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Environmental and Social Management Plan

for

Rail Based Mass Rapid Transit System in Agra

Uttar Pradesh Metro Rail Corporation Limited
उत्तर प्रदेश मेट्रो रेल कॉर्पोरेशन लिमिटेड
A joint Venture of Govt. of India and Govt. of Uttar Pradesh
Formerly Lucknow Metro Rail Corporation Limited
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Prepared by:

Uttar Pradesh Metro Rail Corporation

For

European Investment Bank

CURRENCY EQUIVALENTS
(As of August 2010)

United States Dollar (USD)	–	Indian rupee (INR)
USD 1.00	=	INR 74.49

ABBREVIATIONS

AAQ	–	Ambient Air Quality
AAQM	–	Ambient Air Quality Monitoring
ADA	–	Agra Development Authority
AFC	–	Automatic Fare Collection
AMC	–	Agra Municipal Corporation
AMASR	–	Ancient Monument and Archaeological Sites and Remains
AMR	–	Agra Metro Rail
ASI	–	Archaeological Survey of India
BAU	–	Business as Usual
BOD	–	Biological Oxygen Demand
BOQ	–	Bill of Quantity
BRTS	–	Bus Rapid Transit System
BSES	–	Baseline Socio-Economic Survey
C&D	–	Construction and Demolition
CGWB	–	Central Ground Water Board
CMP	–	Comprehensive Mobility Plan
CO	–	Carbon Monoxide
COD	–	Chemical Oxygen Demand
CPCB	–	Central Pollution Control Board
GCS	–	General Consultancy Service
DG Set	–	Diesel Generating Set
DMRC	–	Delhi Metro Rail Corporation
DO	–	Dissolved Oxygen
DPR	–	Detailed Project Report
DRDO	–	Defense Research & Development Organization
EA	–	Executing Agency
EAC	–	Expert Appraisal Committee
EIA	–	Environmental Impact Assessment
EIB		European Investment Bank
EMP	–	Environmental Management Plan
EMOP	–	Environmental Monitoring Plan
EPCA	–	Environment Pollution (Prevention and Control) Authority
ETP	–	Effluent Treatment Plant
ESZs	–	Eco-Sensitive Zones
GHG	–	Greenhouse Gas
GSHAP	–	Global Seismic Hazard Assessment Program
GST	–	Goods and Services Tax
GOI	–	Government of India
GOUP	–	Government of Uttar Pradesh
GRC	–	Grievance Redress Committee
GRM	–	Grievance Redress Mechanism
IEE	–	Initial Environmental Examination
IPT	–	Intermediate Public Transport

ISBT	–	Inter-State Bus Terminus
IMD	–	Indian Meteorological Department
IRC	–	Indian Road Congress
LAO	–	Land Acquisition Officer
LRC	–	Local Resettlement Committees
Max	–	Maximum
Min	–	Minimum
MORSTH	–	Ministry of Road Surface Transport And Highways
MOEFCC	–	Ministry of Environment, Forests and Climate Change
MoHUA	–	Ministry of Housing and Urban Affairs
MRTS	–	Mass Rapid Transit System
NAAQS	–	National Ambient Air Quality Standard
NCR	–	National Capital Region
NATM	–	New Austrian Tunnelling Machine
NGT	–	National Green Tribunal
NGO	–	Non governmental Organization
NH	–	National Highway
NOC	–	No Objection Certificate
NOx	–	Oxides of Nitrogen
OHE	–	Overhead Traction System
O & M cost	–	Operation & Maintenance Cost
PAC	–	Pradeshik Armed Constabulary
PAPs	–	Project Affected People
PCU	–	Passenger Car Units
PD	–	Project Director
PIU	–	Project Implementation Unit
PM	–	Particulate Matter
PHPDT	–	Peak Hour Peak Direction Trips
PPE	–	Personal Protective Equipment
PPT	–	Parts Per Trillion
PSU	–	Public Sector Undertaking
RAP	–	Resettlement Action Plan
RO	–	Reverse Osmosis
ROW	–	Right of Way
RRO	–	Resettlement and Rehabilitation Officer
RSPM	–	Respiratory Suspended Particulate Matter
SC	–	Scheduled Caste
SDO	–	Social Development Officer
SIA	–	Social Impact Assessment
SMU	–	Social Management Unit
STP	–	Sewage Treatment Plant
ST	–	Scheduled Tribe
SOx	–	Oxides of Sulphur
SPCB	–	State Pollution Control Board
SPM	–	Suspended Particulate Matter
SPV	–	Special Purpose Vehicle
TBM	–	Tunnel Boring Machine
TDS	–	Total Dissolve Solids
TOD	–	Transit Oriented Development
TTZ	–	Taj Trapezium Zone
UNESCO	–	United Nations Educational, Scientific and Cultural Organization
UPMRC	–	Uttar Pradesh Metro Rail Corporation
UPSRTC	–	Uttar Pradesh State Road Transport Corporation

VOC	–	Vehicle Operating Cost

WEIGHTS AND MEASURES

dB (A)	–	A-weighted decibel
ha	–	hectare
km	–	kilometre
km^2	–	square kilometre
KWA	–	kilowatt ampere
Leq	–	equivalent continuous noise level
µg	–	microgram
m	–	meter
MW (megawatt)	–	megawatt
PM 2.5 or 10	–	particulate matter of 2.5 micron or 10 micron size

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EXECUTIVE SUMMARY

1. Agra, the city of Taj Mahal is the 3rd most populous city in Uttar Pradesh and is administrative headquarters of the Agra district. Agra was the capital city of Mughals during their rule. The City is a major tourist hub with number of monuments like Agra Fort, Tomb of Akbar and Fatehpur Sikri besides the Taj Mahal, which have been listed as the UNESCO World Heritage sites. In the past few decades Agra Development Authority Area has experienced an unprecedented spatial expansion from 61.8 sq km in 1971 to 520.2 sq km in 2008. The city's population grew from 5.9 lakh in 1971 to 9.8 lakh in 1991, 12.7 lakh in 2001 and 15.9 lakh in 2011.

2. The administrative limits of the Agra Nagar Nigam encompass an area of 141.0 sq. km with a population density of about 9,043 persons per sq. km. The highest density lies in the old city areas like Lohamandi and Shahganj, etc. where the settlements started flourishing from the Mughal period.

3. Unequal spatial development has led to pockets of high density in terms of employment and population, putting pressure on the infrastructure. A major challenge is to provide connectivity and promote growth by providing adequate inputs to the infrastructure which would improve the quality of life of the residents.

4. Large-scale urbanization and rapid growth of vehicles population has laid severe stress on the urban transport system in Agra city. The sharing of limited right of way by a variety of modes and other utility services has resulted in traffic congestion, accidents and environment deterioration. The nature of trips that the people have to make is also quite varied and they use private means of transport for most of these trips given the convenience of accessibility. The usage of private modes is growing unabated mainly due to inadequate and inconvenient public transport facilities with poor level of service. The augmentation in the capacity of public transport infrastructure has become necessary.

5. In order to alleviate the transport related problems in the City, Comprehensive Mobility Plan (CMP) has been prepared in 2017 adhering to Ministry of Housing and Urban Affairs (MoHUA), Government of India guidelines. It identifies various short, medium and long-term measures of transport infrastructure in the City. CMP recommends mass transport systems along two major travel corridors.

6. Based on the proposals from CMP, an Alternatives Analysis has been carried out to find the most viable mass transit system along two identified corridors. Alternatives Analysis Report recommends to implement a Metro Rail system on these two corridors in Agra. The Government of Uttar Pradesh has engaged RITES Ltd. to prepare a ‘Detailed Project Report (DPR) for Metro Rail System in Agra’.

7. Agra City, has experienced rapid tourism, economic and population growth in recent years, which has led to a significant increase in traffic volumes and trip numbers and associated deterioration of environmental conditions in the urban area. To counter such environmental degradation and stem economic losses resulting from traffic congestion and low travel times, the Government of India (GOI) has identified public transport as a key means of restraining the use of private vehicles and improving the regional air quality and environmental conditions.

8. CMP proposes implementation of mass transit system for two priority corridors in Agra and Alternatives Analysis Report recommends Metro Rail System for these two corridors.Two corridors were agreed upon for the study. Corridor 1 starts from Sikandara and ends at Taj East Gate (Hotel Trident) whereas corridor 2 starts from Agra Cantt. Railway Station and ends at Kalindi Vihar (Trans Yamuna Colony Phase-II) which traverses through city from west to east and South to North respectively. An interchange station between the corridors has been proposed near St. John's College.

9. Topographical survey of the Corridor 1- (Sikandara to Taj East Gate) and Coridor-2 (Agra Cantt. to Kalindi Vihar) have been carried out to collect all manmade and natural features like roads, building, drain, railway line telephone/electric pole etc., falling in the proposed metro corridor for better and accurate planning of the metro alignment. Survey covered picking up of relevant details like roads, footpaths, dividers/central verges, railway tracks, trees, manholes and other structures, H.T., L.T., Transmission lines, bridges, ROBs / RUBs, ponds, streams, major drains, level crossing, religious structures such as Temples, Gurudwaras, Mosques, Churches, Monuments, tombs etc. Spot/ Ground levels were taken at 25 m intervals in longitudinal as well as traverse direction and at sudden change of levels.

10. Two corridors have been finalized for implementation in Phase – I of Agra Metro Rail Project network as per details given under:

11. Corridor-1: Sikandara to Taj East Gate: Considering centre line of Sikandara station as 0.00m, this corridor is 14000m long starting from -50m and running upto 13950m. This corridor consists of elevated and Underground stretches along with Switch over Ramps (SOR)

12. Corridor-2: Agra Cantt. to Kalindi Vihar : Considering centre line of Agra Cantt. Metro Station as 0.00m, this corridor is 15400m long starting from (-)50m and running upto 15350m. This corridor is proposed as completely elevated. Depot entry having a length of about 800m has been proposed after Kalindi Vihar Station

13. No archaeological monuments are directly affected. There are 2 Archaeological Monuments along the corridor-1 and 2 along the Corridor-2 are within prohibited area of 100 meters and 6 monuments are passing within 200 meters of regulated area. In underground section the tunnel will be constructed by State of Art Technology i.e. Tunnel Boring Machine (TBM) and stations will be constructed by Cut and Cover method which is widely accepted and the safest technique being adopted by metro in India and abroad.

14. 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 officer of the UPMRC 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.

15. Prior to the construction/operation, identification of safety hazards would be made by Project Authority and prepare safety programmes following rules, regulations and guidelines.

16. In accordance with the Construction Contract the Contractor shall provide the following facilities at the labour camps: (temporary) living accommodation, sanitation facilities like toilets and drains, health awareness campaigns, facilities for water supply and waste water treatment and solid waste management.

17. In accordance with the Construction Contract the Contractor will be required to provide shelter at workplace, canteen facilities, first aid facilities, day crèche facilities on work sites.

18. Construction works shall be executed as laid down in the Safety Health and Environment (SHE) manual prepared by the Contractor and approved by PIU.

19. The contractor shall use and maintain equipment so as to conserve energy. Measures to conserve energy include but not limited to the following: use of tools, plant and equipment of correct specifications; energy efficient motors and pumps; efficient lamps; optimal maintenance.

20. The contractor shall identify the nature and quantity of hazardous waste generated as a result of his activities and shall and shall obtain authorization from State Pollution Control Board. Hazardous waste would mainly arise from the maintenance of equipment which may include used engine oils, hydraulic fluids, waste fuel, spend mineral oil/cleaning fluids from mechanical machinery, scrap batteries or spent acid/alkali, spend solvents etc. Hazardous Waste needs to be stored in a secure place and adequately labelled and packaged. The contractor shall maintain a record of sale, transfer, storage of such waste and make these records available for inspection.

21. Precipitation systems will be installed to prevent wash water from construction sites polluting surface water courses.

22. Environmental sanitation also referred to as Housekeeping is the act of keeping the working environment cleared of all construction material/debris, scraps and used material/items, thereby providing a first-line of defence against accidents and injuries. General environmental sanitation shall be carried out by the contractor and ensured at all times at Work Site, Construction Depot, Batching Plant, Stores, Offices and toilets/urinals.

23. The proposed Metro alignment runs along major arterial roads of the city which serves Institutional, Commercial and Residential areas. Large number of sub-surface, surface and overhead utility services, viz. sewers, water mains, storm water drains, telephone cables, electrical transmission lines, electric poles, traffic signals etc. already exist along the proposed alignments. 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. As such, these may affect construction and project implementation time schedule/costs, for which necessary planning/action needs to be initiated in advance.

24. Prior to the actual execution of work at site, detailed investigation of all utilities and location will be undertaken well in advance by making trench pit to avoid damage to any utility. While planning for diversion of underground utility services e.g. sewer lines, water pipe lines, cables etc., during construction of Metro, the following guidelines could be adopted:

    a. Utility services shall be kept operational during the entire construction period and after completion of project.
    b. 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.

c. 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.

d. In case of underground utility services running across the alignment, the spanning arrangement of the viaduct may be suitably adjusted.

25. The proposed alignment is passing within the prohibited area,2 archaeological monuments in case of Corridor-1 and 2 archaeological monuments in case of Corridor-2 coming in prohibited area. Necessary procedure will be followed for Construction within the regulated area of Archaeological Monuments. Prior to the initiation of construction, UPMRC will conduct condition survey of all archaeological/heritage structures in the vicinity of alignment so as to follow up during construction and operation of the project.

26. 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. Mitigation measures will be adopted to reduce the air pollution.

27. There may be an increase in ambient noise level due to construction. The exposure of workers to high noise levels can be minimized by job rotation, automation, protective devices and soundproof compartments, control rooms etc. Noise level from loading and unloading of construction materials can be reduced by usage of various types of cranes and placing materials on sand or sandy bag beds.

28. In the case of vibrations from pile driving very deep barriers (in excess of 10 m) were found to reduce vibration. In-ground barriers are trenches that are either left open or filled with a material (such as bentonite or concrete) that has stiffness or density significantly different from that of the surrounding soil. However, trenches may be too costly for situations involving houses. They could perhaps be justified for larger buildings with strict vibration limits, such as operating theatres of hospitals or high-tech factories with sensitive processes. An economical alternative to trenches in a residential area could be a row of lime or cement piles of diameter 0.5 m to 1 m and a depth of 15 m in the right-of-way adjacent to the road. Ballast-less track is supported on two layers of rubber pads to reduce track noise and ground vibrations.

29. 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 like cut and cover can be employed to ensure that traffic impedance is minimized. During operation decongestion scheme should involve taxi and auto rickshaw stands, a halting space for public buses, drop off-pick up for owned modes. Parking space at stations if any is to be planned well.

30. Construction and Demolition (C&D) debris is that part of the solid waste stream that results from land clearing, excavation, construction, demolition, remodeling and repair of structures, roads and utilities. C&D waste generated from metro construction has potential use after processing and grading. Post-grading the waste should be disposed at sites identified by UPMRC in consultation with respective authority like Municipal Corporation etc. such that the sites are away from residential areas, water body/ water course and do not require displacement.

31. Two maintenance depots are planned for Agra Metro. These are at i) PAC land Near Mall Road and ii) Kalindi Vihar. The management plan for depot site includes:

    a) Water supply: Water will be required for operation and functioning of depot which will be through municipal supply or boring tube well into the ground. The ground water will need treatment depending upon its use. For Domestic application a Reverse Osmosis (RO) system will be appropriate.

    b) 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. The tank may be designed for a detention period of 5 to 15 minutes.

    c) Sewage/Effluent Pollution Control: Sewage will be generated from depot which 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. Similarly, effluent is likely to be generated from Depots. This has to be treated as per requirement of UP Pollution Control Board.

    d) Solid Waste Disposal: The solid waste generated from the Depot will be taken by the cleaning contractor weekly and disposed to the Agra Municipal Corporation waste disposal sites in accordance with relevant National and State laws and regulations. Capital and operating cost are included in engineering cost and therefore is not included in EMP.

    e) Surface Drainage: The area should have proper drainage. The Storm water of the depot will be collected through the drains. Rain water harvesting pits shall be provided at different locations in the drains and for surplus storm water, the drainage system should be connected to a nearby disposal site. Capital and operating cost are included in engineering cost and therefore is not included in EMP.

    f) Green belt development: The greenbelt development/ plantation in the depot area not only functions as landscape features resulting in harmonizing and amalgamating the physical structures of proposed buildings with surrounding environment but also acts as pollution sink noise barrier. Treated sewage and effluent in the best combination should be used for green belt development.

    g) Rain water harvesting: To conserve and augment the storage of groundwater, it has been

proposed to construct roof top rainwater harvesting structure of suitable capacity in the proposed depots. Most of the area in depot will be open to sky and it is estimated that approximately 10% area will be covered. Rainwater harvesting potential of depots is calculated as 17,106 cubic meter per year.

h) Recycling of treated waste water: Waste-Water generated at depots is proposed to be collected at ETP & STP through separate sewer lines for treatment. The treated waste water will be recycled for horticulture work of the depots.

32. In conclusion the following are the key environmental benefits of the Project: That amount of GHG emissions will be avoided because of the Project during the operational phase, due to the displacement of diesel buses, automobiles and motorcycles. These reductions are expected to far outweigh any short-term increase in GHG emissions that will be experienced during the construction phase. Based on electric transit systems, the Agra Metro corridor operation is expected to avoid the release of greenhouse, and similar to the Project in length and design, is predicting that between 21 and 35 t CO2 of greenhouse gases per year by the year 2041 will be avoided, the reductions will arise due to the assumed replacement of diesel buses and increased displacement of private automobiles by the train service, relative to automobile transportation.

33. Socially the project will be a benefit to the population in the project area. The population, located in the Agra city will, by using the metro: avoid traffic congestion and reduce safety hazards (especially traffic accidents); reduce health problems (especially respiratory problems) due to air pollution and dust; and save time and benefit from a good transportation alternative to go to Railway Station, Inter-State Bus Terminus (ISBT), monuments such as Taj Mahal, Agra Fort, Jama Masjid, Delhi Gate, Sadiq Khan Tomb, Tomb of Salamat Khan, Guru Ka Taal, Pathar ka Ghoda, Akbar's Tomb, Delhi gate, Roman Catholic Cemetery, Lal Masjid, Ram Bagh etc .

I. INTRODUCTION

A. Preface

In order to alleviate the transport related problems in the City, Comprehensive Mobility Plan (CMP) has been prepared in 2017 adhering to Ministry of Housing and Urban Affairs (MoHUA), Government of India guidelines. It identifies various short, medium and long-term measures of transport infrastructure in the City. CMP recommends mass transport systems along two major travel corridors.

Based on the proposals from CMP, an Alternatives Analysis has been carried out to find the most viable mass transit system along two identified corridors. Alternatives Analysis Report recommends to implement a Metro Rail system on these two corridors in Agra. The Government of Uttar Pradesh has engaged RITES Ltd. to prepare a 'Detailed Project Report (DPR) for Metro Rail System in Agra'.

Environmental and social assessments have been carried out in 2017 in accordance with EIB's environmental and social safeguard policies. Consequently, this ESMP relies heavily on the 2017 Detail Project Report (DPR) for much of the early data collected on the project, and which is still current. The DPR was prepared in 2017 that sampled air quality (8 sites), noise (7 sites), surface water and groundwater quality (7 sites) and Public consultation were organised at medical college, ISBT, Agra University, St. John's College, RBS, Guru katal, Kamlanagar, Foaundry Nagar, Ram bagh, Agra fort, Taj East Gate, Raja ki Mandi from 16/09/2015 to 19/09/2015.The consultant briefed the participants aboutthe objectives of the meeting regarding various social issues related to the project i.e., alignment plan, land acquisition, displacement, rehabilitation & resettlement and compensation and employment etc. The participants were invited to give their valuable suggestions on the above issues and were assured for suitable incorporation of such suggestions in the project within the technical limitations and scope of the project. The above cited information, available detailed design information, results of additional hydrogeological study provided sufficient data to assess the impacts, provide mitigation measures and formulate a detailed EMP for the pre-construction, construction and operation stages of the Project. The anticipated impacts and mitigation measures presented in EMP section. This ESMP has been prepared consistent with the requirements of EIB's SPS.

B. Background to the Project

1. In the past few decades Agra Development Authority Area has experienced an unprecedented spatial expansion from 61.8 sq km in 1971 to 520.2 sq km in 2008. The city's population grew from 5.9 lakh in 1971 to 9.8 lakh in 1991, 12.7 lakh in 2001 and 15.9 lakh in 2011. The administrative limits of the Agra Nagar Nigam encompass an area of 141.0 sq. km with a population density of about 9,043 persons per sq. km. The highest density lies in the old city areas like Lohamandi and Shahganj, etc. where the settlements started flourishing from the Mughal period. Unequal spatial development has led to pockets of high density in terms of employment and population, putting pressure on the infrastructure. A major challenge is to provide connectivity and promote growth by providing adequate inputs to the infrastructure which would improve the quality of life of the residents. Simultaneously, environmental conditions in the urban area have been deteriorating. Increasing levels of air pollution, noise generation and contamination of surface water and groundwater areaffecting public health and amenity of urban residents. Much of this environmental deterioration isattributable to high traffic volumes and increased congestion.

2. To counter such environmental degradation and stem economic losses resulting from traffic congestion and decreasing travel times, the Government of Uttar Pradesh (GOUP) has identified MRTS as a key means of restraining the use of private vehicles within the urban areas of Agra City.
3. Comprehensive Mobility Plan (CMP) for Agra has been updated in 2017. The study area for CMP extends over 520 sqkm of Agra Development Authority (ADA) area. Comprehensive Mobility Plan has been prepared for long term with a vision for transport in Agra to ensure that the city has a planned, best performing transport system to address the needs and concerns of the city. The objectives of CMP is to develop specific actions in the form of short, medium and long term transportation improvement proposals that will achieve the transportation vision for the area.
4. The CMP proposes three mass transit corridors for length of 62 km and four feeder routes for length of 32.5 km. The city bus system improvement plan and bus fleet augmentation is also proposed for Agra. To carry out daily maintenance for development of the city bus infrastructure/depot in line with the fleet augmentation plan is proposed. CMP suggests route rationalization and expansion to be carried out in future years for catering to projected demand in future years. A total of 8 Multi Modal Integration Hubs at Airport, Agra Cant & Fort Railway Station, Raja Ki Mandi Railway Station, Challesar Railway Station, Bichpuri Railway Station, Transport Nagar ISBT and Sadar Market MRTS station are proposed. These hubs will act as transfer station for all PT modes in addition to parking facility and NMT docking.
5. Alternatives Analysis has been carried out to find the most feasible alternative transport system for Agra. Qualitative evaluation of the available alternatives namely Normal Bus System, Bus Rapid Transit, Metro Rail and Light Rail Transit have been carried out. Normal Bus and Bus Rapid Transit have been ruled out in view of limited RoW, inability to meet the passenger demand in future and significant greenhouse gas emissions. In preliminary screening, Metro Rail and Light Rail Transit emerged as prospective mass transport system for Agra for further quantitative evaluations. With several operational metro rail systems in India, its technology as well as various components like track gauge, civil structures and rolling stock components have been standardized and now available within the country. Efforts have also been made by the Government and Implementing Agencies towards indigenizing the various components of metro rail systems. Technical expertise has also been developed in the country over the period of time. Based on both qualitative and quantitative screening carried out Metro System has emerged as the most viable alternative mass transport system to meet the transport needs of Agra city.

Figure 1.1: Proposed Agra Metro Corridor- 1(Sikandara to Taj East Gate)

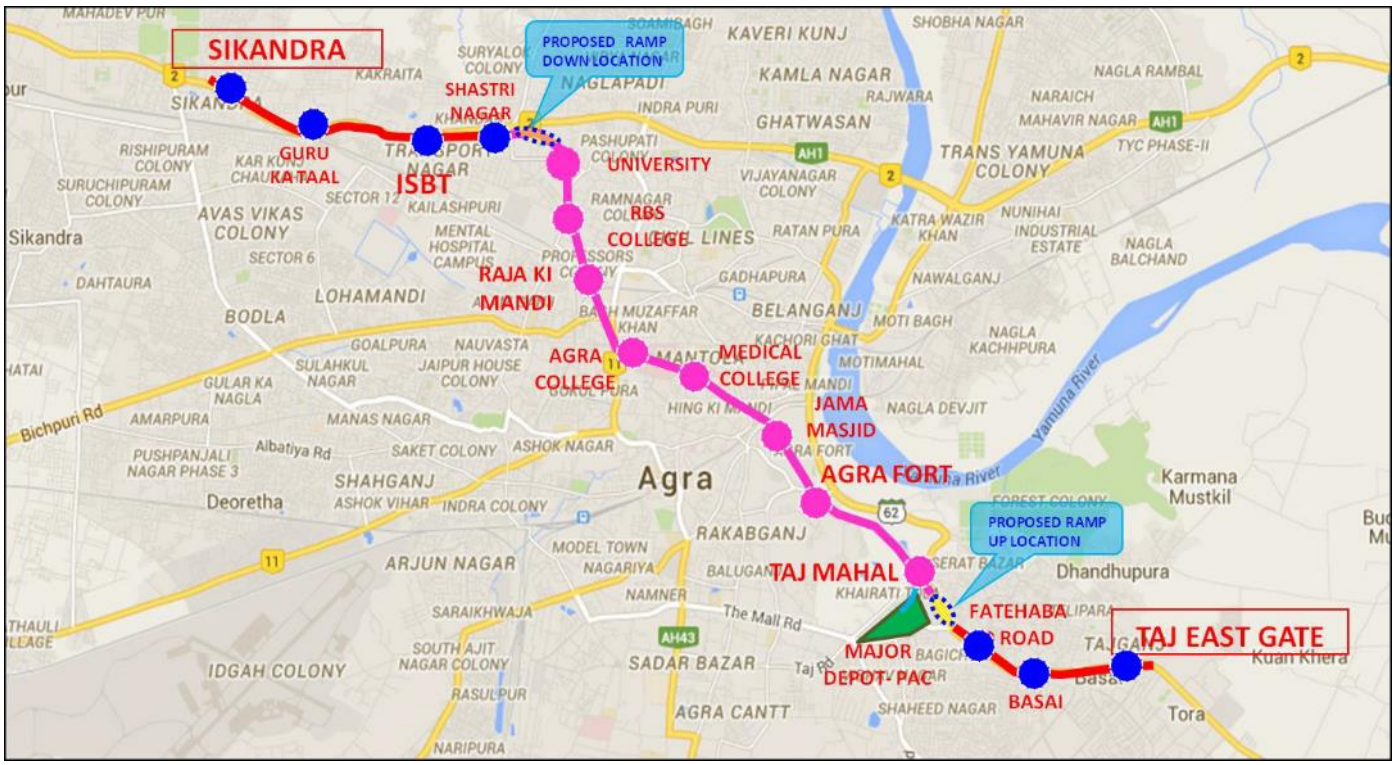
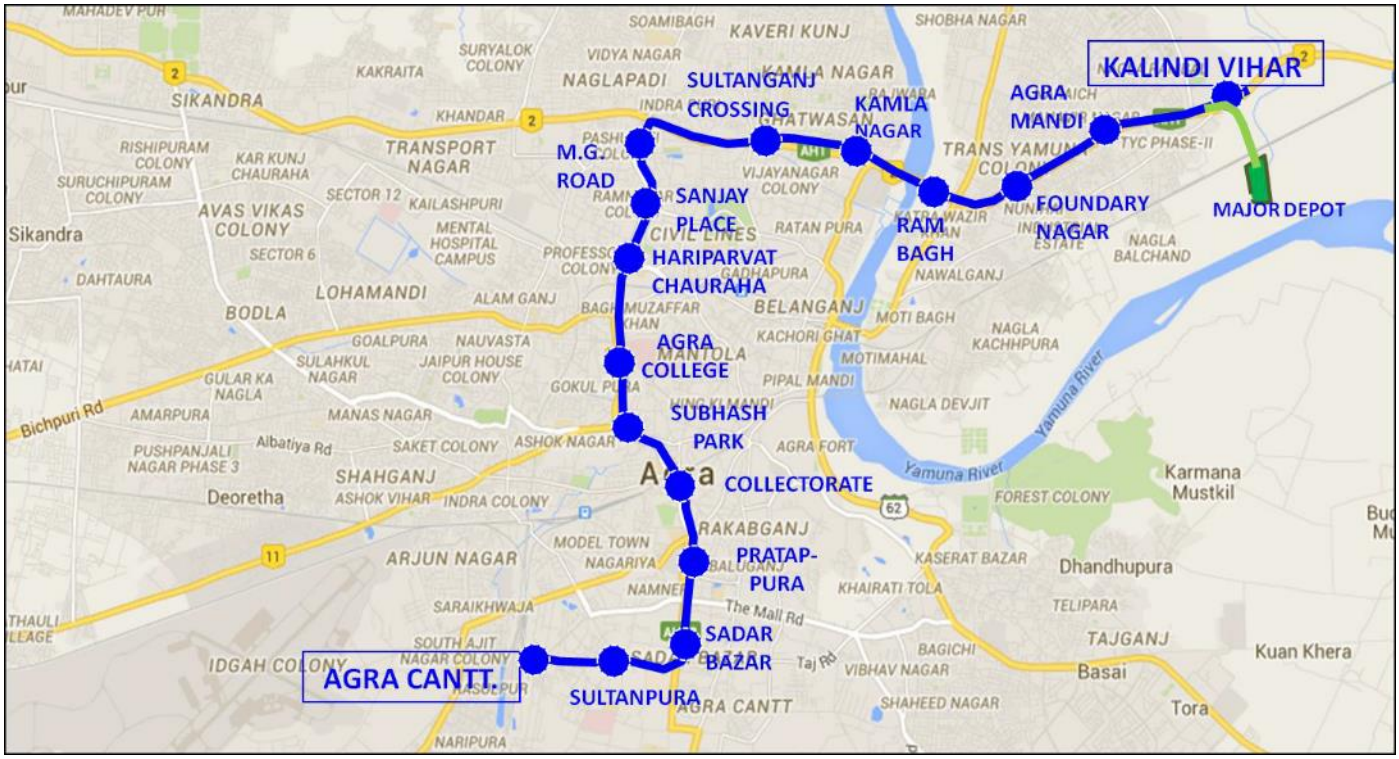


Figure 1.2: Proposed Agra Metro Corridor- 2 (Agra Cantt. To Kalindi Vihar)



Source: DPR AGRA, 2017

C. Project Overview

Two corridors were agreed upon for the study. Corridor 1 starts from Sikandara and ends at Taj East Gate (Hotel Trident) whereas corridor 2 starts from Agra Cantt. Railway Station and ends at Kalindi Vihar (Trans Yamuna Colony Phase-II) which traverses through city from west to east and South to North respectively. An interchange station between the corridors has been proposed near St. John's College. Metro Route of both the corridors was initially planned on Google Map. For detailed planning of the proposed metro route, ground survey was carried out with the help of GPS, Total Station and Auto levels. Details of all the existing features falling in the proposed corridor were collected for proper planning of the alignment and Depot.

Two corridors have been finalized for implementation in Phase – I of Agra Metro Rail Project network as per details given under:

Corridor-1: Sikandara to Taj East Gate

Alignment Description:
Considering centre line of Sikandara station as 0.00m, this corridor is 14000m long starting from -50m and running upto 13950m. This corridor consists of elevated and Underground stretches along with Switch over Ramps (SOR). The corridor is summarised as under in **Table C1.1.**

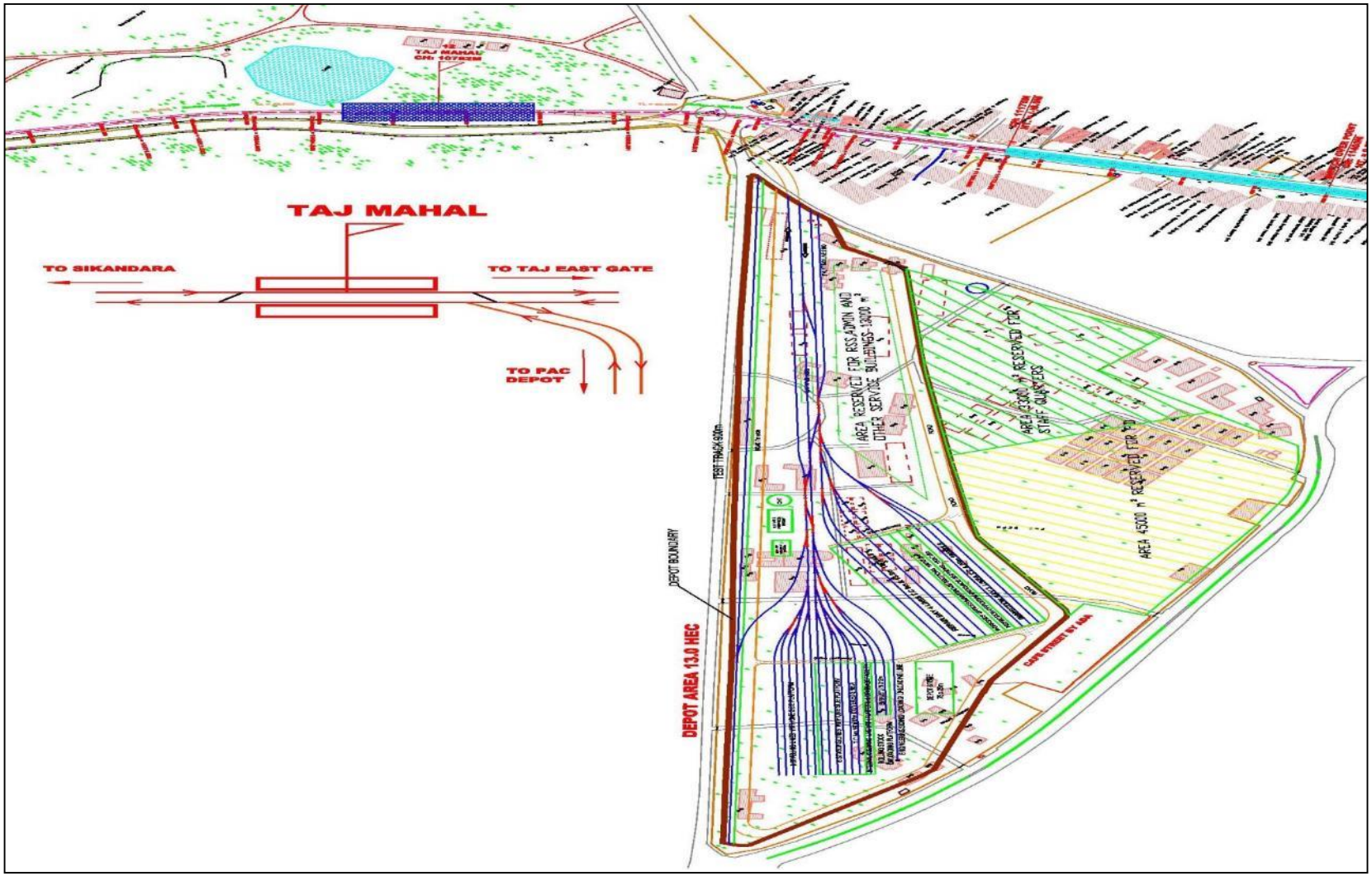
TABLE 1.1 : ALIGNMENT DESCRIPTION

Alignment Type	From (m)	To (m)	Length (m)
Elevated	-50	3551	3601
Switch over Ramp (+)8.0m to (-)8.0m	3551	4010	459
Underground	4010	11175	7165
Switch over Ramp (-)8.0m to (+)8.0m	11175	11600	425
Elevated	11600	13950	2350
Total			**14,000**

The Alignment of Corridor -1 is described in following :-

i. Sikandara to Shastri Nagar Section
ii. Switch Over Ramp from Elevated to Underground
iii. University to Taj Mahal
iv. Switch Over Ramp from Underground to Elevated
V. Fatehabad Road to Taj East Gate

FIGURE 1.3: PAC DEPOT CONNECTIVITY FROM TAJ MAHAL STATION



Corridor-2: Agra Cantt. to Kalindi Vihar

Alignment Description:

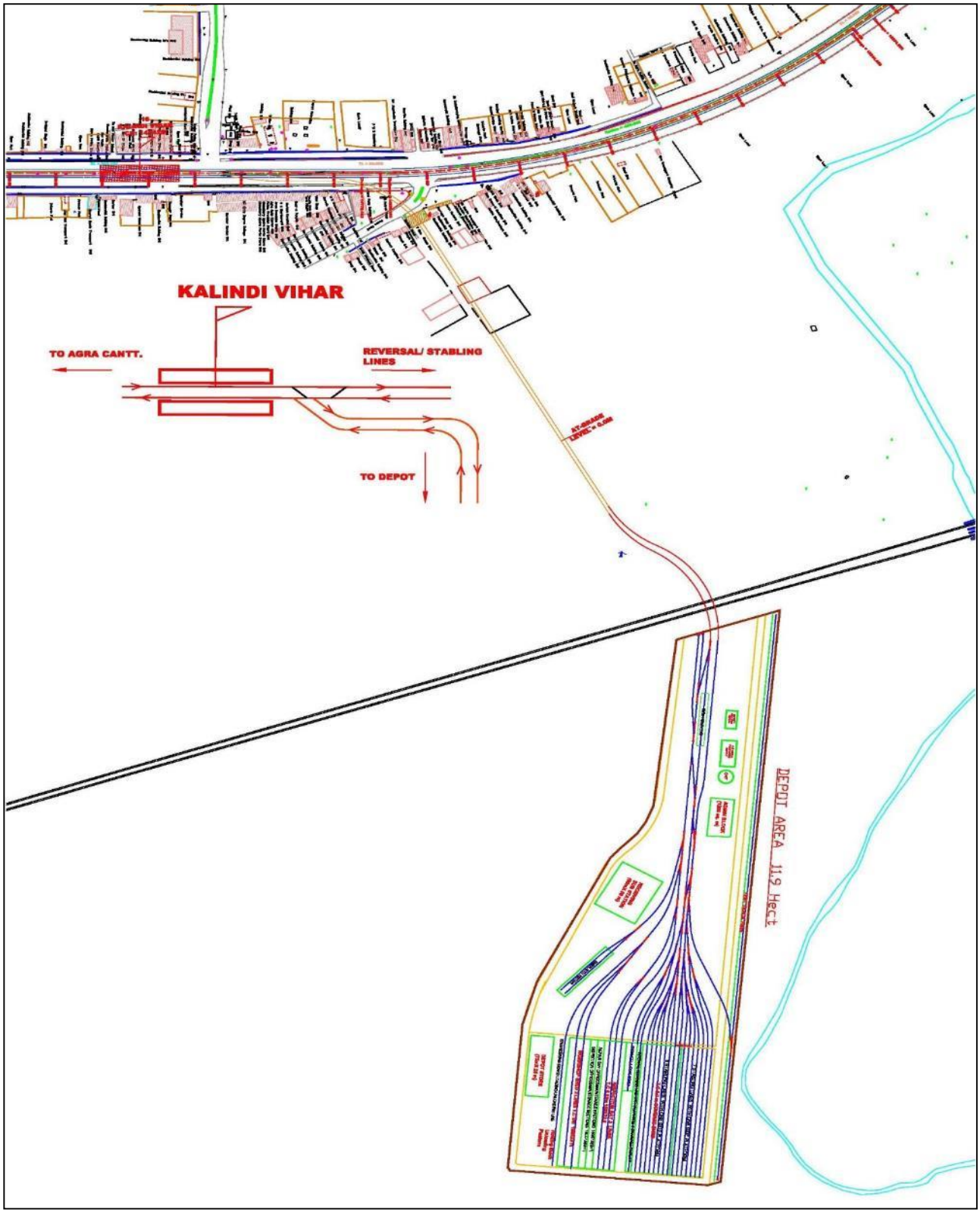
Considering centre line of Agra Cantt. Metro Station as 0.00m, this corridor is 15400m long starting from (-)50m and running upto 15350m. This corridor is proposed as completely elevated. Depot entry having a length of about 800m has been proposed after Kalindi Vihar Station. The corridor is summarised in **Table C 1.2.**

Table 1.2: ALIGNMENT DESCRIPTION OF CORRIDOR - II

Alignment Type	From (m)	To (m)	Length (m)
Elevated	(-)50	15350	15400
Depot Entry	15350	16150	800

- The proposed MRTS alignment of Corridor-2 starts from Agra Cantt. Railway station. The alignment heads in North direction along Station road, MG Road and NH-2. The corridor integrates with Corridor-1 at Agra College station.
- After Agra Cantt. station, alignment runs along station road and takes left turn and passes through private Property and aligns along MG Road. The alignment near DRDO has been kept off the road to avoid DRDO guest house and minimise other private property acquisition. Further, alignment runs along MG Road upto Bhagwan talkies, thereafter, it takes right turn and aligns along NH-2 and runs along it till end i.e. Kalindi Vihar.
- Total of 14 elevated stations have been proposed for the corridor namely, Agra Cantt., Sadar Bazar, Partap-pura, Collectorate, Subhash park, Agra College, Hariparvat Chauraha, Sanjay Place, MG Road, Sultanganj Crossing, Kamla Nagar, Ram Bagh, Foundary Nagar, Agra Mandi and Kalindi Vihar. Sultanpura Station has been proposed as future Station.
- In view of construction ease and to avoid disruption to running road traffic, efforts have been made to locate the elevated stations off the road. However, due to alignment passing through heavily habitated area and narrow roads, only three stations i.e. Subhash Park, Sultanganj Crossing and Ram Bagh could be planned off the road in open land. At other station locations, open land is not available to provide off the road stations.
- Sultanganj Crossing station has been proposed as Mid Terminal. Reversal facilities have been planned at this station. Two separate stabling lines has been proposed for total of 5 rakes.

