhouse gases(GHG) that are additional to any that would occur in the absence of the proposed project activity;

Measure-2: Reduce emission per unit transported modal shift from two, three and four wheelers

- The objective of the project is the establishment and operation of an efficient, safe, rapid, convenient, comfortable and effective modern mass transit system ensuring high ridership levels in the city of Ahmedabad, India.

  The traditional mode of transport including buses, taxis, private cars, rickshaws, motorcycles and bikes. The traditional mode (being run on high intensive carbon fuel) emit huge amount of GHG into the atmosphere. Metro complements other modes of transport and replaces partially trips made by conventional or traditional means of transit by metro. The Metro project replaces trips made by conventional transport modes with metro, being a more efficient, faster, safer and more reliable transport means. The traditional scenario however incorporates technological

advancements in terms of emissions per distance driven of various modes of transport as well as eventual fuel changes of baseline modes of transport during the project activity.

Therefore the emission reductions are additional as the above project activity is expected to result in a reduction in anthropogenic emissions by sources of greenhouse gases(GHG) that are additional to any that would occur in the absence of the proposed project activity;

Measure-3: Displacement of a more GHG-intensive use of electricity by renewable energy and energy efficiency improvements

- Therefore the emission reductions are additional as the above project activity is expected to result in a reduction in anthropogenic emissions by sources of greenhouse gases(GHG) that are additional to any that would occur in the absence of the proposed project activity;

The above mentioned projects also contribute to sustainable development in a significant manner in the environmental, social, economic and technological dimensions.

Environmental improvements are achieved through less GHG and other air pollutant emissions, specifically particle matter, SO2 and NOx. This is achieved through a more efficient transport system and
through using electricity as energy source.

The social impact of metro is basically improved social wellbeing as a result of less time lost in congestion, less respiratory diseases due to less particle matter pollution, and fewer accidents per passenger transported. It is also assumed that the number of road accidents could be reduced by the metro.

Improved **economic performance** of the city basically due to less congestion and due to having a modern public transit system with its corresponding positive image. The projects is expected to have these economic benefits e.g. of reduced congestion and environmental pollution. A monetary quantification of these benefits is complex and prone to discussions as developments of the same parameters also take place in absence of the project and a monetization of non-market traded benefits (e.g. estimation of the value of time savings) can lead to differing results depending on the approach used ï nevertheless it is clear in a qualitative sense that the project contributes to economic benefits. Latter are basically public goods and cannot be captured effectively by metro through ticket charges as benefits are accrued by users as well as non-users of metro.

Technology-wise the metro is a modern and efficient mass transit means not used commonly in India. The project complies with all legal requirements of the environmental legislation of India.

The above measures (1, 2 and3) are eligible to apply through any of mentioned carbon credit schemes.

5.4 CARBON CREDIT CALCULATIONS

Carbon Credits are termed as CER in CDM, VER in VCS and GS credit in Gold Standard. Each unit of CER, VER & GS credit is equivalent to reduction or replacement of one tonne of CO2e into the atmosphere.

Measure-1: Reduce emissions per km by use of regenerating breaking system & electric vehicles

Methodology: Name of the Methodology Used: AMS-III.C.: Emission reductions by electric and hybrid Tool referenced in this methodology: Tool to calculate baseline, project and/or leakage emissions from electricity consumption[16].

Applicability: This methodology is for project activities introducing new electric and/or hybrid vehicles that displace the use of fossil fuel vehicles in passenger and freight transportation.

Establishment and description of baseline scenario: The baseline for the proposed project activity has been arrived at using the methodology specified in the applicable project category for small-scale CDM projects. Indicative simplified baseline and monitoring methodologies for selected small-scale CDM project activity categories for Type-III C defines the baseline as: ñThe baseline is the energy use per unit of service for the vehicle that would otherwise have been used times the average annual units of service per vehicle times the number of vehicles affected times the emission coefficient for the fuel used by vehicle that would otherwise have been used. If electricity is used by the vehicles, the associated emissions shall be estimated in accordance with paragraphs of category I.Dò

Non regenerative braking (rheostatic braking) as in Kolkata metro is selected as the baseline scenario and in the absence of the project activity the same would have been adopted since non regenerative braking system (rheostatic braking) does not face barriers) compared to the project activity.

Thus in the baseline scenario for the project activity, rolling stocks without regenerative braking system would have been used and total electricity consumption of rolling stocks would have been met from NEWNE Grid.

For the project activity, the baseline and project emissions are from the total electrical energy (kWh) consumed in running the rolling stock during the project activity. The associated emissions are estimated as follows:

ERy = BEy ī PEy ī LEy é ..(1)

Where:

ERy Emission reductions in year y (t CO2/y)-Calculated as in equation 1
BEy Baseline Emissions in year y (t CO2/y)- Calculated as in equation 2
PEy Project emissions (t CO2/y)
LEy Leakage emissions in year y (t CO2/y) ï Not applicable as per methodology used

Baseline emission and Project emissions are calculated as follows:

BEy=EGy*EFyé ..(2)
PEy=PGy*EFyé ..(2)

[16] http://cdm.unfccc.int/methodologies/DB/7DYUF4TWIPX6BHOM3EHMM8B8LIKF1M

Where,

BEy = Baseline emissions in year *y* (tCO_2).
EGy = Total electrical energy regenerated with regenerative braking in year y (MWh). The data will be monitored ex-post.
PGy = Electrical energy consumed by the operational rolling stock in year y (MWh). The data will be monitored ex-post.

Measure-2: Reduce emission per unit transported modal shift from two, three and four wheelers

Methodology: Name of the Methodology Used: ACM0016: Mass Rapid Transit Projects. The tool referenced in this methodology is given in the reference documents[17][18][19][20].

Applicability: The project constructs a new rail-based infrastructure or segregated bus lanes. In the case of rail systems the project needs to provide new infrastructure (new rail lines). The segregated bus lanes or the rail-based MRTS replace existing bus routes operating under mixed traffic conditions.

Establishment and description of baseline scenario: Baseline emissions include the emissions that would have happened due to the transportation of the passengers who use the project activity, had the project activity not been implemented. This is differentiated according to the modes of transport (relevant vehicle categories) that the passengers would have used in the absence of the project. The baseline is a continuation of the current transport system consisting of various transport modes between which the population chooses:

- NMT (Non-Motorized Traffic) with bikes and per foot;
- Private passenger car;
- Taxis;
- Motorcycles (two-wheelers);
- Motorized auto-rickshaws (used as taxis);
- Buses;
- Sub-urban rail.

Sub-urban rail does not compete with the proposed metro as it does not offer similar route destinations.

However users of the metro may potentially realize in the baseline or in the project case part of their trip on the suburban rail system. This mode is thus included as mode of transport. For all above listed transport modes the emissions per passenger kilometre (PKM) are calculated. To adjust for emission improvement under BAU, a technology improvement factor is applied.

Baseline emissions are calculated per passenger surveyed. For each passenger surveyed the individual baseline emissions are calculated and multiplied with the

[17] http://cdm.unfccc.int/methodologies/DB/8PBZENI1PK0QIJW8RJ5LEDXV6WX60O
[18] Tool for the demonstration and assessment of additionality
[19] Tool to calculate project or leakage CO2 emissions from fossil fuel combustion
[20] Tool to calculate baseline, project and/or leakage emissions from electricity consumption

individual expansion factor thus getting the baseline emissions of all passengers of the specific week surveyed.

As per DMRC[21], every passenger who chooses to use Metro instead of car/bus contributes in reduction in emissions to the extent of approximate 53 gm of carbon-di-oxide (CO_2e) for every trip of 1 km.

With above reference by DMRC carbon credits are estimated for different scenarios as follows:

S.I	Scenarios	Scenario-1	Scenario-2	Scenario-3
	Daily ride per Passenger(KM)	5	10	15
1	Daily number of Passengers	100000	100000	100000
	Carbon Credits (tCO2e/Year)	**9672.5**	**19345**	**29017.5**
2	Daily number of Passengers	200000	200000	200000
	Carbon Credits (tCO2e/Year)	**19345**	**38690**	**58035**
3	Daily number of Passengers	500000	500000	500000
	Carbon Credits (tCO2e/Year)	**48362.5**	**96725**	**145087.5**
4	Daily number of Passengers	800000	800000	800000
	Carbon Credits (tCO2e/Year)	**77380**	**154760**	**232140**
5	Daily number of Passengers	1000000	1000000	1000000
	Carbon Credits (tCO2e/Year)	**96725**	**193450**	**290175**

5.5 STEPS/METHODOLOGY TO AVAIL CARBON CREDITS

UNDER CDM

1. **CDM Prior Consideration:** The submission of the "prior consideration of the CDM" form within 6 months of the project start date is a mandatory requirement for all projects which have already started before a PDD has been published for public comments or a new methodology/revision of methodology has been proposed.

   This is considered an initial notification of the intention to seek CDM status in order to demonstrate that the benefits of the CDM were a decisive factor for taking up the project activity. It has to be submitted to the host countryôs DNA and the UNFCCC secretariat within 6 months of the project start date. All submitted notifications are published on the CDM website.
   Prior Consideration is handled by Project participant/developer and there Consultant.

2. **Project Design Document (PDD):** Project participant prepares project design document, making use of approved emissions baseline and monitoring methodology.

PROJECT DESIGN STEP IN DETAIL

Project Design Document (CDM-PDD): The project design document form was developed by the Executive Board on the basis of Appendix B of the CDM modalities and procedures. Project participants shall submit information on their proposed CDM project using the CDM-PDD form.

[21] http://cdm.unfccc.int/Projects/DB/SQS1297089762.41/view

Proposal of a new baseline and/or monitoring methodology: The proposed new baseline methodology shall be submitted by the designated operational entity to the Executive Board for review and approval, prior to validation and submission for registration of the project.

Use of an approved methodology: An approved methodology is a methodology previously approved by the Executive Board and made publicly available along with any relevant guidance. When an approved methodology is used, the designated operational entity may proceed with the validation of the CDM project activity and submit the CDM-PDD with a request for registration.

Project Design Handled by Project Developer and Consultant

3. **National approval – Host Country Approval (HCA):**Project participant secures letter of approval from Party.

The Designated National Authority (DNA) of a Party involved in a proposed CDM project activity shall submit a letter indicating the following:

- That the country has ratified the Kyoto Protocol.
- That participation is voluntary.
- And, from host parties, a statement that the proposed CDM project activity contributes to sustainable development

National approval Handled by Designated National Authority. In India MoEF is DNA.

4. **Validation or CDM Audit: Project** design document is validated by accredited designated operational entity (DOE), private third-party certifier.

Validation is the process of independent evaluation of a project activity by a designated operational entity against the requirements of the CDM as set out in CDM modalities and procedures and relevant decisions of the Kyoto Protocol Parties and the CDM Executive Board, on the basis of the project design document.

Validation Handled by Designated Operational Entity.

5. Registration

Valid project submitted by DOE to CDM Executive Board(EB) with request for registration. Registration is the formal acceptance by the Executive Board of a validated project as CDM project activity. Registration is the prerequisite for the verification, certification and issuance of CERs related to that project activity.

REGISTRATION STEP IN DETAIL

- Completeness check by secretariat
- Vetting by secretariat
- Vetting by Executive Board
- If a Party or three members of Executive Board request review, project undergoes review, otherwise proceeds to registration

Registration Handled by CDM Executive Board.

6. Monitoring

Designated operational entity verifies that emission reductions took place, in the amount claimed, according to approved monitoring plan. Verification is the independent review and ex post determination by the designated operational entity of the monitored reductions in anthropogenic emissions by sources of greenhouse gases that have occurred as a result of a registered CDM project activity during the verification period. Certification is the written assurance by the designated operational entity that, during the specified period, the project activity achieved the emission reductions as verified.

Monitoring Handled by Project Developer and Consultant

7. CER issuance Handled by Executive Board

Designated operational entity submits verification report with request for issuance to CDM Executive Board.

CER ISSUANCE STEP IN DETAIL

- Completeness check by secretariat
- Vetting by secretariat
- Vetting by Executive Board
- If a Party or three members of Executive Board request review, issuance request undergoes review, otherwise proceeds to issuance

CER issuance Handled by Executive Board

UNDER VCS

Select a methodology applicable to the proposed project: This can either be an existing VCS methodology or one developed under an approved GHG program such as the Clean Development Mechanism (CDM). Following links provide details about methodologies that can be used while developing VCS projects:

- http://www.v-c-s.org/methodologies/find
- http://cdm.unfccc.int/methodologies/index.html
- http://www.climateactionreserve.org/how/protocols/

If a current methodology does not fit, project developers can choose to develop their own methodology through the VCS methodology approval process.

This Step is managed by project developer and its consultant.
List on the Project Pipeline: a section of the VCS Project Database where forthcoming projects must be listed to begin the validation process. Project pipelines can be assessed through following link.

- http://www.v-c-s.org/Project_Pipeline

Contract an approved validation/verification body (VVB): VVB to validate a complete project description. This process determines whether a project meets all VCS rules and requirements. Validation/Verification body can be accessed through following Link.

- http://www.v-c-s.org/verification-validation/find-vvb

Document all measured GHG emission reductions or removals in a monitoring report and have it verified by an approved VVB.
This Step is handled by VVB

Submit all required project documents to a VCS registry operator: Projects can register upon validation or wait until they are ready to issue credits. VCS registry operator can be viewed through following links:

- http://www.v-c-s.org/develop-project/register-projects

This Step is managed by project developer and its consultant.

Request issuance of VCUs: Once VCUs are deposited; the credits can be held, transferred or retired.

This Step is managed by project developer and its consultant.

UNDER GS

STEP-1: IDENTIFY SUITABLE RENEWABLE ENERGY/ENERGY EFFICIENT PROJECT

Assess project eligibility for The Gold Standard as only projects focusing on renewable energy, end-use energy efficiency and/or waste management can apply for Gold Standard certification.

STEP-2: OPEN REGISTRY ACCOUNT

Go to The Gold Standard Registry and open an account. The Gold Standard Registry is a web-based software application that serves as the tracking tool and administration tool for both Gold Standard UNFCCC and VER projects.

STEP-3: LOCAL STAKEHOLDER CONSULTATION

Start writing your Gold Standard Passport, which is the document that presents all required information using The Gold Standardôs fixed template. Draft a non-technical summary explaining the project in laymenôs terms, which must be used when sending out invitations for the Local Stakeholder Consultation.

Start planning the Local Stakeholder Consultation (LSC) process, assessing the potential environmental and socials impacts of the project with relevant (local) stakeholders including NGOs, policymakers and local residents. The consultation sessions takes place in two rounds. The first round is a face-to-face meeting to introduce and explain the project to the local community and collect feedback, comments and concerns. For those who are unable to attend the physical meeting, feedback can also be submitted online. The second round is a follow-up from the first consultation; it does not have to include a physical meeting if everyone has access to, and is able to read, the documentation.

STEP-4: FINAL PROJECT DESIGN DOCUMENTATION

Write up the Local Stakeholder Consultation Report using The Gold Standard template and submit to The Gold Standard via the registry. Once the GS Secretariat deems the report acceptable, the project will be made publicly available in the registry and referred to as an official õlistedô GS applicant. For further information regarding project review timelines please click here.

Write up the Project Design Document (PDD), which provides information focusing on the project design and the application of the selected baseline and monitoring methodology to calculate emission reductions. It is the primary means to communicate about the emission reductions for the host country approval (if required), validation and registration process. Also, revise The Gold Standard Passport based on feedback and comments received during the Local Stakeholder Consultation.

STEP-5: STAKEHOLDER FEEDBACK AND PROJECT IMPLEMENTATION

Carry out the second round of consultation, called the Stakeholder Feedback Round (SFR), in order to show stakeholders how their comments from the first consultation were taken into account, as well as offering a second chance to make additional comments. During the Stakeholder Feedback Round, the LSC Report, the PDD and The Gold Standard Passport must be made publicly available for comments for a 60-day period.

STEP-6: INDEPENDANT AUDITOR (DOE) REVIEWS & VALIDATES PROJECT

Contact an independent UN-accredited auditor (e.g. DOE) to review and to validate the project activity. The validation may start in parallel with the Stakeholder Feedback Round, as long as all comments from the Stakeholder Feedback Round are incorporated into the final validated project documentation and the feedback rounds end before validation completion.

STEP-7: GS REVIEWS AUDIT BEFORE PROJECT REGISTRATION

Following the project validation, the validated PDD, Passport and other relevant project documents plus the validation report must be uploaded into the registry. The Gold Standard Secretariat, the Technical Advisory Committee, and The Gold Standard NGO Supporters then conduct a final document review before the project becomes registered. For more information regarding The Gold Standard project review timelines click here.

STEP-8: GS EXTERNAL (DOE) VERIFICATION

An independent UN-accredited auditor (DOE/AIE) verifies the projectõs emission reductions and sustainable development monitoring activities.

STEP-9: GS REVIEWS VERIFICATION BEFORE ISSUANCE OF CREDITS

Following the project verification, the verified PDD, Passport and other relevant project documents plus the verification report must be uploaded into the registry. The Gold

Standard Secretariat, the Technical Advisory Committee, and The Gold Standard NGO Supporters then conduct a final document review before the project may issue credits. Information regarding the project review timelines can be located here.

Glossary of Terms and Explanation of Important Terms are given by **Appendix-5.1**. The Baseline emission factor-Combined margin emissions factor is given in **Appendix-5.2.** The references used in the Carbon Credit are given in **Appendix-5.3.**

5.6 CHECKLIST OF IMPACTS

The impact evaluation determines whether a project development alternative is in compliance with existing standards and regulations. It uses acceptable procedures and attempts to develop a numeric value for total environmental impact. A transformation of the review of multiple environmental objectives into a single value or a ranking or projects is the final step in impact assessment. There are about numerous methods for carrying out impact assessment, which can be grouped into the following categories:

- Ad ï hoc method,
- Checklist,
- Matrix,
- Network,
- Overlays,
- Environmental Index and
- Cost Benefit analysis.

Each of the methods is subjective in nature and none of these is applicable in every case. Of the 7 methods listed above, checklist has been used and presented.

Checklist is a list of environmental parameters or impact indicators which encourages the environmentalist to consider and identify the potential impacts. A typical checklist identifying anticipated environmental impacts is shown in **Table 5.4**.

TABLE 5.4
CHECKLIST OF IMPACTS

S. No.	Parameter	Negative Impact	No Impact	Positive Impact
A.	**Impacts due to Project Location**			
i.	Displacement of People	*		
ii.	Change of Land use	*		
iii.	Loss of Trees	*		
iv.	Loss of Cultural and Historical Structures		*	
v.	Drainage & Utilities Problems	*		
vi.	Impact on Local Transport			*

S. No.	Parameter	Negative Impact	No Impact	Positive Impact
	Utilities			
B.	**Impact due to Project Design**			
i.	Platforms - Inlets and Outlets		*	
ii.	Ventilation and Lighting		*	
iii.	Railway Station Refuse	*		
iv.	Risk due to Earthquakes		*	
C.	**Impact due to Project Construction**			
i.	Soil Erosion	*		
ii.	Traffic Diversions	*		
iii.	Air Pollution	*		
iv.	Noise Pollution	*		
v.	Impact due to Vibration		*	
vi.	Health risk at construction site	*		
vii.	Impact on Sensitive Receptors		*	
viii.	Problem of excavated soil disposal	*		
ix.	Dust Generation	*		
x.	Problems of Soil Disposal	*		
xi.	Labour Camp	*		
D.	**Impact due to Project Operation**			
i.	Noise & Vibration	*		
ii.	Water Demands	*		
iii.	Refuse disposal and sanitation	*		
iv.	Employment Opportunities			*
v.	Benefit to Economy			*
vi.	Mobility			*
vii.	Safety			*
viii.	Traffic Congestion Reduction			*
ix.	Less fuel Consumption			*
x.	Reduced Air Pollution			*
xi.	Carbon dioxide Reduction			*
xii.	Traffic Noise Reduction			*
xiii.	Reduction in Buses			*
xiv.	Reduction in Infrastructure			*

Appendix-5.1

Glossary of Terms and Explanation of Important Terms

Project Activity Design: The Guidelines for completing the CDM-PDDs and the Glossary of CDM Terms have been developed by the Executive Board on the basis of the CDM modalities and procedures and the subsequent decisions by the Board. Project participants shall submit information on their proposed CDM project activity using a Project design document (CDM-PDD).

Notification of CDM prior consideration: The submission of the "prior consideration of the CDM" form within 6 months of the project start date is a mandatory requirement for all projects which have already started before a PDD has been published for public comments or a new methodology/revision of methodology has been proposed.

Proposal of a New Baseline and/ or Monitoring Methodology: The new baseline methodology shall be submitted by a designated operational entity (DOE) to the CDM Executive Board for review, prior to a validation and submission for registration of this project activity, with the draft project design document (CDM-PDD), including a description of the project and identification of the project participants.

Use of an Approved Methodology: The approved methodology is a methodology previously approved by the Executive Board and made publicly available along with any relevant guidance. In case of approved methodologies the designated operational entities may proceed with the validation of the CDM project activity and submit project design document (CDM-PDD) for registration.

Validation of the CDM project activity: Validation is the process of independent evaluation of a CDM project activity or Programm of activities (PoA) by a DOE against the requirements of the CDM rules and requirements, on the basis of the PDD (or PoA-DD and CPA-DDs).

Registration of the CDM project activity: Registration is the formal acceptance by the Executive Board of a validated project as a CDM project activity. Registration is the prerequisite for the verification, certification and issuance of CERs related to that project activity.

Certification/ Verification of the CDM project activity: Verification is the periodic independent review and ex post determination by the designated operational entity of the monitored reductions in anthropogenic emissions by sources of greenhouse gases that have occurred as a result of a registered CDM project activity during the verification period. Certification is the written assurance by the designated operational entity that, during a specified time period, a project activity achieved the reductions in anthropogenic emissions by sources of greenhouse gases as verified.

Issuance of CERs: Issuance is the instruction by the CDM Executive Board to the CDM Registry Administrator to issue a specified quantity of CERs, lCERs, or tCERs for a project activity or PoA, as applicable, into the pending account of the Board in the CDM registry, for subsequent distribution to accounts of project participants in accordance with the CDM rules and requirements.

Designated National Authority (DNA): Parties participating in the CDM are required to designate a national authority for the CDM. This could be a Ministry of Environment or an Agency or any other government authority. In India Ministry of forest and Environment (MoEF) is DNA.

Project Participants: A Party or a private and/or public entity authorized by a Party to participate in a CDM project activity. The Party remains responsible for the fulfilment of its

obligations under the Protocol and shall ensure that such participation is consistent with the modalities and procedures for CDM.

CDM Executive Board: The CDM is overseen by the CDM Executive Board, which ultimately reports to the Conference of the Parties serving as the Meeting of the Parties to the Kyoto Protocol that comprises countries that have ratified the Kyoto Protocol.

