

INDIA: Bangalore Metro Rail Project – Line R6

Environmental Impact Assessment

August 2017

Prepared by Bangalore Metro Rail Corporation Limited for the European Investment Bank (EIB) and the Asian Infrastructure Investment Bank (AIIB).

CURRENCY EQUIVALENTS

(as of 30 June 2017)

Currency Unit	=	Indian Rupee (INR)
INR 1.00	=	US\$ 0.0155
US\$1.00	=	INR 64.6600

LIST OF ABBREVIATIONS

AFD	-	Agence Française de Développement
ATS	-	Automatic Train Supervision
ATO	-	Automatic Train Operation
ATP	-	Automatic Train Protection
AiIB or the Bank	-	Asian Infrastructure Investment Bank
ASI	-	Archaeological Survey of India
BMRCCL	-	Bangalore Metro Rail Corporation Limited
BMTC	-	Bengaluru Metropolitan Transport Corporation
CBTC	-	Communication Based Train Control
CATC	-	Continuous Automatic Train Control System
CEI	-	Compliance, Effectiveness and Integrity
CPI	-	Consumer Price Index
DPR	-	Detailed Project Report
DMRC	-	Delhi Metro Rail Corporation
EC	-	External Consultant
EIB	-	European Investment Bank
EIRR	-	Economic Internal Rate of Return
EIA	-	Environment Impact Assessment
E&M	-	Electrical and Mechanical
E&S	-	Environmental and Social
EMP	-	Environmental Management Plan
ESMF	-	Environmental and Social Management Framework
ESP	-	Environmental and Social Policy of AiIB
EPBM	-	Earth Pressure Balance Machine
FIRR	-	Financial Internal Rate of Return
GDP	-	Gross Domestic Product
GfP	-	Guidelines for Procurement
GRC	-	Grievance Redressal Committee
GSDP	-	Gross State Domestic Product
GOI	-	Government of India
GOK	-	Government of the State of Karnataka
IA	-	Implementation Agency
KSRTC	-	Karnataka State Road Transport Corporation
MoEFCC	-	Ministry of Environment, Forests and Climate Change
NUTP	-	National Urban Transport Policy
PHPDT	-	Peak Hour Peak Direction Traffic
RAP	-	Resettlement Action Plan
RPF	-	Resettlement Policy Framework
SDG	-	Sustainable Development Goals
SIA	-	Social Impact Assessment
SMF	-	Social Management Framework

SEMU	-	Social and Environmental Management Unit
SPV	-	Special Purpose Vehicle
TBM	-	Tunnel Boring Machine
TOR	-	Terms of Reference
TBC	-	To Be Confirmed

WEIGHTS AND MEASURES

°C	-	degree Celsius
dB(A)	-	decibel acoustic
ha	-	hectare
km	-	kilometer
km/h	-	kilometer per hour
kWe	-	kilowatt-electric
kV	-	Kilo volt(s)
kVA	-	kilo Volt-Amps
kW	-	kilowatt
m	-	meter
mm	-	millimeter
MVA	-	Megavolt Ampere
m ³	-	cubic meter
m ³ /hr	-	cubic meters per hour
mg/l	-	milligrams per liter
m/s	-	meters per second
MTPA	-	metric tons per annum
MW	-	megawatt
ppm	-	parts per million
ppt	-	parts per thousand
rpm	-	revolutions per minute
µg/m ³	-	microgram per cubic meter
SQM	-	Square Meter

NOTES

- (i) The fiscal year (FY) of the Government of India ends on 31 March. FY before a calendar year denotes the year in which the fiscal year ends, e.g., FY2016 ends on 31 March 2017.
- (ii) In this report, "\$" refers to US dollars

GLOSSARY

Adverse impact: An impact that is considered undesirable.

Ambient air: Surrounding air.

Aquatic: Growing or living in or near water.

Baseline (or existing) conditions: The 'baseline' essentially comprises the factual understanding and interpretation of existing environmental, social and health conditions of where the business activity is proposed. Understanding the baseline shall also include those trends present within it, and especially how changes could occur regardless of the presence of the project, i.e. the 'No-development Option'.

Beneficial impacts: Impacts, which are considered to be desirable and useful.

Biological diversity: The variety of life forms, the different plants, animals and micro organisms, genes they contain and the ecosystems they form. It is usually considered at three levels: genetic diversity, species diversity and ecological diversity.

Ecosystem: A dynamic complex of plant, animal, fungal and microorganism communities and associated non-living environment interacting as an ecological unit.

Emission: The total amount of solid, liquid or gaseous pollutant emitted into the atmosphere from a given source within a given time, as indicated, for e.g., in grams per cubic meter of gas or by a relative measure, upon discharge from the source.

Endangered species: Species in danger of extinction and whose survival is unlikely if the existing conditions continue to operate. Included among those are species whose numbers have been reduced to a critical level or whose habitats have been so drastically reduced that they are deemed to suffer from immediate danger of extinction.

Environmental effects: The measurable changes, in the natural system of productivity and environmental quality, resulting from a development activity.

Environmental Impact: An estimate or judgment of the significance and value of environmental effects for natural, socio-economic and human receptors.

Environment and Social Management Plan (ESMP): A Plan to undertake an array of follow-up activities which provide for the sound environmental management of a project/ intervention so that adverse environmental impacts are minimized and mitigated; beneficial environmental effects are maximized; and sustainable development is ensured.

Environmental Management: Managing the productive use of natural resources without reducing their productivity and quality.

Evaluation: The process of looking back at what has been really done or accomplished.

Fauna: A collective term denoting the animals occurring in a particular region or period.

Field Reconnaissance: A field activity that confirms the information gathered through

secondary sources. This field study is essentially a rapid appraisal.

Flora: All of the plants found in a given area.

Habitat: The natural home or environment for a plant or animal.

Land use: Types include agriculture, horticulture, settlement, pisciculture and Industries

Mitigation: An action, which may prevent or minimize adverse impacts and enhance beneficial impacts.

Negative Impact: Negative change from the existing situation due to the project.

Public involvement / Public consultation: A range of techniques that can be used to inform, consult or interact with stakeholders' affected / to be affected by a proposal.

Reversible impact: An environmental impact that recovers either through natural process or with human assistance.

Stakeholders: Those who may be potentially affected by a proposal, e.g. local people, the proponent, government agencies, nongovernmental organizations, donors and others, all parties who may be affected by the project or to take an interest in it.

Terrestrial: Living on land.

TABLE OF CONTENTS

	Page
EXECUTIVE SUMMARY	4
A. INTRODUCTION	6
1. Background	6
2. Project Proponent	6
3. EIA Preparation and Objectives of the EIA	7
4. Scope and Methodology of the EIA	7
5. Structure of the EIA	8
B. POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK	9
1. The National (India) Environmental Laws and Regulations	9
2. EIB Environmental and Social Policies	13
3. International and Regional Agreements and Conventions	16
C. PROJECT DESCRIPTION	17
1. Project Rational and Objectives	17
2. Location of Project Components	18
3. Details of the Project Components	18
4. Construction Methodology	22
5. Cost Estimate	28
6. Land Requirement	28
7. Implementation Plans	28
D. DESCRIPTION OF THE ENVIRONMENT	29
1. Physical Resources	29
2. Ecological Environment	39
3. Socio-economic Environment	40
E. ANTICIPATED IMPACTS AND MITIGATION MEASURES	44
1. Impacts and Mitigation Measures Due to Project Location	45
2. Impacts and Mitigation Measures Due to Project Design	47
3. Impacts and Mitigation Measures Due to Construction Work	48
4. Impacts and Mitigation Measures Due to Project Operation	53
5. Impacts and Mitigation Measures Due to Depot	56
6. Chance Heritage Finds During Tunneling and Cut-and-Cover	58
F. ANALYSIS OF ALTERNATIVES	59
1. Introduction	59
2. Need to Increase Public Transport Share	59
3. Analysis of Alternatives	59
4. No Project Alternative	60
G. CONSULTATIONS, PARTICIPATION AND INFORMATION DISCLOSURE	61
1. Consultations	61
2. Information Disclosure	63
H. GRIEVANCE REDRESS MECHANISM	64
I. ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN	66
1. Introduction	66
2. Objectives of Environmental and Social Management Plan	66
3. Mitigation Measures	66
4. Environmental and Social Monitoring and Reporting Program	71

5. Environmental Reporting System	98
6. Institutional Mechanism and Arrangement for Implementation of ESMP	98
7. Environmental Management Budget and Resources	99
J. CONCLUSION AND RECOMMENDATION	100
APPENDIX 1: WORLD BANK AND GOI AMBIENT AIR QUALITY STANDARDS	101
APPENDIX 2: COMPARISON OF WB EHS AND GOI AMBIENT NOISE LEVEL STANDARDS	102
APPENDIX 3: INDIAN STANDARD DRINKING WATER SPECIFICATION: II 10500:1991	103
APPENDIX 4: RECORD OF PUBLIC CONSULTATIONS	104

LIST OF TABLES

Table 1: Summary of Relevant Environmental Legislation	9
Table 2: Applicable Permits and Clearances Required for the Project	11
Table 3: Salient features of Gottigere - Nagavara Corridor (Reach 6)	19
Table 4: Stations in Gottigere - Nagavara Corridor	20
Table 5: Traffic Forecast for Gottigere – Nagavara Corridor	20
Table 6: Carrying Capacity of Mass Rail Vehicles (Crush@6 Person/Sqm of Standee Area)	21
Table 7: Carrying Capacity of Mass Rail Vehicles (Crush@8 Person/Sqm of Standee Area)	21
Table 8: Traction Power Supply	22
Table 9: Physico-Chemical Characteristics of Soil along the Alignment	30
Table 10: Physico-chemical Characteristics of Ground Water along the Proposed Alignment (2009)	33
Table 11: Physico-chemical Characteristics of Groundwater Samples in Reach 6 (2017)	33
Table 12: Climate data for Bangalore	34
Table 13: Air Quality Parameters along the Proposed Alignment (2009)	35
Table 14: Air Quality Parameters along Reach 6 (2017)	36
Table 15: Air Quality Values and Criteria	37
Table 16: Air Quality Index (AQI) Values and Air Quality Criteria at the Proposed Alignment	37
Table 17: Noise Levels along Proposed Alignment (2009)	37
Table 18: Noise levels (dB) in Reach 6 (2017)	38
Table 19: Overall Affected Trees along the Alignment	39
Table 20: Land Use Pattern of Bangalore	41
Table 21: Average Noise Levels Generated by the Operation of Various Construction Equipments	51
Table 22: Increase In Noise Levels Due to Increased Vehicular Movement	52
Table 23: Noise Generated Due To Drilling	52
Table 24: Maximum Exposure Periods Specified By Osha	53
Table 25: Exterior Noise Levels In Metro Stations	54
Table 26: Interior Noise Levels In Metro Trains	54
Table 27: Water Requirement At Stations	55
Table 28: Details of public consultation en-route the proposed transmission lines	62
Table 29: Cost Estimate for Green Belt Development along the proposed alignment	68
Table 30: Rain Water Harvesting Potential along the Proposed Alignment	69
Table 31: Environmental and Social Management Plan Matrix	72
Table 32: Environmental and Social Monitoring Plan	97
Table 33: Cost of EMP Implementation* (INR in Million)	99

LIST OF FIGURES

Figure 1: Location of Project Components on Topo sheets Country (India) Map.....	18
Figure 2: Rail design showing the elastomeric and rail pads to control noise and vibration	22
Figure 3: Typical Dimensions of the Tunnel Section	23
Figure 4: Typical Cross Section of the Viaduct.....	23
Figure 5: Plan and Cross Section of Typical Station at various Levels	24
Figure 6: Kinematic Envelope on Tangent Track (Tunnel)	25
Figure 7: Typical 6 Car Composition Metro Train	25
Figure 8: Layout Plan of Depot.....	26
Figure 9: Location of Depot on Google-Earth Map.....	27
Figure 10: National Seismic Activity Map	31
Figure 11: Hydrogeological Map of Bangalore.....	32
Figure 12: Mean Monthly Wind Speed over the year in Bangalore (meters/ second).....	34
Figure 13: Wind Rose Plot for Bangalore.....	35
Figure 14: Status of Air Quality along the Proposed Alignment (2009)	36
Figure 15: Measured Noise Level along the Proposed Alignment (2009)	38
Figure 16: Measured Noise Level along the Proposed Alignment	38
Figure 17: Spatial Distribution of Proposed Land Use in Revised Master Plan of BMA - 2015.....	42
Figure 18: Grievance Redress Mechanism	65

EXECUTIVE SUMMARY

1. This Environmental Impact Assessment (EIA) has been prepared for the Gottigere-Nagavara Corridor (Line 6) of Bangalore Metro Rail Project Phase II in Karnataka State of India (the Project). The Bangalore Metro Rail Corporation Limited (BMRCL) is the executing agency of the project. The Phase I of Bangalore Metro Rail project has two corridors - an East-West corridor (18.10 km long) and a North-South corridor (24.20 km long). The commercial operations on Phase I corridors have been commenced. Phase II of the Bangalore Metro Rail Project has been sanctioned, which includes a total length of 74.236 km.
2. BMRCL has requested financing from EIB and AIIB for Gottigere-Nagavara Corridor (Reach 6). The proposed Gottigere-Nagavara alignment is one of the alignments of Phase II corridors. The alignment starts from Gottigere and ends at Nagavara covering 21.275 km consisting of both elevated and underground sections. The elevated stretch is 7.358 km, underground is 13.2 km which includes a ramp length of 717 m. The alignment has 6 elevated stations and 12 underground stations. A maintenance depot is to be constructed at Kothanur.
3. This EIA has been prepared to fulfill policy requirements of EIB. While EIB does not require Project categorization, for purposes of the environmental and social requirements of the co-financier, AIIB, the Project has been placed in environmental and social Category A under the provisions of AIIB's Environmental and Social Policy. This categorization is due to both the environmental risks and impacts and the magnitude of land acquisition and resettlement and rehabilitation (R&R) issues involved.
4. The project components are located in Bangalore City (Bengaluru district) of India. Bengaluru district is situated in the heart of the South-Deccan plateau in peninsular India to the South-Eastern corner of Karnataka State between the latitudinal parallels of 12°39'N and 13°18'N and longitudinal meridians of 77°22'E and 77°52'E at an average elevation of about 900 meters covering an area of about 2,196 sq.kms. of Karnataka State in Southern Part of India. Bangalore is the fifth largest metropolitan city and the third most populous city in the country.
5. During the earlier planning stages of the project, the feasibility of several metro corridors was considered by BMRCL based on traffic and engineering studies. The criteria for selecting the final alignment included traffic demand/ridership, accessibility and integration with existing public transport nodes, available right of way within major roads, ground conditions, capital and operating costs, availability of land for the depot and stations as well as minimum disturbance/avoidance of heritage structures. The selected alignment follows the central median of a major road artery in the south of the city whilst in the most densely populated central and northern area the alignment is underground. Station locations have been selected to maximize ridership and ease intermodal connections.
6. The main residual negative environmental impacts of the project include: (i) 2,70,712.07 square meters of will be acquired for the project; (ii) loss of 698 private structures affecting 838 households (iii) cutting down of about 1312 trees (1192 for alignment and 120 for depot); (iii) finite use of scarce, sometimes carbon intensive, materials, such as cement; (iv) noise, vibration and visual intrusion for properties adjacent to the alignment; and (v) generation of about 1.1 million cubic meter of waste material excavated from the tunneling work. All other negative impacts are temporary and localized. The project does not impact any nature conservation areas or urban parks or sites of historical / archeological importance.

7. The main mitigation measures proposed are as follows: (i) compensation for loss of land and properties to affected people as per The Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013 (ii) compensatory afforestation in line with local rules; (iii) various energy saving measures such as regenerative braking and use of solar panels; (iv) noise reduction measures (i.e. rubber dampers on the rails and parapet on both sides of viaduct acts as a part noise barrier); and (v) reuse of excavated material where feasible and disposal to construction waste in a regulated manner.

8. An Environmental and Social Management Plan (ESMP) with budgetary provisions has been prepared, as mentioned before. Potential settlement of buildings situated above the tunnels alignment will be monitored and adequate insurance cover put in place to compensate or address potential damage, if any.

9. The key positive environmental impacts of the project include (1) reduced private vehicle/ reduction in pollutants, noise and vibration due to traffic; road safety improvements; and a modest reduction in greenhouse gas emissions.

10. Local communities and stakeholders including women groups were involved in the process of environmental and social assessment through on-site discussions. Formal public consultations in the project areas were conducted during environmental and social studies and it will continue throughout the project cycle. As the project will not have any significant environmental and social impacts, local communities support the project. The grievance redress mechanism has been formulated which is consistent with EIB and AIIB requirements and the relevant national regulations.

11. The ESMP has been prepared in conjunction with BMRCLs SHE Manual and it will form part of the contract document of the contractor. Quarterly environmental and social monitoring reports will be submitted to EIB and AIIB and will be disclosed publicly at the EIB and AIIB websites.

A. INTRODUCTION

1. Background

12. This Environmental Impact Assessment (EIA) has been prepared for the Gottigere-Nagavara Corridor (Line 6) of Bangalore Metro Rail Project Phase II in Karnataka State of India (the Project). The Bangalore Metro Rail Corporation Limited (BMRCL) is the executing agency of the project. The Phase I of Bangalore Metro Rail project has two corridors - an East-West corridor (18.10 km long) and a North-South corridor (24.20 km long). The commercial operations on Phase I corridors have been commenced. Phase II of the Bangalore Metro Rail Project has been sanctioned, which includes a total length of 74.236 km (13.2 km underground) and 61 Stations, out of which 12 are Underground Stations. Following six corridors (lines) have been selected for implementation under Phase II.

- Extension of E-W line: Mysore Road Terminal to Kengeri
- Extension of E-W line: Baiyappanahalli to ITPL – Whitefield
- Extension of N-S line: Hesaraghatta Cross to BIEC
- Extension of N-S line: Puttenahalli Cross to Anjanapura Township (up to NICE Road)
- New Line – N –S: Gottigere to Nagavara (Line no. 6)
- New Line - E-W: R.V. Road to Bommasandra (Line no. 5)

13. BMRCL has requested financing from EIB and AIIB for Gottigere-Nagavara Corridor (Reach 6). The proposed Gottigere-Nagavara alignment is one of the alignments of Phase II corridors. The alignment starts from Gottigere and ends at Nagavara covering 21.275 km consisting of both elevated and underground sections. The elevated stretch is 7.358 km and underground is 13.2 km which includes a ramp length of 717 m. The alignment has 6 elevated stations and 12 underground stations.

14. The objective of the Metro Rail Project is to help to decongest the crowded road corridors and offer a more environment friendly mass transportation alternatives to the people of Bangalore.

2. Project Proponent

Project Name : Bangalore Metro Rail Project Phase II – Reach 6
Name of Proponent/s : Bangalore Metro Rail Corporation Limited (or BMRCL)
Address of Proponent : Third Floor, BMTC Complex, KH Road, Shanthinagar, Bangalore-560027, Karnataka, India

15. Bangalore Metro Rail Corporation Limited (BMRCL) is the executing and implementation agency for the Project. BMRCL is a joint venture of Government of India and Government of Karnataka is a Special Purpose Vehicle entrusted with the responsibility of implementation of Bangalore Metro Rail Project. Bangalore Metro, christened as "Namma Metro", not only adds to the beauty of Bangalore skyline, but immensely adds to the comfort level of travel. Besides this, Namma Metro is a major environment friendly addition to the Bangalore City as it significantly contributes to the reduction of carbon emissions.

3. EIA Preparation and Objectives of the EIA

16. This EIA has been prepared by BMRCL as part of detailed project report preparation for Bangalore Metro Rail Project Phase II in the year 2017. The Project is currently at investment stage, and although there are no major changes in the Project design and location are anticipated, this EIA may need updating following detailed surveys of alignment by the Contractor (prior to start of civil works).

17. This EIA has been prepared in accordance with environmental impact assessment requirements of Government of India. It complies with EIB's Statement of Environmental and Social Principles and Standards. It aims to ensure good environmental and social practices.

18. The specific objectives of this EIA are to:

- provide an environmental and social baseline description of the Project;
- identify and describe the potential environmental and social impacts of the Project;
- design mitigation measures to minimize adverse environmental and social impacts;
- describe the public consultation process and grievance redress mechanism; and
- provide an environmental and social management and monitoring plan for the project (including defining institutional responsibilities, capacity building and training, and the required budget).

4. Scope and Methodology of the EIA

19. The scope of this EIA is based on EIB's Statement of Environmental and Social Principles and Standards. Metro Rail projects are exempted by the Ministry of Environment, Forest and Climate Change (MoEFCC) from the requirements of the Environment (Protection) Act 1986. Therefore, environmental impact assessment for the metro rail projects is not required in India.

20. This EIA has been prepared to fulfill policy requirements of EIB. While EIB does not require Project categorization, for purposes of the environmental and social requirements of the co-financier, AIIB, the Project has been placed in environmental and social Category A under the provisions of AIIB's Environmental and Social Policy. This categorization is due to both the environmental risks and impacts and the magnitude of land acquisition and resettlement and rehabilitation (R&R) issues involved. The EIA includes an Environmental and Social Management Plan (ESMP) for project implementation and monitoring, consistent with the requirements of the AIIB.

21. The scope of this EIA is limited to the areas where project facilities will be installed i.e. alignment through which metro line will pass, and area where depot will be located. The purpose of this EIA is to assess potential environmental, health, safety and social risks and impacts of the proposed intervention in Bangalore city of India and propose suitable mitigation measures where required.

22. This EIA consists of Project description and assessment sections. The EIA followed a number of steps:

- Review of available baseline reports, and technical reports/studies related to proposed Project;
- Conduct field visits to collect primary or secondary data relevant to the Project areas to establish the baseline environmental and social condition;
- Assess the potential impacts on environmental and social attributes due to the location, design, installation and operation of the Project through field investigations and data analysis;

- Explore opportunities for environmental and social enhancement and identify measures;
- Prepare an environment and social management plan (ESMP) outlining the measures for mitigating the impacts identified including the institutional arrangements;
- Identify critical environmental and social parameters required to be monitored subsequent to the implementation of the Project and prepare an environmental and social monitoring plan;
- Carry out consultation with key stakeholders and administrative authorities to identify their perception on the Project, introduce project components and anticipated impacts; and,
- Disclose the draft EIA at BMRCL, EIB and AIIB websites and prepare Project brief and/or FAQs in local language to be made publicly available at the offices of BMRCL.

23. This EIA study has been conducted based on review of preliminary EIA conducted as part of feasibility study, EIA of Bangalore Metro Phase 1 project, primary data collected from site visits (including consultations) and secondary information collected from various sources. During site visit the specialists has conducted consultations with key stakeholders and local executive powers for their opinions on the Project. Formal public consultations at key locations along the proposed alignment of the metro line have also been conducted. The results of the consultations as well as an evaluation of the institutional framework have been incorporated into this assessment.

5. Structure of the EIA

24. In line with the EIB's Statement of Environmental and Social Principles and Standards (2009), this EIA Report has been organized into sections which covers (i) project description; (ii) description of the baseline environment; and (iii) impact assessment and mitigation measures. The EIA report has following contents:

- Executive Summary
- Introduction
- Policy, Legal, and Administrative Framework
- Description of the Project
- Description of the Environment and Social Baseline
- Impact Assessment and Mitigation Measures
- Analysis of Alternatives
- Consultations, Participation and Information Disclosure
- Grievance Redress Mechanism
- Environmental and Social Management Plan, and
- Conclusion and Recommendation.

B. POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK

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

26. Environmental assessment of the Project has been carried out in accordance with Government's legislations and requirements. It also complies with EIB requirements. The laws, regulations, policies and guidelines applicable to this project based on the location, design, construction and operation are summarized in the subsequent sections in following order.

- National (India) Environmental Legislation and Legal Administrative Framework,
- EIB environmental and social policies, and
- Summary of international treaties and applicability to the project.

1. The National (India) Environmental Laws and Regulations

27. The Government of India's Environmental Legal Framework comprises a set of comprehensive acts and regulations aimed at conserving various components of the biological and physical environment including environmental assessment procedures and requirements for public consultation. The policies and requirements which are most relevant in the context of this project are provided in Table 1 below.

Table 1: Summary of Relevant Environmental Legislation

Act	Objective	Responsible Institution
Environment (Protection) Act (1986) and Rules (1986)	To protect and improve the overall environment	MoEFCC
Environmental Impact Assessment (EIA) Notification under Environmental Protection Rules (2006, 2009, 2011) and relevant Office Memorandums (OM)	To provide guidance on environmental clearance requirements and clarification on related specific technical issues	MoEFCC
The Wildlife Protection Act (1972 and amended in 1993)	To protect wild animals and birds through the creation of National Parks and Sanctuaries	MoEFCC
The Water (Prevention and Control of Pollution) Act 1972 (Amended 1988) and Rules 1974	To provide for the prevention and control of water pollution and the maintaining or restoring of wholesomeness of water.	CPCB
The Air (Prevention and Control of Pollution) Act, 1981 (Amended 1987) and Rules 1982	To provide for the prevention, control and abatement of air pollution, and for the establishment of Boards to carry out these purposes.	CPCB and Road Authorities

Act	Objective	Responsible Institution
Municipal Solid Waste (MSW) Rules, 2000	Provisions for collection, storage segregation, transportation, processing and disposal of municipal solid wastes.	State Pollution Control Board
Hazardous Waste (Management, Handling and Trans-boundary Movement) Rules 2008 (Amended 2009),	To protection the general public against improper handling, storage and disposal of hazardous wastes	State Pollution Control Board
The Forest (Conservation) Act 1980 (Amended 1988) and Rules 1981 (Amended 2003)	To protect and manage forests	MoEFCC
Central Motor Vehicle Act (1988) and Rules (1988)	To control vehicular air and noise pollution. To regulate development of the transport sector, check and control vehicular air and noise pollution.	State Transport Department
Ancient Monuments and Archaeological Sites and Remains Act (1958)	Conservation of Cultural and historical remains found in India.	Archaeological Dept. GOI
The Karnataka Ancient and Historical Monuments and Archaeological Sites and Remains Act, 1961	To provide for the preservation of ancient and historical monuments and Archeological sites and remains and for the protection of sculptures, carvings and other like objects in the State of Karnataka	Archaeological Dept. GOK
Building and Other construction workers (Regulation and the Employment and conditions of service) Act, 1996	To regulate the employment and conditions of service of building and other construction workers and to provide for their safety, health and welfare measures	Ministry of Labour and Employment
Child labour (Prohibition and Regulation) Act, 1986	To regulate the employment of children including age limits, type of employment, timing of work, information disclosure and health and safety.	Ministry of Labour and Employment
The Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013	The act states that the basic compensation for the Project Affected Persons (PAPs) should be provided according to the market value of the land as at the date of its acquisition. It also entitles PAPs to a hearing before acquisition.	Ministry of Rural Development / Department of Land Resources
The Karnataka Industrial Areas Development Act, 1966	Enacted for the establishment of industrial areas in the State and generally to promote the establishment and orderly development of industries therein	Department of Industry, GoK
Karnataka Municipal Corporations	To protect the public places and	Bangalore

Act	Objective	Responsible Institution
Act, 1976	people from developing projects. Section 288 discusses regarding power to allow certain projections and erections	Municipal Corporation, GoK
Karnataka Preservation of Trees Act, 1976	To provide preservation of trees in the state by regulating the felling of trees and for the planting of adequate number of trees to restore ecological balance	Forest Department, GoK
Karnataka Parks, Play-fields and Open Spaces (Preservation and Regulation) Act, 1985	To provide Preservation and regulation of parks, play-fields and open spaces.	Government of Karnataka

1.1 Relevant Policies

- National Conservation Strategy and Policy Statement on Environment and Development of 1992
- National Environment Policy of 2006
- Policy Statement for Abatement of Pollution of 1992
- National Forest Policy of 1998
- National Policy of Resettlement and Rehabilitation (R&R) of 2007

1.2 Required Clearances/Permissions

28. For Implementation of Metro Rail Project in India, required clearances/ permissions related to environment, social and forests have been summarized in Table 2.

Table 2: Applicable Permits and Clearances Required for the Project

S. No.	Permissions/ Clearances	Acts/ Rules/ Notifications/Guidelines	Concerned Agency	Responsibility
A. Pre-construction Stage				
1	Permission for cutting of trees	Forest Conservation Act (1980) Procedural Guidelines developed by the Department of Forest and Environment, Government of Karnataka. under the orders of the Honorable High Court Tree removal will be guided as per state government rules.	District Forest Office/ State Forest Department for trees felling in forest areas and District Authorities in non-forests Areas.	BMRCL
B. Construction Stage				
2	Consent to operate hot mix plant, Crushers, Batching plant	Air (Prevention and Control Pollution) Act of 1981	Karnataka State Pollution Control Board (To be obtained before installation)	Contractor
3	Authorization for	Hazardous Waste	Karnataka State	Contractor

	disposal of hazardous waste	(Management and Handling) Rules 1989	Pollution Control Board (To be obtained before generation)	
4	Consent for Disposal of sewage from labor camps	Water (Prevention and Control of Pollution) Act 1974	Karnataka State Pollution Control Board (Before setting up the camp)	Contractor
5	Pollution Under Control Certificate	Central Motor and Vehicle Act 1988	Department of Transport, Government of Karnataka authorized testing centers	Contractor
6	Employing Labour/Workers	The Building and Other Construction Workers (Regulation and Employment Conditions of Service) Act, 1996	District Labour Commissioner	Contractor

29. Before the start of civil works for the any section of the subproject road the project proponent (BMRCL) must obtain necessary clearances / permits from statutory authorities.