FIGURE 1.4: CONNECTIVITY TO DEPOT FROM KALINDI VIHAR



D. Project Status

At the time of the preparation of the DPR in 2017 the project was still at a conceptual planning stage and alternatives were being considered along with the mode of construction. These were presented in DPR (2017).

Agra, being a capital city of Mughal Empire followed by being an important civil and military city during the British period, is having very rich Historical and Cultural Heritage and is endowed with numerous Ancient Monuments. Some of these Monuments are located in the close vicinity of proposed Metro alignment and will require necessary approval by competent authority. The applicable Act will be "The Ancient Monuments and Archaeological Sites and Remains Act, 1958, as updated by the Ancient Monuments and Archaeological Sites and Remains (Amendment and Validation) Act, 2010".

The framework EMP to be developed to meet EIB safeguards requirements. Specifically, following tasks carried out :

(i) Collected existing secondary data sources on baseline environmental conditions in the project area to allow characterization of the physical and social environment and identification of deficiencies in available secondary information datasets.
(ii) Undertook a preliminary screening of the potential environmental impacts of the project to confirm the project categorization and determine whether further environmental assessment of the project was required.
(iii) Determined the scope of required further environmental assessment tasks to be developed in the ESMP.

Agra Metro project status mentioned in the **Table 1.3**:

Table 1.3: Agra Metro Project status.

Contract	Name of the Work	Contractor	Schedule		Cumulative Progress % Achieved (Apr' 2021)
			Start	Finish	
AGCC-01	Construction of elevated viaduct and 3 Nos. elevated station (viz. Taj East Gate, Basai & Fatehabad Road Metro Station) including Civil, Architectural Finishes, Water Supply, Fire Fighting, Fire Detection, E&M works and PEB structures on Priority Section of Corridor-1, Phase-I of Agra Metro	M/s. Sam India Builtwell Pvt. Ltd.	23-Oct-20	11-Dec-22	23.58%
AGCC-03	Civil, PEB and E&M works for construction of depot cum workshop, including O&M quarters and structural, architectural, plumbing, drainage, external development, VAC, fire fighting etc. at PAC Land Depot for Corridor-1 of Agra metro	M/s. Lisha Engineers Pvt. Ltd.	14-Oct-20	12-Apr-22	15.69%

E. Purpose of the ESMP

The overall purpose of this ESMP is to review the transport & Environment related problems in the City, Comprehensive Mobility Plan (CMP) has been prepared in 2017 adhering to Ministry of Housing and Urban Affairs (MoHUA), Government of India guidelines. It identifies various short, medium and long-term measures of transport infrastructure in the City. CMP recommends mass transport systems along two major travel corridors. Comprehensive Mobility Plan (CMP) and Detailed Project Report, examine the preliminary/functional design of the project and assess environmental construction and operational management measures that avoid and ameliorate negative effects in order that the project can be constructed to meet EIB safeguards requirements. Specifically, the ESMP has been prepared based on:

i. Extensively utilizing the IEE which collected existing secondary data sources on baseline environmental conditions in the project area which allows characterization of the physical and social environment and identification of impacts;

ii. Determine the specific impacts, both positive and negative, of the project based on supplementary studies, functional engineering design and environmental mitigation measures required during construction and operational phases of the project.

iii. Prepare a detailed Environmental and Social Management Plan (ESMP) for the project documenting specific mitigation, monitoring, budgetary and institutional measures and identifying any outstanding project components not assessed

iv. Review public involvement activities and agency consultation activities carried out.

II. POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK

India has well defined institutional and legislative framework. The legislation covers all components of environment viz air, water, noise, soil, terrestrial and aquatic flora and fauna, natural resources, and sensitive habitats. The environmental legislations in India are framed to protect the valued environmental components and comply with its commitment to international community under various conventions and protocols as well. EIB has also defined their Environmental and Social Safeguard policies. This assessment is about the applicability of above laws and regulations, and safeguards. This chapter summaries the following:

- Applicability of various national and local laws and regulations at different stages of project implementations
- Applicability of EIB safeguard policies and categorization of the project

A. Country's Legal Framework and Regulatory Requirements for the Project

The legal framework of the country consists of several acts, notifications, rules, and regulations to protect environment and wildlife. Review of Indian legal system has been carried out to identify its applicability to the project.

The following rules, notifications and standards under the Environment (Protection) Act, 1986 are particularly relevant in this case:

- Environment (Protection) Rules, 1986 and its amendments
- EIA Notification, 1994 and its amendments
- Ash Utilization Notification, 1999 and its amendments
- The Forest (Conservation) Act 1980 (AmendNoi.88) and Rules 1981 (Amended 2003)
- The Wildlife (Protection) Act, 1972 (Amended 1993)
- The Water (Prevention and Control of Pollution) Act 1972 (Amended 1988) and Rules 1974
- The Air (Prevention and Control of Pollution) Act, 1981(Amended 1987) and Rules 1982
- The Noise Pollution (Regulation and Control) Rules, 2000 (Amended 2002) and
- Hazardous Waste (Management, Handling and Trans-boundary Movement) Rules 2008 (Amended 2009)
- The Bio Medical Waste Management Rules, 2016
- The Solid Waste Management Rules, 2016
- The Batteries (Management and Handling) Rules, 2001
- The E-Waste (Management) Rules, 2016
- The Plastic Waste Management Rules, 2016
- The Construction and Demolition Waste Management Rules, 2016
- The Ozone Depleting Substance (Regulation and Control) Rules, 2000

1. Requirement of Environmental Clearance

As per provisions of the EIA Notification, 14 September 2006 as amended up to 1 December 2009, any person who desires to undertake any new project in any part of India or the expansion or modernization of any existing industry or project listed in Schedule-I of the said notification shall submit an application to the Ministry of Environment and Forests, Government of India in accordance with the guidelines issued by the Central Government in the Ministry of Environment and Forests from time to time. Metro Rail project is not included in the Schedule-I of the EIA Notification, 2006. Thus, the project does not require an environmental clearance certificate from the Ministry of Environment and Forests, Government of India. Other metro projects such as the Delhi Metro was not required to secure any Environmental Clearance.

2. Forest Clearance

As per Indian "Forests Conservation Act (1980), every project requiring diversion of forest land for non-forestry purposes require forest clearance from MoEF. The project does not require forest clearance as it does not involve diversion of forest land. However activities proposed in the project should be regulated as per ESZ norms. Vide letter dated 31 July 2013, MoEF&CC informed States that a default area of 10 km from the boundary will be the ESZ of such protected areas for which proposals identifying ESZs were not forwarded by the States to MoEF&CC.

The Department of Forests, Government of Uttar Pradesh is responsible for the conservation and management of trees/forests in the project area. It is proposed to plant ten saplings for each tree to be cut. The native plant species and miscellaneous indigenous tree species recommended for afforestation. 27290 trees, on maturing will absorb about 595 ton of CO2 per year and will release 1337 ton of Oxygen per year.

3. Required Clearances/Permissions

The following environment related permits/clearances/NOCs will be applicable/required for the Agra Metro Rail project. Applicable Environmental Rules and Regulation:

Table 2.1: Applicable Environmental Rules ans Regulations

Sl. No.	Applicable Clearances	Act	Approving Agency/Authority and Statutory requirements	Responsibility	
				Primary	Supervision
1	Permission for Removal of Tree along the	Forest Conservation Act(1980) Forest Conservation Rules(2003)	State Forest Department	UPMRCL	

Sl. No.	Applicable Clearances	Act	Approving Agency/Authority and Statutory requirements	Responsibility	
				Primary	Supervision
	alignment/ Depot/Yard				
2	Consent to Establish and consent to operate batching plant and casting yard	The Water (Prevention and Control of Pollution) Act 1974 amended 1988 and , The Air (Prevention and Control of Pollution) Act 1981 amended 1987	SPCB	Contractor	UPMRCL/GC
3	Consent to Establish and operate ETP/STP	Water (Prevention and Control of Pollution) Act 1974 amended 1988	SPCB	Contractor	UPMRCL/GC
4	NOC for undertaking construction activities within 200 m of the Notified Heritage site	The Ancient Monuments and Archaeological Sites and Remains Act, 1958 amended in 2010	Expert Advisory Committee of ASI	UPMRCL	
5	C&D waste management plan	C&D waste management rule , 2016	Local Authority	UPMRCL/Contractor	
6	Authorization for generation handling storage and transportation hazardous waste	Hazardous and other wastes (management & transboundary movement) rule 2016	SPCB	Contractor	UPMRCL/GC
7	Pollution Under Control Certificate	Central Motor Vehicles Act 1988/ Vehicular Exhaust Norms CPCB 2002	Transport Department	Contractor	
8	DG Sets permission	Notification on control of noise from DG sets , 2002 and its amendment 2005 and its subsequent	SPCB	Contractor during operation and	

Sl. No.	Applicable Clearances	Act	Approving Agency/Authority and Statutory requirements	Responsibility	
				Primary	Supervision
		amendment		UPMRCL during operation	
9	Compliance of Noise and Vibration	The Noise Pollution (Regulation & Control) Rule 2000	Contractual obligation to manage and Statutory Obligation	Contractor	
10	Power Supply	UP Electricity Regulatory Commission (Electricity Supply Code and Other Conditions of Supply) Regulations, 2005, and its amendment 2018	Electrical Dept	Contractor	
11	Employing Labour	Executing Agency of Building and other Construction Act,1996	Labour & Employment Department,	Contractor	
12	NGT and EPCA compliances	Applicable NGT and EPCA guideline time to time	NGT/EPCA Statutory Obligation	UPMRCL	
13	Registration of Workers	Labour Welfare Acts	Labour & Employment Department	Contractor	
14	Solid Waste Management	Solid Waste Management Rule, 2016	Municipal Authority	Contractor	
15	Fly ash Utilization	Fly ash utilization notification, September 1999, 2009 and its subsequent amendments	MoEFCC The ministry has also made it mandatory for power plants to give fly ash free of cost to users within 300-kilometre-radius	Contractor	
16	Bio Medical Waste	Bio-medical Waste Management Rules,	SPCB/SMC	Contractor	

Sl. No.	Applicable Clearances	Act	Approving Agency/Authority and Statutory requirements	Responsibility	
				Primary	Supervision
	Management	2016			
17	Taj Trapezium Zone (TTZ), Agra	MoEFCC, GOI in the year 1999 notified Taj Trapezium Zone Pollution (Prevention & Control) Authority, Agra for protection and improvement of the environment in the TTZ area	Statutory requirement	Contractor during Civil work	
18	Battery management	Batteries Management Rules, 2001	CPCB	Contractor/UPMRCL	
19	E-Waste Management	E-waste Management Rules, 2016	Statutory requirement	Contractor	
20	Plastic Waste Management	Plastic Waste Management Rules 2016	Statutory requirement	Contractor	

Table 2.2: SPECIAL ORDER/PROVISIONS

Sl. No	Applicable Laws/Rules/Order	Conditions	Responsibility	Monitoring Responsibility
1	Hon'ble NGT vide its order dated 15.11.2019	No authority shall allow the discharge of polluted sewage or polluted effluents directly into a water channel or stream in violation of the law even during monsoon season and they shall ensure that the standards for faecal coliform are duly maintained	Contractor	GC/UPMRCL
2	Agra Taj Mahal -UNESCO World Heritage site	The United Nations Educational, Scientific and Cultural Organization (UNESCO) seeks to encourage the identification, protection, and preservation of cultural and natural heritage around the world considered to be of outstanding value to humanity. This is embodied in an international treaty called the Convention concerning	Contractor / UPMRCL	GC/UPMRCL

Sl. No	Applicable Laws/Rules/Order	Conditions	Responsibility	Monitoring Responsibility
		the Protection of the World Cultural and Natural Heritage, adopted by UNESCO in 1972		
3	Taj Trapezium Zone (TTZ)	Taj Trapezium Zone (TTZ) is a defined area of 10,400 sq km around the Taj Mahal to protect the monument from pollution. The Supreme Court of India delivered a ruling on December 30, 1996 regarding industries covered under the TTZ, in response to a PIL seeking to protect the Taj Mahal from environmental pollution. It banned the use of coal/ coke in industries located in the TTZ with a mandate for switching over from coal/ coke to natural gas, and relocating them outside the TTZ or shutting down. The TTZ comprises monuments including three World Heritage Sites the Taj Mahal, Agra Fort and Fatehpur Sikri. TTZ is so named since it is located around the Taj Mahal and is shaped like a trapezoid	Contractor / UPMRCL	GC/UPMRCL
4	Central Motor Vehicle Act-1988 Central Motor Vehicle Rules and (Amendment) 1989 To check vehicular air and noise pollution	Vehicles to be used for construction and other purposes need to meet the standards and certificates prescribed as per the Rules, 1989 to control noise, pollution, etc	Contractor	GC/UPMRCL

B. EIB Environmental Requirements

The EIB has defined its safeguard requirements under its Environmental and Social Standards. The prime objectives of these safeguard policies are to: (i) avoid adverse impacts of projects on the environment and affected people, where possible; and (ii) minimize, mitigate, and/or compensate for adverse project impacts on the environment and affected people when avoidance is not possible. Since Agra Metro project is likely to have potential environmental risks and impacts and requires compliance with the safeguard requirement of SPS.

III. DESCRIPTION OF THE PROJECT

A. Project Location

Agra is geographically located at 27°12' North latitudes and 78°12' East longitudes. It has an extremely strategic location on the confluence of three distinct geo-physical regions namely the plain of Uttar Pradesh, the plateau of Madhya Pradesh and the desert of Rajasthan. The city also falls in the center of the four-culture areas- Braj, Bundelkhand, Rajputana and western U.P. Both these factors have played significant roles in shaping the life and history of the city. It lies in the Indo-Gangetic Plain on the Yamuna River about 200 km southeast of Delhi.

The administrative limits of the Agra Nagar Nigam encompass an area of 141.0 sq. km with a population density of about 9,043 persons per sq. km. The highest density lies in the old city areas like Lohamandi and Shahganj, etc. where the settlements started flourishing from the Mughal period.

The project is located within the urban area of Agra city. In the past few decades Agra Development Authority Area has experienced an unprecedented spatial expansion from 61.8 sq km in 1971 to 520.2 sq km in 2008. The city's population grew from 5.9 lakh in 1971 to 9.8 lakh in 1991, 12.7 lakh in 2001 and 15.9 lakh in 2011. Two corridors were agreed upon for the study. Corridor 1 starts from Sikandara and ends at Taj East Gate (Hotel Trident) whereas corridor 2 starts from Agra Cantt. Railway Station and ends at Kalindi Vihar (Trans Yamuna Colony Phase-II) which traverses through city from west to east and South to North respectively. An interchange station between the corridors has been proposed near St. John's College.

Metro Route of both the corridors was initially planned on Google Map. For detailed planning of the proposed metro route, ground survey was carried out with the help of GPS, Total Station and Auto levels. Details of all the existing features falling in the proposed corridor were collected for proper planning of the alignment and Depot.Project Location map of Agra Metro Rail is presented in **figure III A 1.1.**

FIGURE 3.1: Project Location Map of Agra Metro Rail

B. Need for Project

1. Introduction

The need for the project is demonstrated by the current and future traffic conditions along the corridor that will be served by the project. Data on current passenger demand and movements are presented together with the results of an analysis of the capacity of the existing transport network. Predictions relating to future passenger demand and movements are then presented based on DPR Agra, 2017. Conclusions are assessed based on the ability of the project to fulfil future demand and ease future capacity constraints.

2. Current Transport Conditions of Agra Metro Project Corridor

The city is a major tourist hub with number of monuments like Taj Mahal, Agra Fort, Tomb of I'timād-ud-Daulah , MehtabBagh, PanchMahal, Jama Masjid, Tomb of Akbar (Sikandara), Moti Masjid, Guru KaTaalGurudwara, Ram Bagh, Mankameshwar Temple, etc. Tourists from all over the world visit the city round the year. **TABLE** 3**.1** shows the number of tourists visited at various heritage monuments.

The registered vehicles in Agra have increased significantly over the years. The year wise vehicle registered in Agra is presented in **TABLE 3.2.** This high density and rapid growth of vehicles have worsened the transport situation to a significant extent. The phenomenal increase of cars - demand more road space and has resulted in dense concentration of traffic on roads.

TABLE 3.1: TOURIST AT VARIOUS HERITAGE MONUMENTS

Heritage Monument	2010-2011	2011-2012	2012-2013	2013-2014	2014-2015	2015-2016	2016-2017
TajMahal	4813006	5381946	7036050	5689743	6145307	6641590	7182244
Agra Fort	1366966	1474752	1563020	1593417	1679309	1770041	1865888
Tomb of Akbar (Sikandara)	441677	434343	459486	430095	430881	432915	435910
I'timād-ud-Daulah	84166	117315	142357	143674	173258	208933	251955
FatehpurSikri	448953	554809	577709	601263	670898	751496	844792

Source: Agra Development Authority, * Estimation based on average growth rates

TABLE 3.2: YEARWISE VEHICLE REGISTERED IN AGRA ROAD TRANSPORT OFFICE

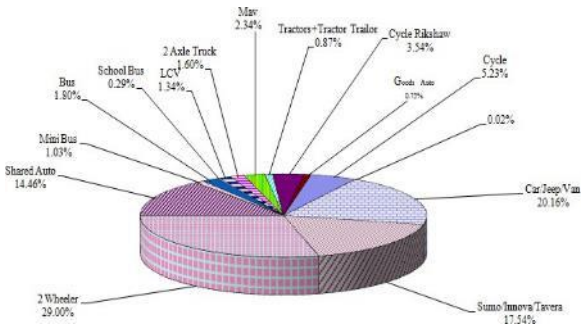
Vehicle Category	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Two Wheeler	31860	31615	38675	42294	52268	57118	62828	75654	76172	74875	73026
Car	4398	3827	4958	5744	6958	7438	7230	8592	9371	9546	10122
Jeep	208	230	414	402	474	959	1332	1416	1431	1232	1140
Van	317	222	341	267	371	400	426	831	1218	983	555
Taxi	131	166	276	425	400	448	435	361	547	630	682
Ambulance	15	13	24	29	20	33	26	65	35	54	28
Auto (3-Wh)	3431	379	570	431	565	748	449	504	297	3698	1144
E-Rickshaw	0	0	0	0	0	0	0	0	1	167	364
Bus	96	88	98	101	41	43	17	7	13	11	25
Mini Bus	55	34	34	94	25	38	17	12	11	19	21
School Bus	13	9	12	30	39	30	58	50	53	61	129
Goods 3-Wheeler	384	691	800	948	1477	1307	1164	971	548	931	637
Light Comm. Vehicle	247	263	233	324	465	482	506	471	302	214	261
Truck	72	82	84	49	62	22	15	13	12	24	30
Multi-Axle Vehicle	101	77	78	83	178	195	144	125	155	147	246
Heavy Machinery Equipment/Vehicle	0	0	4	1	0	0	0	0	0	0	4
Fire Brigade	0	0	0	2	0	0	0	0	1	0	0
Tractor	955	575	1193	1055	2331	2007	1900	2731	1677	1507	1569
Tractor with Trailer	27	21	12	8	16	11	2	1	4	1	1
Other Vehicles	1	0	3	5	4	4	2	4	6	2	2

Source: Regional Transport Office, Agra

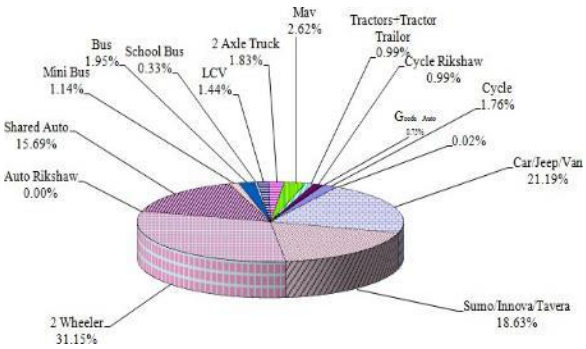
The daily traffic volumes total vehicles (PCUs) at major midblock locations observed are Trans Yamuna Colony, Phase 2 along NH-2 (76593 Vehicles, 80994 PCUs), Trans Yamuna Colony, Phase 1 along NH-2 (71173 Vehicles, 75732 PCUs), at Kamla Nagar T Point along NH- 2 (73812 Vehicles, 76992 PCUs) and Diwani Chowk, MG Road (58593 Vehicles, 51053 PCUs). The daily traffic composition along these midblock locations is presented in Figure 3.2.

FIGURE 3.2: DAILY TRAFFIC COMPOSITION ON MAJOR MIDBLOCK LOCATIONS

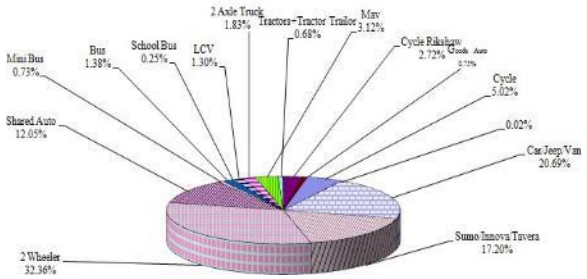
Trans Yamuna Colony, Phase 2



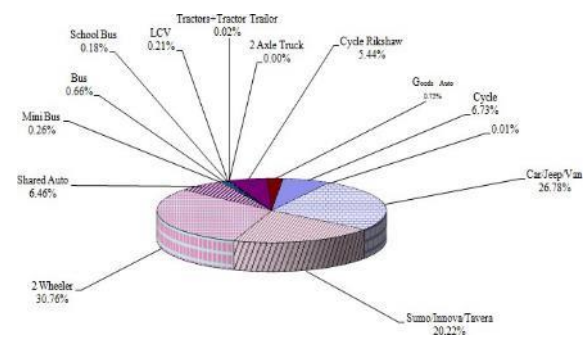
Trans Yamuna Colony, Phase 1



Kamla Nagar T Point



Diwani Chowk, MG Road



Source: Agra DPR 2017

Private auto, shared auto, cycle rickshaw and e-rickshaws supplement the main-line haul transportation service modes. IPT modes play a vital role in bridging the gap between the Public transport terminals of the city to the ultimate destination of the passenger trip. This gap is filled by two types of IPT Modes – Motorized and Non-motorized. Motorized modes are registered as per Motor vehicle Act. The major motorized IPT modes are Piaggio Ape shared auto, Bajaj Shared Auto, Tata Magic, Battery Operated Rickshaw and 6-seater battery operated Golf cart seen near Taj Mahal, Red Fort area which is a shuttle service between Taj Mahal and Red Fort. There are 15 routes on which IPT modes run on shared carriage and are listed in **TABLE 3.3.**

TABLE 3.3: INTERMEDIATE PUBLIC TRANSPORT ROUTES IN AGRA

S. No	IPT Routes	Length (km)
1	Dayalbagh- Bhagwan Talkies- Kamla Nagar	11.0
2	Dayalbagh- collectorate- Bijlighar	9.0
3	Kamla Nagar- Water Works Chauraha-Bijlighar	12.0
4	Bhagwan talkies- Madiakatra- Shahganj- Agra Cantt	13.0
5	Bhagwan talkies- Madiakatra- Shahganj- Agra Cantt	10.0
6	Trans Yamuna- Water Works- Bhagwan Talkies- ISBT- Sikandra	12.0
7	Dhanauli- Kheria Moad – Idgah- Sai Ka Takia- Bijlighar	11.0
8	Sikandara- Bodla- Shahganj	8.0
9	Shahganj- Collectorate- Bijligarh	7.0
10	Bijlighar- Purani Mandi- Taj Ganj	7.0
11	Bijlighar- Baluganj- Naulakha- Bundukatra	8.0
12	Bijlighar- Rajpur Chungi	8.0
13	Bijlighar- Water Works- Trans Yamuna/Rambagh	8.0
14	Agra Cantt.-Idgah- Saika Takia- Bhagwan Talkies	11.0
15	Shaihd Nagar-Bijlighar- I'timād-ud-Daulah -Trans Yamuna Colony-Chhalesar	10.0

Public transport plays a crucial role in the commuter transportation in any city. It offers economies of scale with minimized road congestion and low per capita road usage. Cheaper and affordable public transport systems world over have proved to promote mobility – move people more efficiently and safely with increased opportunities for education, employment, social development etc.

At present the public transport services are rather limited and bus is the only mass transport system in the Agra. Agra Mathura City Transport Services Limited (AMCTSL) operates the city bus services consisting of mainly normal buses and few low floor buses & mini buses. The fleet size of about 170 buses is a noticeable feature of poor supply public transport.

The present supply of buses per lakh populations works out to only nine buses, which cannot be compared with any standards. The benchmark for assessing the supply of buses should be about 60 to 70 buses per lakh population for city like size of Agra. Private auto, shared auto, cycle rickshaw and e-rickshaws supplement these transportation services. The routes on which buses Agra Mathura City Transport Services Limited presently operate have less patronage and thus are incurring losses.

High growth of private modes over the years has resulted in declining trend of public transport system share. This has resulted in increased traffic congestion on road because of limited improvement in road transport infrastructure facilities. The challenge is to reverse this trend and ensure that public transport system is augmented to cater to the significant daily travel demand.

Private auto, shared auto, cycle rickshaw and e-rickshaws supplement these transportation services. The void created by public transport modes has been filled by IPT modes in form of auto rickshaws and 6 seater Vikrams. The sharing of limited right of way by a various of modes

has resulted in traffic congestion, accidents, inadequate parking area and environment deterioration.

3. Future Transport Conditions of Agra Metro Project Corridor

Master Plan for Agra 2021 gives the likely growth to take place within the various areas of study area. The development plan also gives locations of various land uses such as residential, commercial, industrial uses etc.

The population of surrounding towns of Agra is also expected to grow rapidly due to its close proximity to Agra. This will result in higher traffic interaction between the city and these towns. It is expected that the inter-city traffic to/from Agra will grow at growth rate of 3% per annum up to the horizon year of 2041 in various adjoining towns.

Transit Oriented Development (TOD) aims to develop planned sustainable urban growth centers, having walkable and livable communes with high density mixed land-use within the walking distance of (500 m) along the metro corridors. The population and employment in the traffic zones along the corridors have been estimated considering impact of TOD.
The following assumptions have been made for forecasting transport demand for the years 2021, 2031 and 2041.

i. Calibrated and validated travel demand model has been used.

ii. Land use parameters (population, employment and student enrolment) have been distributed in various traffic zones for 2021, 2031 and 2041.

iii. Impact of the development due to the metro corridors (TOD) have been considered while distributing it in traffic zones.

iv. Fare levels of buses and vehicle operating costs of different vehicles have been taken as same as in the year 2015. The fare levels of metro have been considered same as that of the Lucknow Metro network.

v. Inter-city passenger to/from the study area will grow at the growth rate of 3% in various adjoining towns.

vi. The special generator passenger traffic of bus terminals and railway stations in Agra is expected to grow at 6% per annum respectively.

vii. Inter and Intra-city goods traffic is expected to grow at 5% per annum up to 2041.

The Phase-I metro system is expected to be operational by 2024. Desired shifting of passengers from other modes of transport to proposed metro system is a slow & continuous process. Metro ridership gradually increases over a period of time and initially 2024 ridership can be assumed same as that of the year 2021.

Transport Demand Forecast for Business as Usual (BAU) Scenario, 2041

Considering the above assumptions and calibrated / validated traffic demand model, forecasting of transport demand has been carried out for ‘Business as Usual’ (BAU) scenario in the year

2041. Daily inter and intra city trips by various modes in BAU scenario for the year 2041 is given in **TABLE 3.4.** The inter and intra city motorized trips modal split (% of trips by public transport to total motorized trips) in favor of public transport in 2041 is expected to be about 30% same as existing modal share. The total no. of PT trips (including shared auto trips) will increase from 6.2 Lakh to about 10.9 Lakh indicating a high capacity mass transport network will be needed to address the travel demand requirements in the study area in the horizon years. Traffic assignment for peak hour traffic (in PCU'S) on road network in bau scenario 2041 is given in **FIGURE III.B.3.1.**

TABLE 3.4: DAILY INTER & INTRA CITY TRIPS BY VARIOUS MODES IN BAU SCENARIO, 2041

SN	Mode	2015		2041 BAU	
		Trips	Modal Share	Trips	Modal Share
1	Car	1,84,823	8.8%	282672	8.0%
2	Two Wheeler	12,52,018	59.4%	2091967	59.1%
3	Auto	53,659	2.5%	83228	2.4%
4	PT + Share Auto	6,18,164	29.3%	1083065	30.6%
	Total	**21,08,664**	**100.0%**	**3540932**	**100.0%**

Transport Demand Forecast for Recommended Scenario

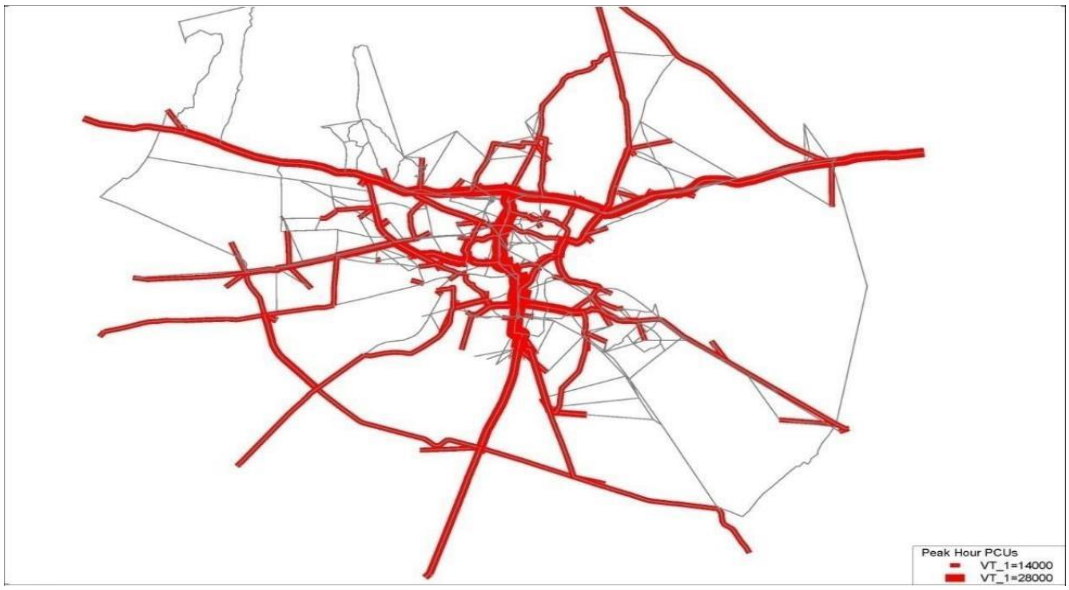
The trips made between two adjacent stations of proposed mass transit corridors have been worked out for the years 2021, 2031 and 2041. The maximum peak hour peak direction trips for proposed metro corridors are given in **TABLE 3.5.** Total proposed Metro length in Phase-I is about 30 Km.

TABLE 3.5: MAXIMUM PEAK HOUR SECTION LOADING ON PHASE I METRO CORRIDORS

Corridor No.	Corridor details	Maximum PHPDT				Length (Km)
		2024	2031	2041	Design	
1	Sikandara to Taj East Gate	10200	15300	19400	24000	14.0
2	Agra Cantt. to Kalindi Vihar	14100	18700	23300	27000	16.0

Total Length of Phase I					**30.0**

The **FIGURE 3.3** shows the horizon year trip assignments on the road network in terms of peak hour PCUs for 2041.



