

Environmental Impact Assessment (Draft)

March 2021

India: Chennai Metro Rail Investment Project
Corridor 4

Main Report

Prepared by the Chennai Metro Rail Limited (CMRL) for the Asian Development Bank.

CURRENCY EQUIVALENTS

(as of 1 January 2021)

Currency Unit	=	Indian Rupee (₹)
₹ 1.00	=	\$0.0137
\$1.00	=	₹73.094

ABBREVIATIONS

ADB	:	Asian Development Bank
AIIB	:	Asian Infrastructure Investment Bank
CBTC	:	Communication based Train Control
CGWB	:	Central Ground Water Board
C&D	:	construction and demolition
CMA	:	Chennai Metropolitan Area
CMDA	:	Chennai Metropolitan Development Authority
CMRL	:	Chennai Metro Rail Limited
CPCB	:	Central Pollution Control Board
CMP	:	Comprehensive Mobility Plan
CMFRI	:	Central Institute of Mining and Fuel Research
CRZ	:	Coastal Regulatory Zone
EHS	:	Environmental, Health, and Safety
EIA	:	Environmental Impact Assessment
EMP	:	Environmental Management Plan
EMoP	:	Environmental Monitoring Plan
ESF	:	Environment and Social Framework
ESP	:	Environment and Social Policy
ESHS	:	Environment, Social, Health and Safety
FTA	:	Federal Transit Administration
GoI	:	Government of India
GoTN	:	Government of Tamil Nadu
GC	:	General Consultants
GRM	:	Grievance Redress Mechanism
IMD	:	India Meteorological Department
JICA	:	Japan International Cooperation Agency
KLD	:	Kilo Litres Per Day
MoEF&CC	:	Ministry of Environment, Forests and Climate Change
MDBs	:	Multilateral Development Banks
MRTS	:	Mass Rapid Transit System
NDB	:	New Development Bank
NAAQS	:	National Ambient Air Quality Standards
NBWL	:	National Board of Wildlife
NGT	:	National Green Tribunal
PAP	:	Project Affected Persons

RDSO	:	Railway Design & Standards Organisation
RAP	:	Resettlement Action Plan
SIPCOT	:	State Industries Promotion Corporation of Tamil Nadu
SPV	:	Special Purpose Vehicle
SIA	:	Social Impact Assessment
TNCZMA	:	Tamil Nadu Coastal Zone Management Authority
TBM	:	Tunnel Boring Machine
TNPCB	:	Tamil Nadu Pollution Control Board
WHO	:	World Health Organization

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
MW	-	Megawatt
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

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., FY2021 ends on 31 March 2021.

(ii) In this report, "\$" refers to US dollars.

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EXECUTIVE SUMMARY

1. Chennai, the capital city of the state of Tamil Nadu, is part of the Chennai Metropolitan Area (CMA) that is home to over 8.65 million people and plays a vital role in the economy of South India.¹ Like other metropolitan areas in the country, CMA is currently facing the challenges of accelerated urbanization growth that have considerably strained the area's transportation system. The increase in economic activities has boosted the regional economy and job creation, which in turn necessitates improvement in ease of travel and connectivity.

2. Chennai Metro Rail Limited (CMRL), a joint venture of the Government of India (GoI) and the Government of Tamil Nadu (GoTN) with equal equity ownership, is responsible for implementing, operating, and maintaining the city's metro system. CMRL developed the Comprehensive Mobility Plan for CMA in 2015 and identified three corridors (corridors 3, 4, and 5) for the second phase of the Chennai Metro Rail to alleviate CMA's transportation capacity constraints.

3. GoI requested the Multilateral Development Banks² (MDBs) to assist the implementation of the 26.8 km of Chennai metro corridor 4 upto depot entry, which consists of 16.5 km of elevated section and 10.3 km of underground section. This line has 4 stations in common with Corridor 5, offers interchange with Corridor 3, Phase I Metro and MRTS; it connects with suburban railway system. This alignment has been finalized after examining alternatives. The total capital cost of Corridor 4 is estimated to be USD 2.17 billion. It is estimated that project will be commissioned 5 years from award of civil contracts. CMRL will take full responsibility of the implementation of Corridor 4.

4. As per provisions of the Environmental Impact Assessment (EIA) Notification 2006 and its subsequent amendments by the Ministry of Environment, Forests and Climate Change (MoEF&CC), Metro Rail Projects are exempted from requirements of Environmental Clearance. However, the Light House to Foreshore Road section will fall in Coastal Regulatory Zone (CRZ) IA and II and CRZ clearance will be required as per CRZ Notification 2019.

5. This EIA comprising baseline data on existing conditions of physical, ambient and ecological environment, together with the identified and anticipated environmental impacts and proposed mitigation measures, has been prepared in accordance with GoI's legislative framework and MDBs' environmental safeguard policies³. In accordance with proposed packaging of Corridor 4, underground stretch, elevated stretch and depot will be financed by different MDB and constitute Associated Facilities to each package. The environmental impacts and mitigation measures of all 4 packages are analyzed in this report. Corridor 4 overall is expected to generate environmental and socio-economic benefits in terms of decreasing air pollution from traffic congestion and serving the growing travel demand. As per the MDB's safeguard policies, the Corridor 4 has been categorized as "Category A" due to the significant impacts anticipated during construction.

6. Corridor 4 consists of 12 underground stations from Lighthouse to Meenakshi College, 18 elevated stations from Power House to Poonamallee Bypass and one depot at Poonamallee

¹ Indian National Census, <https://www.census2011.co.in/census/metropolitan/435-chennai.html> The Census Organization of India, 2011.

² Asian Development Bank (ADB), Asian Infrastructure Investment Bank (AIIB) and New Development Bank (NDB).

³ ADB's Safeguard Policy Statement (SPS) 2009, AIIB's Environmental and Social Framework (ESF), and NDB's Environmental and Social Framework (ESF).

Bypass. The depot will have capacity for 31 trains of 6 cars for maintenance and repairs of the operational rolling stock. Standard Gauge (1435mm) will be adopted with a minimum track center distance of 4000 mm, 16-ton maximum axle load capacity and a design speed of 80 kmph. The elevated station is generally located on the road median 140 m long and 24 m wide and is a three level structure, with a minimum vertical clearance of 5.50 m under the concourse. To reduce physical and visual impact of the elevated station, stations have been made transparent with minimum walls on the sides. The underground station is two- or three-level station with entrances and ventilation shafts at the ground level, a concourse with ticketing and automatic fare collection system (AFCs) at the mezzanine level and finally 140 m long and 12 m wide island platforms at the lowest level. 25 kV AC traction system and Communication based Train Control (CBTC) Signaling system shall be adopted for Corridor 4. Rolling stock is of light weight stainless steel/aluminum body for energy efficiency. Universal accessibility has been reflected in the design following international best practices. Green building features like rainwater harvesting, solar energy panels at elevated stations' roofs, energy efficient air conditioning and lightning will be considered in station design.

7. The terrain along Corridor 4 alignment is mostly flat, no more than 3 m above mean sea-level. The Geotechnical Investigation is ongoing with the results showing that the soils are slightly alkaline with dominant types of sandy and clay. The section of alignment from Light House to Foreshore Estate Road station is located in CRZ IA and II. The CRZ II stretch is defined as areas that have already been developed up to or close to the shore-line. 536 trees are likely to be felled along the corridor up to Poonamallee Bypass depot. Three assets, namely Santhome Church, Rosary Church and Our Lady of Light Shrine are located on at distance within 100m from Corridor 4.

8. Despite the seemingly abundant sources of water, Chennai suffers continuously from water stress since the entire basin is dependent on rainfall. Water quality was sampled at 9 locations. Most of the parameters are well within the prescribed permissible limits as per the Bureau of Indian Standards. However, the concentration of Total Dissolved Solids and Total Hardness are observed to be higher than the prescribed limits as per the IS for the water samples collected at Santhome Church this could be due to higher salinity and mineral content (Calcium and Magnesium) in the groundwater. .

9. Results of the air monitoring show that air quality was moderate, while the parameters of Sulphur Dioxide (SO₂) and Nitrogen Dioxide (NO₂) were within the permissible level of National Ambient Air Quality Standards (NAAQS) and World Health Organization (WHO) guideline. Particulate Matter was within NAAQS but exceeded WHO guideline. Concentration of Carbon Monoxide (CO) exceeded the permissible level of NAAQS in all the monitoring locations but was generally within WHO guideline. The noise levels monitored at 8 locations along the alignment were above the national and international permissible limits. Noise levels was also monitored at 30 sensitive locations belonging to the silence zone, with 60% slightly exceeding Ambient Noise Standard of 50dB the daytime limit (23.3% per WHO guideline of 55dB), and 1 out of 30 exceeding 40 dB the night-time limit. The peak particle velocity baseline values to demonstrate the vibration level at 11 out of 13 monitored locations is found to exceed acceptable criteria for ground borne vibration prescribed by Federal Transit Administration (FTA) USA and Railway Design & Standards Organisation (RDSO) India which are more valid for operation of this project. However the observed levels at all 13 locations are well below the construction vibration damage criteria for blasting which are relevant only if blasting is undertaken during construction as per Central Institute of Mining and Fuel Research (CMFRI) India. A full baseline will be collected prior to contractor's mobilization to elaborate the current baseline.

10. Based on analysis of project and environmental settings, a detailed assessment of potential impacts due project location and design, construction and operation has been carried out. For each of these adverse impacts, mitigation measures have been proposed. The key positive environmental impacts of Corridor 4 include reduced use of private vehicle leading to reduction in pollutants; road safety improvements; increased accessibility and mobility, and a modest reduction in greenhouse gas emissions. The main residual negative impacts of Corridor 4 include fugitive and point source dust emission, surface noise and vibration from excavation and demolition, disturbance to road traffic, disposal of large quantities of construction and demolition wastes, and occupation and community health and safety, which are mainly temporary and localized. The detailed analysis of noise and vibration is yet to be finalized. The results will be incorporated in the updated EIA prior to contractor's mobilization.

11. The main mitigation measures proposed are as follows: (i) to plant twelve saplings for each tree to be cut as against ten saplings ordered for infrastructure projects by the Honorable Madras High Court, with estimated compensatory afforestation cost in place accordingly; (ii) noise reduction measures (i.e. noise barriers at sensitive receptor locations); and (iii) reuse of excavated material where feasible and disposal of construction waste in a regulated manner. Corridor 4 will take into consideration the climate change effects of an anticipated continuous increase in ambient temperature, intensity of cyclones and storm surge, heavy precipitation events, and sea level rise in the future. Several climate change considerations to be integrated into Corridor 4 design include: (i) installation of floodgates at stations with flooding risks; (ii) improving adaptability to seasonal thermal variations in the stations through the use of large open spaces for unrestricted air movement, cross-ventilation and ensuring that enclosed areas are well ventilated; (iii) designing for better adaptability to rising sea level/high tide/heavy flooding through the use of higher plinth levels and check valves for sewer lines in flood-prone areas and the use of resilient materials that can get wet and then dry out with minimal damage; (iv) using solar panels on station buildings and roofs to reduce the extensive use of grid-generated electricity supplied to the station for its operation and maintenance; and (v) through better station roof design, providing for rainwater harvesting by channeling rainwater through gutters and pipes to either harvesting pits in the ground or to recharge groundwater.

12. Various alternatives such as modes of transport, alignment, proposed design etc. have been considered and analyzed for its likely impacts on various environmental parameters. Additionally, an evaluation of potential environmental impacts in terms of 'with' and 'without' project situation has been considered for the justification of Corridor 4.

13. Meaningful consultations were carried out with various stakeholders during EIA preparation and will continue throughout Corridor 4 implementation. Women felt that Corridor 4 will provide (i) better access to higher levels of education, health services (especially in emergencies), and social interactions; (ii) better transport option; and (iii) increase in leisure time. Concerns voiced by Project Affected Persons (PAPs) and stakeholders have been incorporated in Corridor 4 design. Individual consultation of PAPs will also be carried out during implementation. Information disclosure will follow the procedure for MDBs' Category A projects.

14. Grievance Redress Mechanism (GRM) has been proposed for Corridor 4 comprises the procedures to address grievances i) first at the Project Implementation Unit (PIU) level, ii) second at Grievance Redress Committee (GRC), to ensure grievances from PAPs and workers are addressed to facilitate timely project implementation. A GRC will be formed which will have representatives from Contractors, General Consultant (GC), CMRL, local administration, and PAPs. Unsatisfied PAPs will have the option to escalate the grievances at any point of time.

15. An Environmental Management Plan (EMP) with institutional arrangements, budgetary provisions, schedule for EMP implementation and its monitoring has been prepared, including appropriate mitigation measures, provisions related to occupational health and safety, labour camp and construction site management, and traffic and public utility management etc. to address all impacts during Project pre-construction, construction and operation phases. The EMP has been developed in conjunction with general safety, health and environment provisions (which are included in the standard bidding document) and it forms part of the contract document of the contractors. Biannually monitoring reports will be prepared by GC and submitted to MDBs through CMRL. A third-party monitor will also supervise work independently and submit biannual reports to CMRL and MDBs. The preliminary estimated cost of the EMP including implementation and monitoring is USD 2.93 million (INR 213.62 million). This cost estimate is exclusive of land acquisition and resettlement & rehabilitation cost.

16. Benefits far outweigh negative impacts. Overall, the major social and environmental impacts associated with Corridor 4 are limited to the construction period and can be mitigated to an acceptable level by implementation of recommended measures and by best engineering and environmental practices. In addition, stringent monitoring requirements and actions have been included in the Environmental Monitoring Plan (EMoP) on noise and vibration levels that will be generated during construction. CMRL shall ensure that the EMP and EMoP are included in Bill of Quantity and forms part of bid document and civil works contract. The same shall be revised if necessary, during project implementation or if there is any change in the project design and with approval of MDBs.

17. This EIA report is structured as following: (i) Introduction of background, methodology of preparation of the report; (ii) Policy and legal framework within which environmental safeguards for Corridor 4 shall be recommended and implemented; (iii) Project description with enumeration of salient features of Corridor 4 which have bearing upon its environmental impacts; (iv) Environmental baseline of Corridor 4 in terms of physical, ambient, and ecological baseline (socioeconomic baseline will be presented in Social Impact Assessment Report); (v) Identification of negative and positive impacts arising from pre-construction, construction and operation of Corridor 4 and respective measures to mitigate negative impacts and where feasible enhance generate positive impacts; (vi) Analysis of alternatives including its need and alternatives of technology and alignment; (vii) Consultations with stakeholders and plan for disclosure of project information; (viii) Mechanism for stakeholders to communicate grievances and suggestions and for their Redressal; (ix) EMP and institutional arrangement for implementation of environmental impact mitigation measures; and (x) Conclusion.

1 INTRODUCTION

1.1. Background

1. Chennai Metropolitan Area (CMA) comprises the city of Chennai, 8 Municipalities, 11 Town Panchayats and 179 Village Panchayats in 10 Panchayat Unions. The extent of CMA is 1,189 sq.km. The CMA falls in three Districts of Tamil Nadu viz. Chennai District (176 sq.km), part of Tiruvallur District (637 sq.km), and part of Kancheepuram District 376 sq.km). In year 2011, resident population of CMA was 8.65 million.

2. Chennai, the capital city of the state of Tamil Nadu, plays a vital role in the economy of South India.¹ The Chennai Metropolitan Development Authority (CMDA) devised the Chennai Second Master Plan 2026 and estimated that the population would grow to 12.6 million people with an estimate of daily passenger traffic of 20.8 million in 2026.² CMA has emerged as a leading national automotive hub with major manufacturers including Ford, Hyundai, Renault, Nissan, Daimler (Mercedes) operating their plants in the area. CMA also houses a growing number of software firms (including Infosys, TCS, Wipro etc.), financial services (KPMG, Deloitte, Price water house Coopers etc.) and call centers. Like other metropolitan areas in the country, CMA is currently facing the challenges of accelerated urbanization growth that have considerably strained the area's transportation system. The increase in economic activities has boosted the regional economy and job creation, which in turn necessitates improvement in ease of travel and connectivity.

3. The existing transportation system in CMA is marked by high traffic density, carbon emissions, and frequent road incidents. In addition to the high volume of vehicles and already congested roads, inadequate parking space and the encroachment of street space by vendors on major road have exacerbated the traffic congestion. Major roads along the proposed project alignments are forecast to function beyond respective design service volume in year 2035 in absence of the project lines. The accelerating use of private vehicles has put Chennai in the fifth rank in carbon emission from the transport sector among 54 South Asian cities.³

4. Inadequate transportation infrastructure and poor service have resulted in an unfavorable decrease in the share of public transport from 54 percent in 1970 to 28 percent in 2014.⁴ The Chennai Second Master Plan 2026 proposes to increase the public and private mode split to 70:30. The mass transit transportation, especially an integrated metro system will be essential to achieve this intended split.

5. The city has two mainline railway terminals. Urban Mass Rapid Transit System (MRTS) of 19.35 km from Chennai Beach to Velachery is in operation, land acquisition for balance MRTS section from Velachery to St Thomas Mount is in process. Chennai Metro Phase 1 of 45 kms is in operation, work on extension to Thiruvottiyur is in progress. Chennai suburban railway network supplements MRTS. Schematic diagram of urban mass rapid transit network is in Figure 1.1.

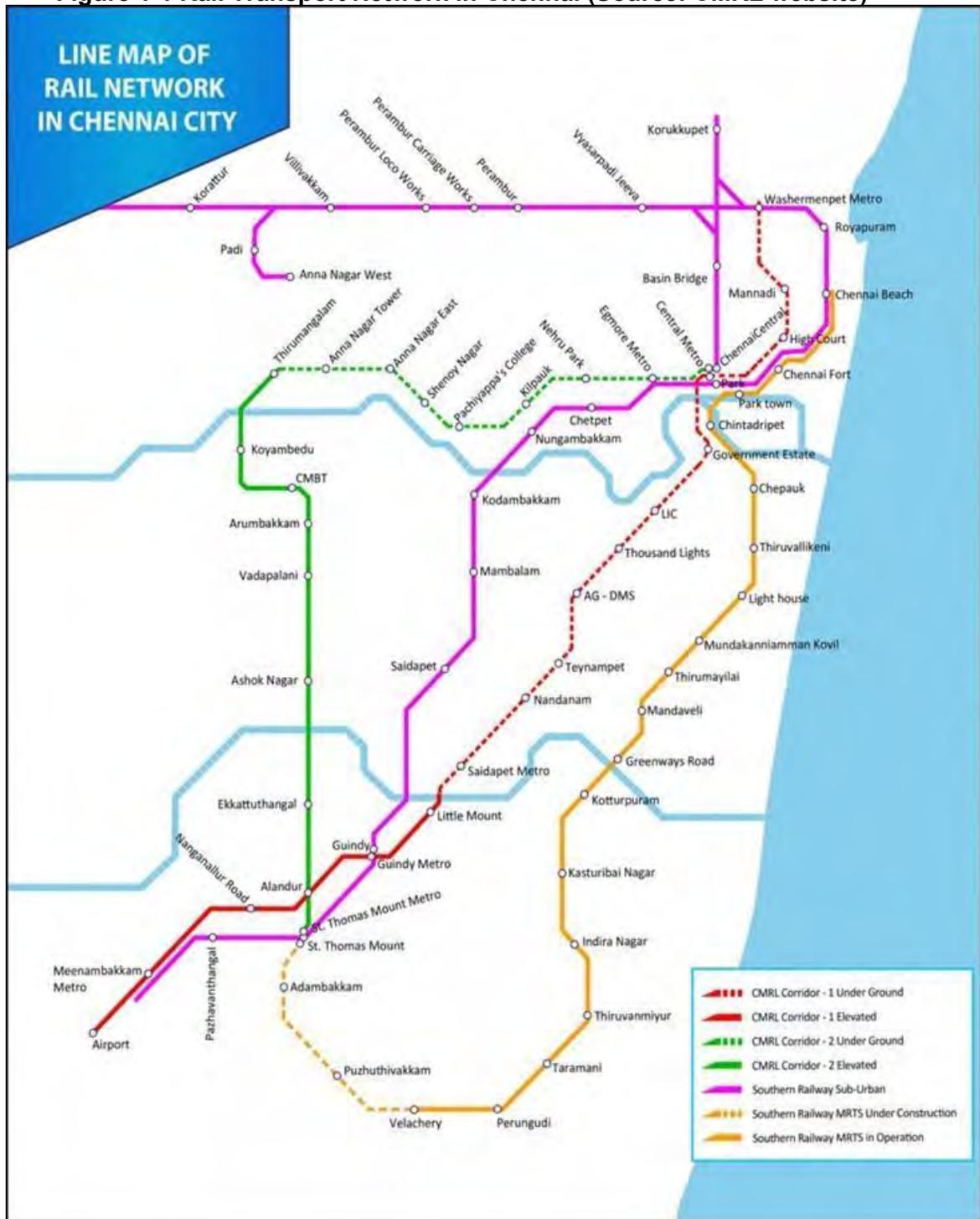
¹ Indian National Census, <https://www.census2011.co.in/census/metropolitan/435-chennai.html> The Census Organization of India, 2011.

² Second Master Plan for Chennai Metropolitan Area 2026, Chennai Metropolitan Development Authority, 2008.

³ International Council for Local Environmental Initiative Study, 2012.

⁴ Comprehensive Detailed Project Report for Chennai Metro Phase-II, Chennai Metro Rail Limited, 2018.

Figure 1-1 Rail Transport Network in Chennai (Source: CMRL website)



1.1.1. Chennai Metro Network

6. **Phase 1** of Chennai metro as shown in Figure 1.2 covers 54.05 km in two corridors - Washermanpet to Airport (23.09 Km), Chennai Central to St. Thomas Mount (21.96 Km) via Koyambedu and extension from Washermanpet to Wimco Nagar (9.00 km) in Thiruvottiyur. As

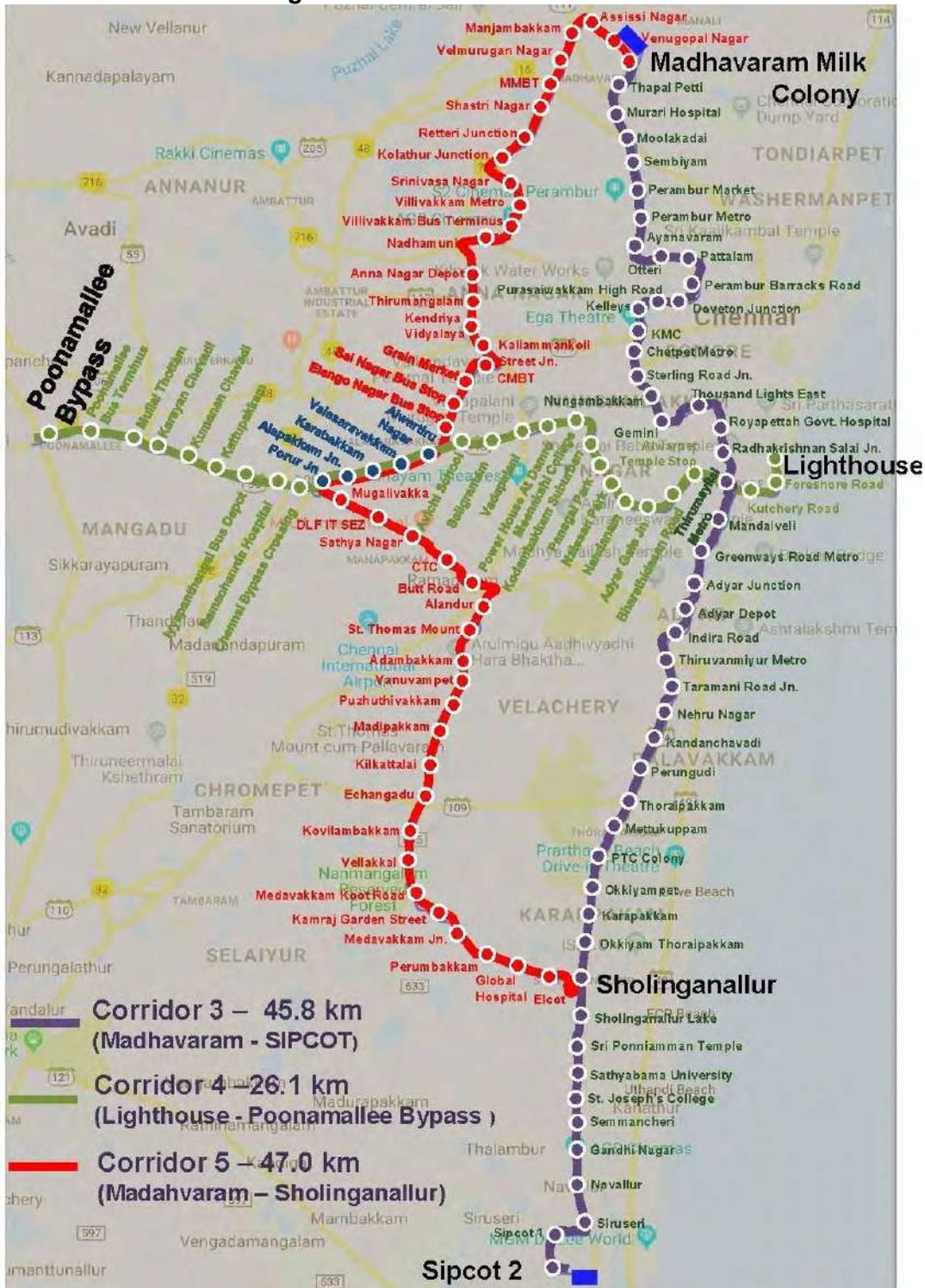
on February 2020, Phase 1 excluding the extension from Washermanpet to Thiruvottiyur is in commercial operation.