1.3 Institutional Administrative Framework

30. The administrative framework in India for implementation and monitoring of Metro Rail Projects involves following agencies.

31. **Ministry of Environment, Forests and Climate Change (MoEFCC):** MoEFCC is apex body in India responsible protection and enforcement of laws and regulations. In view of the growing importance of environmental affairs, the Government of India set up a Department in November 1980 under the portfolio of the Prime Minister. The Department, later renamed as the MoEFCC plays a vital role in environmental management for sustained development and for all environmental matters in the country.

32. The major responsibilities of MoEFCC includes - Environmental resource conservation and protection, Environmental Impact Assessment of developmental projects, Co-ordination with the other ministries and agencies, voluntary organizations and professional bodies on environmental action plans, Policy-planning, Promotion of research and development, manpower planning and training and creation of environmental awareness; Liaison and coordination with international agencies involved in environmental matters.

33. Developmental project proponents are also required to submit Environmental Impact Statements/Assessments to establish that preventive measures are planned by installing adequate pollution control and monitoring equipment, and that effluent discharged into the environment will not exceed permissible levels. The MoEFCC appraises these statements/assessments and approves the project from the environmental angle. The respective State Pollution Control Board is to give a No Objection Certificate (NOC) before the EIA exercise is undertaken.

34. **Karnataka State Pollution Control Board (KSPCB):** The KSPCB was constituted in the year 1974 under the provision of Water (Prevention and Control of Pollution) Act, 1974. Subsequently the Water (Prevention and Control of Pollution) Cess Act, 1977, Air (Prevention and Control of Pollution) Act, 1981 and Environmental Protection Act, 1986 in addition to Rules framed under these Acts were also entrusted to the State Board. The prime objective of all these Acts is maintaining, restoring and preserving the wholesomeness of quality of environment and prevention of hazards to human beings and terrestrial flora and fauna.

35. The Board has its Central Office at Bangalore. The enforcement of the above stated Acts and Rules are being implemented through thirty three Regional Offices. The Central Office of the Board is responsible for making general policies relating to enforcement of the above said Acts and Rules and it also carries out general administration and co-ordination with other agencies. The Central Laboratory of the Board is well - equipped and can take up analysis of water, waste water, stack emission samples, ambient air samples, bio-assay tests, bacteriological analysis, etc.

36. **Central Ground Water Board:** The CGWB is responsible for the development, dissemination of technologies, and monitoring of India's groundwater resources, including their exploration, assessment, conservation, augmentation, protection from pollution and distribution. The CGWB, under the Ministry of Water Resources, was established in 1970. Various activities related to regulation and control of ground water development in the country is the responsibility of the Central Ground Water Authority (CGWA) specifically constituted under the Environmental (Protection) Act, 1986. The CGWA has identified over exploited-areas across India where groundwater withdrawal are regulated. To date, 43 critical/overexploited notified areas have been identified in 10 states. Construction of new ground water structures is prohibited in the notified areas while permission of drilling tube wells is being granted only to the government agencies responsible for drinking water supply.

37. **Bangalore Metro Rail Corporation Ltd. (BMRCL):** Incorporated in the year 1994, BMRCL was formed as a 50:50 joint venture of Government of India and Government of Karnataka in the year 2005, as a Special Purpose Vehicle entrusted with the responsibility of implementation of Bangalore Metro Rail Project. During the implementation of Phase 1 of the Bangalore Metro Rail Project, the BMRCL had no formal environmental and social safeguard unit and environmental and social concerns were handled on an ad-hoc basis internally. However, it was agreed that a separate safeguard cell will be appointed for manage social and environment.

2. EIB Environmental and Social Policies

38. The EIB finances projects to achieve a number of priority EU policy objectives. In this work it is guided by a series of standards as outlined in the Statement of Environmental and Social Principles and Standards (2009). The manner in which these are applied by EIB in its daily project work is described in the Environmental and Social Practices Handbook (2013).

2.1 *Environmental and Social Principles and Standards*

39. As a priority, EIB funds projects that support sustainable development through the protection and improvement of the natural environment, and the promotion of sustainable communities. The objectives of the Treaty of the European Union underpin the EIB standards and its general approach, i.e. regarding “preservation of the environment, protection of human health, rational utilization of natural resources and promotion of measures at international level”. In particular climate change, biodiversity and ecosystem considerations are integrated into the lending policies and practices of the Bank. This reflects EIB’s contribution to the UN Framework Convention on Climate Change, the UN Convention Biological Diversity (CBD) and the UN Millennium Development Goals (MDG).

40. To qualify for EIB funding a project should promote one or more of the following EU policy objectives:

- Provide an appropriate response to the threat of climate change
- Contribute to sustainable natural resource management
- Improve urban quality of life
- Safeguard human health by enhancing the natural and build environments

41. While all projects should give an overall positive contribution to sustainable development in order to be considered for funding, EIB still requires that projects comply with the

environmental and social requirements of the Bank. The Bank pays particular attention to the rights of disadvantaged groups and the impacts that a project might have on people in the workplace and in the local community. The principles and standards are derived from European Union policy and law and in addition to the EU Treaty include:

- The fundamental human rights referred to in the EU Charter
- Relevant EU environmental and social legislation
- Internationally recognized good environmental and social practices from a number of sources
- A set of social standards equivalent to the common requirements of the Multilateral Financial Institutions (MFIs)

42. The principles and standards guide all projects financed by EIB. Within the EU, projects shall comply with EU law unless EIB considers higher standards are appropriate. In the rest of the world, the legal principles and standards of the EU are used as the benchmark, though with the possibility of derogation if deemed justifiable.

43. EIB does not finance projects that do not comply with appropriate national environmental and social legislation in force at the time. In the Statement, the promoter is made responsible for the application and enforcement of the EIB requirements including compliance with relevant laws and other obligations placed on the promoter by the Bank which are typically reflected in legal undertakings.

44. The following principles underlie EIB's approach to managing the environmental and social issues of projects:

- Integration – principle that environmental considerations be merged into all EIB work.
- High level of environmental protection – principles of applying a precautionary approach, taking preventive action rather than damage control, environmental damaged to be rectified at source and the polluter should pay.
- Rights based approach to considering the social aspects of a project, by following the Charter of Fundamental Rights of the European Union, and the UN Universal Declaration on Human Rights.

45. The environmental and social performance standards ensure compliance with Bank requirements and include:

- Emission standards: projects should include measures to prevent, reduce or eliminate pollution that arises directly or indirectly from their activities.
- Ambient standards: projects are required to ensure that they meet the relevant ambient standards, including national standards.
- Procedural standards: e.g. projects for which the EIB requires an EIA, the process and content must be consistent with the requirements of the EU Directive.
- Human rights: financing restricted to projects that respect human rights as defined by Charter of the Fundamental Rights of the European Union and international good practices.
- Involuntary resettlement: people whose livelihoods are negatively affected by a project should have their livelihoods improved or at a minimum restored, and losses should be compensated for. Management of resettlement includes need for an Action Plan and culturally appropriate consultation of affected communities.
- Indigenous people and other vulnerable groups: covers indigenous groups, ethnic minorities, women, migrants, the very young and the very old. The promoter should pay special attention to these groups when affected by the project.
- ILO core labour standards: core labour standards are to be adhered to/reached during the project implementation.
- Occupational and community health and safety: seeks to avoid and minimize risks and impacts to the health and safety of workers and communities.
- Cultural heritage: respecting cultural heritage and not financing projects that threaten

the integrity of sites that have a high level of protection for reasons of cultural heritage, e.g. UNESCO World Heritage sites.

- Consultation, participation and public disclosure: based on the Aarhus Regulation promoting transparency of environmental information and the inclusion of stakeholders in projects through consultation in order to identify and manage public concern at an early stage. Includes provisions for the public disclosure of key project information such as the Non-Technical Summary and the ESIA.
- Biological diversity: reducing the biodiversity impacts of projects in line with core international conventions such as HELCOM, OSPAR and Ramsar.
- Climate change: seeks to reduce contributions to climate change through energy efficiency measures, clean technology and promoting projects that lead to reductions in carbon emissions.

2.2 Environmental and Social Practices Handbook

46. The Environmental and Social Practices Handbook (the Handbook) translates the environmental and social principles and standards described in the statement into the operational policies followed by EIB staff. It explains how Bank staff conducts routine work on environmental and social matters through the project cycle.

Pre-appraisal stage

- Identification of environmental and social issues
- Screening according to different loan types
- Categorization of project according to severity of environmental and social impact
- Identification of the legal requirements for project compliances
- Assessment of the project's climate change implications
- Sharing of environmental information for the opinion of DG Environment
- Publication on project website

Appraisal stage

- Environmental and social assessment
- Assessment of EIA process
- Assessment of biodiversity and natural resource management
- Climate change
- Appraisal of social issues including Resettlement Framework and Resettlement Action Plan
- Appraisal of the environmental and social capacity of the promoter
- Public consultation
- Disclosure of information and documents
- Final environmental and social impact rating
- Identification of monitoring requirements

Monitoring stage

- Follow-up during implementation and during operation

47. The Handbook also includes a range of Guidance Notes for use in the assessment of social impacts of a project covering:

- Involuntary resettlement
- Rights and interests of vulnerable groups
- Labour standards
- Occupational and community health and safety

48. Since the project is located outside EU Zone, Environmental Assessment is not required as per EIB policy requirements.

3. International and Regional Agreements and Conventions

49. India is a party and signatory to several international and regional environmental agreements to which the MoEFCC is the National Focal Point. Key international agreements that India is signatory to and relevant for the project are provided below:

- i. Convention Relative to the conservation of Flora and Fauna in their Natural State(1933)
- ii. International Plan Protection Convention (1951)
- iii. Convention on Wetlands of International Importance, Especially as Waterfowl Habitat (Ramsar,1971)
- iv. Convention concerning the Protection of the World Cultural and Natural Heritage (Paris, 1972)
- v. Convention in International Trade in Endangered Species of Wild Fauna and Flora (Washington, 1973)
- vi. Convention on Migratory Species of Wild Animals (Bonn, 1979)
- vii. Convention on the Prior Informed Procedure for Certain Hazardous Chemicals and Pesticides in International Trade (PIC or Rotterdam, 1990)
- viii. United Nations Framework Convention on Climate Change (Rio De Janeiro,1992)
- ix. Convention on Biological Diversity (Rio De Janeiro, 1992)
- x. Protocol to the United Nations Convention on Climate Change (Kyoto, 1997)

50. The interventions proposed under the Project shall be implemented in compliance with applicable international/regional conventions and declarations to which India is a party.

C. PROJECT DESCRIPTION

1. Project Rational and Objectives

51. Mass Rapid Transport System (MRTS) is an elevated/underground suburban railway system which facilitates large commuters to travel any part of the city within short duration. The large capacities of such systems make them potentially more efficient in terms of cost and comfort journey than any other automobile transportation. In addition, it helps to decongest the crowded road corridors and offers a more environment friendly mass transportation alternatives.

52. Bangalore Metro Rail Corporation Limited (BMRCL), a joint venture of Government of India and Government of Karnataka is a Special Purpose Vehicle entrusted with the responsibility of implementation of Bangalore Metro Rail Project.

53. The Phase I of Bangalore Metro Rail project has two corridors - an East-West corridor - 18.10 km long, starting from Baiyappanahalli in the East and terminating at Mysore Road terminal in the West and a 24.20 km North-South corridor commencing at Nagasandra in the North and terminating at Puttenahalli in the South. The commercial operations on Reach-1 (MG Road to Baiyappanahalli station) have commenced on 20th October 2011. The commercial operations on Reach-3 and Reach 3A (Peenya Industry to Mantri Square Sampige Road Station) have commenced on 1st March 2014. The commercial operations on Reach-3B (Peenya Industry to Nagasandra) have commenced on 1st May 2015 and the commercial operations on Reach-2 (Magadi Road to Mysore Road Terminal) have commenced on 18th November 2015. The commercial operation of Reach 4 and 4A including UG-1 section (Mantri Square Sampige Road to Puttenahalli) have commenced on 18th June, 2017.

54. To meet the growing transport demand of Bangalore city, the government has decided to implement Phase II of metro rail system with the total length of 74.236 km (13.2 km underground) and 61 Stations, out of which 12 are Underground Stations. For the Phase II of Bangalore Metro, following six corridors has been considered:

- i. Extension of E-W line: Mysore Road Terminal to Kengeri
- ii. Extension of E-W line: Baiyappanahalli to ITPL – Whitefield
- iii. Extension of N-S line: Hesaraghatta Cross to BIEC
- iv. Extension of N-S line: Puttenahalli Cross to Anjanapura Township (up to NICE Road)
- v. New Line – N –S: Gottigere to Nagavara (Line no. 6)
- vi. New Line - E-W: R.V. Road to Bommasandra (Line no. 5)

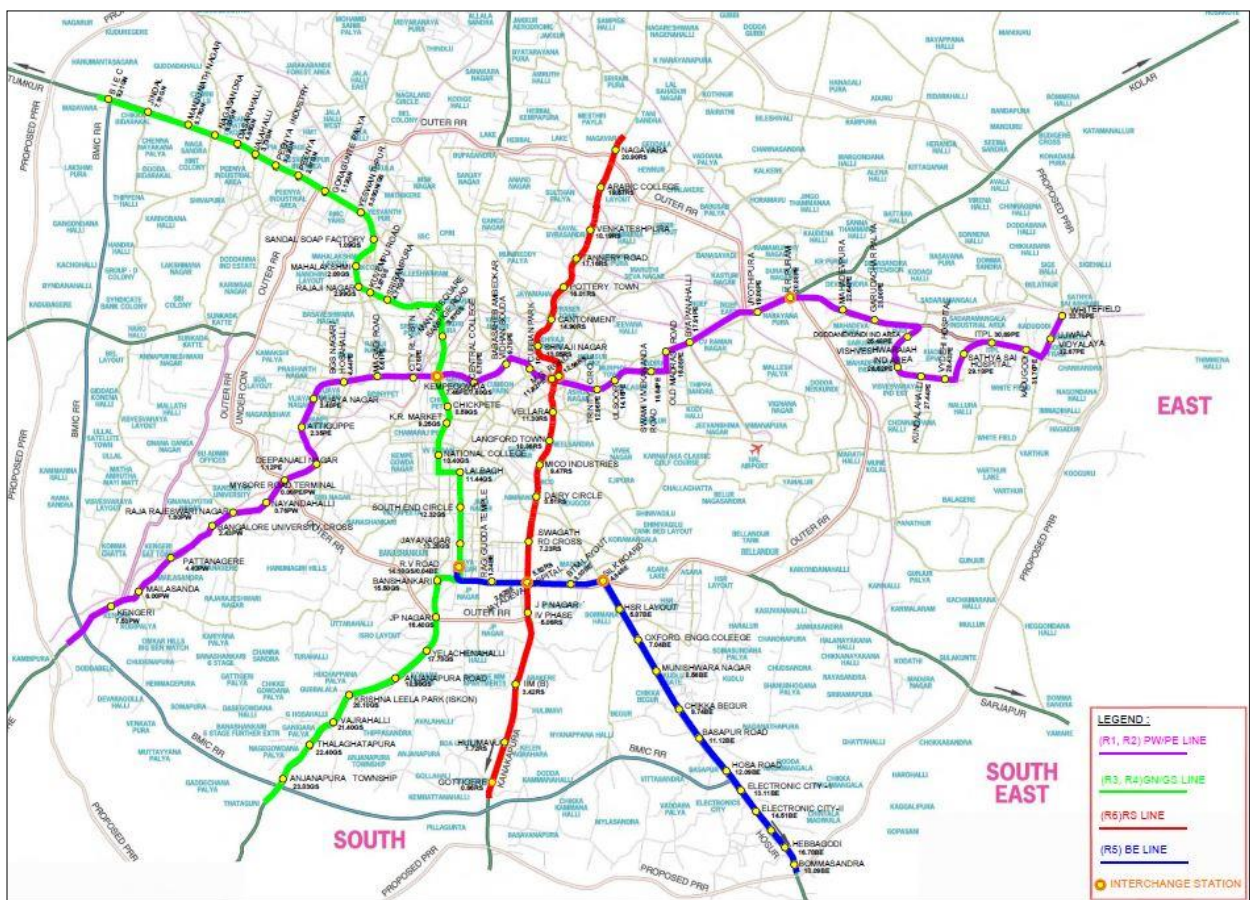
55. The proposed alignment is one of the alignments of Phase II corridors. The alignment starts from Gottigere and ends at Nagavara covering 21.275 km consisting of both elevated and underground sections. The elevated stretch is 7.385 km and underground is 13.2 km which includes a ramp length of 717 m. The alignment has 6 elevated stations and 12 underground stations.

56. The aims of a metro project are to: (i) mitigate climate change and pollution (air and noise) by providing more environmentally sustainable transport means, (ii) contribute to the economic growth by reducing urban congestion and thus increasing labour productivity and (iii) improve the livelihood of socially disadvantaged population by enhancing their mobility and thus their access to education, jobs and other services.

2. Location of Project Components

57. The project components are located in Bangalore City (Bengaluru district) of India. Bengaluru district is situated in the heart of the South-Deccan plateau in peninsular India to the South-Eastern corner of Karnataka State between the latitudinal parallels of 12°39'N and 13°18'N and longitudinal meridians of 77°22'E and 77°52'E at an average elevation of about 900 meters covering an area of about 2,196sq.kms. of Karnataka State in Southern Part of India. Bangalore is the fifth largest metropolitan city and the third most populous city in the country. As per the 2001 census, total population of Bangalore was 5.6 million. With the formation of 'Greater Bangalore' in 2007, the city's population has become 8.4 million in the Census of 2011. Bangalore City is one of the most cosmopolitan and commercially advanced cities in the country. Figure 1 show the location map of the project.

Figure 1: Location of Project Components on Topo sheets Country (India) Map



3. Details of the Project Components

58. The salient features of the proposed Bangalore Metro Rail Project Phase II (reach 6) are summarized in subsequent sections.

3.1 Alignment and Stations

59. The proposed route is 21.275 km starting from Gottigere on Bannerghatta Road to Nagavara on Thanisandra road. The initial alignment from Gottigere to Swagath Road Cross (Short of Dairy Circle) is elevated with 6 stations and from Dairy Circle to the end i.e. Nagavara is underground with 12 stations. The alignment runs initially on Bannerghatta Road connecting many populated areas such as Gottigere, Hulimavu, IIMB, J P Nagar IV Phase, Jayadeva Hospital, Swagath Road Cross, Dairy circle, MICO Industries. It then joins and runs below the Hosur road

via Langford Town, Vellara; then traverses below Brigade Road, the commercial hub; then crosses below Bangalore Metro Phase-I elevated E-W line and reaches Kamraj Road where the M G Road underground station of this line is situated which is integrated with the elevated M G Road station of Phase-I. After this, the underground alignment passes by the side of busy Shivaji Nagar Bus-stand where the Shivaji Nagar underground station of this line is located. After this, the alignment traverses below the built up area by the side of the Shivaji road and takes a turn towards right. There after it cuts across HKP road, Cock Burn Road and AM Road and reaches Cantonment Metro Station at Bambo Bazar BBMP field. From here, the alignment crosses Miller Road and takes turn towards left to pass below SWR line and reach Pottery Town open ground area. Here the Pottery Town underground Station is planned. From here the underground alignment turns left to reach below the Tannery road and continues almost below the Tannery road and crosses the Salem Railway line and then Outer Ring Road (ORR) to reach the last Station of this line namely Nagavara, which is located immediately after the crossing of the ORR. The route length is 21.275 km (up to dead end) and there are 18 (06 Elevated + 12 Underground) Stations in this 2nd N-S line of Phase-II.

60. The salient features of the proposed corridor alignment are given in Table 3 and detailed are stations are given in Table 4.

Table 3: Salient features of Gottigere - Nagavara Corridor (Reach 6)

Salient Features	Details of Gottigere to Nagavara Corridor
Length of the alignment	21.275 Km
Nature of alignment	Elevated – 7.385 km Underground – 13.2 km
Number of stations	06 (Elevated) 12 (Underground)
Project implementation	
- Start Date	2017
- Completion Date	2021
Train capacity	2004 passenger/trip (6 coach)
Frequency	1 train for every 4 minutes (Peak hours)
Connecting Areas	Gottigere, Hulimaavu, IIMB, JP Nagar, Jaynagar, Wilson garden, Richmond Town, MG Road, Shivajinagar, Benson Town, Pulikeshnagar, Govindapura and Nagavara
Industry/Companies along the proposed alignment	Intech Telecom Systems, Adobe system Pvt Ltd, Oracle, Dharmaram College, Bangalore Dairy, Accenture
Educational Institutions along the proposed alignment	IIMB, PSBB Learning Leadership Academy, Govt Institute of Training, Dharmaram College, Baldwin Boys School, Sacred Heart/Good Shepherd School, St. Joseph Educational Institution, Hafiziya High School, Niswan Urdu School, Quwahtul Islam School, Gem High School, Government urdu school, Arabic College
Hospitals along the proposed alignment	Wockhard Hospital, Apollo Hospital, Jayadeva Hospital, Government Hospital, Bowring and Lady Curzon Hospital
Flyover along the alignment	Jayadeva Flyover, Dairy Circle Flyover, Phase I Metro viaduct, ORR Flyover at Nagavara

Salient Features	Details of Gottigere to Nagavara Corridor
Major road approach to the alignment	Marenahalli Road, Mari Gowda Road, Gen Thimmaiah Road, MG Road, Millar Road, Saint John Church Road, Arabic College Road and ORR.

Table 4: Stations in Gottigere - Nagavara Corridor

SN	Station Name	Chainage (m)	Type
1	Gottigere	662	Elevated
2	Hulimavu	1722	Elevated
3	Indian Institute of Management(IIM –B)	3423	Elevated
4	J P Nagar - IV Phase	5055	Elevated
5	Jayadeva Hospital	5823	Elevated
6	Swagath Road Cross	7233	Elevated
7	Dairy Circle	8511	Underground
8	MICO Industries	9466	Underground
9	Langford Town	10364	Underground
10	Vellara	11299	Underground
11	M G Road	12558	Underground
12	Shivajinagar	13845	Underground
13	Cantonment	14897	Underground
14	Pottery Town	16012	Underground
15	Tannery Road	17163	Underground
16	Venkateshapura	18191	Underground
17	Arabic College	19569	Underground
18	Nagavara	20902	Underground
	End of Ramp Chainage	21433	

3.2 Ridership

Table 5: Traffic Forecast for Gottigere – Nagavara Corridor

Year	Peak Hour Sectional loading	Number of passengers (Lakhs/day)	Passenger KM (Lakhs)	Mean trip length (km)
2021	16,381	4.03	38.20	9.50
2031	22,806	5.58	52.69	9.50
2041	25,315	6.19	58.81	9.50

3.3 Rolling Stock, Traction and Signalling

- 2.88 m wide modern rolling stock with stainless steel body Standard Gauge.
- Axle load - 15 t
- Seating arrangement - Longitudinal
- Capacity of 6 Coach unit - 1574 Passengers (with 6 Pas/Sqm)
- Class of accommodation – One

3.4 Passenger Carrying Capacity

61. In order to maximize the passenger carrying capacity, longitudinal seating arrangement shall be adopted. The whole train shall be vestibule to distribute the passenger evenly in all the coaches. Criteria for the calculation of standing passengers are 4 persons per square meter of standing floor area in normal state (AW2 load) and crush load 6 persons standee per sq meter (AW3 load) and exceptional dense crush load of 8 persons/sq meter (AW4 load).
62. Therefore, for the Rail Vehicles with 2.88 m maximum width and longitudinal seat arrangement, conceptually the crush capacity (AW3 load) of 43 seated, 204 standing thus a total of 247 passengers for a Driving Motor car and 50 seated, 220 standing thus a total of 270 for a trailer/Motor car is envisaged. In the exceptional dense crush capacity (AW4 load), 43 seated, 273 standing thus a total of 316 passengers for a Driving Motor Car, and 50 seated, 293 standing thus a total of 343 for a trailer and motor car is envisaged.
63. Following train composition is adopted:
6-car Train: *DMC–TC–MC+MC–TC–DMC*
64. 6-Car trainset composition has been adopted for all the lines of Phase-II.
65. Table 6 and 7 shows the carrying capacity of the individual cars and 6-Car train set with standing passenger @ 4 passenger per sq meter of standee area (normal load), with standing passenger @ 6 passenger per sq meter of standee area (Crush load) and @ 8 passenger per sq meter of standee area (Dense crush load) respectively.

The seating and Standee capacity of DMC, MC and TC in the unit of “*DMC–TC–MC+MC–TC–DMC*” with external sliding door are given as under Table 6 & Table-7:-

Table 6: Carrying Capacity of Mass Rail Vehicles (Crush@6 P/sqm of standee area)

	Driving Motor car		Trailer car / Motor car		6 Car Train	
	Normal	Crush	Normal	Crush	Normal	Crush
Seated	43	43	50	50	286	286
Standing	137	204	147	220	862	1288
Total	180	247	197	270	1148	1574

NORMAL (AW2) -4 P/sqm of standee area; CRUSH (AW3) -6 P/sqm of standee area

Table 7: Carrying Capacity of Mass Rail Vehicles (Exceptional dense Crush @8 P/sqm of standee area)

	Driving Motor car		Trailer car / Motor car		6 Car Train	
	Normal	Crush	Normal	Crush	Normal	Crush
Seated	43	43	50	50	286	286
Standing	137	273	147	293	862	1718
Total	180	316	197	343	1148	2004

NORMAL (AW2) – Seating + 4 P/sqm of standee area; EXCEPTIONAL DENSE CRUSH (AW4) -Seating + 8 P/sqm of standee area

3.5 Maintenance depot

66. The Maintenance depot for the corridor is proposed at Kothanur.

3.6 Traction Power Supply

Table 8: Traction Power Supply

Particulars	Gottigere- Nagavara Corridor
Traction system voltage	750 V DC
Current Collection	Third Rail Bottom Collection
Received Power Sub Station	Kothanur & Nagavara
Power Supply Source	220 / 66 KV AC
No. of Receiving Sub Stations	2
No. of Traction Sub Stations	18 (including Depot)
SCADA system	Provided

4. Construction Methodology

- ◆ Elevated viaduct consisting of prestressed concrete Box shaped Girders on Single pier/Portal with pile/Open foundations.
- ◆ Underground by tunneling by TBM/NATM, Stations by Cut & Cover.