Source: Agra DPR 2017

Daily ridership on the entire metro system for the years 2024, 2031 and 2041 is expected to be 5.7 Lakh, 7.4 Lakh and 8.7 Lakh passengers respectively. Line wise daily passenger boarding (including the interchanges between metro stations) and trips for 2024, 2031 and 2041 are shown in **TABLE III.B.3.3**.

TABLE 3.6: DAILY RIDESHIP ON METRO SYSTEM IN YEAR 2021, 2031 & 2041

S No.	Corridor Name	Daily Boardings (Lakh)			Daily Trips (Lakh)		
		2024	**2031**	**2041**	**2024**	**2031**	**2041**
1	Sikandara to Taj East Gate	3.57	4.81	5.5	2.70	3.42	4.2
2	Agra Cantt. to Kalindi Vihar	3.72	5.53	6.5	3.00	3.94	5.0
	Total Daily Boardings / Trips	**7.29**	**10.34**	**12.0**	**5.70**	**7.36**	**9.2**

4. Summary of Project Need

In order to alleviate the transport related problems in the City, Comprehensive Mobility Plan

(CMP) has been prepared in 2017 adhering to Ministry of Housing and Urban Affairs (MoHUA), Government of India guidelines. It identifies various short, medium and long-term measures of transport infrastructure in the City. CMP recommends mass transport systems along two major travel corridors. Based on the proposals from CMP, an Alternatives Analysis has been carried out to find the most viable mass transit system along two identified corridors. Alternatives Analysis Report recommends to implement a Metro Rail system on these two corridors in Agra. The Government of Uttar Pradesh has engaged RITES Ltd. to prepare a 'Detailed Project Report (DPR) for Metro Rail System in Agra'.

Project Phases

C Pre-Construction

Two corridors were agreed upon for the study. Corridor 1 starts from Sikandara and ends at Taj East Gate (Hotel Trident) whereas corridor 2 starts from Agra Cantt. Railway Station and ends at Kalindi Vihar (Trans Yamuna Colony Phase-II) which traverses through city from west to east and South to North respectively. An interchange station between the corridors has been proposed near St. John's College.

Metro Route of both the corridors was initially planned on Google Map. For detailed planning of the proposed metro route, ground survey was carried out with the help of GPS, Total Station and Auto levels. Details of all the existing features falling in the proposed corridor were collected for proper planning of the alignment and Depot. Detailed Methodology of the Survey and other descriptions are given in subsequent paragraphs.

i. Before starting the detailed topographical survey work, a team of expert in the field of alignment design and survey has conducted reconnaissance survey to familiarize with the area and selection of control points along the proposed Metro Route.

ii. Topographical survey of the Corridor 1- (Sikandara to Taj East Gate) and Coridor-2 (Agra Cantt. to Kalindi Vihar) have been carried out to collect all manmade and natural features like roads, building, drain, railway line telephone/electric pole etc., falling in the proposed metro corridor for better and accurate planning of the metro alignment.

iii. Topographical survey was carried out in detail covering all the activities which are mentioned in Terms of Reference of the Contract using modern surveying instrument like GPS, Total Station and Auto/Digital Level. Survey Drawings were prepared in AutoCAD format.

iv. Topographical survey and alignment design has been carried out in following steps:

a. Establishment of Horizontal Control Points using DGPS
b. Densification of Horizontal Control Points using Total station
c. Establishment of Vertical Control Points
d. Detailed survey of corridor
e. Preparation of drawings.
f. Site verification of features and finalization of drawings.

g. Alignment design on basis of verified drawings.

Following considerations have been kept in view, while designing the alignment.

a. The alignment has been proposed to cover the high density traffic corridors and origination/destination centers.
b. The elevated alignment has been generally proposed along the median of the road.
c. Track Centre of 4.6 m has been proposed for elevated section so as to provide flexibility of adopting Double U-shaped Girders for superstructure.
d. Underground alignment has been designed with a view to avoid high rise buildings having deep foundations.
e. To minimise the construction cost, underground stations have been proposed to be constructed by Cut and Cover method.
f. Traffic diversion will be required where elevated stations are proposed along the road.
g. Effort has been made to minimize disruption to road traffic during construction phase.
h. Effort has been made to position the ramps and depots on Government land.

Following activities are part of the detailed design activities:

a. Pre-construction condition surveys of buildings in proximity of underground works

b. Analysis of options for spoil management

c. Traffic management requirements and measures during construction and operation

d. Analysis of noise and vibration protection requirements for project operation

e. Requirements for drainage and wastewater treatment systems

f. Landscaping and re-vegetation planting

g. Investigations into heritage issues associated with Temple of Literature complex

h. Topographical, geological and geotechnical surveys

i. Updated patronage forecasts

j. Project cost estimation

In total, 42 BHs have been drilled of 30 m depth each, all along the length of proposed Metro alignment. 22 BHs have been drilled in Corridor-I (Sikandara to Hotel Trident- Taj East Gate), 18 BHs have been drilled in Corridor-II (Kalindi Vihar to Agra Cantt. Railway Station) & 2BHs have been drilled for depots.

Agra, being a capital city of Mughal Empire followed by being an important civil and military city during the British period, is having very rich Historical and Cultural Heritage and is endowed with numerous Ancient Monuments. Some of these Monuments are located in the close vicinity of proposed Metro alignment and will require necessary approval by competent authority. The applicable Act will be "The Ancient Monuments and Archaeological Sites and Remains Act, 1958, as updated by the Ancient Monuments and Archaeological Sites and Remains (Amendment and

Validation) Act, 2010".

The PIU headed by the Project Director (PD) is responsible for the overall execution of the project and planning and implementation of resettlement and rehabilitation component of the project. The PIU will coordinate with all implementing agencies and monitoring the progress of the project. Implementing Agency will set up a Social Management Unit (SMU) which shall look after land acquisition, resettlement and rehabilitation activities. The SMU shall ensure that all land acquisition issues are handled according to the Land Acquisition and Rehabilitation & Resettlement policy/guidelines as it is laid down in this report. It will also monitor that all the procedural and legal issues involved in land acquisition are fulfilled. The SMU will assist for getting all the necessary clearances and implementation of the resettlement activities prior to start of any civil work.

D Project Construction

Construction of elevated, underground alignment involves following type of constructions:-

- Sub-structure - Columns on Open/Pile foundations with pier cap at top of columns. Alternatively, Portal arrangement is provided at certain locations.
- Superstructure by segmental construction of whole unit construction. Box segments are most common type of segmental construction. I-Girder and U-girder are most common type of non-segmental construction methods where the structural element for whole span length is pre casted and launched in position.
- Underground alignment by means of tunnels made through Tunnel Boring Machine / open cut and cover method/ NATM method.
- Underground stations by means of cut and cover method or NATM method.
- Earth retaining structures like diaphragm walls, sheet piles, secant piles etc.

Cast in-situ and Pre-Cast Construction

Cast in-situ construction

In cast in-situ construction method, structure is cast at its final location of use. This involves erection of temporary shuttering, scaffolding and support system for casting the structure. The temporary supports and shuttering is removed when the concrete is set and structure attains the strength to bear its dead weight and other loads. This method involves longer construction time and interference to road users for longer period. This method is restricted to casting of substructure - open foundation, pile, pile caps, columns; station structure; earth retaining structures.

Pre - cast construction

In this method, structural segments are pre-casted in casting yards, pre-stressed and then transported to the location of use and launched by means of suitable launching arrangement. The structural elements for superstructure i.e. box segments, I-Girders, U-girders and sometimes pile caps are casted by pre-cast technique. Pre cast construction may be segmental or non-

segmental type.

Casting yard is required for casting of precast structural segments and other precast units like U-girder, I-Girder etc. The construction depot has arrangement for casting beds, curing and stacking area, batching plant with storage facilities for aggregates and cement, site testing laboratories, reinforcement steel yard and fabrication yard etc. An area of about 2.5 Ha to 3 Ha is required for each construction depot.

Structural System of Viaduct

Sub-structure

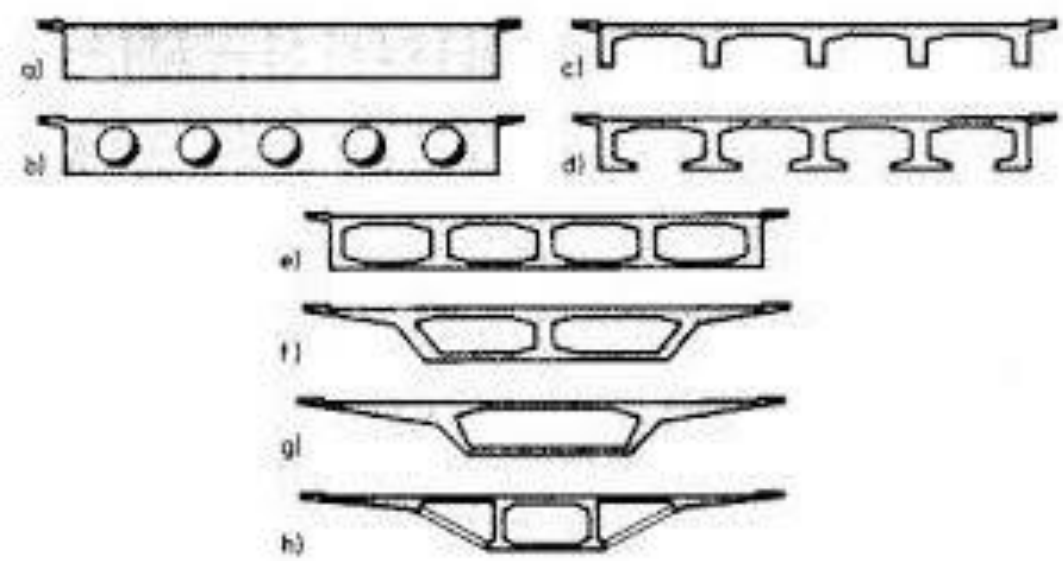
Two broad categories of sub-structure i.e Pile Foundation and Open foundation are considered for Metro Systems. For heavy/medium loads and loose/soft/filled up upper strata, Pile foundation systems are proposed. This requires lesser space and time for excavation.

Superstructure

The choice of superstructure has to be made keeping in view the ease of constructability, maximum safety, least disturbance and inconvenience to road users and maximum standardization of the form-work for wide span ranges. Following types of superstructure may be considered.

i) Precast segmental box girder using external unbonded tendon.
ii) Precast U-Channel superstructure with internal pre-stressing.
iii) Precast U-Channel segmental superstructure using external unbonded tendon.
iv) I-Girder with internal pre-stressing.
v) Special spans

FIGURE 3.4: TYPES OF SUPERSTRUCTURE



Construction of Elevated Stations

Elevated stations with elevated concourse over the road are proposed for elevated stretch of alignment. To keep the rail level low, it is proposed not to take viaduct through the stations. Thus a separate structural configuration is required, with shorter spans and lower depth of superstructure, although this may necessitate the break in the launching operations at each station location.

Sub-structure for the station portion will also be similar to that of viaduct and will be carried out in the same manner. Two configurations as under are available for elevated station super-structure:-

a. Three legged portal structure supporting concourse and platform level decks through series of Precast I girders resting on the Portal beam ledge.
b. Cantilever structure with single centre pier with the arms extending in transverse direction at concourse level and platform level.- Concourse and Platform decks are supported by I girders resting on extended pier arms.

Construction of Tunnels for Underground Alignment

For underground alignment, tunneling arrangements are decided based upon following objectives:-

- Minimization of the surface settlement to maintain all metropolitan activities without adverse effect.
- Expeditious tunnel execution to minimize duration and space of the surface effects due to tunnelling.
- Economy in tunnelling costs.

To achieve above objectives, use of Tunnel Boring Machine (TBM) is the prime method of tunneling. Locations where deployment of TBM is not possible (tunneling of short length, cross passages, underground stations which are not possible by cut and cover method etc.) are tackled by NATM method.

E Project Operation

- **Depot & Rolling Stock** :

The Operation & Maintenance facilities for Sikandara to Taj East Gate Corridor and Agra Cantt. to Kalindi Vihar corridor of Agra MRTS are proposed to be provided at PAC Depot for about 37 rakes of 3 cars and at Kalindi Vihar Depot for about 43 rakes of 3 car respectively for maintenance and repairs of the rolling stock operational on each corridor. Since, track connectivity between the two corridors is not feasible, separate maintenance depots have been proposed for each corridor. The depots will have infrastructure to maintain rakes with necessary facilities viz stabling lines, scheduled inspection lines, workshop for overhaul, unscheduled maintenance including major repairs, wheel profiling, heavy interior/under frame/roof cleaning etc. for the rolling stock operational on the corridor as well as maintenance facilities for Civil – track, buildings, water supply; Electrical – Traction, E&M; Signaling & Telecomm.; Automatic Fare Collection etc.

The following aspects of the depots are covered in the planning of the facilities:

- Conceptual design and layout of Servicing Shed and Workshop to provide maintenance facilities and stabling facilities for Rolling Stock.
- Operational and functional safety requirements.
- Ancillary buildings for other maintenance facilities.
- Electrical & Mechanical Services, power supply and distribution system.
- Water Supplies, Drainage & Sewerage.

IV. DESCRIPTION OF THE ENVIRONMENT

A. Introduction

The following sections present information on the biophysical and social environmental components of the project area. Much of the information was compiled from a range of secondary data sources presented in the DPR 2017, and utilized with additional data and design measures for this ESMP. Available information for each issue is presented as follows:

(i) Environmental conditions in Agra: Data is presented on environmental conditions in Agra to allow comments to be made on expected environmental conditions or trends in the project area.

(ii) Monitoring data in project area: DPR was prepared for the project to meet the requirements of the Environment Protection Act 1986. A review of the quality and accuracy of this data was carried out and relevant results were reported.

(iii) Conclusions and Additional Information Requirements: Using information on expected environmental conditions in the project area, together with the results of monitoring data presented in the report, preliminary conclusions were drawn on the adequacy of existing datasets and information deficiencies identified.

B. Physical Resources

1.1 LOCATION, CLIMATE, PHYSICAL SETTING AND REGIONAL LINKAGES

Agra is geographically located at 27°12' North latitudes and 78°12' East longitudes. It has an extremely strategic location on the confluence of three distinct geo-physical regions namely the plain of Uttar Pradesh, the plateau of Madhya Pradesh and the desert of Rajasthan. The city also falls in the center of the four-culture areas- Braj, Bundelkhand, Rajputana and western U.P. Both these factors have played significant roles in shaping the life and history of the city. It lies in the Indo-Gangetic Plain on the Yamuna River about 200 km southeast of Delhi.

Agra is characterized by a semiarid climate that borders on a humid subtropical climate. The city features mild winters, hot and dry summers and a monsoon season. However the monsoons, though substantial in Agra, are not quite as heavy as the monsoon in other parts of India. This is a primary factor in Agra featuring a semiarid climate as opposed to a humid subtropical climate.

The climate of Agra features a semi-arid climate that borders on a humid subtropical climate. The city features mild winters, hot and dry summers and a monsoon season. The monsoon, though substantial in Agra, is not quite as heavy as the monsoon in other parts of India. The average monsoon rainfall during June to September is 628.6 millimeters. Agra has a reputation of being one of the hottest towns in India. In summers the city witnesses a sudden surge in temperature and at times, mercury goes beyond the 46°C mark in addition to a very high level of humidity. During summer, the daytime temperature hovers around 46-50°C. Nights are relatively cooler and temperature lowers to a comfortable 30°C. The minimum temperature sometimes goes as low as 2° or 3°C but usually hovers in the

range of 6° to 8°C.

The physical setting of the city are such that the urban sprawl in Agra has taken place more or less in a unidirectional manner, a greater thrust of residential areas has been observed in north-west and south-east directions and development of transport facilities has not kept pace. Natural barriers such as River Yamuna, manmade barriers like the presence of the cantonment area near the city's CBD area have guided the city's growth.

The river Yamuna enters the city from the north-east corner, flows towards south for some distance and then turns towards east. The general slope is from west to east in CIS-Yamuna area on the right bank of the river Yamuna. The strata consist of mainly sandy soil. The city stretches for about 9.0 km along the Yamuna river. The major part of the city is on the Western side of Yamuna and has grown beyond the river on the eastern side and is called the Trans Yamuna.

Regional Linkages

Agra forms an important regional urban center. All traffic weather by rail or road going south invariably passes through Agra thus making it a major transport node at the regional level as well as at the national level. This has also led to an extremely rapid and haphazard growth pattern .

Agra has a radial pattern of road network, which includes one expressway, four national highways and other major roads namely, Mathura- Kanpur Road (NH-2), Yamuna expressway, Aligarh Road (NH-93), Gwalior Road (NH-3), Jaipur Road (NH-11), Fatehabad Road and M.G. Road etc.

Mall Road, M.G. Road-2 and Bodla Road are some of the major sub-arterial roads within the city. The old part of Agra, being a historical city has network of narrow roads. The road infrastructure facilities such as signages, traffic signals, etc. have not expanded in accordance with the increase of population and vehicles. The regional transport connectivity of Agra is shown in **FIGURE 4.1:.**

Agra is served majorly by 2 railway stations, namely, Agra Cantt and Raja Ki Mandi which provide connectivity to major cities viz. Delhi, Mumbai, Kolkata, Chennai, Hyderabad, Bangalore, Ahmedabad, Bhopal, Srinagar, Jaipur, Guwahati, etc.

Aiport at Kheria Airforce station is used to serve the domestic air traffic along with defence and presently has very small numbers of domestic flyers using it. However, the Master Plan 2021 for Agra proposes Kheria to be retained as the site for airport operations.

1.2 DEMOGRAPHIC AND SOCIO ECONOMIC PROFILE

Study Area for the current assignment is the administrative boundary of Agra Development Authority (ADA) as shown in **FIGURE 4.2**. It includes Agra Municipal Corporation (AMC), Agra Cantonment, urban spillover and rural areas. The majority of population of the study area resides in the AMC area which comprise of 141 sq km out of total 520 sq km of ADA area. As per Agra Master Plan, the proposed population for ADA area in 2021 will be 25.5 lakh.

Population Growth

As per Census 2011, the population of Agra city is about 15.9 lakh. The average decadal growth from the year 1921 to 2011 stands at about 27.0% while average annual growth rate is 2.4%.The decadal population growth of Agra city is shown in **TABLE 4.1.**

TABLE 4.1.: DECADAL POPULATION GROWTH TRENDS IN AGRA CITY

S. No.	Year	Population	Average Annual Growth Rate (%)	Decadal Growth %
1	1921	185532	-	-
2	1931	229764	2.2	23.8
3	1941	284149	2.1	23.7
4	1951	375665	2.8	32.2
5	1961	508680	3.1	35.4
6	1971	634622	2.2	24.8
7	1981	747318	1.6	17.8
8	1991	948063	2.4	26.9
9	2001*	1275000	3.0	34.5
10	2011*	1585704	2.2	24.4

Source: Agra Master Plan, 2021, * Census figures

FIGURE 4.1: REGIONAL TRANSPORT CONNECTIVITY

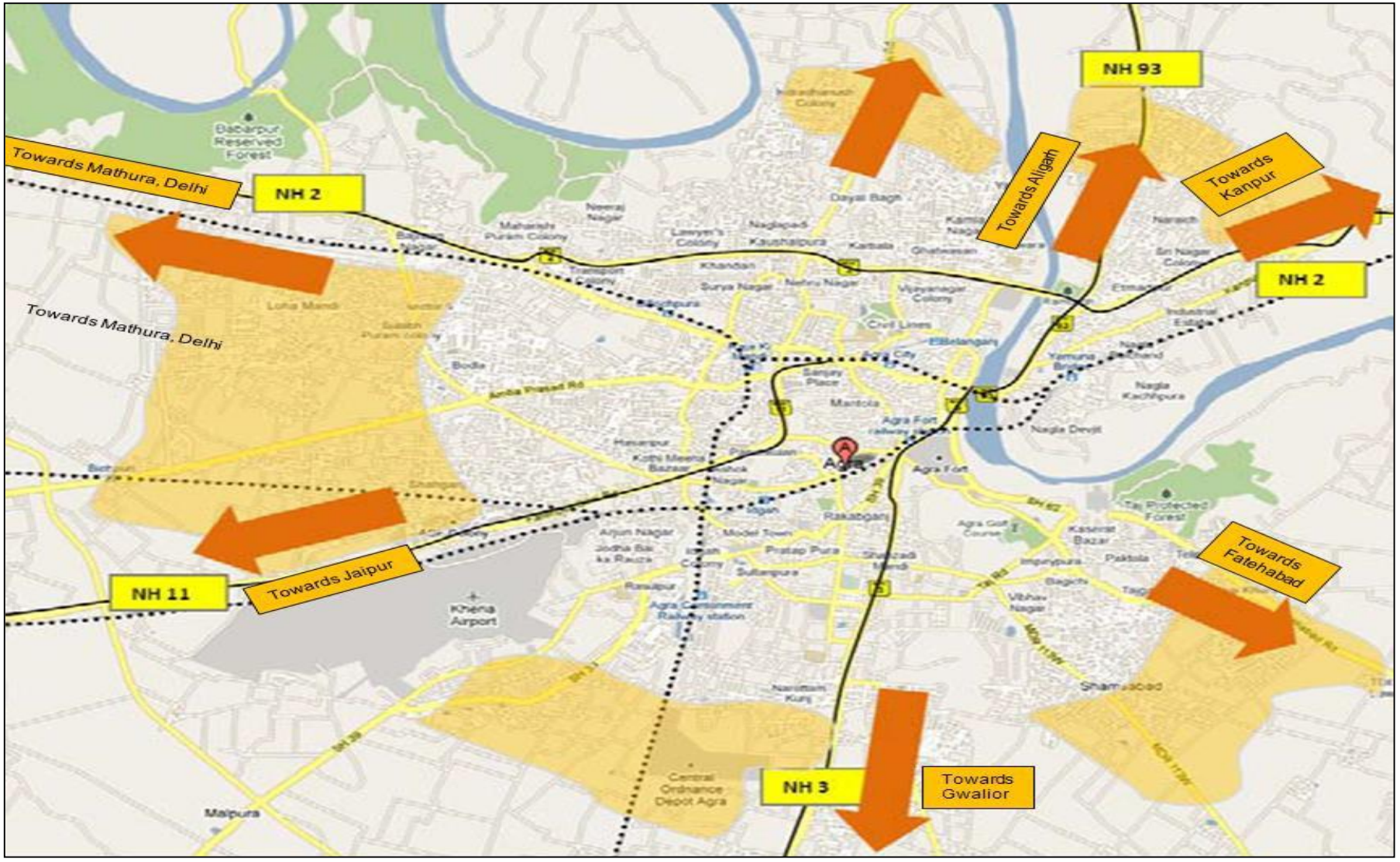
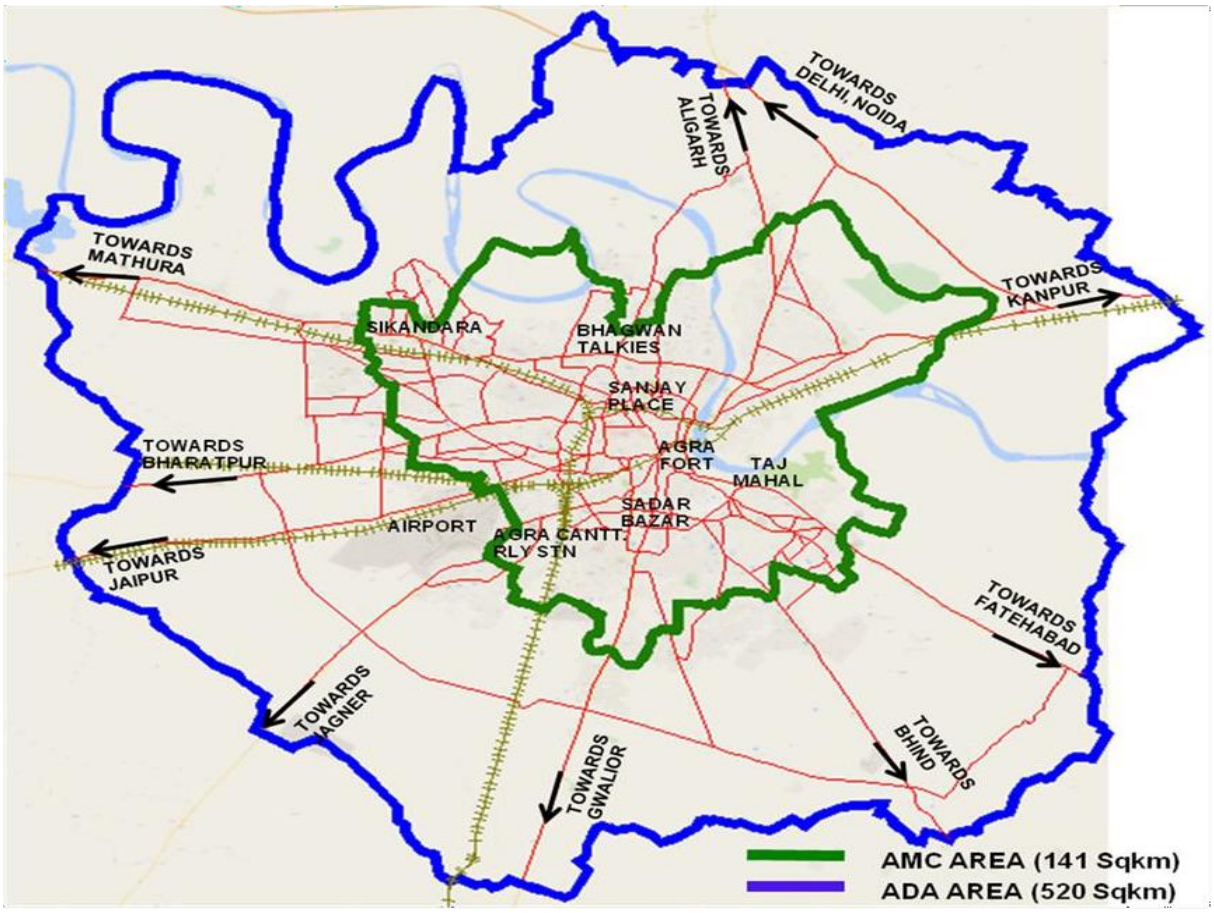


FIGURE 4.2: STUDY AREA - AGRA DEVELOPMENT AUTHORITY AREA



Population Density, Migration and Spatial Pattern

Agra is the second most self-employed in India in 2007. Agra has many industries. There are about 7,000 small scale industrial units. Being industrial and tourism centre has laid population increase from migrant workers over the years. It has been observed that the average annual growth in population had increased to 3% during 1991-2001 from average annual growth 2.4% previous decade (1981-91).

The population based on the growth trends taken separately for Core, Middle, Outer and special areas collectively forming the study area in addition to existing growth pattern from Census Data. The population in the study area in the base year 2017 is 23.7 Lakh. Accordingly, the population in the study area for the horizon years 2017, 2021, 2031 and 2041 is presented in **TABLE 4.2**

TABLE 4.2.: PROJECTED POPULATION IN ADA FOR HORIZON YEARS

Year	Population (lakh)
2017	23.7
2021	25.5
2031	31.3
2041	36.2

Urban Land Use Structure:

Land use Characteristics as per Agra Master Plan 2021

Agra has predominantly mixed landuse, especially in the housing, commercial and industrial sectors. The central part of the city is extremely crowded. High density is observed near Sanjay Place, M.G. Road, SadarBatti Road, Kinari Bazar Road and Daresi Areas. The density pattern in the peripheral areas exhibits a scattered development concentrated along major roads. The industrial policy in the state encourages industries to establish themselves outside urban areas and therefore, no new industries are developing in the city limits. High concentration of activities is observed on major arterial road system in the city. Acute traffic congestion is witnessed on these arteries throughout the day.

About 62% of area is categorized as residential and a significant 11% is assigned towards Traffic and Transportation. On the other hand the proportion of commercial and industrial land-use constitutes 2.6% and 7% respectively. The land use distribution (2001) is presented at **TABLE 4.3**.

TABLE 4.3: EXISTING LANDUSE – 2001

S. No	Landuse	Area (in Ha.)	%
1	Residential	48.9	61.8
2	Commercial	2.1	2.6
3	Industrial	5.4	6.9
4	Public Utilities and Services	8.4	10.7
5	Public/ Semi-Public Insituitions	1.8	2.3
6	Traffic and Transportation	8.6	10.9
7	Cremation ground	0.3	0.4
8	Parks and Playgrounds/ Recreational Areas	1.1	1.3
9	Historical/ Archeological areas	1.2	1.5
10	Nursery	0.3	0.3
11	Garden/ Green land areas	0.7	0.9
12	Sewage Plant	0.4	0.5
Sub - Total		79.0	100.0
13	Remaining Land (includes Agriculture land, forest land, Rural areas, River, Drains, Open land etc)	441.2	
Grand Total		520.2	

Source: Agra Master Plan 2021

The proposed allocation for land under various uses for year 2021 is given in **TABLE 4.4 and FIGURE 4.3.** About 50% of area is categorized as residential and 11% of area has been reserved under Traffic and Transportation.

The development authority takes care of the appropriateness of developments in Study Area as per proposed Master Plan 2021. The landuse plan has been formulated considering the existing landuse and the projected demand for various activities.

TABLE 4.4: PROPOSED LANDUSE – 2021

S. No	Landuse	Area (in Ha.)	%
1	Residential	99.2	49.5
2	Commercial	5.4	2.7
3	Industrial	16.1	8.0
4	Public Utilities and Services	17.6	8.8
5	Public/ Semi-Public Insituitions	5.1	2.5
6	Traffic and Transportation	21.6	10.8
7	Tourism	1.8	0.9
8	Parks and Playgrounds/ Recreational Areas	8.8	4.4
9	Other open Green lands	4.2	2.1
10	Other areas	20.5	10.3
Sub- Total		**200.4**	**100.0**
11	Remaining Land (includes Agriculture land, forest land, Rural areas, River, Drains, Open land etc)	319.8	
Grand Total		**520.2**	

Source: Agra Master Plan 2021

Zoning and Floor Space Index (FSI) Pattern

Further zoning regulations, planning norms and building classification for transit oriented development and mixed land use along mass rapid transit corridors have been notified by the Government of Uttar Pradesh vide letter have been notified by the Government of Uttar Pradesh vide letter no. 03/ Eight-3-15-198 vividh/14 dated 04.03.2015.

Uttar Pradesh Government has approved property development for Lucknow Metro vide letter no. 2624/ Eight-1-13-09 LDA/13 dated 20.08.2013 with 30% of the total area available with 5 (five) FSI to be used for commercial activity development and balance 70% for residential activity development .

Major Activity Centres in Agra

The major Landuse in Agra are Industrial, Institutional and mixed Residential cum Commercial activities. A brief of these activities along with prominent locations are presented in **FIGURE 4.4**

The employment for year 2011 has been worked out from the census data figures and has been extrapolated to obtain base year 2017 employment figures. Keeping in view the economic profile of the study area, development prospects and transport intervention policies, WFPR of 32 % has been assumed from Agra Master Plan for the Horizon years. Thus, it has been estimated that 11.6 lakh workers would comprise the workforce in the study area by 2041.

The total workers in the Study Area has been estimated at 6.7 lakh for the year 2017 with a Work

Force Participation based on Master Plan, Economic and Landuse profiles.

FIGURE 4.3: PROPOSED LANDUSE DISTRIBUTION FOR AGRA – 2021

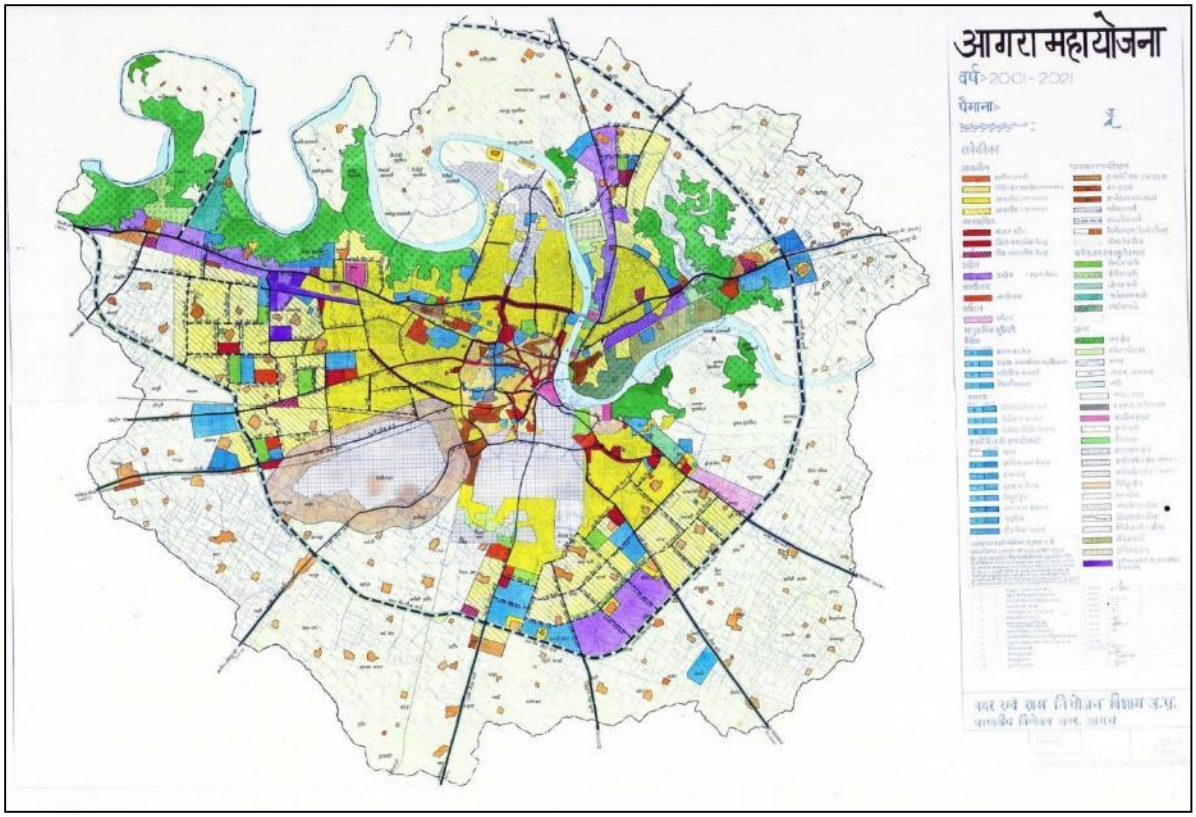
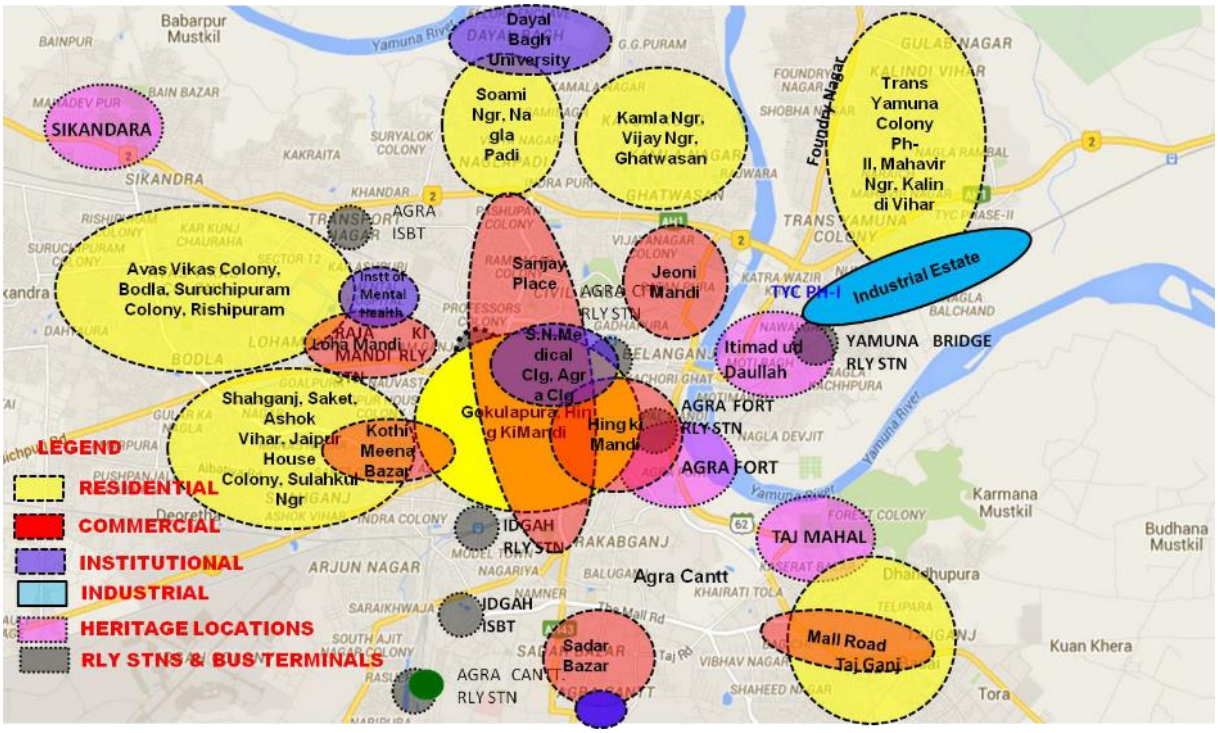


FIGURE 4.4: MAJOR AREAS AND LANDUSE ACTIVITIES



C. EXISTING SCENARIO

1.1 Environmental Baseline

Data on land environment has been collected and compiled from various sources and during field 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. Water quality, soil quality, ambient air and noise environment in the surrounding areas 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). 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 4.5**. The general environmental attributes pertaining to the proposed metro project along with parameters to be collected and its frequency are presented in **TABLE 4.6**

TABLE 4.5: SCOPING MATRIX

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
D. Noise Pollution	
Construction Phase	Noise due to operation of various equipment
	Noise due to increased vehicular movement
Operation Phase	Noise from Metro operation
	Noise due to DG sets

ASPECT OF ENVIRONMENT	LIKELY IMPACTS
E. Ecology	
Construction Phase	Removal of vegetation cover/loss of biomass
F. Socio-Economics	
Construction Phase	Loss of Livelihood due to relocation caused by land acquisition/increase in vulnerability
	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

The collection and compilation of environmental baseline data is essential to assess the impacts on environment due to the project activities. The environment includes water, land, air, ecology, noise, vibration and socio–economic issues etc.