Figure 1-2 Metro Network Phase 1 (Source: CMRL website)



7. **Phase 2** includes Corridor 3, 4 and 5 as shown in Figure 1.3. The final alignments will be decided based on engineering designs.

Figure 1-3: Metro Network Phase 2



Source: Comprehensive DPR Chennai Metro Phase 2, RITES, Dec 2018

8. **Corridor 3** Madhavaram to SIPCOT, length of the corridor is 45.813 km comprising 30 underground stations and 20 elevated stations. It provides interchange with Corridor 4 and Corridor 5. It offers interchange with Phase I Metro and MRTS and connects with suburban railway system.

9. The 35.044 km long section from Madhavaram depot to Sholinganallur station via Adyar runs on the Eastern periphery of the city: it is being funded by JICA. This section comprises 30 underground stations and 10 elevated stations. Viaduct and stations 9.627 km long from Sholinganallur to SIPCOT is being financed by ADB; civil construction is scheduled to be commenced by July 2021 and completed by July 2024. Systems works are scheduled to be completed and metro commissioned by November 2025.

10. **Corridor 4** Lighthouse to Poonamallee bypass, length of the corridor is 26.8 km comprising 12 underground stations (Lighthouse to Meenakshi College) and 18 elevated stations (Power House to Poonamallee bypass). Corridor 4 has 4 stations (the latest alignment of Corridor 5 shows the Porur Jn station will be avoided by Corridor 5) in common with Corridor 5, offers interchange with Corridor 3, Phase I Metro and MRTS; it connects with suburban railway system. Civil construction of the underground section from Lighthouse to Meenakshi College is scheduled to commence in December 2021 and completed by December 2025. System works are scheduled to be completed and the entire Corridor 4 is commissioned by December 2026.

11. Corridor 4 is being funded by MDBs AIIB and ADB. The MDB funding arrangement is as follows:

- (i) Asian Development Bank (ADB): Alignment and formation/tunneling (10.3 km from Lighthouse to Meenakshi College), 10 underground stations structural civil cost.
- (ii) Asian Infrastructure Investment Bank (AIIB): Alignment and formation (16.5 km from Power House to Poonamallee bypass), 18 Elevated stations structural civil cost, General Consultancy.
- (iii) New Development Bank (NDB): P. way, station building components VAC and TVS, E&M, Lifts and Escalators, Architectural finishes and MMI.

12. **Corridor 5** Madhavaram to Sholinganallur, Revenue length of the corridor is 47.008 km comprising one at grade station, 41 elevated stations and 6 underground stations. It is integrated with Phase I Metro and MRTS; connects with suburban railway system. MDB Corridor 5 is the 30.125 km section connecting CMBT to Sholinganallur including 29 elevated stations. CMBT forms part of Corridor 5 from Madhavaram to CMBT being financed by JICA and Sholinganallur station forms part of Corridor 3 from Madhavaram to Sholinganallur being financed by JICA. Construction of viaduct and stations of MDB Corridor 5 from CMBT to Sholinganallur is scheduled to be commenced by July 2021 and completed by June 2024. Systems works are scheduled to be completed and metro commissioned by November 2025.

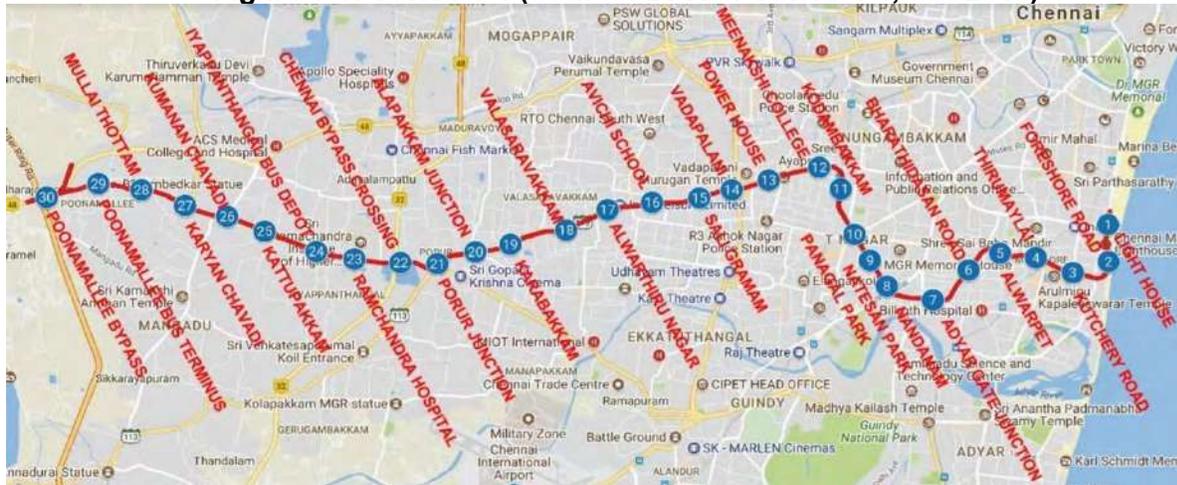
13. MDB Corridor 5 is being funded by MDBs AIIB and ADB. The MDB funding arrangement is as follows:

- (i) AIIB: Alignment and formation, stations
- (ii) ADB: P. way, E&M, Lifts and Escalators, Architectural finishes and MMI.

1.1.2. Nature, Size and Location of Corridor 4

14. Figure 1.4 shows the alignment and station plan of Corridor 4.

Figure 1-4: Corridor 4 (Source: DPR of Corridor 4, Oct 2018)



15. Corridor 4 is financed in parallel by:

- Asian Development Bank (ADB) includes Alignment and formation/tunneling (10.3 km from Lighthouse to Meenakshi College), 12 underground stations structural civil cost.
- Asian Infrastructure Investment Bank (AIIB) includes Alignment and formation (16.5 km from Power House to Poonamallee bypass), 18 Elevated stations structural civil cost, General Consultancy.
- New Development Bank (NDB) includes P. way, station building components VAC and TVS, E&M, Lifts and Escalators, Architectural finishes and MMI.
- Government will finance the remaining components including Depot and Rolling Stock.

16. These three institutions are collectively termed in this report as Multilateral Development Banks (MDBs).

17. The Government of Tamil Nadu (GoTN) has created a Special Purpose Vehicle (SPV) for implementing the Chennai Metro Rail Project. This SPV named as “Chennai Metro Rail Limited (CMRL)” was incorporated on 03.12.2007 under the Companies Act. It has now been converted into a Joint Venture of Government of India (GoI) and GoTN with equal equity holding. CMRL as the implementing agency, shall be responsible for implementing, operating, and maintaining the city’s metro system. CMRL developed the Comprehensive Mobility Plan for CMA in 2015 to identify the present and future mobility patterns of CMA. The detailed study identified three corridors (corridors 3, 4, and 5) for the second phase of the Chennai Metro Rail to alleviate CMA’s transportation capacity constraints.

1.2. Environmental Impact Assessment

1.2.1. Categorization

18. The environmental screening has been carried out for Corridor 4 as per MDBs’ policies. Based on preliminary assessment of significance of impacts borne out of field visits and secondary information, Corridor 4 will entail significant adverse impacts. Although, the proposed project will bring in many benefits to the area, there is potential for environmental impacts on the physical cultural structures due to vibration from tunnelling works during construction and future

operation of the metro. Impacts on structures also come from the shallow foundation which may bring damage due to subsidence, particularly for those close to the alignment. The civil works pose significant environment, health and safety risks as well. Therefore, the project has been classified as category 'A' and requires full impacts assessment to be documented in an Environmental Impact Assessment (EIA) Report per MDBs' requirement.

1.2.2. Purpose of the EIA Report

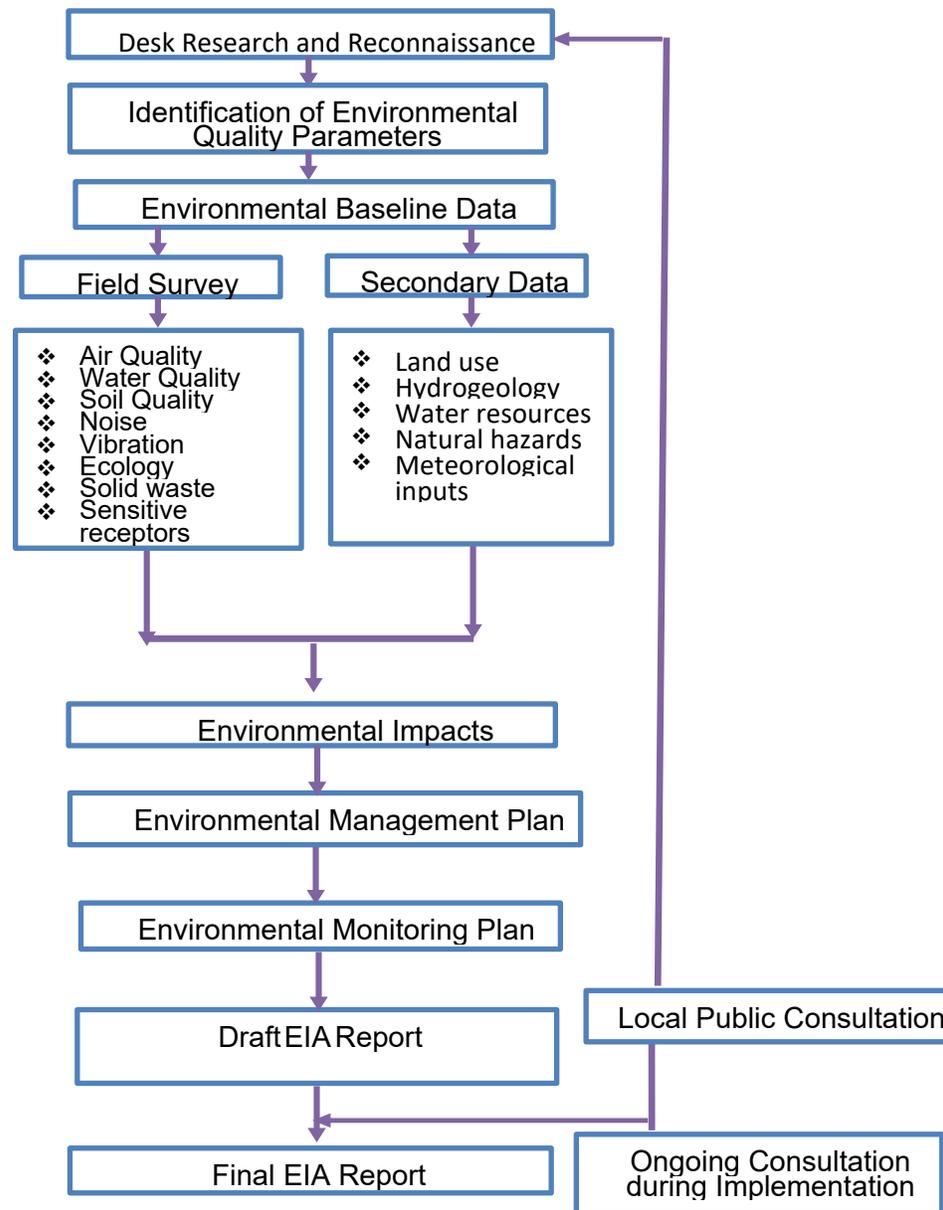
19. This EIA report documents the environmental assessment of Corridor 4 and identifies the environmental issues to be considered at planning and design stage. In this report, the different activities that are likely to take place during construction and operation, have been analysed and the potential impacts that may accompany them have been discussed. The EIA addresses the environmental management requirements of Gol and the MDBs. In general, the EIA Report is outlined as below to address various aspects:

- Provide background of the project in terms of land use, existing Metrorail network and the proposed Metrorail corridors, methodology of preparation of the report and its content;
- Analysis of policy and legal framework within which environmental safeguards for the project shall be recommended and implemented;
- Provide information about the baseline environmental settings;
- Provide information on potential environmental impacts of Corridor 4 with its magnitude, distribution, and duration;
- Provide information on required mitigation measures with cost to minimize the impacts;
- Analysis of the alternatives considering alternative locations, designs, management approaches, for selection of most feasible and environmental acceptable options;
- Provide details of stakeholders' consultations;
- Plans for stakeholders to communicate grievances and suggestions and for their Redressal; and
- Formulate environmental management and monitoring plan with institutional measures for effective implementation of mitigation measures proposed.

20. Social Impact Assessment (SIA) with a Resettlement Action Plan (RAP) for implementation is presented as a separate Report.

1.2.3. Approach and Methodology

Figure 1-5: Methodology of Environmental Impact Assessment



21. As shown in Figure 1.5, the EIA followed a number of steps:

- Review of available baseline reports, and technical reports/studies related to Corridor 4;
- Conduct field visits to collect primary or secondary data relevant to Corridor 4 areas to establish the baseline⁵;
- Assess the potential impacts on environmental attributes due to the location, design, installation and operation of Corridor 4 through field investigations and data analysis;

⁵ The Baseline data for air, water and soil quality was collected in width 75m on either side of proposed centre line of alignment, and data for noise and vibration in width 200m on either side of alignment. Sensitive receptors located in width 100m on either side of centre line of alignment were identified according to the silence zone defined by the Central Pollution Control Board.

- Explore opportunities for environmental enhancement and identify measures;
- Prepare an environment management plan (EMP) outlining the measures for mitigating the impacts identified including the institutional arrangements;
- Identify critical environmental parameters required to be monitored subsequent to the implementation of Corridor 4 and prepare an environmental monitoring plan;
- Carry out consultation with key stakeholders and administrative authorities to identify their perception on Corridor 4, introduce project components and anticipated impacts; and,
- Disclose the draft EIA, including the Executive Summary in local language at CMRL and MDBs' websites to be made publicly available.

2. POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK

22. 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. MDBs have also defined its Environmental and Social Policies. This chapter will describe the applicability of above laws and regulations, conventions, protocols, and safeguards.

23. 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,
- ADB, AIIB and NDB environmental and social policies and standards, and
- Summary of international treaties and applicability to the project.

2.1. The National (India) Environmental Laws, Policies and Regulations

24. Gol'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. As per the EIA notification 2006, railway projects are not covered under the notification and hence environmental clearances related requirements do not envisage, this is applicable for metro rail projects as well. However, Corridor 4 will require Coastal Regulation Zone (CRZ) Clearance per the CRZ Notification 2019. Other relevant environmental legislations are mentioned in the Table 2.1.

2.1.1. Coastal Regulation Zone applicable to the Project

25. Alignment of the Corridor 4 passes through CRZ IA and II according to the CRZ Notification 2019. CRZ clearance needs to be obtained from Tamil Nadu Coastal Zone Management Authority (TNCZMA). Under the regulation, Gol declared the coastal stretches of seas, bays, estuaries, creeks, rivers and backwaters which are influenced by tidal action (in the landward side) up to 500 metres from the High Tide Line (HTL) and the land between the Low Tide Line (LTL) and the HTL as CRZ with four categories.

26. As per CRZ Notification 2019, construction in CRZ I area, shall be permitted subject to a detailed marine or terrestrial or both environment impact assessment, to be recommended by

TNCZMA and approved by the Ministry of Environment, Forest and Climate Change (MoEF&CC). Construction in CRZ II area, CRZ II permission is required from TNCZMA.

2.1.2. Metro Rail Policy 2017

27. GoI's Union Cabinet approved a new Metro Rail Policy in 2017 that aims to enable the development and implementation of metro projects in a comprehensive and sustainable manner from the social, economic, and environmental perspectives. The Policy improves the integrated management of Metro development in three main aspects, (i) The new policy proposes that every city should setup a Unified Metropolitan Transport Authority for planning and developing multimodal transportation, which enable the overall planning and development of all modes of transport under the strong lead institutions; (ii) The need to carry out an alternative analysis is a welcome addition in the policy to help in better system selection; and (iii) The requirement to look at the 5-km catchment area for providing feeder services through walking, cycling and para-transit modes is promising.

2.1.3. Legislations Relevant to the Project

28. The policies and requirements which are most relevant in the context of this Corridor are provided in Table 2.1 below.

Table 2-1: Summary of All Relevant Environmental Legislation to Corridor 4

SI No.	Legislation	Objective	Responsible Institution
1.	Environment (Protection) Act (1986) and Rules (1986); National Conservation Strategy and Policy Statement on Environment and Development of 1992; National Environment Policy of 2006	To protect and improve the overall environment	MoEF&CC
2.	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	MoEF&CC
3.	CRZ Notification, 2019	To ensure livelihood security to the fishing communities and other local communities living in the coastal areas; To conserve and protect coastal stretches and; To promote development in a sustainable manner based on scientific principles, taking into account the dangers of natural hazards in the coastal areas and sea level rise due to global warming	TNCZMA and MoEF&CC

Sl No.	Legislation	Objective	Responsible Institution
4.	The Wildlife Protection Act (1972 and amended in 1993)	To protect wild animals and birds through the creation of National Parks and Sanctuaries	MoEF&CC
5.	The Noise Pollution (Regulation and Control) Rules, 2000 (Amended 2002)	To provide for the prevention and control of noise pollution and for the establishment of Boards to carry out these purposes	Central Pollution Board (CPCB)
6.	Metro Rail Transit System, Guidelines for Noise and Vibrations, RDSO, Ministry of Railways, September 2015	To provide for the prevention and control of vibration	NA
7.	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
8.	The Tamil Nadu Water (Prevention and Control of Pollution) Rules, 1983 amended May 2009		Tamil Nadu Pollution Control Board (TNPCCB)
9.	Model Groundwater (Control and Regulation) Bill 1970, amended in 1972, 1996 and 2005	To provide for the prevention, control and abatement of groundwater pollution	Central Ground Water Authority (CGWA)
10.	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
11.	Municipal Solid Waste (MSW) Rules, 2000; Solid Waste Management Rules, 2016	Provisions for collection, storage segregation, transportation, processing and disposal of municipal solid wastes	TNPCCB
12.	Hazardous and Other Wastes (Management and Transboundary Movement) Amendment Rules 2019	To protection the general public against improper handling, storage and disposal of hazardous wastes	TNPCCB
13.	The Forest (Conservation) Act 1980 (Amended 1988) and Rules 1981 (Amended 2003); National Forest Policy of 1998	To protect and manage forests	MoEF&CC
14.	Construction and Demolition Waste Management Rules, 2016	Large generators (who generate more than 20 tons or more in one day or 300 tons per project in a month) shall submit waste management plan and get appropriate approvals from the local authority before starting construction or demolition or remodeling work	TNPCCB

SI No.	Legislation	Objective	Responsible Institution
15.	The Mines and Minerals (Development and Regulation) Act, 1957	To protect the environment from quarry operation	State Department of Geology and Mines
16.	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	Transport Commissionerate and State Transport Authority
17.	Indian Treasure Trove Act, 1878 (as modified up to September 1949); Ancient Monuments and Archaeological Sites and Remains Act (1958)	Conservation of Cultural and historical remains found in India Chance find during construction	Archaeological Survey of India
18.	Annexure XXV, Special Rules for conservation of Heritage Buildings Vol II: Second Master Plan for Chennai Metropolitan Area 2026 amended May 2013	To protect heritage assets	Chennai Metropolitan Development Authority (CMDA)
19.	National Policy on HIV/AIDS and the World of Work National Policy on Safety, Health and Environment at Workplace	To regulate the safety, health and environment at workplace	Department of Labour and Employment
20.	Building and Other construction workers (Regulation and the Employment and conditions of service) Act, 1996; Minimum Wages Act, 1948; Workmen's Compensation Act, 1923; The Contract Labour (Regulation & Abolition) Act, 1970 and Rules Employees State Insurance Act, 1948 (ESI); Minimum Wages Act, 1948, The Payment of Wages Act, 1936, amended in 2005; Maharashtra Labour Welfare Fund Act, 1953 (as amended) The Equal Remuneration Act 1976; Workmen's Compensation Act, 1923	To regulate the employment and conditions of service of building and other construction workers and to provide for their safety, health and welfare measures	Department of Labour and Employment
21.	Interstate Migrant Workers Act 1979	In case workers and labourers working at the project sites are migrants from other states during construction	Department of Labour and Employment
22.	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	Department of Labour and Employment

2.1.4. Required Clearances/Permissions

29. As per GoI EIA Notification 2006, all railways projects in India are exempted from Environmental Clearance (EC), this is applicable for Corridor 4 as well. Chennai being a coastal city, Light House to Foreshore Road falls under the coastal areas CRZ 1A and CRZ II prescribed in the CRZ Notification 2019 and requires CRZ clearance from TNCZMA.

30. Before the start of civil works for any section of Corridor 4, CMRL must obtain necessary clearances/permissions from statutory authorities. For implementation of Corridor 4, required clearances/ permissions related to environment, social and forests have been summarized in Table 2.2.

Table 2-2: Applicable Permissions and Clearances Required for Corridor 4

Sl. No	Permissions/ Clearances	Acts/Rules/Notifications/ Guidelines	Concerned Agency	Responsibility and Timeframe
A. Pre-construction Stage				
1.	Permission for felling of trees	Forest Conservation Act, 1980	CMDA	CMRL (3 - 6 months)
2.	CRZ clearance for CRZ I CRZ permission for CRZ II	CRZ Notification, 2019	TNCZMA & MoEF&CC	CMRL (6 months)
3.	Permission of construction near the National Shrine of St. Thomas Basilica, Santhome High Road; Rosary Church, Rosary Church Road and Our Lady of Light Shrine, Luz Church Road, which are located within 100m from the alignment of Corridor 4	The Ancient Monuments and Archaeological Sites and Remains (Amendment) Bill, 2018 Annexure XXV, Special Rules for conservation of Heritage Buildings Vol II: Second Master Plan for Chennai Metropolitan Area 2026 amended May 2013	Member Secretary CMDA	Contractor and CMRL (3 - 6 months)
4.	Building for and Permissions stations depots	Second Master Plan for Chennai Metropolitan Area 2026 amended May 2013	CMDA	Contractor and CMRL (6 months)
B. Implementation Stage				
5.	Consent to Establish & for Operate Ready Concrete casting yard	Air (Prevention and Control of Pollution) Act 1981	TNPCB	Contractor engaged by CMRL To be obtained before installation

Sl. No	Permissions/ Clearances	Acts/Rules/Notifications/ Guidelines	Concerned Agency	Responsibility and Timeframe
6.	Permission for withdrawal /dewatering of groundwater ⁶	Environment (Protection) Act, 1986 Chennai Metropolitan Area Groundwater (Regulation) Act, 1987 as amended till 2008 Guidelines/Criteria for evaluation of proposals/requests for ground water abstraction (With effect from 16.11.2015)	CGWA	Contractor engaged by CMRL To be obtained before construction (3 months)
7.	Consent to recharge groundwater with tunnel dewatering water	Water (Prevention and Control of Pollution) Act 1974 amended 1988, Environment (Protection) Amendment Rules, 2017 (Discharge Standard for Sewage Treatment Plants (STPs)), Model Groundwater (Control and Regulation) Bill 1970, amended in 1972, 1996 and 2005	CGWB/PWD	Contractor engaged by CMRL To be obtained before construction (3 months)
8.	Authorization for storage (diesel) and disposal of Hazardous Waste	Hazardous and Other Wastes (Management & Transboundary Movement) Amendment Rules, 2019	TNPCB	Contractor engaged by CMRL To be obtained before installation (3 months)
9.	Consent for disposal of sewage from labour camps.	Water (Prevention and Control of Pollution) Act 1974 amended 1988 Environment (Protection) Amendment Rules, 2017 (Discharge Standard for STPs)	TNPCB	Contractor engaged by CMRL To be obtained before installation (3 months)

⁶ The Contractor will avoid extraction of groundwater as much as possible. If not avoidable, the permission will be obtained prior to the extraction.