67. Figure 2 to Figure 9 shows the plans and cross sections of various project facilities and components.

Figure 2: Rail design showing the elastomeric and rail pads to control noise and vibration

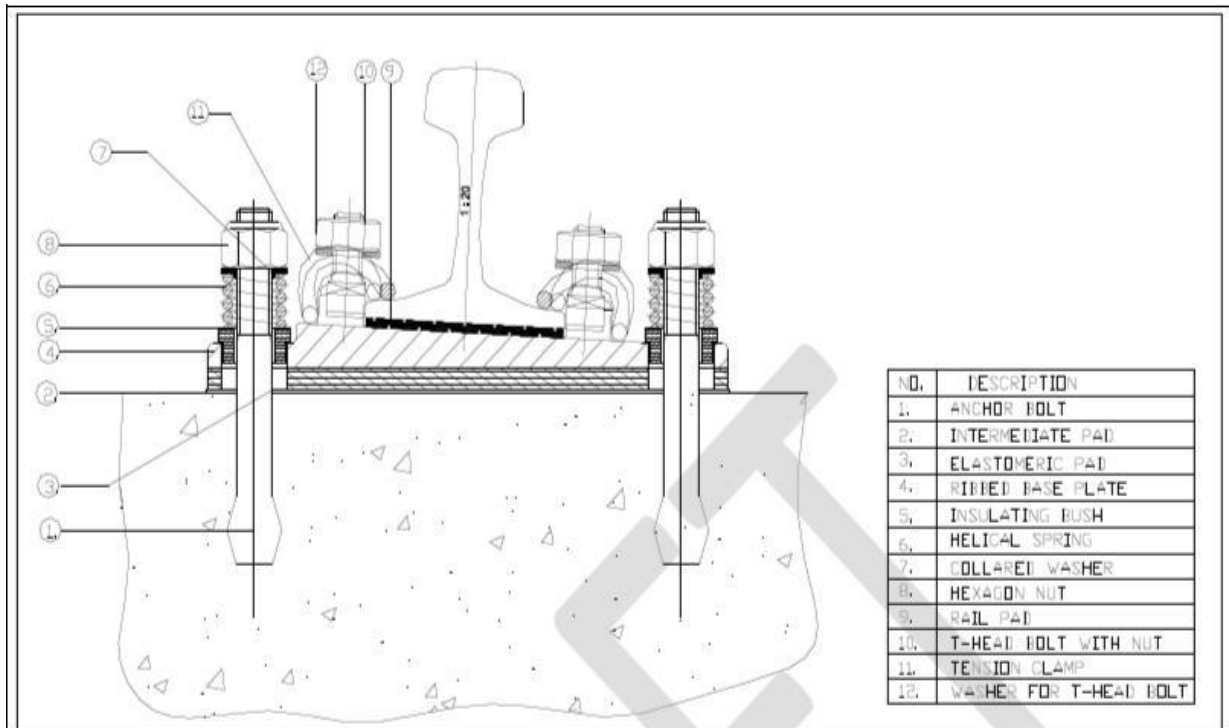


Figure 3: Typical Dimensions of Cut and Cover Tunnel Section



Figure 4: Typical Cross Section of the Viaduct

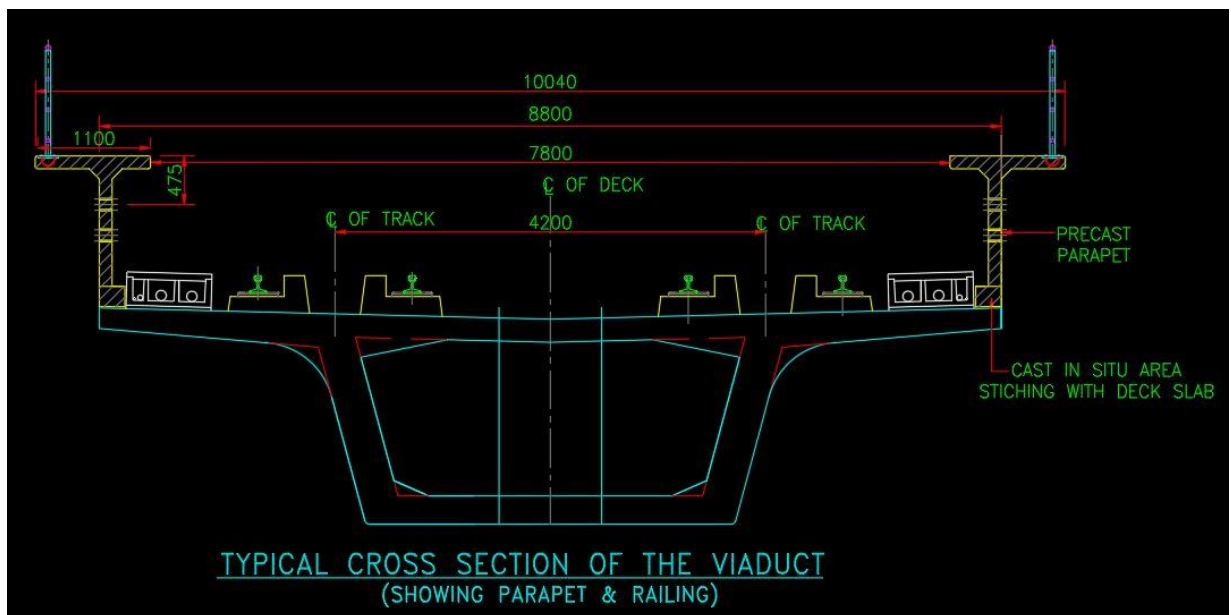


Figure 5: Plan and Cross Section of Typical Station at various Levels

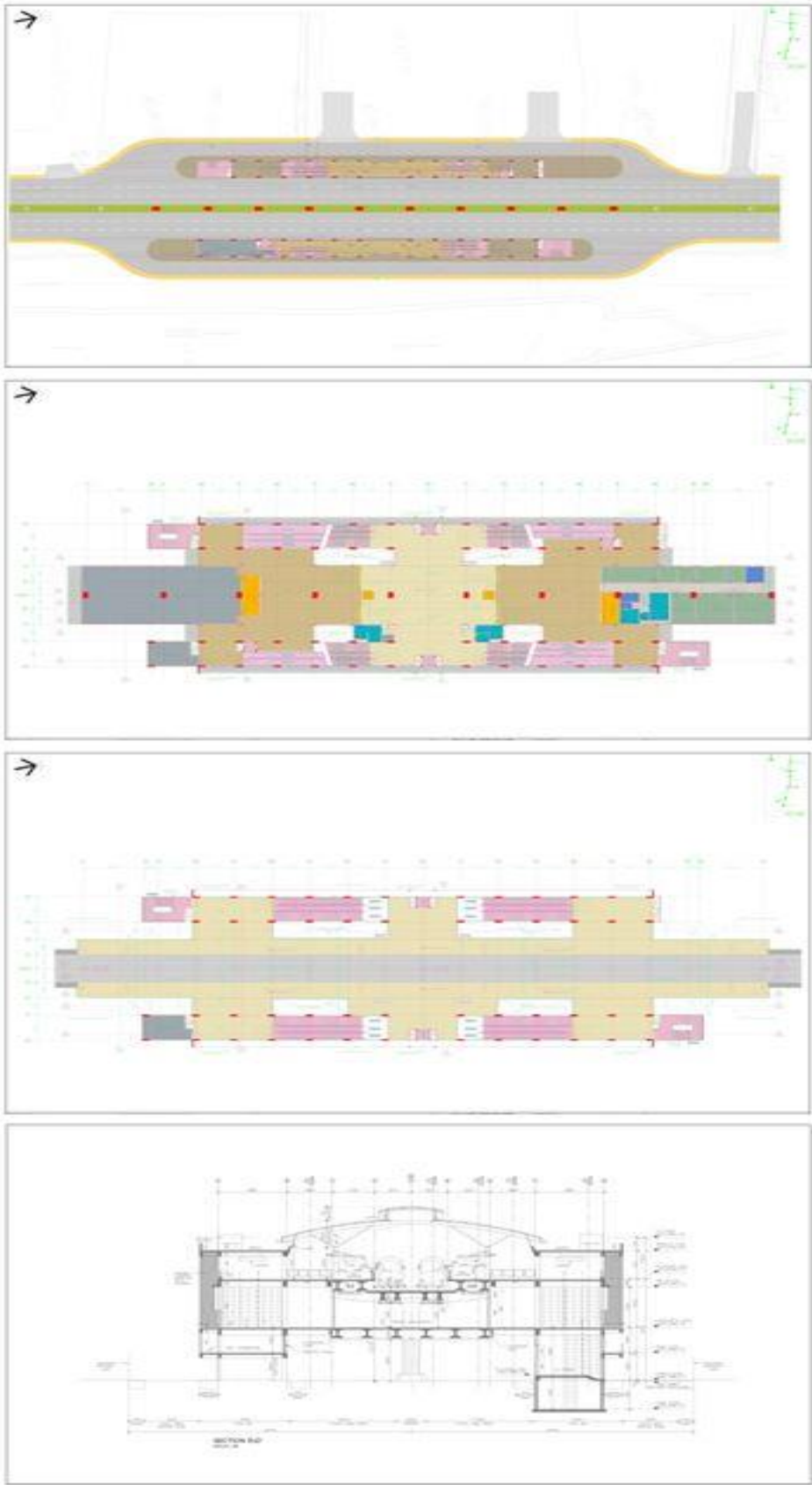


Figure 6: Kinematic Envelope on Tangent Track (Tunnel)

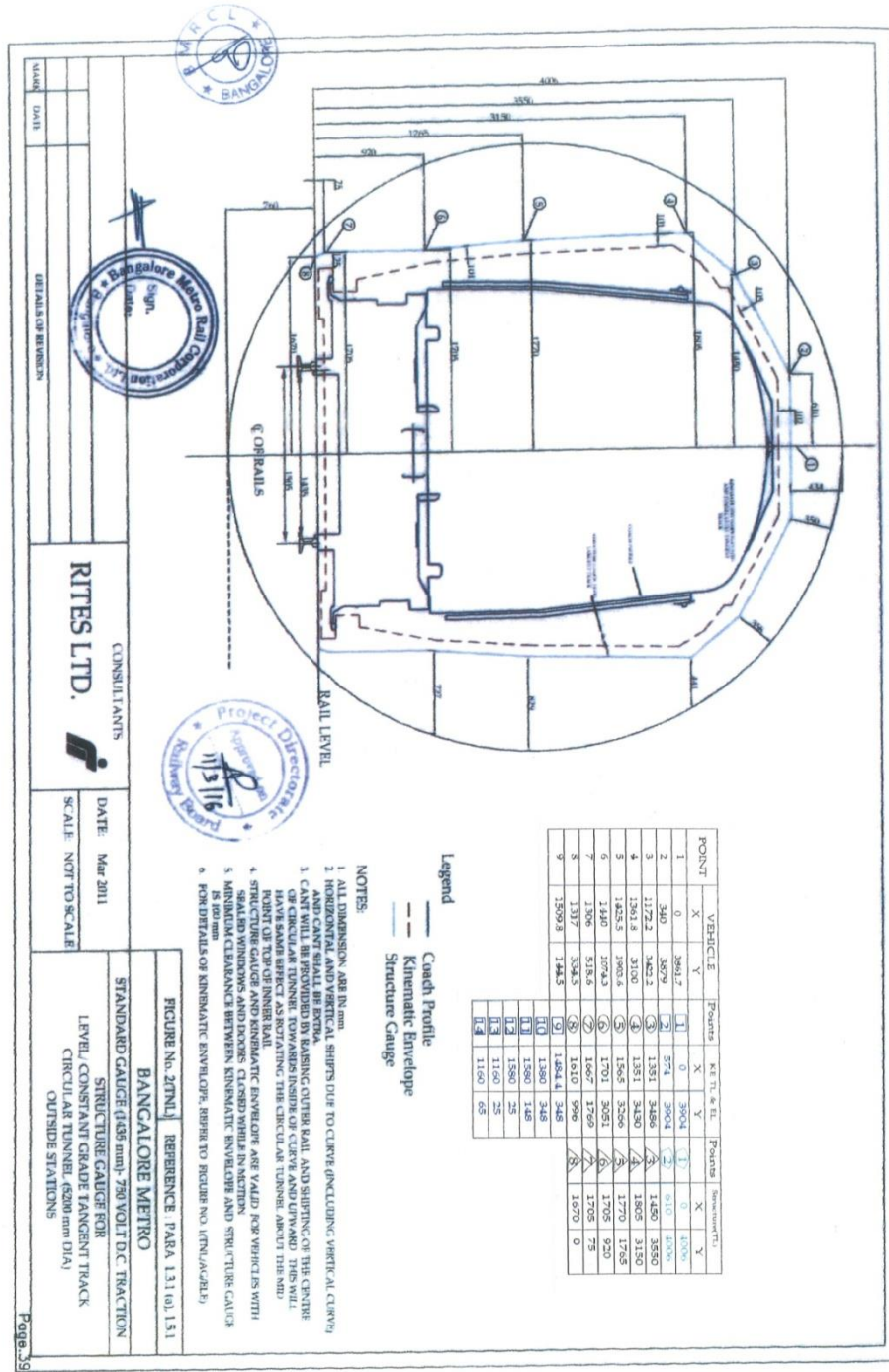


Figure 7: Typical 6 Car Composition Metro Train



Figure 8: Layout Plan of Depot at Kothanur



Figure 9: Location of Depot on Google-Earth Map



5. Cost Estimate

68. The total completion cost of the proposed corridor is estimated at Rs. 11908.32 crore.

6. Land Requirement

69. Since land is scarce commodity especially in metropolitan areas, every effort has been made to keep land requirement to the barest minimum and acquisition of the private property has been kept minimal. Land acquisition in the proposed project is of two types, one is for permanent usage and the other is for temporary usage. Permanent land is the land to be acquired throughout the life of the project it cannot be retrieved by the occupants. Temporary land is the land which is needed in addition to permanent land during construction phase. This can be retrieved by the occupant once the project is completed. Land is mainly required for route alignment, station buildings, platforms, entry/exist structures, traffic integration, power sub-stations, temporary construction depots / work sites and sick line facilities etc. As per the land acquisition proposal prepared by BMRCL, 2,70,712.07 square meters of land will be required for the project.

7. Implementation Plans

70. The project will be implemented within 45 months. The construction works for elevated sections are expected to commence by September 2017 and finish by July 2020. The construction work for underground section is expected to commence by January 2018 and finish by December 2020. The construction of depot is expected to commence by January, 2018. The system works for elevated section (including integrated testing, commissioning and service trial) will be expected to finish by December 2020. For underground section, the system works (including integrated testing, commissioning and service trial) will be expected to finish by April 2021. The operation will be expected to start by May 2021.

71. As the implementing agency (as well as a Borrower), BMRCL will take full responsibility of the implementation of the Project. The Planning Department of BMRCL will be the interface between BMRCL and EIB & AIIB, and also the internal coordinator among the functional departments to lead the preparation and implementation of the Project.

D. DESCRIPTION OF THE ENVIRONMENT

72. The proposed project is located in Bangalore city of Karnataka State covering Bengaluru district. The basic environmental settings of the district and Bangalore city where project is located in particular are discussed in this section.

1. Physical Resources

1.1. Topography

73. Bangalore has two unique Topography terrains—North Bangalore taluk and the South Bangalore taluk. The North Bangalore taluk is a relatively more level plateau and lies between an average of 839 to 962 meters above sea level. The middle of the taluk has a prominent ridge running NNE-SSW. The highest point in the city, Doddabettahalli, (962m) is on this ridge. There are gentle slopes and valleys on either side of this ridge. The low-lying area is marked by a series of water tanks varying in size from a small pond to those of considerable extent, but all fairly shallow.

74. The topography of Bangalore is flat except for a central ridge running NNE-SSW. The highest point is Doddabettahalli, which is 962 m (3,156 ft) and lies on this ridge. No major rivers run through the city, though the Arkavathi and South Pennar cross paths at the Nandi Hills, 60 km (37 mi.) to the north. River Vrishabhavathi, a minor tributary of the Arkavathi, arises within the city at Basavanagudi and flows through the city. The rivers Arkavathi and Vrishabhavathi together carry much of Bangalore's sewage. A sewerage system, constructed in 1922, covers 215 km² (133 mi²) of the city and connects with five sewage treatment centers located in the periphery of Bangalore.

75. The South Bangalore taluk has an uneven landscape with intermingling hills and valleys. The southern and western portions of the city consist of a topology of granite and gneissic masses. The eastern portion is a plane, with rare minor undulations.

76. There are no major rivers flowing through the city. However, rivers Arkavathi and Kaveri merge within the proximity of Nandi Hills, which lie 60 km north of Bangalore. River Vrishabhavathi, a tributary of Arkavathi, flows for a small stretch in the Bangalore North taluk and carries a bulk of the city's sewerage. The city has a handful of freshwater lakes and water tanks such as Madivala tank, Hebbal tank, Ulsoor lake and Sankey Tank. Groundwater occurs in silty to sandy layers of alluvial sediments and jointed quartzite.

77. The rock types prevalent in the district belong to the Saugar, Charnokite and Peninsular Gneissic Complex (PGC) groups. The PGC is the dominant group of rocks and covers two-thirds of the area and includes granites, gneissic and migmatites. The soils in Bangalore vary from red laterite to clayey soils.

1.2 Physiography

78. The project area comprises of urban and semi-urban areas of Bangalore city. The average elevation of Bangalore is 920 m above MSL covering an area of about 750 sq km. The city lies between 12.97°N and 77.56°E. The city is bounded by Kolar District in the northeast direction, Chikballapur District in the north, Tumkur District in the northwest, Mandya District in the southwest, Ramanagaram District in the south and the neighboring state of Tamil Nadu in the southeast. The city is generally flat, but it has a prominent ridge in North East and South West. Northern part of the project area is relatively more level plateau. Southern part represents uneven landscape with rocky features raising from 30-70 meters above ground level. Eastern part of the project area is almost plain with minor undulations. The highest point measured is Doddabettahalli, which is 962 m and lies above this ridge. There is no river flowing in the city, only few freshwater lakes and water tanks existing within

the city serve as source of groundwater recharge. Some of the important lakes are Madivala Tank, Hebbal Lake, Ulsoor Lake, Sankey Tank etc.

1.3 Geology & Minerals

79. The geology of the city is unique having various types of rock such as granites, gneisses and migmatites found in the area. The area has mature topography with scattered isolated hillocks around, where rocks are exposed. The rock type exposed in the district belongs to Saugar Group, Charnockite Group, Peninsular Gneissic Complex (PGC), Closepet granite and basic younger intrusive. Saugar group comprises ultramorphic rocks, amphibolites, Quartzite banded magnetites, quartzite occurring as small bands and lenses within the magmatites and gneisses. PGC is the dominant unit and covers about two-thirds of the area, which includes granites, gneisses and magmatites. The bed rocks essentially consist of granites and gneisses intruded by number of basic dykes.

1.4 Soils

80. The project area has Red Loamy and Laterite soils. Red loamy soils is mainly seen in the eastern and southern parts of Bangalore north and south taluks. It generally occurs on hilly to undulating landscape on granite and gneissic terrain. Laterite soils are mainly covered in Anekal taluk and western parts of Bangalore North and South taluks. Laterite soils occur on undulating terrain forming plain to gently sloping topography of peninsular gneissic region. The surface soil samples from a depth of 0 - 20 cm were collected along the proposed alignment and collected samples were analyzed for soil physico-chemical properties (Table 9).

81. The bulk density of soils ranged from 1.25 - 1.63 g/cm³. Thus, the porosity and water holding capacity also varied largely and found in the range of 38.1 - 51.7 % and 40.5 - 50.3 % respectively. The soil pH ranges from 6.21 - 7.89 while Electrical Conductivity (EC) ranges from 0.321 – 0.885 dS/m. The soil organic matter, measured in terms of Soil Organic Carbon (SOC) is very important from the point of soil health as it regulates soil physical, chemical and biological properties. The soil organic carbon was found in the range of 0.23 - 0.46 per cent. Slightly lesser range of organic carbon may be due to degradation of land from urban infrastructure activities and varied to a great extent depending on the land use. Similarly, the available N, P₂O₅ and K₂O are also in lesser range compare to productive soils.

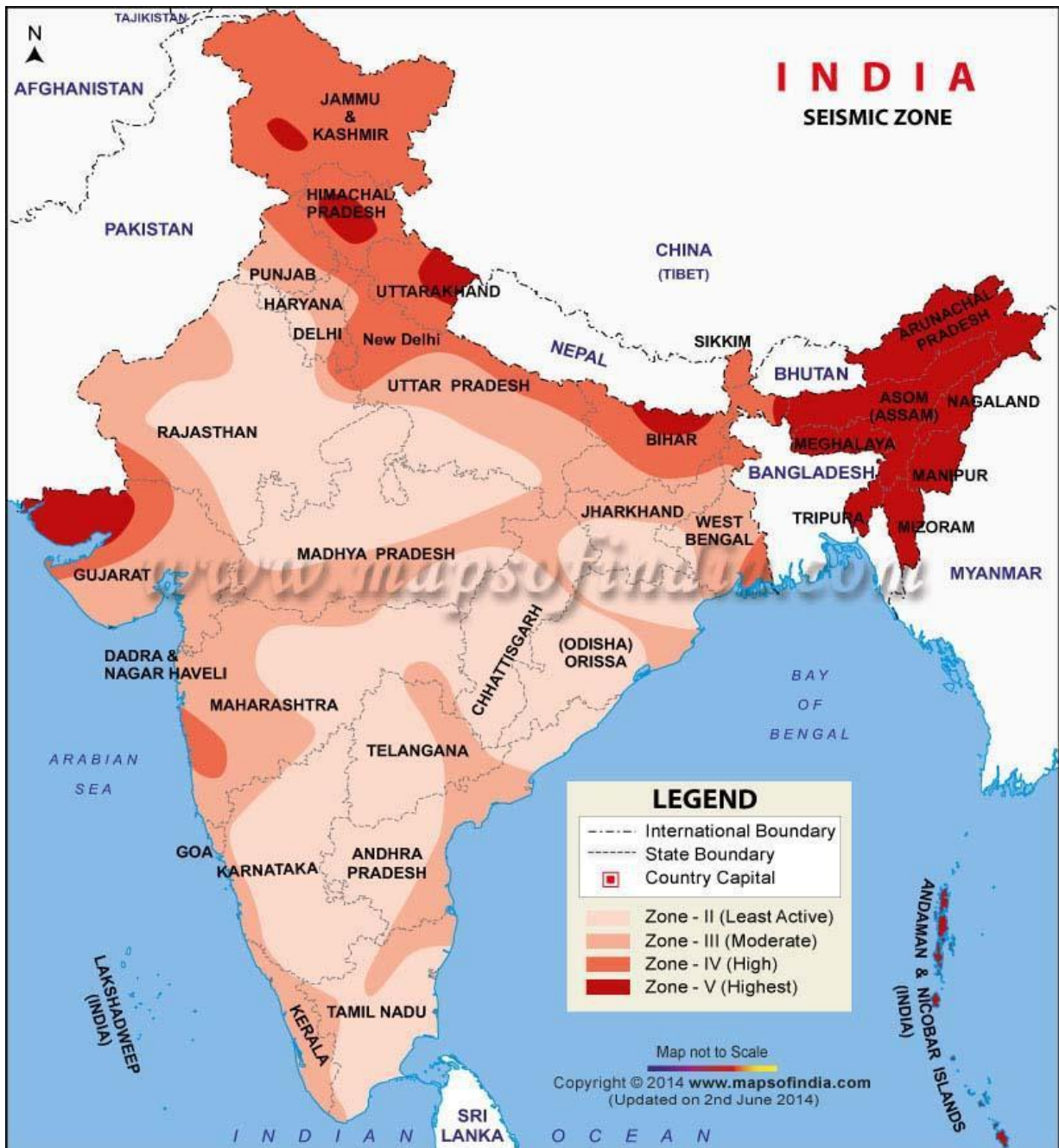
Table 9: Physico-Chemical Characteristics of Soil along the Alignment

Sl. No.	Parameters	Measured Range
1	pH	6.21 – 7.89
2	EC (dS/m)	0.321 – 0.885
3	Bulk Density (g/cm ³)	1.25 - 1.63
4	Porosity (%)	38.1 – 51.7
4	Water Holding Capacity (%)	40.5 – 50.3
5	Organic Carbon (%)	0.23 - 0.46
6	Available Nitrogen (kg ha ⁻¹)	223 - 378
7	Available P ₂ O ₅ (kg ha ⁻¹)	15.6 - 31.5
8	Available K ₂ O (kg ha ⁻¹)	156 – 321

1.5 Seismicity

82. Bangalore City and District has generally remained nearly untouched by major seismic activity due to its location in a seismically stable region. Only mild tremors have been recorded in the city. The national Seismic activity map is given in Figure 10. The Geotechnical characteristics and natural hazards are given below:

Figure 10: National Seismic Activity Map



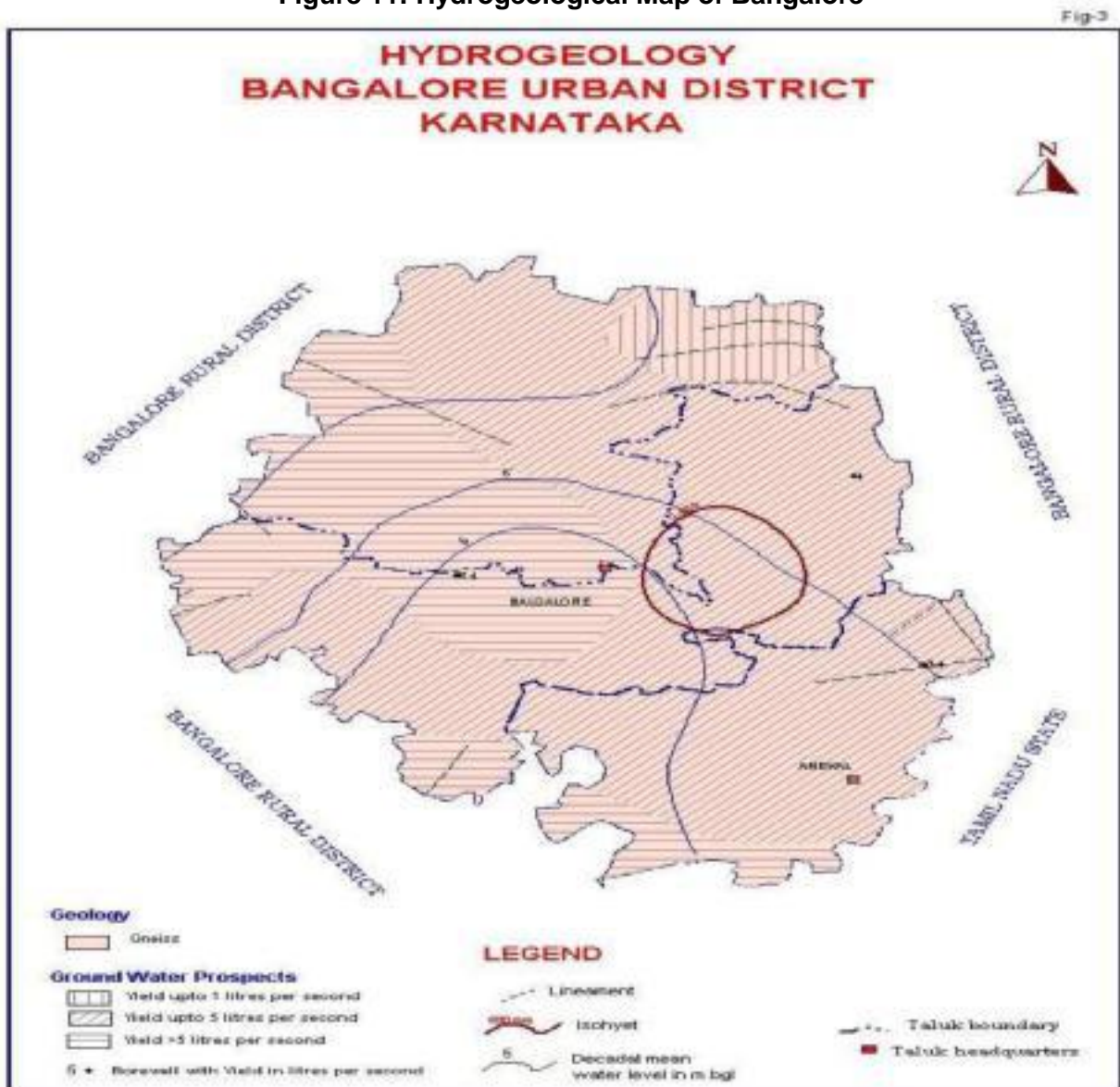
83. The nature of seismic activity in Bangalore district as recorded by Department of Mines and Geology, Government of Karnataka is shown in Table 10 above. The area has been demarcated into two engineering geologic provinces mainly based on bearing capacity / compressive strength and foundation characters of the rock types. The bearing capacity of the rock types vary from medium (500 kg/cm²) to high (1000-2000 kg/cm²) and the foundation characters are good to very good. The Bangalore district falls under seismic zone II (as per IS: 1783-part 10 2002).

84. The study area has no major threat of an earthquake because it is located in seismically stable zone (Zone II). The city has generally remained untouched by major seismic activity but only mild tremors have been recorded occasionally to till date as per records of Directorate of Mines and Geology, Government of Karnataka and Bhabha Atomic Research Centre.

1.6 Surface and Ground Water Hydrology

85. The hydro-geological map of Bangalore district is presented below. Geomorphologically the area can be divided into uplands, plateaus and pediplains. The major part of the district is covered by denudational plateaus and pediment – pediplain covered by NNE – SSW trending hills and the intermittent plains. Isolated granite hills constitute hog – backs. Laterite covered flat topped hills in the northeastern part from plateaus. Bangalore city situated on a N-S trending highland with an average altitude of 920 m. Above Mean Sea Level (MSL) forms a divide between the river Arkavati on the west and Pinakini on the East. The major part of the Bangalore Metropolitan city is situated on a hog back of granite. Figure 11 shows that Hydrogeological Map of Bangalore.

Figure 11: Hydrogeological Map of Bangalore



86. The Ground water samples were collected from borewells at different locations along the proposed alignment for analysis of Physico-chemical characteristics. Sampling was done in year 2011 (during DRP preparation as well as 2017 during preparation of this EIA). The collected samples were analyzed as per the CPCB drinking water standards (Appendix 3). The Physico-chemical characteristics of ground water samples collected are summarized in Table 10 and Table 11 respectively for 2009 and 2017.

Table 10: Physico-chemical Characteristics of Ground Water along the Proposed Alignment (2009)

Parameters	Observed range	CPCB Limits (Drinking water) as per IS 10500:2012
pH	6.95 - 7.51	6.5-8.5
Total Chlorides	112.14 – 265	250
Total Hardness	105.6 – 221	300
Calcium as Ca	35.27 – 60.74	75
Magnesium as Mg	13.15 – 32.14	30
Sulphate as SO ₄	8.75 – 28.65	200
Nitrate as NO ₃	11.25 – 20.33	45
Total Dissolved Solids	415 – 518	500

Table 11: Physico-chemical Characteristics of Groundwater Samples in Reach 6 (2017)

Parameters	Observed range at Jayadeva Hospital Junction	CPCB Limits (Drinking water) as per IS 10500:2012
pH	6.89	6.5-8.5
Electrical Conductance	750	-
Total Dissolved Solids	370	500
Acidity	ND	-
Total Alkalinity	296	200
Total Hardness	170	300
Calcium Hardness	108	75
Magnesium Hardness	14.88	30
Chlorides	48	250
Fluorides	0.14	1.5
Nitrates	24.5	45
Sodium	07	-
Potassium	12	-
Sulphates	117	200
Phosphates	0.5	-
Dissolved Oxygen	8.2	-
Biochemical Oxygen Demand	12.6	-
Chemical Oxygen Demand	29.1	-

Note: All values are in mg/L except pH and EC. EC in μ mhos/cm; ND-Not Detected

87. The ground water samples were collected in the proposed alignment shows that, most of the parameters analyzed were below the CPCB standards (Appendix 3). However, the total Chlorides, Magnesium and Total Dissolved Solids are slightly higher in compare to CPCB standards. This may be due to industrial and high domestic discharge may lead to ground water contamination at city area. There is no lake nearing to the alignment hence Physico-chemical characteristics of surface water were omitted.