Designated Operational Entity: Emission reductions resulting from each project activity shall be certified by operational entities on the basis of:

a) Voluntary participation approved by each Party involved;

b) Real, measurable, and long-term benefits related to the mitigation of climate change; and

c) Reductions in emissions that are additional to any that would occur in the absence of the certified project activity.

Designated Operational Entities (DOE) are third party certifiers designated by the Conference of the Parties serving as the meeting of the Parties to the Kyoto Protocol based on a recommendation from the CDM EB who is responsible for their accreditation.

The main functions of a designated operational entity are:

(a) Validating proposed CDM project activities;

(b) Verifying and certifying reductions in anthropogenic emissions by sources of greenhouse gases;

The DOE must demonstrate that it, and its subcontractors, have no real or potential conflict of interest with the participants in the CDM project activities for which it has been selected to carry out validation or verification and certification functions. It must perform one of the following functions relating to a given CDM project activity: validation or verification and certification.

Upon request, the Executive Board may, however, allow a single designated operational entity to perform all these functions within a single CDM project activity.

Appendix-5.2

Baseline emission factor-Combined margin emissions factor

As per Para 12 of the baseline methodology, AMS-I.D (Version 17), Ătthe emission factor can be calculated in a transparent and conservative manner as follows:

(a) A combined margin (CM), consisting of the combination of operating margin (OM) and build margin (BM) according to the procedures prescribed in the ñTool to calculate the Emission Factor for an electricity systemò;

OR

(b) The weighted average emissions (in t CO2/MWh) of the current generation mix. The data of the year in which project generation occurs must be used.
Calculations shall be based on data from an official source (where available) and made publicly available.

The following information has been used for the calculation of baseline emissions:

Step 1: Identify the relevant electric power system

The Indian power grid consists of two well defined grids, namely Northern, Western, Eastern and North-Eastern grid (NEWNE) and southern grid. The ñAhmadabad Metro Projectò is in the NEWNE Regional grid of the Indian Power grid system. Therefore, NEWNE grid has been identified as the relevant electric power system.

Step 2: Select an operating margin (OM) method

The calculation of the operating margin emission factor ($EF_{grid, OM,y}$) is based on one of the following methods:
(a) Simple OM, or
(b) Simple adjusted OM, or
(c) Dispatch data analysis OM, or
(d) Average OM.

Any of the four methods can be used, however, the simple OM method (option a) can only be used if low-cost/must-run resources constitute less than 50% of total grid generation in: 1) average of the five most recent years, or 2) based on long-term averages for hydroelectricity production.

As per the latest version of CEA data, the share of generation from low- cost must-run plants is as under:

Year	2007-08	2008-09	2009-10	2010-11	2011-12
NEWNE	19.0%	17.4%	15.9%	17.6%	19.2%

It is clearly evident that the share of low -cost must-run plants is throughout less than 50%, therefore Simple OM method can be used to calculate the operating margin emission factor.

Step 3. Calculate the operating margin emission factor according to the selected method

The simple OM emission factor is calculated as the generation-weighted average CO2 emissions per unit net electricity generation (tCO2e/MWh) of all generating power plants serving the system, not including low-cost / must-run power plants / units. It may be calculated:

Based on data on fuel consumption and net electricity generation of each power plant / unit (Option A), or

Based on data on net electricity generation, the average efficiency of each power unit and the fuel type(s) used in each power unit (Option B), or
Based on data on the total net electricity generation of all power plants serving the system and the fuel types and total fuel consumption of the project electricity system (option C)

Option A has been used to calculate the simple OM of the southern grid, due to the type of data available. The latest version of the data published by CEA has been considered for all the calculations and the results for last three years are as under:

Year	2009 – 10	2010 – 11	2011 – 12
Simple Operating Margin (tCO2/MWh) including imports	0.9777	0.9707	0.9688
Net generation (GWh) including imports	4,58,043.0846	4,76,986.7213	4,58,043.08456
Generation-weighted OM	0.9724		

Step 4: Identify the cohort of power units to be included in the build margin

The sample group of power units*m* used to calculate the build margin consists of either:

(a) The set of five power units that have been built most recently, or

(b) The set of power capacity additions in the electricity system that comprise 20% of the system generation (in MWh) and that have been built most recently.

As per the latest version of the CEA data, set of power capacity additions in the electricity system that comprise 20% of the system generation (in MWh) and that have been built most recently, constitutes the larger annual generation.

Step 5: Calculate the build margin emission factor

The Latest (based on the available data at the time of submission of the PDD) generation-weighted average emission factor ($tCO2_e$/MWh) of all power units m during the most recent year 2011-12 for the Northern grid is

Year	2011- 2012
Build Margin (tCO2/MWh)	0.9164

Step 6: Calculate the combined margin emissions factor
The combined margin emissions factor is calculated as follows:

$EFy = w_{OM} * EF_{OM,y} + w_{BM} * EF_{BM,y}$

Particulars	Details	Remarks
Operating margin (tCO2/MWh)	0.972	-
Build Margin (tCO2/MWh)	0.916	-
EF_y Combined Margin (tCO2/MWh)	0.944	Weighted Average considering 50:50 weightage on OM & BM respectively

Appendix-5.3

References

1. http://unfccc.int/2860.php
2. http://cdm.unfccc.int/
3. http://www.goldstandard.org/
4. http://www.v-c-s.org/
5. http://www.cdmindia.gov.in/
6. http://www.delhimetrorail.com/

CHAPTER - 6
ENVIRONMENTAL MANAGEMENT PLAN

6.1 APPROVALS/CLEARANCES REQUIREMENT

On the basis of baseline study and impacts, issues like tree cutting, development near Archaeological Monuments and muck disposal etc needs necessary approvals/clearance from the relevant concerned authorities. PMU will ensure that all necessary approvals/clearances are in place before implementation. Before commencement of the construction the necessary permission required for the project is given in **Table 6.1**.

TABLE 6.1
NECESSARY APPROVALS/CLEARANCES REQUIREMENT

S. No	Issues	Provision of Laws & Regulations	Due Date	Approving Authority	Remarks
Pre-Construction Stage					
1.	Permission for felling of trees	Tree removal will be guided as per state government rules.	Before Construction	The Park and Garden Department of Ahmedabad Municipal Corporation (AMC)/Western Railway	
2.	Construction within the regulated area of Archaeological Monuments	The Ancient Monuments and Archaeological Sites and Remains (Amendment and Validation) Act, 2010	Before Construction	Director - General Archaeological Survey of India	NOC Form Enclosed at Appendix 6.1
Implementation Stage					
3.	Consent to operate hot mix plant, crushers, batching plant	Air (Prevention and Control of Pollution) Act 1981	Before Construction	Gujarat State Pollution Control Board	Form Enclosed at Appendix 6.2
4.	Permission for withdrawal of groundwater for construction	Environment (Protection) Act, 1986	Before Construction	Regional Director, Central Ground Water Board	Form Enclosed at Appendix 6.3
5.	Authorization for Disposal of Hazardous Waste	Hazardous Waste (Management and Handling and transboundary movement) Rules 2008	Before Construction	Gujarat State Pollution Control Board	Form Enclosed at Appendix 6.4
6.	Consent for disposal of sewage from labour camps.	Water (Prevention and Control of Pollution) Act	Before Construction	Gujarat State Pollution Control Board	Form Enclosed at Appendix 6.5

S. No	Issues	Provision of Laws & Regulations	Due Date	Approving Authority	Remarks
		1974			
7.	Employing Labour/ workers	The Building and Other Construction Workers (Regulation of Employment and Conditions of Service) Act, 1996	Before Construction	District Labor Commissioner	
8.	Muck disposal permission	Environment Protection Act	Before Construction	State Pollution Control Board/ MoEF (Govt. Of India) and Urban Development and Urban housing department of Government of Gujarat	
Operation Stage					
9.	Consent to Operate	Environment Protection Act	After Construction	State Pollution Control Board (Gujarat Pollution Control Board)	
10.	Installation of DG Sets and discharge of Wastewater from Depot.	Air Consent and Water Consent under Air Act and Water Act	After construction	Gujarat Pollution Control Board	Appendix 6.2 & Appendix 6.5

6.2 MANAGEMENT PLANS

The Ahmedabad Metro Rail Project will provide employment opportunity, quick mobility service and safety, traffic de-congestion, less fuel consumption and reduced air pollution during operation phase on one hand; and problems of muck disposal, traffic diversion, utility dislocation etc. on the other hand during construction of the project.

Protection, preservation and conservation of environment have always been a primary consideration in Indian ethos, culture and traditions. Management of Environment by provision of necessary safeguards in planning stage of the project itself can lead to reduction of adverse impacts due to a project. This chapter, therefore, spells out the set of measures to be taken during project construction and operation to mitigate or bring down the adverse environmental impacts to acceptable levels based on the proposed Environmental Management Plan (EMP).

The most reliable way to ensure that the management plan will be integrated into the overall project planning and implementation to establish the plan as a component of the project. This will ensure that it receives funding and supervision along with the other investment components. For optimal integration of EMP into the project, there should be investment links for:

- Funding,
- Management and training, and
- Monitoring.

The purpose of the first link is to ensure that proposed actions are adequately financed. The second link helps in embedding training, technical assistance, staffing and other institutional strengthening items in the mitigation measures to implement the overall management plan. The third link provides a critical path for implementation and enables sponsors and the funding agency to evaluate the success of mitigation measures as part of project supervision, and as a means to improve future projects. This chapter has been divided into three sections:

- Mitigation measures,
- Disaster management, and
- Emergency measures.

For every issue discussed for above measures, the implementing agency as well as staffing, equipment, phasing and budgeting have been presented as far as possible. All required funds will be channeled through the project authority. The Environmental Management Plans have been prepared and discussed in subsequent sections.

6.3 MITIGATION MEASURES

The main aim of mitigation measures is to protect and enhance the existing environment of the project. This section includes measures for:

- Compensatory Afforestation,
- Construction Material Management,
- Safety Management Measures during the construction period
- Labour Camp,
- Energy Management,
- Hazardous Waste Management,
- Environmental Sanitation,
- Utility Plan,
- Archaeological and Historical Preservation,
- Air Pollution Control Measures,
- Noise Control Measures,
- Vibration Control Measures,

- Traffic Diversion/Management,
- Soil Erosion Control,
- Muck Disposal,
- Draining of Water from Tunnel,
- Water Supply, Sanitation and Solid Waste Management,
- Sensitive Receptors
- Management Plans for Depot,
- Training and Extension, and
- Environmental Enhancement Measures.

6.3.1 Compensatory Afforestation

A) Afforestation

The objective of the afforestation program should be to develop natural areas in which ecological functions could be maintained on a sustainable basis. The Park and Garden Department of Ahmedabad Municipal Corporation (AMC), Gujarat is responsible for the tree cutting in the project area except trees which are falling under existing Railway corridor on North-South alignment. The permission of tree cutting for trees falling under existing Railway corridor is given by Railway Authority. An application along with the location map of trees to be removed should be submitted to the concerned Departments for permission. As mentioned in section 3.6.2 about 1638 trees are observed at alignment and Depot locations. The detail of tree likely to be removed or transplanted is given in the **Table 6.2**.

TABLE 6.2
DETAILS OF TREES CUT AND TRANSPLANTATION

Sr. No	Particulars	Number of Trees observed	Number of trees to be cut	Number of trees to be Transplanted	Remarks
1	Along Alignment	1391	274 (20%)	1117 (80%)	(Stations, Alignment Metro corridor)
2	Depot	247	122 (50%)	25 (10%)	40% (i.e 100) trees in depot area will remain as where it is.
	Total	**1638**	**396**	**1142**	

The number of trees to be transplanted depends on the site condition and root condition & health of tree. More stress should have been given for transplantation of the tree rather than removal. The trees which are not possible to transplant will only be cut. The trees which are cut will be compensated by planting ten times the number of trees. As per estimation, 396 trees are likely to be cut for which 3960 trees are required to be planted. The compensation for loss of these trees works out to Rs. 87.12 Lakhs @ Rs. 2200 per tree.The total area required for afforestation of these trees comes out to about 6.34 ha. It is presumed that Government land will be provided for afforestation; hence no land cost will be involved. Land for plantation of trees will be identified by the project proponent in consultation with AMC/Forest Department of State Government. The native plant species

recommended for afforestation by Park & Garden Department with their botanical names to be planted are indicated in the **Table 6.3**.

TABLE 6.3
SCIENTIFIC NAMES OF TREE FOR PLANTATION

S. No	Local Name	Botanical Name
1	Gulmohar	*Delonix regia*
2	Neem	*Azadirachta indica*
3	Ashoka	*Saraca asoca*
4	Jamun	*Syzygium cumini*
5	Desi Badam	*Terminalia catappa*
6	Pongam	*Millettia Pinnata*
7	Karanj	*Pongamia pinnata*

B) Transplantation

The trees recommendation for transplantation will be transplanted in the nearby open area while transplantation of trees from the depot area will be done within the Depot boundary area or in the nearby available municipal area. The structural component of depot should be planned in such a way that about 40% of the trees will get saved. The management plan for transplantation of trees is summarized below:

- Preliminary root investigation should be carried out,
- Health diagnosis of the tree should be carried out for treating infected trees,
- Soil condition where the tree has to be transplanted is thoroughly checked & necessary treatments are applied to the soil after digging a pit,
- The pit size has to be kept in accordance with the root ball of the tree,
- Packing material should be strong enough to hold the soil around the root zone,
- Crane should be used to lift the packed tree and a trolley or truck should be used to transport the tree,
- Timely feeding of the plant should be done with soluble fertilizers and watering,
- JCB should be used for digging pits,
- There should be regular monitoring for fertilizer schedules and the chemicals like insecticides and pesticides.
- Scaffolding should be used wherever required to support the trees,
- Any broken stems during transplantation should be removed cautiously.

After transplantation, there are chances of external infections to the tree which needs maintenance for at least 2-3 months. The cost towards transplantation of trees varies with its girth. An average girth of 1 metre has been taken for the cost estimation. The cost for transplanting 1142 number of trees is about **Rs. 571 Lakh** @ Rs. 50,000/- per tree. The cost i.e Rs. 50,000/- for one tree transplantation is including lead of 1.5 km with all tools, testing, man & machinery, necessary preparation and maintenance.

6.3.2 Construction Material Management

The construction material to be used are coarse aggregates, cement, coarse sand, reinforcement steel, structural steel, water supply, drainage and sanitary fittings etc. The material will be loaded and unloaded by engaging labour at both the locations by the contractor.

The duties of the contractor will include monitoring all aspects of construction activities, commencing with the storing, loading of construction materials and equipment in order to maintain the quality. During the construction period, the construction material storage site is to be regularly inspected for the presence of uncontrolled construction waste. Close liaison with the MEGA Officer and the head of the construction crew will be required to address any environmental issues and to set up procedures for mitigating impacts. The scheduling of material procurement and transport shall be linked with construction schedule of the project. The Contractor shall be responsible for management of such construction material during entire construction period of the project. Sufficient quantity of materials should be available before starting the each activity. The contractor should test all the materials in the Government labs or Government approved labs in order to ensure the quality of materials before construction. This is also the responsibility of the contractor, which would be clearly mentioned in the contractorõs agreement.

6.3.3 Safety Management Measures

Prior to the construction, identification of safety hazard would be made by Project Authority to establish the safety programmes following rules, regulations and guidelines. These would help to avoid and reduce the accidents. The comprehensive safety programmes will include deployment of a full time safety engineer who will prepare safety plan/schedule for their implementation during construction and operation. The personnel working would wear protective headgear, footwear and other special garments that applicable code requires. The specific working areas in underground construction can have their own unique hazards that personnel requires to be made aware of by providing training and displaying the instruction wherever it requires. The weatherproof first aid boxes will be made available at appropriate locations. The emergency measures include tunnel evacuation plan and procedures independent of the tunnel power supply. The tunnel will be provided with mechanically induced reversible flow primary ventilation for all work areas. Detailed instructions will be followed for handling and storage of explosives to be used in controlled blasting if any.

6.3.4 Labour Camp

The Contractor during the progress of work will provide, erect and maintain necessary (temporary) living accommodation and ancillary facilities for labour to standards and scales approved by the MEGA. All temporary accommodation must be constructed and maintained in such a fashion that uncontaminated water is available for drinking, cooking and washing. Safe drinking water should be provided to the dwellers of the construction camps. Adequate washing and bathing places shall be provided, and kept in clean and drained condition. Construction camps are to be the responsibility of the concerned contractors and these shall not be allowed in the construction areas but sited away. Adequate health care is to be provided for the work force. The labour camps cleanliness and workerõs hygiene will be monitored as a part of Labour Laws of the Country during

construction of proposed project. Deployment of labour at the construction site will be made by following the fairer process as mentioned in civil contract agreement.

Shelter at Workplace: At every workplace, shelter shall be provided free of cost, separately for use of men and women labourers. The height of shelter shall not be less than 3m from floor level to lowest part of the roof. Sheds shall be kept clean and the space provided shall be on the basis of at least 0.5m^2 per head.

Canteen Facilities: A cooked food canteen on a moderate scale shall be provided for the benefit of workers wherever it is considered necessary. The contractor shall conform generally to sanitary requirements of local medical, health and municipal authorities and at all times adopt such precautions as may be necessary to prevent soil pollution of the site.

First aid facilities: At every workplace, a readily available first-aid unit will be provided. Suitable transport will be provided to facilitate transportation of injured and ill persons to the nearest hospital. Construction contractor will provide health check-up camps for construction workers at least once in a month.

Day Crèche Facilities: At every construction site, provision of a day crèche shall be worked out so as to enable women to leave behind their children. At construction sites, where the number of women workers is more than 25 but less than 50, the contractor shall provide with at least one hut and one maidservant to look after the children of women workers. Size of crèches shall vary according to the number of women workers employed. Huts shall not be constructed to a standard lower than that of thatched roof, mud walls and floor with wooden planks spread over mud floor and covered with matting. Huts shall be provided with suitable and sufficient openings for light and ventilation. There shall be adequate provision of sweepers to keep the places clean. There shall be two maidservants (or aayas) to the satisfaction of local medical, health, municipal or cantonment authorities.

Prevention of Infectious Diseases: Construction workers are more prone to Infectious diseases such as HIV/AIDS. It should be prevented by following actions as depicted below:

- One-one interactions ï helps to build confidence,
- Counselling- addressing the myths and misconceptions,
- Community events-street theatre, puppetry, cultural programs are proven communication tools to the illiterate community to message dissemination,
- STD clinic - early identification through testing,
- Condom promotion- encouraging condom usage, an accessible place, made available at all times and free distribution.

- Advertisement board at appropriate location will be put to make aware about the infectious diseases.
- Co-ordination with State Aids Control Society and Health Department

Sanitation Facilities: Construction camps shall be provided with sanitary latrines and urinals. Drains for waste water should be provided for the flow of used water outside the camp. Drains and ditches should be treated with bleaching powder on a regular basis. The sewage system for the camp must be properly designed, built and operated so that no health hazard occurs and no pollution to the air, ground or adjacent watercourses takes place. Compliance with the relevant legislation must be strictly adhered to. Garbage bins must be provided in the camp and regularly emptied and the garbage disposed off in a hygienic manner.

Water Supply and Waste water Treatment Facility for Workers Camps: It is estimated that about 63 KLD water will be required daily for the camps, which will be taken from bore well/Municipal Water Supply. Bore well water will be chlorinated for use as drinking water. About 80% of the water supply will be generated as sewage/waste water, which needs to be treated before disposal or may be connected to nearby sewerage network.

As per the Contract Labour (Regulation & Abolition) Act, 1970, there shall be at least one latrine for every 25 male. The sewage from the community water closet would be treated through septic tank and disposed off through soak pits. The drinking water facilities and sewage disposal sites should be located away from each other. A provision of **Rs. 14.40 Lakh** would be made for these facilities as reported in **Table 6.4**.

TABLE 6.4
COST OF WATER SUPPLY AND SANITATION FACILITIES

S.INo	Description	Rate (Rs/Unit)	Numbers	Cost (Lakh)
1	Water Treatment & Supply Facilities	1,50,000	4	6.00
2	Community water closet	25,000	20	5.00
3	Septic Tank & Soak pit including connection	85,000	4	3.40
			Total	**14.40**

Solid Waste Management

It is estimated that about 315 Kg per day municipal solid waste will be generated from the labour camp. The collection, conveyance and disposal facilities shall be made available by providing 20 litres capacity bin with handle and cover for 8 workers. In addition, one community bins would be provided for effective collection of the waste. The disposal of the waste will be at municipal corporation landfill site. The cost of these facilities including maintenance for 5 years works out to be about **Rs. 32.72 Lakh** as summarized in **Table 6.5.**

TABLE 6.5
COST OF DOMESTIC SOLID WASTE MANAGEMENT FACILITIES

Sl	Description	Numbers	Rate (Rs/Unit)	Cost (Lakh)
1	Solid waste collection bins @ Rs. 200/bin Community bin 4 no. @ Rs. 15,000/bin	60 4	200 15000	 0.72
2	Transportation	-	Lump sum	20.00
3	Manpower cost of 3 persons @ 5000 per person per year for 5 years	4	4x60x6,000	12.00
			Total	**32.72**

6.3.5 Energy Management

Energy conservation measures are often the easiest, quickest and cheapest way to reduce costs and implement environmentally pro-active Energy conservation program both on energy demand and supply. The contractor shall use and maintain equipment so as to conserve energy and shall be able to produce demonstrable evidence of the same upon MEGA request.

Measures to conserve energy include but not limited to the following:

- Use of energy efficient motors and pumps,
- Use of energy efficient lighting,
- Adequate and uniform illumination level at construction sites suitable for the task,
- Proper size and length of cables/ wires to match the rating of equipment, and
- Use of energy efficient air conditioner.

The contractor shall design site offices for maximum daylight and minimum heat gain. The rooms shall be well insulated to enhance the efficiency of air conditioners and the use of solar films on windows may be used where feasible.

6.3.6 Hazardous Waste Management

Hazardous Waste needs to be stored at a secured place. It shall be the responsibility of the contractor to ensure that hazardous wastes are stored, based on the composition, in a manner suitable for handling, storage and transport. The contractor shall identify the nature and quantity of hazardous waste generated as a result of the project activities. Hazardous Waste will be handled and disposed as per the Hazardous waste (M& H) Rules, 2008 and shall be authorized with Gujarat Pollution Control Board (GPCB). Outside the storage area, the contractor shall place a ódisplay boardô which will display quantity and nature of hazardous waste. The labeling and packaging is required to be easily visible and be able to withstand physical conditions and climatic factors. The contractor shall approach only Authorized Recyclers with GPCB for disposal of Hazardous Waste, under intimation to the MEGA.

6.3.7 Environmental Safeguard

Environmental sanitation also referred to as Housekeeping, is the act of keeping the working environment cleared of all unnecessary waste, thereby providing a first-line of defense against accidents and injuries. Contractor shall understand and accept that

improper environmental sanitation is the primary hazard at any construction site and ensure that a high degree of environmental sanitation is always maintained. Environmental sanitation is the responsibility of all site personnel, and line management commitment shall be demonstrated by the continued efforts of supervising staff towards this activity.