Sl. No	Permissions/ Clearances	Acts/Rules/Notifications/ Guidelines	Concerned Agency	Responsibility and Timeframe
10.	Pollution Under Control Certificate for various vehicles use for construction	Central Motor and Vehicle Act, 1988	Transport Commissioner rate and State Transport Authority, GoTN authorised testing centres	Contractor engaged by CMRL To be obtained before installation (3 months)
11.	Employing Labour/ workers	The Building and Other Construction Workers (Regulation of Employment and Conditions of Service) Act, 1996	District Labour Commissioner	Contractor engaged by CMRL To be obtained before installation (1 month)
12.	Roof Top Rainwater Harvesting (RWH)	Central Groundwater Authority (CGWA) Guidelines and Chennai Metropolitan Water Supply and Sewerage Board (CMWSSB)	CGWA / CMWSSB	Contractor engaged by CMRL To be obtained before installation (3 months)
13.	Permission for use of fresh water for construction and drinking purpose.	Environment (Protection) Act, 1986	Municipal Corporation	Contractor engaged by CMRL To be obtained before installation (3 months)
14.	Permission for Quarry Operation	The Mines and Minerals (Development and Regulation) Act, 1957	State Department of Mines and Geology	Contractor engaged by CMRL To be obtained before construction (2 – 6 months)
15.	Authorization for Disposal of Construction and Demolition Waste	Construction and Demolition Waste Management Rules, 2016	TNPCB	Contractor engaged by CMRL To be obtained before installation (2 months)

Sl. No	Permissions/Clearances	Acts/Rules/Notifications/Guidelines	Concerned Agency	Responsibility and Timeframe
16.	Heritage Assets (St. Thomas Basilica, Rosary Church and Our Lady of Light Shrine)	Annexure XXV, Special Rules for conservation of Heritage Buildings Vol II: Second Master Plan for Chennai Metropolitan Area 2026 amended May 2013	CMDA	Contractor engaged by CMRL To be obtained before construction (2 months)
17.	Consent to Establish labour camps, precasting and material yards, hot mix plant, crushers, batching plant, stations, depots	Air, Water and Noise Regulations	TNPCB	Contractor engaged by CMRL To be obtained before installation The Application forms for seeking Consent are available from the office of TNPCB at Chennai. (3 months)
18.	Consent to muck/waste disposal	Construction & Demolition Waste Management Rules 2016 Solid Waste Management Rules 2016	TNPCB	Contractor engaged by CMRL To be obtained before installation (2 months)
19.	Consent to Operate Depot and Compliance with discharge norms of wastewater	Water (Prevention and Control of Pollution) Act 1974 amended 1988; The Tamil Nadu Water (Prevention and Control of Pollution) Rules, 1983 amended May 2009; Environment (Protection) Amendment Rules, 2017 (Discharge Standard for Sewage Treatment Plants(STPs))	TNPCB	CMRL (3 months)

Sl. No	Permissions/ Clearances	Acts/Rules/Notifications/ Guidelines	Concerned Agency	Responsibility and Timeframe
20.	Installation and operation of DG sets at stations and depots	Air (Prevention and Control of Pollution) Act, 1981 amended 1987; CPCB Notification April 1994 of National Ambient Air Quality Standards	TNPCB	CMRL (2 months)

2.1.5. Institutional Administrative Framework

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

32. Ministry of Environment, Forests and Climate Change (MoEF&CC)

MoEF&CC is apex body in India responsible for 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 MoEF&CC plays a vital role in environmental management for sustained development and for all environmental matters in the country.

33. The major responsibilities of MoEF&CC 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.

34. 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 MoEF&CC appraises these statements/assessments and approves the project from the environmental angle.

35. **Tamil Nadu State Pollution Control Board (TNPCB):** Tamil Nadu Pollution Control Board was formed under the provisions of section 4 of Water (Prevention & Control of Pollution) Act, 1974. The Board is also functioning as the State Board under section 5 of the Air (Prevention & Control of Pollution) Act, 1981. 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.

36. **Central Ground Water Board (CGWB):** 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 groundwater 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 is 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. **The National Green Tribunal (NGT):** NGT has been established on 18.10.2010 under the National Green Tribunal Act 2010 for effective and expeditious disposal of cases relating to environmental protection and conservation of forests and other natural resources including enforcement of any legal right relating to environment and giving relief and compensation for damages to persons and property and for matters connected therewith or incidental thereto. It is a specialized body equipped with the necessary expertise to handle environmental disputes involving multi-disciplinary issues. The Tribunal shall not be bound by the procedure laid down under the Code of Civil Procedure, 1908, but shall be guided by principles of natural justice.

38. The Tribunal's dedicated jurisdiction in environmental matters shall provide speedy environmental justice and help reduce the burden of litigation in the higher courts. The Tribunal is mandated to make and endeavour for disposal of applications or appeals finally within 6 months of filing of the same. Initially, the NGT is proposed to be set up at five places of sittings and will follow circuit procedure for making itself more accessible. New Delhi is the Principal Place of Sitting of the Tribunal and Bhopal, Pune, Kolkata and Chennai shall be the other four place of sitting of the Tribunal.

2.2 International and Regional Agreements and Conventions

39. India is member of almost all major Multilateral Environmental Agreements (MEAs), under four clusters, namely the following:

- A. Nature conservation;
- B. Hazardous material;
- C. Atmospheric emissions; and
- D. Marine environment.

40. The Nature conservation and Climate change agreements will be applicable to this Corridor.

A. Nature conservation

No.	Nature Conservation
1	Ramsar Convention on Wetlands
2	CITES (Convention on International Trade in Endangered Species of Fauna and Flora)
3	TRAFFIC (The Wildlife Trade Monitoring Network)
4	CMS (Convention on the Conservation of Migratory Species)
5	CAWT (Coalition Against Wildlife Trafficking)
6	CBD (Convention on Biological Diversity)
7	ITTC (International Tropical Timber Organisation)
8	UNFF (United Nations Forum on Forests)
9	IUCN (International Union for Conservation of Nature and Natural Resources)
10	GTF (Global Tiger Forum)

B. Hazardous material

No.	Hazardous material
1	Cartagena Protocol on Biosafety
2	SAICM (Strategic Approach to International Chemicals Management)

3	Stockholm Convention on Persistent Organic Pollutants (POPs)
4	Basel Convention on the Control of Trans-boundary Movement of Hazardous Waste and Their Disposal
5	Rotterdam Convention on Prior Informed Consent (PIC) for certain Hazardous Chemicals and Pesticides in International Trade

C. Atmospheric emissions

No.	Atmospheric emissions
1	UNFCCC (United Nations Framework Convention on Climate Change)
2	Kyoto Protocol
3	UNCCD (United Nations Convention to Combat Desertification)
4	Montreal Protocol (on Ozone Depleting Substances)

D. Marine environment

No.	Marine environment
1	IWC (International Whaling Commission)

2.3 MDBs' Requirements Applicable to the Project

41. MDBs' project planning activities related to environmental and social safeguards generally comprise, a) screening and categorization by Bank; b) due diligence of the project by Bank; c) environmental and social assessment by Borrower and its review by Bank; d) information disclosure by Borrower and Bank and consultation by Borrower; e) monitoring and reporting by Borrower and Bank; and f) grievances.

2.3.1 Safeguard Policy Statement (SPS) 2009 of ADB

42. ADB's SPS 2009 sets out the policy objectives, scope and triggers, and principles for three key safeguard areas:

- i. Environmental Safeguards,
- ii. Involuntary Resettlement Safeguards, and
- iii. Indigenous Peoples Safeguards.

2.3.2 Environmental and Social Framework (ESF) 2019 of AIIB

43. ESF of AIIB comprises the following:

- i. **Environmental and Social Policy (ESP).** This comprises mandatory environmental and social requirements for each Project
- ii. **Environmental and Social Standards.** Three associated mandatory environmental and social standards (ESSs) set out more detailed environmental and social requirements relating to the following:
 - ESS 1: Environmental and Social Assessment and Management;
 - ESS 2: Involuntary Resettlement; and
 - ESS 3: Indigenous Peoples.

2.3.3 Environment and Social Framework (ESF) 2016 of NDB

44. ESF of NDB comprises the Environmental and Social Policy and three Environment and Social Standards:

- ESS 1: Environment and Social Assessment: Screening, impact assessment, alternatives, management plan, consultations, grievance mechanism, information disclosure, monitoring.
- ESS 2: Involuntary Resettlement
- ESS 3: Indigenous Peoples.

2.4 Applied Standards

45. The project will follow national as well as international best practices and standards related to environment, health and safety including IFC/WB Environmental, Health, and Safety (EHS) General Guidelines (April 30, 2007), whichever is stringent.

3. PROJECT DESCRIPTION

3.1 Rationale

46. India has experienced rapid growth in urbanization over several decades, with the share of the urban population from 17.9 percent in 1960 to 34.0 percent in 2018.⁷ By 2030, Indian cities are projected to be home to another 250 million people. High technology and export-oriented manufacturing jobs are growing fastest in the outskirts of large metropolitan areas. The metropolitan areas are facing extremely high population densities and traffic congestion. Infrastructure development remains key to plan urban development taking into consideration economic activities, mobility, and environmental and social outcomes.

47. GoI has made efforts to reform the transport sector in recent years. To create safe, affordable, quick, comfortable, reliable, and sustainable urban transport systems for Indian cities, the Ministry of Urban Development (MoUD) formulated the National Urban Transport Policy (NUTP) in 2006. The NUTP proposes the development of a metro rail system in every city of India with a population of more than two million people. GoI's Union Cabinet approved a new Metro Rail Policy in 2017 that aims to enable the development and implementation of metro projects in a comprehensive and sustainable manner from the social, economic, and environmental perspectives. As of February 2019, metro line services with a total length of 585 km are operational in India.⁸

48. Chennai, the capital city of the state of Tamil Nadu, is part of the CMA playing a vital role in the economy of South India. The CMDA devised the Chennai Second Master Plan 2026 and estimated that the population and daily passenger traffic would grow to 12.6 million people and 20.8 million in 2026, respectively.⁹ CMA has emerged as a leading national automotive hub with major manufacturers operating their plants in the area. CMA also houses a growing number of software firms, financial services, and call centres. Like other metropolitan areas in the country, CMA is currently facing the challenges of accelerated urbanization growth that have considerably strained the area's transportation system. The increase in economic activities has boosted the regional economy and job creation, which in turn necessitates improvement in ease of travel and connectivity.

49. The existing transportation system in CMA is marked by high traffic density, carbon emissions, and frequent road incidents. In addition to the high volume of vehicles and already congested roads, inadequate parking space and the encroachment of street space by vendors on major road have exacerbated the traffic congestion. The accelerating use of private vehicles has put Chennai in the fifth rank in carbon emission from the transport sector among 54 South Asian cities.¹⁰ Chennai also recorded the highest number of road incidents in India, with a staggering 7,846 cases in 2016.¹¹

⁷ <https://data.worldbank.org/indicator/SP.URB.TOTL.IN.ZS?locations=IN> ¹¹

Urbanization Beyond Municipal Borders, The World Bank, 2013.

⁸ Press Information Bureau, Ministry of Housing and Urban Affairs, Government of India,

⁹ Second Master Plan for Chennai Metropolitan Area 2026, Chennai Metropolitan Development Authority, 2008.

¹⁰ International Council for Local Environmental Initiative Study, 2012.

¹¹ Accidental Death and Suicides in India (ADSI), National Crime Records Bureau, 2016.

50. CMRL, a joint venture of the GoI and GoTN with equal equity ownership, is responsible for implementing, operating, and maintaining the city's metro system. CMRL developed The Comprehensive Mobility Plan for CMA in 2015 to identify the present and future mobility patterns of CMA. The detailed study identified three corridors (corridors 3, 4, and 5) for the second phase of the Chennai Metro Rail to alleviate CMA's transportation capacity constraints.

3.2 Description of the Corridor 4

51. The first phase of the Chennai Metro Rail covers 54 km in two corridors, with 45 km currently already in operations since 2015 and another 9 km to be operational in 2020. GoI, GoTN, and the Japan International Cooperation Agency (JICA) funded the first phase that provides direct connection between northern and southern parts of Chennai.

52. The Chennai Metro Corridor 4 from Lighthouse to Poonamallee Bypass has a length of 26.8 km, of which 16.5 km is elevated, and 10.3 km is underground, with 18 and 12 stations, respectively. Stations of Corridor 4 are depicted in Figure 3.1 and summarized in Table 3.1.

Figure 3-1: Corridor 4 (DPR of Corridor 4, Oct 2018)

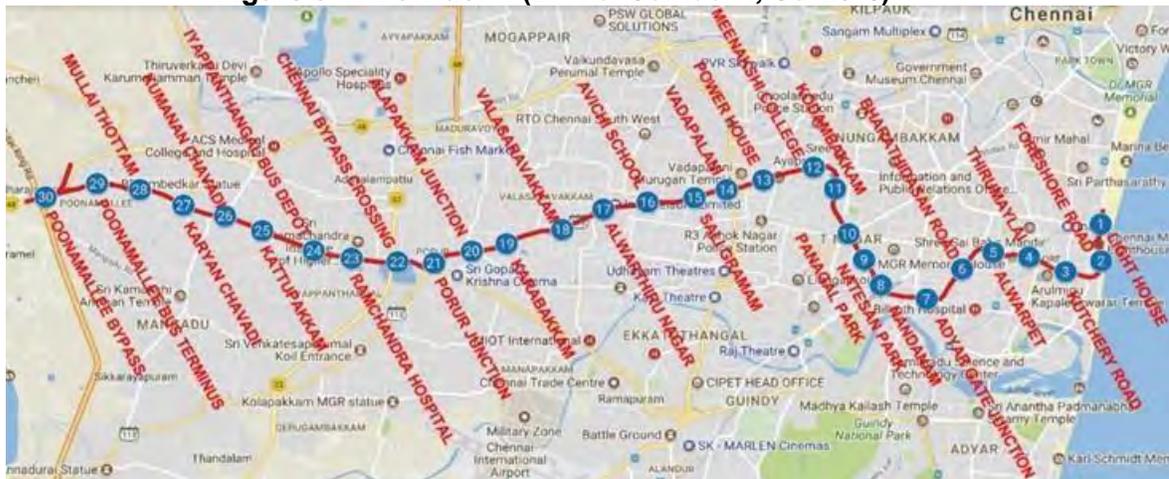


Table 3-1: : List of Stations –Corridor 4

No	Station Name	Chainage (m)	Inter-station Distance(m)	Elevated/ Underground
1	Lighthouse	20	-	UG(190x21.80)2L
2	Foreshore Estate Road	806	786	UG(190x21.80)2L
3	Kutchery Road	1764	958	UG(190x21.80)2L
4	Thirumayilai Metro	2564	800	UG(190x21.80)2L
5	Alwarpet	3302	738	UG(190x21.80)2L
6	Bharathidasan Road	4141	839	UG(190x21.80)2L
7	Adyar Gate Junction	5177	1036	UG(150x21.40)3L
8	Nandanam	6188	1011	UG(150x21.40)ML
9	Natesan Park	6813	625	UG(150x21.40)3L

No	Station Name	Chainage (m)	Inter-station Distance(m)	Elevated/ Underground
10	Panagal Park	7436	623	UG(150x21.40) 2L
11	Kodambakkam Metro	8453	1017	UG(150x21.40) 2L
12	Meenakshi College	9275	822	UG(190x21.80)2L
13	Power House	10315	1040	Elevated(140x21.95)
14	Vadapalani	11064	763	Elevated(140x21.95)
15	Saligramam	11740	665	Elevated(140x21.95)
16	Avichi School	12666	948	Elevated(140x21.95)
17	Alwarthiru Nagar	13602	916	Elevated(140x21.95)
18	Valasaravakkam	14545	934	Elevated(140x21.95)
19	Karabakkam	15685	1124	Elevated(140x21.95)
20	Alapakkam Junction	16425	761	Elevated(140x21.95)
21	Porur Junction	17243	818	Elevated(140x21.95)
22	Chennai Bypass Crossing	18052	810	Elevated(140x21.95)
23	Ramchandra Hospital	18975	923	Elevated(140x21.95)
24	Iyappanthangal Bus Depot	19777	774	Elevated(140x21.95)
25	Kattupakkam	20859	1109	Elevated(140x21.95)
26	Kumanan Chavadi	21647	810	Elevated(140x21.95)
27	Karyan Chavadi	22529	880	Elevated(140x21.95)
28	Mullaitthottam	23517	947	Elevated(140x21.95)
29	Poonamallee Bus Terminus	24367	873	Elevated(140x21.95)
30	Poonamallee Bypass	25785	1070	Elevated(140x21.95)

3.2.1 Land Use

53. Land use along the alignment is summarised in Table 3.2.

Table 3-2: Land use abutting the Alignment

Corridor	Section / Station	Land Use
Lighthouse to Poonamallee bypass	Lighthouse	Institutional + Open Space Reservation along seafront on either side *
	Santhome Church	Institutional
	Lighthouse to Santhome Church	CRZ IA and II @
	Nandanam to Panagal Park	Commercial + Residential * ^
	Meenakshi college	Institutional + Residential *
	Powerhouse to Vadapalani	Commercial + Residential on either side * ^
	Porur lake	Water body *
	Ramachandra Hospital	Institutional + Residential on either side *

* Figure 4.4 Land use in CMA 2006, Master Plan 2026

@ Ecologically Sensitive Areas in CMA, Master Plan 2026

^ Land use away from alignment is residential

54. Topographical survey was carried out in detail using modern surveying instruments. The geotechnical investigations determined the required strength characteristics of the underlying soil/rock strata to design the foundation of the proposed structure. A total of 52 bore holes were drilled all along the proposed Corridor 4 alignment. Also, since the proposed site is located in seismic Zone III of India, suitable seismic measures will be adopted in the design of the structures.

3.2.2 Salient Design Features

55. The salient features of Corridor 4 Project are summarized in Table 3.3.

Table 3-3: Salient Features of Chennai Metro Corridor 4

Gauge(Nominal):	1435 MM
Route Length:	26.8km (10.3 km Underground and 16.5 km Elevated)
Number of Stations:	30 (12 Underground and 18 Elevated)
Speed:	
1. Design Speed	80 kmph
2. Maximum Design Speed	90 kmph
3. Schedule(Booked)Speed	32 kmph

Train Operation Plan:

Particulars	2025	2035	2045	2055
Trains/hour (3 Car, 6 Car)	13 (13,0)	13 (6,7)	14 (3,11)	15 (0,15)
Head Way (Second)	277	277	257	240
Capacity (6p/m ² ;8p/m ²)	9,958;12,675	15,628;19,878	19,634;24,969	23,640;30,060
Max. PHPDT Demand	11,707	18,944	23,816	29,940
Total Coach Requirement	78	129	156	186

Traction Power Supply:

1. Traction System Voltage 25 kV AC
2. Current Collection Overhead Electric Traction
3. Receiving Substations Two RSSs at Avichi School and Panagal Park stations (RSSs)

Power Demand (MVA):

Load	2025		2035		2045		2055	
	Normal	Emergency	Normal	Emergency	Normal	Emergency	Normal	Emergency
3 km from Kilpauk GSS-Panagal Park RSS (Chainage -255 to 7436) 7.691km								
Traction	2.45	8.39	3.62	12.41	4.40	15.10	5.36	18.38
Auxiliary	11.67	19.95	14.58	24.40	16.32	27.46	17.49	29.62
Total	14.12	28.34	18.20	36.81	20.72	42.56	22.85	48.00
3.5 km from Koyambedu GSS-Avichi School RSS (Chainage -7436 to 25829)								

18.38km								
Traction	5.94	8.39	8.79	12.41	10.70	15.10	13.02	18.38
Auxiliary	8.28	19.95	9.82	24.40	11.14	27.46	12.13	29.62
Total	14.22	28.34	18.61	36.81	21.84	42.56	25.15	48.00

Rolling Stock:

1. Rolling Stock with light weight Stainless Steel/Aluminum Body
2. Max. Axle Load 16 T
3. Dimensions L22.6 x W2.9m x H3.9m

Maintenance Facilities:

Maintenance depot has been proposed near Poonamallee Bypass station for 31 rakes of 6 cars for washing, maintenance and repairs of the rolling stock operation.

Signalling, Telecommunication and Train Control:

1. Type of signalling Communication based Train Control System (CBTC) with unattended train operation permitting an operational headway of 90 seconds.
2. Telecommunication Integrated System with Optic Fiber cable, Supervisory Control and Data Acquisition (SCADA), Close Circuit Television (CCTV), Central Voice Recording System (CVRS) etc.

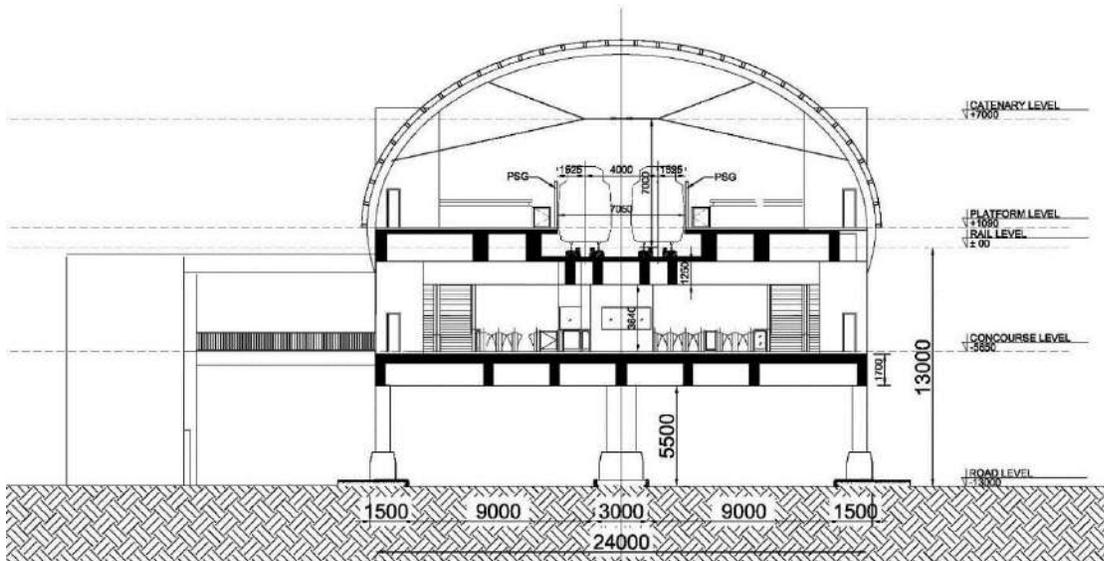
Fare Collection:

Automatic Fare Collection (AFC) System with smart card/token etc.

3.2.3 Station Design

56. Elevated stations located at the median of existing roads will be 140 m long and 24 m wide. The stations will be constructed using the cantilever method. The typical elevated station consists of three levels: ground, concourse and platform. Passenger facilities, operational and commercial areas are provided at the concourse level. Platforms will be at a level of 13 m and concourse floor at about 7 m above the road, with a minimum of 5.5 m of vertical clearance under the concourse. To reduce physical and visual impact, stations will be transparent with minimum walls on the sides. Figure 3.2 shows the typical elevated station.

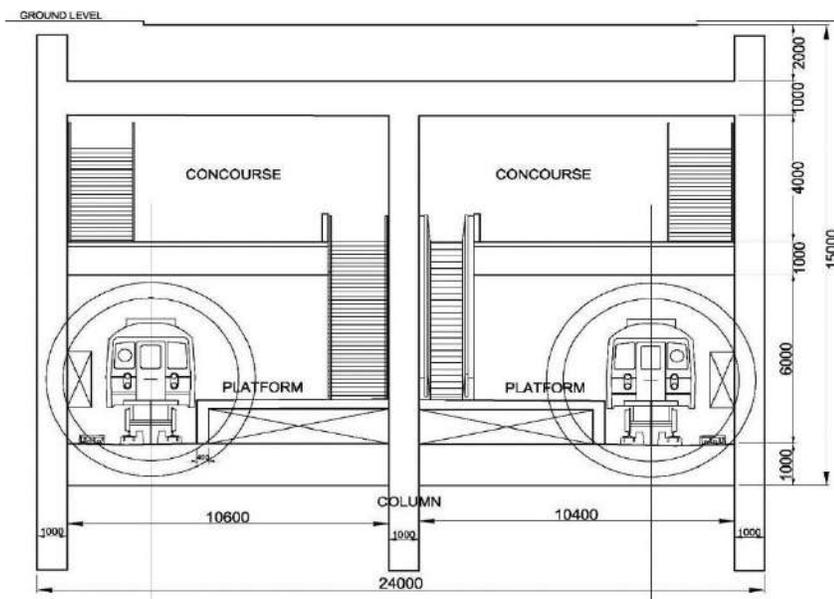
Figure 3-2: Typical Elevated Station



Source: Detailed Project Report for Chennai Metro Rail Phase II corridors, February 2017

57. The typical underground station is a two- or three-level station with entrances at ground level, a concourse with ticketing and passenger area, and platforms at the lowest level. Platforms will 140 m long and 12 m wide with easy accessibility features including escalators and elevators. Universal accessibility and green building features will be considered in the design. Two end concourses have been proposed, one at each end. The concourse is divided into paid and unpaid area. Since very limited space is available on the ground at station, all the over-ground structures are therefore, planned as and where space is available and are not necessarily grouped at ground level. The stations will be constructed using the cut and cover method. Figure 3.3 shows the typical underground station.