1.7 Climate

88. Bangalore has a tropical savanna climate with distinct wet and dry seasons. Due to its high elevation, Bangalore usually enjoys a more moderate climate throughout the year, although occasional heat waves can make summer somewhat uncomfortable. The coolest month is December with an average low temperature of 15.4 °C (59.7 °F) and the hottest month is April with an average high temperature of 35 °C (95 °F). The highest temperature ever recorded in Bangalore is 38.9 °C (102 °F) (recorded in March 1931). The lowest ever

recorded is 7.8 °C (46 °F) in January 1884. Winter temperatures rarely drop below 14 °C (57 °F), and summer temperatures seldom exceed 36 °C (97 °F). Bangalore receives rainfall from both the northeast and the southwest monsoons and the wettest months are September, October and August, in that order. The summer heat is moderated by fairly frequent thunderstorms, which occasionally cause power outages and local flooding. The heaviest rainfall recorded in a 24-hour period is 179 millimetres (7 in) recorded on 1 October 1997. Climate data for Bangalore is presented in Table 12.

Table 12: Climate data for Bangalore

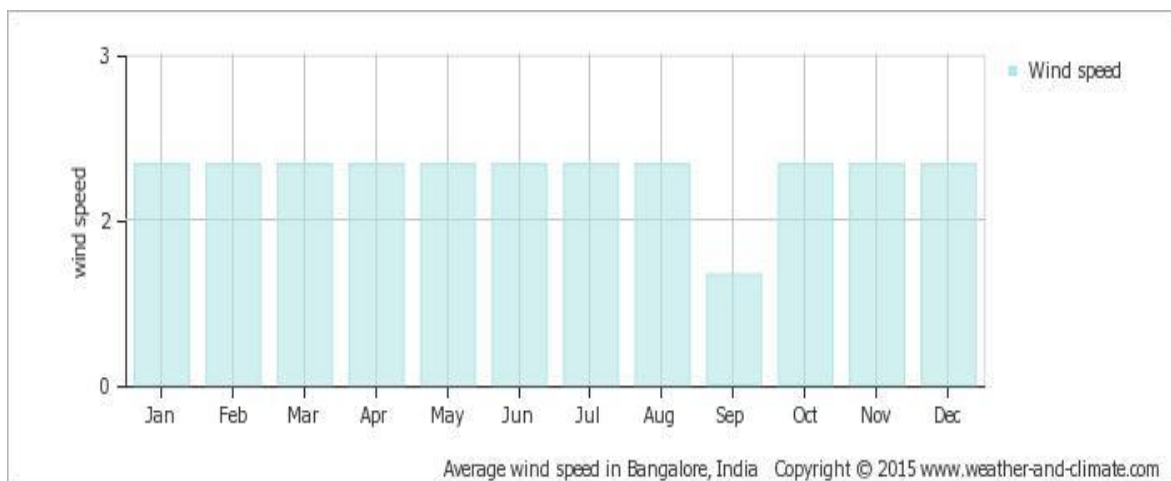
Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Record high °C	32.8	35.9	37.3	38.3	38.9	38.1	33.3	33.3	33.3	32.4	31.7	31.1	38.9
Average high °C	27.6	30.2	33.2	35.4	33.8	29.4	28.1	27.5	28.3	28	27	26.2	29.4
Average low °C	15.3	17.2	19.6	21.8	21.5	20.2	19.8	19.6	19.7	19.4	17.7	16	19
Record low °C	7.8	9.4	11.1	14.4	16.7	16.7	16.1	14.4	15	13.2	9.6	8.9	7.8
Average rainfall mm	1.8	7.9	7	40	110.2	89.1	108.9	142.5	241	154.5	54.1	17.5	974.5
Average rainy days	0.2	0.5	0.8	3	6.9	6	7.4	10	10.3	7.9	3.9	1.6	58.5
Average relative humidity	60	52	45	51	60	72	76	79	76	73	70	68	65.2
Mean monthly sunshine hours	262.3	247.6	271.4	257	241.1	136.8	111.8	114.3	143.6	173.1	190.2	211.7	2360.9

Source #1: Indian Meteorological Department. Source #2: NOAA (humidity and sun: 1971–1990)

89. Wind speed and wind direction play a major role in the dispersion of air pollutants. The stronger the winds the greater will be the dilution and dissipation of pollutants. The surface winds over Bangalore have a fairly clear-cut seasonal character with Eastern wind component predominating in one period and Western wind component in the other, with a dominant Western wind direction. In the three year observations (1999, 2000, 2001) the Eastern winds were mostly less than 4 m/s, while the western winds reported more than 4 m/s. The other prominent wind directions observed were West-West South (WWS) and West-West North (WWN). During the period may to September, the winds are WSW to W while during the period November to March, they are ENE to ESE. April and October are transition months when the change over from the Easterly to the Westerly wind regime and vice versa takes place, respectively.

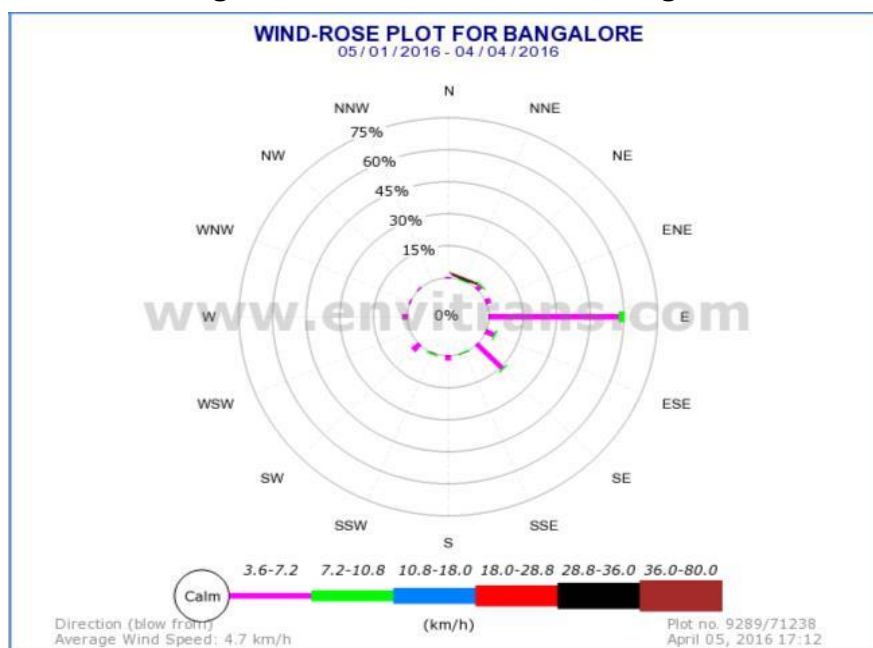
90. The average wind speed in Bangalore is record highest in August whereas September is least wind speed month as shown in Figure 12 and 13.

Figure 12: Mean Monthly Wind Speed over the year in Bangalore (meters/ second)



Source: Weather data from: Mangalore, India.

Figure 13: Wind Rose Plot for Bangalore



1.8 Ambient Air Quality

91. The existing levels of ambient air quality parameters were assessed at various representative locations along the proposed alignment for Suspended Particulate Matter (SPM), Respirable Particulate Matter (RPM), Sulphur dioxide (SO₂), Oxides of Nitrogen (NO_x) and Carbon Monoxide (CO).

92. Respirable Dust Sampler 460 BL was deployed to monitor RPM, SPM, SO₂ and NO_x. The sampler was placed to obtain 8 hourly average values of the above said parameters in the month of June - July 2009 and also in the month of July 2017. The parameters were monitored and analyzed as per CPCB (Central Pollution Control Board) and NAAQ (National Ambient Air Quality) standards (Appendix 1).

93. One grab sample was collected at each ambient air quality monitoring station for analyzing CO and the spot concentration of CO was recorded using Indicator Tube Technique. The results of air quality measured in the study area in comparison with NAAQ standards are given in Table 13 and Table 14 for 2009 and 2017 respectively. Figure 14 present the graphical distribution of air quality.

Table 13: Air Quality Parameters along the Proposed Alignment (2009)

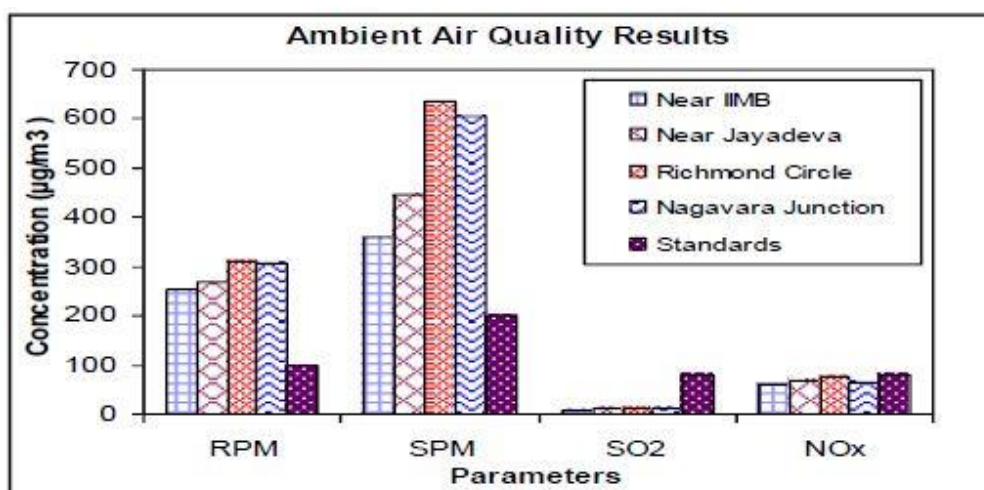
Monitoring Locations	Parameters Concentration (µg/m ³)				
	PM _{2.5} (µg/m ³)	PM ₁₀ (µg/m ³)	SO ₂ (µg/m ³)	NO _x (µg/m ³)	CO (ppm)
Near IIMB, Bannerghatta Road	255.23	358.07	8.5	60.97	1.7
Near Jayadeva Hospital	269.21	445.75	9.5	66.34	1.9
Richmond Circle	309.70	635.21	11.6	75.24	2.3
Nagavara Junction	305.47	605.64	11.2	63.26	1.9
National Ambient Air Quality Standards					
Standards	100	200	80	80	2.0

Table 14: Air Quality Parameters along Reach 6 (2017)

Monitoring Location	Parameters Concentration					
	PM2.5 (µg/m ³)	PM10 (µg/m ³)	SO ₂ (µg/m ³)	NO _x (µg/m ³)	CO (ppm)	CO ₂ (ppm)
Jayadeva Hospital Junction	4.31	172.69	40.25	43.4	7.2	403
Standards	60	100	80	80	2.0	-

Source: Quarterly monitoring report submitted by Bangalore University, July 2017

Figure 14: Status of Air Quality along the Proposed Alignment (2009)



94. Air monitoring results of 2011 clearly shows that the air quality parameters at most of the monitoring locations along the proposed alignment were found to exceed the National Ambient Air Quality Standards (Appendix 1). It is observed that, PM_{2.5} and PM₁₀ are exceeded in most of the locations when compared to National Standards Of 60 and 100 (µg/m³). The increased PM_{2.5} and PM₁₀ are due to vehicular pollution which is increasing exponentially along the proposed alignment and bad maintenance of roads also influenced the rise in air pollutants. In 2017 the PM_{2.5} level at Jayadeva Hospital junction is found within permission limits but PM₁₀ is high with a recorded value of 172.69 (µg/m³) against the permissible limit of 100 (µg/m³).

95. The booming industries, software companies on Bannerghatta Road have indirectly influenced very higher concentration of RPM and SPM. However, the concentration of SO₂ and NO_x is below permissible limits in sampling locations. The Bharat Stage-III emission norms have been introduced during 2005 drastically reduce SO₂ level in subsequent years. The decreased levels of NO_x are due to banning of old vehicles in recent days, better traffic management, introduction of improved vehicular technology, etc. The concentration of CO was slightly higher at Richmond circle in compared to NAAQS Standards.

96. Air Quality Index (AQI) was characterized to know the quality of air at different locations. The higher the AQI value, greater is the level of air pollution and leads to greater damage to health. The air quality index and the criteria assigned to each index is depicted in Table 15 and Table 16.

Table 15: Air Quality Values and Criteria

AQI Values	Air Quality Criteria
0-25	Clean Air
26-50	Light Air Pollution
51-75	Moderate Air Pollution
76-100	Heavy Air Pollution
>100	Severe Air Pollution

Table 16: Air Quality Index (AQI) Values and Air Quality Criteria at the Proposed Alignment

Monitoring Locations	AQI Values	Air Quality Criteria
Near IIMB, Bannerghatta Road	130.28	Severe Air Pollution
Near Jayadeva Hospital	146.72	Severe Air Pollution
Richmond Circle	183.96	Severe Air Pollution
Nagavara Junction	175.34	Severe Air Pollution

97. It is observed that air quality index in almost all locations exceed 100 which fall under the category of "Severe Air Pollution". Therefore, immediate attention is required to reduce air pollutants at the city area.

1.9 Noise Quality

98. The ambient noise levels were recorded at appropriate locations with a time interval of about 30 minutes using Sound Level Meter as per IS:4954 and procedures of CPCB. Noise source often fluctuates widely during a given period of time hence; Equivalent Noise Levels (Leq) is essential to assess the impact. Equivalent noise levels were computed with the help of Lday and Lnight of the study area. Lday is defined noise level measured over a period of 16 hours during day (6 am to 10 pm). Lnight is defined as noise level measured over a period of 8 hours during night (10 pm to 6 am) in the month of June - July 2009 and July 2017. The noise levels measured are given in Table 17 (Figure 15) and Table 18 (Figure 16) for 2009 and 2017 respectively.

Table 17: Noise Levels along Proposed Alignment (2009)

Monitoring Locations	Noise level dB (A) Leq	
	Day (Leq)	Night (Leq)
Near IIMB, Bannerghatta Road	74.5	68.3
Near Jayadeva Hospital	77.4	71.5
Richmond Circle	79.5	72.6
Nagavara Junction	78.1	72.1
Ambient Noise Standards		
Industrial Area	75	70
Commercial Area	65	55
Residential Area	55	45

Note: Day Time - 0600 hour to 2200 hour (16 hours);
Night time - 2200 hour to 0600 hour (08 hours)

Figure 15: Measured Noise Level along the Proposed Alignment (2009)

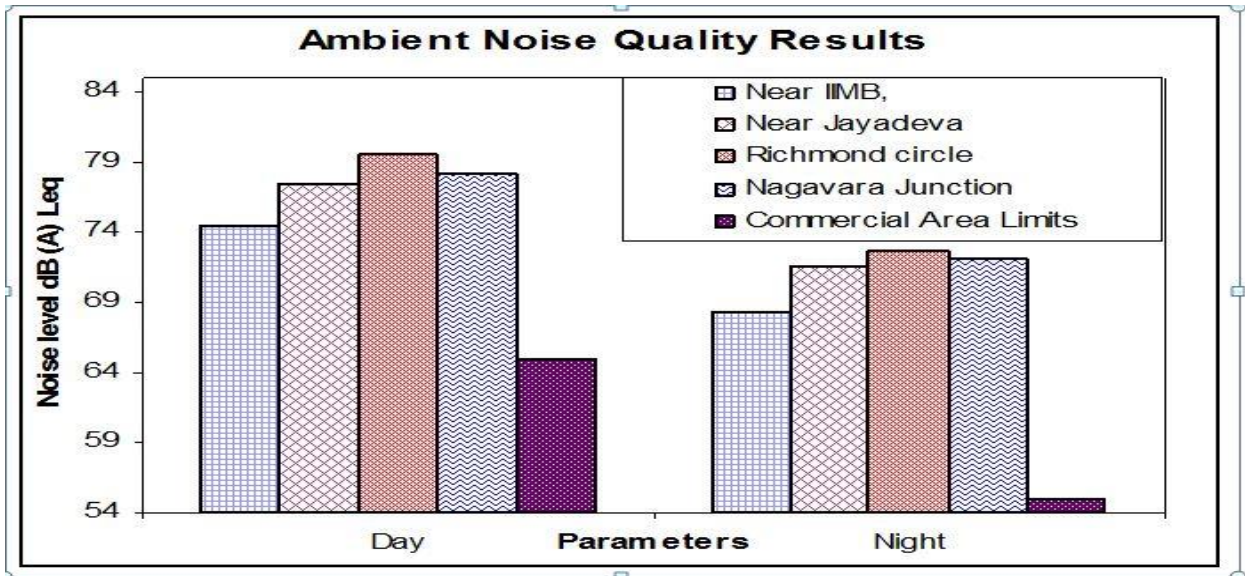
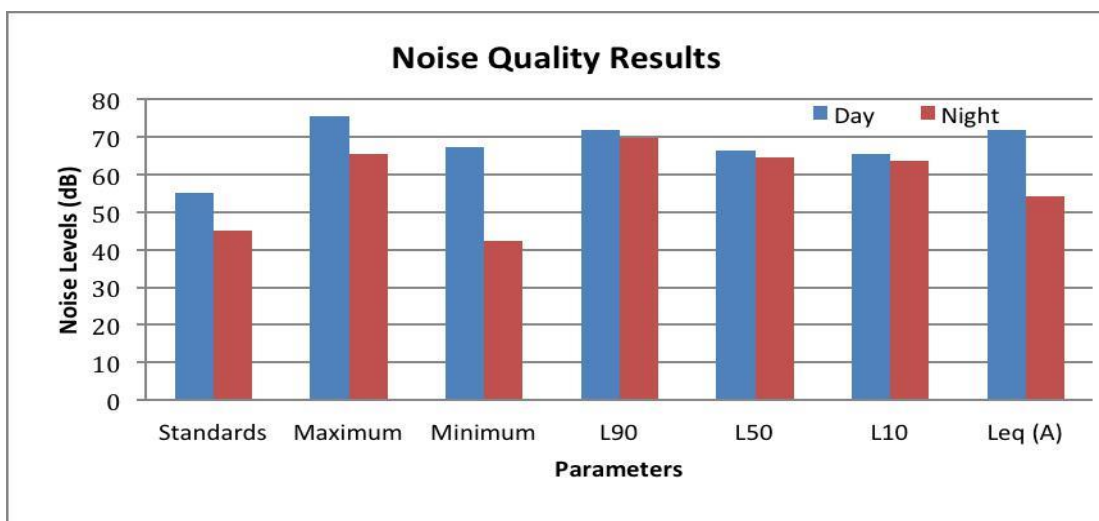


Table 18: Noise levels (dB) in Reach 6 (2017)

Monitoring Location	Noise Level dB(A) at Jayadeva Hospital Junction	
	Day (Leq)	Night (Leq)
Standards	55	45
Maximum	75.5	65.3
Minimum	67.3	42.3
L90	71.7	69.7
L50	66.2	64.5
L10	65.3	63.7
Leq (A)	71.8	54.2

Source: Quarterly monitoring report submitted by Bangalore University, July 2017

Figure 16: Measured Noise Level along the Proposed Alignment



99. It is observed that noise equivalent levels along the proposed Phase II North - South alignment varied in the range 74.5 – 79.5 dB (A) in the day time and 68.3 – 72.6 dB (A) during night time. The increased noise level in the study area is mainly due to commercial activities

and vehicular movement round the clock. It is found that, noise levels in all the stations exceeded the permissible ambient noise levels. In addition, most of the locations even exceeded the industrial area standard limits also. In 2017 also the equivalent average noise levels at Jayadeva Hospital Junction on Reach 6 are higher side (day time - 71.8 dB(A) and night time 54.2 dB(A)) compared to National Noise Standards (Appendix 2).

2. Ecological Environment

2.1 Forest and Green Cover

100. Bangalore city has the dubious distinction of being one of the fastest growing Metropolitan cities in Asia. Despite this fast growth, Bangalore is still known as the 'Garden City of India' with well-planned parks and huge green spaces dot the city landscape, which is scattered over the city vast spread out areas. The city is continuously growing further with the surrounding villages and towns being absorbed into the city limits following the creation of Greater Bangalore. This has led to large scale conversion of agricultural lands, lakes and tanks to urban areas rapidly thus adversely affecting the environment and ecosystem of the city and the immediate fringe areas.

101. Green cover assessment study has been carried out to record the plant species existing all along the proposed Metro rail alignment. The trees from the central line of the alignment at varying distance viz. 0-5 m and 5-10 m was recorded. The trees present at a distance of 19 m from the central line and 140 m length was recorded for the proposed elevated stations. At underground stations trees were monitored at a distance of 20 m from the central line and 200 m length of the station corridor.

102. The trees likely to be cut or trimmed due to Metro rail alignment were identified. The girth of the tree was measured at a height of 1.3 m above ground and the height of the tree was measured through visual observation. Canopy cover was calculated by measuring the length of the longest branch in all the four directions (CEE, 1994). The tree biomass was estimated using Regression Equations available for each species.

103. There is no forestland along the project alignment and depot area. Also project components are not located in any notified protected areas or environmentally sensitive area (i.e. national parks, wildlife sanctuaries, biosphere reserves etc.).

2.2 Trees along the Project Alignment

104. An inventory of the tree to be affected by the project has been carried out. The tree species girth and approximate height was recorded and biomass has been quantified. Table 19 show the component wise details of the trees to be affected by the proposed metro line 6 project.

Table 19: Overall Affected Trees along the Alignment

Locations	No. of trees to be cut
Elevated Section	877
Underground Section	315
Sub-Total	1192
Depot Area	120
Sub-Total	120
Total	1312

105. It can be seen from the table that a total of 1312 trees will be affected by the proposed project. Of these 1192 trees will have to be cut in proposed alignment (where 877 trees are in

elevated section and 315 trees are in underground section). The depot for the corridor has been planned at southern end at Kothanur where 33 acres of land have been acquired. The proposed depot will affect 120 trees. Since, maximum trees are going to be affected at stations; the station area will be restricted as per the minimum land requirement. However, compensatory afforestation will be taken care without any much damage to ecosystem.

106. To minimize tree cutting it is proposed to transplant young trees to the extent possible. Local forestry officials will be consulted to transplant the trees at suitable locations.

3. Socio-economic Environment

3.1 General Profile

107. Bangalore officially known as Bengaluru, is the capital of the Indian state of Karnataka. It has a metropolitan population of about 9.62 million, making it the third most populous city and fifth most populous urban agglomeration in India. It is located in southern India on the Deccan Plateau. Its elevation is over 900 m (3,000 ft) above sea level, the highest of India's major cities.

108. Bangalore lies in the southeast of the South Indian state of Karnataka. It is in the heart of the Mysore Plateau (a region of the larger Precambrian Deccan Plateau) at an average elevation of 900 m (2,953 ft). It is located at 12.97°N 77.56°E and covers an area of 741 km² (286 sq mi). The majority of the city of Bangalore lies in the Bangalore Urban district of Karnataka and the surrounding rural areas are a part of the Bangalore Rural district. The Government of Karnataka has carved out the new district of Ramanagara from the old Bangalore Rural district.

109. Bangalore is recognized as one of the most vibrant economic metropolitan in India due to the presence of several global IT industries apart from a large number of research institutions of national significance.

3.2 Demography

110. Bangalore district with a total population of 96, 21,551 is the most populous district in the State. The total area of Bangalore district is 2196 sq. km. and it is the smallest district in the state in terms of area. The district has the highest a density of 4,381 and it ranks 1st in the State. Bangalore district accounts for 15.8 percent of the total population of the State and stands at 1st place in the State. Bangalore has the highest decadal growth rate of 47.2 percent in the State. Bangalore is the most urbanized district with 90.9 percent of its population residing in urban areas. It has the highest institutional and houseless population. The district has the lowest Sex ratio of 916 in the State. The district with a Sex ratio of 944 among the child population in the age-group 0-6 holds the 24th rank in the State. The proportion of child population (0-6 age-group) is 10.9 percent in the district and holds the rank of 16th in the State. The district has a second highest literacy rate of 87.7 in the State. The male literacy rate in the district is 91.0 percent and the female literacy rate is 84.0 percent. Bangalore ranks at second place in terms of female literacy rate. The Scheduled Caste population contributes 12.5 percent and the Scheduled Tribe population contributes 2.0 percent to the total population of the district. The district has registered a work participation of 44.1 percent and stands at 21st place in the State. The work participation rates for Male and Female population in the district are 62.0 and 24.6 respectively, the female work participation rate being lowest in the state. Among the total workers in the district 90.9 percent are Main workers and 9.1 percent are Marginal workers. Major work force of 92.9 percent is Other Workers. Only 4.6 percent are engaged in Agricultural sector i.e., Cultivators (2.3 percent) and Agricultural Labourers (2.3 percent) and 2.6 percent of the total

workers are engaged in Household Industry. About 55.9 percent of the total population in the district is non-workers. Bangalore district has undergone jurisdictional changes after 2001 census with the creation of one new sub-district (Taluk) Bangalore East by bifurcation of Bangalore South Taluk and the merger of 8 erstwhile Statutory Towns of 2001 Census with Bangalore (M. Corp.) to form Bruhat Bangalore Mahanagara Palike. Bangalore district have 588 villages, 2 Statutory Towns and 14 Census Towns.

3.3 Land Use Pattern

111. The term land use is generally adopted to man man's activities, which are directly related to the use of land as resource. Land use can be defined as an activity or development, which occupies land, for the specific purpose. It is not essential to define all aspects of land usage in Bangalore for the purpose of this report. As part of baseline survey, location specific data have been generated. As the proposed Metro Rail Project is likely to bring about a change in the existing land use pattern to some extent, it is important to record the present situation related to land use aspects.

112. There is substantial development in the North of Bangalore comprising of Banaswadi, Peenya Industrial Estate, Yashwantpur, Yelahanka and Bangalore International Airport. Banaswadi has many software companies, while Peenya is famous for manufacturing machine tools and it is one of the oldest and largest industrial areas in South-East Asia. The road from Bellary road to Yelahanka is witnessing rapid residential development. The trend is expected to remain positive in the area with development of International Airport acting as a catalyst for further growth. There are large IT companies like Hewlett Packard, Infosys, Siemens and Wipro etc. in Electronic City which is spread in an area of 332 acres in South. Sarjapur road is another promising area for industrial growth in the south of the city. Jaynagar, J.P Nagar, BTM layout are the areas adjoining to Electronic city developed primarily as residential areas.

113. East of Bangalore has grown rapidly and developing as a commercial area. Though the connectivity is not sufficient, initiatives were taken place by the government in the form of over bridges, underpass, road widened activities may not sufficient. Kormangala, Indiranagar and Hosur road are the prime areas. West of Bangalore has predominantly been the residential focus with prime areas being Rajajinagar, Vijayanagar, Basaveswarnagar, Magadi road. It is mainly comprised of residential areas. There is a massive population growth in North-East and in the South of the city along Hosur Road and Whitefield Road in the East.

114. The land use pattern of the city depicts (Table 20 and Figure 17) how various physical, social, economic factors have influenced the change over the past decades and the existing land use is essential for future planning of the project. Since the project is situated in the states capital, the core area of the city consists of administrative offices and it is also a traditional business areas. The Bangalore Master Plan 2015 indicates that about 43 % area is used for residential purposes, 21 % land area is utilized for transport & communication, 14% land utilized for open spaces and 7% for industrial use. The area is covered under residential and roads include large number of avenues.

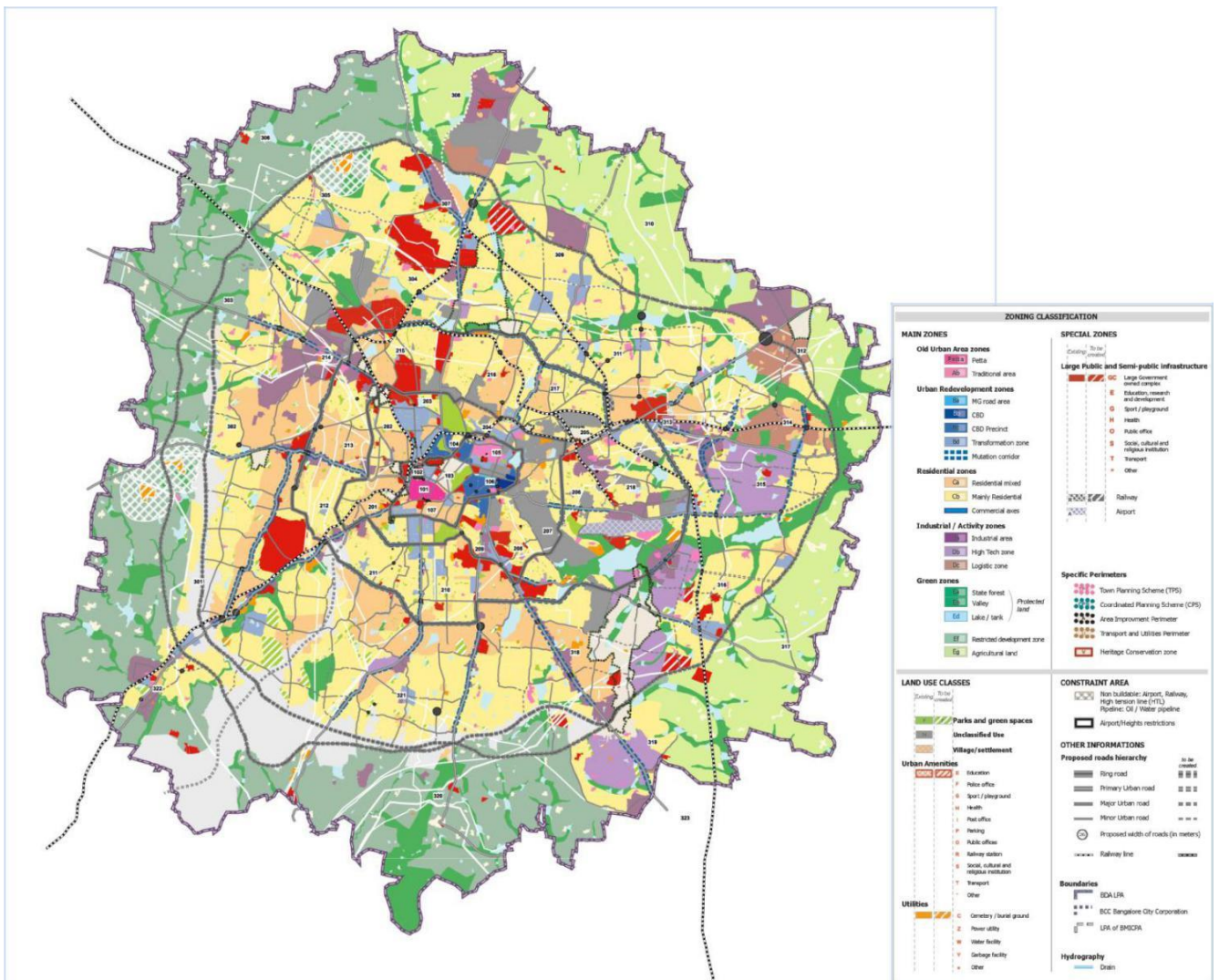
Table 20: Land Use Pattern of Bangalore

Land Use	Existing land Use (2003)		Proposed Land Use (2011)	
	Area (sq. Km)	% of Distribution	Area (sq. Km)	% of Distribution
Residential	159.76	37.91	243.69	43.16
Commercial	12.83	3.04	16.43	2.91
Industrial	58.83	13.96	38.44	6.81
Open Spaces	13.10	3.11	77.88	13.79

Public & Semi-public Uses	46.56	11.05	49.08	8.69
Public Utilities	2.49	0.59	-	-
Offices & Services	4.27	1.01	-	-
Transport & Communication	88.31	20.96	116.97	20.72
Unclassified	35.26	8.37	22.14	3.92
Total	421.41	100.00	564.63	100.00
Agriculture Land	649.24			
Lake & tank	39.02			
Quarry	9.61			
Vacant	187.72			
Total	1,307.00			

Source: Bangalore Master Plan 2015, Bangalore Development Authority, Government of Karnataka.