General environmental sanitation shall be carried out by the contractor to ensure for good environmental sanitation at Work Site, Construction Depot, Batching Plant, Labour Camp, Stores, Offices and toilets/urinals. Towards this the Contractor shall constitute a special group of environmental sanitation personnel. This group shall ensure daily cleaning at work sites and surrounding areas and maintain a register as per the approved format by the MEGA.

Team of environmental sanitation squad shall carry out:

- Full height fence, barriers, barricades etc. shall be erected around the site in order to prevent the surrounding area from excavated soil, rubbish etc, which may cause inconvenience and endanger to the public. The barricade especially those exposed to public shall be aesthetically maintained by regular cleaning and painting as directed by the Employer. These shall be maintained in one line and level.

- The structural dimension of the barricade, material and composition, its colour scheme, MEGA logo and other details.

- All stairways, passageways and gangways shall be maintained without any blockages or obstructions. All emergency exits passageways, exit fire doors, break-glass alarm points, fire-fighting equipment, first aid stations, and other emergency stations shall be kept clean, unobstructed and in good working order.

- All surplus earth and debris are removed/disposed off from the working areas to officially designated dump sites. Trucks carrying sand, earth and any pulverized materials etc. shall be covered while moving in order to avoid dust or odour impact.
- No parking of trucks/trolleys, cranes and trailers etc. shall be allowed on roads, which may obstruct the traffic movement.

- Roads shall be kept clear and free movement of road traffic shall not be obstructed by placing materials like pipes, steel, sand, boulders, concrete, chips and brick etc on the roads.

- Water logging on roads shall not be allowed.

- Turbid water from construction area shall be treated by sedimentation tank as required.

- Proper and safe stacking of material is of paramount importance at yards, stores. The storage area shall be well laid out with easy access and material stored / stacked in an orderly and safe manner.
- Flammable chemicals / compressed gas cylinders shall be safely stored.

- Unused/surplus cables, steel items and steel scrap lying scattered at different places within the working areas shall be removed to pre-identified locations(s).

- All wooden scrap, empty wooden cable drums and other combustible packing materials, shall be removed from work place to pre-identified location(s).

- Empty cement bags and other packaging material shall be properly stacked and removed.

The Contractor shall ensure that all his sub-contractors maintain the site reasonably clean as per provisions related to environmental sanitation.

6.3.8 Utilities

Utilities like sewers, water mains, storm water drains, telephone cables, electrical transmission lines, electric poles, traffic signals etc. should not get affected due to the proposed metro construction. These utility services have to be maintained in working order during different stages of construction by temporary / permanent diversions or by supporting in position. As such, these may affect construction and project implementation time schedule/costs, for which necessary planning / action needs to be initiated in advance.

While planning for diversion of underground utility services e.g. sewer lines, water pipe lines, cables etc., during construction of Metro rail, the following guidelines could be adopted:

- Utility services have to be kept operational during the entire construction period and after completion of project. All proposals should therefore, ensure their uninterrupted functioning.
- Sewer lines and water supply lines are mainly affected in underground cut and cover construction. These services are proposed to be maintained by temporarily replacing them with CI/Steel pipelines and supporting them during construction, these will be encased in reinforced cement concrete after completion of construction and retained as permanent lines.
- Where permanent diversion of the affected utility is not found feasible, temporary diversion with CI/Steel pipes without manholes is proposed during construction. After completion of construction, these will be replaced with conventional pipes and manholes.
- The elevated viaduct does not pose much of a difficulty in negotiating the underground utility services, especially those running across the alignment. The utilities infringing at pier location can be easily diverted away from the pile cap location.
- In case a major utility is running along/across the alignment which cannot be diverted or the diversion of which is difficult, time consuming and uneconomical, the spanning arrangement of the viaduct and layout of piles in the foundation may be suitably adjusted to ensure that no foundation needs be constructed at the location, where utility is crossing the proposed alignment. The utility service can also be encased within the foundation piles.

The Organizations / Departments responsible for concerned utility services are reported in **Table 6.6.**

TABLE 6.6
ORGANIZATIONS RESPONSIBLE FOR UTILITIES AND SERVICES

S. No.	ORGANIZATION/ DEPARTMENT	UTILITY/SERVICES
1.	Ahmedabad Municipal Corporation	Sewerage and drainage lines. Water mains and their service lines, including hydrants and fountains etc, water treatment plants, pumping stations, Roads, surface water drains, nallahs, sewer lines, street lights, high mast lights etc.
2.	Public Works Department	Roads, surface water drains, nallahs etc.
3.	NHAI	Roads
4.	Torrent Power, UGVCL	Power cables and their appurtenances, pole mounted transformer and HT Line
5.	Bharat Sanchar Nigam Limited (BSNL), Vodafone, Idea, Bharti Airtel, Aircel, Etisalat DB Telecom, Videocon and Uninor	Telecommunication cables, junction boxes, telephone posts, O.H. lines etc.
6.	Office of Commissioner of Police, Ahmedabad	Traffic signal posts, junction boxes and cable connection etc.
7.	Gujarat State Petronet Limited (GSPL)	Gas Pipelines

6.3.9 Archaeological and Historical Structure Preservation

The proposed East West alignment is passing within the regulated area around the 7 archaeological monuments as listed in section 3.7 and Figure 3.14 of Chapter-3. No damage to Archeological Monuments is anticipated; however, during construction stage, archaeological or historical structures may get affected by construction activity. Necessary procedure will be followed for Construction within the regulated area of Archaeological Monuments from Archaeological Survey of India as per The Ancient Monuments and Archaeological Sites and Remains (Amendment and Validation) Act, 2010. The application format is enclosed at **Appendix 6.1**. Existing ground vibration studies were carried out during September 2014 at these archaeological monuments. Prior to the initiation of construction, MEGA will conduct condition survey of all historical important structures in the vicinity of alignment. This survey will help to identify the impact on the structures during construction and operation of the project. Any impact would be compensated by adequate management plan to preserve the structures. The management plan will include ground vibration monitoring during construction and operation of project.

The tunnel will be constructed by using the state of the art technology i.e. Tunnel Boring Machine which gives negligible vibration and does not affect the surrounding structure. Among the 4 underground stations along the E-W alignment, 3 stations are being constructed by cut and cover method which is widely accepted and the safest technique being adopted by metros in India and abroad. The above technology has been adopted and successfully implemented by DMRC in the Delhi while carrying out works in the regulated/prohibited areas (ASI protected monuments) as well as close to public and

private buildings and there is no damage to these structures due to the construction activities of Delhi Metro.

6.3.10 Air Pollution Control Measures

During the construction period, the impact on air quality will be mainly due to increase in Particulate Matter (PM) along haul roads and emission from vehicles and construction machinery. Though an air quality during construction shows insignificant impact, nevertheless certain mitigation measures which shall be adopted to reduce the air pollution are presented below:

- The Contractor shall take all necessary precautions to minimize fugitive dust emissions from operations involving excavation, grading, and clearing of land and disposal of waste. He shall not allow emissions of fugitive dust from any transport during handling of materials, construction or storage activity. The emission should not remain visible in atmosphere beyond the property line of emission source for any prolonged period of time without notification to the Employer.

- The Contractor shall use construction equipment to minimise or control of air pollution. He shall maintain evidence of design and equipment to make these available for inspection by Employer.

- Contractorôs transport vehicles and other equipment shall conform to emission standards fixed by Statutory Agencies of Government of India or the State Government from time to time. The Contractor shall carry out periodical checks and undertake remedial measures including replacement, if required, so as to operate within permissible norms.

- The Contractor shall use cover for materials of dust generating like debris and soil being transported from construction sites. All trucks carrying loose material should be covered and loaded with sufficient free board to avoid spills through the tailboard or sideboards.

- Contractor shall install barriers around the open construction sites before commencing the work.

- The temporary dumping areas shall be maintained by the Contractor at all times until excavated material is re-utilized for backfilling wherever necessary or as directed by Employer. Dust control activities shall continue even during any work stoppage/public holidays.

- The Contractor shall place material in a manner that will minimize dust production. Material shall be wetted each day, to minimize dust production. During dry weather,

dust control measures must be used daily especially on windy, dry days to prevent any dust from blowing across the site perimeter.

- The Contractor shall sprinkle water at construction sites to suppress dust, during handling of excavation soil or debris or during demolition. The Contractor will make water sprinklers, water supply and water delivering equipment available at any time that it is required for dust control use. Dust screens will be used, as feasible when additional dust control measures are needed especially where the work is near sensitive receptors.

- The Contractor shall provide a wash pit or a wheel washing and/or vehicle cleaning facility at the exits from work sites such as construction depots and batching plants. At such facility, high-pressure water jets will be directed at the wheels of vehicles to remove all spoil and dirt.

6.3.11 Noise Control Measures

There will be an increase in noise level due to construction of the proposed Metro corridors. The increases in levels are marginal; hence local population will not be adversely affected. However the exposure of workers to high noise levels especially, near the engine, vent shaft etc, need to be minimized. This could be achieved by:

- Job rotation to the extent possible,
- Automation,
- Construction of permanent and temporary noise barriers,
- Re-route and regulate the traffic, a main source of noise,
- Use electric equipment instead of diesel powered equipment,
- Use hydraulic tools instead of pneumatic tools,
- Acoustic enclosures should be provided for individual noise generating construction equipment,
- Scheduling of truck loading, unloading and hauling operation,
- Proper operation and maintenance of the construction vehicles and equipments would keep them within noise limit,
- Schedule work to avoid simultaneous activities,
- Anti drumming floor and noise absorption material,
- Low speed compressor, blower and air conditioner,
- Mounting of under frame equipments on anti-vibration pad,
- Smooth and gradual control of door,
- Provision of GRP baffle on the via-duct for elimination of noise transmission,
- Provision of sound absorbing material in the supply duct and return grill of air conditioner,
- Sealing design to reduce the aspiration of noise through the gap in the sliding doors and piping holes, and

- Sound proof compartments/ control rooms etc.

The workers employed in high noise level area could be employed in low noise level areas and vice-versa from time to time. Automation of equipment and machineries, wherever possible, should be done to avoid continuous exposure of workers to noise. At work places, where automation of machineries is not possible or feasible, the workers exposed to noise should be provided with protective devices. Special acoustic enclosures should be provided for individual noise generating equipments, wherever possible.

Workers in those sections where periodic adjustment of equipment/machinery is necessary, should be provided with sound proof control rooms so that exposure to higher noise level is reduced. Effective measures should be taken during the construction phase to reduce the noise from various sources. The noise from air compressor can be reduced by fitting exhaust and intake mufflers. Noise proof barriers will be provided on the construction boundary near the residential area.

Noise level from loading and unloading of construction materials can be reduced by using various types of cranes and placing materials on sand or sandy bag beds. The ballast-less track is supported on two layers of rubber pads to reduce track noise and ground vibrations. In addition, baffle walls as parapets will be constructed at up to the rail level so as to reduce sound levels.

6.3.12 Vibration Control Measures

The purpose of vibration mitigation is to minimize the adverse effects due to ground-borne vibration that could be generated with this proposed project. Ground borne vibration is not common as environmental noise, therefore, the mitigation measures should be well planned and implemented before the start of project. Mitigation measures shall vary with the location and type of structures and geological conditions. The vibration impact analysis has been conducted considering the worst case scenario. An actual vibration impact shall be carried out prior to the start of construction and during the construction on the basis of detailed soil investigation and TBM activities involved. Detailed geotechnical investigation is required prior to the tunnel construction. By adopting good construction practices, generation of vibration will be controlled during construction and operation.

Following measures to be taken during construction of tunnel, the contractor shall prepare a monitoring scheme prior to construction at such locations.

- Detailed vibration investigation should be carried out prior to construction at locations where the alignment is close to historical / heritage structures at every 50 to 100 m during the TBM operation.

- Limiting the speed of tunneling in accordance to geological conditions would reduce ground borne vibration.
- Use of support system such as steel arches, shotcrete installed behind the cutterhead would reduce the vibration.
- Continuous vibration monitoring equipment shall be installed during construction.
- Use of shielded TBMs with bulkhead pressurized face would reduce the ground borne vibration.
- Regular maintenance and operation would minimized vibration during TBM operation.
- Vibration monitoring shall also be conducted inside as well as on the top of the building mainly for old structures.
- Proper vibration mitigation measures to be taken during construction of tunnels and also during operation of metro rail.
- Pre-construction structural integrity inspections of historic and sensitive structures.
- The people residing in the buildings close to the proposed metro rail alignment shall be informed about the vibrations and to vacate the location if needed.
- Install supporting wall piles to reduce vibration and settlement impact,
- Information dissemination about the construction method, probable effects, quality control measures and precautions to be used.
- Inform the public about the project and potential vibration-related consequences,

Vibration emanates from rail - wheel interaction and the same can be reduced by minimizing surface irregularities of wheel and rail, improving track geometry, providing elastic fastenings, and separation of rail seat assembly from the concrete plinth with insertion of resilient and shock absorbing pad.

While designing the track structure for Mass Rapid Transit System all the above points have been taken into consideration in the following ways:

- To prevent development of surface irregularities on the rail, a fairly heavy rail section of 60 kg/m, 90 UTS rail, supported at every 60 cms has been proposed. Further rail grinding at regular intervals by rail grinding machine and also lubrication of rail by vehicle mounted lubricator have been contemplated.
- Rails will be continuously welded and also will be laid to fine tolerances so that any noise/vibration on account of track geometry could be reduced.
- The vibration generated from rail-wheel interaction will be greatly absorbed by the elastic fastening system proposed to be used.

The lower vibration will be achieved by providing of bolster less type bogies having secondary air spring.

6.3.13 Traffic Diversion/ Management

Traffic is most likely to be affected during construction of metro rail project. Hence Traffic Diversion Plans are required in order to look for options and remedial measures so as to mitigate any traffic congestion situations arising out due to acquisition of road space during Metro construction. As the whole alignment of proposed metro is underground little disturbance will took place at the station locations only. Any reduction of road space during Metro construction results in constrained traffic flow. In order to retain satisfactory levels of traffic flow during the construction period; traffic management and engineering measures need to be taken. They can be road widening exercises, traffic segregation, one-way movements, traffic diversions on influence area roads, acquisition of service lanes, etc.

Various construction technologies are in place to ensure that traffic impedance is at the minimum. They are:

- In "Cut-and-Cover" method, the stretch between two points will have to be blocked during construction. However, temporary decking may be provided by blocking the road carriageway partially to permit traffic movement along the same stretch if possible.

- Wherever the stations are isolated, areas available around it should be utilized for road diversion purposes such as lay-byes and service roads.

Only temporary diversion plans will be required during construction of the Metro. At the onset, all encroachments from road ROW for stations and entry/exit will have to be removed. These encroachments vary from "on-street" parking to informal activities. During the construction of works on underground section, it is proposed that temporary decking may be provided by blocking the road carriageway partially to permit "through" as well as right-turning traffic movements. Total blockage of traffic along the underground section is not recommended due to non-availability of reasonably good alternate road network.

Keeping in view the future traffic growth and reduction of carriageway due to Metro construction, implementation of traffic management/diversion plans shall become inevitable for ensuring smooth traffic movement and similar traffic diversion plans shall be formulated and followed during the execution of project.

Traffic Management Guidelines: The basic objective of the following guidelines is to lay down procedures to be adopted by contractor to ensure the safe and efficient movement of traffic and also to ensure the safety of workmen at construction sites.

- All construction workers should be provided with high visibility jackets with reflective tapes. The conspicuity of workmen at all times shall be increased so as to protect from speeding vehicular traffic.
- Warn the road user clearly and sufficiently in advance.
- Provide safe and clearly marked lanes for guiding road users.
- Provide safe and clearly marked buffer and work zones
- Provide adequate measures that control driver behavior through construction zones.
- The primary traffic control devices used in work zones shall include signs, delineators, barricades, cones, pylons, pavement markings and flashing lights.

The contractor will hire a transportation consultant that carryout the traffic survey and suggest alternative routes for smooth flow of traffic.

6.3.14 Soil Erosion Control

Soil Erosion during construction of proposed Metro rail will cause very little impact. The surface facilities and related transport will cause soil erosion. Prior to the start of the construction, the Contractor shall submit his schedules to the MEGA for carrying out temporary and permanent erosion/sedimentation control works as applicable for the items of clearing and grubbing, roadway and drainage excavation, embankment/sub-grade construction, pavement courses and shoulders. He shall also submit his proposed method of erosion/sedimentation control and his plan for disposal of waste materials. Visual monitoring will be carried out during construction which includes photographic records and site description data. The visual inspection should be conducted on quarterly basis by the contractor in presence and consultation with PMC. Monitoring may be undertaken by staff with good observational skills, the ability to reliably record and report site conditions. Work shall not be started until the erosion/sedimentation control schedules and methods of operations for the applicable construction have been approved by the MEGA.

The surface area of erodible earth material exposed by clearing and grubbing, excavation shall be limited to the extent practicable. The Contractor may be directed to provide immediate control measures to prevent soil erosion and sedimentation that will adversely affect construction operations, damage adjacent properties, or cause contamination of nearby streams or other watercourses. Such work may involve the construction of temporary berms, dikes, sediment basins, slope drains and use of temporary mulches, fabrics, mats, seeding, or other control devices or methods as necessary to control erosion and sedimentation.

The Contractor shall be required to incorporate all permanent erosion and sedimentation control features into the project at the earliest practicable time as outlined in his accepted schedule to minimize the need for temporary erosion and sedimentation control measures. Temporary erosion/sedimentation and pollution control measures will be used to control the phenomenon of erosion, sedimentation and pollution that may develop during normal construction practices, but may neither be foreseen during design stage nor associated with permanent control features on the Project. Under no conditions shall a large surface area of credible earth material be exposed at one time by clearing and grubbing or excavation without prior approval of the MEGA.

Temporary erosion is sometimes caused due to the Contractor's negligence, carelessness or failure to install permanent controls. Sedimentation and pollution control measures then become necessary as a part of the work as scheduled or ordered by the MEGA, and these shall be carried out at the Contractor's own expense. Temporary erosion, sedimentation and pollution control work, which is not attributed to the Contractor's negligence, carelessness or failure to install permanent controls, will be performed as ordered by the MEGA.

6.3.15 Muck Disposal

Construction of underground tunnel for metro projects is a specialised and complex task. Owing to paucity of space in the busy cities and for safety reasons, elaborate measures need to be adopted for collection, transfer, storage and disposal of excavated muck. Muck collection, transportation, disposal and its treatment need to be carried out in a systematic manner. Muck collection should be transported in containers from the Tunnel excavation sites. These containers should be such that muck should not spill during movement to disposal site.

As discussed in Chapter-4, approximately 16,03,000 cubic meters of excavated soils will be generated from the construction of the 3 underground stations. Among the 4 underground stations along the E-W alignment, 3 stations are being constructed by cut and cover method. Out of this about 10 % will be used for back filling. 16,03,000 m^3 of muck will be disposed by adopting five options as described below.

I. **Identified area at Vastral Gam:** About 18 Hac. area is available at Vasral Gam for dumping of excavated muck. The land available is partly low lying. About 5 meter depth is available for filling at this low lying area. The Map showing proposed area at Vastral is given at **Appendix-6.6.**

II. **Ahmedabad Riverfront Improvement Project:** A good option being explored is to provide the excavated soil to Ahmedabad Riverfront Improvement Project which needs huge quantity of soil to extend the length of riverfront improvement. A large quantity of soil and graded material is required as fill material at river front. About

29.2 Hac. low lying area is available adjoining Motera Stadium for dumping of excavated muck. The Map showing proposed area at Riverfront Improvement Project is given at **Appendix-6.7**.

III **Recycle and Reuse:** Muck generated can be reused as aggregate material for road beds, ballast for railways, construction material and graded material can be used in concrete. The use can be decided only after thorough geotechnical investigation, testing of the muck and choice of TBM. This alternative will require land for setting up a plant to convert the muck to a useful form.

Capacity these options described above is approximately assessed for the disposal of muck as depicted in **Table 6.7**. Any one or more of the options will be selected on the basis of detailed investigation and getting the necessary clearances/permission from the concerned authority. Out of three options discussed above filling material at Riverfront Improvement Project seems to be most feasible option. Accordingly cost estimate for muck disposal has been prepared and given in **Table 6.8.** The use can be decided only after thorough geotechnical investigation and testing of the muck. Muck will be monitored/ analyzed for heavy metals prior to their disposal at dumping site and monitoring programme is given in the Environmental Monitoring Plan.

TABLE 6.7
CAPACITY OF MUCK DUMPING OPTIONS

Sl.	Options	Capacity of dumping site in m^3	Remarks
1.	Vastral Gam	360000	Average depth of fill taken as 2.0 m
2.	Riverfront	584000	
3.	Recycle and Reuse	-	Separate detailed study will be required for this alternative

TABLE 6.8
COST OF MUCK DISPOSAL

SI	PARTICULARS	COST (Lakh)
1	Environmental Study/Clearances (Lump sum)	50.00
2	Detailed Investigation (Lump Sum)	150.00
3	Transportation Cost @ 60 trips per day (Considering lead of 25 km on either side)*	3561.00
4	Plantation & Beautification works (Rs. 1.20 Lakhs/Hac.)	48.00
5	Miscellaneous (5%)	190.45
	Total	**3999.45**

6.3.16 Draining of Water from Tunnel

In cut and cover type construction, continuous pumping is an economical alternative. The well point system is recommended for dewatering as the volume of water to be pumped out. The deep well system is adopted where the water table has to be lowered over a

large depth in a small area. The deep wells can be installed either inside or outside the diaphragm walls or inside the cut.

A suitable piezometer is installed to monitor the water table constantly and to see how much lowering has been effectively done. The dewatering should not be stopped unless it is ensured from design calculations that the load of the constructed box component has reached a stage where it will be able to counter act the hydrostatic pressure from below. The dewatering can be achieved by:

- Leading the ground water to a sump by drains and pump out the water from the sump. To prevent loss of fines, inverted filter may have to be used.

- Dewatering as suggested above may not be effective in preventing sand flows. Lowering of the ground water by properly designed single or double stage well points will be effective in such cases.

- The construction of diaphragm walls of concrete along the side of channels, before the commencement of excavation will be required. The concrete walls are taken down to rest on bed rock or impervious strata or, in their absence, deep enough below the bottom of excavation, to serve as an effective cut off for the inflow of ground water into the proposed excavation. The trenches are kept continuously filled with a thiotropic material like Bentonite slurry, which has the effect of stabilising the trench and preventing any subsidence. As the excavation proceeds, concrete wall can be strutted mutually or anchored with surrounding rocks.

- During operation phase, seepage water will be drained along the side of walls (retaining). Proper drainage system need to be incorporated in design and implemented during construction phase.