TABLE 4.6: ENVIRONMENTAL ATTRIBUTES AND FREQUENCY OF MONITORING

S. NO.	ATTRIBUTE	PARAMETER	FREQUENCY	SOURCE
LAND ENVIRONMENT				
1	Soil	Soil Characteristics	Once	Field studies/ literature review
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	24 hr in one Season	Field Studies
6	Meteorology	Temperature, Relative humidity, Rainfall, wind direction and speed	Last five years	India Meteorological Department/ literature review
7	Noise	Noise levels in dB (A)	24 hr in one Season	Field studies
SOCIO-ECONOMIC				
9	Socio-economic aspects	Socio-economic characteristics	Once	Field Studies, Literature review
ECOLOGY				

10	Ecology	Flora & Fauna	Once	Literature and Field observations

1.2 Land Environment

The land environment primarily consists of Physiography, soil, geology & minerals, and land use pattern.

Physiography: Agra is a city on the banks of river Yamuna in the northern state of Uttar Pradesh, India. It is 378 kilometers west of the state capital, Lucknow, 206 kilometers south of the national capital New Delhi and 125 kilometers north of Gwalior. It is located at latitude 270 18' N and longitude 780 02' E with an elevation of 171 m above mean sea level and having the area of 188.40 sq km. The physiographical map is shown in **FIGURE 4.5**.

Soil: The soil mostly consists of the quaternary sediments of the Indo-Gangetic plains. It consists of recent unconsolidated fluvial formations containing sand, silt and clay. Its texture is mostly fine. The seven soil samples were collected along both the corridors, location details are provided in **TABLE 4.7** and sampling location map is shown **FIGURE 4.7**. The laboratory analysis results so obtained are reported in **TABLE 4.8** The soils are slightly alkaline in nature. The soils are mainly clay loam, slightly silty and loam in texture. Organic matter content in soils varies from 0.66% to 0.86%. The soil map of Agra district is shown in **FIGURE IV.C.1.4**.

TABLE 4.7 SAMPLING LOCATIONS FOR SOIL

Location
Corridor - 1
Near Agra Fort (Electric) office
Near Hotel Trident
Agra ISBT
Corridor - 2
Agra Cantt. Railway Station
St. John College
TYC Phase-II
Vijay Nagar

Corridor-1: Sikandara to Taj East Gate,
Corridor-2: Agra Cantt. Rly Station to Kalindi Vihar

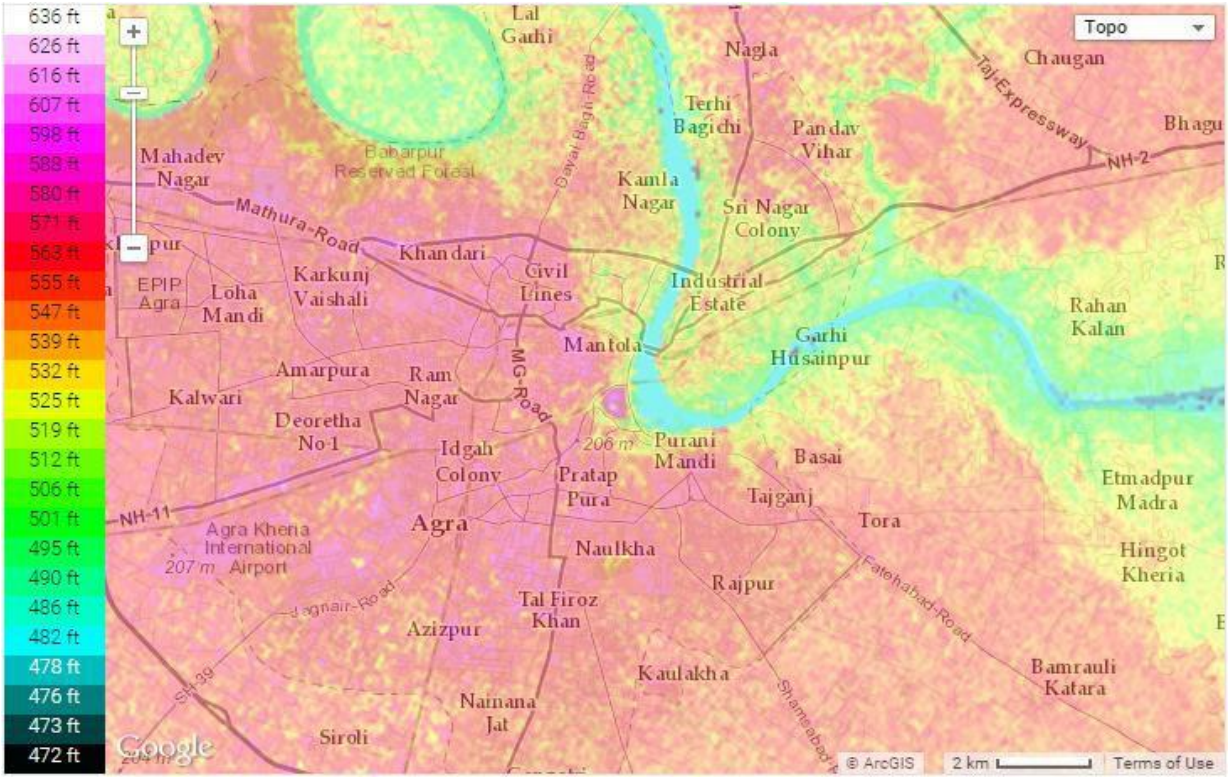
Geology and Minerals: Most of the state of Uttar Pradesh lies in the Gangetic Plain. This is a fore-deep, a downward of the Himalayan foreland, of variable depth, converted into flat plains by long-vigorous sedimentation. This is known as a geosyncline and the Gangetic Plain is the Indo-Gangetic Geosyncline. A generalized geological succession of the formations present in and around Agra city is given below:

Formation	Lithology	Age

Quaternary	Gangetic Alluvium	Recent Pleistocene
Vindhyan	Unconformity Upper Bhander Sandstone	Pre-cambrian
	Lower Rewa Sandstone	

The entire city of Agra is underlain by quaternary sediments constituting an admixture of sand, silt, clay and kanker. The geological map of Uttar Pradesh is shown in **FIGURE 4.5.**

FIGURE 4.5: PHYSIOGRAPHICAL MAP OF STUDY AREA



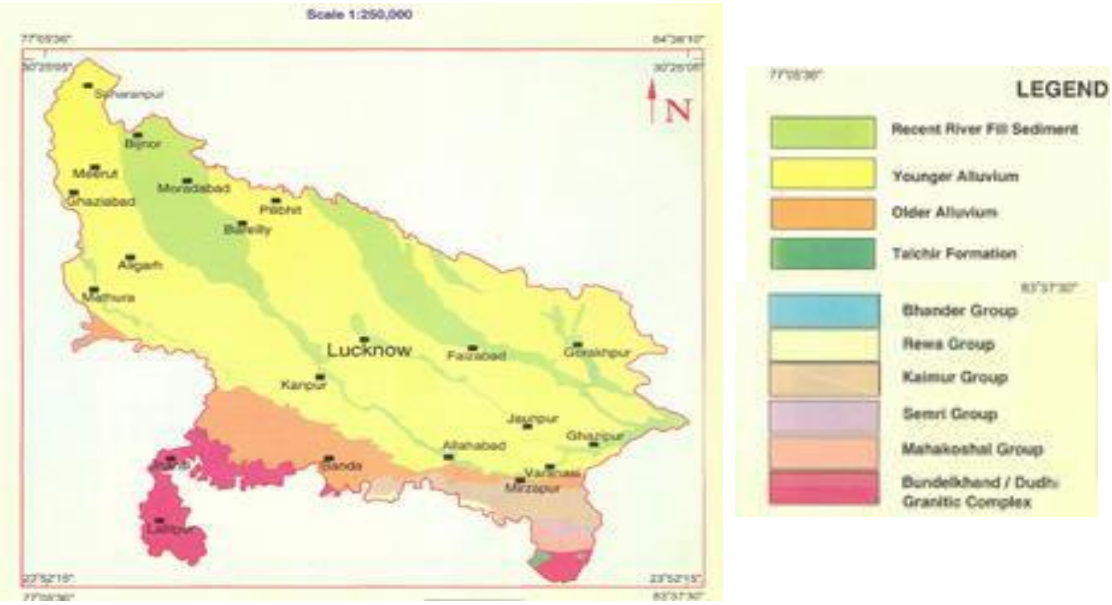
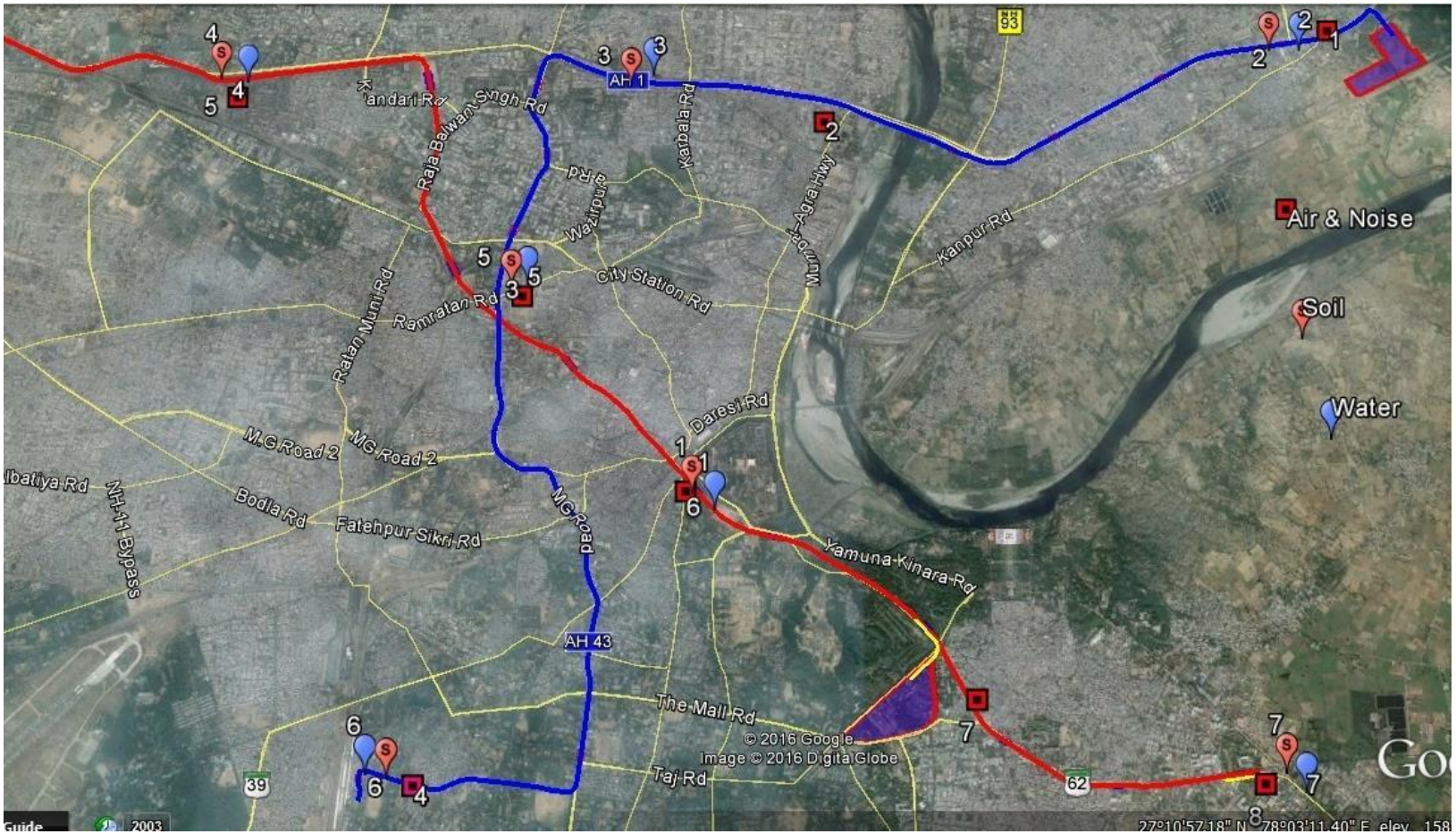


FIGURE 4.6.: GEOLOGICAL MAP OF UTTAR PRADESH

FIGURE 4.7.: MONITORING LOCATION MAP FOR AIR, NOISE, WATER AND SOIL



Sampling Location - Soil & Water: 1) Near Agra Fort (Electric) office; 2) Near Hotel Trident; 3) St. John College; 4) Agra ISBT; 5) Agra Cantt. Railway Station; 6) TYC Phase-II; 7) Vijay Nagar

Air & Noise: 1)Near Agra Cant Railway Station 2) Near St. John's College 3) Near Kagarol Ki Sarai (Near Agra Fort) 4) Near Agra ISBT (Transport Colony) 5) Near Impeypur (Bansal Nagar) 6) Basai (Near Hotel Trident) 7) Near 100 foot road (Near Kuberpur) 8) Water Works near Langre Ki Chawki

TABLE 4.8: RESULTS OF LABORATORY ANALYSIS OF SOIL SAMPLE

S. No.	Parameter	Unit	Corridor - 1			Corridor - 2			
			Near Agra Fort	Agra ISBT	Near Hotel Trident	St. John College	Trance Yamuna Colony Phase-II	Vijay Nagar	Agra Cantt Rly Stn
1	pH (at 25^0C)	-	7.81	8.00	8.30	7.92	8.21	8.35	8.19
2	Electrical Conductivity (EC)	mS/cm	0.18	0.21	0.38	0.22	0.24	0.23	0.32
3	Chloride	Mg/kg	478.58	708.29	804.01	861.44	430.72	469.00	363.72
4	Available Nitrogen	Kg/hec	12.10	15.77	15.16	16.33	101.10	14.30	13.56
5	Total Zinc as Zn	mg/kg	87.43	78.16	84.14	81.65	81.41	84.10	71.86
6	Manganese as Mn	mg/kg	516.14	519.15	577.18	578.14	488.14	542.16	482.10
7	Total Lead as Pb	mg/kg	15.74	14.12	15.06	13.44	12.14	13.10	11.46
8	Total Copper as Cu	mg/kg	22.4	24.66	23.88	26.32	19.14	23.14	20.18
9	Organic Carbon	%	0.38	0.39	0.44	0.48	0.42	0.44	0.50
10	Water soluble Sulphate	mg/kg	60.55	61.23	53.14	57.46	46.14	54.18	48.62
11	Boron	mg/kg	0.61	0.71	0.52	0.63	0.48	0.54	0.43
12	Iron	mg/kg	101.10	81.32	64.12	76.18	82.16	78.14	62.14
13	Nickel	mg/kg	21.41	17.40	14.23	16.01	18.14	19.10	12.58
14	Bicarbonate (HCO_3)	mg/kg	4.50	4.45	4.31	4.08	3.76	4.10	3.65
15	Calcium as Ca	mg/kg	2084.96	842.16	1700.67	1913.26	147.17	1144.68	163.53
16	Magnesium as Mg	mg/kg	57.05	133.95	64.50	119.07	54.57	153.80	69.46
17	Sand	%	28.20	30.10	33.20	31.60	32.10	35.10	34.20
18	Silt	%	42.30	45.10	45.20	47.20	43.20	41.30	44.30
19	Clay	%	29.50	24.80	21.60	21.20	24.70	23.60	21.50
20	Sodium as Na	mg/kg	228.0	508.00	563.00	200.00	369.00	515.00	310.20

21	Potassium as K	kg/hec	518.20	387.52	320.32	618.20	302.40	176.90	565.31
22	Nitrogen	Kg/hec	203.67	223.14	234.14	233.10	184.15	211.41	207.41
23	Sulphur	mg/kg	24.15	26.18	22.14	28.14	21.14	23.41	20.14
24	Phosphate	mg/kg	102.10	103.18	82.14	110.14	92.00	98.14	88.22
25	Organic Matter	%	0.66	0.67	0.76	0.83	0.72	0.76	0.86
26	Orthophosphate	mg/kg	105.0	106.27	84.60	113.44	94.76	101.08	91.32
27	Carbonate	mg/kg	4.51	4.66	4.66	5.21	3.67	4.23	4.08
28	Arsenic	mg/kg	BDL	BDL	BDL	BDL	BDL	BDL	BDL
29	Mercury	mg/kg	BDL	BDL	BDL	BDL	BDL	BDL	BDL
30	Cadmium as Cd	mg/kg	26.30	20.45	15.10	17.46	21.16	19.88	14.12
31	Molybdenum	mg/kg	0.14	0.16	0.18	0.21	0.09	0.10	0.08

FIGURE 4.8: SOIL MAP OF AGRA DISTRICT

Alluvial plain (0-1% slope): 1. Deep, loamy soils and slightly eroded, 2.Deep, fine soils moderately saline and sodic associated with loamy soils, slightly eroded,
3. Deep, fine soils and slightly eroded associated with loamy soils slightly saline and moderately sodic, 4. Deep, silty soils associated with loamy soils slightly eroded, 5. Deep, silty soils and slightly eroded associated with fine soils

Ravinous land (3-5% slope): 6. Deep, loamy soils and severely eroded, 7. Deep, loamy soils, very severely eroded associated with silty soils, very severely eroded

Dissected uplands (3-5% slope): 8. Deep, loamy soils and moderately eroded associated with loamy soils, slightly eroded **Undulating Lands with hillocks (1-3% slope):** 9. Deep, loamy soils with moderate erosion associated with sandy soils with moderate erosion
Gentle to very gentle sloping lands with monad nocks:
10. Deep, loamy soils and slightly eroded associated with loamy skeletal soils, severely eroded, 11. Deep, loamy soils, moderately eroded, 12. Deep, loamy soils and slightly eroded associated with silty soils, slightly saline and moderately sodic, 13. Deep, loamy soils and slightly eroded associated with loamy soils, moderately eroded

Source: NBSS & LUP, Regional Centre Delhi

Land-use: Existing land use for the Agra Development Area is given in **TABLE 4.9**.The residential area having majority i.e. more than 60% of total area than the community facility and Traffic and Transportation.

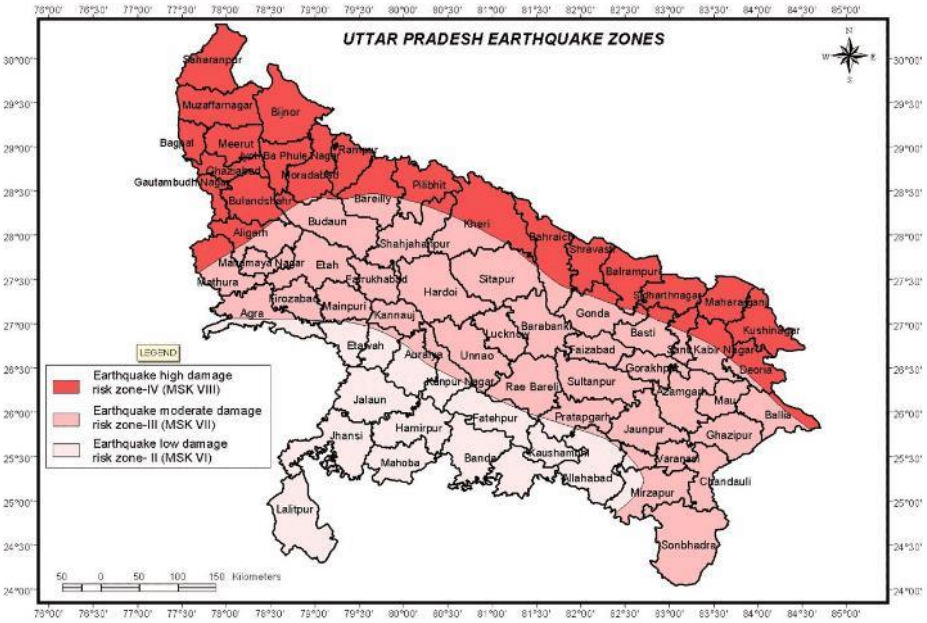
TABLE 4.9: EXISTING LAND USE OF AGRA DEVELOPMENT AREA 2001

Land use class	Area	Percentage (%)
Residential	4886.34	61.84
Commercial	148.74	1.88
Wholesale Commercial	58.88	0.75
Industrial	542.72	6.87
Community facility	842.62	10.66
Office	177.93	2.25
Traffic & Transportation	858.65	10.87
Crenulations / Burial ground	31.25	0.4
Park Place Ground	105.22	1.33
Historical Monument	116.48	1.47
Nursery	24.09	0.3
Gardens	69.12	0.87
Sewage Farms	38.35	0.49
Total	7901.39	100
Other Agricultural, forest, settlement, rivers, open spaces etc	4411	
Total	**52020.63**	

Source: Agra Master Plan – 2021

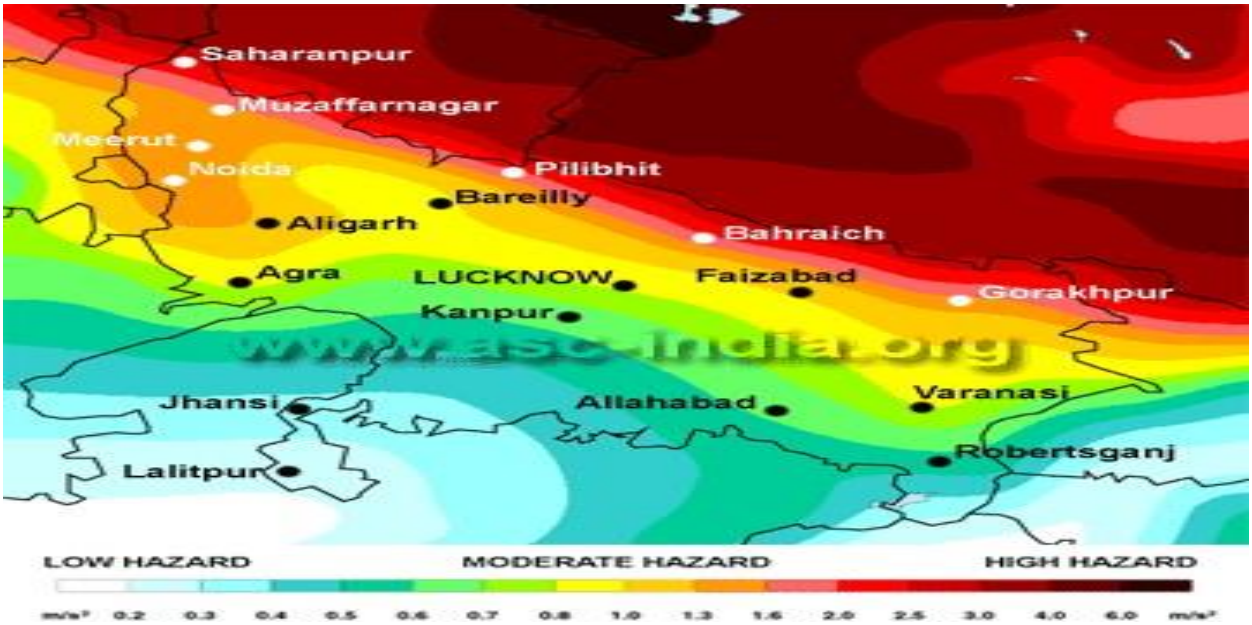
Seismicity: In the seismic zoning map of India prepared by Bureau of Indian Standards (BIS) the area of Agra and its neighborhood lies in Zone III as shown in **FIGURE 4.9**

FIGURE 4.9: SEISMIC ZONING MAP OF UTTAR PRADESH



According to Global Seismic Hazard Assessment Program (GSHAP) data, the state of Uttar Pradesh falls in a region of moderate to high seismic hazard as shown in **FIGURE 4.10**

FIGURE 4.10: SEISMIC HAZARD MAP OF UTTAR PRADESH



Source: Amateur Seismic Centre, Pune

Agra falls in moderate to least active seismic zone and corresponds to MSK intensity VII, making it prone to Earthquakes. The existence of the Great Boundary Fault near Jalesar, dense urban population and weak structures in old Agra city make it highly vulnerable to seismic hazards. Although no major earthquake has occurred in Agra in recent years, yet tremors have been felt whenever there is an earthquake in the NCR. One of the most powerful earthquakes in Uttar Pradesh struck the districts of western Uttar Pradesh at 21:01 IST on October 10th, 1956. The massive shock was centered near Jehangirpur, in Bulandshahr District. No fatalities were reported. The shock was also strongly felt at Delhi, where there was some minor damage.

1.3 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 the needs of in its various stages of the project cycle and also to assess the impact of the project activities on water environment.

Hydro-geological Characteristics: Groundwater occurs under unconfined to semi-confined conditions. Depth to water level varies from 17 to 23 m below ground level (bgl) but in the topographic lows and in the vicinity of Agra canal and Yamuna, water table is within depth of 10 mbgl. The water level data show a declining trend. The regional water table data shows that the ground water movement in general is from west to east on the right bank and east to west on the left bank. The local topography plays an important role in controlling the ground water movement in the area. Some of the portion of the corridors like Jama Masjid to Tajmahal for Corridor -1 and Kamla Nagar to Foundary Nagar for Corridor – 2 is falling near Yamuna River where ground water level is about 10mbgl.

Water Resources: The source of water supply in the city is mainly surface water. The river Yamuna is the onlysurface water source, which enters the town from northeast corner, flow towards south of thecity for some distance and then turns towards left. The Jal Nigam has also

installed Hand-pumps to supplement the required water supply. The urban water supply is a perpetual problem in this saline tract, where fresh water is available only in patches. According to the Agra JalSansthan (AJS), the total water demand of the city is 320 million litres per day (MLD), which includes the demand for bulk supply, estimated at 75 MLD in the year 2006. The water demand as estimated for the 1.42 million-population in 2005 was 245 MLD, which was calculated on a 170 litres per capita daily (lpcd) standard. For this, the city has two water treatment plants with a capacity to treat 410 MLD in entirety. The forecasted water demand for 2016 is 402 MLD.

Drainage: River Yamuna forms the major drainage of the city and it flows from North to South-East of the city. The overall drainage is controlled by the Yamuna River. The drainage system of Agra was laid about 55 years back and drains are in bad condition. The system comprises hierarchy of natural and man-made drains that ultimately discharge surface run off and sewage to River Yamuna because at most part of the city there is no sewerage system. Natural nalhas are the main carriers of the storm water. These drains were formerly natural water drainage. Now they serve as sewage disposal drains.

Water Quality: Water quality includes the physical, chemical and biological characteristics of water. An understanding of the various factors influencing water quality is thus very important as human health is largely dependent on the quality of water available for use.

In order to assess the baseline water quality status of the study area, 7 samples along both the corridors were collected in the project area. The sample locations from which water sample were collected are shown in **FIGURE 4.10**. 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 and IS 10500-2012. The results of analysis are presented in **TABLE 4.11**.

TABLE 4.10: DESCRIPTION OF WATER QUALITY MONITORING LOCATIONS

S. No.	Location No.	Location	Environmental Setting
Corridor - 1			
1	Loc-1	Near Agra Fort (Electric) office	Bore well
2	Loc-4	Agra ISBT	Bore well
3	Loc-7	Near Hotel Trident	Hand pump
Corridor - 2			
4	Loc-2	TYC Phase-II	Hand pump
5	Loc-3	Vijay Nagar	Bore well
6	Loc-5	St. John College	Hand pump
7	Loc-6	Agra Cantt. Railway Station	Bore well

Corridor-1: SikandaratoTaj East Gate,
Corridor-2: Agra Cantt. Rly Station to Kalindi Vihar

TABLE 4.11: PHYSICO-CHEMICAL ANALYSIS OF WATER SAMPLES IN PROJECT AREA

S. No	Parameter	Units	Corridor – 1				Corridor - 2			Acceptable Limit/Permissible Limit
			Loc-1	Loc-4	Loc-5	Loc-7	Loc-2	Loc-3	Loc-6	
1	pH at 25°C	-	7.23	7.62	7.01	7.32	7.67	7.32	6.69	6.5-8.5/no relaxation
2	Turbidity	NTU	0	0	17.8	64.3	0	0	0	1/5 max
3	Total Dissolved Solids	mg/l	1708	1375	2280	1928	1264	2618	3896	500/2000 max
4	Aluminium as Al	mg/l	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.03/0.02 max
5	Free Amonia (as NH3)	mg/l	<1	<1	<1	<1	<1	<1	<1	-
6	Barium (as Ba)	mg/l	BDL	0.003	BDL	BDL	0.009	BDL	BDL	0.7 max/ no relaxation
7	Boran (as B)	mg/l	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.5/1
8	Calcium as Ca	mg/l	162	121.4	194.3	113.3	105.3	145.7	307.7	75/200
9	Chloride as Cl	mg/l	384.3	266.1	611	473	167.5	680	1202.3	250/1000
10	Copper as Cu	mg/l	BDL	BDL	0.016	0.006	BDL	BDL	BDL	0.05/1.5
11	Fluoride as F	mg/l	>1	>1	>1	>1	>1	>1	>1	1.0/1.5
12	Iron as Fe	mg/l	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.3/ no relaxation
13	Magnesium (as Mg)	mg/l	29.5	59	128	123	5	132.8	226.3	30/100
14	Manganese as Mn	mg/l	0.024	BDL	0.03	0.09	BDL	BDL	BDL	0.1/0.3
15	Nitrate as NO3	mg/l	BDL	11.2	BDL	BDL	1.1	17.7	2.2	45/ no relaxation
16	Phenolic Compounds	mg/l	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.001/0.002
17	Seleniem (as Se)	mg/l	BDL	0.003	0.099	BDL	BDL	0.004	BDL	0.01/ no relaxation
18	Silver (as Ag)	mg/l	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.01/ no relaxation
19	Sulphate as SO4	mg/l	62.4	95.2	73.1	66.5	59.1	155.2	152	200/400
20	Sulphide (as S)	mg/l	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.05/ no relaxation
21	Total Alkalinity as CaCO3	mg/l	484.8	636.3	899	666.6	495	444.4	565.6	200/600
22	Total Hardness as CaCO3	mg/l	525.2	545.4	1010	787.8	282.8	909	1696.8	200/600
23	Zinc as Zn	mg/l	BDL	BDL	BDL	0.07	BDL	BDL	BDL	5/15
24	Cadmium (as Cd)	mg/l	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.003/ no relaxation
25	Cynide (as CN)	mg/l	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.05/ no relaxation
26	Lead as Pb	mg/l	BDL	0.003	BDL	0.003	BDL	BDL	BDL	0.050.01/ no relaxation

27	Mercury (as Hg)	mg/l	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.001/ no relaxation
28	Nickel	mg/l	BDL	BDL	BDL	0.005	BDL	BDL	BDL	0.02/ no relaxation
29	Arsenic as As	mg/l	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.01/0.05
30	Total Chromium (as Cr)	mg/l	BDL	0.008	BDL	BDL	BDL	0.013	BDL	0.05 max/no relaxation
31	Total Suspended Solids	mg/l	0	0	78	25	0	0	0	-
32	Vanadium (as V)	mg/l	BDL	0.0024	BDL	BDL	BDL	BDL	BDL	-
33	Amonical Nitrogen (as N)	mg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.5/No relaxation
34	Total Kjeldahl Nitrogen (as N)	mg/l	<0.1	2.66	<0.1	<0.1	0.38	6.5	0.64	-
35	Chromium (as HexavalentCromium)	mg/l	BDL	BDL	BDL	BDL	BDL	BDL	BDL	-
36	Oil and Grease	mg/l	0	0	0	0	0	0	0	-
37	Dissolved Oxygen		7	4.2	6.2	6.6	7.1	6.8	5.4	-
38	Chemical Oxygen Demand	mg/l	0	12.4	16.5	0	0	3.8	20.6	-
39	Biochemical Oxygen Demand (3 day 27 deg C)	mg/l	Nil	5	7	Nil	Nil	2	6	-
40	Total Phosphate as P	mg/l	BDL	0.69	BDL	BDL	0.57	0.4	0.78	-
41	Dissolved Phosphate (as P)	mg/l	BDL	0.6	BDL	BDL	0.5	0.4	0.70	
42	Sodium as Na	mg/l	230	285	380	335	310	555	580	-
43	Potassium as K	mg/l	160	9	10.5	160	9.5	11	14	-
44	Nitrate Nitrogen	mg/l	BDL	2.53	BDL	BDL	0.25	4.2	0.5	-
45	Total Nitrogen	mg/l	<0.1	2.66	<0.1	<0.1	0.38	6.5	0.64	-
46	Organic Phosphorus	mg/l	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.002 max
47	Coliform Count	MPN/100 ml	Absent	Present	Absent	Absent	Present	Present	Present	Absent
48	Fecal Coliform	MPN/100 ml	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
50	Total Coliform Organism	MPN/100 ml	Absent	Present	Absent	Absent	Absent	Present	Absent	Absent

(Acceptable Limit/Permissible Limits as per IS 10500-2012)

The results of analysis of water samples indicates that most of the parameters are within the permissible limit except Turbidity at location 5 & 7, TDS at location 3, 5 & 6, Calcium and Chloride at location 6, Magnesium at location 3, 5, 6 & 7, Total Alkalinity at location 4, 5 & 7,

Total Hardness at location 3, 5, 6 & 7, COD at 3, 4, 5 & 6, BOD at location 3, 4, 5 & 6 and Coliform 2, 3, 4 & 6. Water from these sources should be treated before using it for drinking purposes. Bacteriological contamination may be due to existing sewer/drains flowing adjacent to the source.

1.4 Meteorology and Air Environment

Meteorology is an important parameter in environmental impact assessment study. It is responsible for the movement of air and air pollutants. Meteorological data like mean rainfall and maximum & minimum temperature of the district for a period of 1901 to 2000 and of other parameters relative humidity, wind speed and cloud for a period of 1971 to 2000 are given in **TABLE 4.12**. It is depicted from the table that temperature of the district varies from 22.3OC - 41.7OC in summer to a minimum of around 8.2OC – 28.8OC in winter and Relative humidity varies from 37% to 78%.

TABLE 4.12: METEOROLOGICAL DATA

Month	Mean Temperature (Deg. Cent)		Mean Rainfall (mm)	Relative Humidity (%)	Wind Speed (Kmph)	Cloud (octas)
	Max	Min				
January	22.3	7.7	13.2	69.53	2.75	1.93
February	25.5	10.3	17.6	60.02	4.26	1.94
March	31.9	15.5	9.3	48.99	5.43	1.87
April	37.9	21.5	6.3	37.78	6.76	1.64
May	41.7	26.5	11.3	37.84	7.95	1.54
June	40.7	28.9	55.7	61.64	8.16	2.85
July	35.3	26.8	203.3	72.7	7.52	5.33
August	33.2	25.7	243.2	78.59	6.24	5.31
September	34	24.3	129.7	70.18	5.22	3.04
October	34	19.1	24.8	59.45	2.52	1.05
November	29.2	12.5	4.3	62.23	1.34	0.89
December	23.9	8.2	6.1	69.67	1.55	1.52

Source: Indian Meteorological Department, Pune (National Data Centre, Pune)

The latest rainfall data for the year 2009-2013 is given in **TABLE 4.13** which depicts the highest rainfall i.e. 281.3 mm in the month of August 2012. August month is generally having highest rainfall in the area.