Figure 3-3: Typical Underground Station (2-level)



Source: Detailed Project Report for Chennai Metro Rail Phase II corridors, February 2017

3.2.4 Ventilation and Air-Conditioning System

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

- Supplying fresh air for the physiological needs of passengers and the staff
- Removing body heat, obnoxious odours and harmful gases
- Removing large quantity of heat dissipated by the train equipment/fixtures
- Removing fumes and heat emitted by station equipment/fixtures

59. The tunnel ventilation shaft will be provided at each end of the station vertically from ground to concourse or platform level.

3.2.5 Depot

60. Major maintenance depot is proposed at Poonamallee Bypass. The depot comprises automatic coach washing plant, Operations Control Centre, maintenance infrastructure viz stabling lines, scheduled inspection lines, workshop for overhaul, unscheduled maintenance for the rolling stock and maintenance facilities for Civil – track, buildings, water supply; electrical – traction, E&M; signaling & telecommunication; automatic fare collection etc. Figure 3.4 shows the layout plan of Poonamallee Depot, which is proposed to have the following functions:

- Major overhauls of all the trains.
- All minor schedules and repairs.
- Lifting for replacement of heavy equipment and testing thereafter.
- Repair of heavy equipment.

Figure 3-4: Layout Plan of Poonamallee Depot



3.2.6 Labour Camp

61. The Contractor during the progress of work, will provide, erect and maintain necessary (temporary) living accommodation and ancillary facilities for labour. Contractor will establish construction camps as part of the project. Emphasis will be given to use existing facilities (established under ongoing lines). However, locations of the camps will be finalized after mobilization of contractor and in consultation with CMRL. The Contractor engaged by CMRL will also coordinate with the development authority for land use clearance, TNPCB and Municipal Corporation to establish the labour camps before construction.

3.2.7 Construction Activities and Methodology

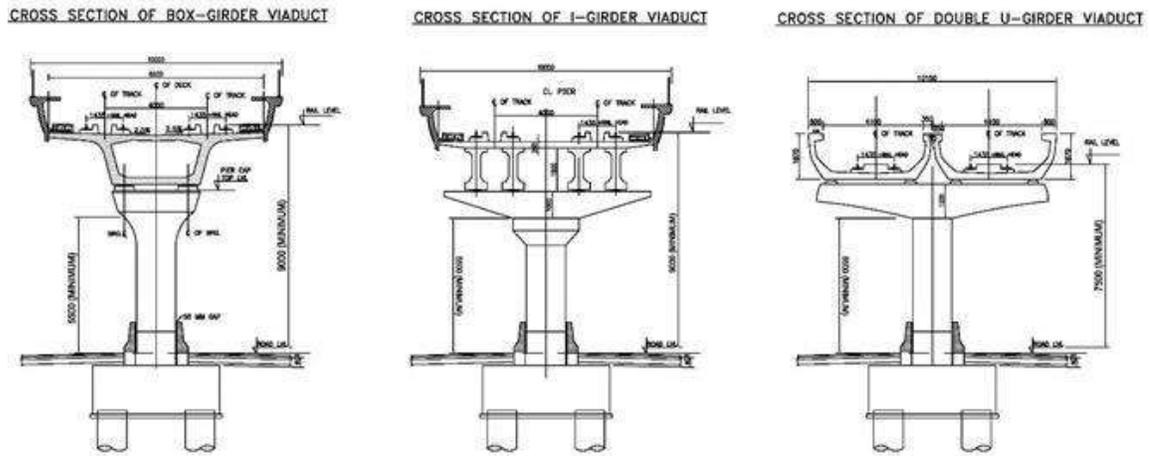
62. Main construction activities include demolition of structures and ground clearing; Excavation and fill; Tunneling; Transport of construction materials, muck and waste; Casting of concrete elements and preparation of concrete and their transportation; Pile driving where cast-in-situ is not feasible, blasting in rock etc.

63. Elevated Sections. Substructure - open foundation, pile, pile caps, columns; station structure; earth retaining structures shall be cast-in-situ. The structural elements for superstructure i.e. box segments, I-Girders, U-girders and sometimes pile caps are pre-cast. Pre-cast construction may be segmental or non-segmental type. In case of segmental method, structural segments are pre-casted in casting yards, pre-stressed and then transported to the location of use and launched by means of suitable launching arrangement. The construction yard has arrangement for casting beds, curing and stacking area, batching plant with storage facilities for aggregates and cement, site testing laboratories, reinforcement steel yard and fabrication yard etc. An area of about 3 ha is required for each construction yard.

64. Underground Sections. Usually sections between underground stations are constructed by tunneling using Tunnel Boring Machine (TBM) while underground stations are built by cut-and-cover method. In the latter method, sidewalls of excavation at stations are supported in various ways. Between two stations tunnel is constructed by TBM. It will be launched from launching shaft. It is dragged in station area and continues from other side of station. Ground settlement analysis and monitoring is required during tunneling by TBM. Two separate tunnels are constructed by two different TBM. The initial plan is one to enter at Lighthouse Station, exit at Bharathidasan Road and the other one to enter at Natesan Park and exit at Bharathidasan Road and Meenakshi College. Depending upon the soil/rock strata, suitable type of TBM shall be used for tunneling. Locations where deployment of TBM is not possible (tunneling of short length, cross passages, underground stations which are not possible by cut and cover method etc.) are tackled by New Austrian Tunneling Method (NATM).

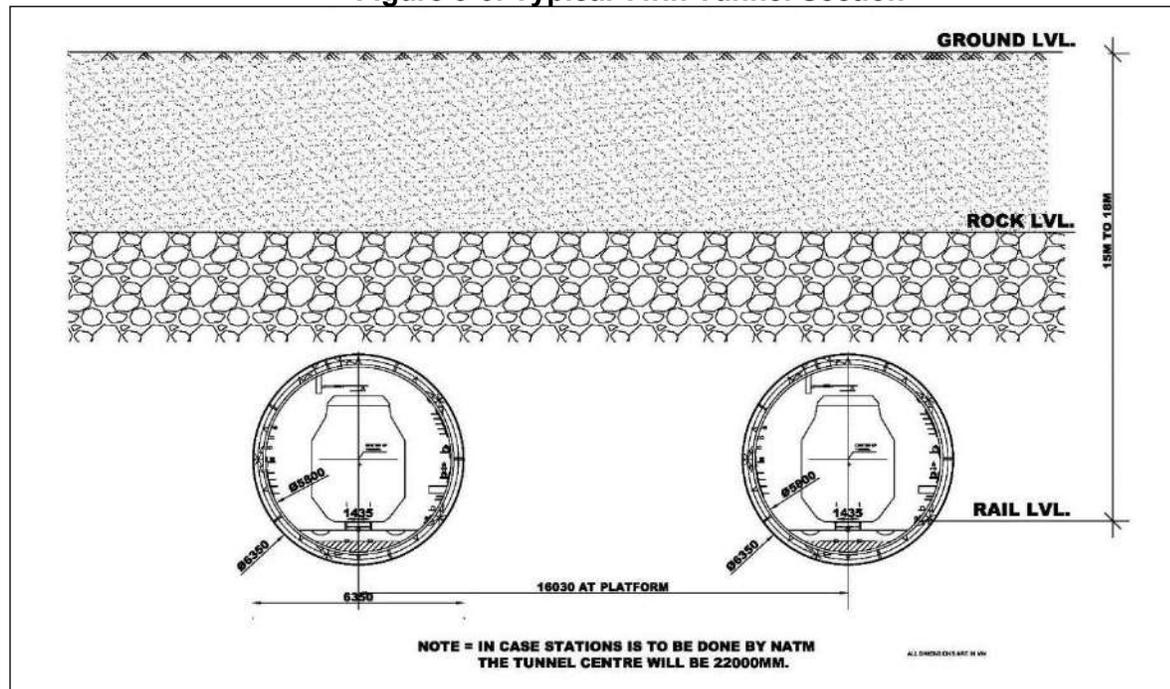
65. The typical viaduct and tunnel are shown in Figure 3.5 and 3.6.

Figure 3-5: Typical superstructure of viaduct



Source: Detailed Project Report for Chennai Metro Rail Phase II corridors, February 2017

Figure 3-6: Typical Twin Tunnel Section



Source: Detailed Project Report for Chennai Metro Rail Phase II corridors, February 2017

3.3 Associated Facilities

66. Associated facilities are those that are not included or funded by the Project but are: (i) directly and materially related to the Project; (ii) carried out or planned to be carried out, contemporaneously with the Project; and (iii) necessary for the Project to be viable and would not be constructed or expanded if the Project did not exist.

67. Associated facilities for Corridor 4 are the power transmission/distribution system, existing grid substations (GSS) and water supply network. The construction and operation of Corridor 4

will require power and water from existing electricity grid and water supply system. Electricity is required for operation of Metro system for running of trains, station services (e.g. lighting, lifts, escalators, signaling & telecom, firefighting etc. and workshops, depots & other maintenance infrastructure within premises of metro system). The power requirements of a metro system are determined by peak-hour demands of power for traction and auxiliary applications. These existing grid substations and water supply network are being operated and managed by respective agencies under full compliance with state and local policies and regulatory frameworks.

68. Chennai City has 230kV, 110kV, 33kV power transmission and distribution network to cater to various types of demand in the vicinity of proposed corridor. Keeping in view of reliability requirements of the corridor, two Receiving Substations (RSS) are proposed to avail power supply for traction as well as auxiliary services from Tamil Nadu Transmission Corporation Limited grid sub-stations at 110kV voltage through transmission lines or cable feeders for Corridor 4. M/s TANGEDCO has confirmed the availability of supply.

69. Gas Insulated Substation (GIS) type substations, which offer the advantage of considerable saving in space requirement as well as reduced maintenance, are proposed for each Receiving cum Traction Substation and Auxiliary Substations of Corridor4. Each elevated station shall be provided with an Auxiliary Substation with two 33kV/415V, 3phase, 500 kVA dry type cast resin transformers and the associated HT & LT switchgear. In addition, provision shall be made for one DG set at each station for emergency loads. Two transformers (33kV/415V, 3-phase) of 3.2 MVA at each underground ASS for the underground stations are proposed to be installed (one transformer as standby). In addition, it is proposed to provide standby DG set of 250 kVA at all elevated stations and 2 x 910 KVA capacity at underground stations to cater to all emergency loads. Power Demand is estimated in Table 3.3.

70. During construction, water consumption will be of the order of 492 KLD for construction and 578 KLD for labour camps. During operation, the water demand at depot and stations comprising train washing, drinking, toilet, cleaning and air conditioning in Chennai will be of the order of magnitude indicated in Table 3.4. The water requirement for the stations will be met through the public water supply system. Municipal water supply will be supplemented by rainwater harvesting at elevated stations.

Table 3-4: Water Requirement

S. No.	Particular	Water Demand at Each Station (KLD)	Total Water Demand (KLD)
1	In Underground stations with water softening plant	85.0	1,020
2	In Elevated stations without air conditioner	16.6	298.80
3	Depot	286	286
Total			1,604.80

71. In accordance with proposed packaging of Corridor 4, underground stretch, elevated stretch and depot will be financed by different MDB and constitute Associated Facilities to each package. The environmental impacts and mitigation measures of all packages are analyzed in this report.

3.4 Implementation Plan, Schedule and Cost

72. Corridor 4 will be implemented under design consultant and civil work contracts. There will be several packages for different components such as civil works contracts, detailed design, system contracts, supply and installations, rolling stock etc. It is estimated that project will be commissioned 5 years from award of civil contracts. Figure 3.7 shows the detailed schedule. The total capital cost of Corridor 4 is estimated to be USD 2.17 billion.

Figure 3-7: Implementation Schedule of Corridor 4

S.N	DESCRIPTION	START	FINISH	REMARKS
1	LAND ACQUISITION	Jan-19	Jun-21	WIP
2	GEO TECH INVESTIGATION			
a	UNDER GROUND SECTION			
	Inviting the Tender for Geo tech Investigation, Evaluation & Awarding work	Aug-18	Dec-18	COMPLETED
	Geo Tech. & Survey Works (U.G Section)	Dec-18	May-19	COMPLETED
b	ELEVATED SECTION			
	Inviting the Tender for Geo tech Investigation, Evaluation & Awarding work	Jan-19	Jun-19	COMPLETED
	Geo Tech. & Survey Works (Elevated Section)	Jun-19	Jan-20	COMPLETED
3	DETAILED DESIGN CONSULTANT			
a	UNDER GROUND SECTION			
	Invite & Awarding tender for Detail Design Consultant Works	Aug-18	Mar-19	COMPLETED
	DDC -Execution of wok	Mar-19	Mar-25	WIP
b	ELEVATED SECTION			
	Invite & Awarding tender for Detail Design Consultant Works	Dec-18	Jun-19	COMPLETED
	Detail Design Consultant Works	Jun-19	Jun-25	WIP
4	GENERAL CONSULTANCY			
	Invite & Awarding tender for General Consultancy	Jan-20	Mar-21	
	GC works	Apr-21	Dec-26	
5	CONSTRUCTION OF UNDERGROUND STATIONS AND ASSOCIATED TUNNEL (C4-UG-01)- ADB			

S.N	DESCRIPTION	START	FINISH	REMARKS
	Inviting & Awarding Tender for Stations and associated Tunneling Works	Feb-21	Nov-21	
	Construction of Underground Stations and associated Tunneling Works	Dec-21	Dec-25	
6	CONSTRUCTION OF UNDERGROUND STATIONS AND ASSOCIATED TUNNEL (C4-UG-02)- ADB			
	Inviting & Awarding Tender for Stations and associated Tunneling Works	Feb-21	Nov-21	
	Construction of Underground Stations and associated Tunneling Works	Dec-21	Dec-25	
7	CONSTRUCTION ELEVATED STATIONS AND VIADUCT (C4-ECV-01)-aiib			
	Inviting & Awarding Tender for Stations and Viaduct Construction	Jul-20	Feb-21	wip
	Construction of Elevated Stations and Viaduct	Mar-21	Dec-24	
8	CONSTRUCTION ELEVATED STATIONS AND VIADUCT (C4-ECV-02)- AIIB			
	Inviting & Awarding Tender for Stations and Viaduct Construction	Jul-20	Mar-21	wip
	Construction of Elevated Station and Viaduct.	Apr-21	Dec-24	
9	CONSTRUCTION OF DEPOT			
	Inviting & Awarding tender for Depot Construction	Jan-21	Aug-21	
	Construction of Depot	Sep-21	Sep-24	
d	Installation of Rails, turnout, fastening		Apr-26	
11	Systems works, testing, trial runs, commissioning		Dec-26	

wip: work in progress

Source CMRL Feb 2021

4. ENVIRONMENTAL BASELINE

73. The collection of current baseline information on physical, ambient, ecological and socioeconomic environment of the project area of influence, provides an important reference for conducting an EIA. The description of environmental settings includes the characteristic of area in which the project activities would occur and likely to be affected by project related impacts. Compiled existing baseline conditions include primary data on air quality, water quality, noise, soil, ecology and biodiversity, and socioeconomic aspects. Secondary data were also collected from published source and various government agencies.

4.1 Data Collection Methodology

74. The data on water, air, and noise were collected through field monitoring conducted in July 2016 and May 2017. The noise and vibration data were further elaborated in 2019 to include the sensitive receptors along the Corridor 4. Data on biodiversity was collected through the field studies in May 2018. Meteorological data was collected from India Meteorological Department (IMD). Efforts have been made to compile the available data from literature, books, maps and reports. The methodology adopted for data collection is highlighted wherever necessary. Environmental attributes and samplings of baseline surveys are presented in Table 4.1 and monitoring locations are presented in Table 4.2 and Figure 4.2. The detailed analysis reports received from the monitoring laboratory are provided in **Annexure 1**, whereas summary from the reports are discussed in respective sections.

Table 4-1: Environmental Attributes and Data Source

Sl. No	Attribute	Parameter	No. of Samples	Source
Physical Environment				
1.	Geology	Geological Status	---	Literature review
2.	Seismology	Seismic Hazard	---	Literature review
3.	Climate	Climate Parameters	---	Literature review
4.	Soil Quality	Physico-chemical parameters	9	Sampling/ Monitoring locations
Ambient Environment				
5.	Water Quality	Physical, Chemical and Biological parameters	8 (Groundwater) 1 (Surface)	Sampling/ Monitoring locations
6.	Ambient Air Quality	PM, SO ₂ , NO ₂ and CO	8	Sampling/ Monitoring locations
7.	Noise	Noise levels in dB (A) L _{max} , L _{min} , L _{eq} , L ₁₀ , L ₅₀ , L ₉₀	30 (Sample Sensitive Receptors)	Sampling/ Monitoring locations
8.	Vibration	Peak Particle Velocity in mm/s	13 (Sample Sensitive Receptors)	Sampling/ Monitoring locations
Ecological Environment				
9.	Trees	Number	Once	Field Studies/ Reconnaissance survey

Sl. No	Attribute	Parameter	No. of Samples	Source
Socio-Economic Environment				
10.	Socio-economic aspects	Socio-economic profile	Once	Field Studies by Social Team, Literature review.

Table 4-2: Details of Sampling / Monitoring Locations*

S. No	Distance from the Sampling Locations to the Alignment (A: Air, W: Water; S: Soil, N: Noise)	Land Use**
4A	At Crossing of NH 4 Bypass & Poonamallee Flyover, 23m (A, W, S, N)	Commercial
4B	Near Kumunan chavadi Bus Stop, MSS Nagar 15m (A, W, S, N)	Residential
4C	Near Porur Lake, Padmavati Nagar, 27m (A, W, S, N)	Residential
5C***	Alwarthiru Nagar junction (A, W, S, N)	Residential
4D	Permal Street, Shradha Nagar, 16m (A, W, S, N)	Residential
4E	Vadapalani Junction, 54m (A, W, S, N)	Commercial
4F	Kodambakkam Meenakshi College, 75m (A, W, S, N)	Silence Zone
4G	Santhome Church, 36m (A, W, S, N)	Silence Zone
4H	Porur Lake (water & soil only), 58m (W, S)	Water body

*Locations for noise and vibration at sensitive receptors are listed under Table 4.17 and Table 4.19 respectively.

**As per CPCB guideline which is presented under Noise Section.

***This sampling location is the shared alignment of Corridor 4 & 5.

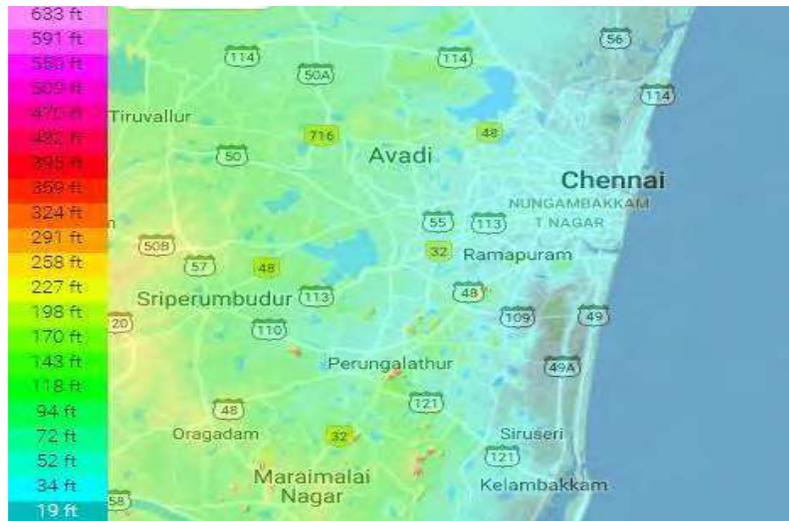
75. Sampling locations were selected to represent land uses along the alignment namely commercial, residential and silence zone (religious and educational uses). The baseline information is categorized as physical, ambient, ecological and socioeconomic environment with depiction in following sections.

76. A further 270 environmentally sensitive receptors located within 200m on either side of alignment as listed in **Annexure 2** have been identified from site reconnaissance, comprising educational centres, religious places, hospitals and courts of law. To elaborate the baseline, a full set of baseline of air, water (surface and ground), soil, noise and vibration will be collected prior to the construction commencement.

4.2 Physical Environment

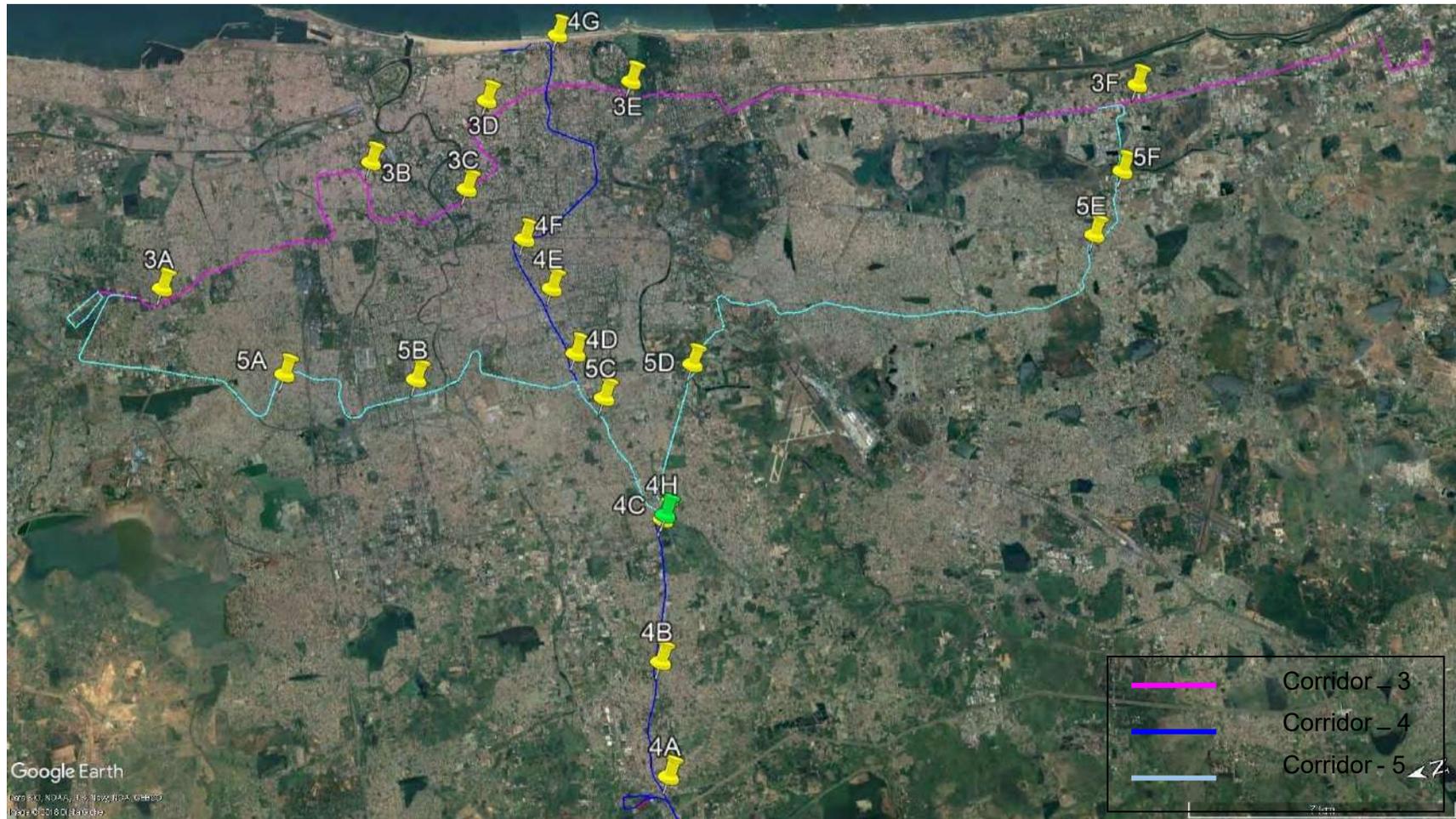
4.2.1 Physiography

Figure 4-1: Topographical setting of Project Area



77. Chennai is located on the South– Eastern coast of India in the North–Eastern part of Tamil Nadu. It is situated on a flat coastal plain that's why it is also known as the Eastern Coastal Plains. The study area is lies between Latitude of 13° 10' N to 12° 49' N and Longitude of 80° 10' E to 80° 14' E. Chennai is a low-lying area and the land surface is almost flat. It rises slightly as the distance from the sea-shore increases but the average elevation of the city is not more than 3 m above mean sea-level, while most of the localities are just at sealevel and drainage in such areas remains a serious problem. The topographical setting of project area is shown in Figure 4.1.