The pumped water from sump wells will be put into storm water drain to avoid any load to waste water treatment plants. These storm water drains finally join natural existing streams/nallahs.

6.3.17 Water Supply, Sanitation and Solid Waste Management

The public health facilities, such as water supply, sanitation and toilets are much needed at the stations. Water should be treated before use up to WHO drinking water standards. The collection and safe disposal of human wastes are among the most important problems of environmental health. The safe sewage disposal systems would be provided.

Requirements of drinking water supply at station are about 6 KL/day. Raw water requirement for station is about 240-250 KL/Day. The water requirement at Depot will be 123 KLD. This shall be provided from municipal/ground water source.

Solid waste generated at station is about 3.6 Ton per month. The maintenance of adequate sanitary facilities for temporarily storing refuse on the premises is considered a responsibility of the MEGA project authorities. The storage containers for this purpose need to be designed. However it is suggested that the capacity of these containers should not exceed 50 litres and these should be equipped with side handles to facilitate handling. To avoid odour and the accumulation of fly-supporting materials, garbage containers should be washed at frequent intervals. This should be collected and transported to local municipal bins for onward disposal to disposal site by municipality. Waste generated during and after construction will be disposed in accordance with relevant National and State laws and Regulations.

6.3.18 Sensitive Receptors

As discussed in section 4.4.17, the impact on sensitive receptors is anticipated due to noise and vibration during construction work of stations. The management plan for noise & vibration control mentioned at section 6.3.10 & 6.3.12 will reduce the noise & vibration level substantially. The noise & vibration due to construction activities will be monitored and recorded at sensitive receptors. Construction contractor must provide a mechanism for receiving and responding to complaints arising due to impacts on sensitive receptors. Avoid nighttime construction activities near sensitive receptors if possible.

6.3.19 Blasting Control

The predicted ground vibration and noise due to air blast by blasting is 14.96 mm/sec and 136 dB respectively for 15 meter distance from charge. Explosive charge mass per delay should be strictly restricted to 1 kg for each blast event. Controlled blasting may required at station location to be constructed by NATM and Cut & Cover method. Good planning is essential to mitigate noise, vibration and air blast impacts which might otherwise lead to unacceptable effects on the community or the natural environment. There are a number of factors that can either increase or decrease the intensity of ground vibrations and noise due to air blast. Measures which are commonly adopted include:

- Identify potential problem areas surrounding the project site,
- Prior to start of construction, condition survey of building is required to be done. If any existing cracks are measured initially and it is again measured after blasting to see the impact and mitigation measures to be adopted to safeguard the building,
- Determine the conditions that exist prior to commencement of construction,
- Inform the public about the project and potential blasting-related consequences,
- Schedule the work to reduce adverse effects,

- The blast should be well designed for the geological conditions, rock type and availability of the explosive,
- Design the blast to reduce vibration and air over pressure,
- All blasting operations shall be conducted under the direct supervision of a blaster holding a current license issued under the state or local laws.
- Blasting should generally be carried out during the hours of 0900 hrs to 1700 hrs Monday to Saturday. Blasting should not take place on Sundays and public holidays,
- Blasting mats or back fill material must be utilized to control fly-rock damage to surrounding structures,
- Use blast signals to notify nearby residents that blasting is imminent,
- Monitor and record the vibration and air overpressure effects of the blast,
- Respond to and investigate complaints,
- Information from manufacturer should be collected for the physical properties, performance characteristics and sensitivity of the explosive which will help in correct choice of explosive.

6.3.20 Management Plans for Depot

The depots are planned at Apparel Park (19.5 hac) for East-West corridor and at Giyaspur (25.2 hac) for North-South corridor for the proposed metro project. The management plans for depot site includes:

- Water Supply,
- Oil Pollution Control,
- Sewage/Effluent Pollution Control,
- Solid Waste
- Surface Drainage,
- Green belt development,
- Rain water harvesting, and
- Recycling of treated waste water.

Water supply: About 123 KLD of water will be required for operation and functioning of depots. This could be either met from Municipal Corporation or through boring tube well into the ground. The ground water will need treatment depending upon its use. Domestic and some of the industrial application, a Reverse Osmosis (RO) plant of 8 liter/ minute capacity will be appropriate. The water treatment plant flow chart is given in **Figure 6.1**. The estimated cost of water supply plant is about **Rs.50 Lakh**.

Oil Pollution Control: The oil tends to form scum in sedimentation chambers, clog fine screens, interfere with filtration and reduce the efficiency of treatment plants. Hence oil and grease removal tank has to be installed at initial stage of effluent treatments. Such tanks usually employ compressed air to coagulate the oil and grease and cause it to rise promptly to the surface. Compressed air may be applied through porous plates located in bottom of the tank. The tank may be designed for a detention period of 5 to 15 minutes. This accumulated oil and grease will be disposed off through approved re-cyclers.

Sewage/Effluent Pollution Control: About 94 KLD of sewage/effluent is likely to be generated at depot. The sewage could be treated up to the level so that it could be used for horticulture purpose in the campus and can also be discharged into the stream a process flow chart is presented in **Figure 6.2.** The estimated cost of sewage/effluent treatment plant is about **Rs.60 Lakh**. This has to be treated as per the requirement of regulatory pollution control agency of the state (GPCB).

Solid Waste Disposal: About 3.6 Ton per month of solid waste will be generated from the Depot which will be taken by the cleaning contractor weekly and disposed to the Ahmedabad Municipal Corporation waste disposal sites in accordance with relevant National and State laws and regulations.

Surface Drainage: The Storm water of the depot will be collected through the drain. Rain water harvesting pits are provided at different locations in the drains and for surplus storm water, the drainage system is connected to a nearby disposal site. The drainage costs have been included in project cost.

Green belt development: The greenbelt development / plantation in the depot area not only functions as landscape features resulting in harmonizing and amalgamating the physical features with surrounding environment but also acts as pollution sink / noise barrier. In addition to augmenting present vegetation, it will also check soil erosion, make the ecosystem more diversified and functionally more stable, make the climate more conducive and restore balance. It is recommended to have a provision of **Rs 40 Lakh** in the cost estimate for the green belt development. Treated sewage and effluent in the best combination should be used for green belt development.

Rain water harvesting: To conserve and augment the storage of groundwater, it has been proposed to construct roof top rainwater harvesting structure at the constructed depot site. Depot cum workshop area of 46,496 sq.m (i.e 23248x2) is available at both depots for roof top rain water harvesting. An annual average rainfall is 756 mm, 255 KLD rain water will be harvested. The total recharge pit area of 10x10x3 will be required. A provision of **Rs. 15 Lakh** has been kept in the cost estimate.

Recycling of treated waste water: Waste water generated at depot is proposed to be collected at ETP for treatment and recycled for horticulture work of the depot.

6.3.21 Training Programmes

The training programmes need to be conducted by the experts, for MRTS officers. These programmes could be extended for the local population for their active participation in the project implementation. Apart from training, such programme should include guidelines for safety, methods of disaster prevention, action required in case of emergency, fire protection, environmental risk analysis etc.

Two international training programme per year for 10 numbers of MEGA officers are proposed to acquire the latest know how about the construction, operation and maintenance of Metro rail. During the project construction period 50 numbers of MEGA staff will get the International training for which estimated cost will be Rs. 125.50 Lakhs. The overall cost involved for National and International training programmes will be **Rs. 138.00 Lakh** which is presented in **Table 6.9.**

TABLE 6.9
COST FOR TRAINING PROGRAMME

S. NO	ITEM	COST (Lakh)
1.	Curriculum Development and course preparation 2 months Rs.50000/month	1.00
2.	10 Extension Officer (1year) Rs.35, 000/month	3. 50
3.	Instructor 20 sessions of 10 days each	5.00
4.	Demonstration/Presentation Aids	1.00
5.	Material etc	2.00
6.	International Training for 50 MEGA staff	125.50
	Total	**138.00**

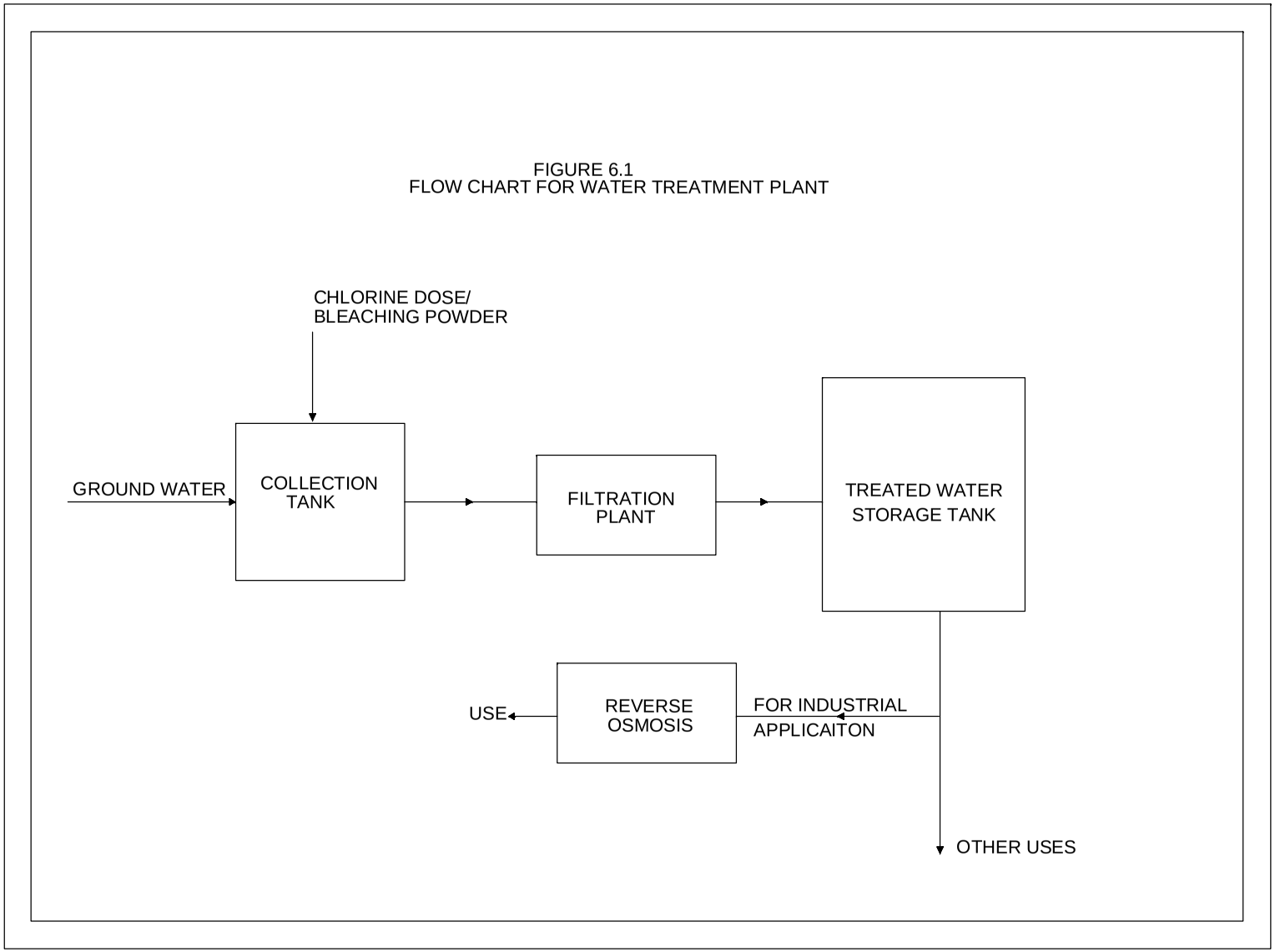
6.3.22 Environmental Enhancement Measures

In addition to mitigation measures adopted for negative impacts during construction and operation of the project, some of the measures for improvement of environment have been undertaken as described below:

- Landscaping & beautification
- Solar energy
- Renovation of Heritage structures/religious places
- Environmental awareness programmes
- Utility facilities to unprivileged people

The cost for environmental enhancement measures has been kept as **Rs. 85.00 Lakh** (Lump sum).

FIGURE 6.1
FLOW CHART FOR WATER TREATMENT PLANT



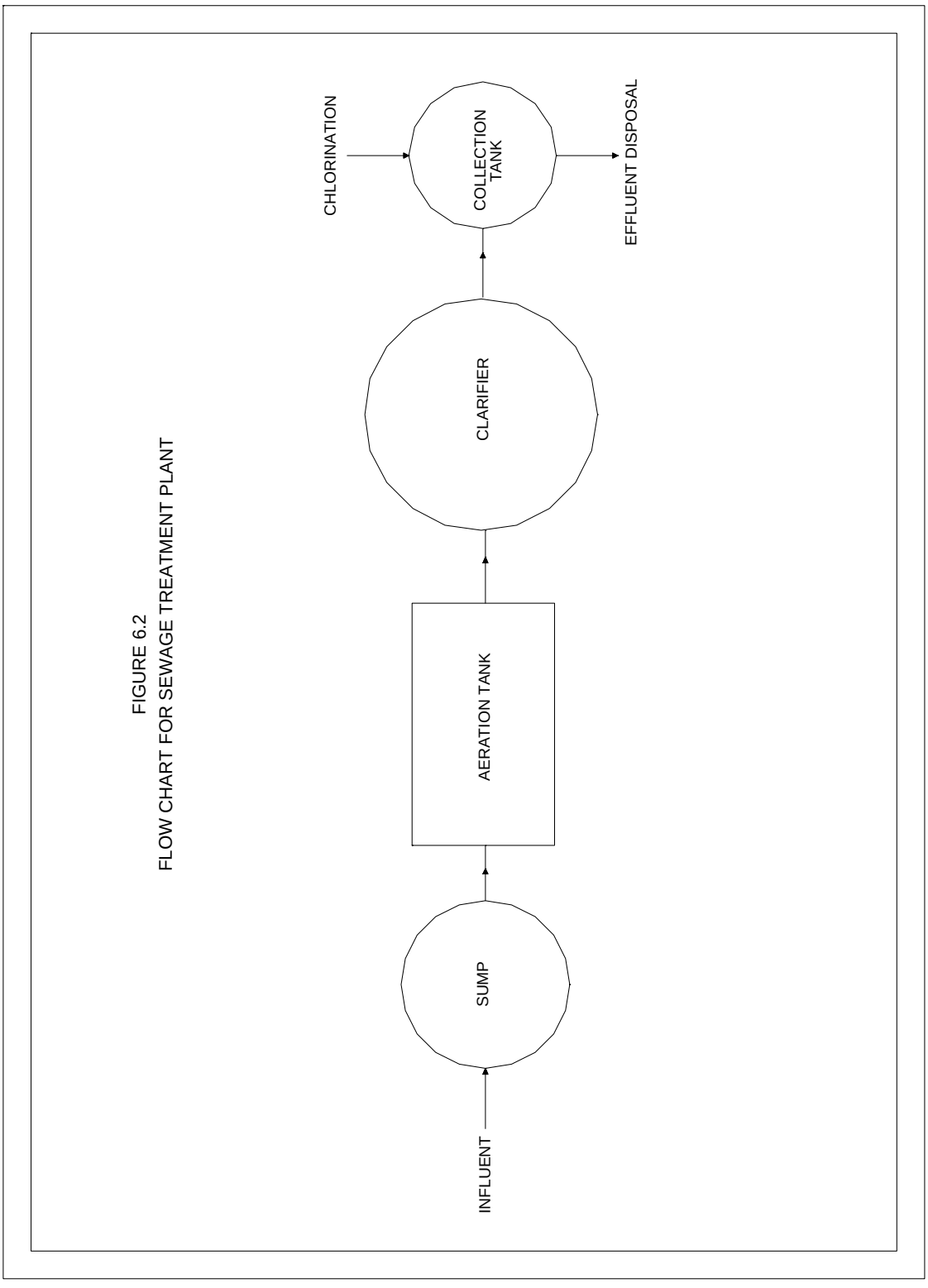


FIGURE 6.2
FLOW CHART FOR SEWAGE TREATMENT PLANT

6.4 EMP Reporting Arrangement and Institutional Strengthening

Supervision involves periodic checking to ascertain whether activities are going according to the plans. It provides necessary feedback for project management team to keep the program on schedule. The supervision and reporting process with respect to implementation status of mitigation measures during construction will initiate from the contractor at the lowest rung who will report to the Project Implementation Agency (PIA) through the project management consultant.

During construction phase of the project, the EMP implementation comprises of the following key activities:

- Implementing various mitigation and enhancement measures within the time frame recommended
- Overseeing the implementing various mitigation and enhancement measures and fine tuning/advocating more measures, if needed, depending on site conditions;
- Project level monitoring of key performance indicators to evaluate the implementation of EMP measures at the recommended intervals.
- Periodical reporting of status of EMP implementation and monitoring results and key performance indicators and
- Constant evaluation of EMP measures implemented based on the data available from project level monitoring and status reports and providing directions accordingly.

These activities to be carried out by various agencies that will be involved in the implementation of Metro project. It is also to be noted that all these activities will be carried out concurrently or at regular intervals and at different duration and location. This makes it pertinent that all agencies involved work within a predefine setup. The coordination model proposed during construction and operation phases is presented in **Figure 6.3** and **Figure 6.4** respectively. The identified agencies and their sphere of work are presented in following section.

Project Implementation Agency (PIA)

The responsibility of implementing environmental mitigation measures lies with the PIA. PIA in this project will be Metro Link Express for Gandhinagar & Ahmedabad Company Limited (MEGA). The responsibility also includes various tasks such as notifying various affected parties such as the resident and commercial establishment, facilitate the relocation of people, notify other utility departments such as telephone, water supply, sewerage etc. which used the road for providing public utility services.

FIGURE 6.3
INSTITUTIONAL MECHANISM FOR EMP IMPLEMENTATION
(CONSTRUCTION PHASE)

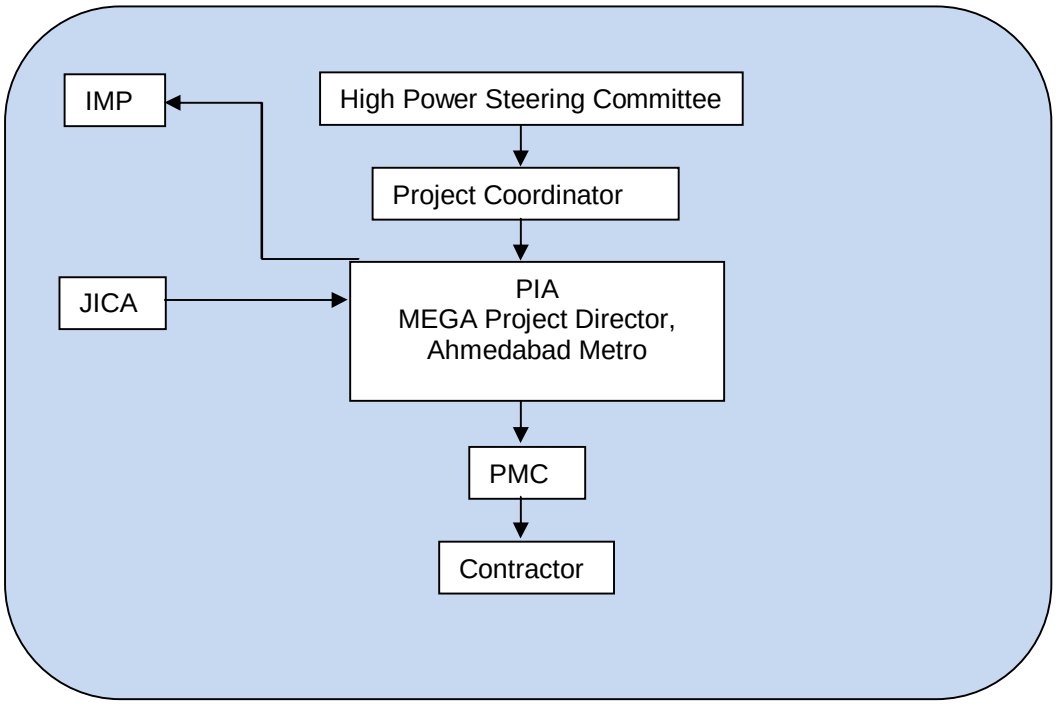
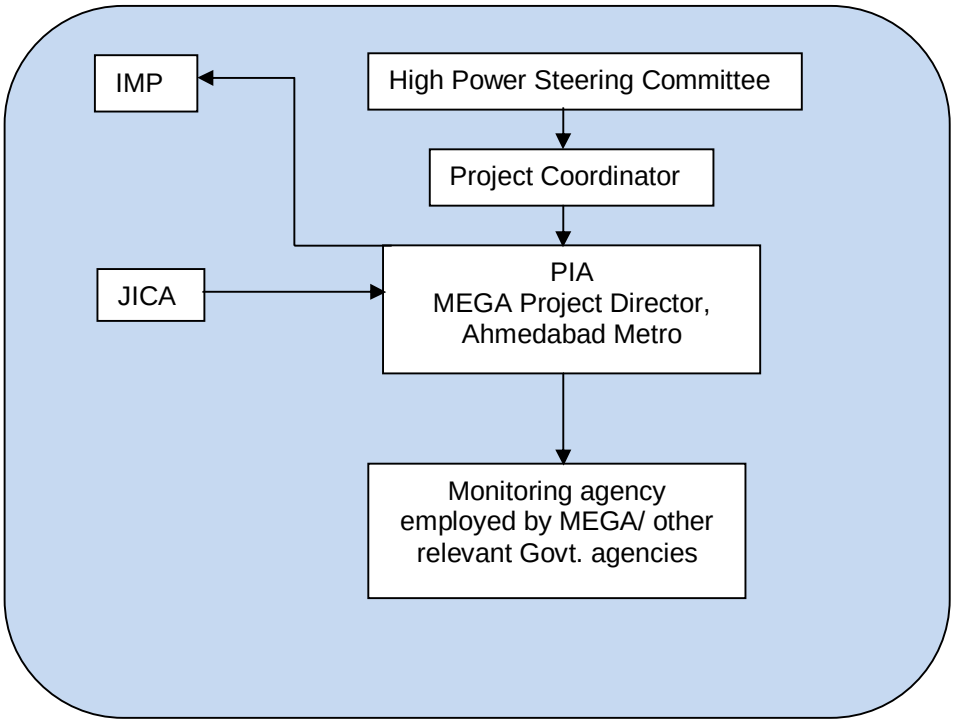


FIGURE 6.4
INSTITUTIONAL MECHANISM FOR EMP IMPLEMENTATION
(OPERATION PHASE)



Project Management Consultant (PMC)

The PIA will get the EMP implanted through the Project Management Consultant (PMC) appointed for managing engineering and construction related activity. The PIA will delivered the responsibility of overseen the implementation of as per the contract agreement. In order to effectively discharge the duties PMC will have an environmental officer/expert in the project management unit. The environmental officer will work for a full time basis at the site office. The officer must possess experience in the environmental management of metro projects.