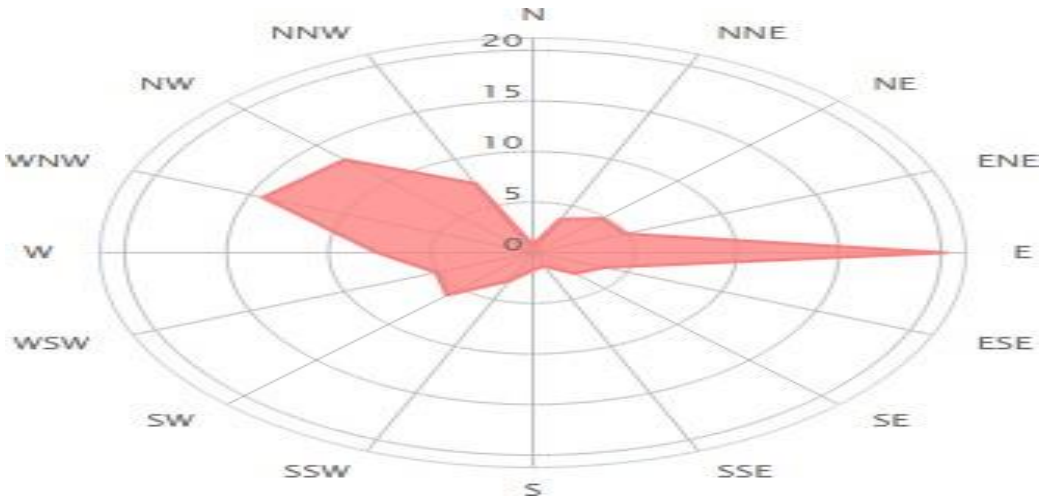
The wind rose diagram has been prepared based on the daily data for the period of 09/2011 to 05/2015. The prominent direction is East, North West and West North West. Wind rose diagram for the Agra is shown in **FIGURE 4.11**

TABLE 4.13: AVERAGE RAINFALL (MM)

Month/Year	Rainfall (mm)				
	2009	2010	2011	2012	2013
January	0	1.3	0	23.4	10.5
February	0	8.6	16.9	1.1	27.3
March	0	0	3	0	2.3
April	1.6	0	2.7	5.4	0.5
May	38	0	14.3	0.7	3.2
June	16.8	13.5	86.9	5.7	70.6
July	74.1	98.2	110.5	184.8	163.1
August	76.7	119.7	116.6	281.3	269.1
September	84.4	146.7	66.4	90.2	76
October	62.6	1.5	0	0.6	83.2
November	14.8	27.8	0	0	0.2
December	2	1.7	0	0	5

Source: Indian Meteorological Centre, Delhi

FIGURE 4.11: WIND ROSE DIAGRAM



Air Quality: Eight monitoring stations selected at strategic locations along both the corridors. The

monitoring result for ambient air quality is presented in **TABLE 4.14.** The monitoring stations were selected to generate the representative samples for air quality covering residential, institutional and industrial area along the corridors. The monitoring was done from 08.06.2015 (9 am) to 12.06.2015 (9 am).

The National Ambient Air Quality Standard (NAAQ) laid down by Ministry of Environment, Forest &Climate Change (MoEFCC) on 16thNovember 2009 has been given in **TABLE 4.15**. The result of air quality monitoring compared with National Ambient Air Quality Standard and found that particulate matter (PM10 &PM2.5) is exceeding the permissible limit in residential areas at all monitoring locations except PM10 at location 8. Whereas other parameters like SO2, NO2, O3, Pb, NH3, CO and HC are within permissible limit except CO at locations 4, 7 & 8 are exceeding permissible limit.

TABLE 4.14: AIR QUALITY RESULT

SN	Parameters	Unit	Concentration of Pollution							
			Corridor - 1				Corridor – 2			
			3	4	5	6	1	2	7	8
1	Sulphur Dioxide (SO_2)	µg/m^3	BDL	11.2	BDL	BDL	9.8	BDL	8.5	10.4
2	Nitrogen Dioxide (NO_2)	µg/m^3	17.1	26.6	13.6	16.3	19.4	15.3	20.3	24.6
3	Particulate matter (PM_{10})	µg/m^3	166	253	138	147	185	156	172	223
4	Particulate Matter ($PM_{2.5}$)	µg/m^3	96	126	72	84	98	84	93	116
5	Ozone (O_3)*	µg/m^3	29.4	43.8	25.4	27.5	31.5	28.6	30.4	37.3
6	Lead (Pb)	µg/m^3	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
7	Carbon Monoxide (CO)*	mg/m^3	1.7	2.3	1.4	1.2	1.9	1.5	1.6	2.2
8	Ammonia (NH_3)	µg/m^3	22.3	18.9	16.3	12.8	14.6	12.4	15.2	14.1
9	Hydrocarbon	µg/m^3	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL

BDL- Below Detection Limit; BDL for Pb< 0.2 µg/m3, Hydrocarbon < 5 mg/m3

*Total monitoring period 8 hours

Near Agra Cant Railway Station 2) Near St. John's College 3) Near Kagarol Ki Sarai (Near Agra Fort) 4) Near Agra ISBT (Transport Colony) 5) Near Impeypur (Bansal Nagar) 6) Basai (Near Hotel Trident) 7) Near 100 foot road (Near Kuberpur) 8) Water Works near Langre Ki Chawki

TABLE 4.15.: NATIONAL AMBIENT AIR QUALITY STANDARDS

		Concentrati on

Pollutant	Time	Industrial, Residential, Rural & other Area	Ecological Sensitive area
Sulphur Dioxide (SO_2) in μg/m3	Annual	50	80
	24 Hours	80	80
Oxides of Nitrogen (NOx) in μg/m3	Annual	40	30
	24 Hours	80	80
Particulate Matter size less than 10μm (PM_{10}) in μg/m3	Annual	60	60
	24 Hours	100	100
Particular Matter size less than 2.5μm ($PM_{2.5}$) in μg/m^3	Annual	40	40
	24 Hours	60	60
Carbon Monoxide (CO) in mg/m3	8 Hours	02	02
	1 Hour	04	04
Ozone (O_3) in μg/m^3	8 Hours	100	100
	1 Hour	180	180
Lead (Pb) μg/m^3	Annual	0.50	0.50
	24 Hours	1.0	1.0
Ammonia (NH_3)μg/m^3	Annual	100	100
	24 Hours	400	400

Source: CPCB guidelines for AAQM

1.5 Noise Environment

The hourly noise monitoring was carried out for 24 hours on 08.06.2015 (9 am) to 12.06.2015 (9 am) at eight locations along the proposed metro corridors. The result was analysed to evaluate Leq, L10, L50, L90, Lday, Lnight, LDN, LMAX and LMIN which are depicted in **TABLE 4.16**. The Ambient Noise Quality criteria laid down by CPCB has been given in **TABLE 4.17**. The noise level monitoring results are exceeding the permissible limit specified for residential area.

TABLE 4.16: AMBIENT NOISE LEVEL MONITORING RESULT

S.No.	Monitoring Location	Leq	L_{10}	L_{50}	L_{90}	L_{max}	L_{min}	L_{day}	L_{night}	L_{DN}
Corridor - 1										
1	Near Kagarol Ki Sarai (Near Agra Fort)	65.2	73.3	68.0	65.7	84.9	48.1	66.7	58.7	67.5
2	Near Agra ISBT (Transport Colony)	69.3	78.0	72.1	69.7	103.5	49.6	70.9	59.4	70.4
3	Near Impeypur (Bansal Nagar)	57.7	66.4	60.5	58.1	91.9	38.0	59.3	47.3	58.7
4	Basai (Near Hotel Trident)	59.8	68.5	62.7	60.3	94.1	39.0	61.5	48.4	60.7
Corridor - 2										
5	Near Agra Cant Railway Station	68.2	77.4	71.2	68.6	91.3	45.0	69.3	64.2	71.6
6	Near St. John's College	59.1	66.6	61.9	59.6	89.2	42.0	60.2	55.7	62.9

7	Near 100 foot road (Near Kuberpur)	66.1	74.5	68.9	66.6	94.9	46.1	67.8	54.6	66.9
8	Water Works near Langre Ki Chawki	67.6	75.9	70.4	68.0	96.2	45.3	69.0	61.3	69.9

TABLE 4.17: AMBIENT NOISE STANDARDS CRITERIA

Area Code	Category of Area	Limits in dB (A) Leq	
		Day time*	Night time
A	Industrial area	75	70
B	Commercial area	65	55
C	Residential area	55	45
D	Silence Zone**	50	40

Source: CPCB guideline (as per The Noise Pollution (Regulation and Control) Rules, 2000)

* 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.

1.6 Ecology

No rare or endangered species are known in this section of river Yamuna: the nearest access point to riverine National Chambal sanctuary is about 50km from Agra. Babarpur Reserved Forest is about 1.5 km and Soor Sarovar Bird Sanctuary about 9 km away from the proposed Sikandara Metro Station of Corridor-I. Soor Sarovar Bird Sanctuary comprises of fresh water wetland, popularly known as Keetham jheel. Unique for scenic beauty, religion-cultural heritage and rich assembling of fauna and flora. It is an important birding destination for ornithologists. The predominant tree species along the corridors are Bargad, Cassia, Champa, Gulmohar, Karanj, Neelgiri, Neem, Pakad, Peepal, Sagwan, Seijan, Arjun, Jamun, Mango, Khajur, Babul, Gularand Sheesam etc.The predominant shrub species observed in the study area is ProsopisJulifera. Site construction activities will results in loss of trees about 2729. An inventory of trees in the two corridors and two depots likely to be lost has been prepared and summarized in the **TABLE 4.18**. Estimated cost of compensatory afforestation is included in the EMP.

TABLE 4.18: SUMMARY OF TREE INVENTORY

S. No	Description	Number of Trees
Corridor-I (Sikandara – Taj East Gate)		
1	Alignment	784
2	PAC Depot	1226
Sub-Total		**2010**
Corridor-II (Agra Cantt. – KalindiVihar)		
3	Alignment	565
4	Kalindi Vihar Depot	154
Sub-Total		**719**
Total		**2729**

Common birds observed in the project area are pigeons, parrot, crows, and doves. The Saras Crane was

observed near Kalindi Vihar Depot. On consultation with the local people in the vicinity of the project area, it is learnt that peacocks and swift are frequently observed at lush green vegetation of Shahjahan Park. The predominant mammals observed in the project area are mongoose, bat, monitor lizard, monkey, languor and mice etc.

1.7 Depot

Two depots are proposed for the Agra metro. One depot is at PAC land, Mall Road Agra has been proposed having 16.3 hectare land and another depot near Kalindi Vihar along NH 2 having 11.9 hectare land. PAC Depot is in between Taj Road and Fatehabad Road as shown in **FIGURE 4.12**. Depot site at Kalindi Vihar is near NH 2 is mostly vacant land/agriculture land as shown in **FIGURE 4.13**

FIGURE 4.12: PROPOSED PAC DEPOT FOR CORRIDOR-1

FIGURE 4.13: PROPOSED KALINDI VIHAR DEPOT FOR CORRIDOR-2

V. ANTICIPATED ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

A. DETAILED ENVIRONMENT IMPACT ASSESSMENT

1.1 Positive Environmental Impacts

Based on project particulars and existing environmental conditions, positive potential impacts have been identified that are likely to result from the proposed metro project and where feasible within the scope of this Report these are quantified. The positive environmental impacts are listed below:

- Employment Opportunities
- Benefits to Economy
- Traffic Congestion Reduction, Quick Service and Safety

- Traffic Noise Reduction
- Reduction of Traffic on Road
- Less Fuel consumption
- Reduced Air pollution

1. **Employment Opportunities**

The civil works of the project is likely to be completed in a period of 5 years. During this period manpower will be needed for various project activities. In post-construction phase, about 980 people will be employed for operation and maintenance of the system. Thus, the project would provide substantial direct employment equal to the above number. In addition to these, more people would be indirectly employed for allied activities.

2. **Benefits to Economy**

The project will streamline and facilitate movement of public from different parts of Agra. These corridors will yield saving due to reduction in road traffic and reduction in number of buses, usage of private vehicles. Reduction in fuel consumption, vehicle operating cost and travel time of passengers was observed. With the development of the 2 corridors of Agra Metro project, it is likely that more people will be involved in trade, commerce and allied services.

3. **Traffic Congestion Reduction, Quick Service and Safety**

With the implementation 2 corridors of Metro, travel time of passengers travelling by other modes of vehicles in the absence of Metro will got reduced. The proposed development will reduce journey time and hence congestion and delay. Also, implementation of the metro will provide improved safety and lower number of accidents, injuries and accidental deaths. The reduced vehicles on road in turn will reduce accidents and increase safety of persons.

4. **Traffic Noise Reduction**

Reduction in traffic volume affects the noise levels. A 50% reduction of the traffic volume may result 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 Agra Metro Rail substantially reduces the vehicular traffic which ultimately reduces noise level.

5. **Reduction of Traffic on Road**

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. On implementation of the project, the consumption of petrol, diesel and CNG will get reduced. The estimated numbers of vehicle trips that will be reduced due to construction of Agra Metro are given in **TABLE 5.1**.

TABLE 5.1: VEHICLE KM SAVED PER DAY

Mode	Daily Vehicle Km Reduced due to MRTS			
	2024	2031	2041	2051

Car	29369	36031	45016	56240
2-Wheeler	468645	625663	742389	927495
Auto Rickshaw	7904	15120	16752	20929
Bus	175923	222009	283827	354597

6. Less Fuel Consumption

Based on number of vehicle kilometre reduction, reduction in fuel (diesel and petrol) consumption is reported in **TABLE 5.2**. The saving of Diesel and Petrol will directly benefit the country in monetary terms. Net saving on fuel expenditure at current price level is given in **TABLE 5.3**.

TABLE V.1.2: FUEL SAVED PER YEAR

Year	Diesel (Lakh liters)	Petrol (Lakh liters)	CNG (Lakh Kg)
2024	1.5	23.5	129.6
2031	1.9	31	164
2041	2.3	37	209.4
2051	2.9	46.2	261.6

TABLE 5.3: SAVING IN FUEL EXPENDITURE PER YEAR (RS. Lakh)

Fuel	2024	2031	2041	2051
Diesel	80	100	120	150
Petrol	1670	2200	2630	3280
CNG	2330	2950	3770	4710
Total	**4080**	**5250**	**6520**	**8150**

7. 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. The major vehicular pollutants that define the ambient air quality are: Particulate matter, Nitrogen oxides, Carbon monoxide, Hydro Carbons and Carbon dioxide. In addition to the above pollution, un-burnt products like aldehydes, formaldehydes, acrolein, acetaldehyde and smoke are by products of vehicular emissions. The reduction of air pollutants with the present corridors are presented in **TABLE 5.4**.

TABLE 5.4: POLLUTION REDUCTION (TONS/YEAR)

Pollutant	2024	2031	2041	2051
Carbon Monoxide (CO)	428	555	686	857
Hydro-Carbons (HC)	304	389	489	611
Nitrogen Oxide (NOx)	468	596	754	942

Particulate Matter (PM)	6	8	10	13
Carbon Dioxide (CO2)	56389	71482	90893	113556

Cost of Human Health saving from lifecycle emissions of PM2.5 and cost of carbon capture from lifecycle emissions of GHG caused by gasoline and diesel is worked out (Climate change and health costs of air emissions from bio-fuels and gasoline, Jason Hill et al, PNAS, 2008) at rate of Rs 5.82 per litre and Rs.6.42 per litre in **TABLE 5.5** for period up to year 2051.

TABLE 5.5: LIFE CYCLE SAVINGS FROM EMISSIONS (Rs. LAKH)

Year	Diesel (Lakh liters)	Petrol (Lakh liters)	Total (Lakh liters)	Cost of Human Health saving from lifecycle emissions of $PM_{2.5}$	Cost of carbon capture savings from lifecycle emissions of GHG
2024	1.5	23.5	25	145.4	160.4
2031	1.9	31	32.9	191.2	210.9
2041	2.3	37	39.3	229	252.9
2051	2.9	46.2	49.2	286.1	315.6

1.2 Negative Environmental Impacts

Based on project particulars and existing environmental conditions potential negative impacts likely to result from the proposed development are quantified. Negative impacts are listed under the following headings:

- Impacts due to Project Location
- Impacts due to Project Design
- Impacts due to Construction and
- Impacts due to Project Operation
- Impacts due to Depot

1. 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:

-
- Displacement and loss of livelihood of Project Affected People (PAPs)
- Change of Land use
- Impact on/loss of wildlife/trees/forest
- Utility/Drainage Problems
- Impact on archaeological monuments and
- Impact on Local Transport Facilities

a. Displacement and loss of livelihood of Project Affected People (PAPs)

People who have their properties along the alignment may be affected due to the acquisition of land for proposed Agra Metro corridors. Majorly land will be taken from government departments however, some displacement of temporary or permanent nature may happen.

b. Change of Land use

Land will be required permanently for stations, Depot, Ramp and running section. Both government and private land will be acquired for the project the detail of which is given in the section on Civil Engineering.

c. Impact on/loss of wildlife/trees/forest

By virtue of being not listed in EIA Notification 2006, the project does not require Environmental Clearance under this Notification. In regard to the requirement (as per Order of Hon. Supreme Court) that activities in ESZ of Protected Areas require clearance of NBWL before EC is considered, MoEF has clarified vide letter dated 2 July 2012 that for projects which do not attract EIA Notification 2006, NBWL clearance for activities within ESZ is not require. The project does not require forest clearance as it does not involve diversion of forest land. However activities proposed in the project should be regulated as per ESZ norms. Vide letter dated 31 July 2013, MoEF&CC informed States that a default area of 10 km from the boundary will be the ESZ of such protected areas for which proposals identifying ESZs were not forwarded by the States to MoEF&CC. In February 2011, Guidelines for declaration of environmentally sensitive zones (ESZ) around national parks and wildlife sanctuaries were issued by MoEF&CC in which the following were clarified: i) the purpose of declaring ESZ is to create shock absorber for the protected areas, the Guidelines of September 2000 (Report of the Committee on identifying parameters.

These Guidelines identified activities in ESZ in three groups: prohibited, regulated and permitted: Activities involved in the project are regulated; discharge of effluents and solid waste in natural water bodies is prohibited.

There are approximately 2729 (this data as per DPR report, further number of trees required cutting has been reduced) the trees along the two corridors and the two depot sites. These trees are likely to be affected during construction. Trees are major assets in purifications of urban air, which by utilizing CO_2 from atmosphere, release oxygen into the air. However, with removal of these trees, the process for CO_2 conversion will get effected and the losses are reported below:

i.	Total number of Trees	:	2729
ii.	Decrease in CO_2 absorption due to loss of trees	:	59,492 kg/year
iii.	Decrease in Oxygen production due to tree loss	:	1,33,721 kg/year

d. Utility/Drainage Problems

The proposed Metro corridors are planned to run through the urban area above the ground i.e. elevated in less densely populated and underground in populated and sensitive areas. The alignment will cross drains,

large number of sub-surface, surface and utility services, viz. sewer, water mains, storm water drains, telephone cables, overhead electrical transmission lines, electric pipes, traffic signals etc. These utilities/ 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.

e. Impact on archaeological 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. Utmost care needs be taken so that no significant impact is anticipated on the historical structures due to project activities during construction and operation.

f. 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.

2. Impacts due to Project Design

Impacts due to project design are seen in following ways;

- Consumption of energy and water at stations and vibration impact of underground line in trade off with visual intrusion.

- Inter-modal integration will lead to increased use of metro while avoiding congestion outside stations.

3. Impact Due to Project Construction

Although environmental hazards related to construction works are mostly of temporary nature, it does not mean that these should not be considered. 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 and pollution
- Traffic diversion and risk to existing buildings
- Muck disposal and Debris Disposal
- Dust Generation and Air Pollution
- Increased water demand
- Impact due to labor camp
- Welfare of labor on site
- Safety of labor
- Impact due to Supply of Construction Material
- Impact due to construction near Archaeological Monuments
- Impact on Ground water and Surface water quality

- Noise and Vibration

a. Soil Erosion and Pollution

Minor incidence of soil erosion due to runoff from unprotected excavated areas may result especially when erodibility of soil is high.

b. Traffic Diversion and Risk to Existing Buildings

During construction period, complete/partial traffic diversions on road will be required, as most of the construction activities are on the road. 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. Such plans and their cost form part of the section on Engineering. As part of pre-construction/construction activities building condition survey will have to be conducted cost of which is not included in EMP.

c. Muck Disposal

The metro route is both elevated and underground. The construction activity involves cut and cover, tunneling, excavation and fill. Owing to paucity of space in busy cites and for safety reasons, elaborate measures need to be adopted for collection, storage, transfer and disposal of soil. All these activities will generate about 3.68 Mm3 of soil. Out of this, about 1.10 Mm3 is likely to be reutilized in backfilling in underground stations and Depots. The balance 2.57 Mm3 shall be disposed off in environmental friendly manner. Disposal of excess soil should be permitted in low lying areas owned by ADA. The excess soil disposal site will be those identified by ADA and communicated to UPMRC. Identification of measures required at soil disposal sites and their indicative cost forms part of EMP. Problems could arise from dumping of construction soils (concrete, bricks), waste materials (from contractor's camp) etc. causing surface and ground water pollution. About 10% to 15% of the construction material such as waste material from contractor camps is left behind by the contractor as construction waste/spoils.

d. Dust Generation and Air Pollution

Transportation of earth and establishment of the material will involve 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. Protective measures shall be undertaken during construction phase. It is estimated that, about 0.87 Mm3 of earth will be transported in trucks for backfilling in stations, depots and final disposal. The estimated truck movement required to transport the soil/earth will be about 48 trucks per day for the entire length of construction period. On an average a truck is anticipated to move about 20 km per trip for some quantity of muck used in depot site and stations as well as final disposal. Hence total distance travelled would be 960 km per day. The total dust emission/pollution would be 1.24 gm/km or 2.2 kg/day. The emission due to truck movement i.e. CO, HC, NOx and PM will be 2.69 kg/day, 0.74 kg/day, 4.8 kg/day and 0.1 kg/day respectively.

e. Increased Water Demand

The water demand will increase during construction phase. Water requirement for construction of metro will be met through municipal supply: in exceptional cases and for short term tube-wells bored specially for the purpose of metro construction will be used after taking approval from competent authority i.e. Central Ground Water Board (CGWB).

f. Labour Camp

Facilities such as temporary living accommodation for construction workers at locations away from construction sites; facilities for water supply, treatment / disposal of waste water, sewage and solid waste; collection and disposal of solid waste; health care are statutory requirement and essential to productivity.

g. Welfare of Labor on construction site

Facilities such as shelter at workplace, canteen, first aid and day crèche are statutory requirement and essential to productivity.

h. Safety of Labor

Safety of labor during construction on elevated and underground sections is a statutory requirement and also has impact on progress of work.

i. Impact due to Supply of Construction Material

Construction material such as aggregate and earth are sourced from approved quarries such that environmental impacts as well as wastage of natural resources are minimized and mitigated.

j. Impact due to Construction near Archaeological Monuments

No archaeological monuments are directly affected. There are 2 Archaeological Monuments along the corridor-1 and 2 along the Corridor-2 are within prohibited area of 100 meters and 6monuments are passing within 200 meters of regulated area.

In underground section the tunnel will be constructed by State of Art Technology i.e. Tunnel Boring Machine (TBM) and stations will be constructed by Cut and Cover method which is widely accepted and the safest technique being adopted by metro in India and abroad.

k. Impact on Ground and Surface Water Quality

Ground water contamination can take place if chemical substances get deposited in soil and are leached by water and percolate to the ground water table. Surface water source can be contaminated if untreated construction wash water is let in from construction sites. One major bridge is planned on the alignment on river Yamuna, proposed to be constructed with well foundation in lean season.

I. Noise and Vibration

Construction noise and vibration may disturb people at home, office, school or retail religious buildings depending upon their vicinity to construction site. The major sources during construction are movement of vehicles for transportation of construction material and operation of construction equipment. There are number of sensitive receptors like School, College, Hospital, Temple, Mosque, near the alignment. Typical predicted noise levels for combination of dumper, excavator and pneumatic tools during construction are as follows: Leq of 93.3 dB (A) at 5m distance; Leq of 65.3 dB (A) at 100m distance.

4. Impacts Due to Project Operation

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

- Noise and Vibration
- Water supply and sanitation at Stations
- Traffic congestion

a. Noise and Vibration

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. There are number of sensitive receptors like School, College, Hospital, Temple, Mosque, near the alignment. The major impacts on sensitive receptors during operation phase will be noise and vibration. Noise prediction with average train speed of 25 km/hr and no noise barriers is presented **TABLE 5.6**.

TABLE 5.6: NOISE LEVELS AT DIFFERENT DISTANCES DURING OPERATION

Distance (m)	Noise Level in dB (A)
10	84
20	78
30	74
40	71
50	70
60	68
70	67
80	65
90	64
100	64

It is assumed that train average speed is 25 km/hr, and no barrier is present. Due to reduction of vehicular traffic, the road traffic noise is expected to come down.

b. Water Supply and Sanitation

The water demands will be on station for drinking and toilet primarily of staff, station cleaning and AC chiller. Water Demand is calculated and presented in **TABLE 5.7.**

TABLE 5.7: WATER REQUIREMENT

S. No.	Particular	Water Demand at Each Station (KLD)	Total Water Demand (KLD)
1	At Stations for Drinking Purpose	6.000	186
2	In Underground stations for AC, cleaning, chiller and other purposes with softening plant	85.000	680
3	In Elevated stations for AC, cleaning, chiller and other purposes	16.600	382
Total			**1248**

c. Traffic congestion

Upon operation of metro services passenger rush at stations will increase resulting in congestion around stations.

5. Impacts Due to Depot

In order to develop areas as depot, it will need filling by earth brought from outside. The earth from underground metro corridor tunnelling and cut and cover will be utilised to fill the deport site. The facilities will generate water and noise issues. Problems anticipated at depot sites are:

- Water supply
- Sewage and Effluent disposal
- Oil Pollution
- Noise Pollution
- Surface drainage
- Solid Waste
- Cutting of trees.

a. Water Supply

Water supply will be required for different purposes in the depot. As per the Indian Railway Work Manual, the water demand for train washing and other purposes (Departments, workshop and Contractor office) is 3600 liter per day in each case. The water demand at PAC depot would be 133 KLD and for Kalindi Vihar depot will be 155 KLD. This water will be collected through bore wells at each Depot after taking approval from competent authority. Hence, there will be no negative impact on the residents living in the vicinity of tube wells whose water demand is, in any case, met by municipal water.

b. Sewage and Effluent

About 107 KLD waste water will be generated at Depot at PAC land near Mall Road and 124 KLD at Kalindi Vihar Depot. Hence total waste water generation from both depots will be about 231 KLD, which will be treated at effluent treatment plant. 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 and will be treated at packaged type sewage treatment plant. From here it will discharge to the nearest manhole of existing sewerage system of the corporation for that necessary permission/ approvals from the AMC are required. There will be minimal impact due to wastewater from the Depot.

c. Oil Pollution

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

d. Noise Pollution

The main source of noise from depot is the operation of workshop. The roughness of the contact surfaces of rail and wheel and train speed is the factors, which influence the magnitude of rail - wheel noise.

e. Surface Drainage

In case of filling in low-lying area of depot sites, the surface drainage pattern may change.

f. Solid Waste

Solid waste will be generated from each of the Depot sites which will be taken by the cleaning contractor weekly and recycled/disposed of at ADA waste disposal sites.

VI. INFORMATION DISCLOSURE, CONSULTATION, PARTICIPATION AND GRIEVANCE REDRESS MECHANISM

A. Introduction

Public involvement is an iterative process and continuity of effort is an important part of due diligence for any major project. Therefore, this section presents the public involvement program for the project in three parts: one, the work carried out until 2017 and documented in the Agra DPR 2017; two, the efforts reported in the EIB Draft Poverty and Social Analysis and the Comprehensive Mobility Plan (CMP) has been prepared in 2017 adhering to Ministry of Housing and Urban Affairs (MoHUA), Government of India guidelines and; three, consultation carried out under this report where documented, the anticipated program planned for pre- construction, construction and operational stages of the Project.

B. SOCIAL IMPACT ASSESSMENT

Development of proposed two metro rail corridors involves acquisition of land for stations, running sections, TSS, Depot and for other facilities. Acquisition of this private land may cause social disruption and economic loss for the families/people who are likely to be affected. 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 minimize any negative impacts. The details of land acquisition, number of affected structures (legal and illegal) and affected families and socio-economic profile of affected families on the basis of sample survey and Resettlement Action Plan (RAP) is presented in this section.

1.1 Objective of SIA and RAP

The objectives of Social Impact Assessment are:

i. Identify PAPs by type and extent of loss
ii. Identify the possible adverse effects of the project on the people and the area
iii. Suggest culturally and economically appropriate measures for mitigation of adverse effects of the project
iv. Provision of institutional mechanism for implementation of RAP
v. Provision for grievance redresses mechanism;
vi. A time frame for implementation of RAP
vii. Provision of budget for each activity of RAP, and,
viii. Monitoring and Evaluation (M&E) of implementation of RAP

The SIA includes RAP is based on an integrated and holistic approach to deal with project impacts and aims at rebuilding lives and livelihoods of those affected as quickly as possible.

1.2 Approach & Methodology

Socio-economic survey was conducted in the corridor of impact zone to identify the affected structures, families/persons and list out the adverse impacts of the project. The SIA which includes RAP has been prepared in accordance with Right to Fair Compensation and Transparency in land acquisition, Rehabilitation and Resettlement Act, 2013, and multi/bilateral funding agencies' guidelines on social and environmental consideration. The methodology adopted to prepare SIA report was desk research, site visits and information dissemination, enumeration of structure, socio-economic survey, compilation, verification and analysis of data, public consultation at local

level. Various steps involved in the study have been described in brief in the following paragraphs.

- The consultant reviewed the final topographical maps and Detailed Project Report (DPR) of the project.

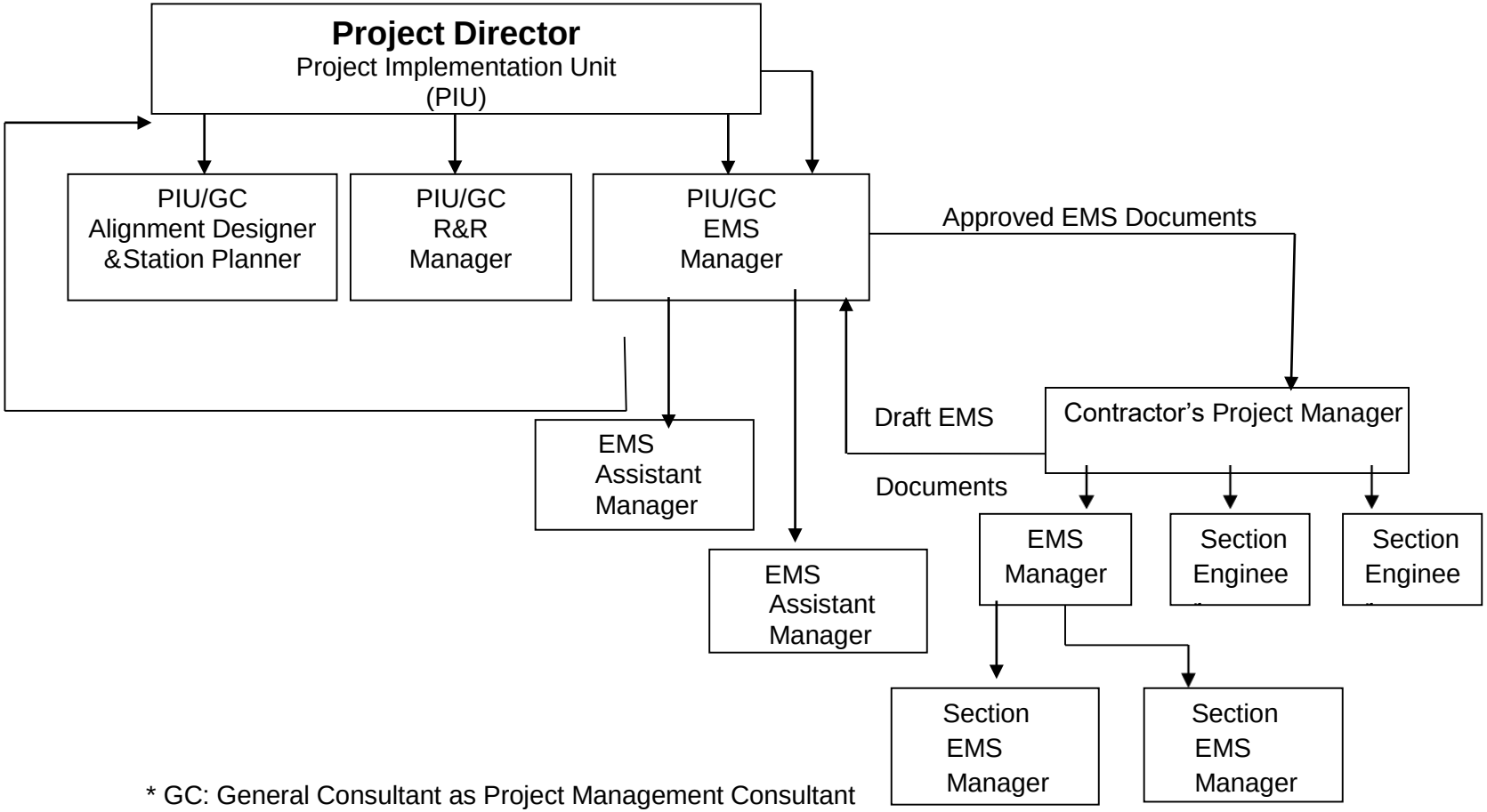
- Conducted sample socio-economic survey covering affected households, squatters, kiosks and small business entrepreneurs with the help of pretested “Household Questionnaire”. Important aspects covered in the questionnaire were identification particulars of PAPs, his or her family details, social profile, occupation, income, details of structure, commercial / self employment activities, household income, annual expenditure, employment pattern, type of effects / loss etc. Most part of the questionnaire has been pre-coded except those reflecting the opinion and views of the PAP, which have been left open-ended.

- The base line data have been collected from secondary sources such as the Census and the Statistical Hand Book. Primary data have been collected through household survey conducted by RITES Social team. The Socio-Economic Baseline data was collected during October 2015.

- The development of proposed metro project has significant positive impacts in Agra city. The project may also bring myriad forms of unavoidable adverse impacts on the socio and economic environment around. “Social Risk Assessment” approach has been used to determine the associated risk of adverse impacts.

- Consultations with concerned stakeholders at the project level with affected families, communities, local leaders, and vulnerable groups were conducted for the purpose of disseminating information among the people and obtaining their views, comments and concerns.

FIGURE 6.1: EMS ORGANIZATION



* GC: General Consultant as Project Management Consultant

1.3 Potential Social Impacts

The proposed metro rail will have number of positive impacts like:

i. Generate Employment opportunity
ii. Economic growth
iii. Mobility
iv. Safety in travelling
v. Reduced traffic congestion
vi. Savings in fossil fuel (reduction in air pollution)
vii. More systematic and cheaper way of commute

At the same time the project may bring myriad forms of adverse impacts on socio-economic condition of families/people that are likely to be affected due to acquisition of land. The anticipated negative impacts are

i. loss of land
ii. loss of structures
iii. loss of livelihood
iv. loss of residence
v. impact on vulnerable families/persons
vi. impact on gender
vii. Loss of common property and religious structures.

1.4 Inventory of Affected Structures

Table **6.1** presents the usage type of structures likely to be affected.