Figure 4-2: Monitoring Locations



Field Survey: July 2016/May 2017

Table 4-3: Results of Laboratory Analysis of Soil Sample

S. No.	Parameter	Unit	Corridor 4									Soil Standards
			4A	4B	4C	5C	4D	4E	4F	4G	4H	
1	pH (at 25°C)	-	8.24	8.2	8.05	7.11	7.98	7.23	7.10	7.02	8.14	6.0*
2	Conductivity (1:2 soil water sus.)	mS/cm	0.36	0.32	0.24	0.19	0.29	0.12	0.17	0.28	0.27	1*
3	Chloride	mg/kg	142.31	1223.09**	359.93	24.79	262.50	33.37	29.87	47.67	97.67	-
4	Total Zinc as Zn	mg/kg	72.13	68.36	69.14	12.35	70.54	14.32	13.28	14.22	57.49	150
5	Manganese as Mn	mg/kg	262.50	108.56	141.38	166.32	196.43	200.01	199.12	179.42	52.79	1,800
6	Total Lead as Pb	mg/kg	BDL	BDL	BDL	9.65	BDL	10.75	10.69	10.23	BDL	200
7	Total Copper as Cu	mg/kg	19.50	15.10	14.80	14.82	16.20	20.02	18.27	19.25	13.20	200
8	Organic Carbon	%	0.35	0.33	0.35	0.73	0.36	0.59	0.62	0.69	0.40	-
9	Water Soluble Sulphate	mg/kg	36.45	26.58	40.16	20.12	36.48	27.29	20.88	20.23	38.50	-
10	Boron	mg/kg	1.48	1.84	1.66	1.86	1.86	2.38	1.98	2.66	1.78	-
11	Iron	mg/kg	1343.34	1258.05	1299.51	420.37	1351.19	444.35	412.65	368.24	1210.29	-
12	Nickel	mg/kg	BDL	BDL	BDL	18.27	BDL	12.35	12.93	12.79	BDL	100
13	Bicarbonate	mg/kg	168.40	135.63	168.44	125.69	125.48	148.68	142.62	150.13	128.28	-
14	Calcium	mg/kg	665.33	625.25	480.96	140.09	384.77	108.16	145.06	136.29	436.87	-
15	Magnesium	mg/kg	34.05	102.14	41.34	27.28	89.98	28.12	20.36	28.13	38.91	-
16	Sand	%	22.41	32.53	32.97	34.93	38.86	34.09	34.45	33.45	36.54	-
17	Silt	%	59.37	59.19	59.34	38.88	56.04	39.67	38.88	40.05	59.56	-
18	Clay	%	18.22	8.28	7.69	28.19	5.10	24.27	26.67	26.50	3.90	-
19	Sodium	mg/kg	23.70	2.97	129.33	56.45	164.02	42.10	51.85	75.70	24.32	-
20	Potassium	kg/hect	176.98	372.97	271.60	70.18	249.50	97.16	88.38	98.92	200.49	-
21	Sulphur	mg/kg	38.19	36.98	42.55	29.18	48.55	22.87	30.23	29.56	36.22	500
22	Organic Matter	%	0.60	0.57	0.60	1.26	0.62	1.02	1.08	1.19	0.69	-
23	Orthophosphate	mg/kg	12.40	10.12	5.80	70.65	16.54	67.09	59.54	68.98	16.54	-

S. No.	Parameter	Unit	Corridor 4									Soil Standards
			4A	4B	4C	5C	4D	4E	4F	4G	4H	
24	Carbonate	mg/kg	5.65	16.54	10.20	2.99	4.20	5.10	4.92	4.36	6.40	-
25	Arsenic	mg/kg	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	1
26	Mercury	mg/kg	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	2
27	Cadmium as Cd	mg/kg	BDL	BDL	BDL	1.24	BDL	1.72	1.32	1.68	BDL	1
28	Molybdenum	mg/kg	BDL	BDL	BDL	0.60	BDL	0.69	0.76	0.80	BDL	5
29	Available Nitrogen	Kg/hect	140.86	146.54	172.50	199.97	158.40	304.51	269.61	308.12	189.80	-

* As per Bureau of Indian Standards. The rest are as per ISO Soil Standards.

** As per the Geo-investigation report 2020, the Chloride as Cl ranges from 19.83 to 277.69 mg/kg.

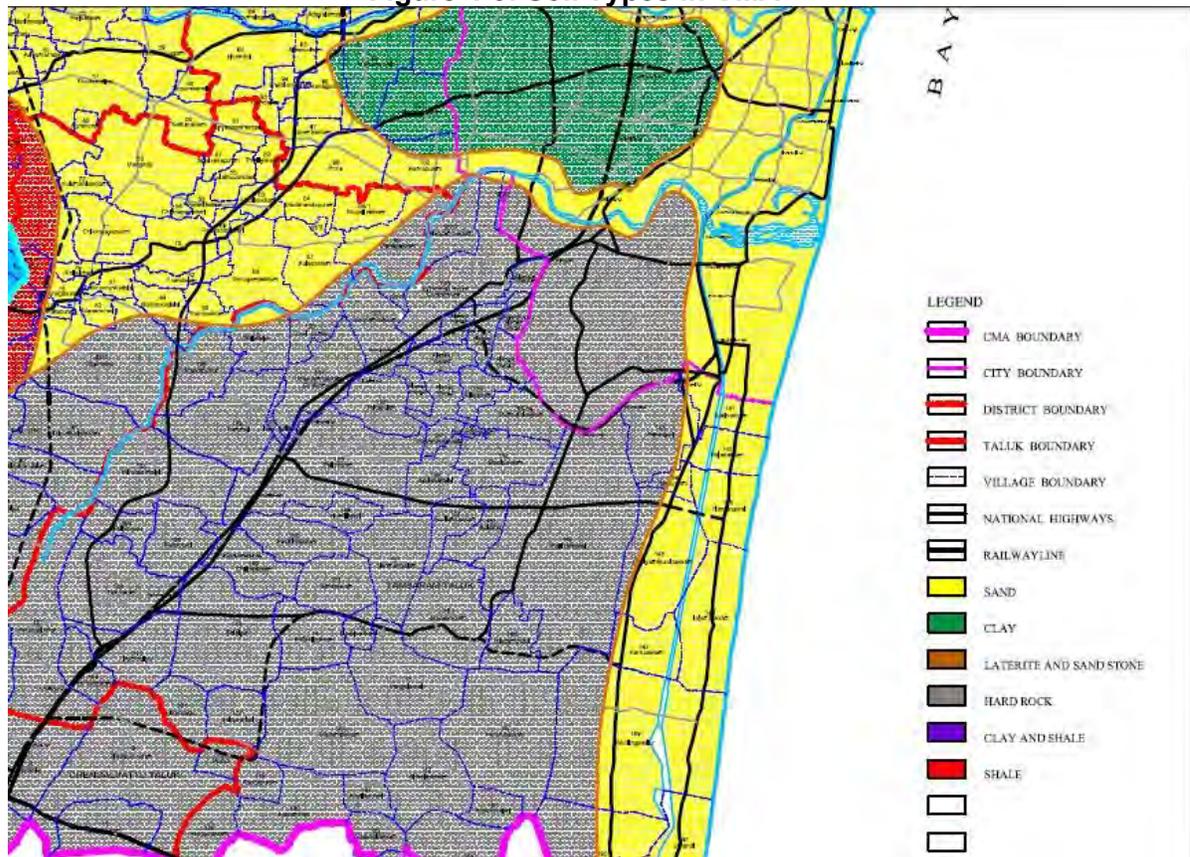
4.2.2 Soil

78. The recent sandy soil (Entisols) is immature soils and is predominant in the city and it occurs in small patches. The major soil in this region belongs to Alfisols and Entisols. Inceptisols and Vertisols are found in a very limited area only. These soils are generally poor in soil nutrients. They have medium to high permeability. They have low water holding capacity except in patches of clayey soils. The laboratory analysis results for soil are reported in Table 4.3. The soils are slightly alkaline in nature. Organic matter content in soils varies from 0.57% to 1.26%. The soil types found along the alignments, as recorded in the Master Plan 2026 for CMA are presented in Table 4.4 and Figure 4.3, subject to more specific findings from geotechnical investigations.

Table 4-4: Soil Types along alignment

Corridor / Section	Type of soil
Corridor 4	
Lighthouse to Nandanam	Sandy
Nandanam to Porur	Clay
Porur to Poonamallee bypass	Sandy

Figure 4-3: Soil Types in CMA



Second Master Plan for Chennai Metropolitan Area 2026, CMDA

79. The pH of the soil samples across all the sampling locations are observed to be alkaline. The conductivity of the soil is observed less than 1 mS/cm. The concentration of Zinc, Manganese, lead, copper, Nickel, Sulphur, Arsenic, Mercury, Cadmium (Cd) and Molybdenum

are observed to be well within the limits (IS as well as ISO Soil standards). The recorded available Nitrogen has been observed within medium range (in comparison with soil rating chart¹⁵) for samples collected at 4E, 4F and 4G, for other locations it is less than the stipulated limit of < 240Kg/ha.

4.2.3 Geology and Minerals

80. The geological formations in the region are from the Archaeans to the recent Alluvium (Table 4.5). The geological formations can be grouped into three units, namely (i) the Archaean crystalline rocks, (ii) consolidated Gondwana with Tertiary sediments and (iii) the recent Alluvium. Most of the geological formations are concealed by the alluvial materials, except for a few exposures of crystalline rocks like charnockites along the railway track in Guindy area. The thickness of Gondwana shales is highly variable in the city. It is more than 130 m at Porur and Koyembedu whereas it exceeds 25 m in Ashok Nagar and 60 m in Sterling Road. The highly variable nature of Gondwana sediments indicated the irregularly eroded crystalline basement, over which the Gondwana sediments are deposited.

Table 4-5: Geological Formation in the Project Area

Geological succession in Chennai district Group	System	Age	Lithology	Aquifer Characteristics
Quaternary	Recent	Sub-Recent	Soils, Alluvium (sand & silt)	Moderate to good porous aquifer system
Tertiary	(Cuddalore Sandstone equivalents)	Eocene to Pliocene	Sandstone & and shale (fossiliferous)	Moderately Porous Aquifer
---UNCONFIRMITY---				
Mesozoic	Upper Gondwana (Sri Perumbudur Beds)	Lower Cretaceous to Lower Jurassic	Brown Sandstone and siltstone; Grey shale; Black shale	Less Porous aquifer with minor fractures
---UNCONFIRMITY---				
Azoic	Archaean	--	Charnockites, Granites, Gneisses	Fractured Aquifer

Source: cpheeo.nic.in

4.2.4 Land Use

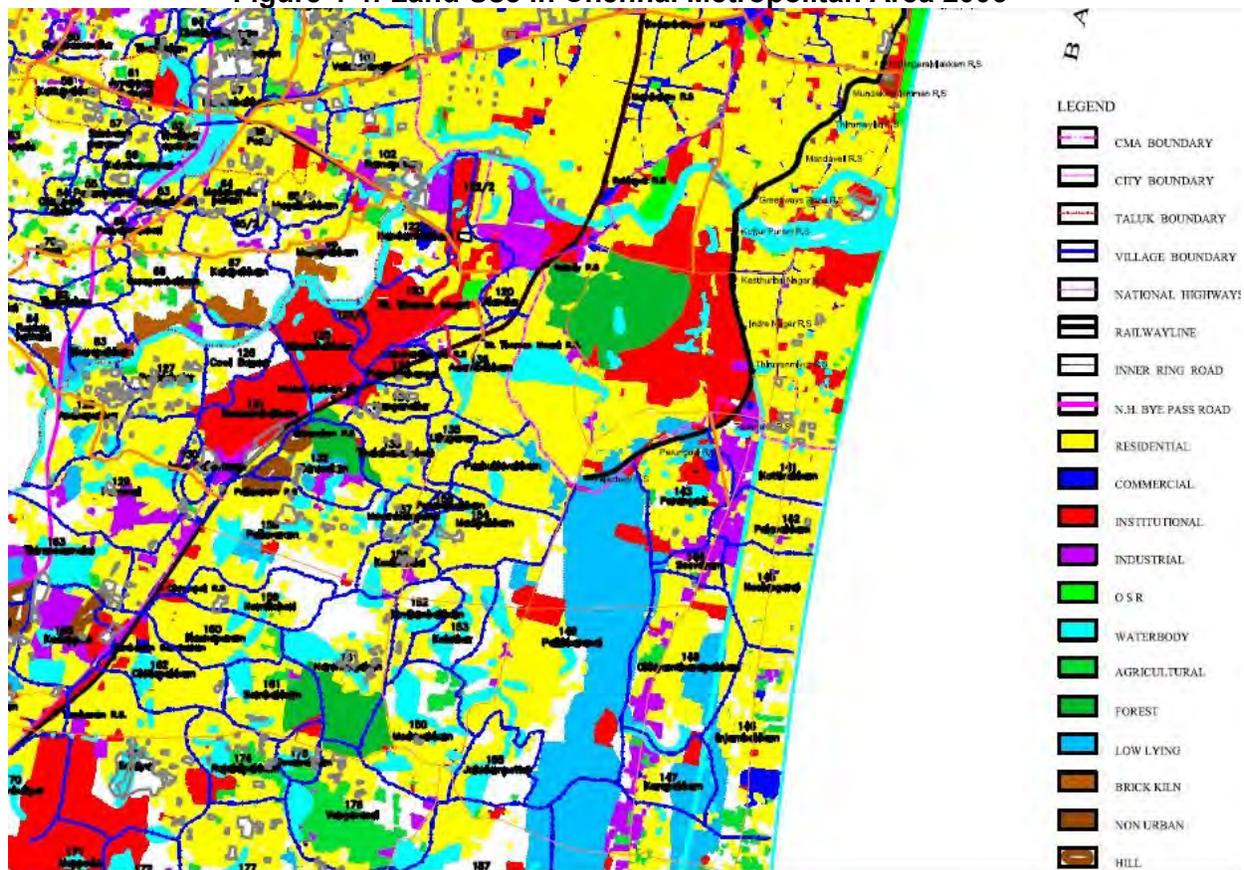
81. While there is no great increase in extent of lands zoned for urban activities, the intensity of development is likely to increase in sparsely developed and less developed areas to optimum levels thus increasing the efficiency of urban form. Restricting reclassification and open layout developments would prevent urban sprawl beyond the area zoned for urban development.

¹⁵ http://agritech.tnau.ac.in/agriculture/agri_soil_soilratingchart.html

82. In the North, large industrial units are located at Ennore, Thiruvottiyur and Manali; industrial estates are located at Madhavaram, Kodungaiyur and Gummipoondi. In the West important industrial locations include Ambattur, Padi and Sembiam. ICF Perambur and HVF Avadi are important industries under public sector. Many small and medium scale industries are located at Ambattur, Villivakkam, Thirumazhisai, Poonamallee and Noombal. Thermal power plant is located at Basin bridge. Hyundai car factory at Sriperumbudur, Hindustan Earth Movers at Tiruvallur and automobile industries at Irugattukottai are other important industries. In the south most of the industries are located along the G.S.T Road (NH45). Simpson, Addison and TVS industries are located in the heart of the City along Anna Salai. Madras Export Processing Zone (MEPZ) spread over an area of 105 hectares is located at Tambaram. Leather tanneries and leather-based industries are located near Tambaram.

83. Large-scale automobile engineering, glass and ceramic industries are located at Maraimalai Nagar. Mahindra Industrial Park developed over an area of 520 hectares is located near Chengalpattu along the GST Road. The highlights of land use in CMA are residential use and water bodies. Land use in year 2006 is depicted in Figure 4.4 and classified in Table 4.6. The predominant land use pattern along the corridor 4 is dominated by residential and commercial. The buildings along the alignment of Corridor 4 are majorly low rise varying from 4 to 6-storey.

Figure 4-4: Land Use in Chennai Metropolitan Area 2006



Source: Second Master Plan for Chennai Metropolitan Area, 2006

Table 4-6: Land Use in CMA

Land use	Land use 2006		Land use 2026		
	Area (ha)*				
	Chennai City	Rest of CMA	Chennai City	Rest of CMA	
Residential	9,523	22,877	8,342	45,593	
Commercial	1,245	390	714	880	
Industrial	908	6,563	822	10,690	
Institutional	3,243	3,144	2,868	3,888	
Land use	Land use 2006		Land use 2026		
	Open Space and Recreational	366	200	1,000	392
	Agricultural	99	12,470	Nil	7,295
Non-urban	82	2,433	113	2,333	
Others	2,087	56,507	3,754	28,147	
Urbanisable	Nil	Nil	Nil	2,075	
Total	17,553	104,584	17,613	101,293	

* Rounded off Source: Second Master Plan for Chennai Metropolitan Area, 2026

4.2.5 Seismicity

84. As per seismic zoning map of India shown at Figure 4.5, Tamil Nadu and Chennai are located in Moderate Seismic Zone (Zone III–BIS: 1893 (2001)). A study of seismic hazard for representative locations in Chennai (Seismic Hazard Assessment of the city of Chennai, India, Subhadeep Banerjee and A Boominathan, ASEM, Aug-Sept 2017) concluded that Santhome falls in class D; Vadapalani and Alwarpet fall in class C. Out of 5 classes (A, B, C, D and E) of soil that have been defined (NEHRP, USA) to rate building shaking due to seismic events, class A is the least vulnerable and class E is most vulnerable. Another micro zonation study (First level seismic micro zonation map of Chennai city - A GIS approach, Ganapathy, Natural hazards and earth system sciences 11(2) · February 2011) concluded that hazard for Santhome to Nandanam section except Alwarpet is low and Nandanam to Alwarthiru nagar section is moderate as depicted in Figure 4.6.

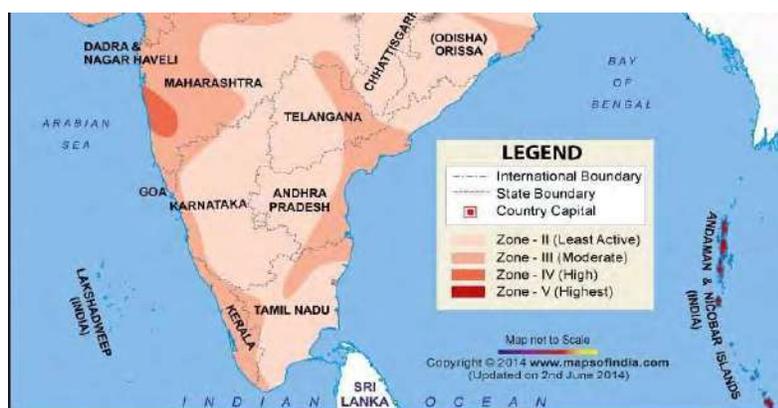
Figure 4-5: Seismic Zone Map of India

Figure 4-6: Seismic micro zonation of Chennai

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G. P. Ganapathy: First level seismic microzonation map of Chennai city

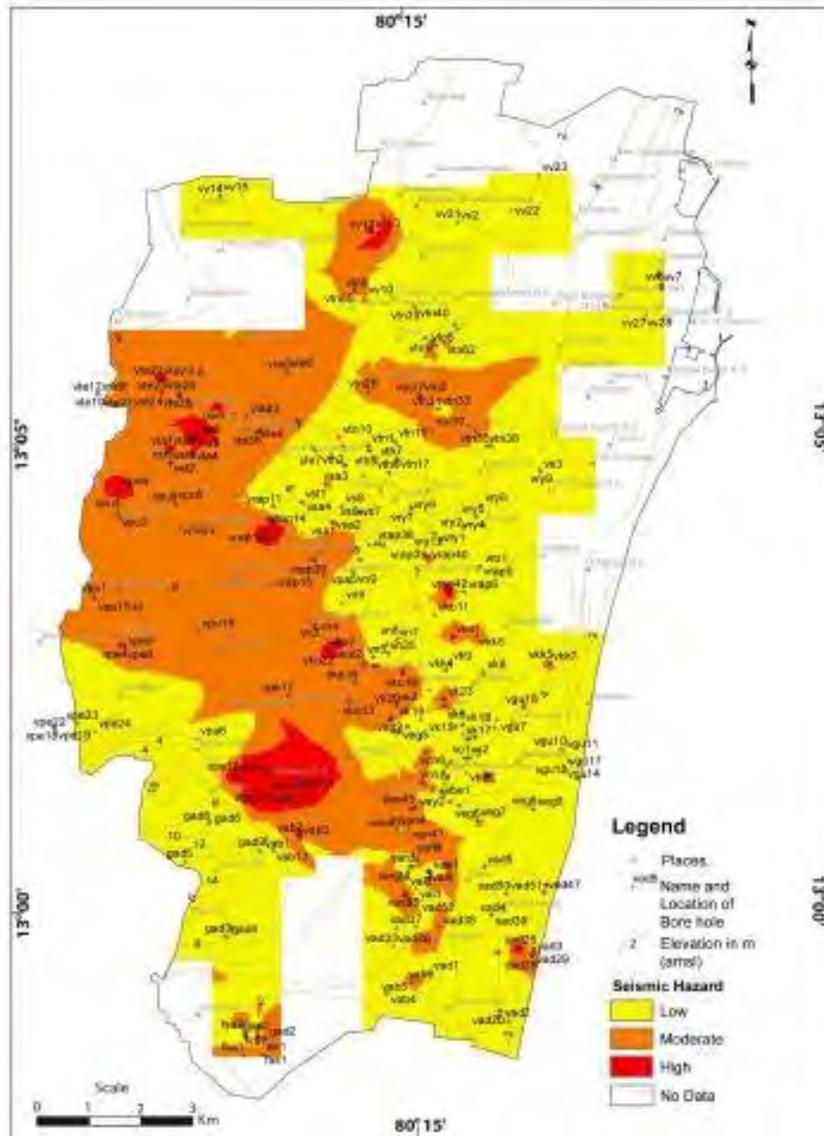


Fig. 8. First level seismic microzonation map of Chennai city.

Nat. Hazards Earth Syst. Sci., 11, 549–559, 2011

www.nat-hazards-earth-syst-sci.net/11/549/2011/

First level seismic micro zonation map of Chennai city - A GIS approach, Ganapathy, Natural hazards and earth system sciences 11(2) · February 2011

85. Last reported tremor in Chennai was on 12 February 2019 due to earthquake measuring 5.1 Richter (Source: IMD) with epicenter 10 km deep in Bay of Bengal.

86. The known faults and shear zones of the peninsular shield closely follow the pattern of major rivers. The fault details around Chennai city are listed in Table 4.7 which shows that none of them passes through the project site.

Table 4-7: Seismic Faults

Table 1. The details of faults and seismicity in the vicinity of Chennai city.

Sl. no.	Name of fault	Fault length <i>L</i> (km)	Distance (km)	Hypocentral distance, <i>R</i> (km)	Moment magnitude (<i>M_w</i>)	PGA (g)
1	Fault 15d	40	10	14	4.0	0.066
2	Fault 24	365	10	14	4.4	0.106
3	Fault 53	137	32	34	4.1	0.029
4	Kilcheri fault	26	33	34	4.0	0.025
5	Fault 15a	105	46	47	4.5	0.032
6	Neotectonic fault	105	48	49	3.8	0.013
7	Palar fault	85	59	60	4.0	0.013
8	Tambaram fault	10	59	60	4.4	0.021
9	Fault 15	96	61	62	3.7	0.009
10	Fault 52	115	67	68	3.6	0.007
11	Fault 15e	50	68	69	4.5	0.020
12	Fault 54	129	70	71	3.8	0.009
13	Mahapalipuram fault	5	75	76	4.0	0.010
14	Kalkulam fault	36	82	83	3.6	0.005
15	Muttukadu fault	11	95	96	3.5	0.004
16	Fault 26d	160	96	97	4.5	0.013
17	Fault 56e	75	97	98	4.5	0.013
18	Fault 26	1000	98	99	4.5	0.013

(Source: Seismic hazard assessment of Chennai city considering local site effects A Boominathan*, G R Dodagudar, A Suganthi and R Uma Maheswari, J. Earth Syst. Sci. 117, S2, November 2008)

4.2.6 Meteorology

4.2.6.1 Temperature

87. Chennai has a tropical wet and dry climate. The city lies on the thermal equator and is also on the coast, which prevents extreme variation in seasonal temperature. Meteorological data like monthly total rainfall, maximum & minimum temperature, wind rose and relative humidity of the Chennai for a period of Jan 2011 to Dec 2017 collected from Indian Meteorological Department (IMD). Table 4.8 and Table 4.9 depicts that the hottest part of the year is in the month of May with maximum temperature varies 41.0°C to 43.0°C. The coolest part of the year is in the month of January, with minimum temperature varies 17.7°C to 20.3°C.