Project Contractor

Project contractor will implement the EMP measures, enhancement measures and measures as directed by PIA and PMC. The responsibility to implement the EMP measures will be built in to the contractual agreement. The contractor shall submit a report on compliance of environmental mitigation measures periodically to the PMC. The PMC will review and approve the environmental compliance report (ECR) submitted by the contractor and forward the ECR to PIA after approval. The PIA will then submit the ECR to Joint Project Director (JPD), environment which after review and monitoring will submit to Independent Monitoring Panels through the Project Director, MEGA. The Project Director accordingly submits report to the JICA.

MEGA

MEGA as an apex organization shall initiate coordinate process among the concern organization for EMP implementation. MEGA shall take lead in

- Reviewing the progress of the project for the subsequent year- institution wise
- Reviewing and discussing the salient features of the report in the year on environmental aspects and their violations
- Organizing and coordinating training programs for all member organization

Independent Monitoring Panel (IMP)

This has been constituted by MEGA with the objective to ensure that the Banks policies: related to social and environmental issues are followed. The Chairman of IMP should have been Secretary Level to Government of Gujarat. The other members are eminent environmental engineers, a senior Journalist and a leading Advocate. The IMP will meet periodically to review the periodical reports, environmental compliance report etc. In addition to above JICA will monitored implementation of environmental management during and post construction.

6.5 DISASTER MANAGEMENT

Disaster is an unexpected event due to sudden failure of the system, external threats, internal disturbances, earthquakes, fire and accidents. As per the disaster management

act, 2005 "disaster" means a catastrophe, mishap, calamity or grave occurrence in any area, arising from natural or manmade causes, or by accident or negligence which results in substantial loss of life or human suffering or damage to, and destruction of, property, or damage to, or degradation of, environment, and is of such a nature or magnitude as to be beyond the coping capacity of the community of the affected areaò

A disaster is a tragic event, be it natural or manmade, which brings sudden and immense agony to humanity and disrupts normal life. It causes large scale human suffering due to loss of life, loss of livelihood, damages to property and persons and also brings untold hardships. It may also cause destruction to infrastructure, buildings, communication channels essential services, etc.

6.5.1 Need for Disaster Management Measures

The effect of any disaster spread over in operational area of Ahmedabad Metro is likely to be substantial as MEGA deals with thousands of passengers daily in underground tunnels, viaducts and stations. Disaster brings about sudden and immense misery to humanity and disrupts normal human life in its established social and economic patterns. It has the potential to cause large scale human suffering due to loss of life, loss of livelihood, damage to property, injury and hardship. It may also cause destruction or damage to infrastructure, buildings and communication channels of Metro. Therefore there is an urgent need to provide for an efficient disaster management plan.

The first step is to identify the causes which develop/ pose unexpected danger to the structural integrity due to construction. The potential causes are excessive load, cracks, failure and malfunctioning of sensing instruments, accident, etc. These need to be looked into with care.

6.5.2 Objectives

The main objectives of this Disaster Management Measures are as follows:

- ✓ Save life and alleviate suffering.
- ✓ Provide help to stranded passengers and arrange their prompt evacuation.
- ✓ Instill a sense of security amongst all concerned by providing accurate information.
- ✓ Protect Metro Rail property.
- ✓ Expedite restoration of train operation.
- ✓ Lay down the actions required to be taken by staff in the event of a disaster in MEGA in order to ensure handling of crisis situation in coordinated manner.
- ✓ To ensure that all officials who are responsible to deal with the situation are thoroughly conversant with their duties and responsibilities in advance. It is important that these officials and workers are adequately trained in anticipation to

avoid any kind of confusion and chaos at the time of the actual situation and to enable them to discharge their responsibilities with alertness and promptness.

6.5.3 Provisions under Disaster Management Act, 2005

A. The National Disaster Management Authority (NDMA)

Establishment of National Disaster Management Authority:-

(1) With effect from such date as the Central Government may, by notification in the Official Gazette appoint in this behalf, there shall be established for the purposes of this Act *(The Disaster Management Act, 2005),* an authority to be known as the National Disaster Management Authority.

(2) The National Authority shall consist of the Chairperson and such number of other members, not exceeding nine, as may be prescribed by the Central Government and, unless the rules otherwise provide, the National Authority shall consist of the following:-

(a) The Prime Minister of India, who shall be the Chairperson of the National Authority, ex officio;

(b) Other members, not exceeding nine, to be nominated by the Chairperson of the National Authority.

(3) The Chairperson of the National Authority may designate one of the members nominated under clause (b) of sub-section (2) to be the Vice- Chairperson of the National Authority.

(4) The term of office and conditions of service of members of the National Authority shall be such as may be prescribed.

B. State Disaster Management Authority:

Establishment of State Disaster Management Authority:-

(1) Every State Government shall, as soon as may be after the issue of the notification under sub-section (1) of section 3, by notification in the Official Gazette, establish a State Disaster Management Authority for the State with such name as may be specified in the notification of the State Government.

(2) A State Authority shall consist of the Chairperson and such number of other members, not exceeding nine, as may be prescribed by the State Government and, unless the rules otherwise provide, the State Authority shall consist of the following members, namely:-

(a) The Chief Minister of the State, who shall be Chairperson, ex officio;

(b) Other members, not exceeding eight, to be nominated by the Chairperson of the State Authority;

(c) The Chairperson of the State Executive Committee, ex officio.

(3) The Chairperson of the State Authority may designate one of the members nominated under clause (b) of sub-section (2) to be the Vice- Chairperson of the State Authority.

(4) MEGA would abide by the constitutional delegation stated under para 3 as above.
(5) The term of office and conditions of service of members of the State Authority shall be such as may be prescribed.

C. Command & Control at the National, State & District Level

The mechanism to deal with natural as well as manmade crisis already exists and that it has a four tier structure as stated below:-

(1) National Crisis Management Committee (NCMC) under the chairmanship of Cabinet Secretary
(2) Crisis Management Group (CMG) under the chairmanship of Union Home Secretary.
(3) State Level Committee under the chairmanship of Chief Secretary.
(4) District Level Committee under the Chairmanship of District Magistrate.

All agencies of the Government at the National, State and district levels will function in accordance with the guidelines and directions given by these committees.

D. Plans by Different Authorities at District Level and their Implementation

Every office of the Government of India and of the State Government at the district level and the local authorities shall, subject to the supervision of the District Authority:-

(a) Prepare a disaster management plan setting out the following, namely:-

(i) Provisions for prevention and mitigation measures as provided for in the District Plan and as is assigned to the department or agency concerned;
(ii)Provisions for taking measures relating to capacity-building and preparedness as laid down in the District Plan;

(iii)The response plans and procedures, in the event of, any threatening disaster situation or disaster;
(b) Coordinate the preparation and the implementation of its plan with those of the other organizations at the district level including local authority, communities and other stakeholders;

(c) Regularly review and update the plan; and

(d) Submit a copy of its disaster management plan, and of any amendment thereto, to the District Authority.

6.6 PROVISIONS AT METRO STATIONS/OTHER INSTALLATIONS

6.6.1 Preventive Action

Once the likelihood of a disaster is suspected, action has to be initiated to prevent a failure. Engineers responsible for preventive action should be aware of availability of repair equipments, materials, labour and expertise for use during emergency.

6.6.2 Reporting Procedures

The level at which a situation will be termed a disaster shall be specified. This shall include the stage at which the surveillance requirements should be increased both in frequency and details. The Engineer-in-Chief should notify the officer for the following information:

- Exit points for the public,
- Safety areas in the tunnel, and
- Nearest medical facilities.

6.6.3 Communication System

An efficient communication system is absolutely essential for the success of any disaster management plan. This has to be worked out in consultation with local authorities. More often, the entire communication system gets disrupted when a disaster occurs. The damage areas need to be clearly identified and provided with temporary and full proof communication system.

6.6.4 Emergency Action Committee

To ensure coordinated action, an Emergency Action Committee should be constituted. Chairman cum Director, MEGA will be the Chairman of this Committee. The committee may comprise of:

- Head of operations,
- Head of technical services,
- Head of security,
- Fire brigade,
- Police representatives, and
- NGO

Emergency Action Committee will prepare the evacuation plan and procedures for implementation based on local needs and facilities available. The plan should include:

- Demarcation of the areas to be evacuated with priorities,

- Safe route to be used, adequacy of transport for evacuation, and traffic control,
- Safe area and shelters,
- Security of property left behind in the evacuated areas,
- Functions and responsibilities of various members of evacuation teams, and
- Setting up of Joint Control Room.

All personnel involved in the Emergency Action Plan should be thoroughly familiar with all the elements of the plan and their responsibilities. They should be trained through mock drills for the Emergency Action Plan. The staff at the site should be trained for problem detection, evaluation and emergency remedial measures. Individual responsibility to handle the segments in emergency plan must be allotted.

Success of an emergency plan depends on public participation, their response to warning notifications and timely action. Public has to be educated on the hazards and key role in disaster mitigation by helping in the planned evacuation and rescue operations.

It is essential to communicate by whom and how a declared emergency will be terminated. There should be proper notification to the public on de-alert signals regarding termination of the emergency. The notification should be clear so that the evacuees know precisely what to do when re-entering or approaching the affected areas.

6.7 EMERGENCY MEASURES

The emergency measures are adopted to avoid any failure in the system such as lights, fire, means of escape, ventilation shafts etc. The aim of Emergency Action Plan is to identify areas, population and structures likely to be affected due to a catastrophic event of accident. The action plan should also include preventive action, notification, warning procedures and co-ordination among various relief authorities. These are discussed in following sections.

6.7.1 Emergency Lighting

The emergency lights operated on battery power should be provided at each station. The battery system should supply power to at least 25% of the lights at the station, platforms, tunnels/viaducts for a period of 2 hours. The underground station should have transformer at each end of the platform. Both the transformers need to be kept energized and should feed independently alternate rows of lights so that in case of failure of one transformer, there will not be complete darkness. The tunnels need to be provided with fluorescent incandescent lamps at a spacing of 20 m.

6.7.2 Fire Protection

The building materials should be of appropriate fire resistance standard. For underground structures the fire resistance period should be at least 4 hours, and 2 hours for surface or over head structures. Wood shall not be used for any purpose, excluding artificial wood products, which are flame resistant. The materials which have zero surface burning characteristics need to be used. The electrical systems shall be provided with automatic circuit breakers activated by the rise of current as well as activated by over current. The design of a station will include provision for the following:

- Fire prevention measures,
- Fire control measures,
- Fire detection systems,
- Means of escape,
- Access for fireman, and
- Means of fire fighting.

Accumulations of refuse of inflammable material like paper, plastic cartons constitute a major fire hazards and should not be permitted. Smoking should be strictly prohibited at all locations of MRTS.

All aspects of fire prevention and control will be dealt in close collaboration with the city fire fighting authority. Smoke control will be achieved by the following means:

- Downstand bulkheads of a minimum depth of 600 mm to provide smoke containment. These will be provided around openings for escalators, lifts and stairs in underground stations, and

- In underground stations the ventilation system will be designed to extract smoke in the event of fire

A minimum of 30 minutes supply of water is to be assured in the case of fire. The pumps/overhead tanks shall have the capacity to discharge the water at the rate of 1100 litres per minute at a head of 21 m at nozzle mouth.

The storage capacity in an underground or overhead tank may be divided into two parts i.e. dead storage and running storage. Fire fighting pumps shall be provided with a diesel pump as a standby arrangement, in case of power failure.

Fire of electrical origin, water cannot be used until the electric system has been made dead and earthen. For electrical fires, non-aqueous extinguishers like chemical dry powder or CO_2 gas are utilized for fire fighting. Fire extinguishers with these agents shall be liberally provided at static installations and on the rolling stock.

Generally there are often more casualties from smoke inhalation than from burning. Smoke needs to be transported away from the site of the fire. In order to achieve this, fresh air has to be introduced into the underground section and exhaust gases should be sucked out from other section.

Openings, including ducts and passages, between MRTS property and any adjoining structures which allow free access into the MRTS property will be protected by fire doors, fire shutters, fire dampers etc. as appropriate. Fire detection and alarm systems will be provided as per the prevailing state of art technology.

A. Fire Prevention and Safety Measures

Fire prevention measures will be designed and implemented to minimize the risk of outbreak of fire by appropriate choice, location and installation of various materials and equipment. In stations planning, potential sources of fire can be reduced by:

i. Fire Prevention

- Use of non-combustible or smoke retardant materials where possible,
- Rolling stock is provided with fire retarding materials, low smoke zero halogen type electric cable is also provide,
- Provision of layout which permits ease of maintenance for equipment and cleaning of the station premises,
- Provision of special storage spaces for combustible materials such as paint and oil,
- Prohibition of smoking in fire prone areas,
- Good housekeeping.

ii. Safety

Following provisions will be required from fire safety point of view:

- Automatic sprinkler/detection system to be provided if floor area exceeds 750 sq.m
- One wet riser-cum-down comer per 1000 sqm floor area with static underground storage tank, overhead tanks and pumps of suitable capacity with hydrants, first-aid reel, etc.
- Portable fire non-aqueous extinguishers of Carbon di Oxide, chemical dry powder etc. at suitable places.
- Automatic smokes venting facilities.
- Two separate means of exit shall be provided, if more than 10 persons are working and the area exceeds 1400 sq.m.

- Fire resisting doors shall be provided at appropriate places along the escape routes to prevent spread of fire and smoke.
- The travel distance for fire escape shall not exceed 20 m where escape is available in more than one direction; the distance could be upto 40 m.

B. Fire Alarm and Detection System

A complete fire detection system with equipment complying with the requirements of Ahmedabad Fire Services shall be provided through out each station and ancillary buildings including entrance passageways, subways and adits etc. to give visual and audible indication of alarm conditions actuated by the operation of break glass contact or fire sensors e.g. detector heads, linear heat detecting cables etc. The system shall be operated from 24 V DC Power sources.

Manually operated call points shall be provided at every hydrant and nose reel points, station head wall, tail wall and other locations. Alarm bells shall be installed in each plant room complex at both platform and concourse level and shall be clearly audible at all points in the room/area. Heat detector shall be installed at roof level, ceiling and floor cavity.

Smoke probe units shall be installed in rooms/compartments. When an alarm point is operated, the fire pump shall start to operate automatically. A station fire control and indicating panel shall be provided/ installed in the station controllers room, for the control, indication and monitoring of the whole detection and fire fighting systems. While designing the fire fighting system, the zone of Ahmedabad Fire Services shall be taken into account for linking with the same.

C. Fire Control Measures

Control of the spread of fire and smoke will be achieved by partition of fire risk areas, planning for smoke extraction, and arrangement for smoke containment. Partition is aimed at limiting the extent of a fire. The openings must be capable of being sealed in the event of fire. With the exception of station public areas, a fire compartment will not exceed 1500 m^2. Partition of the public areas in stations is not practicable for operational reasons. The fire resistance period of this separated area should be about 3 hours.

D. Access for Fireman

A secondary access to the station, not used by passengers for evacuation, shall be available to fireman when the need arises. The entry point shall be easily accessible from the road. Access shall be available to all levels of the station. The minimum width of the stairs is 1.0 m and maximum height should not exceed 60 cm.

6.7.3 Ventilation Shafts

The Environmental Control system for underground stations requires ventilation openings between various plants, plant rooms and the atmosphere. Shafts are required for exhaust air, fresh air intake and draft relief. Ventilation shafts will be provided at each station.

6.6.4 Emergency Door

The rolling stock is provided with emergency doors at both ends of the cab to ensure directed evacuation of passengers in case of any emergency including fire in the train.

6.8 SUMMARY OF ENVIRONMENTAL MANAGEMENT PLAN (EMP)

The negative environmental impacts stemming out of the proposed project can be mitigated with simple set of measures, dealing with careful planning and designing of the metro alignment and structures. Adequate provision of environmental clauses in work contracts and efficient contract management will eliminate or reduce significantly all possible problems. A common problem encountered during implementation of environmental management plans of such projects is lack of environmental awareness among engineers and managers concerned with day to day construction activities, which can be solved through regular environmental training programs. A set of preliminary EMP is presented in **Table 6.10,** which defines actions to be undertaken during the design stage, pre-construction, construction and operation stage of the project. The effectiveness of environmental considerations will, however, depend on appropriate inclusion of these in the work contracts.

The major concern during the construction stage is that the contractors, due to lack of enforcement, would not practise good environmental sanitation (housekeeping), may intend to get unauthorized use of the easily available natural resources and other available infrastructure like roads and water resources. This would result in degradation of ambient air quality, water resources and land environment around the construction sites and workers camp. Improper management of earthwork activities would disrupt the natural drainage and increase soil erosion. Improper management may result in spillage of explosives into the hands of unsocial elements. Finally the implementation of the mitigation actions requires that the project implementation unit would record an end-of-construction mitigation checklist, before releasing the final payment of any work contract.

In addition to that MEGA, should prepare and establish Environmental and Health Policy and Procedures and that should become an integral part of contract document.

Operational phase mitigation would involve good environmental sanitation (housekeeping) practice at metro establishments including effective solid waste collection

and disposal, wastewater disposal, upbringing of plantations and green area. During the operation period, the metro operating unit will be required to confirm receipt of the construction period mitigation report through the PIU and prepare and follow on timetable of actions.

TABLE 6.10
ENVIRONMENTAL MANAGEMENT ACTION PLAN (EMP)

Environmental Impact	Mitigation Measures Taken or To Be Taken	Time Frame	Implementing Organization	Responsible Organization
DESIGN PHASE				
Metro Alignment	The proposed corridor alignment was selected to minimise the land disturbance to avoid archaeological sites, temples and other environmentally sensitive areas.	During Design	DPR and design consultant	PIU
Cultural Heritage	Avoided by adjustment of alignment.	During Design	DPR and design consultant	PIU
Inadequate design provision for safety against seismological hazard	Make sure that design provides for safety of structures against worst combination of forces in the probability of an earthquake likely to occur in seismic zone-III.	DPR and detailed design stage	DPR and design consultant	PIU
PRE –CONSTRUCTION STAGE				
Water requirement	The requirement of water for construction purpose etc., shall be planned and arranged from Municipal water supply/Ground water.	Pre construction stage	Contractor	PIU/EMP implementing agency
Disposal of final treated effluent from treatment plat	Options for final disposal shall be studied and the suitable disposal route shall be decided carefully to minimize the impact of receiving bodies. As far as possible zero discharge rules may be adopted.	During design stage / and pre construction of treatment plant	Contractor	PIU/EMP implementing agency
CONSTRUCTION PHASE				
Environmental Management and Monitoring	This will include institutional requirements, training, environmental management and monitoring	During and after construction	Contractor	PIU/EMP implementing agency

Environmental Impact	Mitigation Measures Taken or To Be Taken	Time Frame	Implementing Organization	Responsible Organization
Dust	Water should be sprayed during construction phase, wherever it is required to avoid dust. Vehicles delivering materials should be covered to reduce spills and dust blowing off the load.	During construction	Contractor	PIU/EMP implementing agency
Air Pollution	Vehicles and machinery are to be regularly maintained so that emissions conform to National and State AAQ Standards.	Beginning with and continuing throughout construction	Contractor	PIU/EMP implementing agency
Equipment Selection maintenance and operation	Construction plants and equipment will meet recognized international standards for emissions and will be maintained and operated in a manner that ensures relevant air, noise, and discharge regulations are met.	During construction	Contractor	PIU/EMP implementing agency
Noise	Workers in vicinity of strong noise will wear earplugs and their working time should be limited as a safety measure. Noise barriers (Stone walls or plantation) for silence zones including schools and hospitals. The use of automation construction techniques.	Beginning and through construction	Contractor	PIU/EMP implementing agency
Vibration	The detailed vibration investigation will be required prior to construction. Awareness about vibration impact to the public residing near to the alignment, if required.	Beginning and through construction	Contractor	PIU/EMP implementing agency
WATER				
Contamination from Wastes	All justifiable measures will be taken to prevent the wastewater produced in construction from entering directly into rivers and other water bodies.	Throughout construction period	Contractor	PIU/EMP implementing agency
Wastage of water	Measures shall be taken to avoid misuse of water. Construction agency shall be instructed	Beginning with and continuing	Contractor	PIU/EMP implementing agency

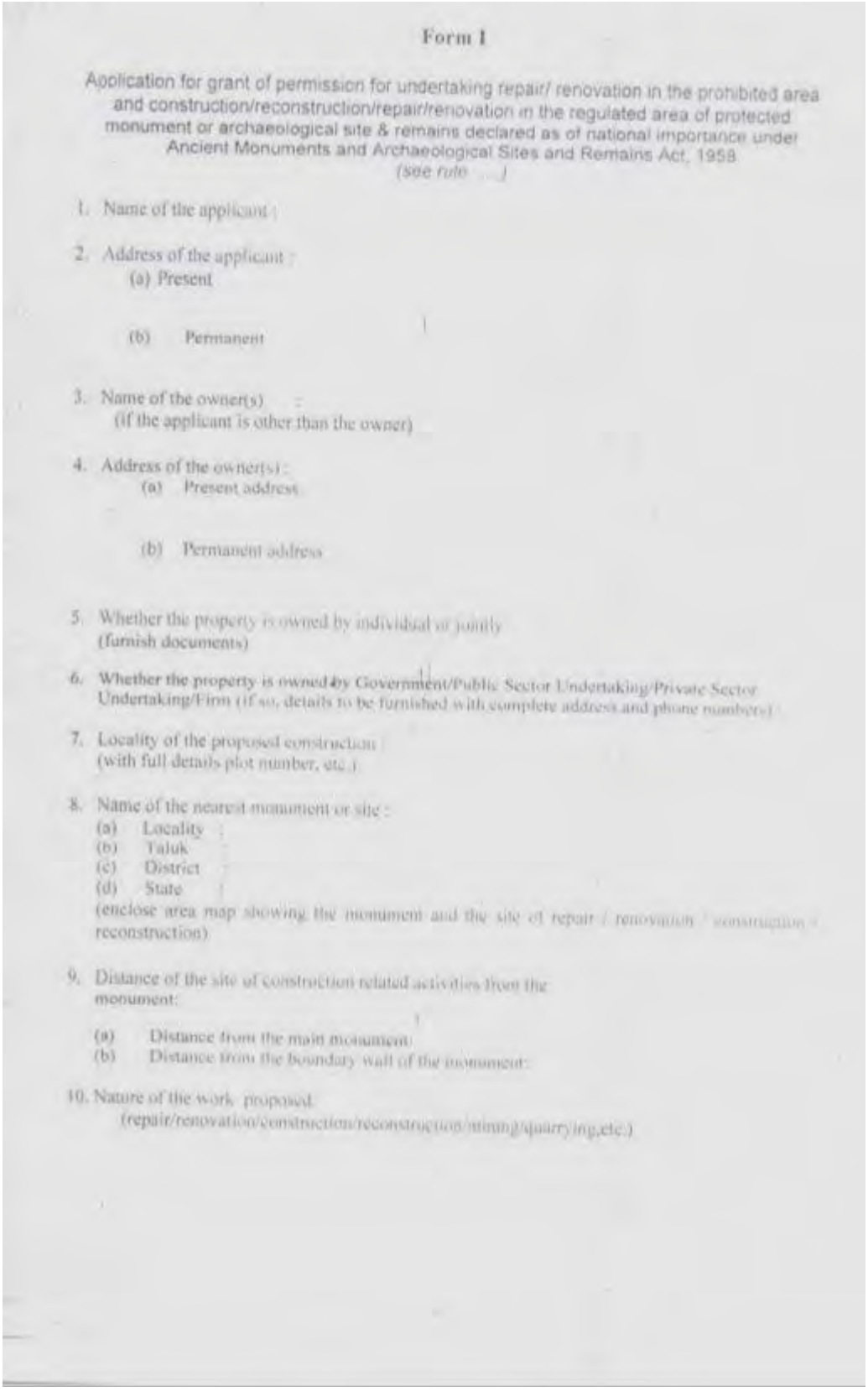
Environmental Impact	Mitigation Measures Taken or To Be Taken	Time Frame	Implementing Organization	Responsible Organization
	accordingly to follow strict procedures while using the water for construction and drinking purpose.	throughout construction		
Sewage disposal during construction at Service Centres	A minimum distance of any sewage or toilet facility from water sources should be 200 metres.	Throughout construction period	Contractor	PIU/EMP implementing agency
Sanitation and Waste Disposal in Construction Camps	Sufficient measures will be taken in the construction camps, i.e. provision of garbage tank and sanitation facilities. Waste in septic tanks will be cleared periodically. Drinking water will meet Indian National Standards. Garbage will be collected in a tank and disposed of daily. Camps will be located at a minimum distance of 200 m from water sources.	Before and during building of construction camps	Contractor	PIU/EMP implementing agency
SOIL				
Quarrying	Quarrying will be carried out at approved and licensed quarries only. Soil parameters of the dumping site should be monitored.	During construction	Contractor	PIU/EMP implementing agency
FLORA AND FAUNA				
Loss of trees and Plantation	Ten times trees will be planted against every tree cut. Plantation of trees as per Ahmedabad Municipal Corporation and Railway authority. More importance should be given for transplantation of tree rather than cut.	During construction and after completion of construction activities.	PIU through Contractor	PIU /EMP Implementation Agency
SOCIAL				
Traffic jams and congestion	If there are traffic jams during construction, measures should be taken to relieve the congestion with the co-ordination of transportation and traffic police department	During construction	Contractor	PIU/ Traffic department