Table 6.1: CORRIDOR WISE IMPACT ON STRUCTURES

Corridor/Station	Type of Structures			Total
	Residential	Commercial	Others	
Corridor-I (Sikandra to Taj East gate)				
Sikandra	3	0	2	5
Guru Ka Taal	3	0	0	3
ISBT	7	5	0	12
Shastri Nagar	5	6	2	13
University	0	1	0	1
RBS College	0	0	1	1
Raja Ki Mandi	0	0	1	1
Agra College	0	0	2	2
Medical College	0	0	1	1
Jama Masjid	13	0	1	14
Agra Fort	0	0	0	0
Taj Mahal	0	0	0	0
Fatehabad Road	5	0	1	6
Basai	0	0	1	1
Taj East Gate	2	0	0	2

Corridor/Station	Type of Structures			Total
	Residential	Commercial	Others	
Sub Total	**38**	**12**	**12**	**62**
Corridor-II (Agra Cantt. Railway Station to KalindiVihar)				
Agra Cantt.	0	0	0	0
Sultanpura	1	3	0	4
Sadar Bazaar	0	0	1	1
Partap-Pura	0	0	1	1
Collectorate	5	0	1	6
Subhash park	0	0	2	2
Agra College	1	0	1	2
Hariparvat Chauraha	0	0	1	1
Sanjay Place	0	0	1	1
M G Road	10	0	1	11
Sultanganj Crossing	6	0	5	11
Kamla Nagar	4	2	2	8
Rambagh	35	0	0	35
Foundary Nagar	0	0	0	0
Agra Mandi	0	0	0	0
KalindiVihar	0	0	0	0
Sub Total	**62**	**5**	**16**	**83**
Total	**100**	**17**	**28**	**145**

Source: Primary Surveys, 2016

Note: R: Residential, C: Commercial, R+C: Residential+ Commercial

*Number of structures is identified based on sample socio-economic survey, site visits with the help of alignment drawings and not on the basis of peg marking on the ground. Therefore, these are only approximate figures and not exact. The exact number of affected families, persons, properties and detail of ownership will be considered after census (100%) survey.

The magnitude of project impact on the structures, which is categorized as partially and fully affected structures are presented here. On the basis of alignment drawings it was found that out of total 145 structures, about 125 structures (86.2 %) will be fully affected and remaining about 20 structures (13.7%) will be partially affected (**Table 6.2**). However, the exact number of fully and partially affected structures will be known after peg marking on the ground level.

Table 6.2: MAGNITUDE OF PROJECT IMPACTS

Name of Corridor	Magnitude of Impacts		
	Fully	Partially	Total
Sikandara to Taj East Gate	54 (12.9)	8 (87.1)	62 (100)
Agra Cantt. Railway Station to Kalindi Vihar	71 (85.5)	12 (14.5)	83 (100)
Total	**125 (86.2)**	**20 (13.7)**	**145 (100)**

Source: Primary Surveys, 2016

1.5 Impact on PAFs/PAPs

About 119 families consisting 572 persons will be affected due to the proposed metro project. Corridor wise number of PAFs and PAPs is presented in **Table 6.3** Exact number of affected and displaced families/persons will be quantified during detailed Census/Baseline Socio-Economic Survey (BSES) after peg marking of alignment on the ground.

Table 6.3.: IMPACT ON PAFs AND PAPs

Name of Corridor	Total PAFs	Total PAPs*
Sikandara to Taj East Gate	52	250
Agra Cantt. Railway Station to Kalindi Vihar	67	322
Total	**119**	**572**

Source: Primary Surveys, 2016

***Number of PAPs is counted based on average size of family**

Out of the total 119 families, 42 are in the category of Title Holders (TH) and the remaining 77 are in Non Title Holders (NTH) category. The NTH category includes tenants, squatters and kiosks. The squatters and kiosks are on public land without any legal permission. Corridor wise detail of title holders and non-title holders are given in **Table 6.4**

Table 6.4TITLEHOLDERS AND NON-TITLEHOLDERS

Name of Corridor	Titleholders	Non-Titleholders	Total PAFs
Sikandara to Taj East Gate	6	46	52
Agra Cantt Railway Station to Kalindi Vihar	36	31	67
Total	**42**	**77**	**119**

Source: Primary Surveys, 2016

Table 6.5 indicates that out of the total 119 PAFs, 17 PAFs shall be affected physically as their residential units are getting affected due to the proposed project. Majority of PAFs are likely to be affected residentially in Sikandara to Taj East corridor.

Table 6.5 LOSS OF RESIDENCE

Name of the Location	Total PAFs	Residentially Affected Family
Sikandara to Taj East Gate	52	12
Agra Cantt Railway Station to KalindiVihar	67	5
Total	**119**	**17**

Source: Primary Surveys, 2016

Table 6.6 indicates that out of total 119 affected families, there are 102 PAFs whose business/livelihoods will be affected due to the loss of the commercial structures vis-a-vis business base in both corridors. Majority (62) of commercial PAFs are likely to be affected in Agra Cantt Railway Station to Kalindi Vihar corridor. About 40 PAFs are likely to be affected in Sikandara to Taj East Gate corridor.

Table 6.6: LOSS OF LIVELIHOOD

Name of the Location	Total PAFs	Commercially Affected Family
Sikandara to Taj East Gate	52	40
Agra Cantt Railway Station to Kalindi Vihar	67	62
Total	**119**	**102**

Source: Primary Surveys, 2016

1.6 Impact on Community and Religious Structures

The proposed project shall also affect the common property resources. The common property includes religious structures and public toilets. **Table 6.7** shows that 14 religious structures and five public toilets shall be affected. These structures may not be saved as they are falling within the right of way and the corridor of impact. These common properties of the same size and type shall be redeveloped by the project developer at the desired place in consultation with local people.

Table 6.7: LOSS OF COMMON PROPERTY RESOURCES

Name of the Corridors	Common Property Resources			Total
	Religious structures	Public toilet	Others	
Sikandara to Taj East Gate	6	1	5	12
Agra Cantt Railway Station to Kalindi Vihar	8	4	4	16
Total	**14**	**5**	**9**	**28**

Source: Primary Surveys, 2016

1.7 Demographic and Socio-Economic Profile of PAFs

The socio-economic analysis of surveyed household has been presented here. The data collected through sample socio-economic survey generated demographic and socio- economic profile of project affected families. The data has been compiled and presented in tabular form.

1. Gender and Sex Ratio

The data on gender and sex ratio is very helpful indicator to know the participatory share of male and female in the society, which is also an important indicator for human development index. Among the surveyed population it is observed that there are 53.52 % are male and remaining 46.47 % are female. It is observed that male dominate in both corridors. The sex ratio is 837 per 1000 males in Sikandara to Taj East Gate corridor and that in Agra Cantt. Railway Station to Kalindi Vihar is 895 in corridor (**Table 6.8**).

Table 6.8: GENDER AND SEX RATIO

Corridor	Total Surveyed PAFs	Total PAPs	Gender		Sex Ratio
			Male	Female	
Sikandara to Taj East Gate	36	147 (100)	80 (54.42)	67 (45.58)	837
Agra Cantt Railway Station		208	110	98	

to Kalindi Vihar	54	(100)	(52.8)	(47.11)	895
Total	**90**	**355 (100)**	**190 (53.52)**	**165 (46.47)**	**866**

Source: Primary Surveys, 2016

2. Religious and Social Group

Data on religious groups were collected in order to identify people with the specific religious belief among the surveyed families. The religious beliefs and social affiliation of the people are indicators that help understand cultural behaviour of the groups. The social and cultural behaviour will help understand the desires and preferences of PAPs, which is a prerequisite to rehabilitate the affected people and their families. **Table 6.9** shows that only two religions are followed in the study area viz., Hindu and Muslims. The studies results show that about (80.00%) of the surveyed families are Hindu followed by Muslim (20.00%). Majority of families are Hindu in both corridors.

Table 6.9: RELIGIOUS GROUP

Corridor	Hindu	Muslim	Total PAFs
Sikandara to Taj East Gate	27 (75.00)	9 (25.00)	36 (100)
Agra Cantt Railway Station to KalindiVihar	45 (84.2)	9 (15.8)	54 (100)
Total	**72 (80.00)**	**18 (20.00)**	**90 (100)**

Source: Primary Surveys, 2016

Table 6.10 discloses information about social affiliation of a group. The social affiliation of the group differentiates them for benefits under government schemes. Social groups indicate ranking within the society, preferences and vulnerability. In general, the families belonging to Scheduled Castes (SCs) and Scheduled Tribes (STs) under the provisions of Constitution of India get preferential treatment in the government benefits because the group includes the people who are traditionally vulnerable. Except general category, allother groups need attention and to be addressed for their backward socio-economic conditions. The survey results show that about (48.88%) belong to Other Backward Caste followed by general (44.44%) and Scheduled Caste (4.0%) and Scheduled Tribe (2.0%). Scheduled Castes and Scheduled Tribe families are found in Agra Cantt Railway Station to Kalindi Vihar corridors. Therefore, special attention is required to address their issues.

Table 6.10: SOCIAL GROUP

Corridor	General	OBC	Schedule Castes	Schedule Tribes	Total PAFs
Sikandara to Taj East Gate	11 (30.55)	24 (66.66)	1 (2.77)	0	36 (100)
Agra Cantt Railway Station to Kalindi Vihar	29 (53.7)	20 (37.03)	3 (5.5)	2 (3.7)	54 (100)
Total	**40 (44.44)**	**44 (48.88)**	**4 (4.4)**	**2 (2.2)**	**90 (100)**

Source: Primary Surveys, 2016

3. Mother Tongue and Place of Nativity

It was found in both corridors that all surveyed families speak Hindi as a mother tongue. Majority of surveyed families are from Uttar Pradesh followed by Bihar state.

4. Age Group

The distribution of person's age in various group shows that 17.3% of the total persons belong to below five years, about 25.6 % belong to the 6-18 years age group. About 30.7 % belong to 19-35 years that is potentially productive group. About 43.2% belong to the age group of 36 to 60 years. About 13.9% of total persons belong to above 60 years, who are dependent population. It is observed that majority of persons belong to 36 to 60 years age group.

5. Marital Status

The marital status of the surveyed family members is indicated under three categories – married, unmarried, and other (widow/widower, separated, divorced). It is observed that out of total surveyed people, majority of them (56%) are married, 42 % are unmarried and about two percent are widowed/divorced/separated.

6. Family Pattern and Family Size

Majority of surveyed families are nuclear (92.22%) followed by joint (7.77%). Majority of surveyed families belong to nuclear family (96.29%) in Agra Cantt Railway Station to Kalindi Vihar corridor and Joint family (3.70%) in Sikandara to Taj East Gate corridor. Majority of nuclear families are found in both corridors. Family size has been classified into three categories i.e. individual, small (2-4), medium (5-7) and large (7 & above). Majority of families (67.77%) are small in size followed by 23.33% families are medium type and remaining 8.88 % families have their members more than seven. Small size families are found in both corridors.

7. Educational Attainment

The analysis indicates that out of the total surveyed people, about 7.7% are illiterate, 19.4% are educated up to primary class, 16.5 % are educated up to High School, and 19.7% have studied up to higher secondary level. Other than this, about 36.7 % of persons have attained college. Education level of surveyed people is better in Agra Cantt Railway Station to Kalindi Vihar corridor as compared to Sikandra to Taj East Gate corridor.

8. Economic Conditions

The economic condition of PAFs describes occupational pattern, family income, employment information and number of earning and dependent members. The occupational pattern includes work in which the head of the project affected families are involved. The family income includes income of all the earning members. The earning members include the people who work and earn to contribute to the family; however dependents include housewife, children, elderly people and others who cannot work and earn.

About 1.1% of families reported less than Rs.5000/- monthly income. About 14.5% of families' monthly income is less then Rs.5001-10000, 38.9% of families' income is between Rs.10001 to 20000/-,(30.0) % of families' income is between Rs.20001 to 40000.Families' earning more than Rs.40000/- monthly constitutes about 15.6 %. The average income of a family is Rs.12400/- per month. Average family expenditure is Rs.10200/- per month. On an average earning member per family is two (**Table 6.11**).

Table 6.11: FAMILY MONTHLY INCOME

Corridor	Family Monthly Income (in INR)					Total PAFs
	<5000	5001 - 10000	10001 - 20000	20001 - 40000	>40000	
Sikandara to Taj East Gate	0 (0)	5 (13.9)	20 (55.5)	7 (19.5)	4 (11.1)	36 (100)
Agra Cantt Railway Station to Kalindi Vihar	1 (1.8)	8 (14.8)	15 (27.8)	20 (37.1)	10 (18.5)	54 (100)
Total	**1 (1.1)**	**13 (14.5)**	**35 (38.9)**	**27 (30.0)**	**14 (15.6)**	**90 (100)**

Source: Primary Surveys, 2016

9. Occupational Pattern

Occupational pattern of the surveyed persons is recorded to assess their skill so that income generation plan can be prepared accordingly for alternative income generating scheme. Secondly, occupational pattern helps in identifying dominating economic activity in the area. The survey shows that majority of surveyed persons are employed in business and trade activities. Out of the total surveyed PAPs, about 64.5% of them are involved in business, 17.7% are in daily labour and 10% and 7.8% are in government and private sector respectively. It is observed in both corridors that majority of PAPs are involved in business/trade activities.

10. Household Assets

The TV, Refrigerator, two wheeler, and telephone are owned by majority. The other prominent assets are bicycle and computer.

11. Vulnerable Groups

As per the international funding agencies guidelines vulnerable group is defined as indigenous people, ethnic minorities, the poorest, women, the aged, the disabled and other socially/economically vulnerable groups who would be adversely affected from a project. As regards vulnerability among surveyed PAFs, there are twenty one families belong to vulnerable category. Out of these about one family are women headed households, three families are Scheduled Castes, two families are Scheduled Tribes, twelve families are below the line of poverty including women headed households, and four families having disability people. Numbers of vulnerable families are found more in Agra Cantt Railway Station to Kalindi Vihar

Gender Issues: There are two woman-headed household among the surveyed vulnerable families found in the Sikandra to Taj East Gate corridor. About 45 percent of total surveyed population is female. Socio-economic parameters like literacy, work force participation rate and general health conditions etc. reveals that social status of women is low respectively, thereby brought forward the scope of considering the families headed by women as vulnerable.

The proposed project is expected to open up new economic opportunities for women to upgrade their skills and also better accessibility to educational and health facilities. Women as a segregated class are not involved in any economic activity, which demands attention for their special needs. To ensure that women are secure in receiving payments all benefits will be provided in joint-account where the woman will be the first beneficiary accounts. During discussion with PAPs, women members of the family are also consulted. Consultations with women will be carried out during

project implementation stage to provide more opportunities to them to voice their concerns and suggestions.

12. Tribal Issues

There are three families who belong to scheduled tribes. Moreover, they are found in the project area no longer live in forests/hills. The tribal population has integrated with the main stream population. Few of them fall within the category of BPL population; compensation packages provided in the Entitlement Matrix would sufficiently take care of their R&R needs. There is also a number of State and Central Government schemes targeted at this population and annually about 5 to 6 percent of budget allocation is made to finance special programmes for tribal development.

13. Awareness and Opinion about the Project

During socio-economic survey, some questions were asked to the families regarding the awareness, source of information and opinion about the proposed metro rail project. The findings of the survey with regards to awareness, source of information and opinion about the proposed project is presented in **Table 6.12**.

Table 6.12: PROJECT RELATED INFORMATION

S. N.	Description	Sikandara to Taj East Gate	Agra Cantt Railway Station to Kalindi Vihar
1	Awareness about the Project		
	Yes	36	54
	No	0	0
2	Source of Information		
	News Paper	36	41
	Survey Team	0	0
	Television	0	0
	Friends/People	0	13
3	Opinion about the Project		
	Good	35	54
	Bad	1	0
	Can't Say	0	0

Source: Primary Surveys, 2016

1.8 Public Consultation and Participation

Public consultation were organised at medical college, ISBT, Agra University, St. John's College, RBS, Guru katal, Kamlanagar, Foaundry Nagar, Ram bagh, Agra fort, Taj East Gate, Raja ki Mandi from 16/09/2015 to 19/09/2015.The consultant briefed the participants about the objectives of the meeting regarding various social issues related to the project i.e., alignment plan, land acquisition, displacement, rehabilitation & resettlement and compensation and employment etc. The participants were invited to give their valuable suggestions on the above issues and were assured for suitable incorporation of such suggestions in the project within the technical limitations and scope of the project. Some of the views expressed, suggestion given or queries raised by the participants are as follows:

- Local people showed happiness during public consultations as the project will provide hassle free movement in the congested part of the

city.

- Suitable safety measures should be taken in the project during construction and operation phases

- Vacant land should be used for metro station instead of acquiring residential and commercial plots or structures of local people.

- Employment opportunity should be provided to the local people particularly to the project-affected people on priority basis in all stages of the metro project.

- Compensation for acquired land should be provided on time to the affected families/people at market rate.

- Source of livelihood should not be disturbed. The affected businessmen should be given alternate employment.

- Shop for shop- All shop keepers should be rehabilitated by constructing market complex in nearby area.

- Govt. should provide a constructed house for each affected family.

- During construction phase, traffic on the roads should be managed in such a way that it should not cause congestion of traffic and accidents during construction phase.

- Construction labor camps should not be located near the core city area that is frequented by the tourists

- It is evident from the discussion with local people during social survey that the people in Agra have no objection to the proposed metro rail project. According to them loss of residential structures and homestead land will mean a lot of problem for people. Compensation for acquisition of private land should be given to those who are likely to lose their land at the current market price.

1.9 Resettlement Policy, Framework and Entitlement Matrix

The applicable laws on land acquisition, rehabilitation and resettlement for the proposed metro rail project are:

a. Right to Fair Compensation and Transparency in land acquisition, Rehabilitation and Resettlement Act, 2013(RTFCTLARR Act).

b. Government Order (G.O) of Government of Uttar Pradesh bearing no. 24/2015/387/8-1-15-50-LDA/204 specifically for LMRP Project dated 04.02.2015. This is in accordance with provisions of Section 46 of the Act, 2013 formulating a committee of officials from relevant Government departments for determination of negotiated price for land acquisition.

c. Multi/Bilateral Agencies' Involuntary Resettlement Policy

The Entitlement Matrix

An Entitlement Matrix (**Table 6.13** & **Table 6.14**) has been developed in compliance with National Laws and EIB standards. The entitlement matrix summarizes the types of losses and corresponding nature and scope of entitlements. PAPs who are squatters and not legal titleholder of land and buildings shall also be eligible for R&R if enumerated during the census survey. Therefore, the date of completion of census survey shall be the Cut-off Date. It is on this date that all impacted persons will be identified and the nature of the impact disclosed. PAPs who settle in the affected areas after the cut-off date will not be eligible for compensation and/or other assistance. They, however, will be given sufficient advance notice, requested to vacate premises and dismantle affected structures prior to project implementation. Their dismantled structures will not be confiscated and they will not pay any fine or suffer any sanction. The entitlement matrix presents the entitlements of the affected and displaced people in the following order.

a) Entitlement for titleholders consisting of

- loss of private land;
- Loss of private residential structure;
- Loss of private commercial structures;
- Impact to tenants(residential/commercial/residential cum commercial)

b) Entitlement to Non-Titleholders consisting of

- Impact to squatters, Encroachers, kiosks

c) Loss of Employment to workers/employees

d) Assistance to affected and displaced vulnerable people

e) Common infrastructure and Common Property Resources (CPRs)

Table 6.13: ENTITLEMENT MATRIX

(Compensation for Land Acquisition and Rehabilitation)

Entitlement Matrix (Compensation for land acquisition)			
S.No	**Category of Impact**	**Eligibility for Entitlement**	**UPMRC Adopted Policy/Entitlement**
1.	Loss of Private Land	Title holder	Market value/ Circle rate as per stamp Act.
2.	Loss of other immovable assets (value of assets attached to land or building)	Titleholder	Will be determined on the basis of valuation by authorized expert based on a replacement value.
3.	Solatium for loss of Land, Structure and other immovable assets	Titleholder	100% of arrived value of land and building. The compensation is calculated for land, structures and such assets attached to the building or land as applicable and the total of all considered before considering the solatium, including any transaction costs and fees.

Entitlement Matrix (Compensation for land acquisition)			
S.No	**Category of Impact**	**Eligibility for Entitlement**	**UPMRC Adopted Policy/Entitlement**
4.	Loss of other immovable assets(value of assets attached to land or building)	Squatters/Kiosks/ Encroachers	One time financial assistance based on valuation of the property subject to a minimum of **Rs.25,000.**

Replacement cost = Market value +Transaction Cost+ solatium

Table 6.14: Entitlement Matrix (Rehabilitation Masures)			
Sl No.	**Category of Impact**	**Eligibility for Entitlement**	**UPMRC Adopted Policy/Entitlement**
1	Construction allowance	Displaced family whose residential structure is lost due to acquisition	**Rs. 1, 50,000** will be given to displaced family whose dwelling units are lost completely or become unviable due to displacement. The amount has been worked out on the basis of construction of house as per Indira Awas Yojana of GOI.
2	Subsistence grant for displaced family	Displaced family (including tenants/leaseholders)	Onetime payment of **Rs. 36,000** shall be paid to each Displaced Family. Displaced Family belonging to the Scheduled Castes or the Scheduled Tribes or vulnerable group (including households headed by Females/Physically Challenged persons/Senior Citizens without having adult members) shall receive an amount equivalent to fifty thousand rupees. (**Rs.50,000**). This amount is additional to subsistence grant. Additionally, Vulnerable groups who are impacted will be extended facility of Skill Improvement Training.
3	Transportation cost	Displaced family (including tenants/leaseholders)	One time financial assistance of **Rs.50,000**for shifting family, building material, belongings and cattles shall be given to each displaced family.

Table 6.14: Entitlement Matrix (Rehabilitation Masures)			
Sl No.	**Category of Impact**	**Eligibility for Entitlement**	**UPMRC Adopted Policy/Entitlement**
4	Cattle shed / petty shops cost	Affected Family (including tenants/leaseholders)	Each Affected Family having cattle shed or having a petty shop in the acquired land shall get one-time financial assistance based on valuation of the structure subject to a minimum of **Rs. 25,000** for re-construction of cattle shed or petty shop as the case may be.
5	One time grant to artisan, small traders and certain others.	Affected Family (including tenants/leaseholders)	Each Affected Family of an artisan, small trader or self-employed person (including workers/wage earners working in non-titleholder commercial establishments like mobile vendors/kiosks) or a Displaced Family which owned non- agricultural land or commercial, industrial orinstitutional structure in the affected area,shall get one-time financial assistance based on valuation subject to minimum of **Rs. 25,000**. In case of temporary displacement of affected persons, allowance for their wage loss for a fixed number of days may be given at applicable state government rates for unskilled labour.
6	One time resettlement allowance	Affected Family (including tenants/leaseholders	Each Affected Family will be given a one time resettlement allowance of **Rs. 50,000**
7	Loss of community structures	Community	100% replacement cost of equal type

***Same entitlement matrix will be followed for Agra Metro Rail Project**

1.10 Institutional Framework

The SPV, that will be formed will be the in charge of the overall project activities and will facilitate land acquisition, capacity building and implementation of RAP. The PIU headed by the Project Director (PD) is responsible for the overall execution of the project and planning and implementation of resettlement and rehabilitation component of the project. The PIU will coordinate with all implementing agencies and monitoring the progress of the project. Implementing Agency will set up a Social Management Unit (SMU) which shall look after land acquisition, resettlement and rehabilitation activities. A Social Development Officer (SDO) with educational background of Social Work or Sociology will be appointed in SMU as full time by IA. The SMU shall ensure that all land acquisition issues are handled according to the Land Acquisition and Rehabilitation & Resettlement policy/guidelines as it is laid down in this report. It will also monitor that all the procedural and legal issues involved in land acquisition are fulfilled. The SMU will assist the IA for getting all the necessary clearances and implementation of the resettlement activities prior to start of any civil work. A Resettlement and Rehabilitation Officer (RRO) with background of social science may be appointed in this SMU to supervise and monitor overall activities of RAP and he/she will report day to day progress to SDO. RRO will also work closely with the District Collector to expedite the payment of compensation for land acquisition and assistance to APs. The RRO will form Local Resettlement Committees (LRC) in each project affected areas consisting of local representatives and other stakeholders including APs, women to assist in the implementation of RAP activities within the project area. Some of the specific functions of the SMU in regards to resettlement management will include the following:

- Overall responsibility of planning, implementation and monitoring of land acquisition, resettlement and rehabilitation activities in the project;
- Ensure availability of budget for R&R activities;
- Liaison lined agencies support for land acquisition and implementation of land
- acquisition and resettlement;
- Coordinating with line Departments

NGO will be appointed by IA to extend implementation support to IA in the form of assisting affected families/persons during relocation and preparation of Income Restoration Plan (IRP). The NGO will help educating PAPs on proper utilization of compensation and rehabilitation grant and help them in getting financial assistance.

During implementation phase of RAP, IA will appoint a consultant(R&R) through General Engineering Consultancy (GEC) to assist IA in implementation of resettlement plan. The consultant will carry out due diligence in the implementation of resettlement and rehabilitation programmes as per the provisions of Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013 through periodic monitoring. The consultant will be responsible for (i)preparation of database of affected structures, families, persons, (ii)verification of database through field survey,(iii)improve monitoring system,(iv)capacity building of implementation staffs,(v)regular follow up implementation activities and other relevant activities.

Efficient grievance Redressal mechanism will be developed to assist the PAPs resolve their queries and complaints. Grievances of PAPs will be first brought to the attention of field level staffs of IA. Grievances not redressed by the staffs (field level) will be brought to the Grievance Redressal Committee (GRC). The main responsibilities of the GRC are to: (i) provide support to PAPs on problems arising from land/property acquisition; (ii) record PAPs grievances, categorize, and prioritize grievances and resolve them; (iii) immediately inform the SMU of serious cases; and

(iv)report to PAPs on developments regarding their grievances and decisions of the GRC.

1.10.1 Work Schedule

The R&R activities of the proposed project are divided in to three broad categories based on the stages of work and process of implementation. In the project preparation stage, identification of required land for acquisition, census & socio-economic survey, public consultation, preparation and review/approval of draft RAP, disclosure of RAP, establishment of GRC and preparation of resettlement site shall be carried out. Activities like notification of land acquisition, valuation of structure, payment by competent authority, shifting of PAPs shall be taken up during RAP implementation. During monitoring and evaluation stage internal monitoring will be carried out by IA and mid and end term evaluation will be carried out by an independent evaluation agency, **Figure VII.B.1.2.**

1.10.2 Monitoring and Evaluation of RAP

RAP implementation will be monitored both internally and externally. IA will be responsible for internal monitoring through their field level officers of Social Management Unit and will prepare quarterly reports on the progress of RAP implementation. An Independent Evaluation Consultant may be hired by IA for mid and end term evaluation of RAP implementation.

i. Internal Monitoring

The internal monitoring for RAP implementation will be carried out by IA. The main objectives of internal monitoring are to:

- Measure and report progress against the RAP schedule;
- Verify that agreed entitlements are delivered in full to affected people;
- Identify any problems, issues or cases of hardship resulting from the resettlement process, and to develop appropriate corrective actions, or where problems are systemic refer them to the management team;
- Monitor the effectiveness of the grievance system
- Periodically measure the satisfaction of project affected people.

Internal monitoring will focus on measuring progress against the schedule of actions defined in the RAP. Activities to be undertaken by the IA will include:

- Liaison with the Land Acquisition team, construction contractor and project affected communities to review and report progress against the RAP;
- Verification of land acquisition and compensation entitlements are being delivered in accordance with the RAP;
- Verification of agreed measures to restore or enhance living standards are being implemented;
- Verification of agreed measures to restore or enhance livelihood are being implemented;
- Identification of any problems, issues, or cases of hardship resulting from resettlement process;
- Through household interviews, assess project affected peoples' satisfaction with resettlement outcomes;
- Collection of records of grievances, follow up that appropriate corrective actions have been undertaken and that outcomes are satisfactory.

Monitoring is a continuous process and will be carried out by field level officers of Social Management Unit on regular basis to keep track of the R&R progress. For this purpose, the indicators suggested have been given in Table 6.15. In this regard a RAP Monitoring Plan will be

prepared by the Project Authority. The RAP Monitoring Plan will identify the organisational responsibilities, the methodology and the schedule of monitoring and reporting on the effectiveness of RAP implementation including the definition of detailed KPIs to report on the physical progress of resettlement activities, the disbursement of compensation, the effectiveness of public consultation and participation activities, and the sustainability of income restoration and development efforts among affected communities.

Table 6.15: INDICATORS FOR MONITORING OF RAP PROGRESS

Indicators	Parameters Indicators
Physical	Extent of land acquired Number of structures dismantled Number of land users and private structure owners paid compensationNumber of families affected Number of families purchasing land and extent of land purchasedNumber of PAPs receiving assistance/compensation Number of PAPs provided transport facilities/ shifting allowanceExtent of government land identified for house sites
Financial	Amount of compensation paid for land/structureCash grant for shifting ousters Amount paid for training and capacity building of staffs
Social	Area and type of house and facility at resettlement site PAPs knowledge about their entitlements Communal harmony Morbidity & mortality rate Taken care of vulnerable population Women concern
Economic	Entitlement of PAPs-land/cash Number of business re-establishedUtilization of compensation House sites/business sites purchased Successful implementation of IncomeRestoration Schemes
Grievance	Number of community level meetingNumber of GRC meetings Number of cases disposed by IA to the satisfaction of PAPsNumber of grievances referred and addressed by GRC Cases of LA referred to court, pending and settled

ii. Independent Evaluation

As mentioned earlier, an Independent Evaluation Agency (IEA) will be hired by IA for mid and end term evaluation. The external evaluation will be carried out to achieve the following:

- Verify results of internal monitoring,

- Assess whether resettlement objectives have been met, specifically, whether livelihoods and living standards have been restored or enhanced,
- Assess resettlement efficiency, effectiveness, impact and sustainability, drawing lesions as a guide to future resettlement policy making and planning, and
- Ascertain whether the resettlement entitlements were appropriate to meeting the
  objectives, and whether the objectives were suited to affected persons' conditions,
- This comparison of living standards will be in relation to the baseline information available in the BSES. If some baseline information is not available, then such information should be collected on recall basis during the evaluation.

iii. Reporting Requirement

IA will be responsible for supervision and implementation of the RAP. IA will prepare quarterly progress reports on resettlement activities. The Independent Evaluation Agency will submit draft and final reports of their assignment to IA and determine whether resettlement goals have been achieved, more importantly whether livelihoods and living standards have been restored/ enhanced and suggest suitable recommendations for improvement.

VII. ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN

This ESMP outlines the contents of construction and operational phases both. It constitutes guidelines for use in the field by the contractor(s) and their personnel during construction as well as by the personnel of UPMRC during operations.

UPMRC and its construction contractor, through its engineering and environmental consulting team, is responsible for implementing the ESMP and ensuring that all personnel are informed about the EMP and the requirement to implement the procedures it contains. The ESMP is intended as a quick reference for Project personnel and regulators to monitor compliance, and is structured to allow updates and revisions as work continues.

The primary purpose of this ESMP is to establish the Environmental and Social Protection Procedures to be implemented by UPMRC staff, consultants and contractors. UPMRC has committed to developing and implementing a comprehensive ESMP to help ensure a high level of environmental protection throughout this undertaking. This ESMP provides the protection procedures associated with activities anticipated for the construction and operations.

Environment and Social Management has been categorized into:

1. **Pre-construction activities:**

In which project related information will be shared like about the project details, construction schedule etc to ensure all major stakeholders are consulted and their feedback is being incorporated in the project design, if any.

For resolution of any social or environmental grievance, UPMRC will establish a GRC as part of project requirement to facilitate and resolve grievance brought up by stakeholders.

Permission for cutting of trees shall be taken from forest department before start of work to ensure work shall not hamper due to any obstruction in the alignment design. In case of Agra project, compensatory afforestation will be carried out by Forest Department, Agra; for which all applicable dues for plantation activity along with its maintenance for 10 and land cost where plantation activity will be performed is already transferred.

Contractor will prepare and submit Environment and social management plan covering all major project activities and their potential impacts along with specific mitigation plan for approval by UPMRC and GC.

2. **During Construction**

Site specific management plan covering Air quality management, Noise and Vibration, C&D waste management, Spillage protection measures, Solid waste management, Drainage/flooding issue, Traffic management, Health and Safety of Workers and other social issues etc which are prepared by contractor and approved by UPMRC shall be implemented. Action points against each are tabulated below.

During underground works, special attention shall be given to Archaeological Monuments, Fragile Buildings, Community Structures and possible Chance Finds. Same has been outlined in the table.

3. **During Operation**

Plan shall be developed covering aspects related to Noise and Vibration, Solid waste management, Emergency preparedness plan and Health & Safety plan for staff and workers during the operation stage of Metro project.

Social Management Plan: As part of SIA conducted during DPR stage in 2017, identification of PAP's, loss of land, resettlement requirements, loss of community structure etc. was covered followed by Stakeholder Management Framework and Resettlement Action Plan.

Here, Fresh study to assess Social Impact assessment is proposed and work in this direction is already started as there may be changes in the numbers of PAPs over the year. To understand the actual number of PAP and type of loss, specific Stakeholder Management Plan and resettlement action plan will be developed and implemented. [1]

In the fresh Social Impact Assessment Study, Stakeholder Engagement Plan will cover the methods of stakeholder engagement, strategy to conduct stakeholder engagement, strategy to incorporate views of vulnerable groups, monitoring and evaluation of SEP etc.

Resettlement Action Plan will cover gender action plan, relocation and income restoration plan, training need identification etc.

Engaged contractor will arrange for resources related to environment and social management. Environment team will look after mitigation of potential environmental impact that may arise due to project activities. Engineering team of engaged contractor along with UPMRC field team will manage the day to day affairs of communities residing in the vicinity of project. Issues related to access, provision of utilities services, dust related issues will be dealt by field team of UPMRC and engaged contractor. Any disruption of basic services will be attended on priority and mitigation will be provided. Similarly, issues related to labour welfare and basis amenities to labour will be attended by engaged contractor; UPMRC team will ensure all the facilities related to labour welfare are being provided at site and at labour camp, if established.
Issues related to R&R activites will be attended by field staff and brought to GRC if applicable for compensation. GRC will then decide and attend the matter as per applicability, as per Agra RPF.

All the Social plans shall be developed in accordance with the number of PAP's, their relocation preferences, social and economic status, vulnerable category etc to ensure PAP's shall be able to maintain their social and economic pre-resettlement status.

However, all the compensation and entitlement for both temporary or permanent resettlement shall be governed by the Resettlement Policy Framework of UPMRC.

Cost/funds for environment and social management related activities pertaining to contractor are majorly included in the engineering cost hence individual cost is not covered in this ESMP. However, funds related resettlement and rehabilitation will be arranged separately directly by UPMRC based on actual requirement.

RESPONSIBILITIES

The contractor shall set up an Environmental team to execute the environmental requirements. Social aspects related to labour welfare will be managed by admin department and labour welfare officer of engaged contractor.

The duties of the Contractor's Team will include (but not limited to):

- To monitor the various Environmental and social parameters as required by the Plan
- To inspect, investigate and audit the work methodology with respect to environmental

[1] Social Impact Assessment is expected to be completed by May 2022

mitigation and control

- To anticipate Environmental issues before they arise and plan for their mitigation
- To audit and prepare audit reports, weekly/monthly reports on site environmental conditions for submission to the employer
- To work closely with UMRC Environmental Team and be available for discussion/clarification
- To send progress on Environmental issues and make presentations when requested
- Manage day to day assistance to community residing in vicinity of project related to provision of access, for proper functioning of utilities, any other issue that might arise due to project work.

Reporting to the Employer, the Contractor shall:

- Work within the scope of contract and other tender condition.
- Operate and strictly adhere to the requirements of his contract specific-SEP Undertake any corrective actions as instructed by his Environmental Manager
- To lead his Environmental team, the Contractor shall deploy an Environment Manager who shall be responsible for environmental control, pollution monitoring, and record keeping and be available to the Employer for resolution of environmental issues.

PROJECT ENVIRONMENTAL AND SOCIAL PLAN

- To effectively implement monitoring, mitigation and remedial requirements, an appropriate contractual and supervisory framework needs to be established.
- The basis of framework within which implementation will be managed is through the preparation of contract-specific Project Environmental and Social (majorly related to labour welfare) Plan by the Contractor.
- The Employer will audit this contract-specific plan and advise necessary remedial actions required through contractual means.
- Within the period defined in the contract the Contractor shall submit a draft contract – specific Project Environmental and Social Plan (majorly related to labour welfare) for the approval of the Employer and a final version prior to the commencement of the works.
- The Project Environmental and Social Plan shall provide details of the means by which the Contractor (and all subcontractors working for the Contractor) will implement the recommended mitigation measures and achieve the environmental and social performance standards defined both in Indian environmental legislation and in the Conditions of Contract.
- The Contract specific Project Environmental and Social Plan shall demonstrate the determination and commitment of Contractor's organization towards environment and social indicate how the environmental and social performance requirements laid out in the Employer's requirements will be met and, where appropriate exceeded.
- The contract-specific Project Environmental and social Plan will contain description of all procedures developed to meet the requirement defined in various sections of this plan and the related legislations, to control environmental and social issues. Elements of the plan must address the management of pollution, the monitoring programme, and the reporting requirements along with labour welfare measures to be arranged as per legal requirements.
- In a nutshell, the contract-specific Project Environmental and social Plan will specify which procedures and associated resources shall be applied by whom and when as may be applicable to the activities and processes of the contract in order to meet with UMRC's environmental and social requirements, the environmental and social regulations and

requirement found in the Conditions of Contract and this Plan.