Figure 17: Spatial Distribution of Proposed Land Use in Revised Master Plan of BMA - 2015



3.4 Economy

115. Bangalore is under eastern dry agro climatic zones of the State. The total forest area of the district is around 2.3 percent of the total geographical area. The topographical and climatic features of the district are subject to small regional variations and are favorable for the growth of a variety of plants. The soil of Bangalore district consists of red laterite and red fine loamy to clay soils. The chief crops grown in these soils comprise ragi, rice, paddy, maize, millets, pulses, oil seeds, and vegetables and fruit crops. The irrigation potential is quite low in the district as there are no major rivers flowing in the district. Bangalore (Urban) district has many tanks and most of these have been providing irrigation facilities to small patches of land that come under their respective holdings. The number of marginal holdings below one hectare and small holdings of size one to two hectares constitute 84.14 % of the total holdings. Only 0.47% holder own land more than ten hectares. Livestock rearing plays a very vital role in rural economy in supplementing family income from agriculture and also providing employment.

3.5 Trade and Commerce

116. Bangalore district is industrially the most advanced district in Karnataka. The district is endowed with minerals such as gneissic rocks, clay, quartz etc. besides infrastructure facilities such as accessibility to raw materials, machinery power, technicians, labourers, transport and communications, climatic conditions, marketing opportunities and financial facilities for the growth and development of industries. The clay at Whitefield area has attracted special attention. Various oilseeds; vegetable and fruits are also raised to a considerable extent. Mulberry cultivation for the support of silk-worms is an important branch of industry in the district. Many crafts and industries have flourished in the district from ancient times. Production of textile goods is the most notable industry. Bangalore carpets were well known for their durability and for the peculiarity of having the same pattern on both the sides. Extraction of oil, tanning, basket making, pot manufacture, weaving etc., were some of the traditional crafts flourishing from good old days. Metal works in gold, silver, brass and copper were carried on throughout the district. The physical geography of the region of Bangalore district, largely covered by vast plains, has facilitated good communication system from the earlier centuries which in turn has contributed much for the development of trade and commerce in the district.

3.6 Physical Cultural and Archaeological Resources

117. The proposed metro line corridor does not involve any loss of cultural or archaeological assets.

E. ANTICIPATED IMPACTS AND MITIGATION MEASURES

118. The potential impacts and risks were analyzed in the confines of the metro alignment's direct impact area, which is defined in this study as 100 meters on both sides of the metro's centerline. Influence area where most of the socio-economic and cumulative impacts will occur is defined as the entire confine of the area in Bangalore city.

119. There are no environmentally sensitive areas along the alignment of the proposed Bangalore metro rail line 6 project. However project involves land acquisition and resettlement of people for both viaduct section as well as underground sections of the metro. The project is classified as Category A mainly due to social impacts. There are no impacts on historical monuments or cultural resources. The negative environmental impacts will mainly occur during construction work. The significant impacts screened are:

- Loss of about 1312 trees for construction of metro rail alignment as well as depot area.
- Increased local air pollution due to rock crushing, cutting and filling works, and chemicals from asphalt processing.
- Risks and vulnerabilities related to occupational health and safety due to physical, chemical, biological, and radiological hazards during project construction and operation.
- Dislocation or involuntary resettlement of people as there will be a need for land acquisition for elevated as well as underground sections and also for depot.
- Dislocation and compulsory resettlement of people from shops living near the stations.
- Noise and vibration due to tunnelling boring machine, excavation machines, and materials hauling.
- Increased noise and air pollution resulting from traffic volume during construction.

120. **Expected Benefits from the Project:** Metro rail systems have an advantage over other modes of transport because they provide higher carrying capacity, faster, smoother, and safer travel, occupy less space, and are non-polluting and energy-efficient. To summaries the benefits a metro rail system:

- Reduction in air pollution level is the single most important indications due to metro rail alignment. Air pollution reduction predicted that, the proposed metro alignment will reduce nearly 8-9 tonnes of air pollutants per day.
- BEES model indicates, a net gain of 42% EIU units with respect to baseline, which demonstrates a positive benefit to the surrounding community.
- Metro rail would effectively bring down the traffic congestion problems on city's roads to an extent of nearly about 32%. In addition, this will also ensure reduction in accidents and provides safety transport facility in lesser time.
- The reduction of vehicles will manifest in reduced fossil-fuel consumption and it will directly influence State Economy. However, the fuel reduction can save fuel cost nearly about Rs. 48 crores/ annually due to proposed Metro commissioning.
- Metro rail used cut down travel time by more than half which works out to a substantial saving on productive man-hours and improve working efficiency. Considering an average 30 minutes time savings / passenger / trip, per day can save approximately 1.72 lakhs man hours.
- Introduction of metro rail provides good infrastructure and improve city aesthetic and economic growth by attracting global investors. There will be less strain on the roads and consequently provides longer durability to the existing roads.

- The proposed metro rail will improve socio-economic benefits of the common public through employment, trade and tourism.

121. **Adverse Environmental Impacts:** Negative impacts that are likely to result from the proposed metro line development have been 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.

122. For each of these headings, potential impacts are evaluated and mitigating measures have been proposed.

1. Impacts and Mitigation Measures Due to Project Location

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

- Change of Land use
- Loss of trees/forest
- Utility/Drainage Problems
- Socio-economic impacts
- Impact on Historical and Cultural Monuments.

1.1 Land Use

124. The project will require acquisition of land (permanent and temporary). The required land (permanent & temporary) for the construction of the proposed alignment from Gottigere to Nagavara and depot at Kothanur is both government as well as private land, which shall be acquired and handed over to the contractors by Bangalore Metro Rail Corporation Limited (BMRCL).

125. As per the land acquisition proposal prepared by BMRCL, 270,712.07 square meters of land will be required for the Project. Out of the total land requirement, 218,900.2 square meters of land will be acquired permanently and 51,811.87 square meters of land will be temporarily procured through lease for the construction period.

126. The land acquisition and resettlement & rehabilitation activities of the project will be governed by the following general principles, which are based on The Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013.

1.2 Trees cutting

127. The proposed metro line 6 (Gottigere - Nagavara corridor) is in urban/city area and will not pass through any forests. Hence no loss to forest is anticipated due to the project. However, about 1312 trees (1192 on main alignment and 120 on depot location) do exist in patches in the corridor selected for the project. The application has been made to Bangalore Municipal Corporation (BMC) for tree cutting/trimming at project site. Compensatory plantation will be made through afforestation drive to compensate loss of trees. As per guidelines for each tree felled 10 plants will be compensated. In total 13120 trees will be planted. These include trees in alignment, station area and Depot area.

128. In addition to the compensatory plantation, green belt area can be developed for the total 7.5 Km under the elevated corridor using native shrubs, herbs and grasses. A central ribbon area will be planted with small tree species which grows up to height of 4-5 m. The peripheral ribbons will be planted with grasses and perennial herbs interspersed with medicinal plants like Tulasi, Vinca, Evolvulus, Hemidiscus etc. Appropriate shade loving and light loving trees could be preferred depending on the location. Thus the green belt will provide aesthetic view of elevated track and also helps to serve as dust and noise absorbent barrier.

129. Efforts will be made to minimize the cutting of trees by transplantation of the young trees. Transplantation will be done in coordination with local forestry department. About 65 trees need to translocate to nearby park, which are having shallow root systems.

1.3 Issues related to Utility/ Drainage

130. Proposed metro line 6 is planned to run through the urban areas of Bangalore city from Gottigere - Nagavara. The alignment will cross many properties, drains/ nalas, large number of sub-surface, surface and utility services, viz. sewer, water mains, storm water drains, telephone cables, overhead electrical transmission lines, electric pipes, roads, 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. Since these affect construction and project implementation time schedule/ costs for which necessary planning/ action needs to be initiated in advance.

131. During construction phase there will be great amount of issues will be encountered for the utility system/infrastructure facilities already existing within the alignment. The most important and hazardous aspect will be has pipe lines network running along the alignment. A decision has to be taken regarding encasing these pipelines as shifting/relocating will be of great inconvenience to the residential areas. Also it is a hazardous operation of relocation and therefore a proper HAZOP study (& risk analysis) has to be conducted preconstruction period for any kind of handling of this issue in concurrence with gas supply agency. The similar study has to be conducted for water supply and High Tension lines with the concurrence with concern agencies.

1.4 Socio-Economic Impact

132. The preliminary social impact assessment on proposed Bangalore metro line 6 (Gottigere-Nagavara corridor) project reveals that due to land acquisition and impact on structures including non-titled holders, a total of 838 households will be affected, which includes 712 households linked to commercial units and 126 residential households. In addition, there are 153 tenants including 136 commercial and 17 residential will be affected due to the project. Based on the average household size of city it is estimated that about 3890 persons will be affected by the Project.

133. Due to the project proposal and land acquisition requirement, various types of structures will be affected under the Project. As per the preliminary estimation carried out by BMRCL, a total of 698 private structures will be affected due to the Project. Out of the 698 private structures, 642 are title holders and 56 are non-title holders.

134. The loss of livelihoods under the project includes business loss by owners (712), loss of rental income by residential owner (17), loss of rental income by commercial owners (136), business loss by commercial tenants (136) and commercial squatters (44).

135. The affected people will be compensated and assisted as per the provisions of Resettlement Policy Framework (RPF) for the proposed Gottigere-Nagavara Corridor of Bangalore Metro Phase II. Since the environmental and social safeguard of the project is to

be implemented with reference to EIB's Environmental and Social principles and Standards, the Bangalore Metro Rail Corporation Ltd. (BMRCL) prepared this RPF to ensure full compliance with the requirements of safeguard policies of both the aforesaid institutions and all applicable national policies.

136. Resettlement & Rehabilitation activities of BMRP will be governed by the following general principles, which are based on The Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013.

1.5 Impact on Historical places

137. There is no historical monument having any archeological value in the vicinity of the proposed alignment. Thus on this aspect there would be no impact.

138. Since the project involves tunneling for underground metro rail section there are possibilities that contractor may encounter artifacts during TBM operation. Chance find measures are included in the ESMP to minimize the impacts on historical / archeological artifacts, in case found during tunneling operation.

2. Impacts and Mitigation Measures Due to Project Design

139. Considered impacts, due to project designs are:

- Lighting,
- Risk Due to Earthquake
- Vibration due to TBM
- Project Affected People (PAPs).

2.1 Lighting

140. The platforms, concourse, staircase and escalator areas both for elevated and underground stations will have adequate and uniform fluorescent lighting to provide pleasant and cheerful environment. It is proposed to adopt the norms prevailing in Metro for illumination. It is pertinent to note that care has been taken at design stage itself to avoid too much illuminating the stations which could attract birds during night. Maximum illumination level proposed is 200Lux which provides normal lighting.

2.2 Earthquake

141. The project area lies in Zone II (seismically stable zone) of Bureau of Indian Standards (BIS) Seismic Zoning Map.

142. *Mitigation Measures:* Seismic factor proposed by India Meteorological Department (IMD) for the purpose of design of Civil Engineering structures shall be incorporated suitably while designing the structures. Relevant IS codes have also been adopted while designing the civil structures to sustain the earthquake of highest magnitude in Seismic zone II.

2.3 Vibration from Tunnel Boring Machine (TBM) and Metro Operation

143. Use of TBM will generate vibrations. This will affect structures of old houses, archaeological monuments, roots of plants and underground installations

144. Vibrations will also be generated due to blasting activities. This will be of specific importance while using blasting in congested areas and near old & archaeological significance.

145. *Mitigation Measures:* A study has been commissioned by BMRCL to National Physical Laboratory (NPL) to identify the impacts of using TBM near Tipu Sultan's fort and summer residence. German standard DIN 4150 and British standard BS 7385 as a reference standard (since no Indian standard exists). The impact found was nominal. None the less, some recommendations were made to minimize any such damage to structures. The depth of construction will be in approx. 18 m, at this depth, chances of hitting tree roots and underground installations is minimum. The study has concluded that the resultant peak particle velocity will not cause damage to the structure. The Archaeological Survey of India (ASI) has awarded an approval to the project on this basis

146. The intensity of vibration is directly proportional to the maximum explosive charge per delay used and the distance between the reference structure and the blast site. The permissible limits for the structure are governed by the limits prescribed by the Director General of Mines Safety. All precautions with regard to minimizing the maximum charge per delay shall be taken such that vibration levels shall not exceed the prescribed limit.

147. The vibration is generally caused from rail-wheel interaction. This can be reduced by minimizing any surface irregularities on the wheel and rail by wheel turning and rail grinding respectively. To minimize the vibration shock absorbing pad has to be provided and there has to be a distance between rail seat assembly and concrete plinth.

2.4 Project Affected People (PAPs)

148. The project will require acquisition of about 270,712.07 square meters of land. Due to land acquisition and impact on structures including non-titled holders, a total of 838 households will be affected, which includes 712 households linked to commercial units and 126 residential households.

149. The affected people will be compensated and assisted as per the provisions of Resettlement Policy Framework (RPF) for the proposed Gottigere-Nagavara Corridor of Bangalore Metro Phase II. A Resettlement Action Plan (RAP) will be prepared based on the detailed socio-economic assessment of PAPs.

3. Impacts and Mitigation Measures Due to Construction Work

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

- Top soil erosion (depot), pollution and health risk at construction site,
- Traffic diversion and risk to existing building,
- Dust generation,
- Increased water demand,
- Impact due to supply of construction material,
- Disposal of construction and demolition waste,
- Excavated soil disposal problems,
- Impacts due to batching plant and casting yard,
- Noise pollution,
- Impacts of labour camps.

3.1 Soil Erosion Impact

151. Change in land use and excavation of soil will lead to soil erosion. Every care has to be taken to avoid damage to the topsoil (more specific) from median, and depot site topsoil. It has to be preserved and utilized. Problems could arise from dumping of construction spoils (concrete, bricks) waste materials (from contractor camps) etc. causing surface and ground

water pollution. However, it is proposed to have mix concrete directly from batching plant for use at site. Health risks include disease hazards due to lack of sanitation facilities in labour camps (water supply and human waste disposal) and insect vector disease hazards of local workers and disease hazards to the local population.

152. *Mitigation measures* should include proper water supply, sanitation, drainage, health care and human waste disposal facilities. In addition to these, efforts need to be made to avoid water spills, adopt disease control measures and employment of local labour. Problems could arise due to difference in customs of workers from outside and local residents. These risks could be reduced by providing adequate facilities in worker's camps, raising awareness amongst workers and by employment of preferably local labour.

3.2 Traffic Coordination issues

153. During construction period, complete/partial traffic diversions on road will be required, as most of the construction activities on elevated sections are on the part of existing highway and service road. Traffic would not get affected on the highway but on service roads, rather than completely blocking the roads it will be advisable to make the service roads as one way to allow for operation of traffic together with construction activities. Advance traffic updates/information on communication systems will be an advantage to users of affected roads. The rail corridor does not pose any serious risk to existing buildings since there is safe distance between buildings and proposed corridor except at a few shops the alignment is passing over the temporary shops. Here special care has to be taken for safety of the structures during construction when they will be shifted for short duration.

3.3 Excavated Soil Disposal

154. The proposed alignment is both elevated and underground; there are 6 elevated stations and 12 underground stations with one ramp. Soil excavation is found at the ramp area and the underground alignment. From the estimations made on the basis of preliminary drawings and literature study, it is estimated that the total quantum of soil to be excavated at proposed alignment is about 10.81 lakh cubic meters. The excavated soil can be used for backfilling.

155. *Mitigation Measures:* The soil would be used for refilling at station site but muck from tunnelling part will be disposed off at locations/sites approved by pollution control board and BMC. Responsibility of disposal of this soil will lie with contractor and will be regulated by BMC rules. Some Bentonite muck would also be generated in the project. Disposal of Bentonite would be at designated land fill site.

3.4 Air Pollution due to Dust Emission

156. During construction phase, incremental air quality levels (Suspended Particulate Matter) will be observed as per the routine experience during any such construction activity.

157. Transportation of soil 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. Movement of trucks and other heavy equipments at construction site would generate dust during construction phase. With the development of the activity the major issues related with ambient air quality will be the construction activity including access roads, movements of construction vehicles and whereas post-construction activity will have movement of vehicular traffic. All the measure will be taken to avoid any deviations in the air quality by adopting scientific methods, which includes mandatory EURO II certification to construction vehicles, dust entrapment, water sprinkling, etc. (ensure the contractor) Emission from above sources will have temporary but not significant impact on air quality.

158. Deterioration in ambient air quality during construction stage is expected to occur due to the transportation of material required for construction, various construction activities, vehicular emissions etc. However, implementation of appropriate measures (listed above) will help in keeping the air quality level below existing background levels.

159. *Mitigation Measures:* The main source of air pollution in the proposed project occurs only during construction. Transportation of construction materials, excavation and filling of land are the major sources of dust. This can be reduced to a greater extent by optimized use of soil material within the vicinity. Water should be sprayed at the construction site / vehicle movement areas regularly to reduce dust emissions. Adequate dust suppression measures particularly near habitation, such as water sprinkling, covering / area concealing etc. should be practiced to control fugitive dust during construction. All vehicles, equipment and machinery used for construction shall be regularly maintained to ensure that the pollution emission levels to meet the prescribed norms of CPCB.

160. Vehicles carrying earth, cement and other construction material shall be suitably covered during transportation in order to reduce spreading of material all along the road. There will not be any built up pollutants in the long run. Green belt development will also serve an effective way to reduce air pollution. Some of the effective species which absorb air pollutants are Azadirachta indica, Terminalia chebula and Dalbergia sissoo, Albizia amara and Mangifera indica are proposed under greenery development.

3.5 Water Demand

161. The water demand will increase during construction phase for meeting out drinking and domestic water requirement of workers. Sufficient water for construction purpose would be made available by BMC as it is responsible for water supply in Bangalore. Water requirement for construction of metro rail will be met through the public supply. It is suggested to use treated STP water for the purpose of construction. Proper care shall be taken while drawing water from public facilities to avoid any negative impact on the residents living in the vicinity of project whose water demand is, in any case, met by Bangalore Municipal Corporation supplied water.

3.6 Construction Material

162. Metro construction is a material intensive activity. Huge quantity of different construction materials will be required for construction of metro corridor both underground and elevated sections. These shall be sourced from the nearest source. Quarry operations are independently regulated activities and outside the purview of the project proponent. It is nonetheless, appropriate to give consideration to the environmental implications in selection of quarry sources since poorly run operations create dust problems, contribute noise pollution, ignore safety of their employees, or cause the loss of natural resources. So, the construction material shall be sourced only from legalized and approved quarries.

3.7 Construction and Demolition Waste Impacts (Debris)

163. Construction and demolition debris is defined as that part of the solid waste stream that results from land clearing and excavation, and the construction, demolition, remodeling and repair of structures, roads and utilities. Construction and demolition waste includes concrete, stones and dirt generated during excavation (sometimes collectively referred to as "fill material" or rubble). Construction and demolition waste may be generated from Pile caps, residual cement bags, residual steel scrap, excess construction material stacked at site etc. It is a waste stream that is separate and distinct from residential and commercial waste, commonly called municipal solid waste.

164. *Mitigation Measures:* The Construction and demolition waste would be handled and disposed off to waste processing facility or for back filling of low lying areas, leaving no significant impact on environment.

3.8 Casting Yard and Batching Plant Impacts

165. During construction phase there would be establishment and operation of Batching Plant and Casting Yard which would be located in an area designated and allotted by BDA away from habitation. There would be requirement to get NOC (Consent to establish) and Consent to operate under water and air Acts from Karnataka Pollution Control Board. Simultaneously, there would be requirement to get the authorization for storage and handling of hazardous chemicals to store and handle used oils and other such materials. The Application forms for seeking Consent to establish; Consent to operate and Authorization for storage of Hazardous chemicals are available from the office of Karnataka Pollution Control Board at Bangalore.

166. There would be significant movement of men, material and machinery in batching plant and casting yard. It is expected that both batching and casting yard would be located at same complex. Huge quantity of cement, aggregates and other construction materials would be used in batching plant and casting yard. There would be generation of dust, noise, flue gases and other contaminants from the working of heavy machinery for handling and transporting the construction materials. The mitigation measures have been elaborated in EMP.

3.9 Noise Levels

167. The noise pollution will be generated by construction activities, mainly due to digging, piling etc. and also due to the construction equipments if they are not in maintained condition. Also during such activities if existing vehicular traffic is not properly diverted then congestion and then continuous honking habits will also lead to incremental noise levels which are of indirect nature. This will also pave way for vehicular air pollution which is also to be minimized effectively. The metro line construction is equipment intensive.

3.9.1 Noise Due to Operation of Construction Equipments

168. The major sources of noise during construction phase are due to operation of various construction equipments. The noise levels generated by various construction equipments are given in **Table 21**.

Table 21: Average Noise Levels Generated by the Operation of Various Construction Equipments

Equipment	Noise level (dB(A))
Floating pontoon with mixer machine and crane	70
Winch machine	80
Transit mixer	75
Dumpers	75
Generators	85
Batching plant	90
Dredger	85
Booster pumps	85

169. No increases in noise levels are anticipated as a result of various activities, during the project construction phase due to the following:

- i) Assumption that all equipment are operating from a common point leads to over-estimation of increase in noise level
- ii) Attenuation of 30 dB(A) of noise by wall of any structure
- iii) Noise attenuation due to various factors.

3.9.2 Noise due to increased vehicular movement

170. During construction phase, there will be significant increase in vehicular movement for transportation of construction material. In addition to the noise mentioned above, there will also be background noise of the usual traffic resulting due to traffic congestion and confusion arising due to traffic diversion measures. Efforts should be made to keep the noise levels under control by appropriate noise attenuation and adopting employee safety measures. Temporary route direction markings will be placed in appropriate locations. At present, there is no vehicular movement near the barrage site. During construction phase, the increase in vehicular movement is expected to increase up to a maximum of 5 to 6 trucks/hour (Table 22).

Table 22: Increase In Noise Levels Due to Increased Vehicular Movement

Distance (m)	Ambient noise level dB (A)	Increase in noise level due to increased vehicular movement dB (A)
10	36	72
20	36	67
50	36	61
100	36	57
200	36	52
500	36	46
1000	36	42

171. As mentioned earlier, there will be significant attenuation due to various factors, e.g. absorption by construction material, air absorption, atmospheric inhomogeneties, and vegetal cover. Thus, no significant impact on this account is anticipated.

3.9.3 Noise Generated due to Drilling

172. The noise levels monitored at a 10 m distance from the source and operator's cabin is given in the **Table 23**.

Table 23: Noise Generated Due To Drilling

Equipment	Noise level at source dB (A)
Standing idle (inside cabin)	70-72
Standing idle (10 m radius)	72-74
On load (inside cabin)	78-80
On load (10 m radius)	82-84

173. The noise levels during various construction activities have been compared to various standards prescribed by Occupational Safety and Health Administration (OSHA), which are being implemented in India through rules framed under Factories Act. For 8 hour duration, equivalent noise level exposure should be less than 90 dB (A).

3.9.4 Impacts of Noise on Labour

174. The effect of high noise levels on the operating personnel has to be considered as this may be particularly harmful. It is known that continuous exposures to high noise levels above 90 dB(A) affects the hearing acuity of the workers/operators and hence, should be avoided. To prevent these effects, it has been recommended by Occupational Safety and Health Administration (OSHA) that the exposure period of affected persons is limited (**Table 24**).

Table 24: Maximum Exposure Periods Specified By Osha

Maximum equivalent continuous Noise level dB(A)	Unprotected exposure period per day for 8 hrs/day and 5 days/week
90	8
95	4
100	2
105	1
110	½
115	¼
120	No exposure permitted at or above this level

175. *Mitigation Measures:* For elevated corridors, ballast less track structure is supported on two layers of rubber pads to reduce noise and vibrations. In addition, baffle wall as parapets will be constructed upto the rail level so as reduce sound levels. Noise at source will be controlled or reduced by incorporating suitable feature in the design of structures and layout of machines and by use of resilient mounting and dampers etc.

176. To reduce the harmful effects, personnel working at high noise levels would be provided with noise protective gears such as ear muffers, sound barriers etc. Vehicles used for transportation of construction materials would be equipped with proper silencers. Careful planning has been made to operate the construction equipments to have minimal disturbances. The construction equipments would be run only during the daytime and their noise would be monitored as per CPCB standards.

3.10 Loss of Historical and Cultural Monuments

177. No historical/ cultural monuments will be lost as a result of the proposed development. Since the project involves tunneling for underground metro rail section there are possibilities that contractor may encounter artifacts during TBM operation Chance find measures are included in the ESMP to minimize the impacts on historical / archeological artifacts, in case found during tunneling operation.

4. Impacts and Mitigation Measures Due to Project Operation

178. Along with many positive impacts, 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 pollution,
- Water supply and sanitation at Stations,
- Station refuse disposal and sanitation,
- Pedestrianization and visual issues,
- Safety.

4.1 Noise Levels

179. Operation phase is extremely important from two important environmental issues viz. noise levels and vibration levels. The noise will be generated due to friction of the rolling stocks on the tracks which will generate incremental noise levels. The major noise level generating activities includes 1. Approach and braking of rolling stocks 2. Rolling stock leaving from station, 3. During its travel between two stations and 4. Announcements on the Metro station. These noise generations for all above activities have been recorded from past experience from existing Metros in India as well as project authorities. The following data includes various noise levels in above activities. 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. Airborne noise is radiated from elevated structures. The noise level at 2 m distance from the rail alignment is about 73 dB(A). The noise level reduces with distance logarithmically. Refer **Tables 25 and 26**.

Table 25: Exterior Noise Levels in Metro Stations

S. No.	Description	Average Noise Levels (dB)A
		Elevated tracks
1	Background Noise Level	64.0± 1.5
2	Train entering the PF (Max)	80.0± 1.5
3	Train leaving the PF (Max)	75.0± 0.5
4	Train stationary in PF	67
5	Train running at 75 Kmph	82 (7.5 meters on centre of the track on either side)

Table 26: Interior Noise Levels in Metro Trains

S. No.	Description	Average Noise Levels (dB)A
		Elevated tracks
1	Train stationary (Saloon) Elevated and At- Grade	68
2	Train stationary (Driving Cab) Elevated and At- Grade	68
3	Train running@ 75 Kmph in saloon at Elevated	75
4	Train running@ 75 Kmph in Driving Cab at Elevated	70

180. *Mitigation Measures*: Establishment of tree cover all along the corridor and precast concrete parapet blocks on either side of tracks will further reduce the noise levels during operation phase. In addition, an appropriate chronological land use planning would be made available to prevent and minimize noise and vibration impacts.

4.2 Water and Sanitation Requirements at Stations

181. Public facilities such as water supply, sanitation and washrooms are very much needed at the stations. The water requirement for stations would be for drinking, toilets, cleaning and also for other purpose like AC. Water Demand as per existing Metro corridors (in India) is calculated and presented in **Table 27**. It is assumed that there would be similar water requirements in Bangalore Metro as well. Raw water should be treated and brought to national drinking water standards, before used for consumption. In addition, water will be required for contractor's camps during construction. The water requirement for the stations will be met through the public water supply system or purpose built tubewells after taking necessary approvals from CGWA.

Table 27: Water Requirement At Stations

Sr. No.	Particular	Water Demand for each station KLD
1	At Stations for Drinking Purpose	6
2	In Elevated stations for AC, cleaning, chiller and other purposes	17
Total		23

182. Thus there would be total water requirement of 322 KLD in 14 stations out of which 274KLD of wastewater will be generate. However, arrangement of water will have to be made at each station separately with proper drainage system for wastewater.

183. *Mitigation Measures:* Wastewater generated will be collected and treated prior to disposal into municipal drains. Efforts should be made conserve the water by recycling water in the system. Also, as an environmental conservation measure, rainwater harvesting structure will also be constructed at stations and along the viaduct.