Environmental Impact	Mitigation Measures Taken or To Be Taken	Time Frame	Implementing Organization	Responsible Organization
Safety with vehicles, people and livestock and signage	• Safety education and fines. • Allow for adequate traffic flow around construction areas • Provide adequate signage, barriers and flag persons for safety precautions. • Communicate to the public through radio, TV & newspaper announcements regarding the scope and timeframe of projects, as well as certain construction activities causing disruptions or access restrictions	During construction	Contractor	PIU/ Traffic department
Increase in disease Water-borne Insect-borne Communicable diseases	• Make certain that there is good drainage at all construction areas, to avoid creation of stagnant water bodies. • Provide adequate sanitation and waste disposal at construction camps. • Provide adequate health care for workers	During construction At start-up Throughout construction	Contractor	PIU/EMP implementing agency
Location of camp and storage areas	Location of camps and storage areas shall be as per the contract specifications.	Throughout construction	Contractor	PIU/EMP implementing agency
OPERATION PHASE				
Noise and Vibration	Suitable measures should be considered where warranted. The public shall be educated about the regulations of noise and vibration pollution and its implications.	After completion of construction	PIU/EMP implementing agency	PIU/EMP implementing agency
WATER				
Oil pollution	Suitable treatment shall be taken for treatment of oil in depot areas before discharging the wastewater.	During operation of the treatment plant	PIU/EMP implementing agency	PIU/EMP implementing agency
Disposal of final treated	Options for final disposal shall be studied and the suitable disposal	During operation of	PIU/EMP implementin	PIU/EMP implementing

Environmental Impact	Mitigation Measures Taken or To Be Taken	Time Frame	Implementing Organization	Responsible Organization
effluent from treatment plant.	route shall be decided carefully to minimize the impact of receiving bodies. As far as possible zero discharge rules may be adopted.	the treatment plant	g agency	agency

Appendix 6.1

Application for NOC in Regulated Area of Archaeological Monuments



Form I

Application for grant of permission for undertaking repair/ renovation in the prohibited area and construction/reconstruction/repair/renovation in the regulated area of protected monument or archaeological site & remains declared as of national importance under Ancient Monuments and Archaeological Sites and Remains Act, 1958
(see rule ...)

1. Name of the applicant :
2. Address of the applicant :
   (a) Present
   (b) Permanent
3. Name of the owner(s) :
   (if the applicant is other than the owner)
4. Address of the owner(s) :
   (a) Present address
   (b) Permanent address
5. Whether the property is owned by individual or jointly
   (furnish documents)
6. Whether the property is owned by Government/Public Sector Undertaking/Private Sector Undertaking/Firm (if so, details to be furnished with complete address and phone numbers)
7. Locality of the proposed construction :
   (with full details plot number, etc.)
8. Name of the nearest monument or site :
   (a) Locality :
   (b) Taluk :
   (c) District :
   (d) State :
   (enclose area map showing the monument and the site of repair / renovation / construction / reconstruction)
9. Distance of the site of construction related activities from the monument:
   (a) Distance from the main monument:
   (b) Distance from the boundary wall of the monument:
10. Nature of the work proposed:
    (repair/renovation/construction/reconstruction/mining/quarrying,etc.)

11. Details of work proposed
(furnish complete details with drawings)

(i) Number of storeys
(ii) Floor area (storey-wise)
(iii) Height (excluding mumty, parapet, water-storage tank, etc.)
(iv) Height (including mumty, parapet, water-storage tank, etc.)
(iv) basement, if any proposed with details

(Enclose plan, section and elevation drawings of the existing building duly approved by the Building Plan Sanctioning Authority and proposed building plan with section and elevation in case of reconstruction. Enclose building plan, section and elevation of the proposed building in case of construction/reconstruction.)

12. Purpose of the proposed work :
(residential/commercial/institutional/public/community)

13 Approximate date of the commencement :
of the proposed works

14 Approximate duration for completion of the proposed work :

15. Maximum height of the existing modern buildings in the close vicinity of:
(a) near the Monument:
(b) near the site of construction related activity:

16. Whether the monument is located within the Municipal limits/Nagar Panchayat/Village Panchayat

17. Does any Master Plan/zonal development plan/layout plan approved by concerned local authorities exists for the village/town/city :

18. Status of modern constructions in the vicinity of the monument and the proposed site of construction/reconstruction:

19. Open spaces/park/green area close to the protected monument/protected site:

20. Whether any road(s) exists between the monument and the site of Construction / reconstruction:

21. Remarks/additional information, if any:

I ..... declare that the above information is correct. I also undertake to observe the provisions of the Ancient Monuments and Archaeological Sites and Remains Act, 1958, the Ancient Monuments and Archaeological Sites and Remains (Amendment and Validation) Act, 2010 and the Ancient Monuments and Archaeological Sites and Remains Rules, 1959 and Amendment Rules, 2010.

Place:

Seal of firm (if any)

Date:

Signature of the applicant

Note:

1. If the application is on the behalf of the organization / firm, the signature should be of the head of that organization / firm.
2. Enclose photographs showing the monument and the existing modern constructions.
3. Google Earth Images of the area under reference showing the monument and the site of construction related activities.
4. Enclose ownership documents duly attested by an authorized officer of the Government.
5. In case of repairs/renovation a report from a duly authorized / licenced architect to be submitted by the applicant in case of repairs / renovation.

F. No.....

SITE INSPECTION REPORT FOR "N.O.C."

Inspected the site on ..... on site observations are as under:

1. Name & Address of the Applicant :-
2. Ownership of the plot / building
   C.S. No. / R.S. No. / F.P. No. :-
3. Name of the Nearest Monument :-
4. Height of the Monument :-
5. Height of the existing building / structure :-
6. Height of the proposed construction :-
7. Distance of the proposed construction :-
   From the protected area of the monument
8. Area under which proposed construction :-
   Falls "PROHIBITED/REGULATED
9. Maximum height of the existing buildings :-
   In close vicinity of monument

NORTH: -
.....
SOUTH: -
.....
EAST: -
.....
WEST: -
.....

10. Maximum height of the existing buildings :-
    Near the site of proposed construction

NORTH: -
.....
SOUTH: -
.....
EAST: -
.....
WEST: -
.....

11. Remarks

Signature & Seal of Govt Approved
Engineer / Surveyor

❖ Note: Incorrect information may be subjected to outright rejection of the application.

Appendix-6.2

FORM-I
[See Rule 9 (1)]
(To be submitted in triplicate)
Application for consent establishing/operating the industrial plant/plants under Section 21 of the Air (Prevention & Control of Pollution) Act, 1981

From: Date:

_____
_____
_____
_____

To,
The Member Secretary,
Gujarat Pollution Control Board
Sector-10-A
GANDHINAGAR – 382 043
GUJARAT

I/We hereby apply for consent / renewal of consent under Section 21 of the Air (Prevention & Control of Pollution) Act, 1981 to establishment / operate the industrial plant / plants owned by

_____

to be located / located at _____

_____

The relevant details are as under:

1. Full name of the applicant with designation and address and Telephone / Telex number.
2. Full address of the factory / industrial plant/s (Survey No. village plot No. location of premises etc.) with telephone/telex Nos.
3. Names of full time directors / partners / owners with addresses and telephone nos.
4. Plant/project cost (Rs. in Lakhs).
5. Specify whether small, medium or large scale.
6. Date of commission of industrial plant/s or proposed date of commissioning.

7. Total number of employee

8. List of raw materials with monthly consumption rate (MT/month)

	Raw Materials	Quantity in MT/month
(i)		
(ii)		
(iii)		
(iv)		
(v)		
(vi)		
(vii)		
(viii)		

9. List of products with monthly production rate (MT/month)

	Products	Quantity in MT/month
(i)		
(ii)		
(iii)		
(iv)		
(v)		
(vi)		
(vii)		
(viii)		

10. Brief description of the manufacturing process together with a flow diagram and layout plan showing location of all vents, stacks and any other emission points.

11. Details of boilers/heaters/furnaces installed in the plant.

(a) Boilers

Boiler No.	Type of boiler	Type of fuel (coal, HSD, furnace oil, gas etc.)	Fuel consumption rate in MT/houe or KL/hour or M^3 / hour.

(b) Heaters

Heater No.	Type of Heater	Fuel	Fuel consumption rate in MT / hour or KL / hour M^3 / hour.

(c) Furnaces

Furnace No.	Type of Furnace	Fuel	Fuel consumption rate in MT/hour or KL/hour or M^3 / hour.

12. Emission details :

(a) Emission from boilers/heaters/furnaces and other processes involving fuel combustion

(1) Boiler/Heater/Furnace No.	(2) Stack Identification (attached to boiler/heater/Furnace	(3) Concentration of pollutants like particulate Matter (in mg NM^3) SO_x NO_x, (in ppm) B/T	A/T	(4) Rate of emission in Kg/hr.	(5) Height of stack from ground level

(b) Process emissions

(1) Name and location of the process vessel to which the stack/vent is attached	(2) Rate of emission in Kg./hr.	(3) Concentration of pollution like SO_2, NOx, H_2S, Cl HCl etc. in mg/NM^3 B/T	A/T	(4) Height of Vent/outlet/stack from ground level in meters

13. Details of air Pollution control equipment for the control of Pollution resulting from emission of pollutants from process plant and combustion equipment.

Name of equipment	Attached to	Date/proposed date of installation	Efficiency % reduction	Final concentration of pollution being emitted

14. Any other relevant information:

15. Declaration:

(i) I/We hereby submit that in case of any change relating to manufacturing process/product, fuel, emission rate, pollution control equipment, capacity of the plant etc., fresh application for consent shall be made until such Consent is granted, no change will be implemented.

(ii) I/We hereby agree to submit to the Board, application for renewal of Consent at least one month prior to the date of expiry of the present consent period.

(iii) I/We further declare that information furnished through this application is correct to the best of my/our knowledge.

(iv) I/We undertake to furnish any other information within one month of such intimation received from the Board.

(v) I/We enclose herewith Bank Draft No. _____ dated _____ for Rs._____ (Rupees _____ drawn in favour of the Gujarat Pollution Control Board payable at Gandhinagar; as the Consent fees under Section 21 of the Act.

(Please refer to Schedule 1 for the rate of consent fees).

Yours faithfully,

Authentic Signature :

Name of the application :

Designation :

Address :

Accompaniments:

(i) Site plan

(ii) Layout Plan showing location of all vents, Stacks and other emission points.

(iii) Process flow sheet

(iv) Analysis Report of emissions

(v) Details of air pollution control devices

SCHEDULE-1

[See Rule 9 (2)]

RATE OF CONSENT FEES

Serial No.		Consent Fee Rupees [Per unit]
1.	Asbestos and Asbestos Products industrial plants	10,000
2.	Cement, Cement Products industrial plants	
	(a) Plant with production capacity up to 200 MT/day	5,000
	(b) Plant with Production capacity more than 400 MT/day	10,000
3.	Ceramic and Ceramic Products industrial plants	1,000
4.	Chemical and allied industrial plants	10,000
5.	Coal and Lignite based chemical industrial plants	10,000
6.	Engineering industrial plants	
	(a) Without heat treatment and electroplating	1,500
	(b) With heat treatment	2,500
	(c) With electroplating	2,500
	(d) With both	5,000
7.	Ferrous Metallurgical industrial plants	10,000
8.	Fertilizer industrial plants	7,500
9.	Foundry industrial plants	5,000
10.	Food and Agricultural products industrial plants	2,000
11.	Mining industrial plants	10,000
12.	Non-Ferrous Metallurgical industrial plants	10,000
13.	Ores/Mineral Processing industrial plants including beneficiation pelletization, etc.	10,000
14.	Power (Coal Petroleum and their products) industrial plants.	10,000
15.	Paper and pulp (including paper products) industrial plants	5,000
16.	Textile processing industrial plants (made wholly or in part of cotton)	5,000
17.	Petroleum Refinery industrial plants	5,000
18.	Petroleum products and Petrochemical industrial plants	10,000
19.	Plants for recovery from and disposal of waste	5,000
20.	Incinerator plants	10,000
21.	Tyre Industry	5,000
22.	Small scale industrial plants irrespective of the type of process	2,000
23.	Any other industrial plants	
	[a] Large Scale	10,000
	[b] Medium Scale	5,000

INFRASTRUCTURE USE: NEW

CENTRAL GROUND WATER AUTHORITY
(Constituted under section 3 (3) of the Environment (Protection) Act, 1986)

APPLICATION FOR PERMISSION TO ABSTRACT GROUNDWATER FOR INFRASTRUCTURE PROJECTS

1. General Information

(i) Name of the Infrastructure:

(ii) Location details of the Infrastructure unit:

Village: Block/Mandal: Tehsil/Taluka:

District: State:
(Attach site plan and location map)

Lat/Long.

Urban Development Authority/
Municipal Corporation/Gram Panchayat:

(iii) Communication address:

(iv) Type of Infrastructure

(a) Residential township
(b) Commercial activity
(c) Industrial activity
(d) Others

(v) Land use details of the existing/proposed

Total land area: sq m
Rooftop area of buildings/sheds: sq m
Road/paved area: sq m
Green belt area: sq m
Open land: sq m
Any other structure proposed (details shall be given below)

(vi) Source of availability of surface water, if any – furnish details

(vii) Average Annual rainfall in the area: mm

(viii) Whether groundwater utilization for:

(a) New Project

(b) Expansion programme

2. Total number and type of:
   a. Dwelling units:
   b. Commercial units:
   c. Industrial units:
   d. Others:

3. Detail of water requirement /recycled water usage: (Please enclose flow chart of activities and requirement of water at each stage)

(i) Net water requirement: m^3/day
Ground Water required: m^3/day
Surface Water required: m^3/day
Proposed/existing water supply from any agency: m^3/day

(ii) Breakup of water requirement and usage:

Activity	Existing requirement (m^3/day)	Proposed requirement (m^3/day)	Total requirement (m^3/day)	No. of operational days in a year	Annual requirement (m^3/year)
Residential/ domestic					
Commercial activity					
Greenbelt development					
Industrial activity					
Other use					
Grand total					

(iii) Whether ETP/STP proposed, if so furnish following details on reuse of recycled water:

m^3/day m^3/year

i) Quantity of treated water available:
   a. Industrial activity:.....
   b. Commercial activity:.....
   c. Green belt development:.....
   d. Other use:.....
   Total:.....

(iv) Whether project would involve dewatering ground water for excavation for basement construction, etc. Yes/No.
If Yes then following information shall be required:

a	Whether the groundwater table will be intersected by the activity-if so		
	(a) At what depth (m bgl)	Pre-monsoon	Post-monsoon
	Minimum		
	Maximum		
	(b) Maximum depth proposed to dewater (m bgl)		
	(c) Groundwater flow direction (attach map)		
	(d) Any Other information		
b	Quantum of ground water proposed to be pumped out	M^3/day	M^3/year

	a. Type of structure required for pumping out ground water	
	b. Number of pumps proposed to installed	
	c. HP of the pumps	
	d. Operational hours/day	
	e. Operational days/year	
c	Proposed utilization of pumped water (please attach details)	
	a. Water Supply	
	b. Agriculture	
	c. Green belt development	
	d. Suppression of dust	
	e. Recharge	
	f. Any other item 1. 2. 3.	

4. Whether local government water supply network exists in the area, if yes, provide details.

5. Whether obtained/applied for water supply from government/private agency, if so, furnish following details:

   a) If water supply committed, give proofs:
   b) If water supply denied, give proofs:

6. Details of existing/proposed groundwater abstraction structures:

Particulars	Existing structure	Proposed structure
Number of structure		
Type of structure (dug well, tube well, bore well, dug cum bore well)		
Year of construction		
Depth (meter below ground level)		
Diameter (mm)		
Depth to water level (meters below ground level)		
Discharge (m^3/hour)		
Operational hours/day		
Operational days/year		
Mode of lift and Horse Power of pump		
Whether fitted with meter or not		
Whether permission/ registered with CGWA, if so details thereof		

7 Groundwater availability (please enclose a comprehensive report/note on groundwater condition/groundwater quality in and around the area) Applicable to infrastructure units consuming > 500 m^3/day and/or having a land area of > 20 Ha.

8 Details of rainwater harvesting/artificial recharge measures for groundwater recharge in the area. If already implemented, details may be furnished. (Attach report on comprehensive & feasible Rainwater harvesting/recharge proposal).

9 Copy of Approval letter of State Government Agency approving the Infrastructure development to be attached.

10 Copy of referral letter seeking NOC from CGWA from Central/State Pollution Control Board/Ministry of Environment and Forests/other Central/State agencies may be attached.

11 Have you applied for groundwater clearance permission earlier from CGWA/Stage Government Agency, if so, give details thereof with status.

Undertaking

It is to certify that the details and information furnished above are true to the best of my knowledge and belief and I am aware that if any part of the data/information submitted is found to be false or misleading at any stage the application will be rejected out rightly.

Date: Name & Signature of the applicant*
(With official seal)

Place:

* In case signed by any authorized signatory, the details of the signatory with the authorization shall be enclosed.

- ***Incomplete/ partially filled applications would be rejected summarily.***
- *Application Profroma is subject to modification from time to time*
- *Application in duplicate should be submitted either to the* **Member Secretary, Central Ground Water Authority, West Block 2, Wing 3, R K Puram, Sector 1, New Delhi 110066** *or to the* **Regional Director, Central Ground Water Board** *of concerned State.*

No. B

FORM - 1

(See rules 3(2), 5(2) (3) and (6) (ii))

Application for obtaining Authorisation for Collection/Reception / Treatment/ Transports/Storage/Disposal of Hazardous Waste*

From .....

.....

.....

To,

The Member Secretary,
Gujarat Pollution Control Board,
Sector-10 (A), Gandhinagar.

Sir,

I/ We hereby apply for authorisation/renewal of authorisaiton under sub-rule (2) and (3) and clause (ii) of sub - rule (6) of rule 5 of the hazardous Wastes (Management and Handling) Rules, 1989 for collection / reception / treatment / transport / storage / disposal of hazardous wastes.

For Office Use Only

5. Code No.
6 Whether the unit is situated in a critically polluted area as identified by Ministry of Environment and Forests;

To be filled in by Applicant

Part-A : General

3. (a) Name and address of the unit and location of activity.
   (b) Authorisation required for (Please tick mark appropriate activity / activities :
      (i) collection
      (ii) reception
      (iii) treatment
      (iv) transport
      (v) storage
      (vi) disposal
   (c) In case of renewal of authorisation previous authorisation numberand date

* delete whichever is not applicable

1

4. (a) Whether the unit is generating hazardous waste as defined in the Hazardous wastes (Management and Handling) Rules, 1989 and amendments made thereunder;
   (b) If so the type and quantity of wastes

5. (a) Total capital invested on the project :
   (b) Year of commencement of production :
   (c) whether the industry works general / 2 shifts/ round the clock :

6. (a) List and quantum of products and by - products :
   (b) List and quantum of raw material used :

7. Furnish a flow diagram of manufacturing process showing input and output in terms of products and waste generated including for captive power generation and demineralised water.

Part - B : Sewage and Trade Effluent

8. Quantity and source of water for :
   (a) Cooling m^3/d
   (b) Process m^3/d
   (c) Domestic use m^3/d
   (d) Others m^3/d

9. Sewage and trade effluent discharge;
   (a) Quantum of discharge m3/d :
   (b) Is there any effluent treatment plant :
   (c) If yes, a brief description of unit operations with capacity :
   (d) Characteristics of final effluent :
   pH
   Suspended solids
   Dissolved solids
   Chemical Oxygen Demand (COD)
   Biochemical Oxygen Demand *[(BoD_5/20 °C) / BoD_3 / 27 °C]
   Oil and grease
   (additional parameters as specified by the concerned Pollution Control Board)
   (e) Mode of disposal and final discharge point :
   (enclose map showing discharge point) :
   (f) Parameters and Frequency of self monitoring :
   [*] Read BOD (3 days at 27 °C)

Part - C : Stack (Chimney) and Vent Emissions

10. (a) Number of stacks and vents with height and dia (m)
   (b) Quality and quantity of stack emission from each of the above stacks particulate matter and Sulphar dioxide (SO_2) (Additional parameters as specified by the concerned Pollution Control Board)
   (c) A brief account of the air pollution control unit to deal with the emission :
   (d) Parameters and Frequency of self monitoring :

2

Part - D : Hazardous Waste

11. Hazardous Wastes :
    (a) Type of hazardous wastes generated as defined under the Hazardous Wastes (Management and Handling) Rules, 1989.
    (b) Quantum of hazardous waste generated :
    (c) Mode of storage within the plant, method of disposal and capacity :
12. (a) Hazardous Chemicals as defined under the Manufacture, Storage and Import of Hazardous Chemicals Rules, 1989)
    (b) Whether any isolated storage is involved (if yes, attach details) Yes/No

Part-E : Treatment, Storage and Disposal Facility

13. Detailed proposal of the facility (to be attached) to include :
    (i) Location of site (provide map)
    (ii) Name of waste processing technology
    (iii) Details of processing technology
    (iv) Type and Quantity of waste to be processed per day
    (v) Site clearance (from local authority, if any)
    (vi) Utilization programme for waste processed (product Utilization)
    (vii) Method of disposal (details in brief be given)
    (viii) Quantity of waste to be disposed per day
    (ix) Nature and composition of waste
    (x) Methodology and operational details of landfilling / incineration
    (xi) Measures to be taken for prevention and control of environmental pollution including treatment of leachates
    (xii) Investment on Project and expected returns
    (xiii) Measures to be taken for safety of workers working in the plant

Place :
Date :

Signature : .....
Designation : .....