Table 4-8: Monthly Highest Maximum Temperature (Deg C)

YEAR	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2011	31.1	32.6	37.7	35.7	41.7	38.6	38.0	36.9	36.4	35.4	32.6	31.6
2012	31.2	33.6	36.3	35.6	42.5	42.4	38.8	37.3	36.8	36.0	33.6	31.0
2013	30.9	32.5	35.1	37.4	42.7	39.7	38.3	36.9	35.7	35.6	33.6	32.1
2014	30.6	32.3	36.6	38.6	42.8	41.8	39.2	38.5	36.7	36.2	32.5	31.8
2015	31.3	33.1	35.1	36.8	42.2	39.6	41.0	37.6	36.9	35.7	32.6	32.4
2016	33.0	34.0	39.0	41.0	41.0	39.0	37.0	38.0	37.0	37.0	34.0	31.0
2017	31.0	36.0	36.0	41.0	43.0	41.0	39.0	37.0	36.0	36.0	34.0	33.0

Source: Regional Meteorological Centre, Chennai

Table 4-9: Monthly Lowest Minimum Temperature (Deg C)

YEAR	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2011	18.7	17.7	20.1	23.5	23.1	22.7	23.1	20.5	21.6	22.6	18.7	19.0
2012	17.7	19.2	22.4	25.7	27.1	24.2	22.6	23.7	22.0	22.2	17.6	20.7
2013	19.0	19.5	20.4	25.3	24.8	24.7	23.2	23.6	23.0	23.8	22.0	19.1
2014	20.3	19.0	22.1	25.6	24.3	23.0	23.6	22.9	23.7	23.4	21.3	21.0
2015	19.0	20.8	23.2	23.5	25.6	24.6	23.9	23.1	23.5	24.3	22.4	21.5
2016	19.0	20.0	23.0	25.0	25.0	24.0	24.0	24.0	23.0	22.0	19.0	19.0
2017	19.0	19.0	22.0	26.0	27.0	25.0	24.0	24.0	24.0	23.0	23.0	21.0

Source: Regional Meteorological Centre, Chennai

4.2.6.2 Rainfall

88. Chennai gets most of its seasonal rainfall from the North–East monsoon, from October to December. South-West monsoon prevails from June to September. Cyclones in the Bay of Bengal sometimes hit the city. The highest annual rainfall recorded is 1,049.3mm in November 2015, the highest recorded since November 1918 when 1,088 mm of rainfall was recorded. The monthly rainfall is given in Table 4.10.

Table 4-10: Monthly Rainfall (mm)

YEAR	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2011	10.8	88.9	0.0	18.5	12.6	130.2	67.4	368.9	286.2	260	457.2	134.8
2012	16.3	0.0	1.6	0.2	0.0	24.7	79.9	89.5	214.1	422.6	47.0	125.5
2013	Trace	14.3	11.9	3.6	3.6	34.0	146.6	195.1	240.1	157.2	193.7	85.9
2014	0.1	9.9	0.0	0.0	13.5	96.2	69.7	222.6	130.8	405.5	196.9	149.9
2015	2.8	0.0	0.0	12.3	7.9	20.3	205.9	106.5	75.0	159.9	1,049.3	454.7
2017*	0.0	5.0	2.5	0.0	0.5	60.0	55.0	90.0	65.0	160.0	155.0	9.0

Source: Regional Meteorological Centre, Chennai, *www.meteoblue.com

4.2.6.3 Humidity

89. Mean Relative Humidity is presented in Table 4.11 and Table 4.12. It varies 56% to 100% at 08:30 hrs and 57% to 87% at 17:30 hrs. 2016 and 2017 data were collected at different time slots.

Table 4-11: Monthly Mean Relative Humidity at 08:30 hrs (%)

YEAR	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2011	82	81	77	75	64	60	70	79	80	84	85	88
2012	83	77	76	72	65	56	68	73	76	83	80	84
2013	88	84	80	77	73	61	80	83	82	86	86	80
2014	78	79	72	72	67	64	70	78	77	82	82	83
2015	83	81	74	72	69	66	70	77	77	83	91	86
2016*	94	100	94	94	100	100	100	100	100	94	100	100
2017*	100	94	94	94	89	100	100	100	100	100	100	100

Source: Regional Meteorological Centre, Chennai, * at 05.30 hrs (www.timeanddate.com)

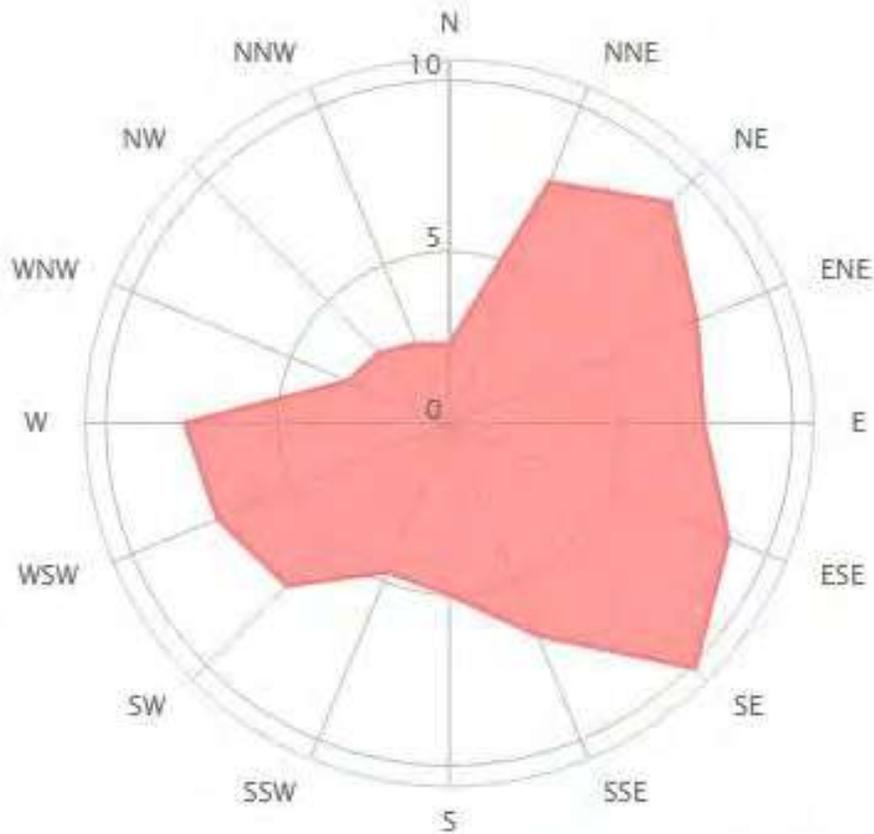
Table 4-12: Monthly Mean Relative Humidity at 17:30 hrs (%)

YEAR	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2011	60	61	59	67	65	58	57	69	74	80	76	67
2012	68	61	68	70	65	59	61	70	73	77	73	78
2013	75	72	69	77	74	60	76	76	78	81	81	73
YEAR	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2014	69	67	64	68	68	66	65	74	75	80	77	76
2015	73	71	67	69	69	65	70	71	75	78	87	78
2016*	38	30	29	30	30	37	37	33	37	30	27	27
2017*	35	24	38	23	25	16	33	42	47	36	43	40

Source: Regional Meteorological Centre, Chennai, *at 14.30 hrs(www.timeanddate.com)

4.2.6.4 Wind

90. The wind rose diagram has been prepared based on the daily data for the period of 10/2009 to 08/2016. The prominent direction is NE, ESE and SE. Wind rose diagram for the Chennai is shown in Figure 4.7.

Figure 4-7: Wind Rose Diagram for Chennai

4.3 Ambient Environment

91. In order to assess the impact on existing ambient environment due to Corridor 4, it is necessary to have baseline status of ambient environmental parameters.

4.3.1 Water Resources

92. As the city lacks a perennial water source, catering the water requirements of the population has remained an arduous task. Groundwater levels from 2013 to 2016 were up to 10m below ground in pre-monsoon as well as post-monsoon seasons and rise in water level of up to 4m in 80% to 90% of observation wells in Chennai district between pre-monsoon and post-monsoon months. From May 2016 and January 2017, the groundwater levels were up to 4m in 46% of observation wells (*Groundwater Yearbook of Tamil Nadu and UT Puducherry, Central Groundwater Board*).

93. As per data provided by Chennai water authority, in 2017, the combined water level in the four reservoirs namely Red Hills, Cholavaram, Chembarambakkam and Poondi lakes was 4,365 mcft or 330 MLD. In May 2019 the combined storage level of these reservoirs was about 160 mcft or 8 MLD. On 19 June 2019, Chennai city officials declared that "Day Zero", or the day when almost no water is left, had been reached, as all the four main reservoirs supplying water to the city had run dry. Two years of deficient monsoon rainfall, particularly in late 2017 and throughout much of 2018 had led to this crisis (*India Today 20 June 2019*).

94. Chennai receives about 985 MLD from various sources against the required amount of 1,200 MLD. As of year 2018, 300 million litres of water was estimated to have been sourced from the four reservoirs in Chennai with their storage standing at 40% of their capacity; 180 MLD from the desalination plants in Minjur and Nemmeli and 70 MLD (against the usual 180 MLD) from Veeranam tank. Krishna water of about 400MLD supplements these sources; and other water sources, including abandoned stone quarries, agriculture wells and Neyveli Corporation mines. (*Down to Earth 22 May 2019*).

4.3.2 Drainage

95. Adyar River originates at the confluence (Thiruneermalai) of two streams that drains the upstream area of Chembarambakkam tank. It is a small river of 42 km length and a catchment of 800 Sq. km. The river carries flow all through 365 days of a year with an average discharge of 89.43 MCM/Year at Kathipara cause way. It drains the southern part of the district and remains flooded during monsoon. During the high tides, the backwater from the Bay of Bengal enters inland up to 3 – 4 km.

96. Cooum is the other main river flowing through the central part of the district and carries only drainage water, which is highly polluted. It originates from the surplus waters from the Cooum tank in Tiruvallur taluk and the tanks, which are in enroute, discharge their surplus water into the river during flood season. The flow of Cooum River at Korattur is 40.2 MCM/year for an average duration of 31 days in a year.

97. Otteri Nulla is another small stream flowing in the northern part of the city. Buckingham canal is the man made one for navigation purposes earlier, but now it act as sewerage carrier in the city.

4.3.3 Water Quality

98. The analysis of water samples is presented in Table 4.13. Laboratory analysis of water sample depicts that most of the parameters are well within the prescribed permissible limits as per the Bureau of Indian Standards except some parameters viz Turbidity at 4A, and 5C, Total Dissolved Solids, Calcium, Total Hardness, and Chloride at 4G, Lead at 4E exceed the permissible limit. Bacteriological contamination found at 4A, 4B, 4C, 4D and 4H. Total Dissolved Solids (TDS) and Total Hardness at Santhome Church sampling location are higher than limits, this could be due to higher mineral content in the groundwater especially Calcium and Magnesium. Laboratory analysis of water sample depicts at most locations that TDS, hardness and coliform are more than prescribed desirable limits for drinking water.

Table 4-13: Results of Laboratory Analysis of Water Sample

S. N	Parameter	Unit	Corridor 4									Acceptable/Permissible Limit for drinking water IS 10500
			4A	4B	4C	5C	4D	4E	4F	4G	4H	
1	pH at 25°C	-	6.87	6.77	6.62	7.13	7.21	7.49	6.56	7.31	7.45	6.5-8.5/no relaxation
2	Turbidity	NTU	59.2	<0.1	<0.1	67.3	<0.1	5.5	<1	<1	<1	1/5 max
3	Total Dissolved Solids	mg/L	1186	1104	675	1826	612	1412	56	4510	418	500/2000 max
4	Aluminium as Al	mg/L	BDL	BDL	BDL	BDL	BDL	0.05	BDL	BDL	BDL	0.03/0.2 max
5	Free Ammonia (as NH ₃)	mg/L	<0.1	>0.1	<0.1	<1	<0.1	<0.1	<0.1	<0.1	<0.1	-
6	Barium (as Ba)	mg/L	BDL	BDL	BDL	0.13	BDL	0.058	BDL	0.099	BDL	0.7 max/ no relaxation
7	Boran (as B)	mg/L	BDL	BDL	BDL	0.004	BDL	BDL	BDL	BDL	BDL	0.5/1
8	Calcium as Ca	mg/L	100.2	116.2	76.2	82.6	48.1	57.8	2.1	289	32.1	75/200
9	Chloride as Cl	mg/L	207	182.3	123.2	670.1	98.6	409	14.8	2118.8	113.3	250/1000
10	Copper as Cu	mg/L	0.0021	0.0023	BDL	BDL	0.0021	BDL	BDL	0.007	BDL	0.05/1.5
11	Fluoride as F	mg/L	>1	>1	>1	>1	>1	>1	<0.1	>1	<1	1.0/1.5
12	Iron as Fe	mg/L	BDL	BDL	BDL	0.15	BDL	BDL	BDL	BDL	BDL	0.3/ no relaxation
13	Magnesium (as Mg)	mg/L	58.4	31.7	19.5	52.7	17	42.6	1.3	95.3	14.6	30/100
14	Manganese as Mn	mg/L	1.16	0.003	BDL	0.54	0.002	0.35	BDL	0.137	0.003	0.1/0.3
15	Nitrate as NO ₃	mg/L	BDL	70.8	21.6	BDL	1.2	5	BDL	11.3	BDL	45/ no relaxation
16	Phenolic Compounds	mg/L	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.001/0.002
17	Seleniem (as Se)	mg/L	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.01/ no relaxation
18	Silver (as Ag)	mg/L	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.01/ no relaxation
19	Sulphate as SO ₄	mg/L	312.7	196	50.8	46.1	85	61.7	BDL	224.2	BDL	200/400
20	Sulphide (as S)	mg/L	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	27.4	0.05/ no relaxation
21	Total Alkalinity as CaCO ₃	mg/L	223.3	396	310	460.6	467	539	9.8	372.4	BDL	200/600
22	Total Hardness as CaCO ₃	mg/L	490	420	270	422.3	190	319.3	10.3	1112.4	152.3	200/600

S. N	Parameter	Unit	Corridor 4									Acceptable/Permissible Limit for drinking water IS 10500
			4A	4B	4C	5C	4D	4E	4F	4G	4H	
23	Zinc as Zn	mg/L	BDL	BDL	BDL	BDL	BDL	0.027	0.14	0.034	140	5/15
24	Cadmium (as Cd)	mg/L	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.003/ no relaxation
25	Cyanide (as CN)	mg/L	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.05/ no relaxation
26	Lead as Pb	mg/L	BDL	BDL	BDL	BDL	BDL	0.045	BDL	BDL	BDL	0.01/ no relaxation
27	Mercury (as Hg)	mg/L	BDL	0.0008	0.00093	0.006	0.00025	BDL	BDL	0.00045	BDL	0.001/ no relaxation
28	Nickel	mg/L	BDL	BDL	BDL	BDL	BDL	0.0025	BDL	BDL	BDL	0.02/ no relaxation
29	Total Arsenic as As	mg/L	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.004	BDL	0.01/0.05
30	Total Chromium (as Cr)	mg/L	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.05 max/no relaxation
31	Total Suspended Solids	mg/L	29.0	9	7	21	7	9	3	8	8	-
32	Vanadium (as V)	mg/L	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	-
33	Amonical Nitrogen (as N)	mg/L	<0.1	>0.1	<0.1	<1	<0.1	<0.1	<0.1	<0.1	<0.1	0.5/No relaxation
34	Total Kjeldahl Nitrogen (as N)	mg/L	BDL	89	27.8	0.2	1.5	11.6	0.1	14.2	1.12	-
35	Chromium (as Hexavalent Cromium)	mg/L	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	-
36	Oil and Grease	mg/L	<5	<5	<5	<1	<5	<1	<1	<1	<5	-
37	Dissolved Oxygen	mg/L	6	6.8	6.6	4.6	6.7	4.4	6.1	4.9	5.7	-
38	Chemical Oxygen Demand	mg/L	32	24	16	64	20	64	Nil	52	56	-
39	Biochemical Oxygen Demand (3 day 27°C)	mg/L	13	9	6	23	8	20	Nil	19	20	-
40	Total Phosphate as P	mg/L	0.1	3.3	1.3	0.9	2.4	1.2	BDL	1.4	0.18	-
41	Dissolved Phosphate (as P)	mg/L	0.1	3.3	1.3	0.9	2.4	1.2	BDL	1.4	0.18	-
42	Sodium as Na	mg/L	135	137.5	110	575	165	455	10.9	925	75	-
43	Potassium as K	mg/L	5.8	47	24.3	15	24.8	29	BDL	61	12	-
44	Nitrate Nitrogen	mg/L	BDL	16	4.9	BDL	0.27	1.13	BDL	2.6	BDL	-
45	Total Nitrogen	mg/L	BDL	89	27.8	0.2	1.5	11.6	0.1	14.2	1.12	-

S. N	Parameter	Unit	Corridor 4									Acceptable/Permissible Limit for drinking water IS 10500
			4A	4B	4C	5C	4D	4E	4F	4G	4H	
46	Organic Phosphorus	mg/L	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.002 max
47	Coliform Count	MPN/100 ml	160	20	40	<1	90	<1	<1	<1	90	Absent
48	Fecal Coliform	MPN/100 ml	50	10	10	<1	30	<1	<1	<1	20	Absent
49	Total Coliform Organism	MPN/100 ml	250	69	80	<1	230	<1	<1	<1	200	Absent

4.3.4 Air Quality

99. The air pollutants emitted by point and non-point sources are transported, dispersed or concentrated by meteorological and topographical conditions. The monitoring results for ambient air quality are presented in Table 4.14. 24-hour air quality monitoring results indicates that the air quality was moderate, while the parameters of Sulphur dioxide (SO₂) and Nitrogen dioxide (NO₂) were within the permissible level of National Ambient Air Quality Standards (NAAQS) and World Health Organization (WHO) guideline. Particulate Matter was within NAAQS but exceeded WHO guideline. Concentration of Carbon Monoxide (CO) exceeded the permissible level of NAAQS in all the monitoring locations but was generally within WHO guideline. CO exceeded prescribed limits on Corridor 4. The NAAQS laid down by CPCB and WHO guideline are given in Table 4.15.

Table 4-14: Ambient Air Quality

SI No	Parameter	Unit	Pollution							
			Corridor-4							
			4A	4B	4C	5C	4D	4E	4F	4G
1	Sulphur Dioxide (SO ₂)	µg/m ³	5.52	12.16	10.47	9.58	8.48	9.43	8.82	10.50
2	Nitrogen Dioxide (NO ₂)	µg/m ³	11.52	18.03	17.53	13.60	23.64	17.53	12.17	17.71
3	Particulate matter (PM ₁₀)	µg/m ³	68.90	82.87	62.68	84.12	58.85	74.14	56.61	47.62
4	Particulate Matter (PM _{2.5})	µg/m ³	36.67	48.75	38.33	41.67	34.64	24.74	29.28	33.33
5	Carbon Monoxide (CO)	mg/m ³	6.0	7.0	6.0	6.0	5.0	8.5	5.8	8.0

Table 4-15: National Ambient Air Quality Standards

Pollutant	Time weighted Average	Concentration in Ambient Air*		WHO Guideline
		Industrial, Residential, Rural & Other Area	Ecological Sensitive Area	
Sulphur Dioxide (SO ₂) µg/ m ³	Annual	50	20	-
	24 Hours	80	80	-
Oxides of Nitrogen (NO ₂) µg/ m ³	Annual	40	30	40
	24 Hours	80	80	-
Particulate Matter (size less than 10µm) or PM ₁₀ µg/ m ³	Annual	60	60	20
	24 Hours	100	100	50
Particular Matter (size less than 2.5µm) or PM _{2.5} µg/m ³	Annual	40	40	10
	24 Hours	60	60	25
	24 Hours	-	-	7
Carbon Monoxide (CO) mg/ m ³	8 Hours	02	02	10
	1 Hour	04	04	30
Ozone (O ₃) µg/m ³	8 Hours	100	100	100
	1 Hour	180	180	-
Lead (Pb) µg/m ³	Annual	0.5	0.5	-
	24 Hours	1.0	1.0	-
Ammonia (NH ₃) µg/m ³	Annual	100	100	-
	24 Hours	400	400	-

*Source: CPCB guidelines for AAQM

4.3.5 Noise

100. The noise data was collected at 8 noise monitoring stations at hourly interval during morning, afternoon and evening such that peak and off-peak hours are covered. Most of the stretch is along the existing road. Later in 2019, monitoring of noise was conducted at 30 sample locations with sensitive receptors which are located within 200 m on either side of the alignment of Corridor 4, as listed in Table 4.19 and shown in Figure 4.8. The noise monitoring results are given in Table 4.16 and Table 4.17.

Figure 4-8: Locations of noise monitoring at sensitive receptors on Corridor 4



Field Survey: Nov/Dec 2019

Table 4-16: Ambient Noise Level Monitoring Results (by land use)

Location	Land Use	Leq	L10	L50	L90	Lmax	Lmin	Lday	Lnight	LDN
Corridor-4 Light House to Poonamallee Bypass										
4A	Commercial	72.45	74.90	72.03	69.88	75.98	68.23	72.92	70.85	71.89
4B	Residential	62.90	66.22	61.12	55.87	67.06	52.36	62.79	57.32	60.06
4C	Residential	72.07	76.63	66.81	58.87	77.20	57.66	70.80	59.90	65.35
5C	Residential	81.19	80.55	76.27	63.35	81.60	61.26	77.66	66.61	72.13
4D	Residential	78.44	78.82	75.13	64.72	78.94	63.03	76.11	68.14	72.12
4E	Commercial	75.07	75.21	74.99	73.08	75.35	72.62	75.02	74.00	74.51
4F	Silence Zone (educational)	73.19	76.01	72.73	70.76	76.27	69.84	73.65	71.37	72.51
4G	Silence Zone (religious)	84.34	81.45	78.97	63.49	82.54	58.91	79.42	66.57	73.00

4E to 4G in July 2016, 4A,4B,4C,4D in May 2017

Table 4-17: Ambient Noise Level Monitoring Results (at sensitive receptors)

No	Name of the Sensitive Receptor	Locations on Corridor 4	Type of Sensitive Receptor	Distance from the outer most proposed tracks (m)	Leq (Day) 50 dB(A)	Leq(Night) 40 dB(A)
1	Queens Mary College	Light House Station - Fore shore Estate Road	College	94.57	53.5	35.1
2	St. Thomas church	Light House Station - Fore shore Estate Road	Church	1.0	46.4	31.6
3	St. Bede's Anglo Indian Hr. Sec. School	Light House Station - Fore shore Estate Road	School	71.16	56.8	35.2

No	Name of the Sensitive Receptor	Locations on Corridor 4	Type of Sensitive Receptor	Distance from the outer most proposed tracks (m)	L _{eq} (Day) 50 dB(A)	L _{eq} (Night) 40 dB(A)
4	Santhome church	Foreshore Estate Road - Kutchery Road	Church	6.32	47.5	32.7
5	Rosary Church	Foreshore Estate Road - Kutchery Road	Church	1.0	44.3	30.4
6	St. Raphael's Girls Hr. Sec. School	Foreshore Estate Road - Kutchery Road	School	6.07	59.6	33.9
7	Majood Jamal	Kutchery Road - Thirumayilai Metro	Mosque	5.5	46.2	33.5
8	Jumma Mosque	Kutchery Road - Thirumayilai Metro	Mosque	11.87	43.7	34.6
9	Luz Church	Thirumayilai Metro - Alwarpet	Church	76.43	45.2	31.3
10	Anjaneyar Temple	Alwarpet - Bharathidasan Road	Temple	9.66	43.6	32.5
11	Trinity Hospital	Alwarpet - Bharathidasan Road	Hospital	7.58	52.8	38.2
12	AVT Hospital	Alwarpet - Bharathidasan Road	Hospital	28.9	55.1	36.8
13	SIET College	Adyar Gate Junction to Nandanam	College	31.17	57.3	35.3
14	Venkateshwara Hospital	Nandanam to Natesan Park	Hospital	38.23	51.6	37.9
15	Government Arts College	Adyar Gate Junction to Nandanam	College	18.48	56.9	33.4
16	Little Oxford Matriculation Higher Sec School	Nandanam to Natesan Park	School	73.81	50.4	34.7
17	Thyagarayar Higher Secondary School	Nandanam to Natesan Park	School	22.45	49.8	31.9
18	Thirumala Tirupathi Devasthanam	Nandanam to Natesan Park	Temple	25.6	54.6	49.6
19	Rose of Sharon Ac Church	Kodambakkam Metro to Meenakshi	Church	180.34	48.9	37.2
20	Meenakshi College for Women	Meenakshi College to Power House	College	120.9	52.9	35.7
21	Chennai Higher Secondary School	Power House to Vadapalani	School	19.00	56.2	34.3
22	Saraswathi Vidyalaya Sr. Sec. School	Power House to Vadapalani	School	12.79	54.7	33.3
23	Vijaya Hospital	Vadapalani Saligramam to	Hospital	15.70	51.1	39.1

No	Name of the Sensitive Receptor	Locations on Corridor 4	Type of Sensitive Receptor	Distance from the outer most proposed tracks (m)	L _{eq} (Day) 50 dB(A)	L _{eq} (Night) 40 dB(A)
24	Karthikeyan Matric School	Vadapalani Saligramam to	School	35.96	49.8	34.7
25	Narayanan E-Tecno School	Alwar thiru nagar to Valasarwakkam	School	14.17	47.3	36.5
26	The Holy Cross Matric Hr. Sec. School	Valasaravakkam to Karambakkam	School	87.30	52.6	38.1
27	Parvathy Hospital	Alapakkam Junction-Porur Junction	Hospital	57.56	48.3	36.7
28	Lakshmi Hospital	Ramchandra Hospitallyappanthangal Bus Depot	Hospital	38.38	52.7	37.6
29	Mangalam Hospital	Mullai Thottam to Poonamallee Bus Terminus	Hospital	23.85	54.1	35.3
30	Government Hospital	Mullai Thottam to Poonamallee Bus Terminus	Hospital	18.01	59.3	41.5

Field survey: Nov/Dec 2019

101. The Ambient Noise limits laid down by CPCB and WHO have been given in Table 4.18. The noise levels monitored at 8 locations along the alignment were above the national and international permissible limits. Noise levels was also monitored at 30 sensitive locations belonging to the silence zone, with 60% slightly exceeding the noise limits of 50dB the daytime limit (23.3% per WHO guideline of 55dB), and 1 out of 30 exceeding 40 dB the nighttime limit. The predominant source of ambient noise at the monitored locations are from road traffic (urban arterials and regional highways).