Below table contain information on potential environmental and social aspects and concerns that might raise during the different stage of project execution for both the construction and operation of the viaduct and tunnel sections[2] along with proposed mitigation measures and defining responsibility for Implementation and Monitoring of EMP:

A Environmental and Social Mitigation Plan

[2] Note that the mitigation measures defined for the construction of the viaduct sections will be considered for the two depot sites.

Table 7.1 : Environmental and Social Mitigation Plan for the Viaduct			
Environmental Aspect/Concern	**Proposed Mitigation Measures**	**Responsibility**	
		Implementation	**Monitoring**
Pre-Construction			
1. Disclosure of project information	a) Strictly implement approved **Stakeholder Engagement Plan (SEP)** b) Prior to start of site works local residents and establishments, local authorities and other stakeholders who are likely to be affected by the project shall be informed on the construction schedule and activities, potential environmental impacts and mitigation measures through public meetings at each community.	UPMRC, Project Supervision Consultant (GC), Project Management Support Consultant, Contractors	UPMRC
2. Cutting of trees	Implement 1:10 tree afforestation in close coordination with Forest Department and also in areas where landscape opportunities exist (e.g., depot areas, areas identified in station buildings, under viaducts)	UPMRC,Project Supervision Consultant (GC), Contractors, Forest Department	Forest Department
3. Lack of mechanism to resolve environmental and Social complaints due to project implementation	Prior to start of site works, UPMRC shall undertake the following: a) establish a **Grievance Redress Mechanism (GRM),** as described in the RPF b) through public awareness campaigns, make public the existence of the GRM c) set-up and publicize a 24-hour hotline for complaints d) ensure that names and contact numbers of representatives of UPMRC and contractors are placed on the notice boards outside the construction site	UPMRC,Project Supervision Consultant (GC), Contractors	UPMRC
4. Disruption to community services due to relocation of facilities (e.g., water supply)	a) Water supply pipelines, power supply, communication lines and other utilities shall be re-provisioned before construction works commence b) Provisions shall be made to preserve the operation of current facilities in sufficient quantity and in agreement with the local community. c) Re-provisioning shall be undertaken in coordination with the utility company. d) Affected households and establishments shall be notified well in advance of such disruption.	UPMRC,Project Supervision Consultant (GC), Contractors	Contractor, GC, UPMRC

5 . Preparation and implementation of management action plans	Prior to start of site works, environmental management action plans covering following specific environmental issues shall be prepared by the contractor and shall be submitted to the project supervision consultant for approval: a) **Dust Control Plan.** The plan shall provide details of mitigation measures, specific location and schedule where such measures shall be implemented to minimize impacts to sensitive receptors (residential areas, schools, hospitals, etc.) due to construction works, sourcing and transport of construction materials, and other project-related activities. b) **Noise Control Plan.** The plan shall provide details of mitigation measures, specific location and schedule where such measures shall be implemented to minimize impacts to sensitive receptors (residential areas, schools, hospitals, etc.) due to construction works, sourcing and transport of construction materials, and other project-related activities. c) **Spoils Disposal Plan.** The plan shall present off-site re-use (if suitable) of excavation spoils and corresponding volume, identification of a suitable disposal location/facility and corresponding capacity, designation of suitable transport routes and schedule for spoil truck movements to minimize traffic disruption/congestion, and environmental mitigation measures to address impacts due to transport and disposal of spoils. Maps or design of the site(s) shall be prepared and used to identify where protection measures are required such as slope stabilization measures, silt fencing, ditching, dust control, cross drains, etc. d) **Spill Management Plan .** The plan shall provide details of procedures, responsibilities, resources, documentation and reporting requirements, training provisions for relevant staff , etc. to avoid spills of hazardous substances and to effectively respond to such incidents, in case these occur. e) **Traffic Management Plan .** The plan shall be designed to ensure that traffic congestion due to construction activities and movement of construction vehicles, haulage trucks, and equipment is minimized. The plan shall be prepared in consultation with local traffic officials and people's committees at the district and commune levels. The plan shall identify traffic diversion and management, define routes for construction traffic from materials storage/parking areas to construction site and from construction site to waste disposal locations, traffic schedules, traffic arrangements showing all detours/lane diversions, modifications to signaling at intersections, necessary barricades, warning/advisory signs, road signs, lighting, and other provisions to ensure that adequate and safe access is provided to motorists in the affected areas. f) **Occupational and Community Health and Safety Plan consistent** with international standards. The Plan shall address health and safety hazards associated with construction activities (e.g., working at heights, excavations, etc.) establishment and operation of construction/worker's camps, casting yard, use of heavy equipment, transport of materials and other hazards associated with various construction activities. g) **Emergency Response Plan** to prevent, mitigate, respond to and recover from emergency events that could occur due to project activities such as accidents, spills of hazardous substances, fire, extreme weather events, and other crises.	Contractors Contractors Contractors Contractors Contractors Contractors	
Construction			
1. Air quality impacts due to	a) Strictly implement approved **Dust Control Plan** which considers the following mitigation in relation to air quality:	Contractor	UPMRC, GC

gaseous and dust emissions	b) 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. c) Carry out periodical checks and undertake remedial measures including replacement, if required, so as to operate within permissible norms. d) Wherever possible, use electrically-powered equipment rather than gas or diesel-powered equipment e) Position any stationary emission sources (e.g., portable diesel generators, compressors, etc.) as far as is practical from sensitive receptors; f) Use only vehicles and equipment that are registered and have necessary permits. g) Burning of wastes generated at the construction sites, work camps and other project-related activities shall be strictly prohibited. h) Construction equipment and vehicles shall be well-maintained and shall meet national emission standards. i)) Specify the use of clean fuels such as ultra-low Sulphur diesel in dump trucks and other heavy-duty diesel vehicles and/or equipment in conjunction with the use of particulate trap control devices, as well as catalytic converters, to avoid excessive diesel emissions. j)) Keep stockpiles moist and cover vehicles with tarpaulin sheets or other suitable materials to minimize dust emission and prevent spillage of materials (e.g., soil, cement, stone, sand, aggregates, etc.). k)) Provide temporary covers (e.g., tarpaulins, grass, etc.) on long term materials stockpiles until excavate is re-utilized for backfilling l) Place material in a manner that will minimize dust production. Material shall be minimized each day and wetted, to minimize dust production. During dry weather, dust control methods must be used daily especially on windy, dry days to prevent any dust from blowing across the site perimeter. m) As much as possible, the casting yard for the Project will make use of already established and licensed site(s) for concrete forming activities where all the pre-cast sections of the viaduct, pier columns and cross members will be fabricated. n) Ensure that necessary environmental approvals are obtained for the establishment and operation of a new casting yard / batching plant. o) Design and implement blasting techniques so as to minimize dust, noise, and vibration generation and prevention fly rock[3]. p) Store excavated materials outside road reserve, but where there is no area, spoils shall be loaded and transported immediately. q) Clean road surfaces of debris/spills from construction equipment and vehicles. r) Undertake daily cleaning of paved routes around the pier construction sites.		

[3] Capital and operating cost are included in engineering cost and therefore is not included in EMP.

	s) Install temporary fencing or barriers around particularly dusty activities in vicinity of sensitive receivers t) water down construction sites as required to suppress dust, during handling of excavation soil or debris or during demolition. 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. u) Ensure availability of water trucks on site and if the works surface and access roads near sensitive receptors (i.e., residential areas, roadside tea and food stalls, schools, hospitals and other sensitive receptors) are dry and dusty, spray water on the exposed surfaces to reduce dust emission. v) All construction equipment and machinery shall be fitted with emission control equipment in full compliance with the national and local regulations. w) Fuel-efficient and well-maintained haulage trucks will be used to minimize exhaust emissions. Smoke belching vehicles and equipment shall not be allowed and shall be removed from the project. x) Impose speed limits on construction vehicles to minimize road dust in areas where sensitive receptors are located. y) Undertake immediate repairs of any malfunctioning construction vehicles and equipment. yy) Discourage idling of engines z) Provide prior notification to the community on schedule of construction activities zz)) Implement 24 hour community complaints hotline		
2. Noise and vibration impacts due to operation of construction equipment/ vehicles and various construction activities	a) Strictly implement approved **Noise Control Plan** which considers the following specific mitigation: b) Erection of temporary walls around the elevated station sites and other construction sites, as necessary. Especially near sensitive areas such as schools, hospitals, houses, etc. Temporary noise barriers (3-5 meter high) can reduce noise level by 5-10 dB(A). c) Use of churned drill pile method will has significantly lower noise and vibration emission levels that diesel hammer piles d) Truck drivers and equipment operators shall minimize the use of horns. e) Position any stationary equipment that produce high noise levels (e.g., portable diesel generators, compressors, etc.) as far as is practical from sensitive receptors; f) All construction equipment and vehicles shall be well maintained, regularly inspected for noise emissions, and shall be fitted with appropriate noise suppression equipment consistent with applicable national and local regulations. g) Use only vehicles and equipment that are registered and have necessary permits. h) Noise level from loading and unloading of construction materials can be reduced by usage of various types of cranes and placing materials on sand or sandy bag beds. i) No noisy construction-related activities will be carried out during the night. Such activities shall be restricted to daylight hours.	Contractor	Contractor, GC,

	j) Impose speed limits on construction vehicles to minimize noise emission along areas where sensitive receptors are located (houses, schools, hospitals, etc.) k) As much as possible, use quiet equipment and working method. l) Whenever possible, completely enclose noisy equipment which can reduce noise level by 15-25 dB(A), restrict use of noisy equipment (e.g.15 min for every consecutive 30 min period) and undertake sequential operation of equipment with objective to reduce noise generated; m) No noisy construction activities near schools during examination period. n) Avoid noisy construction activities in vicinity of sensitive receivers during night time or other sensitive periods (e.g. during school hours in vicinity of schools). o) Provide prior notification to the community on schedule of construction activities p) Implement 24 hour community complaints hotline q) Minimise the exposure of workers to high noise levels by using job rotation, automation, protective devices and soundproof compartments, control rooms etc.[4] r) Use of in-ground deep barriers such as trenches to reduce vibration, especially near buildings with strict vibration limits, such as operating theatres of hospitals or high-tech factories with sensitive processes. s) Use of row or lime or cement piles as barriers to reduce vibration, as appropriate t) Support ballast-less track on two layers of rubber pads to reduce track noise and ground vibrations.		
3. Spoils generation from pier excavation works	Strictly implement approved **Spoils Disposal Plan** which considers the following mitigation in relation to spoil generation: a) Spoil disposal will only be to and client approved areas b) Trucks transporting spoils shall be tightly covered with tarpaulin or other suitable materials to minimize dust emission and spills. c) Wheel washing shall be undertaken to remove mud so as to ensure that access roads are kept clean. d) Road surfaces shall be regularly cleaned of spilled spoils e) Spoil disposal shall not cause sedimentation and obstruction of flow of watercourses, damage to agricultural land and densely vegetated areas.	Contractor	UPMRC, GC

[4] Cost are included in engineering cost and therefore is not included in EMP

	f) The spoils disposal site shall be located at least 50 m from surface water courses and shall be protected from erosion by avoiding formation of steep slopes and grassing.		
4. Pollution due to spills of fuel and other hazardous substances.	a) Strictly implement approved **Spills Management Plan** which considers the following mitigation measures: b) Store fuel and hazardous substances in paved areas with embankment. If spills or leaks do occur, undertake immediate clean up. c) Ensure availability of spill clean up materials (e.g., absorbent pads, etc.) specifically designed for petroleum products and other hazardous substances where such materials are being stored. d) Train relevant construction personnel in handling of fuels and spill control procedures. e) Ensure all storage containers are in good condition with proper labeling. f) Regularly check containers for leakage and undertake necessary repair or replacement. g) Store hazardous materials above flood level. h) Equipment maintenance areas shall be provided with drainage leading to an oil-water separator that will be regularly skimmed of oil and maintained to ensure efficiency. Discharge of oil contaminated water shall be prohibited. i) Store waste oil, used lubricant and other hazardous wastes in tightly sealed containers to avoid contamination of soil and water resources. Transport and off-site disposal of such wastes shall be consistent with national and local regulations. j) Ensure that Hazardous Waste arising from maintenance of equipment which may include engine oils, hydraulic fluids, waste fuel, spend mineral oil/cleaning fluids from mechanical machinery, scrap batteries or spent acid/alkali, spend solvents etc. are stored in a secure place and adequately labelled and packaged. k) Maintain a record of sale, transfer, storage of hazardous waste and make these records available for inspection. l) Identify the nature and quantity of hazardous waste generated as a result of construction activities and obtain authorization from State Pollution Control Board.	Contractor	UPMRC, GC
5. Water pollution, drainage obstruction/ flooding	a) Install precipitation systems to prevent wash water from construction sites polluting surface water courses. b) Placement of construction materials, excavated spoils, equipment shall not block flow of rainwater into canals/drainage structures. c) Prohibit disposal of waste materials to drainage channels. d) Regularly inspect and maintain all drainage channels to keep these free of obstructions.	Contractor	UPMRC, GC

6. Generation of solid wastes	Construction and Demolition (C&D) debris is that part of the solid waste stream that results from land clearing, excavation, construction, demolition, remodeling and repair of structures, roads and utilities. C&D waste generated from metro construction has potential use after processing and grading. Post-grading the waste should be disposed at sites identified by UPMRC in consultation with respective authority like Municipal Corporation etc. such that the sites are away from residential areas, water body/ water course and do not require displacement. a) Provide garbage bins and facilities within the project site for temporary storage of construction waste and domestic solid waste. b) Separate solid waste into hazardous, non-hazardous and reusable waste streams and store temporarily on site in secure facilities with weatherproof flooring and roofing, security fencing and access control and drainage/ wastewater collection systems. c) Ensure that wastes are not haphazardly dumped within the project site and adjacent areas d) Undertake regular collection and disposal of wastes to sites approved by local authorities.	Contractor	UPMRC, GC
7. Erosion control and muck disposal	Prior to the start of the relevant construction, the Contractor shall submit to the UPMRC for approval, his schedules for carrying out temporary and permanent erosion/sedimentation control works as are applicable for the items of clearing and grubbing, roadway and drainage excavation, embankment/sub-grade construction and other structures across water courses, pavement courses and shoulders and his plan for disposal of waste materials. The surface area of erodible earth material exposed by clearing and grubbing, excavation shall be limited to the extent practicable. Works such as construction of temporary berms, slope drains and use of temporary mulches, fabrics, mats, seeding, or other control devices or methods as necessary to control erosion and sedimentation may be involved. Mitigation measures include careful planning, timing of cut and fill operations and re-vegetation[5]. Measures need to be adopted for collection, transfer, temporary storage and disposal of excavated muck. Sites for muck disposal will be decided by UPMRC before start of construction in consultation with respective authority like Municipal Corporation etc. such that the sites are away from residential areas and do not require displacement. The transfer and disposal of surplus soil may create air pollution and leached water problem. To mitigate these problems following mitigation measure will be adopted: a) The disposal sites will be cleaned and then treated so that leached water does not contaminate the ground water. b) Material will be stabilized each day by watering or other accepted dust suppression techniques. c) The height from which soil will be dropped shall be minimum practical height to limit the dust generation. d) The stock piling of earth in the designated locations with suitable slopes e) During dry weather, dust control methods such as water sprinkling will be used daily especially on windy, dry day to prevent any dust from blowing. f) Sufficient equipment, water and personnel shall be available on dumping sites at all times to minimize	Contractor	UPMRC, GC

[5] Capital and operating cost are included in engineering cost and therefore is not included in EMP.

	dust suppression. g) Dust control activities shall continue even during work stoppages. h) The muck shall be filled in the dumping site in layers and compacted mechanically. Dumping sites on sloping ground shall be protected adequately against any possible slide/slope failure through engineering measures. i) It is desirable to first clean the disposal area site for vegetation biomass exists over it. The faces and top should be treated/ vegetated to avoid erosion. Once the filling is complete, the entire muck disposal area shall be provided with a layer of good earth on the top, dressed neatly, and covered with vegetation.[6]		
8. Construction materials management and environmental sanitation	a) Monitor all aspects of construction activities related to storing, loading of construction materials and equipment in order to maintain quality b) Conduct regular inspection of the construction material storage site for the presence of uncontrolled construction waste c) Closely liaison with the officer of the UPMRC and the head of the construction crew to address any environmental issues and setting up impact mitigation procedures d) Ensure that the scheduling of material procurement and transportation is closely linked with the construction schedule of the project e) Ensure proper environmental sanitation/housekeeping at all times of work sites, construction depot, batching plant, stores, offices and sanitation facilities, keeping these cleared of all construction materials/debris, scraps and used materials/items, thereby providing a first-line of defense against accidents and injuries.	Contractor	UPMRC, GC
9.Energy management	a) Use and maintain equipment to conserve energy b) Implement measures to conserve energy including but not limited to the following: use of tools; plant and equipment of correct specifications; energy efficient motors and pumps; efficient lamps; optimal maintenance[7]	Contractor	UPMRC, GC
10. Disruption of utilities and damage to community facilities	a) Strictly implement approved Utility Management Plan. The proposed Metro alignment runs along major arterial roads of the city which serves Institutional, Commercial and Residential areas. Large number of sub-surface, surface and overhead utility services, viz. sewers, water mains, storm water drains, telephone cables, electrical transmission lines, electric poles, traffic signals etc. already exist along the proposed alignments. 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. As such, these may affect construction and project implementation time schedule/costs, for which necessary planning/action needs to be initiated in advance: b) Prior to the actual execution of work at site, detailed investigation of all utilities and location will be undertaken well in advance by making trench pit to avoid damage to any utility. c) Coordinate with utilities to prepare planning for diversion of underground utility services e.g. sewer lines, water pipe lines, cables etc., during construction of Metro, the following guidelines could be adopted:	Contractor	UPMRC, GC

[6] Capital and operating cost are included in engineering cost and therefore is not included in EMP.

[7] Capital and operating cost are included in engineering cost and therefore is not included in EMP.

	d) Utility services shall be kept operational during the entire construction period and after completion of project. e) 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. f) 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. g) In case of underground utility services running across the alignment, the spanning arrangement of the viaduct may be suitably adjusted. h) Ensure that any disruption of utility services are announced in advance to the affected communities. i) Immediately repair any damage caused by the Project to community facilities such as water supply, power supply, communication facilities and the like. j) Access roads damaged during transport of construction materials and other project-related activities shall be reinstated upon completion of construction works.		
11. Traffic congestion and access problems	a) Strictly implement approved **Traffic Management Plan** which considers the following mitigation: b) Provide signs advising road users that construction is in progress and that the road narrows to one lane using cones. c) Employ flag persons to control traffic at the station sites for safety reasons when construction equipment is entering or leaving the work area. d) Lanes through the work site, created by rope or flagging, shall be developed to minimize risks and injuries from falling objects. e) All construction workers should be provided with high visibility jackets with reflective tapes at most of viaduct/tunnelling and station works or either above or under right-of-way. f) As much as possible, lifting and placing of the pre-cast pier and viaduct sections will be done at night to minimize traffic congestion. g) Post traffic advisory signs (to minimize traffic build-up) in coordination with local authorities h) Provide safe and clearly marked lanes for guiding road users. i) Provide safe and clearly marked buffer and work zones j) Provide road signs indicating the lane is closed 500 m before the worksite. k) Primary traffic control devices used in work zones shall include signs, delineators, barricades, cones, pylons,	Contractor	UPMRC, GC

	pavement markings and flashing lights to direct traffic to move to the open lane. l) Provide sufficient lighting at night within and in the vicinity of construction sites. m) Regularly monitor traffic conditions along access roads to ensure that project vehicles are not causing congestion. n) Define and observe schedules for different types of construction traffic trips (e.g., transport of pre-cast sections, haulage of spoils, delivery of construction materials, etc.). o) As much as possible, schedule delivery of construction materials and equipment as well as transport of spoils during non-peak hours. p) Avoid movements of noisy vehicles during night time in vicinity of sensitive receivers. q) Implement suitable safety measures to minimize risk of adverse interactions between construction works and traffic flows through provision of temporary signals or flag controls, adequate lighting, fencing, signage and road diversions. r) Ensure relocation of any affected public transport infrastructure (but stops, shelters etc) prior to commencement of works s) Provide advance notification to the community regarding changes to public transport facilities or routes. t) Schedule construction works to minimize extent of activity along linear construction site at any one time u) Comply with traffic regulations and avoid, where possible, roads with the highest traffic volumes, high density of sensitive receivers or capacity constraints are not used as access to and from the construction areas and spoils disposal sites. v) Install temporary accesses to properties affected by disruption to their permanent accesses. w) Reinstate good quality permanent accesses following completion of construction.		
	y) 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 like cut and cover can be employed to ensure that traffic impedance is minimized[8].		

[8] Capital and operating cost are included in engineering cost and therefore is not included in EMP.

12. Hazards to health and safety of workers and the public due to construction works	a) Strictly implement approved **Occupational and Community Health and Safety Plan**, and approved **Emergency Response Plan** b) Prepare safety programmes following rules, regulations and guidelines based on the identification of safety hazards made by Project Authority c) Appoint an Environment, Health and Safety Manager to look after implementation of required environmental mitigation measures, and to ensure that health and safety precautions are strictly implemented for the protection of workers and the general public in the vicinity of construction areas d) Conduct orientation for construction workers regarding health and safety measures, emergency response in case of accidents, fire, etc., and prevention of HIV/AIDS and other related diseases e) In accordance with the Construction Contract the Contractor will be required to provide shelter at workplace, canteen facilities, first aid facilities, day crèche facilities on work sites. f) Provide first aid facilities that are readily accessible by workers. g) Provide fire fighting equipment at the work areas, as appropriate, and at construction camps. In accordance with the Construction Contract the Contractor shall provide the following facilities at the labour camps: h) Provide adequate housing for all workers at the construction camps. i) Provide adequate drainage in workers camps to prevent water logging/accumulation of stagnant water and formation of breeding sites for mosquitoes. j) Provide reliable supply of potable water. k) Provide separate hygienic sanitation facilities/toilets and bathing areas with sufficient water supply for male and female workers l) Establish clean canteen/rest area. m) Ensure proper collection and disposal of solid wastes within the construction camps consistent with local regulations n) Ensure facilities for water supply and wastewater treatment o) Conduct health awareness campaign for workers in the construction camp p) Construction works shall be executed as laid down in the Safety Health and Environment (SHE) manual prepared by the Contractor and approved by PIU. q) Provide fencing on all areas of excavation. r) Provide appropriate personnel safety equipment such as safety boots, helmets, gloves, protective clothes, breathing mask, goggles, and ear protection s) Ensure reversing signals are installed on all construction vehicles.	Contractor	UPMRC, GC

	t) Implement precautions to ensure that objects (e.g., equipment, tool, debris, pre-cast sections, etc.) do not fall onto or hit construction workers. u) Implement fall prevention and protection measures whenever a worker is exposed to the hazard of falling more than two meters, falling into operating machinery or through an opening in a work surface. Based on a case-specific basis, fall prevention/protection measures may include installation of guardrails with mid-rails and toe boards at the edge of any fall hazard area, proper use of ladders and scaffolds by trained employees, use of fall prevention devices, including safety belt and lanyard travel limiting devices to prevent access to fall hazard, fall protection devices such as full body harnesses, etc. v) Implement precautions to ensure that objects (e.g., equipment, tool, debris, pre-cast sections, etc.) do not fall onto or hit people, vehicle, and properties in adjoining areas. w) Fencing of construction sites and excavation sites and guarding such areas to restrict public access. x) Prior to excavation work, provide fencing on all sides of areas to be excavated. y) Provide warning signs at the periphery of the construction site. z) Strictly impose speed limits on construction vehicles along residential areas and where other sensitive receptors such as schools, hospitals, and other populated areas are located. zz) Educate drivers on safe driving practices to minimize accidents and to prevent spill of hazardous substances and other construction materials during transport.		
13. Social conflicts due to presence of workers	a) Consider the location of construction camps away from communities in order to avoid social conflict in using resources and basic amenities such as water supply. b) Maximize number of local people employed in construction works. c) Maximize goods and services sourced from local commercial enterprises.	Contractor	UPMRC, GC
14. Protection of Archaeological Monuments	a) Coordinate with UPMRC the conduction of condition survey of all archaeological/heritage structures in the vicinity of alignment prior to construction b) Coordinate with UPMRC any follow up of the survey during construction c) Follow the procedures within the regulated area of Archaeological Monuments during the construction stage	Contractor	UPMRC
Operation			
1. Noise emission and vibration from rolling stock and operation of	a) Installation of noise shield on the viaduct, if required b) At the station platform, paging and bell signaling volume shall be adjusted to the lowest level where it will not detract from their function.	UPMRC/O&M	UPMRC

elevated stations	c) Noise monitoring shall continue during operation phase to determine and install suitable noise reduction measures (e.g., unobtrusive noise barriers on the edge of the stations) d) Insulators/anti-vibration devices will be installed under the rails thereby reducing noise and vibration e) The rails are fastened with resilient fasteners and continuously welded further reduces vibration and noise.		
2. Waste generation	a) Waste collection bins or receptacles shall be provided in various areas at the elevated stations, such as offices and areas accessed by passengers. b) Garbage shall be regularly collected and shall be disposed consistent with local regulations. c) The elevated stations shall be provided with toilets and septic tanks to handle sewage generated by employees and passengers.	UPMRC/O&M,contractor	UPMRC
3.Water Management	Public health facilities such as water supply, sanitation and toilets are needed at the stations. Drinking water and raw water requirement for underground and elevated stations can be provided from municipal source in consultation with local agencies. Water should be treated to WHO drinking water standards before use. During operation rainwater harvesting will be carried out at elevated stations and Depots. To avoid excess usage of water during construction following measures will be taken to reduce water consumption: a) Recycle of water consumed in wheel washing. b) Discarded water from the R/O plant at Batching Plants shall be used for re-charge of ground water. c) Water from dewatering will also be used for ground water recharge.	UPMRC/O&M	UPMRC
4. Hazards to health and safety of workers and the public due to operation of viaduct facilities	Prior to operation of the Project, UPMRC shall ensure that the following plans have been developed and adequately resourced. UPMRC shall ensure strict implementation of plan provisions throughout operation phase: • **b) Occupational Health and Safety Plan** for viaduct operation and train staff in the implementation of such plan. • **c) Emergency Response Plan** (e.g., in case of fire, extreme weather events, power outage, equipment breakdown, accidents, etc.) covering operation of viaduct and above-ground stations. UPMRC shall train staff in the implementation of such plan.	UPMRC/O&M	UPMRC

Table 7.2 : Environmental and Social Mitigation Plan for the Tunnel			
Environmental Aspect/Concern	**Proposed Mitigation Measures**	**Responsibility**	
		Implementation	**Monitoring**
Pre-Construction			
1. Disclosure of project information	Prior to start of site works local residents and establishments, local authorities and other stakeholders who are likely to be affected by the project shall be informed on the construction schedule and activities, potential environmental impacts and mitigation measures through public meetings at each community.	UPMRC, Project Supervision Consultant (GC), Project Management Support Consultant, Contractors	UPMRC
2. Lack of mechanism to resolve environmental complaints due to project implementation	Prior to start of site works, UPMRC shall undertake the following: a) establish a **Grievance Redress Mechanism (GRM)**, as described in the RFP b) through public awareness campaigns, make public the existence of the GRM c) set-up and publicize a 24-hour hotline for complaints d) ensure that names and contact numbers of representatives of UPMRC and contractors are placed on the notice boards outside the construction site	UPMRC,Project Supervision Consultant (GC), Contractors	UPMRC
3. Disruption to community services due to relocation of facilities (e.g., water supply)	a) Water supply pipelines, power supply, communication lines and other utilities shall be re-provisioned before construction works commence b) Provisions shall be made to preserve the operation of current facilities in sufficient quantity and in agreement with the local community. c) Re-provisioning shall be undertaken in coordination with the utility company. d) Affected households and establishments shall be notified well in advance of such disruption.	UPMRC,Project Supervision Consultant (GC), Contractors	Contractor, GC, UPMRC

4. Land Subsidence	a) The tunnel boring machine (TBM) contractor shall implement a survey program to monitor the background subsidence rate along the project line. The monitoring data shall be used to assess potential damage that the observed subsidence may cause to buildings under or alongside the tunnels and to estimate the cumulative amount of regional subsidence during the construction stage. b) Take photographs of each structure within the possible affected zone before the construction starts, to be used for assessing potential damage due to subsidence. c) Depending on the results of the assessment, suitable mitigation measures shall be developed and implemented by the contractor to avoid or minimize damage to properties.	Contractor	UPMRC, GC
5. Preparation and implementation of management action plans	Prior to start of site works, environmental management action plans covering following specific environmental issues shall be prepared by the contractor and shall be submitted to the project supervision consultant for approval:	Contractors	UPMRC, GC
	a) **Dust Control Plan** The plan shall provide details of mitigation measures, specific location and schedule where such measures shall be implemented to minimize impacts to sensitive receptors (residential areas, schools, hospitals, etc.) due to construction works, sourcing and transport of construction materials, and other project-related activities.	Contractors	
	b) **Noise Control Plan.** The plan shall provide details of mitigation measures, specific location and schedule where such measures shall be implemented to minimize impacts to sensitive receptors (residential areas, schools, hospitals, etc.) due to construction works, sourcing and transport of construction materials, and other project-related activities.	Contractors	
	c) **Spoils Disposal Plan.** The plan shall present off-site re-use (if suitable) of excavation spoils and corresponding volume, identification of a suitable disposal location/facility and corresponding capacity, designation of suitable transport routes and schedule for spoil truck movements to minimize traffic disruption/congestion, and environmental mitigation measures to address impacts due to transport and disposal of spoils. Maps or design of the site(s) shall be prepared and used to identify where protection measures are required such as slope stabilization measures, silt fencing, ditching, dust control, cross drains, etc. The contractor shall specify spoils dewatering procedures (and facilities), as necessary, and shall describe in detail the mitigation measures to be implemented to ensure that resulting wastewater from spoils dewatering is adequately treated and disposed of to meet applicable standards and requirements. Provisions for random testing of spoils shall be specified to determine contamination levels (e.g., heavy metals) based on national standards.	Contractors	
	d) **Spill Management Plan .** The plan shall provide details of procedures, responsibilities, resources, documentation and reporting requirements, training provisions for relevant staff , etc. to avoid spills of hazardous substances and to effectively respond to such incidents, in case these occur.	Contractors	
	e) **Traffic Management Plan.** The plan shall be designed to ensure that traffic congestion due to construction activities and movement of construction vehicles, haulage trucks, and equipment is minimized. The plan shall be prepared in consultation with local traffic officials and people's committees at the district and commune levels. The plan shall identify traffic diversion and management, define routes for construction traffic from materials storage/parking areas to construction site and from construction site to waste disposal locations, traffic schedules, traffic arrangements showing all detours/lane diversions, modifications to signaling at intersections, necessary barricades, warning/advisory signs, road signs, lighting, and other provisions to ensure that adequate and safe access is provided to motorists in the affected areas.	Contractors	

	f) **Occupational and Community Health and Safety Plan** consistent with international standards. The Plan shall address health and safety hazards associated with construction activities (e.g., working at heights, excavations, etc.) establishment and operation of construction/worker's camps, casting yard, use of heavy equipment, transport of materials and other hazards associated with various construction activities. g) **Emergency Response Plan** to prevent, mitigate, respond to and recover from emergency events that could occur due to project activities such as accidents, spills of hazardous substances, fire, extreme weather events, and other crises.	Contractors	
Construction			
1. Air quality impacts due to gaseous and dust emissions	a) Strictly implement approved **Dust Control Plan** which considers the following mitigation in relation to air quality: b) 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. c) Carry out periodical checks and undertake remedial measures including replacement, if required, so as to operate within permissible norms. d) Wherever possible, use electrically-powered equipment rather than gas or diesel-powered equipment e) Position any stationary emission sources (e.g., portable diesel generators, compressors, etc.) as far as is practical from sensitive receptors; f) Use only vehicles and equipment that are registered and have necessary permits. g) Burning of wastes generated at the construction sites, work camps and other project-related activities shall be strictly prohibited. h) Construction equipment and vehicles shall be well-maintained and shall meet national emission standards. i) Specify the use of clean fuels such as ultra-low Sulphur diesel in dump trucks and other heavy-duty diesel vehicles and/or equipment in conjunction with the use of particulate trap control devices, as well as catalytic converters, to avoid excessive diesel emissions. j) Keep stockpiles moist and cover vehicles with tarpaulin sheets or other suitable materials to minimize dust emission and prevent spillage of materials (e.g., soil, cement, stone, sand, aggregates, etc.). k) Provide temporary covers (e.g., tarpaulins, grass, etc.) on long term materials stockpiles until excavate is re-utilized for backfilling l) place material in a manner that will minimize dust production. Material shall be minimized each day and wetted, to minimize dust production. During dry weather, dust control methods must be used daily especially on windy, dry days to prevent any dust from blowing across the site perimeter. m) As much as possible, the casting yard for the Project will make use of already established and licensed site(s) for concrete forming activities where all the pre-cast sections of the viaduct, pier columns and cross members will be fabricated.	Contractor	UPMRC, GC

	n) Ensure that necessary environmental approvals are obtained for the establishment and operation of a new casting yard / batching plant. o) Design and implement blasting techniques so as to minimize dust, noise, and vibration generation and prevention fly rock[9]. p) Store excavated materials outside road reserve, but where there is no area, spoils shall be loaded and transported immediately. q) Clean road surfaces of debris/spills from construction equipment and vehicles. r) Undertake daily cleaning of paved routes around the pier construction sites. s) Install temporary fencing or barriers around particularly dusty activities in vicinity of sensitive receivers t) water down construction sites as required to suppress dust, during handling of excavation soil or debris or during demolition. 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. u) Ensure availability of water trucks on site and if the works surface and access roads near sensitive receptors (i.e., residential areas, roadside tea and food stalls, schools, hospitals and other sensitive receptors) are dry and dusty, spray water on the exposed surfaces to reduce dust emission. v) All construction equipment and machinery shall be fitted with emission control equipment in full compliance with the national and local regulations. w) Fuel-efficient and well-maintained haulage trucks will be used to minimize exhaust emissions. Smoke belching vehicles and equipment shall not be allowed and shall be removed from the project. x) Impose speed limits on construction vehicles to minimize road dust in areas where sensitive receptors are located. y) Undertake immediate repairs of any malfunctioning construction vehicles and equipment. yy) Discourage idling of engines z) Provide prior notification to the community on schedule of construction activities zz) Implement 24 hour community complaints hotline		
2. Noise and vibration impacts	a) Strictly implement approved **Noise Control Plan**	Contractor	Contractor, GC,

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due to operation of construction equipment/ vehicles and various construction activities	b) Erection of temporary walls around the elevated station sites and other construction sites, as necessary. Especially near sensitive areas such as schools, hospitals, houses, etc. Temporary noise barriers (3-5 meter high) can reduce noise level by 5-10 dB(A). c) Use of churned drill pile method will has significantly lower noise and vibration emission levels that diesel hammer piles d) Truck drivers and equipment operators shall minimize the use of horns. e) Position any stationary equipment that produce high noise levels (e.g., portable diesel generators, compressors, etc.) as far as is practical from sensitive receptors; f) All construction equipment and vehicles shall be well maintained, regularly inspected for noise emissions, and shall be fitted with appropriate noise suppression equipment consistent with applicable national and local regulations. g) Use only vehicles and equipment that are registered and have necessary permits. h) Noise level from loading and unloading of construction materials can be reduced by usage of various types of cranes and placing materials on sand or sandy bag beds. i)) No noisy construction-related activities will be carried out during the night. Such activities shall be restricted to daylight hours. j) Impose speed limits on construction vehicles to minimize noise emission along areas where sensitive receptors are located (houses, schools, hospitals, etc.) k) As much as possible, use quiet equipment and working method. l) Whenever possible, completely enclose noisy equipment which can reduce noise level by 15-25 dB(A), restrict use of noisy equipment (e.g.15 min for every consecutive 30 min period) and undertake sequential operation of equipment with objective to reduce noise generated; m) No noisy construction activities near schools during examination period. n) Avoid noisy construction activities in vicinity of sensitive receivers during night time or other sensitive periods (e.g. during school hours in vicinity of schools). o) Provide prior notification to the community on schedule of construction activities p) Implement 24 hour community complaints hotline q) Minimise the exposure of workers to high noise levels by using job rotation, automation, protective devices and		

	soundproof compartments, control rooms etc.[10] r) Use of in-ground deep barriers such as trenches to reduce vibration, especially near buildings with strict vibration limits, such as operating theatres of hospitals or high-tech factories with sensitive processes. s) Use of row or lime or cement piles as barriers to reduce vibration, as appropriate t) Support ballast-less track on two layers of rubber pads to reduce track noise and ground vibrations.		
3. Spoils generation from tunneling and excavation works at underground station sites	a) Strictly implement approved **Spoils Disposal Plan** which considers the following mitigation approaches: b) Spoil disposal will only be to and UPMRC approved areas c) The capacity of disposal sites shall be adequate to accept the quantity of spoils without alienating areas outside the site boundaries. d) Undertake random sampling of spoils from underground station excavations and tunneling to determine presence of contaminants. e) Disposal of contaminated spoils shall only be to disposal sites equipped and licensed to handle such wastes. f) Determine water content of spoils to ascertain if spoils dewatering is necessary. g) Undertake necessary spoils dewatering and provide adequate treatment facilities to ensure that resulting wastewater meets national standards. h) Stockpiling of spoils shall not be undertaken due to the limited footprint of the construction site. Spoils shall be trucked away immediately to disposal sites.	Contractor	UPMRC, GC
	i) Should any small stockpiles be developed, these shall be covered by plastic sheeting j) Trucks transporting spoils shall be tightly covered with tarpaulin or other suitable materials to minimize dust emission and spills. k) Load-out areas shall be cleaned and watered to ensure no accumulated dust originates that could be dispersed to surrounding areas. l) Wheel washing shall be undertaken to remove mud so as to ensure that access roads are kept clean.		