4.3 Solid Waste Generation at Stations

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

- Garbage,
- MSW (Municipal Solid Waste)
- Floor Sweepings

185. As per the available data from Delhi Metro Phase I and II, the solid waste generation is about 0.8 – 1.2 cum/day at elevated stations. At elevated stations, the solid waste generation is more due to airborne dust compared to underground stations. Thus about 12 to 18 cum of solid waste will be generated from 12 stations of this corridor of line 6 of Bangalore Metro Phase II. The maintenance of adequate sanitary facilities for temporarily storing refuse on the premises is considered a responsibility of the project authorities. The storage containers for this purpose need to be designed. However it is suggested that the capacity of these containers should not exceed 50 litres and these should be equipped with side handles to facilitate handling. To avoid odour and the accumulation of fly-supporting materials, garbage containers should be washed at frequent intervals.

186. *Mitigation Measures:* The construction activities will generate approximately 10.81 lakh cubic meters of soil/debris causing soil erosion during excavation. This can be mitigated by utilizing around 35 % of excavated soil for land filling purposes. The excavated top fertile soil is suggested to be preserved and used later for gardening and lawn establishment. Soil erosion by runoff will be controlled by installing proper drainage systems using contour information. Proper land use plan has been suggested with technical evaluation. Since there

is bulk quantity of soil is generating at the underground alignment area, it is suggested to avoid bringing soil from outside the project boundary and to use the excavated mounds for filling low laying area where it is necessary. Thus, both cost and time saving suggestions have been made in land leveling and soil transportation.

4.4 Aesthetics

187. The introduction of metro system implies a change in streets through which it will operate. An architecturally well designed elevated section can be pleasing to the eyes of beholders. Recent metro rail projects have attempted to incorporate this objective in their designs. Since a low profile would cause the least intrusion, the basic elevated section has been optimized at this stage itself.

4.5 Safety

188. During operation accidents related to train operation like collision, derailment, fire, power outages, or operation stoppage may occur.

189. *Mitigation Measures:* In the unlikely event of simultaneous tripping of all the input power sources or grid failure, the power supply to stations as well as to trains will be interrupted. A standby silent type DG set of adequate capacity at underground stations will sustain the following: essential lighting, signalling, and telecommunications, fire fighting system, lift operation, and tunnel ventilation.

190. To provide a high level of safety with trains running at close headway ensuring continuous safe train separation, eliminate accidents continuous speed monitoring and automatic application of brake in case of disregard of signal / warning by the driver, and provides safety and enforces speed limit on section having permanent and temporary speed restrictions Automatic Train Protection and Automatic Train Supervision sub-systems will be installed.

191. CCTV system will provide video surveillance and recording function for the operations to monitor each station. The monitoring shall be possible both locally at each station and remotely from the OCC.

192. In view of the potential hazards from system failure resulting to accidents, both on- site and off-site emergency measures will be implemented. Emergency conditions during operation includes fire inside the tunnel generating smoke in the tunnel or station track way. During such situation, the tunnel ventilation system will automatically activate providing smoke-free path for evacuation of passengers and for the fire fighting purposes. The ventilation system is operated in a 'push-pull' supply and exhaust mode with jet fans or nozzles driving tunnel flows such that the smoke is forced to move in one direction, enabling evacuation to take place in the opposite direction depending upon the location of Fire on the train. All trains will have public address systems to warn the passengers of any emergency situation.

5. Impacts and Mitigation Measures Due to Depot

193. One Depot is proposed at Kothanur. The depot will have following facilities:

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

194. These facilities will could generate water and noise issues. The depot area may have to be filled up. Problems anticipated at depot sites are:

- Water supply,
- Oil Pollution,
- Cutting of trees
- Sanitation,
- Effluent Pollution,
- Noise Pollution,
- Surface drainage.

5.1 Oil spills

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

5.2 Noise Pollution

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

197. The vibration of concrete structures also radiates noise. Due to less activity, no impact on the ambient noise is anticipated.

198. Appropriate arrangements will be made for proper management of following requirements,

5.3 Water Requirement

199. Water supply will be required for different purposes in the depot. The water requirement for drinking will be 500 litre per day and 1,00,000 litre per day for other requirements (Departments and Contractors office). Rainwater harvesting structures are included in the project design as a water balance measures.

5.4 Solid and Hazardous Waste

200. At per available data, it is estimated that about 2 ton/month of solid waste will be generated from the Depot site which will be taken by the cleaning contractor weekly and disposed to the municipal waste disposal sites.

201. Sludge of the order of 250 kg/year is expected to be generated from the ETP/STP that will be stored in leak proof containers and disposed off as per State Pollution Control Board site.

202. Oil and grease of the order of 2652 litres/ year will be produced from the Depot which will be disposed off through approved re-cyclers.

203. About 2.5 ton/month of iron turning of the PWL for the wheel profiling will be generated from the Depot.

6. Chance Heritage Finds During Tunneling and Cut-and-Cover

204. Although there are no structures or sites of historical or cultural importance are reported in project influence area, however since project alignment is in urban areas there may be possibilities that some artifacts could be found during tunnel excavation work. It very likely that artifacts are buried in the tannery road area.

205. *Mitigation Measures:* before start of tunneling work the contractor and BMRCL will coordinate with Karnataka Archeological department to reconfirm that there are presence of buried artifacts along the tunnel alignment. No tunnel boring or excavation will be allowed unless cleared by the archeological Department.

206. All workers will undergo a briefing with the Archaeology Department to ensure safeguarding of heritage resource and cultural/religious practices.

207. A proof of compliance to this requirement to include the name of participants and date and location of briefing will form part of the monthly report to the CSC.

208. The contractor will comply with the FIDIC Sec. 4.24 on Fossils. Recording (including chain of custody) will be made by the contractor to be validated by the CSC, and expert verification will be made by the Archaeology Department. Temporary work stoppage in the immediate area of the chance find for up to 72 hours to allow for the on-site representative of Archaeology Department to visit the site to make an assessment and provide instructions. Work in the areas adjacent to the chance find will continue as provided in the detailed design.

F. ANALYSIS OF ALTERNATIVES

1. Introduction

209. The Metro was one of the principal objectives of the City's Master Plan and Comprehensive Traffic & Transportation Plan (CTTP). Several alternatives were considered by the BMRCL before arriving at the preferred mode of transport and technical design.

2. Need to Increase Public Transport Share

210. Due to the growing population and economic activities, the traffic problems in Bangalore have been aggravated. The limited road transport system of Bangalore is not able to handle the current traffic. So, Government of Karnataka had decided to implement the metro rail system in city.

211. Traffic Model: Detailed Household surveys and various traffic surveys were carried out during the DPR study. The Transport Demand model was developed and the future OD-Matrices based on the projected Population and employment was developed. The Network for the proposed Gottigere – IIMB - Nagavara alignment has been developed from the same primary database and used in the Transport Demand Model. The Four Stage Transport Demand Model involving trip generation, Trip distribution, Modal Split and Assignment has been used.

212. Bangalore Master Plan: Revised Master Plan-2015 for the BMA gives the likely growth to take place in various areas of the BMA. The population of the BMA is expected to grow from 61 lakh in 2001 (70 lakh in 2006) to 88 lakh in 2015 and 122 lakh in 2025. The plan also gives locations of various land uses such as residential, commercial, industrial, IT uses etc. The proposed growth of population and economy is expected to generate high travel demand. Transport network will also need to be augmented to cater to the expected travel demand.

213. Comprehensive Traffic & Transportation Plan (CTTP): One of the proposals of CTTP (2007) for Bangalore, which will cater to requirements of the projected travel demand up to the year 2025, is the metro rail system. The Phase 1 corridors may be able to give relief to the immediate traffic problems within the core areas and its immediate neighborhood but by the time the Master Plan proposals get implemented and development of areas beyond the outer ring road takes place in right earnest, the above system will fall short and a more extensive system will become necessary. This is especially true because the Master Plan 2015 and its detailed Zonal plans propose the development of around 814.4 Sq. Kms. of area for various urban uses. This brings very large spread of area on which various urban activities will take place. They would now be located right upto the Peripheral Ring Road in practically all directions and at a few places even beyond it. These activities include some with huge employment potential areas like the Electronic City in the east and southern portions of the BMA. It is therefore necessary that the Metro should get extended to the most of the high density centres. Therefore the Phase II corridors have been proposed.

3. Analysis of Alternatives

214. The final alignment for the proposed corridor has been finalized after taking into account environmental and social concerns, considerations of traffic, integration with the existing system and importantly, the overall economic and financial viability. The underlying principles for evaluation for each corridor, without affecting the overall usefulness of the corridor, are:

- Minimum private land acquisition,
- Least disturbance to properties,
- Minimum disturbance to people and

- Minimum disturbance to ecology/ biodiversity.

215. In the analysis of alternatives, a comparison of scenario with and without the project has also been made. Advantages and disadvantages have been spelt out and the analysis is quite exhaustive. These being the over-riding criteria, financial implications of these alternatives were not worked out.

4. No Project Alternative

216. In case the proposed corridor is not constructed, the city will be deprived of the following benefits:

- Economic prosperity,
- Mobility and access to economic opportunities,
- Comfort and Safety, particularly for women and differently abled people,
- Traffic Congestion Reduction, Reduction in Number of Buses,
- Reduced Fuel Consumption, Reduced Air Pollution,
- Carbon Dioxide and Green House Gases (GHG) Reduction,
- Optimality in transportations

217. Since the positive impacts are more than a few negative impacts, consideration of 'no development alternative' is a non-starter and has thus not merited any further consideration.

G. CONSULTATIONS, PARTICIPATION AND INFORMATION DISCLOSURE

1. Consultations

218. EIB and AIB policies require projects to carry out meaningful public consultation on an ongoing basis. Public consultation will: (i) begin early and carry on throughout the project cycle; (ii) provide timely disclosure of relevant information, understandable and accessible to people; (iii) ensure a free and un-intimidated atmosphere without coercion; (iv) ensure gender inclusiveness tailored to the needs of disadvantaged and vulnerable groups; and (v) enable the incorporation of all relevant views of affected people, and stakeholders into project decision making, mitigation measures, the sharing of development benefits and opportunities, and implementation issues.

219. Public consultation and participation is a continuous two way process, involving, promoting of public understanding of the processes and mechanisms through which developmental problems and needs are investigated and solved. The public consultation, as an integral part of environmental and social assessment process throughout the project preparation stage not only minimizes the risks and unwanted political propaganda against the project but also abridges the gap between the community and the project formulators, which leads to timely completion of the project and making the project people friendly.

220. Public consultation/information is an integral part of the BMRCL project cycle. Public consultations with the Project Affected People (PAPs) were made. Attention was given to potential vulnerable people like, squatters, encroachers, schedule caste, and other backward section (OBC) of society were consulted to make them aware and identify adverse impacts of the project.

221. The consultation process in the project started early in line 6 corridor that has a number of issues relating to land acquisition, rehabilitation of affected persons. BMRCL held extensive consultation with PAPs to appraise them on the project benefits, resettlement and rehabilitation measures in the project, redressal of grievances etc.



1.1 Consultation with PAPs

222. As required for the project, consultations were conducted at the early stage of EIA preparation, mostly involving PAPs.

1.2 Public Consultation

223. Consultations were held with PAPs during preparation of this EIA as well as in the process of land acquisition. A formal public consultation session was held on 18 May 2017 at BMRCL Byappanahalli Training Institute, Bangalore to inform the people about project and discuss the resettlement policy framework. Besides this there are several informal consultation session and focus group discussions were organized as part of the project. Details of above public consultation meetings including public notice, list of participants, photographs and public queries & answers are enclosed as Appendix 4.

Table 28: Details of public consultation en-route the proposed transmission lines

Sl. No.	Date & time Consultation	Venue	Person Attended
1.	15 May 2017 11.00 AM	At- BMRCL Byappanhally Training Institute City- Bangalore State- Karnataka	Total 70 PAPs
			
Consultation Session		Stakeholder Consultation Session	

1.3 People's Perception

224. The project has received acceptability among the local people as it will provide smooth flow of traffic and reduce travel time and fuel consumption and subsequently air emissions. The project will bring positive socioeconomic changes in the area. The detailed facts and perception of both the likely affected persons (APs) and other stakeholders are given below:

- It has been observed that by and large all the stakeholders involving affected persons and other stakeholders are aware of the project.
- Local people showed satisfaction during public consultations as the project will provide hassle free movement in the congested part of the city.
- Local people requested that suitable mitigation measures should be taken to mitigate the adverse environmental impacts during the construction period due to shifting of utilities, movement of heavy equipment and noise pollution etc.
- Suggestions were made to control air pollution (dust) during construction by sprinkling of water.
- Local people suggested that air and noise quality should be monitoring regularly during construction period.
- Concerns were raised on the possible impact of vibration.
- Although the project does not attract EIA Notification of 2009 (MoEFCC), pollution control related consents should be secured.
- Suitable safety measures should be taken in the project during construction and operation phases.
- Removal of people (particularly Jeddimara slum area) and demolition of properties for constructing the stations should not be taken before disbursement of compensation and resettling the people.

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

225. BMRCL has addressed the issues raised by public and ensured people that adequate measures are incorporated in the design to minimize adverse environmental and social impacts.

2. Information Disclosure

226. Information disclosure will follow the procedure for EIB and AIIB ESP environmental and social category A projects. It is the policy of the AIIB to have environmental and social assessment reports made available/accessible to the general public.

227. All environmental documents are subject to public disclosure, and therefore, will be made available to the public. This EIA will be disclosed on EIB and AIIB websites. This EIA will be made available for perusal at the EIB and AIIB Offices, at BMRCL HQ in India as well as at other locations accessible to stakeholders (to be determined by the BMRCL). BMRCL will ensure that meaningful public consultations, particularly with project affected persons' are undertaken through the entire project cycle, the design, installation and operation phases.

228. The ESMP includes a grievance redress mechanism (GRM) so that any concerns raised during construction or operation can be addressed.

H. GRIEVANCE REDRESS MECHANISM

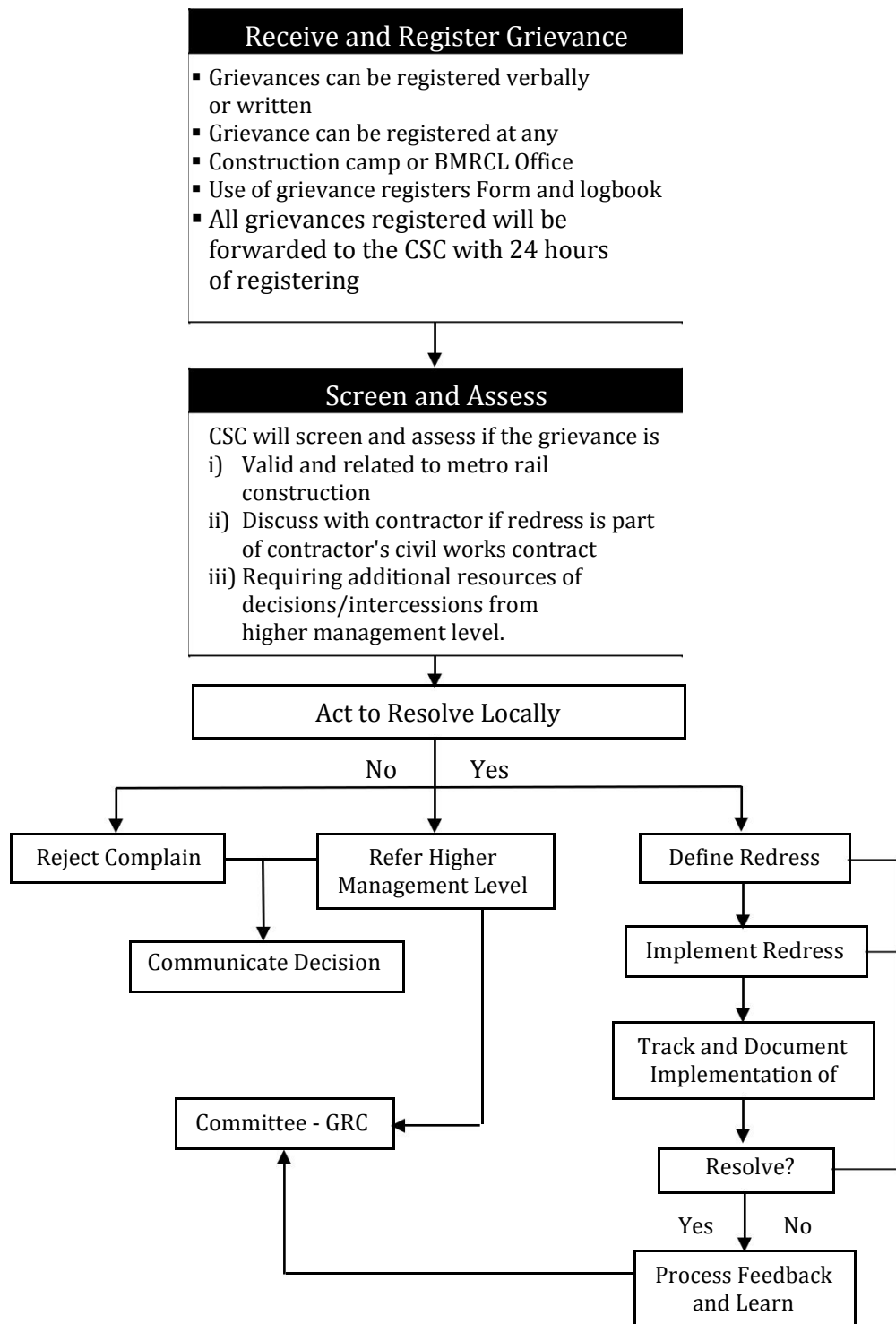
229. Grievance Redress Mechanism (GRM) is an integral and important mechanism for addressing/resolving the concern and grievances in a transparent and swift manner. Grievances related to the implementation of the project, particularly regarding the environmental management plan will be acknowledged, evaluated, and responded to the complainant with corrective action proposed.

230. Many minor concerns of peoples are addressed during public consultation process initiated at the beginning of the project. For handling grievance, Grievance Redress Committee (GRC) will be established at two places, one at the project/scheme level and another at Corporate/HQ level. The Committee comprises of following members under the Chairmanship of Director (Projects and Planning):

1. Director (Projects and Planning), Chairman
2. General Manager (LA & E), Convener
3. General Manager (F & A), Member
4. Chief Public Relation Officer, Member
5. Chief Engineer (Reach 6), Member
6. Manager (Transportation), Member
7. Tahsildar, Member

231. Grievances of people / communities will be first brought to the attention of BMRCL. Grievances not redressed by the staffs (field level) will be brought to the Grievance Redressal Committee (GRC). The GRM framework is shown in the Figure 18.

Figure 18: Grievance Redress Mechanism



I. ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN

1. Introduction

232. The Environmental and Social Management Plan (ESMP) is the synthesis of all proposed mitigation and monitoring actions, set to a time-frame with specific responsibility assigned and follow-up actions defined. It contains all the information for the proponent, the contractor and the regulatory agencies to implement the project within a specified time-frame.

233. This ESMP consists of a set of mitigation, monitoring and institutional measures to be taken for the project to avoid, minimize and mitigate adverse environmental and social impacts and enhance positive impacts. The plan also includes the actions needed for the implementation of these measures. The major components of the Environmental and Social Management Plan are:

- Mitigation of potentially adverse impacts;
- monitoring of ESMP implementation during project implementation and operation; and
- Institutional arrangements to implement the ESMP.

2. Objectives of Environmental and Social Management Plan

234. The main objectives of this ESMP are:

- To ensure compliance with lenders (EIB and AIIB) applicable safeguard policies, and regulatory requirements of Karnataka State and the Government of India;
- To formulate avoidance, mitigation and compensation measures for anticipated adverse environmental and social impacts during construction and operation, and ensure that socially acceptable, environmentally sound, sustainable and good practices are adopted; and
- To stipulate monitoring and institutional requirements for ensuring safeguard compliance.

3. Mitigation Measures

235. The identified environmental issues and suggested mitigation measures with institutional arrangements for implementation, supervision and monitoring have been provided in a matrix format as presented in Table 31. This matrix together with BMRCL's SHE Manual will be part of the contractor's bidding documents. However, the key anticipated potential impacts and suggested mitigation measures specific to the project are summarized in following paragraphs. These mitigation measures will be implemented as part of the project.

3.1 Impacts

236. The key anticipated adverse environmental and social impacts from line 6 corridor are:

1. Change in land use due to acquisition of 270,712.07 square meters of land.
2. Loss of properties / structures of a total of 838 families involving 3890 project affected persons.
3. Impacts on surrounding area due to tree cutting (1312) for the proposed improvement work;

4. Noise and vibration impacts due to operation of tunnel boring machine, excavation machines, and materials hauling.
5. Increased noise and air pollution resulting from traffic volume during construction
6. Temporary impact on land and air environment due to locating construction camp;
7. Temporary impact on land, air and water environment due to establishing and operating construction plants (Hot Mix Plant and Diesel Generator [DG] sets);
8. Impact on air quality, water quality, drainage, road users due to construction activities of project road;
9. Impact on land and water environment due to disposal of construction waste materials; and
10. Impact on occupational health and safety due to all onsite and offsite construction works.

3.2 Mitigation Measures

3.2.1 Compensation for Loss of Land and Displacement of People

237. The project will require acquisition of about 270,712.07 square meters of land affecting a total of 838 households and 698 private structures. The affected people will be compensated and assisted as per the provisions of Resettlement Policy Framework (RPF) for the proposed Gottigere-Nagavara Corridor of Bangalore Metro Phase II. Resettlement & Rehabilitation activities of BMRP will be governed by the following general principles, which are based on The Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013.

238. The total R&R cost estimate (including compensation for land acquisition) is approximately Rs. 23100 millions.

3.2.2 Compensation for Loss of Trees

239. It is estimated that 1312 trees (1192 on main alignment and 120 on depot location) are likely to be cut due to the proposed Reach 6 corridor. A compensatory plantation will be made through afforestation drive to compensate loss of trees. As per guidelines for each tree felled 10 plants will be compensated. In total 13120 trees will be planted. The total value of these trees lost is Rs. 2.67 lakhs. These trees would have occupied about 8.01 ha area @ Rs. 1000 /tree. Thus, the compensatory reforestation cost for the proposed alignments will be 131.20 lakhs, which includes roadside plantation.

3.2.3 Green Belt Development

240. In addition to the compensatory plantation, green belt area will be developed for the total 7.50 Km under the elevated corridor using native shrubs, herbs and grasses. The design of the project shows that in the elevated section of the track, the lower edge of the track will be at 5.5 m height from the ground level with pillars at every 25 m interval, each pillar having 1.5 m diameter. A central ribbon area will be planted with small tree species which grows up to height of 4-5 m. Thus the green belt will provide aesthetic view of elevated track and also helps to serve as dust and noise absorbent barrier.

241. Cost estimates for 1 km Green belt development under the elevated track (width of ribbon = 1.5m) is calculated as below and shown in Table 29.

- One row of small trees at three meter intervals in the central ribbon @ Rs. 125/sapling for 333 saplings (for 1 km elevated length) = Rs. 41600.00

- Small shrubs on both sides of central ribbon to cover 0.75 m width @ Rs. 50/sapling or 1333 saplings for two sides = 2666 seedlings
- Rs. 50 x 2000= Rs. 133300.00
- Grasses and perennial herbs on both the sides of 1000 m @ Rs. 50/m² to cover balance 0.75 m width
- Rs. 50 x 0.75 m x 2000 m = Rs. 75000.00

Table 29: Cost Estimate for Green Belt Development along the proposed alignment

Green belt type	Establishment cost for 1 km	Gottigere to Nagavara (7.50 km)
Small trees	41600	312000
Shrubs	133300	999750
Grass/herbs	75000	562500
Total (INR)	2,49,900	18,74,250

242. The total cost for green belt development under the elevated track for the entire 07.50 km stretch is about 18.74 lakhs.

3.2.4 Transplantation of Trees

243. About 65 trees need to translocate to nearby park, which are having shallow root systems. This requires Rs. 3,000 tree towards translocation expense resulting a total Rs. 2.0 lakhs is required to translocate 65 trees without any damage.

3.2.5 Water Supply and Sanitation

244. The water demand for the proposed project is expected to be around 450 m³ and 300 m³ during construction and operation phases respectively. Much of the water required for construction would be met by treated water from nearest BWSSB and the additional water would be procured from private water supplier chain.

245. Runoff from the construction site can be a source of water pollution. Cement based products/ dust carried by the runoff from the land surface can pollute surface water bodies. Surface covers are proposed to be spread on the land to prevent dust settlement on the land surface. Proper sanitary facility will be made available for the construction workers. The construction workers drinking water demand will be fulfilled only through ground water. Efforts shall be made to reduce the wastage of water during construction by encouraging water recycling techniques. During the operation phase, adequate water supply and sanitation facilities would be made available at all the stations.

3.2.6 Oil Pollution Control

246. There should be provision for the collection of oil and grease generated from construction equipments and sent for their treatments. Precautionary measures have been suggested to prevent these wastes moving in to ground or surface water bodies, as they are important sources of water for domestic use. Oil traps in the heavy machinery area are suggested to collect oil based materials. Similarly, sedimentation basins would be erected prior to the water discharge point to reduce the sedimentation load in the storm water. Since Metro rail is operated through electricity, there will be less chance of oil pollution.

3.2.7 Noise Pollution Control

247. For elevated corridors, ballast less track structure is supported on two layers of rubber pads to reduce noise and vibrations. In addition, baffle wall as parapets will be constructed upto the rail level so as reduce sound levels. Noise at source will be controlled or reduced by incorporating suitable feature in the design of structures and layout of machines and by use of resilient mounting and dampers etc.

248. To reduce the harmful effects, personnel working at high noise levels would be provided with noise protective gears such as ear muffers, sound barriers etc. Vehicles used for transportation of construction materials would be equipped with proper silencers. Careful planning has been made to operate the construction equipments to have minimal disturbances. The construction equipments would be run only during the daytime and their noise would be monitored as per CPCB standards. Establishment of tree cover all along the corridor will further reduce the noise levels during operation phase. In addition, an appropriate chronological land use planning would be made available to prevent and minimize noise and vibration impacts.

3.2.8 Vibration Control

249. The vibration is generally caused from rail-wheel interaction. This will be reduced by minimizing any surface irregularities on the wheel and rail by wheel turning and rail grinding respectively. To minimize the vibration shock absorbing pad has to be provided and there has to be a distance between rail seat assembly and concrete plinth.

3.2.9 Soil/Debris Disposal

250. The construction activities will generate approximately 10.81 lakh cubic meters of soil/debris causing soil erosion during excavation. This can be mitigated by utilizing around 35 % of excavated soil for land filling purposes. The excavated top fertile soil is suggested to be preserved and used later for gardening and lawn establishment. Soil erosion by runoff will be controlled by installing proper drainage systems using contour information. Proper land use plan has been suggested with technical evaluation. Since there is bulk quantity of soil is generating at the underground alignment area, it is suggested to avoid bringing soil from outside the project boundary and to use the excavated mounds for filling low laying area where it is necessary. Thus, both cost and time saving suggestions have been made in land leveling and soil transportation.

3.2.10 Rain Water Harvesting

251. Roof top rain water harvesting can be carried out at elevated stations. The rooftop of the stations will become catchment area for rain. Rain water will be collected and stored in a tank or diverted into artificial recharge tanks. This method is less expensive and very effective to augment the ground water level of the area. As per the rainfall characteristics, generally the annual rainwater harvesting potential for 1000 sqm roof area will be 7,68,000 liters. Therefore around 50400 sqm area at 18 stations can harvest approximately 38.70 million liters of rainwater annually in the proposed alignment from Gottigere to Nagavara (Table 30).

Table 30: Rain Water Harvesting Potential along the Proposed Alignment

Items	IMB to Nagavara
Stations Roof area (sq m)	50,400
Total rainfall available for harvest (Million liters)	38.70

252. Note: Avg. annual rainfall - 850 mm; Rainfall availability for harvest – 70 %

3.2.11 Air Pollution Control

253. The main source of air pollution in the proposed project occurs only during construction. Transportation of construction materials, excavation and filling of land are the major sources of dust. This can be reduced to a greater extent by optimized use of soil material within the vicinity. Water should be sprayed at the construction site / vehicle movement areas regularly to reduce dust emissions. Adequate dust suppression measures particularly near habitation, such as water sprinkling, covering / area concealing etc. should be practiced to control fugitive dust during construction. All vehicles, equipment and machinery used for construction shall be regularly maintained to ensure that the pollution emission levels to meet the prescribed norms of CPCB.

254. Vehicles carrying earth, cement and other construction material shall be suitably covered during transportation in order to reduce spreading of material all along the road. There will not be any built up pollutants in the long run. Operational phase will not have any impact and management plan may not be required as the Metro rail does not pollute environment. During power failures, DG sets may be commissioned at stations. To monitor environmental quality, these DG sets will be monitored as per CPCB guidelines.

3.2.12 Utility Restoration

255. There are many utilities such as water supply and sewer pipe lines, storm water drains, telephone cables, over head transmission lines, electric poles, sub ways, traffic signals etc. are essential and have to be maintained in working conditions during different stage of construction. These assets will be maintained without affecting any damages by shifting temporary/ permanently where it is necessary.

3.2.13 Disaster Management

256. Any unexpected event occurring due to sudden failure of the system like leakage of gas, external threats, internal disturbances, earthquakes, fire and accidents is termed as disaster. A Management Cell is proposed to act at a quick response in any emergency encountered.