3

Rate of Authorisation Fee (with effect from 1/10/03)

Sr. No.	Category	Fee in Rupees (for one year)
1.	Common Facility for final disposal of hazardous waste (TSDF)	10,000/-
2.	Common Facility for incineration of harardous waste	5,000/-
3.	Small Scale Unit (any category)	2,000/-
4	Large Scale unit (other than small scale unit)	5,000/- + 1,000 (For each waste category)

4

GUJARAT POLLUTION CONTROL BOARD

ગુજરાત પ્રદૂષણ નિયંત્રણ બોર્ડ

Paryavaran Bhavan, Sector-10/A, Gandhinagar-382010

પર્યાવરણ ભવન, સેક્ટર-૧૦/એ, ગાંધીનગર ૩૮૨ ૦૧૦

FORM-D

[See Rule 20 and rule 21]

Application for consent to establish or take any step to establish any Industry, operation proccess or any treatment and disposal system for discharge, under section 25 or continutation or discharge under section 26 of the Water (Prevention and Control of Pollution) Act. 1974.

Date :

From :

To,
The Member Secretary,
Gujarat Pollution Control Board
Sector-10/A,
Gandhinagar - 382010

Sir,

I/We hereby apply for consent/renewal of consent under section 25 of the Water (Prevention and Control of Pollution) Act.1974 (6 of 1974) to establish or take any step to establish any Industry or operation or process or a treatment and disposal system or any extension or addition to bring into use any new altered outlet for discharge of sewage/trade effluent* to continue to discharge sewage/trade effluent* from land/premises owned by

The other relevant details are below :

1. Full name of the applicant
2. Nationality of the applicant
3. (a) Individual
   (b) Proprietary concern
   (c) Partnership firm (whether registered or unregistered)
   (d) Joint family concern
   (e) Private Limited Company
   (f) Public Limited Company
   (g) Government Company
      (1) State Government
      (2) Central Government

*Strike out which is not relevant.

(h) Foreign Company

(if a foreign company, the details of registration, incorporation etc.)

(i) Any Other Association or Body

4. Names, Address and Telephone Nos. of Applicant :

(The full list of individuals partners, persons, Chairman (full-time or part-time) Managing Directors, Managing Partners, Directors (full time or Part-time) and other office bearers, be furnished with their period of ternure in the respective office, with telephone, Nos. and residential address).

5. Address of the industry.

(Survey No, Khasra No., location as per the revenue records, Village Firka, Tehsil, District, Police Station or SHO, Jurisdiction of the First Class Magistrate)

6. Details of Commissioning etc :-

(a) Approximate date of proposed commissioning of work.

(b) Expected date of commencement of production.

7. Total number of employee expected to be employed.

8. Details of license, if any obtained under the provisions of Industrial Development Regulation Act., 1951

9. Name of the person authorised to sign this form (the original authorization except in the case of individual proprietor concern is to be enclosed).

10. (a) Details of raw materials and chemicals used per month.

(b) List or products and by - products.

(c) Licence or Annual Capacity of the industry, operation or process etc.

11. State daily quantity of water in kilolitres utilized and its source (domestic / industiral process boiler Cooling others)

12. (a) State the daily maximum quantity of effluents, quantity and mode of disposal (sewer or drains or river of land or lake./ pond / or estary / tidal waters / sea water / off share) Also attach analysis report of the effluents.

Type of effluent, quantity in kiloliters. Mode of disposal.

(I) Domestic

(ii) Industrial

(b) Quality of effluent currently discharged or expected to be discharged

(c) What monitoring arrangement is currently provided or proposed.

13. State whether you have any treatment plant for industrial, domestic or combined effluents.

Yes / No.

14. If yes, attach the description of the process of treatment in brief. Attach information on the quality of treated effluent vis - a vis the standards. State details of solid wastes generated in the process or during waste treatment.

Description	Quantity	Method	Method of disposal

15. I / We further declare that the information furnished above is correct to the best or my / our knowledge.

16. I / We hereby submit that in case of change either of the point of discharge or the quantity of discharge or its quality, a fresh application for CONSENT shall be made and until such CONSENT is granted no change shall be brought into use.

17. I / We hereby agree to submit to the Gujarat Pollution Control Board an application for renewal of consent one month in advance of the date of expiry of the consented period for outlet / discharge if, to be continued thereafter.

18. I / We undertake to furnish any other information within one month of its being called for by the Gujarat Pollution Control Board.

19. I / We, enclose herewith Cash Receipt No. / Bank Draft No.....
date.....for Rs.....(Rupees.....
.....) in favour of the Gujarat Pollution Control Board, Sector - 10/A, Gandhinagar as fees payable under section 25 of the Act.

Signature of the Applicant

Note : *Strike out which is not relevant

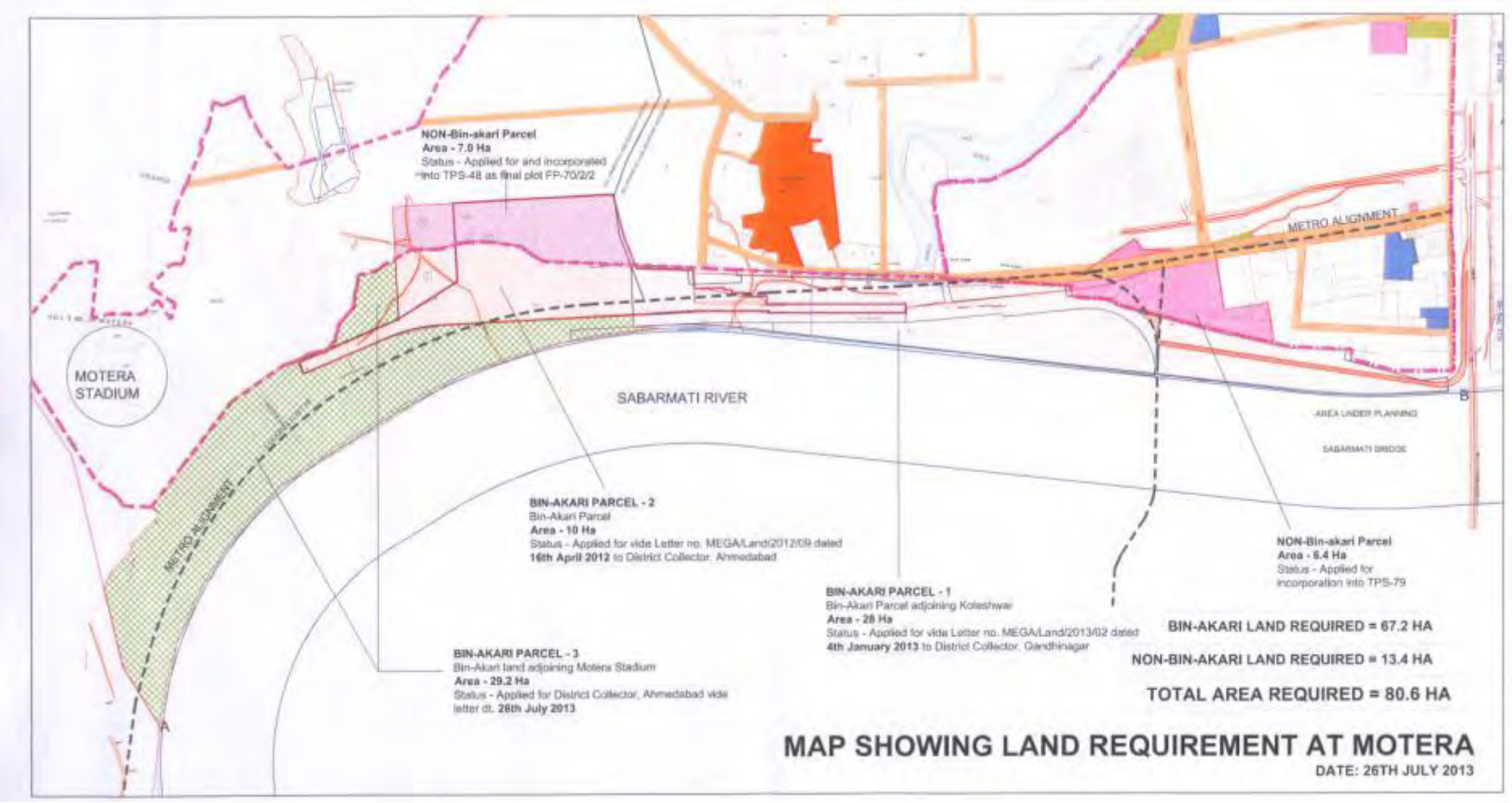
Order of slab	Kiloliters of average water Consumption per day	Fee in Rupees
1	upto 10	1,000
2	Above 10 to 20	1,500
3	Above 20 to 30	2,000
4	Above 30 to 50	2,500
5	Above 50 to 100	3,000
6	Above 100 to 500	5,000
7	Above 500 to 1,000	10,000
8	Above 1,000 to 5,000	20,000
9	Above 5,000	30,000

Appendix-6.6

MUCK DUMPING SITE AT VASTRAL GAM

Appendix-6.7

MUCK DUMPING SITE AT RIVERFRONT



CHAPTER-7
PUBLIC CONSULTATION

7.1 INTRODUCTION

ñPublic Consultationò refers to the process by which the concerns of local affected persons and others who have plausible stake in the environmental impacts of the project or activity are ascertained with a view to taking into account all the material concerns in the project or activity design as appropriate. Consultation is used as a tool to inform stakeholders about the proposed action both before and after the development decisions are made. It assists in identification of the problems associated with the project. Initial Public consultation has been carried out in the project areas with the objectives of minimizing probable adverse impacts of the project and to achieve speedy implementation of the project through bringing in awareness among the community about the benefits of the project.

7.2 METHODS & APPROACH FOR CONSULTATION

Public consultation was accomplished to collect the opinion/views of the stakeholders for the construction of the project. Open discussion was held by conducting one to one meeting at project level and district level by disseminating the information by circulating the project summary/ discussing the issue on the desk. People in meeting were explained about the project activities and their consequences in brief. Queries of the stakeholder were replied by the environmental expert and at the same time their suggestions were also endorsed. It was held at the doorstep of the people or at a common place of people's gathering. In one to one meeting, people expressed open view and asked openly to understand the project while in gathering combined opinion of the people was collected.

7.3 CONSULTATION AT PROJECT LEVEL

The consultations were conducted during the reconnaissance/ field visit during second and third week of September 2014 and based on informal unstructured interviews and focus group discussion. The objective of the consultation was to disseminate the project information and ascertain stakeholderôs views on probable environmental impacts that may arise due to the implementation of the proposed project. Public were intimated about the consultation venue, date and time. The venues, date and time of the public consultations are presented in **Table 7.1**. EIA Consultant officials explained about need of the project describing environmental issues like anticipated positive & negative impacts and use of techniques during construction and time frame of construction period during public consultation. About 46 people from different community participated in public consultation at project level for both the corridors. Of the total, 8 persons at Thaltej, 7 at Vastral Station and 9 at Vastral Gam on E-W corridor were participated. On North-South corridor, 6 persons at APMC, 10 at Ayojan Nagar (near Shreyas Station) and 6 at Sabarmati Power House (AEC) had raised the questions related to environmental issues.

The following issues were discussed during the consultations**.**

- Overall need of the project;
- Project location;
- Environmental concerns; and

TABLE 7.1
PROJECT LEVEL PUBLIC CONSULTATION VENUE

S.No.	Corridor	Venue of the Public Consultation	No. Of Participant	Venue
1	East-West	Thaltej	8	18th Sept 2014
2		Vastral Station	7	18th Sept 2014
3		Vastral Gam	9	18th Sept 2014
4	North-South	APMC	6	19th Sept 2014
5		Ayojan Nagar	10	19th Sept 2014
6		Sabarmati Power House	6	19th Sept 2014

The photographs showing stakeholders participation at public consultation held at various places are shown in **Figure 7.1**.

FIGURE 7.1
PHOTOGRAPHS OF PUBLIC CONSULTATION AT PROJECT LEVEL

Location: Thaltej

Location: Vastral Station

Location: Vastral Gam

Location: APMC

Location: Ayojan Nagar

Location: Sabarmati (AEC)

7.4 ISSUES, SUGGESTIONS AND MITIGATION MEASURES

Issues raised by the stakeholders with their valuable suggestions were noted down for consideration into the report which is depicted at **Appendix 7.1**. **Table 7.2** depicts the stakeholders' consultation at project level in which some of the important issues raised by stakeholders and their suggestions have been incorporated. Relevant issues grouped and placed under single heading. Most of the participants are welcomed the proposed Metro work. The suggestive mitigation measures are taken in detail in the last column of the table.

TABLE 7.2
PROJECT LEVEL STAKEHOLDERS' CONSULTATION

ISSUES RAISED	SUGGESTIONS OF STAKEHOLDERS	MITIGATION MEASURES
Tree removal	New trees should be planted for tree cut.	Cutting of trees will be minimized wherever possible. Compensatory afforestation will be done by transplanting & planting trees.
Air & Noise pollution	Pollution due to air and noise during the construction	Latest technology will be adopted to minimize pollution during construction. Air & noise monitoring will be conducted regularly as per schedule.
Employment	Employment opportunities.	As per policy contractors will give preference to affected PAFs.
Safety	Safety due to proposed Metro	Complete Safety during travelling as compared to road transport.
Traffic Conjunction	No traffic conjunction	Proposed Metro provides relief from road traffic conjunction.

Appendix 7.1

Project Level Public Consultation

Project Name: EIA Study for Proposed Ahmedabad Metro

PUBLIC CONSULTATION

East-West Corridor

Date: 18/9/2012

Location/Venue: Thaltej

Sr. No	Particulars	Name of Person	Sign	Mobile No
1	~~Lalabhai That~~ Teen no Issues as 10 trees planted per cut	Lalabhai Thakorji Corporator (Thaltej)		9328784523
2	~~Mahendra~~ No issue of Pollution as it is temporary.	Mahendrabhai Patel. Mahamantri (Thaltej)		7727202174
3.	Help in reduction of travel time.	Popatji Thakorr Uppramukh		9904615762
4.	— No Issue —	Rohanak Patel Yuva Morcha Pramukh.		7624026515
5.	Increase in safety	Fitubhai Bhanwal Karyakarta		9724744921
6.	Employment opportunities	Umeshbhai Bharot		7777aaa263
7.	—No issue & happy with proposed Metro.	~~Dasharat~~ Prajapati		9879253197
8.	Good initiate by Guj. Govt. Pollution free (less pollu) transportation System.	Atul M Patel Asst. City Engineer (Thaltej)		9375134150

Project Name: EIA Study for Proposed Ahmedabad Metro

PUBLIC CONSULTATION

Date: 18/09/2014

East-West Corridor Location/Venue: Vastral Station

Sr. No	Particulars	Name of Person	Sign	Mobile No
1.	Better opportunity for employment	Kiranji Solanki		08401919442
2.	Reduction in traffic Pollution	Pragin ei Chauhan (Temple Pujarijji)		09998157045
3	Safety	Shaktisinghji Jala		
4.	Metro Connectivity is Going to be better	Bhagvanji Kesiji Jalaji		
5.	Safety & 10 trees Planted for each cut	Vipul bhai (Vinodbhai Parekh)		
6.	Business Increase	Chanduji Prabhuji (Pan shop)		
7.	No problem	Champaben Parmar		

Project Name: EIA Study for Proposed Ahmedabad Metro East - West Corridor.

Date: 19/9/2014

Location: Vastral Gam

Sr. No	Particulars	Name of Person	Sign	Mobile No
1.	Education problem	Arjunbhai	Arjun	
2.	Transportation problem solve due to Metro	Balabhai	[illegible]	
3.	Good Connectivity	Ankit bhai	[illegible]	A.K. Patel
4.	Pollution reduction	Lalchandbhai	[illegible]	
5.	No problem (Metro is good)	Amratbhai	[illegible]	
6.	~~Sai~~ Trees will be saved (10 trees planted for each cut)	Vipulbhai	VIPUL	
7.	Pollution during Constr.	Popatbhai	P.S	
8.	Employment opportunity	Vijaybhai	[illegible]	
9.	Good Connectivity due to metro.	Ashokbhai	A. P Patel	

Project Name: EIA Study for Proposed Ahmedabad Metro

PUBLIC CONSULTATION

Date: 19/8/2014

North-South Corridor Location/Venue: APMC station

Sr. No	Particulars	Name of Person	Sign	Mobile No
1.	Good for connectivity	J.R Prajapati.		9825073523
2.	Safety	[illegible]		9898082934
3.	Safety for school going childerns	[illegible]		[illegible]
4	~~Jaish~~ No problem	Jaish		
5.	No pollution problem	D.L.Doddiya		9898266352
6.	Less drawbacks & more advantage.	R.D. Patel APMC Accountant		

Project Name: EIA Study for Proposed Ahmedabad Metro

PUBLIC CONSULTATION

Date: 19/09/2014

Location/Venue: Ayodhya Nagar (N-S)

Sr. No	Particulars	Name of Person	Sign	Mobile No
1.	Tree cutting inside temple pritutse(Rly.)	Arji Pandya Retired Rly. (Moneliy)		09099668144
2.	Proper utilization of Land (Railway Open land)	K. turakhaia	K.M.T	09423535709
3.	Shorten the trip for going college	Harish Saresa		9924624772
4.	Good Connectivity to main city.	Chetan Chaudhary		9099718899
5.	No traffic Conjunction	Kapil Tanvani		9033588341
6.	Less pollution due to metro.	Hiren Thakur		7874340844
7.	No problem of poll. during constr. as it is good initiate of Guj. Govt.	Sidharth Parmar		8200014132
8.	Good public transport system.	Parth Makvana		9924456155
9.	Good Concept → safely during travelling	Yogesh. Tanvani		9979476538
10.	No problem	Bhagyesh. Raisoni		9687950100

PUBLIC CONSULTATION

Date: 19/09/2014
Location: Sabarmati Power House

Sr.	Description	Name	Mobile	Sign
1.	Route to be extended from Sabarmati to Adalaj via Chandkheda due to updown of people	Mehrubhai	9998123281	
2.	Tree cutting	K.H. Thakur	8758062304	
3.	Safety & reduction of pollution.	Balaji Vamzara		
4.	Better connectivity	Bayabhai Vamzara		
5.	No problem	Narendra Thakar		
6.	Good initiative when it is completed	Dhirubhai		

CHAPTER - 8
ENVIRONMENTAL MONITORING PLAN

The environmental monitoring programmes of development project are a vital process of any Environmental Management Plan (EMP) for review of indicators and take immediate preventive action. This helps in signalling the potential problems resulting from the proposed project activities and will allow for prompt implementation of corrective measures. The environmental monitoring will be required during both construction and operational phases. The following parameters are proposed to be monitored:

- Water Quality,
- Air Quality, Noise and Vibration,
- Soil Quality monitoring,
- Ecological Monitoring,
- Workers Health and Safety

Environmental monitoring during pre-construction phase is important to know the baseline data and to predict the adverse impacts during construction and operations phases. Pre-construction phase monitoring has been done for the proposed project for air, noise, vibration, water, and ecology. The monitoring results are documented in **Chapter - 3**.

8.1. Water Quality Monitoring

Though it is expected that, no impact on water quality is anticipated, monitoring of water quality may be required to assess the impact of the project during construction and operation phase. Water quality parameters shall be monitored during the construction phase and also for at least three years after the completion of the project (Total 8 years). Monitoring shall be carried out at least three times a year to cover seasonal variations. The water quality monitoring program details are given in the **Table 8.1**. The cost for water quality monitoring works out to be **Rs. 1.24 million**.

TABLE 8.1
WATER QUALITY MONITORING PROGRAMME

ITEMS	DESCRIPTION
Parameters to be monitored	pH, Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Total Dissolved Solids, Chlorides, Nitrates, Sulphates, Iron, Calcium, Total Nitrogen, Lead, Total Phosphates, oils and grease.
Location during construction	As per decision of Engineer in Charge **17 Locations:** 2 Depots (Apparel Park and Giyaspur), 3 construction yards (Vastral, Doordarshan and Giyaspur), 4 Labour Camps, 1 Surface Water (Sabarmaiti River), 4 samples on E-W and 3 samples on N-S alignment)
Location during operation	**9 Locations:** one sample each at 2 Depots, 1 surface water sample, 6 samples (3 on each alignment)
Frequency for surface water & ground water	Once in a season; for three season in a year; for Eight years.
Monitoring Cost (Rs.)	Rs. 20.16 Lakh.

Water quality monitoring should be carried out at least three times a year to cover seasonal variations by any Government or recognized private agency. Water quality should be analyzed as per drinking water quality parameters as per BIS: 10500.

8.2. Soil Monitoring

Soils near to the construction area shall be monitored to ascertain the presence of soil polluting chemicals due to construction activities. Soil quality monitoring will be carried out for Depots, Labour camps, station locations, dumping site and the details are given in the **Table 8.2.** The soil quality monitoring program for muck will be based on random sampling of soil coming out during tunneling is given in the **Table 8.3**.