[10] Cost is to be included in the project engineering cost.

	m) Road surfaces shall be regularly cleaned of spilled spoils. n) The spoils disposal site shall be located at least 50 m from surface water courses and shall be protected from erosion by avoiding formation of steep slopes and grassing. o) Spoil disposal shall not cause sedimentation and obstruction of flow of watercourses, damage to agricultural land and densely vegetated areas.		
4. Pollution due to spills of fuel and other hazardous substances.	a) Strictly implement approved **Spills Management Plan** which considers the following mitigation measures: b) Store fuel and hazardous substances in paved areas with embankment. If spills or leaks do occur, undertake immediate clean up. c) Ensure availability of spill clean up materials (e.g., absorbent pads, etc.) specifically designed for petroleum products and other hazardous substances where such materials are being stored. d) Train relevant construction personnel in handling of fuels and spill control procedures. e) Ensure all storage containers are in good condition with proper labeling. f) Regularly check containers for leakage and undertake necessary repair or replacement. g) Store hazardous materials above flood level. h) Equipment maintenance areas shall be provided with drainage leading to an oil-water separator that will be regularly skimmed of oil and maintained to ensure efficiency. Discharge of oil contaminated water shall be prohibited. i) Store waste oil, used lubricant and other hazardous wastes in tightly sealed containers to avoid contamination of soil and water resources. Transport and off-site disposal of such wastes shall be consistent with national and local regulations. j) Ensure that Hazardous Waste arising from maintenance of equipment which may include engine oils, hydraulic fluids, waste fuel, spend mineral oil/cleaning fluids from mechanical machinery, scrap batteries or spent acid/alkali, spend solvents etc. are stored in a secure place and adequately labelled and packaged. k) Maintain a record of sale, transfer, storage of hazardous waste and make these records available for inspection. l) Identify the nature and quantity of hazardous waste generated as a result of construction activities and obtain authorization from State Pollution Control Board.	Contractor	UPMRC, GC
5. Drainage obstruction/ flooding	a) Placement of construction materials, excavated spoils, equipment shall not block flow of rainwater into canals/drainage structures.	Contractor	UPMRC, GC

	b) Prohibit disposal of waste materials to drainage channels. d) Regularly inspect and maintain all drainage channels to keep these free of obstructions. e) Water from underground works shall be led by construction drains into sumps and then to trunk sewers or used to recharge groundwater or re-use for construction.		
6. Potential contamination of groundwater due to tunneling	a) Non-toxic slurry and additives shall be used to minimize the impact of potential pollution to the water wells. b) Minimize the amount of slurry and additives applied to reduce the potential for pollution. c) Ensure that pressure applied to tunneling and ground treatment is controlled to prevent excessive pressure that will drive the slurry out of the desired range increasing the risk of damaging nearby wells and their water quality. d) Cooperate with the water agency to shut down the nearby municipal wells while tunneling or ground treatment is taking place. e) Undertake regular monitoring of water wells located within the range of potential impact with reference to national drinking water standards and pollution indicators (of slurry). Baseline sampling shall also be undertaken prior to start of tunneling.	Contractor	UPMRC, GC
7. Generation of solid wastes	Construction and Demolition (C&D) debris is that part of the solid waste stream that results from land clearing, excavation, construction, demolition, remodeling and repair of structures, roads and utilities. C&D waste generated from metro construction has potential use after processing and grading. Post-grading the waste should be disposed at sites identified by UPMRC in consultation with respective authority like Municipal Corporation etc. such that the sites are away from residential areas, water body/ water course and do not require displacement. a) Provide garbage bins and facilities within the project site for temporary storage of construction waste and domestic solid waste. b) Separate solid waste into hazardous, non-hazardous and reusable waste streams and store temporarily on site in secure facilities with weatherproof flooring and roofing, security fencing and access control and drainage/ wastewater collection systems. c) Ensure that wastes are not haphazardly dumped within the project site and adjacent areas d) Undertake regular collection and disposal of wastes to sites approved by local authorities.	Contractor	UPMRC, GC
8.Erosion control and muck disposal	Prior to the start of the relevant construction, the Contractor shall submit to the UPMRC for approval, his schedules for carrying out temporary and permanent erosion/sedimentation control works as are applicable for the items of clearing and grubbing, roadway and drainage excavation, embankment/sub-grade construction and other structures across water courses, pavement courses and shoulders and his plan for disposal of waste materials. The surface area of erodible earth material exposed by clearing and grubbing, excavation shall be limited to the extent practicable. Works such as construction of temporary berms, slope drains and use of temporary mulches, fabrics, mats, seeding, or other control devices or methods as necessary to control erosion and sedimentation may be involved. Mitigation measures include careful planning, timing of cut and fill operations and re-vegetation[11].		

[11] Capital and operating cost are included in engineering cost and therefore is not included in EMP.

	Measures need to be adopted for collection, transfer, temporary storage and disposal of excavated muck. Sites for muck disposal will be decided by UPMRC before start of construction in consultation with respective authority like Municipal Corporation etc. such that the sites are away from residential areas and do not require displacement. The transfer and disposal of surplus soil may create air pollution and leached water problem. To mitigate these problems following mitigation measure will be adopted: a) The disposal sites will be cleaned and then treated so that leached water does not contaminate the ground water. b) Material will be stabilized each day by watering or other accepted dust suppression techniques. c) The height from which soil will be dropped shall be minimum practical height to limit the dust generation. d) The stock piling of earth in the designated locations with suitable slopes e) During dry weather, dust control methods such as water sprinkling will be used daily especially on windy, dry day to prevent any dust from blowing. f) Sufficient equipment, water and personnel shall be available on dumping sites at all times to minimize dust suppression. g) Dust control activities shall continue even during work stoppages. h) The muck shall be filled in the dumping site in layers and compacted mechanically. Dumping sites on sloping ground shall be protected adequately against any possible slide/slope failure through engineering measures. i) It is desirable to first clean the disposal area site for vegetation biomass exists over it. The faces and top should be treated/ vegetated to avoid erosion. Once the filling is complete, the entire muck disposal area shall be provided with a layer of good earth on the top, dressed neatly, and covered with vegetation.[12]		
9. Construction materials management and environmental sanitation	a) Monitor all aspects of construction activities related to storing, loading of construction materials and equipment in order to maintain quality b) Conduct regular inspection of the construction material storage site for the presence of uncontrolled construction waste c) Closely liaison with the officer of the UPMRC and the head of the construction crew to address any environmental issues and setting up impact mitigation procedures d) Ensure that the scheduling of material procurement and transportation is closely linked with the construction schedule of the project e) Ensure proper environmental sanitation/housekeeping at all times of work sites, construction depot,		

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	batching plant, stores, offices and sanitation facilities, keeping these cleared of all construction materials/debris, scraps and used materials/items, thereby providing a first-line of defense against accidents and injuries.		
10.Energy management	a) Use and maintain equipment to conserve energy b) Implement measures to conserve energy including but not limited to the following: use of tools; plant and equipment of correct specifications; energy efficient motors and pumps; efficient lamps; optimal maintenance[13]		
11. Disruption of utilities and damage to community facilities	a) Strictly implement approved **Utility Management Plan**. The proposed Metro alignment runs along major arterial roads of the city which serves Institutional, Commercial and Residential areas. Large number of sub-surface, surface and overhead utility services, viz. sewers, water mains, storm water drains, telephone cables, electrical transmission lines, electric poles, traffic signals etc. already exist along the proposed alignments. 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. As such, these may affect construction and project implementation time schedule/costs, for which necessary planning/action needs to be initiated in advance: b) Prior to the actual execution of work at site, detailed investigation of all utilities and location will be undertaken well in advance by making trench pit to avoid damage to any utility. c) Coordinate with utilities to prepare planning for diversion of underground utility services e.g. sewer lines, water pipe lines, cables etc., during construction of Metro, the following guidelines could be adopted: d) Utility services shall be kept operational during the entire construction period and after completion of project. e) 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. f) 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. g) In case of underground utility services running across the alignment, the spanning arrangement of the viaduct may be suitably adjusted. h) Ensure that any disruption of utility services are announced in advance to the affected communities. h) Immediately repair any damage caused by the Project to community facilities such as water supply, power supply, communication facilities and the like. i) Access roads damaged during transport of construction materials and other project-related activities shall be reinstated upon completion of construction works.	Contractor	UPMRC, GC
12. Land Subsidence	Depending on the results of the land subsidence monitoring conducted by the TBM contractor, suitable mitigation measures shall be developed and implemented by to avoid or minimize damage to properties.	Contractor	UPMRC, GC

[13] Capital and operating cost are included in engineering cost and therefore is not included in EMP.

13. Traffic congestion and access problems	a) Strictly implement approved **Traffic Management Plan** which considers the following mitigation measures: b) Provide signs advising road users that construction is in progress and that the road narrows to one lane using cones. c) Employ flag persons to control traffic at the station sites for safety reasons when construction equipment is entering or leaving the work area. d) Lanes through the work site, created by rope or flagging, shall be developed to minimize risks and injuries from falling objects. e) All construction workers should be provided with high visibility jackets with reflective tapes at most of viaduct/tunneling and station works or either above or under right-of-way. e) As much as possible, lifting and placing of the pre-cast pier and viaduct sections will be done at night to minimize traffic congestion. f) Post traffic advisory signs (to minimize traffic build-up) in coordination with local authorities Provide safe and clearly marked lanes for guiding road users. g) Provide safe and clearly marked buffer and work zones h)Provide road signs indicating the lane is closed 500 m before the worksite. i) Primary traffic control devices used in work zones shall include signs, delineators, barricades, cones, pylons, pavement markings and flashing lights to direct traffic to move to the open lane. j) Various construction technologies like cut and cover can be employed to ensure that traffic impedance is minimized[14]. k) Provide sufficient lighting at night within and in the vicinity of construction sites. l) Regularly monitor traffic conditions along access roads to ensure that project vehicles are not causing congestion. m) Define and observe schedules for different types of construction traffic trips (e.g., transport of pre-cast sections, haulage of spoils, delivery of construction materials, etc.). n) As much as possible, schedule delivery of construction materials and equipment as well as transport of spoils during non-peak hours. g) o) Avoid movements of noisy vehicles during night time in vicinity of sensitive receivers. h) p) Implement suitable safety measures to minimize risk of adverse interactions between construction works and traffic flows through provision of temporary signals or flag controls, adequate lighting, fencing, signage and road diversions.	Contractor	UPMRC, GC

[14] Capital and operating cost are included in engineering cost and therefore is not included in EMP.

	i) q) Ensure relocation of any affected public transport infrastructure (but stops, shelters etc) prior to commencement of works j) r) Provide advance notification to the community regarding changes to public transport facilities or routes. k) s) Schedule construction works to minimize extent of activity along linear construction site at any one time l) t) Comply with traffic regulations and avoid, where possible, roads with the highest traffic volumes, high density of sensitive receivers or capacity constraints are not used as access to and from the construction areas and spoils disposal sites. m) u) Install temporary accesses to properties affected by disruption to their permanent accesses. n) v) Reinstate good quality permanent accesses following completion of construction.		
	o) 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.		
14. Hazards to health and safety of workers and the public due to construction works	a) Strictly implement approved **Occupational and Community Health and Safety Plan**, and approved **Emergency Response Plan** b) Appoint an Environment, Health and Safety Manager to look after implementation of required environmental mitigation measures, and to ensure that health and safety precautions are strictly implemented for the protection of workers and the general public in the vicinity of construction areas c)Conduct orientation for construction workers regarding health and safety measures, emergency response in case of accidents, fire, etc., and prevention of HIV/AIDS and other related diseases e)In accordance with the Construction Contract the Contractor will be required to provide shelter at workplace, canteen facilities, first aid facilities, day crèche facilities on work sites. d) Provide first aid facilities that are readily accessible by workers. f) Provide fire fighting equipment at the work areas, as appropriate, and at construction camps. In accordance with the Construction Contract the Contractor shall provide the following facilities at the labour camps: g) Prepare safety programmes following rules, regulations and guidelines based on the identification of safety hazards made by Project Authority H) Provide adequate housing for all workers at the construction camps. i) Provide adequate drainage in workers camps to prevent water logging/accumulation of stagnant water and formation of breeding sites for mosquitoes. j) Provide reliable supply of potable water.	Contractor	UPMRC, GC

	k) Provide separate hygienic sanitation facilities/toilets and bathing areas with sufficient water supply for male and female workers l) Establish clean canteen/rest area. m) Ensure proper collection and disposal of solid wastes within the construction camps consistent with local regulations n) Ensure facilities for water supply and wastewater treatment o) Conduct health awareness campaign for workers in the construction camp p) Construction works shall be executed as laid down in the Safety Health and Environment (SHE) manual prepared by the Contractor and approved by PIU q) Provide fencing on all areas of excavation. r) Provide appropriate personnel safety equipment such as safety boots, helmets, gloves, protective clothes, breathing mask, goggles, and ear protection s) Ensure reversing signals are installed on all construction vehicles. t) Implement precautions to ensure that objects (e.g., equipment, tool, debris, pre-cast sections, etc.) do not fall onto or hit construction workers. u) Implement fall prevention and protection measures whenever a worker is exposed to the hazard of falling more than two meters, falling into operating machinery or through an opening in a work surface. Based on a case-specific basis, fall prevention/protection measures may include installation of guardrails with mid-rails and toe boards at the edge of any fall hazard area, proper use of ladders and scaffolds by trained employees, use of fall prevention devices, including safety belt and lanyard travel limiting devices to prevent access to fall hazard, fall protection devices such as full body harnesses, etc. v) Implement precautions to ensure that objects (e.g., equipment, tool, debris, pre-cast sections, etc.) do not fall onto or hit people, vehicle, and properties in adjoining areas. w) Fencing of construction sites and excavation sites and guarding such areas to restrict public access. x) Prior to excavation work, provide fencing on all sides of areas to be excavated. y) Provide warning signs at the periphery of the construction site. z) Strictly impose speed limits on construction vehicles along residential areas and where other sensitive receptors such as schools, hospitals, and other populated areas are located. zz) Educate drivers on safe driving practices to minimize accidents and to prevent spill of hazardous substances and other construction materials during transport.		
15. Social conflicts due to presence of	a) Consider the location of construction camps away from communities in order to avoid social conflict in using resources and basic amenities such as water supply.	Contractor	UPMRC, GC

workers	b) Maximize number of local people employed in construction works. c) Maximize goods and services sourced from local commercial enterprises.		
16. Protection of Archaeological Monuments	a) Coordinate with UPMRC the conduction of condition survey of all archaeological/heritage structures in the vicinity of alignment prior to construction b) Coordinate with UPMRC any follow up of the survey during construction c) Follow the procedures within the regulated area of Archaeological Monuments during the construction stage	Contractor	UPMRC
17. Potential damage to undiscovered archaeological structures	The following 'chance-find' principles will be implemented by the contractor throughout the construction works to account for any undiscovered items identified during construction works: a) Workers will be trained in the location of heritage zones within the construction area and in the identification of potential items of heritage significance b) Should any potential items be located, the site supervisor will be immediately contacted and work will be temporarily stopped in that area c) If the site supervisor determines that the item is of potential significance, an officer from the Archeological Survey of India (ASI) will be invited to inspect the site and work will be stopped until ASI has responded to this invitation. d) Work will not re-commence in this location until agreement has been reached between ASI and UPMRC as to any required mitigation measures, which may include excavation and recovery of the item e) A precautionary approach will adopted in the application of these procedures	Contractor	UPMRC, GC, , DDC, TPA
18. Potential damage to the Religious Structures	a) Consult with authority of religious structure prior to commencement of construction to inform them of construction schedule and activities and identify requirements for specific mitigation measures to minimize air, noise, or traffic impacts in addition to those already required in the EMP. b) Establish a photographic record of the fence and gates, especially at ground level. c) To monitor settlement, install inclinometers along the fence, the gate and other structures closest to the flower garden. These inclinometers shall be left in place after construction and regularly monitored. d) Install a vibration recording device and undertake continuous monitoring for the period when the TBM is traversing the religious structure. e) Adjust tunneling speeds and periodicity should the vibration monitoring indicate excessive vibrations. f) Should the monitoring indicate that settlement has taken place based on photographic record, inclinometer reading and depending on the severity, the following remedial measures shall be applied, as appropriate:	Contractor	UPMRC, GC, , DDC, TPA

	i. Fill the garden area with soil and re-level the ground; ii. Re-install the fence and supports; iii. Jack-up the building(s) and rebuild the base with cement forms or engineered earth; iv. Repair cracks and re-plaster walls.		
Operation			
1. Noise emission from tunnel operation	a) Tunnel ventilation systems shall have suitable noise control measures incorporated into their design to reduce mechanical noise to acceptable levels in the surrounding community. b) Depending on the results of noise monitoring, installation of acoustical treatment to the first few meters (i.e., < 15 m) of the tunnel portal shall be implemented as necessary.	UPMRC / O&M	UPMRC
2. Waste generation	a) Waste collection bins or receptacles shall be provided in various areas at the undergroundd stations, such as offices and areas accessed by passengers. b) Garbage shall be regularly collected and shall be disposed consistent with local regulations c) The underground stations shall be provided with toilets and septic tanks to handle sewage generated by workers and passengers.	UPMRC / O&M, Contractor	UPMRC
3. Hazards to health and safety of workers and the public due to operation of tunnel facilities	a) Prior to operation of the Project,UPMRC shall ensure that the following plans have been developed and adequately resourced. UPMRC shall ensure strict implementation of plan provisions throughout operation phase: • **Occupational Health and Safety Plan** for tunnel facilities operation (rail and stations) and train staff in the implementation of such plan. • **Emergency Response Plan** (e.g., in case of fire, collision. Derailment, floods, power outage, equipment breakdown, accidents, etc.) covering operation of underground rail and stations. UPMRC shall train staff in the implementation of such plan. b) Ventilation systems will be provided in the underground stations. c) Air compressors with fans will be used to cool air, before injecting it into stations. d) Air will be filtered prior to exhaust to the external environment.	UPMRC / O&M, Contractor	UPMRC

	e) Under normal conditions the tunnel section of the route will be ventilated by the piston effects of train movements. The system shall ensure circulation of fresh air to meet both normal and emergency requirements. f) There will be provisions for sufficient emergency exits. g) Pumps will be installed in the tunnel and underground stations to pump storm water and wastewater. Wastewater treatment systems will be installed at stations to treat sewage prior to discharge to the city systems. h) Communications systems (normal and emergency systems), fire protection, emergency response and evacuation systems will be implemented throughout the Project (tunnel, viaduct and depot). i) Back-up electricity and ventilation systems will be installed in the tunnel sections. These systems, shall meet current safety standards. j) A central operations control centre for the project will be established at the depot to coordinate project operation and emergency response procedures. k) Safety and evacuation measures in case of fire and other accidents (e.g., derailment, collision, etc.) shall be developed prior to operation.		

Measures to enhance positive impacts

Rain water harvesting

To conserve and augment the storage of groundwater, it has been proposed to construct roof top rainwater harvesting structure of suitable capacity at the elevated stations and in the elevated alignment. Each pillar can have inbuilt downpipes to collect the rainwater from the viaduct and into the underground tanks. A recharge tank shall be constructed at suitable distance. The water collected will percolate down to the subsoil through numerous layers of sand, gravel and boulders. Total elevated length of the corridors is about 22.4 km. Annual rainfall of Agra is 724.8 mm. Considering a runoff coefficient of 0.85 the annual rainwater harvesting potential of elevated stations and elevated section is estimated as 8,10,220 cubic meter per year. Estimated cost for rainwater harvesting for viaduct and elevated stations is Rs 79.34 Lakh for Corridor-I and Rs 192.33 Lakh for Corridor-II.

Green Buildings

Green building (also known as sustainable building) refers to both a structure and the using of processes that are environmentally responsible and resource-efficient throughout a building's life-cycle: from siting to design, construction, operation, maintenance, renovation, and demolition. Green buildings help in better preservation of environment as in such structures there are provisions for better saving of energy, water and CO2. Such buildings also have better waste management arrangements.

The Indian Green Building Council (IGBC) conducts a rating process for New Buildings which addresses the green features under the following categories:

- Sustainable Architecture and Design
- Site Selection and Planning
- Water Conservation
- Energy Efficiency
- Building Materials and Resources
- Indoor Environmental Quality
- Innovation and Development

All stations and Depots can be designed as green buildings.

B ENVIRONMENTAL MONITORING PLAN AND ENVIRONMENT MANAGEMENT SYSTEM

Environment and Social Monitoring Plan

The environmental monitoring programme is a vital process of any Environmental Management Plan (EMP) of development project for review of indicators and for taking immediate preventive action. Environmental monitoring should be an integral part of works towards better environmental management of air, noise, vibration, water quality etc both during construction and in operation phases of the project. The following parameters are proposed to be monitored:

- Water Quality,
- Air Quality,
- Noise and Vibration,
- Environmental Sanitation and Waste Disposal
- Ecological Monitoring and Afforestation,
- 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.

Construction Phase

During construction stage environmental monitoring will be carried out for air quality, noise levels, vibrations, water quality, and ecology. At this stage it is not possible to visualize the exact number of locations where environmental monitoring must be carried out. However keeping a broad view of the sensitive receptors and also the past experience an estimate of locations has been made and are summarized in **Table 7.3**. These numbers could be modified based on need when the construction actually commences.

Table 7.3: CONSTRUCTION STAGE MONITORING SCHEDULE

Parameter	Frequency	Locations	Years
Air Quality	2x24 hours, twice a month	8	5
Noise	24 hours, once a week	8	5
Vibration	24 hours, once a week	5	5
Water	Once in 6 months	5	5

i. Water Quality

The water quality parameters are to be monitored during the entire period of project construction. Monitoring should be carried out by NABL Accredited/MoEFCC recognized private or Government agency. Water quality should be analyzed following the procedures given in the standard methods. Parameters for monitoring will be as per BIS: 10500. The monitoring points could be ground and surface water.

ii. Air Quality

Air quality is regularly monitored by Central Pollution Control Board at number of places in Agra. In addition to these, air quality should be monitored at the locations of baseline monitoring. The parameter recommended is Particulate Matter (PM2.5 and PM10), SO2, NOX, CO and HC. The contractor will be responsible for carrying out air monitoring during the entire construction phase under the supervision of UPMRC.

iii. Noise and Vibration

The noise and vibration will be monitored at construction sites for entire phase of construction by the site contractor and under the supervision of UPMRC.

iv. Ecological Monitoring

The project authority in coordination with the Department of Forest shall monitor the status of ecology/trees along the project corridors at least 4 times in a year during construction phase in order to maintain the ecological environment. The plantation/afforestation of trees by Department of Forest, Government of Uttar Pradesh will be review four times a year during construction phase.

v. Workers Health and Safety

Monitoring of health risk issues that might arise throughout the project life time will be done. Epidemiological studies at construction sites 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 reoccurring incidents such as irritations, rashes, respiratory problems etc shall be recorded and appropriate mitigation measures shall be taken. Contractor will be the responsible person to take care health and safety of workers during the entire period of the construction and project proponent is responsible to review/audit the health and safety measures/plans.

vi. Operation Phase

Even though the environmental hazards during the operation phase of the project are minimal, the environmental monitoring will be carried out for air, noise, vibration, water and ecology during operation phase of the project. The parameters monitored during operation will be Particulate Matter (PM2.5 and PM10), SO2, NOX, CO and HC for air. Water quality parameters that will be monitored will be as per BIS 10500.

The monitoring schedule is presented in **Table 7.4**. Monitoring should be carried out by NABL Accredited/MoEFCC recognized private or Government agency under the supervision of Uttar Pradesh Metro Rail Corporation. Project Operator i.e. UPMRC will be responsible for successful environmental monitoring of the proposed project during operation phase.

Table 7.4: OPERATION STAGE MONITORING SCHEDULE

Parameter	Frequency	Locations	Years
Air Quality	2x24 Hour, once in a month	8	3
Noise	24 hours once a year	8	3
Vibration	24 hours once a year	5	3
Water	Once a year	2 (Depots)	3
Waste Water	Once in 4 months	2 (Depots)	3
Solid Waste	Once a year	(Depots)	3

Environment Management System is intended to facilitate implementation, tracking and reporting of mitigation and monitoring measures proposed for the project. Roles and responsibilities are summarized**.**

Table 7.5: ROLES AND RESPONSIBILITIES –PREPARATION AND IMPLEMENTATION OF ENVIRONMENTAL MANAGEMENT PLAN (EMP) AND ENVIRONMENTAL MONITORING PLAN (EMOP)

SN	Environmental Impact	Mitigation Measure	Implementing Entity	Responsible Entity
Location and Design Phase				

1	Displacement and private property acquisition, impact of environmentally sensitive areas.	Alignment design to avoid or minimize impact.	DPR and design consultant	PIU
2	Loss of trees and water bodies		DPR and design consultant	PIU
3	Visual intrusion	Capital and operating cost and vibration impact of underground line in trade off with visual intrusion. To design aesthetic structures of viaduct and stationson elevated sections.	DPR and design consultant	PIU
4	Archaeological monuments	Alignment design to avoid or minimize impact.	DPR and design consultant	PIU
Pre-constructionPhase				
5	Displacement and private property acquisition.	Implement R&R Plan	PIU	PIU
6	Loss of trees and water bodies	Implement compensatory afforestation	Forest Department	Forest Department
7	Site measures	Prepare Safety, Health and Environment (SH&E) Manual andsecure approval.	Contractor	PIU
8	Water supply; sewage and solid waste disposal	Requirement for construction to be planned so as to avoid use ofground water.	Contractor	PIU
9	Environmental Management and Monitoring	Implement institutional requirements for implementation of EMP and EMoP.	Contractor	PIU
Construction Phase				
10	Soil erosion, fugitive dust generation, muck disposal and C&D waste management	Implement suitable construction methods and as per SH&E Manual	Contractor	PIU
11	Air and noise Pollution	Vehicles and machinery are to be maintained to emission standards;machinery noise muffles etc and personal protective gear to workers.	Contractor	PIU
12	Vibration	Implement vibration monitoring and building condition surveys at sensitive structures	Contractor	PIU
13	Water pollution	Implement measures such as precipitation tanks on site	Contractor	PIU
14	Soil pollution	Implement measures to prevent ingress of toxic / heavy metals	Contractor	PIU

15	Labour camp: water supply; sewage and solid waste disposal; health	Implement measures as per SH&E Manual	Contractor	PIU
16	Facilities on site and workplace safety		Contractor	PIU
17	Incident Management	Prepare Incident Management Plan with reporting formats.	Contractor	PIU
18	Environmental Monitoring	Prepare Environmental Monitoring Plan.		
19	Availability of institutional capacity	Implement training and establish environment unit.	Contractor	PIU
Operation Phase				
20	Noise Pollution	Implement and maintain noise barriers on viaduct	PIU	PIU
21	Vibration	Implement vibration monitoring and building condition surveys at sensitive structures.	PIU	PIU
22	Water supply, sanitation, sewage and solid waste disposal at stations and depots	Implement prescribed measures including rainwater harvesting at stations and depots; green belt and water recycling at depots.	PIU	PIU
23	Sewage and effluent disposal	Implement STP and ETP at depots.	PIU	PIU
24	Incident Management	Implement Incident Management Plan.	PIU	PIU
25	Environmental Monitoring	Implement Environmental Monitoring Plan.	PIU	PIU

The range of documentation required to be generated and maintained as part of EHS before and during construction and during operation is as follows:

- Controlled documents of mandatory environmental Approvals and clearances along with record extensions thereof
- Controlled documents of approved SH&E Manual, EMP and EMoP with revisions thereof and time schedule of such revisions if any
- Controlled documents of formats of site inspection checklists with revisions thereof and time schedule of such revisions if any
- Reports of site inspections, monitoring data, reports of internal or external audit, observations of PIU and local statutory agency if any like Pollution Control Board, local municipal authority, Forest Department etc. and subsequent remedial action taken by Contractor if any
- Records of coordination meetings of PIU/GC and Contractor with subsequent remedial action taken by Contractor if any
- Records of incident reporting and remedial action taken by Contractor if any and follow-up of such incidents

VIII. CONCLUSIONS AND RECOMMENDATIONS

Agra, the city of Taj Mahal is the 3rd most populous city in Uttar Pradesh and is administrative headquarters of the Agra district. Agra was the capital city of Mughals during their rule. The City is a major tourist hub with number of monuments like Agra Fort, Tomb of Akbar and Fatehpur Sikri besides the Taj Mahal, which have been listed as the UNESCO World Heritage sites. In the past few decades Agra Development Authority Area has experienced an unprecedented spatial expansion from 61.8 sq km in 1971 to 520.2 sq km in 2008. The city's population grew from 5.9 lakh in 1971 to 9.8 lakh in 1991, 12.7 lakh in 2001 and 15.9 lakh in 2011.

The administrative limits of the Agra Nagar Nigam encompass an area of 141.0 sq. km with a population density of about 9,043 persons per sq. km. The highest density lies in the old city areas like Lohamandi and Shahganj, etc. where the settlements started flourishing from the Mughal period.

Unequal spatial development has led to pockets of high density in terms of employment and population, putting pressure on the infrastructure. A major challenge is to provide connectivity and promote growth by providing adequate inputs to the infrastructure which would improve the quality of life of the residents.

Large-scale urbanization and rapid growth of vehicles population has laid severe stress on the urban transport system in Agra city. The sharing of limited right of way by a variety of modes and other utility services has resulted in traffic congestion, accidents and environment deterioration. The nature of trips that the people have to make is also quite varied and they use private means of transport for most of these trips given the convenience of accessibility. The usage of private modes is growing unabated mainly due to inadequate and inconvenient public transport facilities with poor level of service. The augmentation in the capacity of public transport infrastructure has become necessary.

In order to alleviate the transport related problems in the City, Comprehensive Mobility Plan (CMP) has been prepared in 2017 adhering to Ministry of Housing and Urban Affairs (MoHUA), Government of India guidelines. It identifies various short, medium and long-term measures of transport infrastructure in the City. CMP recommends mass transport systems along two major travel corridors.

Based on the proposals from CMP, an Alternatives Analysis has been carried out to find the most viable mass transit system along two identified corridors. Alternatives Analysis Report recommends to implement a Metro Rail system on these two corridors in Agra. The Government of Uttar Pradesh has engaged RITES Ltd. to prepare a ‘Detailed Project Report (DPR) for Metro Rail System in Agra’.

CMP proposes implementation of mass transit system for two priority corridors in Agra and Alternatives Analysis Report recommends Metro Rail System for these two corridors.Two corridors were agreed upon for the study. Corridor 1 starts from Sikandara and ends at Taj East Gate (Hotel Trident) whereas corridor 2 starts from Agra Cantt. Railway Station and ends at Kalindi Vihar (Trans Yamuna Colony Phase-II) which traverses through city from west to east and South to North respectively. An interchange station between the corridors has been proposed near St. John’s College.

Environmental and social assessments have been carried out in 2017 in the form of EIB draft report on Social and Poverty Analysis (2008). Consequently this ESMP relies heavily on the 2017 Detail

Project Report (DPR) for much of the early data collected on the project, and which is still current. The DPR was prepared in 2017 that sampled air quality (8 sites), noise (7 sites), surface water and groundwater quality (7 sites) and Public consultation were organised at medical college, ISBT, Agra University, St. John's College, RBS, Guru katal, Kamlanagar, Foaundry Nagar, Ram bagh, Agra fort, Taj East Gate, Raja ki Mandi from 16/09/2015 to 19/09/2015.The consultant briefed the participants about the objectives of the meeting regarding various social issues related to the project i.e., alignment plan, land acquisition, displacement, rehabilitation & resettlement and compensation and employment etc. The participants were invited to give their valuable suggestions on the above issues and were assured for suitable incorporation of such suggestions in the project within the technical limitations and scope of the project. The above cited information, available detailed design information, results of additional hydrogeological study provided sufficient data to assess the impacts, provide mitigation measures and formulate a detailed EMP for the pre-construction, construction and operation stages of the Project. The anticipated impacts and mitigation measures presented in EMP section. This report has been prepared consistent with the requirements of EIB's SPS.

No archaeological monuments are directly affected. In underground section the tunnel will be constructed by State of Art Technology i.e. Tunnel Boring Machine (TBM) and stations will be constructed by Cut and Cover method which is widely accepted and the safest technique being adopted by metro in India and abroad.

The EMP also defines the environmental monitoring requirements for various project phases. The monitoring program has been prepared following a review of the monitoring plan contained in the DPR and inclusion of measures to address identified deficiencies in monitoring locations, parameters, frequency and methods. The plan addresses project performance monitoring and environment effects monitoring for project pre-construction, construction and operation.

The UPMRC establishes an Environment Division consisting of an environment specialist, occupational health and safety specialist, social. Institutional arrangements for managing the EMP implementation and required institutional strengthening activities have been developed, and costs for implementing the EMP have been estimated.

To ensure that the required mitigation and monitoring measures are implemented, the EMP shall be included in the tender and contract documents for civil works. Semi-annual monitoring on EMP implementation shall be submitted by UPMRC to EIB. An external environmental monitoring expert shall be engaged and retained by UPMRC to verify the monitoring information submitted to EIB and to assess if the EMP is being implemented as required.

In conclusion the following are the key environmental benefits of the Project: That amount of GHG emissions will be avoided because of the Project during the operational phase, due to the displacement of diesel buses, automobiles and motorcycles. These reductions are expected to far outweigh any short-term increase in GHG emissions that will be experienced during the construction phase. Based on electric transit systems, the Agra Metro corridor operation is expected to avoid the release of greenhouse, and similar to the Project in length and design, is predicting that between 2.1 and 3.5 lakh t CO2 of greenhouse gases per year by the year 2041 will be avoided, the reductions will arise due to the assumed replacement of diesel buses and increased displacement of private automobiles by the train service, relative to automobile transportation.

Socially the project will be a benefit to the population in the project area. The population, located in the Agra city will, by using the metro: avoid traffic congestion and reduce safety hazards

(especially traffic accidents); reduce health problems (especially respiratory problems) due to air pollution and dust; and save time and benefit from a good transportation alternative to go to Railway Station, Inter-State Bus Terminus (ISBT), monuments such as Taj Mahal, Agra Fort, Jama Masjid, Delhi Gate, Sadiq Khan Tomb, Tomb of Salamat Khan, Guru Ka Taal, Pathar ka Ghoda, Akbar's Tomb, Delhi gate, Roman Catholic Cemetery, Lal Masjid, Ram Bagh etc .

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