257. For the proposed Metro project all relevant safety codes, acts and regulations such as Electricity Act, Explosive Act, Public Liability Insurance Act, Safety Codes, Policies and Guidelines laid down by Ministry of Railways should be observed during various stages of the project to minimize risk and disaster. Through good design, operation and maintenance and regular inspection any unexpected risks and disaster can be minimized. Hazard has to be controlled by minimizing and mitigating the risk and disaster.

258. To prevent any unexpected accidents, overall ramp safety management system approach is required that involves Risk Analysis and Risk Management. Risk Analysis involves establishing the organization's risk profile and risk management encompasses the various measures that can be implemented to minimize accidents, control loss and transfer risk by insurance on the basis of the identified risk profile of an organization. New safety assessment methods are needed to assess the safety of new concepts.

259. Workers need to be trained to mitigate the risk. In addition, workers should follow the safety rules. Emergency medical aid has to be adopted in the event of accidents involving the hazardous substance. Good sanitation practices should be followed such as proper water supply, sanitation, drainage, health care and human waste disposal facilities etc. In addition, efforts shall be made to avoid any water spills, adopt disease control measures and employment of local labour.

260. BMRCL's Safety, Health and Environment (SHE) Manual as well as Statement of Integrity, Eligibility and Social and Environmental Responsibility (Form-19) are part of Tender

documents and the contractors will implement these documents. Both have been accordance with all applicable legislation and Indian statutory requirements listed as well as the international standards and guidelines including ILO and ISO certificate.

4. Environmental and Social Monitoring and Reporting Program

261. Environmental Monitoring Plan (EMoP) is a companion document of the ESMP. EMoP contain parameters, location, sampling and analysis methods, frequency, and compared to standards or agreed actions that will indicate non-compliances and trigger necessary corrective actions. More specifically, the objectives of the EMoP are:

- Ensure that impacts do not exceed the established legal standards
- Check the implementation of mitigation measures in the manner described in the EIA report
- Monitor implementation of the EMP.
- Provide an early warning of potential environmental damage
- Check whether the proposed mitigation measures have been achieved the intended results, and or/ other environmental impacts occurred

262. The monitoring plan will be used for performance monitoring of the project. A monitoring plan defining all parameters to be monitored, with tentative location, project stages for measurements, implementation and institutional responsibility for different environmental components is prepared for all stages of project and presented in Table 32.

263. In addition to typical environmental indicators related to linear development to be monitored, the EMoP emphasized the need to install accelerometers near the PCRs to monitor vibration levels during construction phase, more particularly during tunnel boring. Further, the External Consultant will install crack and tilt meters on the heritage structures (in case found) to guide the contractor and ensure necessary on-site mitigation measures will be implemented if trigger values are exceeded.

Table 31: Environmental and Social Management Plan Matrix

Note: This ESMP Matrix will form part of the contract document together with BMRCL's Safety, Health & Environment (SHE) Manual Conditions of Contract (CoC) 2016 for all contractors. This ESMP has been aligned with the SHE CoC wherever possible, and in places, cross referencing has been resorted to.

Sl. No.	Activity	Aspect /Parameter affected	Impact	Mitigation measures	Responsibility	
					Implementation	Supervision
	Planning and Design Phase					
1	Land Acquisition	Social	Acquisition of 270,712 square meters of land affecting 698 private structures and 712 households.	LA is being carried out as per the provision of KIAD Act 1996. The affected people will be compensated and assisted as per the provisions of Resettlement Policy Framework (RPF). Resettlement & Rehabilitation activities of BMRP will be governed by the general principles based on The Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013.	BMRCL	GoK
2	Change in Land use	Land	Land use will be slightly changed.	Bengaluru metro was planned for a long-time. The Bengaluru CDP and Revised Master Plan of BMA 2015 both account for Bengaluru Metro. Further, proper permission will be sought from competent authority before construction.	BMRCL	GoK
3	Tree felling	Ecology	About 1312 trees will be affected at alignments, stations and depot area. Additionally in some areas, pruning will be required.	13120 trees will be planted (@1:10 ratio) under compensatory afforestation plan. Environmentally beneficial tree species has been proposed all along the station borders under compensatory afforestation in coordination with local forestry officials. Additionally green belt development for the total 7.50 Km under the elevated corridor has been proposed using native shrubs, herbs and grasses. 65 trees will be transplanted at	BMRCL / Contractor	GoK

Sl. No.	Activity	Aspect /Parameter affected	Impact	Mitigation measures	Responsibility	
					Implementation	Supervision
				suitable locations.		
4	Severance of utilities	Social	The proposed alignments will cross drains and utility services such as sewer, storm water drains, water mains, telephone cables, overhead electrical transmission lines, electric poles, traffic signals etc.	There are many utilities such as water supply and sewer pipe lines, storm water drains, telephone cables, over head transmission lines, electric poles, sub ways, traffic signals etc. are essential and have to be maintained in working conditions during different stage of construction. These assets will be maintained without affecting any damages by shifting temporary/ permanently where it is necessary	BMRCL / Contractor	GoK
5	Loss of aesthetics	Aesthetics	Land acquisition and barricading of site will compromise the visual aesthetics.	Residual aesthetic impact will always remain, which is difficult to mitigate completely. Good housekeeping and proper barricading will ensure minimum complaints from locals.		
	Construction Phase					
6	Contractor Preparatory Works (Upon issuance of Notice to Proceed)	Land	Non-compliance with contract conditions and regulatory requirements.	The Contractor will complete the following activities no later than 30 days upon issuance of Notice to Proceed 1) Appoint Contractor's Health and Safety Officer (HSO) and environmental focal person to EC 2) HSO will engage EC-Environment Specialist to a meeting to discuss in detail the ESMP, seek clarification and recommend corresponding revisions if necessary 3) HSO will request EC copy of monthly monitoring formats and	Contractor	EC/ BMRCL

Sl. No.	Activity	Aspect /Parameter affected	Impact	Mitigation measures	Responsibility	
					Implementation	Supervision
				<p>establish deadlines for submission. 4) HSO will submit for EC approval an action plan to secure all permits and approvals needed to be secured during construction stage which include but not limited to: i) operation of crushers and hot mix plants, ii) transport and storage of hazardous materials (e.g. fuel, lubricants, explosives), iii) waste disposal sites and disposal management plan, iv) temporary storage location, iv) water use, and v) emission compliance of all vehicles. Arrangements to link with government health programs on hygiene, sanitation, and prevention of communicable diseases will also be included in the action plan. 5) HSO will submit for approval of EC the construction camp layout before its establishment.</p>		
7.	Coordinate with the Traffic Department on Traffic Management Plan	Land	Nuisance congestion from	<p>The Contractors will discuss and coordinate the implementation of the traffic re-routing scheme particularly at station area when it starts the cut and cover activities and the hauling and disposal of excavated materials to the project sites.</p> <p>At the minimum, the traffic management plan will have the following components: construction traffic, ensuring access to properties, accommodating pedestrians, parking, access by construction vehicles, faulty traffic lights and problem interchanges, use of public roads, parking provision during construction, use of residential streets and traffic diversion due to temporary road closures, and construction and use of temporary access roads.</p>	Contractor	EC/ BMRCL/ Traffic Police

Sl. No.	Activity	Aspect /Parameter affected	Impact	Mitigation measures	Responsibility	
					Implementation	Supervision
8.	Community Liaison	Land	Complaints	<p>To ensure that ongoing feedback is provided on the progress of the JMRP together with feedback on the environmental management performance of the project.</p> <p>Contractor will provide a minimum of two (2) weeks notification to directly affected residents, businesses and other relevant groups of the intended construction commencement date. In providing a mechanism for communication between the contractor and the community and informing the public of construction details (timing, expected impacts), the concessionaire will undertake consultation and information activities.</p>	Contractor	EC/ BMRCL/GRC
9.	Leveling of Site	Land	Surface leveling will alter the soil texture and compactness, which will affect the infiltration and soil ecology. Also leveling will involve alteration of natural drainage	Infiltration losses could be countered by installing Rain Water Harvesting (RWH) pits.	Contractor	EC/ BMRCL
10.	Mechanical piling	Noise	During mechanical piling operations, noise will be generated which may go up to 88-90 dB (A) at a distance of 5m.	Augur piling will be carried out in place of mechanical piling which will generate less noise than mechanical piling (around 70-75 dB(A)). Also 2m high barricade of GI sheet will be carried out on all sides of piling operations. This could effectively cut down noise levels by 10-15 dB (A). Piling operations will be restricted during day time hours only.	Contractor	EC/ BMRCL
		Land	Piling will affect the texture of land	This is an irreversible impact. Efforts will be made to reduce the impacts of piling by bioremediation of soil.	Contractor	EC/ BMRCL

Sl. No.	Activity	Aspect /Parameter affected	Impact	Mitigation measures	Responsibility	
					Implementation	Supervision
		Health & Safety	Noise and vibration generated during piling will affect the health and safety of the workers	Augur piling methods will be used to reduce the impacts of noise. 2m tall screens of GI sheets will be installed between source (pile driver) and receptors (workers & nearby populations).	Contractor	EC/ BMRCL
11.	Tunnel boring	Health & Safety, Land	Ground Settlement under the weak structures	<p>The contractor will ensure that no inadvertent damage is incurred to the structures.</p> <p>The contractor will ensure that the design value for settlement under structures is not exceed and the trigger value = 3.5mm and Allowable value = 4.2 meters are implemented.</p> <p>Tilt meters will be installed at key positions to ensure the design value is observed with trigger and allowable values.</p> <p>Crack meters will be installed at key positions to ensure design value of 3.0mm is not exceeded with 2.1mm trigger value and 2.5 mm allowable value.</p> <p>The contractor will immediately cease all operation if any of the trigger values are breached. The EC will advise the contractor mitigation measures and practices to control settlement, tilt, and cracks to include but not limited to structural reinforcement and operation parameters of the TBM.</p> <p>The contractor will ensure that no structural damage is incurred and cosmetic damages are repaired under the supervision and control of the local department.</p>	Contractor	EC/ BMRCL

Sl. No.	Activity	Aspect /Parameter affected	Impact	Mitigation measures	Responsibility	
					Implementation	Supervision
12.	Vibration from the tunnel boring	Vibration / Land	Cosmetic and Structural damages to the structures along the underground metro alignment along congested areas.	Vibration during tunneling is expected to be lower than internationally accepted 5mm/s. However, to be on the safe side and as practice in BMRCL, the Contractor is to ensure that vibration levels at the key structure foundation locations will not exceed 2.0 mm/s	Contractor	EC/ BMRCL
13.	Excavation	Air	Excavation will result into fugitive dust generation. The quantum of soil excavated soil will be approximately of about 25 lakh cubic meter.	Water sprinkling to be carried out as per SHE Conditions of Contract at regular interval (to be mutually decided by the contractor and BMRCL)	Contractor	EC/ BMRCL
		Noise	Noise levels during construction will be from crushing plants, asphalt-mixing plants, movement of heavy vehicles, loading, transportation and unloading of construction materials etc.	For elevated corridors, ballast less track structure is supported on two layers of rubber pads to reduce noise and vibrations. In addition, baffle wall as parapets will be constructed up to the rail level so as to reduce sound levels. Noise at source will be controlled or reduced by incorporating suitable features in the design of structures and layout of machines and by use of resilient mounting and dampers etc.	Contractor	EC/ BMRCL
		Surface water	Dumping of construction spoils like concrete, bricks, waste material from camps etc cause surface water pollution.	Proper drainage systems using contour information will be constructed around active and large construction sites.	Contractor	EC/ BMRCL
		Ground water	Dewatering (if done) will adversely affect the groundwater regime.	Dewatering will be done only when required. Groundwater will be collected in sedimentation tanks and reused in non-potable uses. Refer to SHE CoC Cl. 48.3.	Contractor	EC/ BMRCL

Sl. No.	Activity	Aspect /Parameter affected	Impact	Mitigation measures	Responsibility	
					Implementation	Supervision
		Land	Excavation will adversely affect the land	Soil erosion by runoff will be controlled by installing proper drainage systems using contour information It is suggested to avoid bringing soil from outside the project boundary and to use the excavated mounds for filling low laying area where it is necessary	Contractor	EC/ BMRCL
		Aesthetics	Loss of aesthetics value due to excavation and related activities.	The excavation sites will be barricaded on all sides using GI sheets. Hauling will be carried out in non-peak hours. Noisy activities will be discontinued during the night time, esp. in congested areas.	Contractor	EC/ BMRCL
14	Blasting at UG stations	Air	The major source of air pollution during the construction is dust emission. This is due to the movement of vehicles carrying construction materials and workers moving in and around the project site.	Air pollution can be reduced to a greater extent by optimized use of soil material within the vicinity. Water should be sprayed at the construction site / vehicle movement areas regularly to reduce dust emissions. Adequate dust suppression measures particularly near habitation, such as water sprinkling, covering / area concealing etc should be practiced to control fugitive dust during construction.	Contractor	BMRCL / GoK

Sl. No.	Activity	Aspect /Parameter affected	Impact	Mitigation measures	Responsibility	
					Implementation	Supervision
		Noise	Noise levels during construction will be from crushing plants, asphalt-mixing plants, movement of heavy vehicles, loading, transportation and unloading of construction materials etc.	To reduce the harmful effects, personnel working at high noise levels would be provided with noise protective gears such as ear mufflers, sound barriers etc. Vehicles used for transportation of construction materials would be equipped with proper silencers. Careful planning has been made to operate the construction equipments to have minimal disturbances. The construction equipments would be run only during the daytime and their noise would be monitored as per CPCB standards. Establishment of tree cover all along the corridor will further reduce the noise levels during operation phase. In addition, an appropriate chronological land use planning would be made available to prevent and minimize noise and vibration impacts.	Contractor	BMRCL / GoK
		Vibration	Vibrations will be generated due to blasting activities. This will be of specific importance while using blasting in congested areas and near old & archaeological significance.	The intensity of vibration is directly proportional to the maximum explosive charge per delay used and the distance between the reference structure and the blast site. The permissible limits for the structure are governed by the limits prescribed by the Director General of Mines Safety. All precautions with regard to minimizing the maximum charge per delay shall be taken such that vibration levels shall not exceed the prescribed limit.	Contractor	BMRCL/ GoK

Sl. No.	Activity	Aspect /Parameter affected	Impact	Mitigation measures	Responsibility	
					Implementation	Supervision
		Health & Safety	During explosions flying debris will be generated which can pose serious H&S risk	Blast design and use of through bottom initiation with a free face and effective stemming shall minimize the fly rock distance. In addition to a layer of HD rubber mats, wire mesh of 1"X1" size will be used to cover the entire blasting block plus a radius of 3 m around it. This shall inhibit the physical movement of the fly rock within a radius of 10m only. In addition it is proposed to barricade the entire station area to a height to 10m from the blasting surface.	Contractor	BMRCL/ GoK
		Aesthetics	Blasting will raise aesthetics issues among local citizen	The blasting areas beyond 10m from blast area will be barricaded using 2m tall GI sheet barricades. Thus the visual appeal will be slightly restored. Good housekeeping practice should be adopted.	Contractor	BMRCL/ GoK
15	Hauling of excavated material	Air	During transportation of excavated material, fugitive dust will be generated from two sources,(1)from re-suspension of dust from road surface, (2) from the movement of air, against the excavated material being hauled.	The trucks/dumpers carrying the excavated material will be covered using tarpaulin/similar covering materials. Truck tires will be washed to excess remove soil clinging to it.	Contractor	EC/ BMRCL/ GoK
		Noise	Dumper trucks carrying excavated material will result into high noise (typically in excess of 85 dB (A) at one m distance, or 57 dB (A) at10 m distance). The adverse impacts of noise will be most intense in the residential / urban areas.	The routing, timing and logistics of the haul truck movement should be planned to have minimal impacts on noise level.	Contractor	EC/ BMRCL

Sl. No.	Activity	Aspect /Parameter affected	Impact	Mitigation measures	Responsibility	
					Implementation	Supervision
		Social	Incessant movement of trucks could create social issues. This will have higher occurrences near depots.	The local community has to be taken into confidence before the construction commences. Their advice has to be taken and incorporated in decision making.	Contractor	EC/ BMRCL
		Health & Safety	The movement of trucks will increase the traffic risk of the commuters.	The routing, timing and logistics of the haul truck movement should be planned to have minimal impact son noise level.	Contractor	EC/ BMRCL
16	Dumping of excavated materials	Air	The dumping operation of excavated material will generate fugitive dust in the nearby areas.	Site of dumping will be selected in consultation with BBMP and traffic police. It will be located outside of urban habitation. Sprinkling of water should be carried out.	Contractor	EC/ BMRCL /BBMP
		Land	Dumping may increase the height of the land and affect the natural drainage pattern of the area.	The dumping will be done in pre-designated low lying areas identified by BBMP & BMRC for this specific purpose.	Contractor	EC/ BMRCL
17	Traffic diversion	Air	The under construction areas will be restricted for human and vehicular movements. This will result in detouring of vehicles and/or pedestrians, esp. In busy urban areas along central Bangaluru. This may also result into traffic congestion and air pollution from stagnated vehicles in urban areas. Primary pollutants will be NOx, CO, NMHC, Lead and VOCs.	Permission from BBMP and Traffic police will be sought before commencement of work. Detours will be properly planned and enacted during non-peak hours only, if possible. Traffic marshals will be posted near such detours. Proper signage has to be posted informing motorists about detours following IRC norms.	Contractor	EC/ BMRCL

Sl. No.	Activity	Aspect /Parameter affected	Impact	Mitigation measures	Responsibility	
					Implementation	Supervision
		Noise	Barricading & detouring may result into traffic congestion in the urban areas. This will result into (a) noise from vehicular movement and (b) honking noise due to congestion.	Permission from BBMP and Traffic police will be sought before commencement of work. Detours will be properly planned and enacted during non-peak hours only, if possible. Traffic marshals could be posted near busy intersections, to oversee the smooth flow of traffic.	Contractor	EC/ BMRCL
		Social	Traffic diversion (esp. for public transport) will create inconvenience	Plans will be made to spare traffic diversion during peak hours (morning and evening peaks). Also separate arrangements for bus, auto and taxi parking bays will be made. Street furniture for pedestrians will be provided wherever possible.	Contractor	EC/ BMRCL
		Resource consumption	Detouring will increase the road length to be travelled by a car, thus, increasing the overall fuel consumption.	The detour will be planned to be optimum in terms of road length. The faster completion of works will also tend to reduce enhanced fuel consumption.	Contractor	EC/ BMRCL / GoK
18	Restricted pedestrian movement	Social	Restricted pedestrian movement will cause social uproar, esp. in people living near metro stations	Safe passage for pedestrians with proper sun shade / fall protection will be planned. Public consensus will be built.	Contractor	EC/ BMRCL
		Health & Safety	Movement though constricted space may cause potential health & safety issues amongst pedestrians	Safe passage for pedestrians with proper fall protection will be planned.	Contractor	EC/ BMRCL

Sl. No.	Activity	Aspect /Parameter affected	Impact	Mitigation measures	Responsibility	
					Implementation	Supervision
19	Use of TBM	Noise / Vibration	Use of TBM will generate low frequency rumbling noise and vibrations. This will affect structures of old houses, archaeological monuments, roots of plants and underground installations	A study has been commissioned by BMRCL to National Physical Laboratory (NPL) to identify the impacts of using TBM near Tipu Sultan's fort and summer residence. German standard DIN 4150 and British standard BS 7385 as a reference standard (since no Indian standard exists) The impact found was nominal. None the less, some recommendations were made to minimize any such damage to structures. The depth of construction will be in approx. 18 m, at this depth, chances of hitting tree roots and underground installations is minimum. The study has concluded that the resultant peak particle velocity will not cause damage to the structure. The Archaeological Survey of India (ASI) has awarded an approval to the project on this basis.	Contractor	EC/ BMRCL / GoK
		Groundwater	Bi-tube arrangement and use of TBM will interfere with groundwater movements	Indian Institute of Science (IISc) has conducted a geo-hydrological modelling study to find out the impact of tubes and TBM on ground water flow. The effects were found to be nominal.	Contractor	EC / BMRCL
		Land	TBM use will reduce the soil texture and infiltration rate affect infiltration	TBM will operate mostly in rocky sub-strata at depth from 12 – 18 m (inner dia approx. 6 m). Thus, it will not affect soil texture or infiltration. However, u/g tunnels will interfere with ground water recharge. However, RWH will be carried out in the project, esp. in stations and depots.	Contractor	EC/ BMRCL / GoK

Sl. No.	Activity	Aspect /Parameter affected	Impact	Mitigation measures	Responsibility	
					Implementation	Supervision
		Health & Safety	Occupation health and safety of workers working in confined areas (near or behind TBM) could be compromised	Proper H&S evaluation & periodic audit of working condition in tunnels will be done. Air change @ 6 m3/min will be done (SHE CoC Cl. 44.1.1). Safety requirements as per SHE CoC Cl. 34.2 should be adopted. Workers should be made aware of the risks. Training should be provided to all workers engaged in tunnelling.	Contractor	EC/ BMRCL / GoK
20	Muck generation & disposal (incl. spent Bentonite & drill fluid and slurry)	Surface water	Muck generated incl. spent Bentonite & slurry from drilling operations will drain with surface runoff and pollute nearby water bodies	The construction sites will be provided with garland drains with intercepting pits to trap silt & muck. Muck will be stored in lined tanks / ponds (if such area is available). After screening & detention, supernatant liquid from such tanks should be discharged into BBMP drainage lines. Such tank/ ponds could be covered during monsoon. Refer to Cl. 48.6 of SHE CoC.	Contractor	EC/ BMRCL
		Ground water	Muck, spent bentonite & drill fluids may settle down from pond / tanks and will affect groundwater	The tanks/ ponds holding muck will be lined to reduce infiltration into groundwater.	Contractor	EC/ BMRCL
		Aesthetics	Muck generation will create an aesthetic issue	The construction site will be covered from all sides to reduce visual impacts	Contractor	EC/ BMRCL
21	Raft foundation	Land	Construction of raft foundation will generate concrete spoils. This will have adverse effects on land.	Concrete spoils will be collected manually and will be disposed off in proposed disposal grounds.	Contractor	EC/ BMRCL
22	Steel structure preparation	Land	Steel structure preparation will create steel scraps (approx. 5% of total BOQ steel requirement; as per CPWD standard estimate)	Steel scrap will be collected, sorted by diameter and sold to scrap dealers on alter date.	Contractor	EC/ BMRCL

Sl. No.	Activity	Aspect /Parameter affected	Impact	Mitigation measures	Responsibility	
					Implementation	Supervision
		Health & safety	Bar bending & other activities (inc. working at heights) might pose a H&S threat to workers	(a) Workers will be provided appropriate hand gloves (b) Workers working at height or doing hot work will be required to seek permission from site HSE manager and will be provided with rigs, harness & safety belts (pl. refer to SHE CoC Cl. 18)	Contractor	EC/ BMRCL
23	Stacking & warehousing of raw material	Surface water	Washed out raw material could pose serious threat to surface water bodies	Small dikes and garlanding drains along the periphery of the RM yard and ploy boundary could be constructed. This will control runoff and washing out of finer material.	Contractor	EC/ BMRCL / GoK
		Land	Spillage of materials / mix products on the ground could pollute land	Proper care will be taken. Such spills will be cleared by scraping and disposing the products as road sub grade material.	Contractor	EC/ BMRCL
		Health & Safety	Fine products like cement/ silt/ sand could cause harm to respiratory system.	Cement and sand will be stacked under tarpaulin and secured by GI sheet barricading (working & wind break). Workers will be provided with respiratory PPEs.	Contractor	EC/ BMRCL
		Aesthetics	Stacking of raw material will cause aesthetic issues for residential areas located nearby	The height of walls between the residential area and RM yard / construction area will be raised using GI sheets	Contractor	EC/ BMRCL
24	RCC pouring (using concrete pump)	Noise	RCC pouring using concrete pump will generate low frequency rumbling noise. This will be more perceived and irritating in residential areas.	Timing of using RCC pumps will be specified. RCC pumps will be covered from all sides. Bends and excessive head will be avoided.	Contractor	EC/ BMRCL
		Land	Spillage from concrete pouring may contaminate land	The spoils from pouring concrete will be collected and reused as sub-grade material in road constriction.	Contractor	EC/ BMRCL
		Aesthetics	Spoils from concrete pouring will create unpleasant looking visuals	After each pouring cycle, the spoils will be manually collected and reused as sub-grade material in road constriction	Contractor	EC/ BMRCL

Sl. No.	Activity	Aspect /Parameter affected	Impact	Mitigation measures	Responsibility	
					Implementation	Supervision
25	Setting of concrete (using needle vibrator)	Noise	Needle vibrators generate low frequency noise when dipped in concrete and high frequency noise when raised. Sound level vary between 82-93 dB (A).	If the consistency of concrete could be altered, the need for use of vibrator (esp. in low temperature & low thickness casting) could be reduced. Damping could be used to reduce high frequency noise, and thereby reducing the noise levels. Workers should be provided with suitable PPE.	Contractor	EC/ BMRCL / GoK
		Land	During setting, spillage from cast could take place.	The spoils from pouring concrete will be collected and reused as sub-grade material in road constriction.	Contractor	EC/ BMRCL
26	Curing of concrete (use of water)	Surface water	Curing water will drain to the low lying areas and pollute water courses	Garland drainage is proposed to be constructed around the construction yard. This will intercept the runoff generated from site.	Contractor	EC/ BMRCL / GoK
		Ground water	Hydrating water requirement @ 0.38 : 1 water : cement + Curing will require @ 0.06 kg/m ² /hr. of water, most of it will be supplied from groundwater (through tankers)	Groundwater from CGWA designated safe areas will be used. Rainwater harvesting (as a compensatory measure) will be practiced.	Contractor	EC/ BMRCL
		Aesthetics	Curing will create water impounding and may lead to vector propagation	Garlanding drain will be constructed around the construction area. The curing water impounded will be reused for curing.	Contractor	EC/ BMRCL

Sl. No.	Activity	Aspect /Parameter affected	Impact	Mitigation measures	Responsibility	
					Implementation	Supervision
27	Use of Crane & Launchers	Noise	Operation of launchers and crane will generate noise which in times may go up to 85-90 dB (A). Legris & Poulin has found that the average daily noise exposure was approx. 84 to 99 dB (A) for heavy equipment, and 74 to 97 dB (A) for the crane operators.	The sensitive receptors (workers & external parties, if applicable) have to be isolated from heavy construction noise generated. This is possible by erecting reinforced 2 m tall GI sheet barrier around the area where heavy construction works is undertaken. Refer to SHE CoC clause 43.1. Workers working inside or near construction equipment should be provided with proper PPEs like ear plugs / muffs complying with IS 4869. Please refer to SHE CoC Cl. 39 for specs of PPEs.	Contractor	EC/ BMRCL
		Health & Safety	Cranes and launchers are a major safety concern. Once case has already been reported taking place in BMRCL. Delhi Metro has faced two such incidents (a) launcher failure in Laxminagar (Oct, 2008) – 2 killed and 30 injured; (b) toppling of Crane in Zamrudpur (July 2009) – 6 killed and 15 injured.	Operation of launchers and cranes should be only done under the strict supervision of a qualified engineer and a safety supervisor. Only qualified & trained crane/ launcher operators should be allowed. Proper examination of crane, launchers, labours & operators should take place before commencement of work. Refer to Cl. 21 (Lifting Appliances & Gear).	Contractor	EC/ BMRCL
28	Construction of labour camp(s) and associated environmental issues	Surface water	Sewage from labour camps may be discharged into open slopes thus contaminating surface water	Labour camps will be constructed in semi urban / urban set-ups. Thus, sewage and other discharges from the labour camps will be discharged in public sewers. Refer to SHE Conditions of Contract (CoC) Cl.48.7.	Contractor	EC/ BMRCL
		Ground water	In most cases, the labour camps will be supplied water from ground water. In most cases the ground water (drawn from bore well) is not metered or treated	Use of bore well will be restricted for drinking purpose only. Permission of withdrawal from Central Ground Water Authority (CGWA) must be obtained before construction of bore well. Water abstracted must be measured/ recorded periodically. Refer to SHE CoC Cl. 48.1.	Contractor	EC/ BMRCL

Sl. No.	Activity	Aspect /Parameter affected	Impact	Mitigation measures	Responsibility	
					Implementation	Supervision
		Land	Solid waste generated from the labour camps will cause land pollution	Solid waste will have to be disposed in compliance with Municipal Solid Waste (Management & Handling) Rules, 2000, as amended to date.	Contractor	EC/ BMRCL
		Social	Influx of non-local labours will create a social issue	Mixing of skilled non-local labours with local unskilled people will reduce social frictions. However there are no permanent solutions to this problem.	Contractor	EC/ BMRCL
		Health & safety	Living in congested condition, make-shift temporary arrangement; the labours are prone to diseases.	Under Cl. 42.1.1. of SHE CoC, and also under the Building & Other Construction Workers (Regulation of Employment and Conditions of Service) Act, 1996 the employer (contractor) is liable to arrange for health care facilities of labours, free of charge.	Contractor	EC/ BMRCL
		Resources	Labours will consume resources like wood for cooking	Labour camps are provided with canteen systems, so most of the labours don't cook by themselves (as per BOCWR. Cooking is done with Commercial LPG gas cylinders (19.4 kg). However in isolated observations it was noted that labours were using kerosene stoves and cooking within their hutments. This was in contravention of the SHE CoC Cl. 46.5.1 (& BOCWA sec. 34.)	Contractor	EC/ BMRCL
29	Loading/unloading of material	Air	Loading & unloading of construction material will generate fugitive dust	Fugitive dust could be controlled using water sprinkling. Contractors should carry out water sprinkling as per SHE CoC Cl. 47.3.1 & 47.3.11.	Contractor	EC/ BMRCL