Table 4-18: Ambient Noise Limits

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

Source: CPCB guideline (as per The Noise Pollution (Regulation and Control) Rules, 2000) * CPCB day time is from 6.00 AM to 9.00 PM, WHO defines day time as 7.00 AM to 10 PM.

****Silence Zone** is defined as an area up to 100m around premises of Hospitals, Educational Institutions, Courts of law and religious places or any others declared as such.

4.3.6 Vibration

102. Vibration consists of rapidly fluctuating motions of the particles without any net movement. Objects can vibrate differently in three mutually independent directions which are vertical, horizontal and lateral. It is common to describe vibration levels in terms of velocity, which represents the instantaneous speed at a point on the object that is displaced. Vibrations are transmitted from the source to the ground and propagate through the ground to the receiver.

103. The triaxial transducers are placed at proposed survey location. The signals obtained from all three axes are in horizontal, transverse and vertical directions viz. X- Easting, Y-Northing and Z-Vertical direction. The standard measurable units for velocity are in mm/s.

104. Measuring the peak particle velocity (PPV) is mostly used for representation of vibrating situation when the pressure wave passes through the particles. Soil conditions have a strong influence on the level of ground-borne vibration. The PPVs are usually expressed in terms of m/s or mm/s.

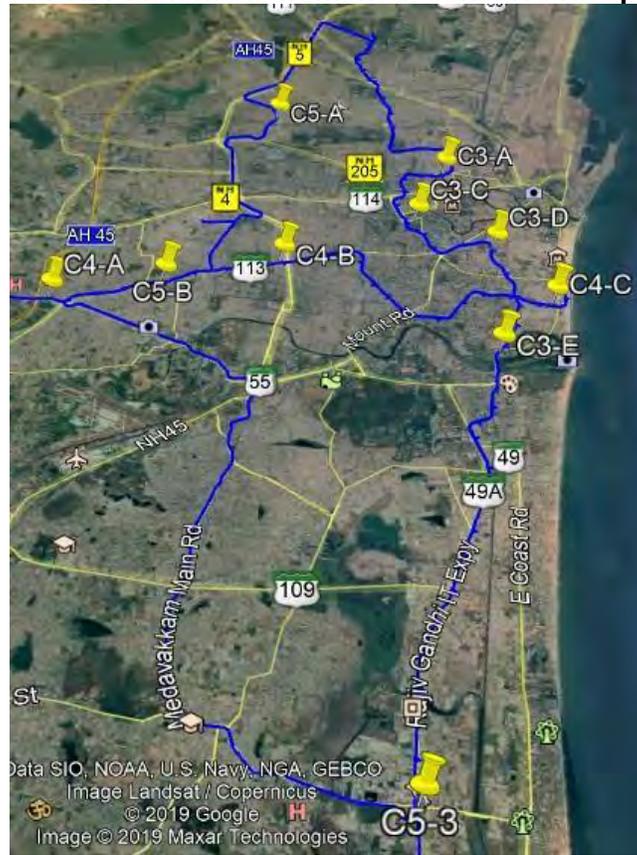
105. The dynamic analysis and seismic response have been studied for 13 identified sensitive receptors on Corridor 4 comprising educational institutions and hospitals which are located near by the project corridors as shown in Figure 4.9 & 4.10. Of these locations, 2 are heritage assets namely Rosary Church and Our Lady of Light Shrine; permission to conduct vibration study at the third heritage asset Santhome Church was not available.

Figure 4-9: Locations of vibration measurement at sensitive receptors Part 1



Field Survey: Nov 2019

Figure 4-10: Locations of vibration measurement at sensitive receptors Part 2



106. The induced ground vibration level is summarized in Table 4.21 and monitoring schedule is shown in Table 4.19.

107. All the measurements are characterized on ground level i.e., pickup point is on ground level. Peak VdB vibration level at 11 out of 13 monitored locations is found to exceed acceptable criteria for ground borne vibration prescribed by the Federal Transit Administration (FTA) USA and Railway Design & Standards Organisation (RDSO) (**Annexure 3**). However the observed levels at all 13 locations are well below the construction vibration damage criteria for blasting as per Directorate General of Mines Safety (DGMS) and Central Institute of Mining and Fuel Research (CMFRI or CMRI) which are relevant only if blasting is undertaken during construction (Table 4.20).

Table 4-19: Monitoring Schedule

No	Location	Monitoring schedule	Duration (hrs)	Date of Commencement
Part 1				
1	C4-D-St.Bede's Indian School Anglo	10:35 AM – 6:52 PM	08	22/11/2019
2	C4-E-Aashraya Hospital	08:52 AM -5:00 PM	08	24/11/2019
3	C4-F- Jain Temple	11:47 AM - 7:59 PM	08	19/11/2019
4	C4-G- Luz Church	10:42 AM – 6:47 PM	08	17/11/2019
5	C4-H-Anjaneyar Temple	10:28 AM -6:37 PM	08	23/11/2019

No	Location	Monitoring schedule	Duration (hrs)	Date of Commencement
6	C4-I – SIET College	11:16 AM - 7:24 PM	08	20/11/2019
7	C4-J-Thirupathi Thirumala Devasthanam Temple	8:43 AM – 5:01 PM	08	21/11/2019
8	C4-K-Koncept Hospital	10:34 AM - 6:38 PM	08	25/11/2019
9	C4-L-The Holy Cross Matric Ilr. Sec School	10:19 AM - 6:28 PM	08	26/11/2019
10	C4-M- Government Hospital	09:46 AM – 5:47 PM	08	27/11/2019
Part 2				
C4-A	Near Porur Lake	7:45 PM -7:40 PM	24	20/07/2019 to 21/07/2019
C4-B	Vadapalani Junction	1:03 PM - 12:55 PM	24	19-07-2019 to 2007-2019
C4-C	Santhome Church	9:57 AM - 10:03 AM	24	16-07-2019 to 1707-2019

Table 4-20: Standards for Vibration

Type of structure	Vibration (mm/s) for dominant excitation frequency, Hz		
	< 8Hz	8-25Hz	>25Hz
DGMS			
(A) Buildings/structures not belonging to the owner			
Domestic houses/structures (kuccha, bricks & cement)	5	10	15
Industrial building	10	20	25
Objects of historical importance & sensitive Structures	2	5	10
(B) Buildings belonging to the owner with limited span of life			
Domestic houses/structures	10	15	20
Industrial buildings	15	25	50

After CMRI Standard (Dhar et al, 1993)

Type of structures	PPV (mm/s)	
	<24 Hz	>24 Hz
Domestic houses, dry well interior, construction Structures with Cemented, bridge	5.0	10.0
Industrial buildings, steel or reinforced concrete structures	12.5	25.5
Object of historical importance, very sensitive Structures, more than 50 years old construction and Structures in poor state condition	2.0	5.0
IS 14881:2001		
Soil, weathered or soft conditions: 70mm/s		
Hard rock conditions: 100mm/s		

Source: DGMS (Tech) (S&T) Circular No. 7 of 1997

Table 4-21: Baseline Vibration

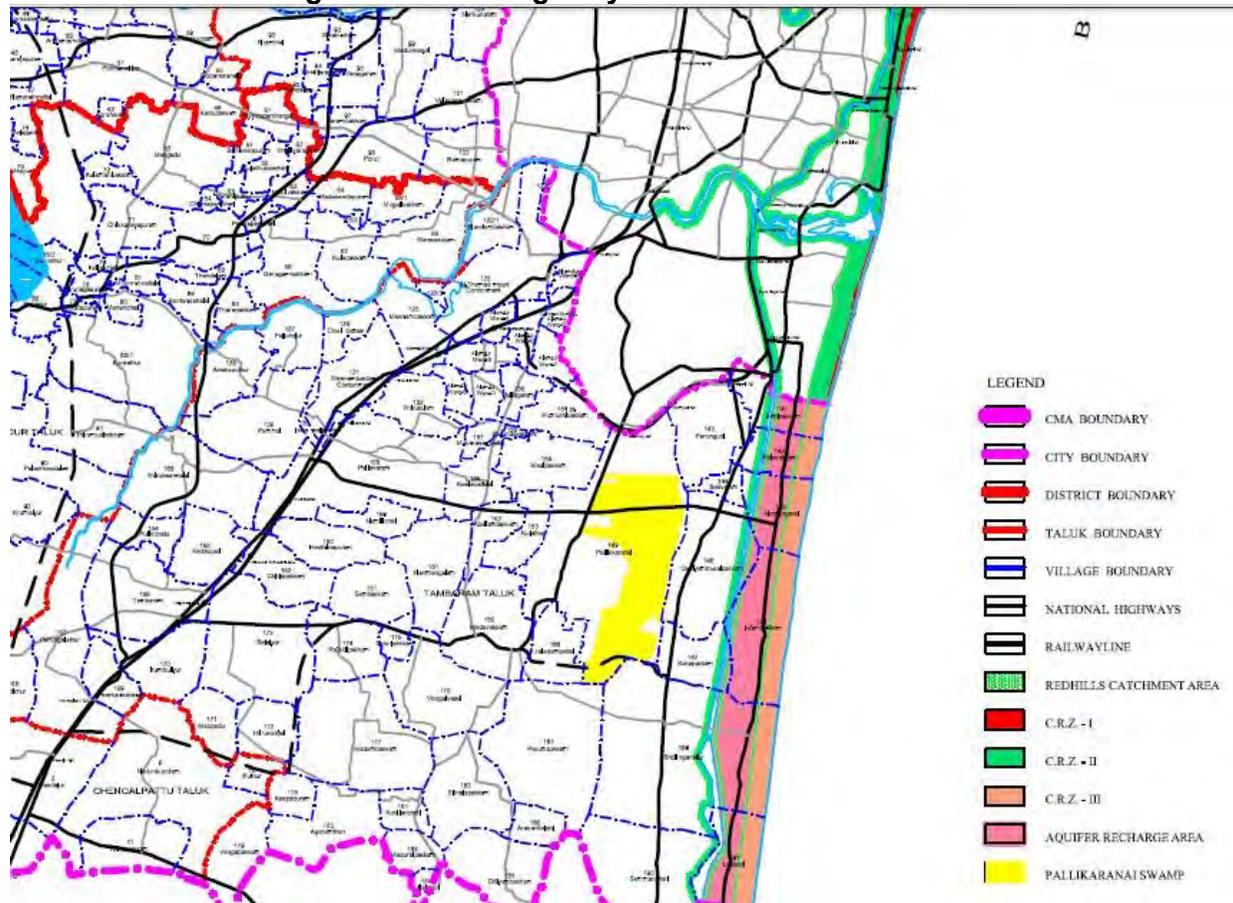
S N	Name of location	Surface Type	PPV (Maximum) mm/sec			VdB (Maximum)			VdB (Average)			VdB RMS	
			East	North	Up	East	North	Up	East	North	Up	Max.	Time
Part 1													
1	C4-D-St. Bede's Anglo Indian School *	Marble	0.231	0.141	0.497	79.176	74.888	85.830	68.43	65.82	68.56	82.82 (Up)	02:26 PM
2	C4-E- Aashraya Hospital **	Cemented Floor	0.089	0.082	0.187	70.85	70.18	77.34	66.09	66.08	63.86	74.33 (Up)	3:19 PM
3	C4-F- Jain Temple ***	Marble	0.303	0.096	0.103	81.53	71.54	72.16	73.86	65.78	65.48	78.52 (East)	12:34 PM
4	C4-G- Luz Church	Cemented Floor	1.840	0.324	0.474	97.20	82.11	85.42	72.70	69.95	69.98	94.19 (East)	6:30 PM
5	C4-H- Anjaneyar Temple	Marble	1.110	0.504	0.833	92.81	85.95	90.32	75.64	68.62	75.55	89.80 (East)	02:25 PM
6	C4-I – SIET College	Marble	0.261	0.170	0.251	80.24	76.51	79.90	68.27	68.16	67.45	77.22 (East)	07:16 PM
7	C4-J- Thirupathi Thirumala Devasthanam Temple	Marble	1.420	0.499	0.792	94.95	85.87	89.88	79.25	69.78	75.51	91.94 (East)	11:54 AM
8	C4-K- Koncept Hospital ****	Marble	0.894	0.200	0.502	90.93	77.92	85.92	74.01	68.73	70.80	87.92 (East)	01:57 PM
9	C4-L-The Holy Cross Matric Hr. Sec School	Tiles	0.439	0.099	0.237	84.75	71.81	79.40	72.32	66.66	69.50	81.74 (East)	11:46 AM
10	C4-M- Government Hospital	Marble	0.311	0.250	0.266	81.76	79.86	80.40	69.31	66.37	69.08	78.75 (East)	10:23 AM
Part 2													
C4-A	Near Porur Lake	Soil	0.207	0.356	0.325	78.22	82.93	82.14	64.34	66.77	72.20	79.92 (North)	04:34 AM
C4-B	Vadapalani Junction	Soil	0.210	0.430	0.788	78.34	84.57	89.83	67.58	75.22	79.29	86.82 (Up)	06:36 AM
C4-C	Santhome Church	Soil	0.456	0.356	0.094	85.08	82.93	71.39	65.49	62.95	62.59	82.07 (East)	12:05 PM

Note: Representing locations of* C4-D- Queens Mary's College ** C4-E- Rosary Church *** C4-F- Jumma Mosque **** C4-K- Meenakshi College for Women

4.4 Ecological Environment

4.4.1 Ecologically Sensitive Areas in CMA

Figure 4-11: Ecologically Sensitive Areas in CMA



Source: Second Master Plan for Chennai Metropolitan Area, 2026

108. The ecologically sensitive areas in Chennai Metropolitan Area (CMA) are depicted in Figure 4.11.

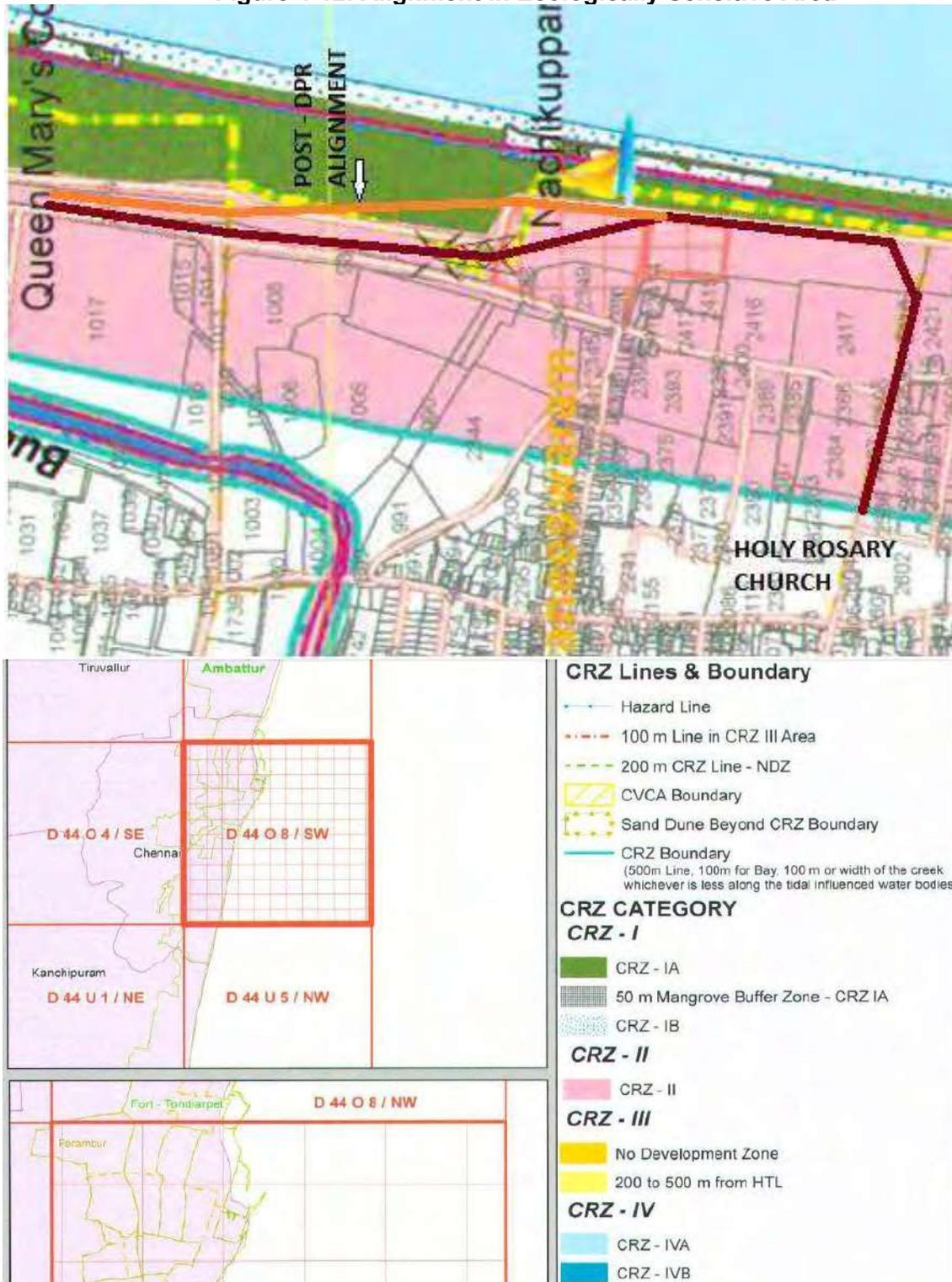
109. The section of alignment from Lighthouse to Foreshore Road with a length of 1,342m along Corridor 4 falls in CRZ. The DPR alignment (shown in violet colour in Figure 4.11) from Lighthouse station to Foreshore Estate Road is located in CRZ II but outside CRZ IA which stretches along the sea front from Anna memorial near Chintadripet (located North of project line) to Kottivakkam (located South of project line). This section is identified as CRZ IA due to its being possible nesting grounds for the Olive Ridley Turtle (Vulnerable).

110. In the alignment (shown in brown in Figure 4.12) which is revised post-DPR, length of about 410m opposite IG office is located in CRZ IA and balance 932m is located in CRZ II.

111. However, the Foreshore Estate Road is a busy area. Figure 4.13 shows location of settlement constructed by Tamil Nadu Slum Clearance Board at location Nochikuppam. This development at Nochikuppam and Domminkuppam located west of Foreshore Road and South of Office of IG Police is executed under Emergency Tsunami Reconstruction Project funded by

the World Bank. The sample photograph shows the Foreshore Estate Road and ETRP buildings where Foreshore Estate Road is congested with running traffic and fish market.

Figure 4-12: Alignment in Ecologically Sensitive Area



Source: Coastal Zone Management Plan Tamil Nadu Sheet No. D 44 O 8 /SW, NCSCM 2017-18

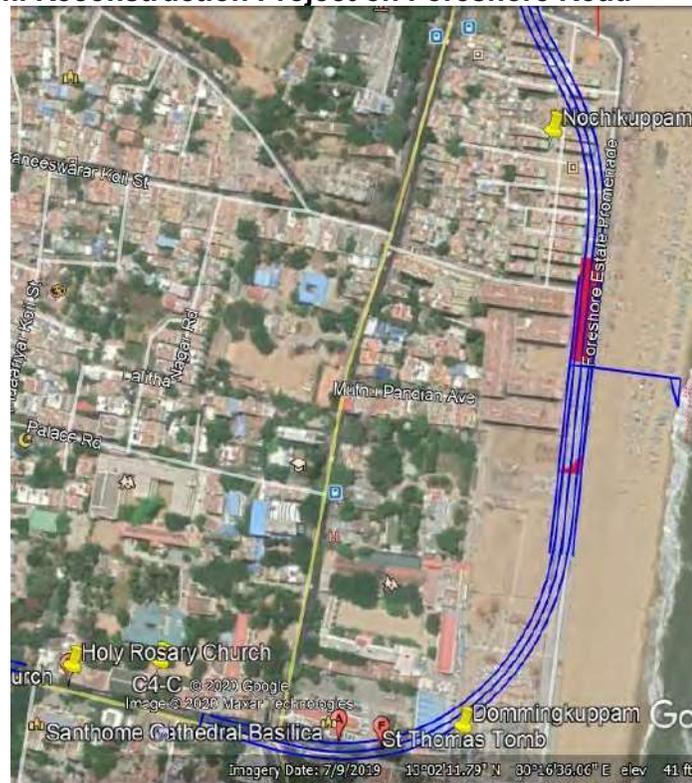
Figure 4-13: Emergency Tsunami Reconstruction Project on Foreshore Road



Vehicles parked on the Loop Road near Marina



Source: Times of India, Feb 2, 2020



112. The elevated alignment of Corridor 4 is proposed to pass across Porur lake, which is located on the fringes of the suburb of Porur in south-west Chennai. Porur Lake functions as a source of water for the people residing in Chennai. It also acts as a drainage area that is connected with the Chembarambakkam Lake. As shown in Figure 4.13, Porur Lake is located at 13.034223 degrees north and 80.15065 degrees east. It occupies a water spread area of 250 acres with a capacity of 46 million cubic feet.

113. Since 1995, the government has prohibited activities like swimming, bathing and washing clothes in Porur Lake. In the year 2012, another initiative was taken by the Water Resources Department, not only to restore the lake, but also to meet the city's growing demands for drinking water. This project was aimed at increasing the capacity of the tank to 70 mcft. Many uncontrolled and illegal activities also termed as encroachment are responsible for disturbing the ecology of any setting or area. Porur Lake also acquired the ill fate of many other lakes in India in terms of degradation of water quality. This is evident from the observations of the residents of Porur. According to these residents, Porur Lake has turned into a dumping ground for garbage and the release of sewage. They have even emphasized on the fact that when this lake's bund would be breached, flooding of several localities around the lake would be its consequence. This troublesome event would take place every year during the monsoon season.

115. The following Table 4.22 lists the bird-watching areas in Chennai. (Source: *Madras Naturalists' Society*)

Table 4-22: Bird Watching Areas in Chennai

S.no	Location
1	Indian Institute of Technology, Adyar – tropical dry evergreen forest with exotic plantation
2	Pallikaranai Marsh – Open water interspersed with reeds and bulrushes
3	Adyar Estuary/creek/Adyar Poonga – Estuary with Mudflats
4	Nanmangalam Forest Reserve – Scrub covered slopes and water covered pools
5	Guindy National Park – Tropical Dry Evergreen Forest
6	Vandalur Hills and Zoo – Undulating terrain with original scrub and planted trees
7	Crocodile Bank – Coastal setting with artificial ponds and tall planted trees being used as a heronry
8	Pallavaram Hills – Original scrub and some trees
9	Manali and Madhavaram Jheel – Lakes
10	Edayanchatram – Open scrub
11	Thiruneermalai, Pammal – Hillock with some scrub
12	Red Hills and Cholavaram – Lakes
13	Ennore Creek – Coastal vegetation
14	Chemmencheri tank – Waterbody
15	Chembarampakkam lake

116. Guindy National Park with an area of 2.70 sq. km, which is under Reserve Forest category is classified as a Protected Area (ENVIS Centre of Wildlife and Protected Areas) and is located at distance of 2.6 km from the project alignment. In terms of density of vegetation cover, the area falls under sparse category.

117. The Guindy National Park is classified under tropical dry evergreen forests of the Coromandal coast and is being used for recreational purposes. The vegetation is mainly of the tropical dry evergreen type, and over 350 species of plants have been found including trees, shrubs, climbers, herbs and grasses. Chital and Blackbuck graze are found in the open grassland on the northern end of the park. Nocturnal animals include the toddy cat, civets, jungle cat, pangolin, and hedgehog. The dense forest, grasslands and water-bodies provide an ideal habitat for a large species of birds. Apart from snakes, certain species of tortoise and turtles, lizards, geckos, chameleons and the common Indian monitor lizard are also found here.