TABLE 8.2
SOIL QUALITY MONITORING PROGRAMME

ITEMS	DESCRIPTION
Parameters to be monitored	pH, Sodium, Potassium, Chloride, Nitrogen, Phosphorous, Organic Matter, Heavy Metals, Oil and Grease.
Location during construction	As per decision of Engineer in Charge 42 Locations: 2 Depots (Apparel Park and Giyaspur), 3 construction yards (Vastral, Doordarshan and Giyaspur), 4 Labour Camps, 2 Dumping sites (vastral and river front at Motera) and Stations (16 stations on E-W and 15 stations on N-S)
Proposed Site during operation	2 Depots (Apparel Park and Giyaspur) and 2 Dumping sites (vastral and Motera river front)
Frequency	Three samples in a season and three times in a year for Eight years.
Monitoring Cost (Rs.)	**Rs. 159.84 Lakh**

TABLE 8.3
SOIL QUALITY MONITORING PROGRAMME FOR MUCK

ITEMS	DESCRIPTION
Parameters to be monitored	pH, Electrical conductivity, Alkalinity, Moisture content, texture, Heavy Metals and Specific gravity.
Location during construction	19 locations: 3 samples per every Kilometer
Frequency	At random sampling @ three samples in one km
Monitoring Cost (Rs.)	**Rs. 1.52 Lakh**

8.3. Air Quality, Noise and Vibration Monitoring

Ambient air quality and Noise levels should be monitored during the construction phase and for at least three years after the completion of the project. Vibration monitoring during construction will be carried out at 12 predefined locations (Archaeological Monuments) and other locations as per the requirement. Together the cost for ambient air quality, Noise levels and Vibration Monitoring works out to be **Rs. 331.3 Lakh** as per the break up given in **Table 8.4, Table 8.5 and Table 8.6** respectively.

TABLE 8.4
AIR QUALITY MONITORING PROGRAMME

ITEMS	DESCRIPTION

Parameters to be monitored	$PM_{2.5}$, PM_{10}, SO_2, NO_x, CO, HC
Location during construction	15 samples as per decision of Engineer in Charge **15 locations:** 2 Depots (Apparel Park and Giyaspur), 3 construction yards (Vastral, Doordarshan and Giyaspur), 4 Labour Camps, 2 Dumping sites (vastral and river front at Motera) and 4 sensitive locations (2 on each alignment)
Proposed Site during operation	**8 Locations:** 2 Depots (Apparel Park and Giyaspur) and 2 Dumping sites (vastral and river front at Motera) and 4 sensitive locations (2 on each alignment)
Frequency	Twice in a week for each season for three season in a year for nine years.
Monitoring Cost (Rs.)	**Rs. 59.4 Lakh**

TABLE 8.5
NOISE QUALITY MONITORING PROGRAMME

ITEMS	DESCRIPTION
Parameters to be monitored	Leq, L90, L50, L10, Lday, Lnight, Lday-night
Location during construction	15 samples as per decision of Engineer in Charge **15 locations:** 2 Depots (Apparel Park and Giyaspur), 3 construction yards (Vastral, Doordarshan and Giyaspur), 4 Labour Camps, 2 Dumping sites (vastral and river front at Motera) and 4 sensitive locations (2 on each alignment)
Proposed Site during operation	**8 Locations:** 2 Depots (Apparel Park and Giyaspur) and 2 Dumping sites (vastral and river front at Motera) and 4 sensitive locations (2 on each alignment)
Frequency	Twice in a week for each season for three season in a year for nine years.
Monitoring Cost (Rs.)	**Rs. 11.9 Lakh**

TABLE 8.6
VIBRATION MONITORING PROGRAMME

ITEMS	DESCRIPTION
Parameters to be monitored	Construction: Field Measured Average Ambient vibration (VdB) & Vibration due to TBM Operation (VdB). For Operation: Vibration due to Metro Train Operation (VdB).
Location during construction	13 Locations as per decision of Engineer in Charge 7 archaeological monuments, 2 locations vertically above U/G section, 4 sensitive locations (2 on each alignment)
Proposed Site during operation	13 Locations as per decision of Engineer in Charge 7 archaeological monuments, 2 locations vertically above U/G section, 4 locations (2 on each alignment)
Frequency	**Construction:** Continuous 6 month monitoring for tunneling section at 2 locations at a time. Once during construction for 4 sensitive locations on elevated section. **Operation:** Monitoring 3 times in a year for 4 years at U/G section (9 locations); and 4 sensitive locations for elevated section.
Monitoring Cost (Rs.)	**Rs. 260 Lakh**

8.4. Ecological Monitoring

The project authority in coordination with the Department of Gardening and Plantation, AMC shall monitor the status of ecology/trees along the project corridors at regular interval during construction phase in order to maintain the ecological environment. The plantation/afforestation of trees by Department of Gardening and Plantation, AMC will be reviewed regularly for MEGA during construction Phase.

8.5. Workers Health and Safety

Continuous Monitoring of health risk issues will be done throughout the project life time. Epidemiological studies at construction sites and workers camp will be performed to monitor the potential spread of diseases. Regular inspection and medical checkups shall be carried out to workers health and safety monitoring. Any recurring incidents such as irritations, rashes, respiratory problems etc shall be recorded and appropriate mitigation measures shall be taken. Contractor will be responsible to take care of health and safety of workers during the entire period of construction and project proponent will review/audit the health and safety measures/plans regularly.

8.6. ENVIRONMENTAL MONITORING DIVISION

It is recommended that MEGA establishes an Environment Division at the initial stage of the project itself. The division should be staffed with an Environmental Engineer/Officer and a Technical Assistant (environment background). The task of the division would be to supervise and coordinate studies, environmental monitoring and implementation of environmental mitigation measures, and it should report directly to Project Director of the project authority. Organizational setups for Environmental Monitoring during construction and operation phase are presented in section 6.3. Costs for the first ten years (including 10% annual increase has been) given **Table 8.7**.

TABLE 8.7
ENVIRONMENTAL DIVISION COSTS

S. No	Particulars	Cost (Lakh)
Per Year		
1.	Environmental Engineer (1No.)	9.60
2.	Technical Assistant (1No.)	4.80
3.	Miscellaneous Expenditure	2.40
	Total Cost per One Year	**16.80**
	Total Cost for Ten Years with 10% annual increase	**311.32**

8.7. REPORTING SYSTEM

The environmental monitoring involves regular checking of the environmental management issues to ascertain the implementation of mitigation measures according to the progress of the project work. It provides the necessary feedback for the impact of the project on environment which ultimately leads to human health. The monitoring report of environmental parameters will be prepared by the environmental engineer and submitted to the PMC. The monitoring report of Air, Noise, Water and soil should be prepared and submitted within fifteen days from end of quarter (Season). The muck and vibration monitoring report should be submitted as per progress of construction work. The reporting procedure will be maintained as per described below:

- The contractor will report to Construction Supervision Consultant (CSC) and CSC will report to MEGA. MEGA may disseminate the information to all interested parties.
- The contactor will submit the report as per the schedule of monitoring given at Section 8.1 of EIA report.
- Non compliance of the monitoring will be seen by the MEGA.
- Photographic monitoring record will be maintained by the contractor. All material source points, disposal locations, plant locations, camp locations, etc should be photographed.
- A full record of construction activities will be kept as a part of normal contract monitoring system under the various stages of construction.
- Operation stage monitoring will be annual or bi-annual provided the Environmental Completion Report shows that implementation has been completed satisfactorily.
- The reporting format for various activities during construction is given at **Appendix 5.1 to Appendix 5.10.**

8.7.1. Record Keeping

Monitoring forms will need to be devised for use, focusing attention on environmental issues and providing feedback for future improvement. Mitigation and enhancement measures adopted in the final design will be explicitly under the bill of quantities (BOQ), so that performance and completion is readily documented. Project diaries would record environmental problems (soil erosion, air quality, water quality, noise level etc), as well as safety incidents and will be retained as part of the accepted environmental management, to be summarized in Quarterly Environmental Reports.

APPENDIX 8.1

DETAILS OF BATCHING PLANT

(To be filled by the Contractor)

Name of Location _____
Report for Batching Plant
Reporting Month……..
Date of Submission……..

1. Environment Features of the surrounding area

1.1	Name and location of Batching Plant	
1.2	Wind direction	
1.3	Name (s), distance population and type of settlements in a 1.5 km radius of site.	

2. Details of Batching Plant and Mitigation Measures taken

2.1	Installed Capacity	
2.2	Average Utilization	
2.5	Last maintenance date	

3. Explain Air Pollution Control Measures taken at the Batching Plant site

4. Explain Noise Pollution Control Measures taken at the Batching Plant site

Remark

Submitted	Checked	Approved
Signature …….	Signature ……	Signature ……
Name ……	Name ……	Name ……
Designation …….		
Contractor	Environmental Engineer of Construction Supervision Consultant	In-charge Officer (PIU)

APPENDIX 8.2

DETAILS OF MUCK DUMPING OPERATIONS

(To be filled by the Contractor)

Dumping site location _____
Reporting Month……..
Date of Submission …….

1. Environment Features of the surrounding area

1.1	Location of Dumping site	
1.2	Capacity of Dumping site	
1.3	Safety measure taken at Dumping site (s)	
1. 2. 3. 4. 5.		

Remark

Submitted	**Checked**	**Approved**
Signature …….	Signature ……	Signature ……
Name ……	Name ……	Name ……
Designation ……		
Contractor	Environmental Engineer of Construction Supervision Consultant	In-charge Officer (PIU)

APPENDIX 8.3

DETAILS OF MACHINERY DURING CONSTRUCTION

(To be filled Monthly by the Contractor)

Location Name _____
Reporting Month……..
Date of Submission ……..
(Attach copy of GPCB emission control certificate every 3 months)

1. Details of Machinery Operation

1.1	Total machinery in operation (Nos.)	
1.2	Number of pavers	
1.3	Number of rollers	
1.4	Number of excavators	
1.5	Number of graders	
1.6	Number of dumpers	
1.7	Number of Cranes	
1.8	No. of workshops with repairs facility (furnish location and type of facility provided)	Workshop on Facility Location Provided
1.9	Number of vehicles in repair at each location	
1.10	Details of waste disposal	
1.11	Others	

Remark

Submitted	**Checked**	**Approved**
Signature …….	Signature ……	Signature ……
Name ……	Name ……	Name ……
Designation ……		
Contractor	Environmental Engineer of Construction Supervision Consultant	In-charge Officer (PIU)

APPENDIX 8.4

SAFETY CHECK LIST

(To be filled by the Contractor)

1 Contract No. _____
2 Name of Contractor _____
3 Representation _____
4 Name of Safety Officer _____
5 Date of Inspection _____

Location 1 …… Location 2 …… Location 3 ……

Adequate at time of Inspection Needs Improvement Needs Immediate Attention	Location 1			Location 2			Location 3			Remark
	A	B	C	A	B	C	A	B	C	
General										
House keeping										
Stacking of Material										
Passageway										
Lighting										
Ventilation										
Others										
Electrical										
Switches										
Wirings										
Fixed Installation										
Portable Lighting										
Portable Tool										
Welding Machine										
Others										
Fire Prevention										
Fire Fighting Appliance										
Dangerous Goods Store										
Gas Welding Cylinders										
Others										
Others										
Dust Control										
Noise Control										
First Aid Equipment										
Washing Facility										
Latrine										
Canteen										
Provision of Personal Protective										
Helmet										
Eye Protector										
Ear Protector										
Respirator										
Safety Shoes										
Safety Belts										
Others										

Remark

Submitted
Signature …….
Name ……
Designation ……
Contractor

Checked
Signature ……
Name ……

Environmental Engineer of
Construction Supervision Consultant

Approved
Signature ……
Name ……

In-charge Officer (PIU)

APPENDIX 8.5

ACCIDENT REPORT
(To be completed on Occurrence of Injury by the Safety Officer)

Type of Accident

D01 ( )	Fall of person from a height		D11 ( )	Explosion
D02 ( )	Slip, trip or fall on same level		D12 ( )	Fire
D03 ( )	Struck against fixed objects		D13 ( )	Contact with hot or corrosive substances
D04 ( )	Struck by flying or falling objects		D14 ( )	Contact with poisonous gas or toxic substances
D05 ( )	Struck by moving objects		D15 ( )	Contact with electric current
D06 ( )	Struck / caught by cable		D16 ( )	Hand tool accident
D07 ( )	Stepping on hail etc.		D17 ( )	Vehicle / Mobile plant accident
D08 ( )	Handling without machinery		D18 ( )	Machinery operation accident
D09 ( )	Crushing / burying		D19 ( )	Other (please specify)
D10 ( )	Drowning or asphyxiation			

Agent Involved in Accident

E01 ( )	Machinery		E11 ( )	Excavation / underground working
E02 ( )	Portable power appliance		E12 ( )	Floor, ground, stairs or any working, surface
E03 ( )	Vehicle or associated equipment / machinery		E13 ( )	Ladder
E04 ( )	Material being handled, used or stored		E14 ( )	Scaffolding/gondola
E05 ( )	Gas, vpour, dust, fume or oxygen		E15 ( )	Construction formwork, shuttering and falsework
E06 ( )	Hand tools		E16 ( )	Electricity supply cable, wiring switchboard and associated equipment
E07 ( )	Floor edge		E17 ( )	Nail, sllnter or chipping
E08 ( )	Floor opening		E18 ( )	Other (Please specify)
E09 ( )	Left shaft		E19 ( )	
E10 ( )	Stair edge			

Unsafe Action Relevant to the Accident

F01 ( )	Operating without authority		F11 ( )	Failure to use eye protector
F02 ( )	Failure to secure objects		F12 ( )	Failure to use respirator
F03 ( )	Making safety devices inoperative		F13 ( )	Failure to use proper clothing
F04 ( )	Working on moving or dangerous equipment		F14 ( )	Failure to use warn others or given proper signals
F05 ( )	Using un-safety equipment		F15 ( )	Horseplay
F06 ( )	Adopting unsafe position or posture		F16 ( )	No unsafe action

F07 ( )	Operating or working at unsafe speed		F17 ( )	Others (please specify)
F08 ( )	Unsafe loading, Placing, mixing etc.		F18 ( )	
F09 ( )	Failure to use helmet		F19 ( )	
F10 ( )	Failure to use proper footwear			

G01 ( )	No Protective gear		G08 ( )	Unsafe layout of job, traffic etc.
G02 ( )	Defective protective gear		G09 ( )	Unsafe process of job methods
G03 ( )	Improper dress / footwear		G10 ( )	Poor housekeeping
G04 ( )	Improper guarding		G11 ( )	Lack of warming system
G05 ( )	Improper ventilation		G12 ( )	Defective tool, machinery or materials
G06 ( )	Improper illumination		G13 ( )	No unsafe condition
G07 ( )	Improper procedure		G14 ( )	Others (please specify)

Personal Factor Relevant to the Accident

H01 ( )	Incorrect attitude / motive		H04 ( )	Unsafe act by another person
H02 ( )	Lack of knowledge or skill		H05 ( )	No unsafe personal factor
H03 ( )	Physical defects		H06 ( )	Other (please specify)

Remark

Submitted
Signature ……
Name ……..
Designation ……..
Contractor

Checked
Signature ……..
Name ……
Designation ……..
Environmental engineer.
Construction Supervision Consultant

Approved
Signature ……
Name ……..
Designation ……
In-charge Officer (PIU)

Part-II – To be completed upon Finalization of Employee's Compensation Claim

101 ( ) No permanent incapacity
102 ( ) Less than 5% incapacity
103 ( ) More than 5% incapacity
104 ( ) Fatal

Submitted
Signature ……
Name ……..
Designation ……..
Contractor

Checked
Signature ……
Name ……
Designation ……..
Environmental engineer.
Construction Supervision Consultant

Approved
Signature ……
Name ……
Designation ……
In-charge Officer (PIU)

APPENDIX 8.6

POLLUTION MONITORING

Construction site location _____
Construction Stage: Report – Date: _____Month _____Year_____
Mitigation measures suggested in last report complied or Not……
If not reasons thereof……
(Location at which monitoring to be conducted as per EMP)

Sl. No.	Chainage (km)	Details of locations	Duration of monitoring	Instruments used	Completion			Standards	Results	Reasons for exceeding standards	Mitigation Measures suggested	Type of area (Residential / Industrial / Commercial)	Remarks
1. Air Monitoring													
		As per decision of Engineer in Charge	As per Section 8.1					CPCB					
2. Water Monitoring													
		As per decision of Engineer in Charge	As per Section 8.1					CPCB					
3. Soil Monitoring													
		As per decision of Engineer in Charge	As per Section 8.1					pH, Organic Matter, Alkalinity, Conductivity, Water holding capacity					
4. Noise Monitoring													
		As per decision of Engineer in Charge	As per Section 8.1					CPCB					
Remark													

Submitted
Signature ……
Name ……..
Designation …….
Contractor

Checked
Signature ……..
Name ……
Environmental Engineer of
Construction Supervision Consultant

Approved
Signature ……
Name ……..
In-charge Officer (PIU)

APPENDIX 8.7

RESTORATION OF CONSTRUCTION SITES
(To be filled by the Contractor)

Construction site location _____
(Reporting by Contractor to PIU)
Construction stage: Monthly Report – Date ……Month ……Year.

Sl. No.	Contract Package	Labor Camp		Construction Camp		Plant Site		Disposal Locations		Top Soil	
		O	R	O	R	O	R	O	R	Preserved	Restored

Remark

Submitted
Signature ……
Name …….
Designation ……..
Contractor

Checked
Signature ……..
Name ……
Designation ……..
Environmental engineer of Construction Supervision Consultant

Approved
Signature ……
Name ……..
Designation ……
In-charge Officer (PIU)

APPENDIX 8.8

FORMAT FOR KEEPING RECORDS OF CONSENT OBTAINED BY CONTRACTOR

Construction site location _____
Construction Stage: Report – Date: _____Month_____ Year_____

Sl. No.	Contractor's Name	Clearance	Applicable Acts	Agencies	Obtained on	Valid up to	Remarks
	Construction site location						

Remark

Submitted
Signature ……
Name ……..
Designation ……..
Contractor

Checked
Signature ……..
Name ……
Designation ……..
Environmental engineer of Construction Supervision Consultant

Approved
Signature ……
Name ……..
Designation ……
In-charge Officer (PIU)

APPENDIX 8.9

CHECKLIST FOR ENVIRONMENT INSPECTION
(Points / Issues to be covered)

Construction site location _____

Date of Inspection_____

Sl. No.	ESMP Measures
1	Provision of a personnel accountable for implementation of ESMP / Safety Measures with Contractor
2	Consent of PCB to Establish Batching Plant
3	Consent of PCB to operate Batching Plant
4	Compliance of PCB Conditions for Batching Plant installation and operation
5	Whether compliance reported through monthly Progress report to In-Charge (PIU)
6	PUC taken for all Construction vehicles
7	Concrete platform with trap under bitumen boiler, Fuel Tank for Batching Plant and generator set provided or not
8	Precautions to prevent contamination of soil by emulsion, oil and lubricant taken while storing
9	Providing cover to fine construction material & bituminous mix during transportation
10	Muck /debris disposal:
	a) Present status of land
	b) Closure and completion plan
11	Site specific traffic Safety management Plan:
	a) Contractor installed the warning / regulatory Traffic signs at the construction site
	b) The arrangement adequate
12	Safety equipment i.e helmet, gloves, gumboot, mask, earplugs etc. provided to workers
13	Health Facility at camp and work site i.e. First Aid kit & suitable vehicle for conveyance in case of emergency / accident
14	Permit for Procuring River sand
15	Licence from Department of mines for quarrying
16	Consent to establish / operation of crusher
17	Provision of labour camp with sanitation & potable water
18	Fire precautions at Plant and site Office
19	Air and noise monitoring done in camp site
20	Whether any cultural property is being impacted
21	Status of drainage provision in camp area
22	General House Keeping

Remark

Submitted
Signature ……
Name ……..
Designation ……..
Contractor

Checked
Signature ……..
Name ……
Designation ……..
Environmental engineer of Construction Supervision Consultant

Approved
Signature ……
Name ……
Designation ……
In-charge Officer (PIU)

APPENDIX 8.10

SUMMARY SHEET
(To be filled monthly by CSC and Submitted to HO, MEGA)

Construction site location _____
Month_____Date_____

Sl No.	Description	Remarks
1	***No Objection Certificate***	
A	Cement Batching Plant	
	Location 1	
	Location 2	
	Location 3	
2	***Pollution Under Certificate***	
	Vehicles	
	Machineries	
3	**No Objection Certificate for Diesel Gen set**	
	Location 1	
	Location 2	
4	**Labour Camps**	
	No. of sites Identified	
	Approved	
	Opened	
	Conforms to conditions imposed at the time of opening of sites	
	Closed	
5	***Workers***	
	No of workers employed	
	No of male workers	
	No of female workers	
	No of day workers	
6	**Borrow Area**	
	No. of sites identified	
	Approved	
	Opened	
	Quantity of available material	
	Quantity of material Utilized	
	Quantity of Topsoil preserved	
	Quantity of top soil used	
	No of sites closed	
	No. of sites Rehabilitated	
7	**Quarry**	
	No. of sites identified	
	Approved	
	Opened	
	Material available	
	Material obtained	
	No. of sites Rehabilitated	
8	**Disposal Locations**	
	No. of sites identified	
	Approved	
	Opened	
	Amount of Waste disposed	
	Type of waste disposed	
	No. of sites Rehabilitated	
9	**Road Safety**	
	Road Safety norms and approved Traffic plan	
10	**Cleaning of Culvert/ drains**	
	No. of culverts/ drains	
	Nos Cleaned	
11	**Trees**	
	No of trees marked for cutting in field	

Sl No.	Description	Remarks
	No of trees cut	
	No of trees to be Planted	
	Trees Planted	
12	**Haul Roads**	
	Adequacy of maintenance of Haul Road Network	

Remark

Submitted
Signature ……
Name ……
Designation …….
Contractor

Checked
Signature ……..
Name ……
Designation ……..
Environmental engineer of Construction Supervision Consultant

Approved
Signature ……
Name ……..
Designation ……
In-charge Officer (PIU)

CHAPTER-9
COST ESTIMATES

9.1 SUMMARY OF COSTS

The environmental costs towards implementation of environmental management plan and mitigation measures during pre-construction, construction and operation of the proposed project are estimated of **Rs. 5916.81 Lakh** and described in **Table 9.1**. These costs are computed in Chapter 6 and Chapter 8. Certain items in the environmental management plan make part of the contractual obligations of the construction contractor. Breakdown of the cost may be referred as per the section described in **Table 9.1**.

TABLE 9.1
ENVIRONMENTAL COSTS

S. No.	ITEM	REFERANCE	COST (Lakh)
1.	Tree Plantation and Transplantation	Section 6.3.1	658.12
2.	Sanitation facilities at Labour camp	Section 6.3.4	47.12
3.	Water supply & Sewage/ Effluent Treatment at Depot	Section 6.3.20	110.00
4.	Green Belt Development & Rain Water Harvesting at Depot	Section 6.3.20	55.00
5.	Environmental monitoring during construction and operation	Section 8.1	512.80
6.	Muck Disposal	Section 6.3.15	3999.45
7.	Training Programmes	Section 6.3.21	138.00
8.	Establishment of Environment Division	Section 8.2	311.32
9.	Environmental Enhancement Measures	Section 6.3.22	85.00
		Total	**5916.81**

Cost of Rehabilitation and Resettlement has been presented in separate report. The Environmental management plan should be implemented in phases so that optimum benefit could be achieved and should be synchronized with the construction schedules.