Sl. No.	Activity	Aspect /Parameter affected	Impact	Mitigation measures	Responsibility	
					Implementation	Supervision
		Noise	Loading & unloading of construction material will generate noise	The RM storage yard will be separately built and enclosed from all sides. This will reduce noise generation at site. Further since concrete preparation will only take place in casting yards (away from habitation) loading & unloading will not be a major problem	Contractor	EC/ BMRCL
		Health & safety	Fugitive dust and noise generation will have potential health & Safety implications.	Cement and sand will be stacked under tarpaulin and secured by GI sheet barricading (working & wind break). Workers will be provided with respiratory PPEs. The RM storage yard will be separately built and enclosed from all sides. The worker will be provided with suitable PPEs. Also they will be trained and encouraged in using PPEs.	Contractor	EC/ BMRCL
30	Use of batching plant	Air	Loading & unloading of construction material into batching plant will generate fugitive dust	As per SHE CoC Cl. 38; all of the 15 batching plant / casting yard shall be barricaded and made as a compulsory PPE zone. This will effectively reduce the fugitive dust generation. In addition, sprinkling will be practiced near batching plant as per SHE CoC Cl. 47.3.1 & 47.3.11.	Contractor	EC/ BMRCL
		Noise	Operation of batching plant will generate noise	As per SHE CoC Cl. 38; batching plant / casting yard shall be barricaded and made as a compulsory PPE zone. This will reduce the impacts of noise generation	Contractor	EC/ BMRCL
		Groundwater	Batching plant will use groundwater for mixing. In most cases water will be supplied from groundwater.	Permission from CGWA must be obtained before digging and operating bore wells. Water abstracted must be measured/ recorded periodically. Refer to SHE CoC Cl. 48.1.	Contractor	EC/ BMRCL

Sl. No.	Activity	Aspect /Parameter affected	Impact	Mitigation measures	Responsibility	
					Implementation	Supervision
		Resources	The batching plant will get its power from DG sets. A 30 m ³ /hr. batching plant will require approx. 60 KW/hr. (or, approx. 75 KVA, assuming PF = 0.8) energy. In most cases the Contractor has used DG sets (from 100 – 250 kVA) for batching plant & ancillary facilities. Thus, the diesel req. will range from 30 - 45L/hr (at 100% load).	Permission from BESCO supply must be obtained by the Contractor. DG sets, if used, should: (a) conform to height of stack norms as per CPCB rules; (b) conform to emission norms as per E (P) Act, 1986; (c) noise level at 1 m distance from enclosure should not be >75 dB(A). Diesel storage if done beyond threshold limit (1000 L) permission from CCOE should be obtained. Diesel should be stored on pukka platforms and spillages should be avoided.	Contractor	EC/ BMRCL
31	Casting of segments and I-beams	Groundwater	Casting will require use of groundwater.	Permission from CGWA must be obtained before digging and operating bore wells. Water abstracted must be measured/ recorded periodically. Refer to SHE CoC Cl. 48.1.	Contractor	EC/ BMRCL
		Resources	Casting (incl. operation of gantry and hydraulic pre-stressing units) will consume lot of energy.	Pre-stressing and casting are basic requirements. However, most of the power should be drawn from approved BESCO lines, not from DG sets.	Contractor	EC/ BMRCL
32	Curing of segments & I beams	Groundwater	Curing will require a significant amount of water, which will mostly supplied from groundwater	Wastages from curing could be collected separately and reused if possible. Stagnation of water (and resultant vector propagation) should be avoided.	Contractor	EC/ BMRCL
33	Hauling of segments to site	Air	During transportation of segments, fugitive dust will be generated from re-suspension of dust from road surface. Plus, there will be air emission from trucks	Truck tyres will be washed to excess remove soil clinging to it. Near the entry/ exit points of the casting yards, water sprinkling will be undertaken. Trucks will need to have PUC certificate (refer to Cl. 47.3.5 SHE CoC) and conform to these norms.	Contractor	EC/ BMRCL

Sl. No.	Activity	Aspect /Parameter affected	Impact	Mitigation measures	Responsibility	
					Implementation	Supervision
		Noise	Trucks carrying segments will result into high noise (typically in excess of 85 dB(A) at 1 m distance, or 57 dB(A) at 10 m distance). The adverse impacts of noise will be most intense in the residential/urban areas.	The routing, timing and logistics of the haul truck movement should be planned to have minimal impacts on noise level.	Contractor	EC/ BMRCL
		Social	Incessant movement of trucks could create social issues.	The local community has to be taken into confidence. Their advice has to be taken and incorporated in decision making.	Contractor	EC/ BMRCL
		Health & safety	The movement of trucks will increase the traffic risk of the commuters.	The routing, timing and logistics of the haul truck movement will be planned to have minimal impacts on noise level.	Contractor	EC/ BMRCL
		Aesthetics	Movement of trucks will create an aesthetic problem	Proper housekeeping activities have to be undertaken near the casting yard and nearby areas.	Contractor	EC/ BMRCL
34	Use of DG sets	Air	Emission from DG sets will create air pollution problems	(a) Primary power source will be BESCO, DG sets will be used only for power back-ups. (a) Emission norms from DG will follow CPCB specification no. GSR 520(E) dt. 1-7-2003 for DG sets rating < 800 KW, and GSR 489(E) dt. 09-07-2002 for DG sets > 800 KW under E(P) Rules, 1986. (b) Stack height of DG sets will be as per CPCB requirement [stack ht. = 0.2*(rating in kVA) 0.5]. (c) Fuels used for DG will be High Speed Diesel (Sulphur <1% m/m)6	Contractor	EC/ BMRCL

Sl. No.	Activity	Aspect /Parameter affected	Impact	Mitigation measures	Responsibility	
					Implementation	Supervision
		Noise	Noise & vibration will be generated from the use of DG sets	DG sets should be enclosed type, with noise levels approx. 75 dB(A) at a distance of 1m in compliance with GSR 371(E) dt. 17-05-2002. The DG sets will be mounted on damping skids, which will reduce the vibration generated from DG sets.	Contractor	EC/ BMRCL
		Resources	DG sets will consume Diesel (and in effect reduce the levels of a non-renewable resource)	DG sets should always be use as a power back up, and not the primary sources of power. This should be made mandatory for all Contractors.	Contractor	EC/ BMRCL
		Aesthetics	Operation of DG sets will cause an aesthetic issue	(a) PM content of DG sets smoke will be as per the CPCB norms, thus the DG will emit dark smokes only during start-up & shut-down. (b) Noise will be controlled using acoustic enclosure. (c) DG sets will be additionally enclosed using GI sheet shuttering to keep them off from public views.	Contractor	EC/ BMRCL
35	Storage of Diesel	Groundwater	Diesel spillage (from underground or above ground storage facility) will affect groundwater quality adversely	As per the SHE CoC Cl. 47.2 an Event Contingency Plan (ECP) has to be prepared by the contractor. Spillage will be controlled using methods mentioned in the ECP (should follow Cl. 120, 125, 126 of Chapter V of Petroleum Rules, 2002).	Contractor	EC/ BMRCL
		Health & safety	Storage of Diesel will attract the provisions of Hazardous Chemicals (Management & Handling) Rules and Petroleum Rules; as amended to date. It could cause serious damage to health & safety of workers / property if ignited.	Proper onsite emergency plan will be prepared and will be approved through BMRCL. If the diesel storage crosses the threshold limits permissions from Chief Controller of Explosives (CCoE). Proper fire protection norms have to be undertaken as per National Building Code, 2005 (if building)/ Oil Industry Safety Directorate Standard 117 (if installation).	Contractor	EC/ BMRCL
	Operational Phase					

Sl. No.	Activity	Aspect /Parameter affected	Impact	Mitigation measures	Responsibility	
					Implementation	Supervision
36	Operation of metro trains	Air	The metro will have a positive impact in terms of reduced congestion at road levels and reduced air emissions	Over period of time, plans should be developed to curb emissions from (a) DG sets and (b) from metro feeder buses.	BMRCL	GoK
		Noise	The most significant source of noise will be Rolling noise from the contact between the wheel and the rail including noise from contact between the brake pad and wheel, followed by noise in traction system and aerodynamics noise. The exterior noise generated by the train is approximately 82dBA at 75 Kmph measured at a distance of 7.5 m from centre of the track on either sides and at height of 1.5m ground level. This noise level will further reduced as distance from centre of the track increases on account of conversion into frictional energy.	The noise level at the bottom of the line will be insignificant and could be marginally different from the ambient (traffic) noise. Since the train will air-conditioned and enclosed from all sides, the impact of exterior noise will be minimal in the train. Maximum interior noise level in the train will be 75dBA.	BMRCL	GoK
		Social	Metro will have a positive impact in terms of connectivity, increased access & social inclusion	Metro is planned to be disabled friendly. Additionally it should plan to run special programmes for needy, weak/ infirm, BPL, students, people with terminal illness etc. to make its acceptability universal	BMRCL	GoK
		Resources	Metro will lead to conservation of fuel, form the car/2W travels saved, that people will otherwise undertake	A detailed study is needed, to find out the exact amount of fuel conserved due to Bengaluru metro. If possible, Bengaluru Metro may apply for CDM funds.	BMRCL	GoK

Sl. No.	Activity	Aspect /Parameter affected	Impact	Mitigation measures	Responsibility	
					Implementation	Supervision
		Health & Safety	Metro rail will have profound benefit in terms of (a) reduced road risk, and (b) reduced air pollution levels	A detailed study is needed to identify the exact benefits generated from Metro.	BMRCL	GoK
		Aesthetics	Metro rail will increase the aesthetics of Bengaluru	A proper housekeeping routine will be followed to enhance the aesthetics of metro rail station & depot	BMRCL	GoK
37	Maintenance of trains in stabling yard	Surface water	The wastewater discharges from workshops will have high oil & grease, high COD & TSS content	Effluent Treatment Plants (ETPs) are planned in both Baiyappanahalli and Peenya Depots. This is in line with SHE CoC Cl. 48.9.	BMRCL	GoK / BBMP
38	Use of DG sets	Air	Emission from DG sets will create air pollution problems	(b) Primary power source will be BESCO, DG sets will be used only for power back-ups. (c) Emission norms from DG will follow CPCB specification no. GSR 520(E) dt. 1-7-2003 for DG sets rating < 800 KW, and GSR 489(E) dt. 09-07-2002 for DG sets > 800 KW under E (P) Rules, 1986. (d) Stack height of DG sets will be as per CPCB requirement [stack ht. = 0.2*(rating in kVA)0.5] (e) Fuels used for DG will be High Speed Diesel (Sulphur <1% mass/mass) ⁷	BMRCL	GoK
		Noise	Noise & vibration will be generated from the use of DG sets	DG sets will be enclosed type, with noise levels approx. 75 dB (A) at a distance of 1m in compliance with GSR 371(E) dt. 17-05-2002. The DG sets will be mounted on damping skids, which will reduce the vibration generated from DG sets.	BMRCL	GoK
		Resources	DG sets will consume Diesel (and in effect reduce the levels of a non-renewable resource)	DG sets will always be use as a power back up, and not the primary sources of power. This should be made mandatory for all Contractors.	BMRCL	GoK

Sl. No.	Activity	Aspect /Parameter affected	Impact	Mitigation measures	Responsibility	
					Implementation	Supervision
		Aesthetics	Operation of DG sets will cause an aesthetic issue	(a) PM content of DG sets smoke will be as per the CPCB norms, thus the DG will emit dark smokes only during start-up & shut-down (b) Noise will be controlled using acoustic enclosure (c) DG sets will be additionally enclosed using GI sheet shuttering to keep them off from public views.	BMRCL	GoK
39	Storage of Diesel	Groundwater	Diesel spillage (from underground or above ground storage facility) will affect groundwater quality adversely	Spillage will be controlled using methods mentioned in the environmental contingency plan (should follow Cl. 120, 125, 126 of Chapter V of Petroleum Rules, 2002).	BMRCL	GoK
		Health & safety	Storage of Diesel will attract the provisions of Hazardous Chemicals (Management & Handling) Rules and Petroleum Rules; as amended to date. It could cause serious damage to health & safety of workers / property if ignited.	Proper onsite emergency plan will be prepared and will be approved through BMRCL. If the diesel storage crosses the threshold limits permissions from Chief Controller of Explosives (CCoE). Proper fire protection norms have to be undertaken as per National Building Code, 2005 (if building)/ Oil Industry Safety Directorate Standard 117 (if installation).	BMRCL	GoK
40	Development of feeder routes	Social	Along with Metro routes, metro feeder routes will be developed. This will have a positive impacts in terms of enhanced connectivity and inclusion in the social mainstream	Metro feeder routes should be planned along major arterial and sub-arterial routes to reduce travel time to the nearest station. Better quality coaches & comfortable rides should be planned to enhance acceptability.	BMRCL	GoK

Sl. No.	Activity	Aspect /Parameter affected	Impact	Mitigation measures	Responsibility	
					Implementation	Supervision
		Health & safety	Better & frequent transport system will reduce risk of traffic accidents	The new feeder routes should (a) follow proper time table; (b) should have frequent services during the morning & evening peak; (c) should have a limited carrying capacity. The feeder buses should arrive and depart from designated „bus bays“ or similar structures. Proper arrangements for road crossing should be established. The appointed personnel should assist passengers to reach their destinations. An easily accessible grievance redressal system should be established by BMRCL.	BMRCL	GoK
		Aesthetics	Better designed coaches will enhance ride pleasure and aesthetics	The buses should be properly maintained from time to time in order to enhance the aesthetic value.	BMRCL	GoK
41	Generation of employment	Social	The proposed project will result into generation of employment	The employment generation capacity has to be enhanced, and spread horizontally amongst the different strata of society.	BMRCL	GoK
42	Ancillary development along metro route	Land	Ancillary developments will take place along with metro corridor	Ancillary development should be controlled and only specific types of developments should be encouraged. A strict land use policy should be developed & followed by BMRCL before commencement of operational. It should be balanced and have reasonable mix of commercial, infrastructure and common spaces.	BMRCL	GoK / BBMP
		Social	Ancillary development along the metro alignment will have positive effect on the social environment	There should be positive participation of the common people in the ancillary development process. An open, transparent & people-centric outlook has to be adopted.	BMRCL	GoK

BMRCL –Bangalore Metro Rail Corporation Ltd., GoK- Government of Karnataka, BBMP -Bruhat Bengaluru Mahanagara Palike , EC - External Consultant.

Table 32: Environmental and Social Monitoring Plan

Environmental Features	Aspect to be Monitored	Time and Frequency of Monitoring	Location	Monitoring Cost (USD)	Responsible party (Implementation/ Supervision)
Construction stage					
Noise	Noise levels in dB(A)	Monthly or when complaint is received	Project Site	3000*48 =144000	Contractor & EC
Air	Emission of dust and particulate matter as PM2.5 and PM10, NOx and SOx, CO	24 hours continuous every month until the stations are completed	Project Site	8000*48=384000	Contractor & EC
Water	DO, Turbidity, Conductivity, pH, E.Coli, TSS, Oil and Grease and TDS	Quarterly	Ground water at construction camps	4000*16=64000	Contractor & EC
Occupational Health and Safety	As specified in project OHS plan prepared by Contractor	Project site Weekly	Project Site	Project Cost	Contractor & EC
Vibrations	PPV mm/s	Continuous monitoring when the tunnel boring is within 300 meters from the structure	At key structure locations	200000*5=1000000	Contractor & EC
			Total	1592000	
Operation Stage					
Occupational Health and Safety	As specified in project OHS plan prepared by Contractor	Station and Depot Monthly	Project Site	50000	BMRCL
Water	DO, Turbidity, Conductivity, pH, E.Coli, TSS, Oil and Grease and TDS	Six monthly	Ground water at Station locations and depot	4000*6*2=48000	Contractor & EC
Noise	Noise levels in dB(A)	At least 2 times in a year for 3 years	Alignment, Station	3000*3*2 =18000	BMRCL
Air	Emission from DG sets (SPM, NOx and SOx)	At least 2 times in a year for 3 years	Project site	8000*3*2=48000	BMRCL
Vibration	PPV mm/s	Continuous monitoring when the tunnel boring is within 300 meters from the structure	At key structure locations	200000	BMRCL
			Total	364000	
			Grand Total	1956000	

Note: the cost estimate is tentative.

5. Environmental Reporting System

264. The monitoring plan covering various performance indicators, frequency and institutional arrangements of the project in the construction and operation stages, along with the estimated cost, is summarized in Table xx.

265. The reporting system will operate linearly with the contractor who is at the lowest rank of the implementation system reporting to the External Consultant (EC), who in turn shall report to the SEMU of BMRCL. All reporting by the contractor and EC shall be on a quarterly basis. The BMRCL SEMU will be responsible for preparing targets for each of the identified ESMP activities.

266. The compliance monitoring and the progress reports on environmental components may be clubbed together and submitted to the SEMU quarterly during the implementation period. The operation stage monitoring reports may be biannual provided the Project environmental completion report shows that the implementation was satisfactory. Otherwise, the operation stage monitoring reports will have to be prepared as specified in the said project environmental completion report. Responsibilities for overseeing will rest with the EC reporting to the SEMU.

267. Photographic records will also be established to provide useful environmental and social monitoring tools. A full record will be kept as part of normal contract monitoring. Reporting and Monitoring Systems for various stages of construction and related activities have been proposed to ensure timely and effective implementation of the ESMP.

268. The reporting system has been prepared for each of the stage of metro rail construction namely:

- Pre construction stage
- Construction Stage
- Operation Stage

269. This reporting shall be done through:

- Reporting by the Contractor to the EC
- Reporting by EC to SEMU,
- Reporting by SEMU to EIB/AIIB.

6. Institutional Mechanism and Arrangement for Implementation of ESMP

270. The Bangalore Metro Rail Corporation Limited (BMRCL) is the executing as well as implementing agency for the project. BMRCL has established a project management unit heading by Chief Engineer (Reach 6). He will be supporting by technical as well as safeguards team. BMRCL has established a Social and Environmental Management Unit (SEMU) within its organization structure to look after environmental and social aspects associated with design, implementation and monitoring of the metro rail projects on BMRCL.

271. The SEMU is headed by the Chief Engineer. He will be supported by four officers with environment, social and land acquisition expertise. SEMU will be responsible for the review of quarterly monitoring reports and also submission of this report to EIB and AIIB.

272. SEMU at BMRCL will be responsible for ensuring compliance with environmental and social safeguards of all metro projects including Reach 6. SEMU will be assisted by

External Consultant (EC) with environment and social expertise. EC will be responsible for supervision of the day-to-day implementation of the ESMP and SHE Manual activities by the contractor. EC will prepare quarterly monitoring reports on environmental and social safeguards implementation.

273. Contractor will have an Environment, Health and Safety Officer (EHSO) who will be responsible for implementation of the ESMP and SHE Manual activities. EHSO will prepare monthly report on progress of ESMP implementation.

7. Environmental Management Budget and Resources

274. The cost of all compensation and rehabilitations works will be an integrated part of the overall project cost, which will be borne by the project. The preliminary estimated cost of the environmental and social management plan for reach 6 line including implementation and monitoring is US\$ 876802 (INR 56.694 million) as detailed in Table 33. This cost estimate is exclusive of land acquisition and resettlement & resettlement cost.

Table 33: Cost of EMP Implementation* (INR in Million)

Sl. No.	Item	Cost for Gottigere- Nagavara Line
1	Compensatory Afforestation	13.12
2	Green Belt Development beneath the elevated track	1.874
3	Translocation of trees	0.20
4	Disposal of excavated soil	20.00
5	Shifting of utilities/Drainage	5.00
6	Rain Water Harvesting	3.50
7	Water Quality/ Epimidiological (Construction and Operation phases)	4.00
8	Air, Noise, and Vibration Monitoring (Construction and Operation phases)	4.00
9	Establishment of Environmental Management Cell including training on ESMP implementation	5.00
Total		56.694

J. CONCLUSION AND RECOMMENDATION

275. The alignment of the proposed Reach 6 corridor line and depot areas are not located in any environmentally sensitive or protected areas. Careful selection of alignment has avoided sites of historical/cultural significance. No major impact on wildlife is envisaged as the forest is not the habitat of any endangered or endemic species of fauna and flora.

276. The key social impacts included acquisition of about 270,712.07 square meters land and impacts on 698 structures affecting 838 families. The project will not result in any long-term significant adverse environmental impacts. Minimal environmental impacts are anticipated, mostly during construction. These can be mitigated successfully by implementing the ESMP with estimated costs for implementation. Environmental and social benefits of the project and long-term investment program objectives outweigh the temporary negative impacts.

277. Best available technology and best management practices are built-in to the project design. All project components will be implemented and monitored in line with the EIB and AIIB's Environmental and Social Policy and Environmental and Social Performance Standards. A quarterly environmental and social monitoring report will be submitted to EIB and AIIB and will be disclosed publicly at the EIB and AIIB website.

278. Due to the limited and manageable nature of impacts this EIA is adequate to comply with EIB and AIIB's Environmental and Social Policy requirements and therefore further detailed environmental analysis for the proposed project is not required.

APPENDIX 1: World Bank And GoI Ambient Air Quality Standards

A comparison between the ambient air quality requirements between the World Bank (WB) Environment, Health and Safety (EHS) guidelines and the National Ambient Air Quality standards (NAAQS) under the Air (Prevention and Control of Pollution) Act, 1981 of GOI as given in table below shows that the NAAQS has requirements on three more parameters (Pb, Co and NH₃) in comparison to the WB EHS. The NAAQS has differentiated standards for two types of areas: i) industrial, residential, rural and other areas and ii) ecologically sensitive areas. The WB EHS has guideline values which are the required standards but allows for gradual compliance to the guideline values through staged interim targets. Most WB EHS guideline requirements are more stringent than NAAQS except for the NO_x one year average in ecologically sensitive areas where the NAAQS requirements are more stringent.

Table 1: Ambient Air Quality standards of WB EHS Vs. the GOI NAAQS

Ambient Air Quality Parameter	Averaging Period	WB Guideline Value		GOI Standards for Industrial, Residential, Rural and Other Areas	GoI Ecologically Sensitive Area (notified by Central Government)
Sulfur dioxide (SO ₂) (ug/m ³)	24-hr	125	(Interim target 1)	80	80
		50	(Interim target 2)		
		20	(guideline)		
	10 min	500	(guideline)		
	Annual	None		50	20
Nitrogen dioxide (NO ₂) (ug/m ³)	1 Year	40	(guideline)	40	30
	24 Hour	None		80	80
	1 Hour	200	(guideline)		
PM ₁₀ (ug/m ³)	1 Year	70	(Interim target 1)	60	60
		50	(Interim target 2)		
		30	(Interim target 3)		
		20	(guideline)		
	24-hr	150	(Interim target 1)	100	100
		100	(Interim target 2)		
		75	(Interim target 3)		
		50	(guideline)		
PM _{2.5} (ug/m ³)	1 year	35	(Interim target 1)	40	40
		25	(Interim target 2)		
		15	(Interim target 3)		
		10	(guideline)		
	24-Hour	75	(Interim target 1)	60	60
		50	(Interim target 2)		
		37.5	(Interim target 3)		
		25	(guideline)		
Ozone (O ₃) (ug/m ³)	8-hr daily max	160	(Interim target 1)	100	100
		100	(guideline)		
Lead (Pb) (ug/m ³)	Annual			0.5	0.5
	24 hours			1.0	1.0
Carbon Monoxide (CO) (ug/m ³)	8 hours			2000	2000
	1 hour			4000	4000
Ammonia (NH ₃) (ug/m ³)	Annual			100	100
	24 hours			400	400

APPENDIX 2: Comparison of WB EHS And GoI Ambient Noise Level Standards

A comparison on noise level requirements between the WB EHS guidelines and the NAAQS under the Air (Prevention and Control of Pollution) Act, 1981 of GOI as given in table B shows that the required levels are equal for residential, institutional and educational areas. The NAAQS requirements for commercial areas are more stringent while the WB EHS requirement for daytime noise in industrial area is more stringent.

Table 2: Ambient Noise level standards of WB EHS Vs. the GOI NAAQS

Receptor	WB EHS		GOI NAAQS	
	Daytime	Nighttime	Daytime	Nighttime
	7:00-22:00	22:00-7:00	6:00-22.00	22:00-6:00
Residential	55	45	55	45
Institutional; educational			None	None
Industrial	70	70	75	70
Commercial			65	55
Silence Zone	None	None	50	40

APPENDIX 3: Indian Standard Drinking Water Specification: II 10500:1991

Sl. No.	Substance/ Characteristic	Desirable Limit	Permissible limit	Remarks
1	Colour, Hazen units, Max	5	25	Extended to 25 if toxic substance are not suspected in absence of alternate sources
2	Odour	Unobjectionable		a) Test cold and when heated b) Test at several dilution
3	Taste	Agreeable		Test to be conducted only after safety has been established
4	Turbidity NTU, Max	5	10	
5	pH value	6.5 to 8.5	No relaxation	
6	Total Hardness (as CaCO ₃ mg/lit)	600	600	
7	Iron (as Fe mg/lit, Max	0.3	1.0	
8	Chlorides (as Cl mg/lit Max	250	1000	
9	Residual Free Chlorine, mg/lit Max	0.2		To be applicable only when water is chlorinated. Treated at consumer end. When protection against viral infection is required, it should be Min 0.5 mg/lit
10	Dissolved Solids mg/l, Max	500	2000	
11	Calcium (as Ca) mg/l, Max	75	200	
12	Copper (as Cu) mg/l, Max	0.05	1.5	
13	Manganese (Mn) mg/l Max	0.1	0.3	
14	Sulphate (As SO ₄), Max	200	400	May be extended up to 400 provided (as Mg) does not exceed 30
15	Nitrate (as NO ₃) mg/l, Max	45	100	
16	Fluoride (as F) mg/l, Max	1.0	1.5	
17	Phenolic Compounds (as C ₆ H ₅ OH) mg/l Max	0.001	0.002	
18	Arsenic (as As mg/l	0.05	No relaxation	To be tested when pollution is suspected
19	Lead (as Pb) mg/l	0.05	No relaxation	
20	Anionic Detergents (as MBAS) mg/l	0.2	1.0	
21	Chromium (as Cr) mg/l	0.05	1.0	To be tested when pollution is suspected
22	Mineral Oil mg/l	0.01	0.03	
23	Alkalinity mg/l	200	600	
24	Total Coliform	95% of the sample should not contain coliform in 100 ml. 10 coliform /100 ml		

APPENDIX 4: Record of Public Consultations

Once in 18.05.2017 such day 11.00 AM till 02.00 PM, waterworks (D.D.M.W.) staff
 staff from the staff staff staff staff staff staff staff staff staff staff staff staff staff staff staff
 staff staff staff staff staff staff staff staff staff staff staff staff staff staff staff staff staff staff staff
 staff staff staff staff staff staff staff staff staff staff staff staff staff staff staff staff staff staff staff
 staff staff staff staff staff staff staff staff staff staff staff staff staff staff staff staff staff staff staff

S No.	Name of staff	Address of staff	Phone No.
1	U&P I	Adv. Chetan Pichamathu CSI - KCB Bangalore	9886002728 <i>[Signature]</i>
2	Mico Industries	No. 832 3rd main E Block 2nd stage Rajarajendra Block	9845746648 <i>[Signature]</i>
3	Vandana for water	Lab. 3rd main KCB NCHM Bangalore	17
4	Nagappa +1	Block II. NCHM Bangalore	9842270623 <i>[Signature]</i>
5	Hall Top Stones N Hd Mico India	Hall Top Stones pulled at the base gate Bangalore water board. Bangalore	9900067784
6	Mico	purshothamaven. C.I 1st F. Secappa No. 207 2nd stage main - Bangalore	741112005 <i>[Signature]</i>
7	Kothanna Dipol +1	Srinivasappa Site No. 35 & 36 Address: NO 19, 6th C Main Govarnanagar. Fp nagan 7th phase. Bangalore	9886600854 17.5.17 <i>[Signature]</i>

8	MICO INDUSTRY	C. R. VOYA SAGAR No 38/1, 1st Cross Shamanna Garden, Baner Road, B. 10/2-30	9886634807 <i>[Signature]</i>
9	MICO Industry 11	Satish, E.N. No-6, 1st Cross, Shamanna Garden, B.G. Road, B. 10/2-30.	9880528896 <i>[Signature]</i>
10	Kulkarni Dapur	K. Manjundakwamy Cross, Rajga Chawki 12, Minerva Road, B. 10/2-30 (GATE - S. S. GARDEN)	9813345514 <i>[Signature]</i>
11	Bannergate Road 207	Dr. Koushik Jaisankar 10/12, E. Side, S.R. Garden, Jayang. Coopers	<i>[Signature]</i> 9845671971
12	,	Arif A. Hussain - Ameer A. Hussain	<i>[Signature]</i> 9447700453
13	1/3 Bannergate Main Road	Norosh Agrawal	<i>[Signature]</i> 9845025370
14	MICO	Dayaram Patal (Ash, Gwal) 1/2 B.G. Road Ushahidwar B. 10/2-30 E.P.H.	9742280011 <i>[Signature]</i>
15	MICO	Zaboor Khan No-22 Kareem Khan Bannergate Mico Post Store	<i>[Signature]</i> Zaboor
16	MICO	Rajesh A. Bagay No-10 2 nd Cross wide of Chand prabha S.R. Garden, B. 10/2-30	9839049554 <i>[Signature]</i>
17		Sri. Shrinani No 112 Old Road B-30 M/S Chand prabha	9700668156 <i>[Signature]</i>