118. Vide letter dated 31 July 2013, MoEF&CC informed States that a default area of 10 km from the boundary will be the Eco-Sensitive Zone (ESZ) of such protected areas for which proposals identifying ESZs were not forwarded by the States to MoEF&CC. Corridor 4 falls in default ESZ of Guindy National Park. Vide MoEF&CC clarification dated 2 July 2012, projects falling in ESZs which are not covered under Notification 2006 and which do not require Environmental Clearance (EC) do not require prior approval of National Board of Wildlife (NBWL). As commercial development equal to or above threshold of 20,000 sqm is not proposed, prior EC

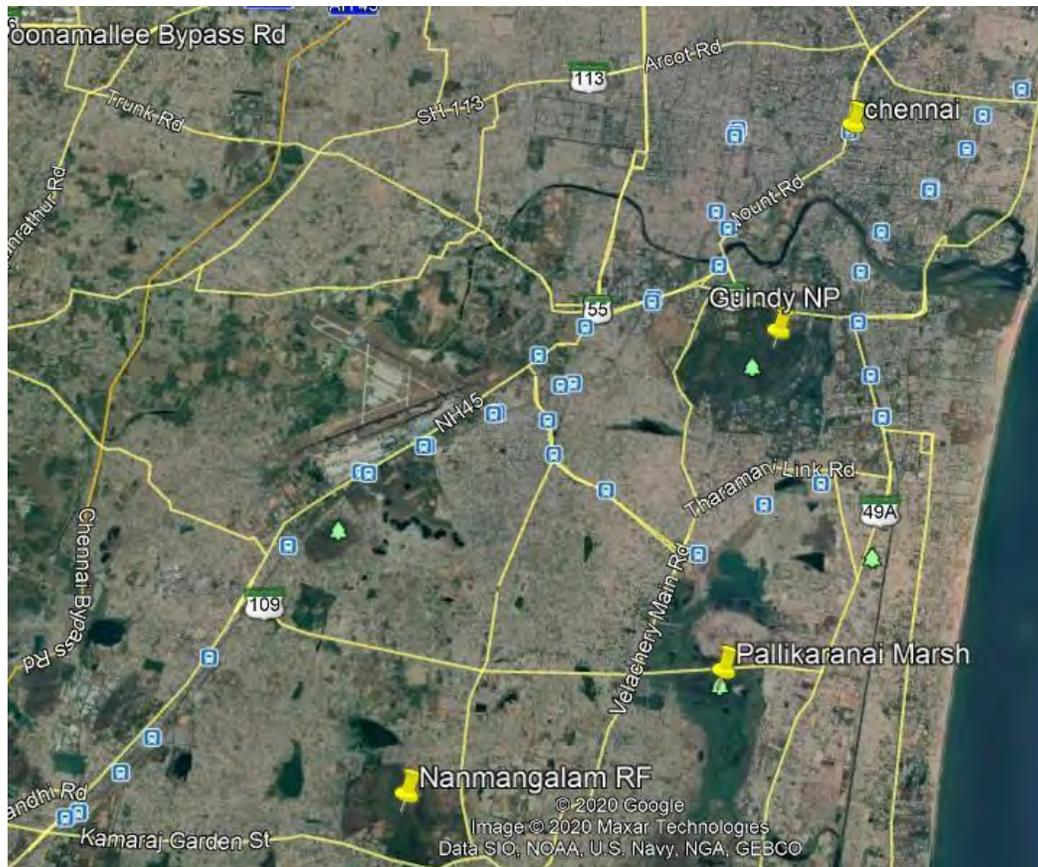
need not be sought and hence prior approval of NBWL need not be sought. In accordance with 2011 Guidelines for declaration of ESZ around national parks and wildlife sanctuaries, activities relevant to the project are categorised in Table 4.23.

Table 4-23: Guidelines for ESZ Activities

Activity	Prohibited	Regulated	To be promoted
Discharge of effluents and solid waste in natural water bodies or terrestrial area	Yes	--	--
Felling of trees	---	Yes	---
Commercial use of natural water resources including ground water harvesting	---	Yes	---
Erection of electrical cables	---	Yes	---
Widening of roads	---	Yes	---
Movement of vehicular traffic at night	---	Yes	---
Air and vehicular pollution	---	Yes	---
Sign boards and hoardings	---	Yes	---
Underground cabling	---	---	Yes
Rain water harvesting	---	---	Yes
Renewable energy	---	---	Yes
Green technology for all activities	---	---	Yes

119. Some of the ecologically sensitive areas of Chennai district are shown in Figure 4.16.

Figure 4-16: Ecologically Sensitive Areas of Chennai District



120. The Nanmangalam Reserve Forest is home to 100-125 species of birds in addition to 40 different species of butterflies and close to 20 species of damselflies and dragonflies. 442 different species of flowering plants are found inside the forest alone. The Reserve Forest's most famous inhabitant and star attraction is the great horned owl.

121. Pallikaranai Marsh is a freshwater swamp. It is one of the three wetlands in the state of Tamil Nadu which are included in wetlands identified under National Wetland Conservation and Management Programme. (MoEF&CC Annual report 2006-2007). Biodiversity of Pallikarnai is seen in (*Source: nammapallikarnai.org*) 125 species of birds, 10 mammals, 21 reptiles, 9 amphibians, 49 fishes, 9 molluscs and 7 butterflies and 120 plant species. It is home to some of the most endangered birds such as the Black bellied tern, Great-knot and black-tailed godwit. Pallikarnai known for diverse variety of visitors and resident bird species. It is also home to some of the mostly rare reptiles such as the fan throated lizard, Russel viper and cobra. Other estuarine fauna present at the marsh includes the windowpane oyster, mud crab, mullet, halfbeak and green chromide. Plankton study shows that the water body is Eutrophic in nature.

4.4.2 Flora and Fauna

122. Corridor 4 passes through Panagal Park which is a recreation park; the metro station will be located underground. Tree count was carried out along the proposed alignment and in depot sites in 2018. Most of the trees exist along the sides of road and on median. The predominant tree species along the project corridors are listed below in Table 4.24.

Table 4-24: Predominant Tree Species along the Corridor (Local name- Botanical name)

Species	IUCN status
1. Vembu- <i>Azadirachta indica</i>	LC
2. Vadam- <i>Terminalia catapa</i>	LC
3. Nirkadambai - <i>Neonauclea purpurea</i>	NE
4. Thoongumoonji - <i>Albizia saman</i>	-
5. Panei - <i>Borassus flabellifer</i>	NE
6. Pungam - <i>Pongamia pinnata</i>	LC
7. MayirKonnai - <i>Delonix regia</i>	LC
8. Nettilingam- <i>Polyalthia longifolia</i>	NE
9. Vagai - <i>Albizia lebeck</i>	NE
10. Thennai - <i>Cocos nucifera</i>	NE
11. Shevaga - <i>Morinda tinctoria</i>	-
12. Nuna - <i>Bombax malabarica</i>	NE
13. Arasu - <i>Ficus religiosa</i>	NE
14. AI - <i>Ficus benghalensis</i>	NE
15. Ma - <i>Mangifera indica</i>	DD

Note: LC Least Concern; NE Not evaluated; DD Data Deficient; - Not known

123. The number of trees likely to be cut is presented in Table 4.25. No rare or endangered species of trees were noticed during field studies. 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.

124. Common birds observed in the project area are pigeons, parrot, crows, and doves. The predominant mammals observed in the project area are mongoose, bat, Squirrel, monkey and mice etc. No rare or endangered species were noticed.

Table 4-25: Tree Cutting

S. No	Description	Number of Trees*
Corridor-4 (Light House to Poonamallee Bypass)		
1	Alignment	140
2	Poonamallee Bypass Depot	396
Sub-Total		536

**This figure will be confirmed upon completion of socio-economic survey, preparation of land plan and impact micro plan*

4.5 Socioeconomic Environment

4.5.1 Utilities

125. Corridor 4 is planned to run through the urban area above the ground i.e. elevated in less densely populated and underground in populated and sensitive areas. The alignment will cross drains, large number of sub-surface, surface and utility services, viz. sewer, water mains, storm water drains, telephone cables, overhead electrical transmission lines, electric pipes, traffic signals, roadside lights etc.

126. These utility services are essential and have to be maintained in working order during different stages of construction, by temporary/permanent diversions and relocation or by supporting in position. Any interruption to these will have serious repercussions on the most sensitive suburban services and direct impact on the public besides set back in construction and project implementation schedule & costs. Therefore, meticulous detailed survey and planning will be required to protect/divert the utility services. The utility maps and network information are attached in **Annexure 4**.

4.5.2 Physical Cultural Resources

127. No archaeological monuments/sites are located on or along the proposed corridors. Three draft lists of heritage assets in CMA are available (CMDA website). Phase I list which was sent in year 2013 comprised 20 assets in Grade I, 43 in Grade II and 3 in Grade III; Phase II list which was sent in year 2014 comprised 38 assets in Grade I, 3 in Grade II and none in Grade III; Phase III list which was sent in year 2016 comprised 29 assets in Grade I, 28 in Grade II and none in Grade III. In Grade I assets no interventions are permitted except to strengthen their life. In Grade II assets, internal changes and adaptive reuse will be generally allowed, but external changes will be subject to scrutiny; ensure the conservation of all special aspects. In Grade III assets, external and internal changes, and adaptive reuse would generally be allowed. Of these the following three are located close to the proposed alignment. These 3 heritage assets in Table 4.26 are as shown in photographs placed below.



Santhome Church



Rosary Church



Our Lady of Light Shrine

Table 4-26: Heritage Assets near the Alignment

S.no	Name of Heritage asset	Approx. distance from road Centre line followed by the C4 alignment (m)	Grade
1	National Shrine of Santhome Church, Santhome High Road, Santhome	1	I
2	Rosary Church, Rosary Church Road	1*	I
3	Our Lady of Light Shrine, Luz Church Road	73	I

Note: * Distance up to boundary is 1m, distance up to building is 17m.

4.5.3 Demographic Features

128. The Project will improve passenger transportation in Chennai Metropolitan Area which is projected to support resident population of 125.82 lakh in year 2026. As in year 2014, almost all households in the urban parts of the 3 districts contributing to CMA are supported by at least one employed person. In the project affected households, about 50% of are working on salary or daily wages or contract or job works, 40% are business owners; 17% of households are in vulnerable category comprising those below income poverty line (about 4%), socially weak communities and women headed households. The other socioeconomic baseline is described in the standalone Social Impact Assessment.

5. ANTICIPATED IMPACTS AND MITIGATION MEASURES

129. The potential impacts and risks were analyzed in the confines of Corridor 4 alignment's direct impact area, which is defined in this study as a strip of 15m, however, sensitive receptors located within 200m on either side of the alignment were identified. Influence area where most of the socio-economic and cumulative impacts will occur is defined as the entire confine of the area in Chennai city.

130. There are no environmentally sensitive areas along the alignment of the corridor 4 except about 410m length passing through CRZ IA and 932m length passing through CRZ II between Lighthouse station and Foreshore Estate Road station. CRZ IA comprising ecologically sensitive

features stretches from Anna memorial near Chintadripet which is located North of the project to Kottivakkam which is located South of the project. The CRZ II stretch is defined as areas that have already been developed up to or close to the shore-line, and shows no record of sensitive aqua fauna. The negative environmental impacts will mainly occur during construction work and noise impacts during operation phase. The significant impacts screened are:

- Loss of about 536 trees for construction of metro rail alignment as well as depot area.
- Subsidence, noise and vibration due to tunnelling boring machine (TBM), excavation machines, and materials hauling.
- Safety risks, inconvenience of traffic nuisance and poor accessibility due to road closures and diversions, noisy conditions etc. will also be created due to plying of large number of heavy trucks transporting construction material, equipment and machinery in and around the project area.
- Increased noise and air pollution resulting from traffic volume during construction.
- Increased local air pollution due to rock crushing, cutting and filling works, and chemicals from asphalt processing.
- Risks for damage to structures from vibration during construction and operation stages.
- 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.

5.1 Impacts Screening

131. Adverse impacts that are likely to result from Corridor 4 development have been listed in Table 5.1 under the following headings:

- Impacts and Mitigation Measures during Project Location and Design;
- Impacts and Mitigation Measures during Construction;
- Impacts and Mitigation Measures during Project Operation; and
- Impact and Mitigation Measures due to Depot.

Table 5-1: Impacts Screening

S.N.	Parameter	Adverse Impacts											Significance before mitigation	Residual impacts after mitigation		
		Duration			Extent			Intensity/Risk			Likelihood					
		S	T	P	O	L	C	L	M	H	U	L			D	
A.	Impacts due to Location and Design (Pre-Construction)															
1	Social Impact			*		*			*			*			Moderate	Minimal –ve
2	Impact on trees and ecosystems			*		*			*			*			Moderate	Minimal –ve
3	Impact on utilities			*		*			*			*			Major	None
4	Impact on Heritage assets		*		*				*			*			Minor	Minimal –ve
5	Flooding of project due to sea level rise resulting from climate change			*	*				*		*				Moderate	Minimal –ve
6	Flooding of project due to anomalous heavy rainfall		*			*			*	*					Minor	Minimal –ve
7	Earthquake Risk			*	*				*		*				Moderate	Minimal –ve
8	Alignment, Architecture and Station Planning			*	*				*			*			Moderate	Minimal –ve
9	Use of Energy, Water and materials			*	*				*			*			Moderate	Minimal –ve
11	Location of construction yards		*		*				*			*			Minor	Minimal –ve
12	Location of muck disposal sites			*		*			*			*			Moderate	Minimal –ve
B.	Impacts due to Project Construction															
1	Ambient Air Pollution		*			*			*			*			Moderate	None
2	Noise and Vibration		*			*			*			*			Major	None
3	Muck disposal			*			*		*			*			Major	Minimal –ve
4	Waste disposal			*			*		*			*			Moderate	None
5	Impacts due to labour camp		*			*			*			*			Moderate	None
6	Labour Safety		*		*				*			*			Moderate	None
7	Increased energy demand		*			*			*			*			Minor	None
8	Increased water demand		*			*			*			*			Minor	None
9	Impact on water and soil quality		*			*			*			*			Moderate	Minimal –ve
10	Ground subsidence			*		*				*		*			Moderate	None
11	Dewatering		*		*				*			*			Minor	None
12	Soil Erosion		*		*				*			*			Minor	Minimal –ve
13	Traffic and utility diversion		*			*				*		*			Major	None
C.	Impacts due to Project Operation															
1	Noise			*		*			*			*			Major	Minimal –ve

S.N.	Parameter	Adverse Impacts											Significance before mitigation	Residual impacts after mitigation	
		Duration			Extent			Intensity/Risk			Likelihood				
		S	T	P	O	L	C	L	M	H	U	L			D
2	Vibration			*		*			*				*	Major	Minimal -ve
3	Energy Consumption at stations			*		*			*				*	Moderate	Minimal -ve
4	Water supply and Sanitation at Stations			*		*		*					*	Moderate	Minimal -ve
5	Health and Safety			*	*				*			*		Moderate	Moderate -ve
6	Depot • Water supply • Sewage and Effluent • Oil Pollution • Noise • Surface Drainage • Solid waste • Loss of trees			*	*			*					*	Moderate	Minimal -ve
POSITIVE IMPACTS															
1	Employment Opportunities			*		*			*				*		Moderate +ve
2	Benefits to Economy			*		*			*				*		Moderate +ve
3	Direct benefits to passengers			*		*			*				*		Moderate +ve
4	Reduced fuel consumption			*		*			*				*		High +ve
5	Reduced air pollution			*		*			*				*		High +ve

Note:

Impact: +ve = positive; -ve = negative

Duration: S = Short-lived; T = Temporary; P = Permanent

Extent: O = on-site; L = Local; C: Chennai Metropolitan Area (regional)

Intensity: L = low; M = medium; H = high

Likelihood: U: unlikely; L: likely; D: definite

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

5.2 Impacts and Mitigation Measures during Project Location and Design Phase

133. 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 and Socio-economic impacts
- Loss of trees
- Loss of biodiversity
- Impacts on Utilities
- Impact on Physical Cultural Resources (PCRs)
- Climate Vulnerability
- Operational Noise and Vibration

5.2.1 Land Use and Socio-economic Impacts

134. The proposed project will require transfer of 34.23ha government land out of which 31.34ha is for Poonamallee depot and acquisition of 15.09ha private land out of which 7.64ha is for depot. 1,072 families comprising title holders, tenants and non-title holders who are residents physically displaced and business owners economically displaced due to acquisition of land and buildings will be affected by the project. These families comprise 1,565 persons. These figures will be revised upon completion of field socio-economic survey of affected families, revision of detailed drawings, preparation of land plan and micro plan of impacts.

5.2.2 Tree cutting

135. The land acquisition, resettlement and socio-economic impacts are assessed in the SIA report.

136. The construction of Corridor 4 will require cutting of about 536 public trees in total. None of trees to be cut are rare or endangered species. With removal of these trees, the process for CO₂ conversion will get affected and the losses are reported below:

- Total number of Trees : 536
- Decrease in CO₂ absorption due to loss of trees: 1,608 kg/year
- Decrease in Oxygen production due to tree loss: 5,896 kg/year

137. Amount of oxygen produced per tree per year for urban forests was adopted as 11 kg (Oxygen Production by Urban Trees in the United States, David J. Nowak, Robert Hoehn, and Daniel E. Crane, Arboriculture & Urban Forestry 2007). Based on model for tropical trees (Tree allometry and improved estimation of carbon stocks and balance in tropical forests, J.Chave et al, Oecologia 2005) and wood density for Asian species as per Food Agriculture Organization (FAO), CO₂ sequestered per year per tree has been estimated for this report as 3 kg for typical tree of 30 cm girth.

138. Location for compensatory plantation will be decided by CMRL in consultation with owner of the land as well Forest Department such that displacement does not become necessary. Tamil Nadu Forest Department, Government of Tamil Nadu is responsible for the conservation and management of the trees. It is found that about 536 trees are likely to be lost in the project under

line, stations and maintenance/stabling depot. It is proposed to plant twelve saplings for each tree to be cut. Hence 6,432 trees shall be planted. The native plant species and miscellaneous indigenous tree species are recommended for plantation.

139. At Panagal Park, an ecological restoration plan is required with a process of assisting the recovery of the ecosystem that will have been degraded, damaged or destroyed due to the construction of Corridor 4. Passive restoration actions may include fencing and signing sensitive areas during construction, which will minimize construction impacts. Active restoration actions include soil decompaction, revegetation, removal formal or informal trails out of sensitive area. These actions will accelerate ecosystem recovery and promote the health and longevity of the Panagal Park.

140. In addition to the compensatory plantation, green belt area can be developed for the total length of 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. In a case study of green belt in cement industry in India, ambient concentrations of SO₂ was found to reduce by 39%, NO_x by 40%, SPM by 37%, THC by 86%, CO by 93%, VOCs by 87.1% across the green belt and the overall air pollutant removal efficiency was calculated as 63% (Assessment of Carbon Sequestration Ability of Trees for Adopting in Green Belt of Cement Industries in Karnataka, March 2016, Central Pollution Control Board Zonal Office South). Thus the green belt will provide aesthetic view of elevated track and also helps to serve as dust and noise absorbent barrier.

141. Efforts will be made to minimize the cutting of trees by transplantation of the young trees. Transplantation will be done in coordination with the forest department.

5.2.3 Loss of Biodiversity

142. CMRL will obtain the CRZ clearance from TNCZMA prior to contractor's mobilization. CMRL will ensure the compliance of the general conditions and specific conditions set forth in the CRZ clearance.

143. Corridor 4 passes through Panagal Park which is a community park; underground station is proposed underneath with access on roads at its periphery. The station will be constructed by cut and cover, loss of trees and birds and animals dependent on trees will be dislocated. Lighting at Panagal Park and Natesan Park stations will be kept to the minimum and of frequencies and brightness which do not affect bird behavior. Construction and operation of the metro viaduct on these sections could disturb nesting and breeding due to noise.

144. Artificial Light at Night (ALAN) has been linked to important maladies such as cancer incidence and reduced skeletal muscle function. Effects of ALAN on wildlife have been recorded: influences on nest site selection by sea turtles, changes in the diversity and behavior of nocturnal moths, and alterations to ecological interactions of insects. Trees in close proximity to sources of artificial lights budburst earlier than trees away from lights. In birds, a positive phototaxis effect (attraction to lights) resulting in high mortality due to collision with illuminated buildings and windows. More subtle effects of light pollution on birds are also known, such as disorientation, alterations in reproductive physiology, disruption of circadian rhythms, and changes of flight behavior (Light pollution is greatest within migration passage areas for nocturnally-migrating birds around the world, Sergio A. Cabrera-Cruzetal, Scientific Reports volume 8, Nature). Independently the elevated structure could impede flight of birds.

5.2.4 Impacts on Utilities

145. Corridor 4 is planned to run through the urban area above the ground i.e. elevated in less densely populated and underground in populated and sensitive areas. The alignment will cross drains, large number of sub-surface, surface and utility services, viz. sewer, water mains, storm water drains, telephone cables, overhead electrical transmission lines, electric pipes, traffic signals, roadside lights 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.

146. The Organizations / Departments responsible for concerned utility services are reported in Table 5.2.

Table 5-2: Organizations Responsible for Utilities and Services

S.no	Organization/ Department	Utility/Services
1.	PWD / Chennai Municipal Corporation	Road
2.	Chennai Municipal Corporation/ Chennai Metro Water Supply and Sewerage Board (CMWSSB)	Sewerage and drainage lines. Water mains and their service lines, including hydrants and fountains etc., water treatment plants, pumping stations, Roads, surface water drains, nallahs, sewer lines, streetlights, high mast lights etc.
3.	NHAI	National Highways
4.	TNHD	State Highways
5.	BSNL (OFC and Telephone Cables)	Tele cables, junction boxes, telephone posts, O.H lines
6.	Airtel, Vodafone, Idea, Jio	Telecommunications cables, junction boxes, telephone posts, etc.
7.	Power Grid Corporation of India Ltd.	HT towers, cables
8.	Irrigation Dept.	Canal
9.	BPCL	Gas pipelines
10.	Gas Authority of India (GAIL)	Gas pipelines
11.	Chennai Corporation and Tamil Nadu Generation and Distribution Corporation Limited (TANGEDCO)	HT/other overhead Power lines

147. During construction phase there will be great amount of issues encountered for the utility system/infrastructure facilities already existing within the alignment. The most important and hazardous aspect will be pipelines 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 by contractor and CMRL during pre-construction 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.

148. The alignment of the metro will negotiate a number of utilities which will have to be maintained in working order during construction. They may require temporary or permanent diversion subject to their depth, details such as piling configuration or span of viaduct, utility protection measures, etc. Utility lengths to be diverted are as follows: sewer and water supply

lines (depth 2.5m below ground) 3,420m and 15,000m between Lighthouse and Meenakshi College, and Power House and Poonamallee Bypass respectively; telecom cables (depth 1m to 4m below ground) 40,919m and 185,990m respectively; above ground HT/LT electric cables 22,888m Power House and Poonamallee Bypass.

149. Delayed approvals and diversion of utilities can affect construction schedule while damage to utilities can cause disruption to essential services to the citizens. Ahead of start of construction on the respective sections, diversion plans will have to be prepared based on updated location drawings and concurrence of respective agencies. Preferably they will have to be diverted by the agencies themselves.

150. Span and pile arrangement of the viaduct may be suitably adjusted to ensure that pier foundations do not foul with major underground utilities. They will be diverted either temporarily or permanently before or during construction in those sections where the alignment cannot be fine-tuned to avoid conflict with utilities.

5.2.5 Impacts on PCRs

151. No archaeological monuments / sites are located on the project corridor. The following three assets are located within 75m from the alignment.

Table 5-3: Heritage assets near the alignment

No	Name of heritage asset	Approx. distance from road followed by the alignment (m)
1	National Shrine of St. Thomas Basilica, Santhome High Road, Santhome	1
2	Rosary Church, Rosary Church Road	1
3	Our Lady of Light Shrine, Luz Church Road	73

152. The alignment will be fine-tuned, if feasible, to steer away from heritage assets on Corridor 4.

153. Since the project involves cut & cover, and piling for piers there are possibilities that contractor may encounter artifacts during piling operation. Chance find measures are included in the EMP to minimize the impacts on historical / archeological artifacts, in case found during excavation work. CMRL will inform and coordinate with Archaeological Survey of India if any ancient remains are encountered during construction work.

154. In locations where alignment is within 75m (as per the reference distance of acceptable vibration impacts) to historical/heritage structures, the contractor shall prepare a monitoring scheme prior to construction at such locations. This scheme for monitoring subsidence and vibration level at such historical / heritage sites shall be submitted to CMRL for approval. The scheme shall include:

- Monitoring requirements for vibrations at regular intervals throughout the construction period.
- Pre-construction structural integrity inspections of historical / heritage / sensitive structures in the project area, especially for any buildings the TBM will pass nearby.
- Information dissemination about the construction method, probable effects, quality control measures, and precautions to be used.

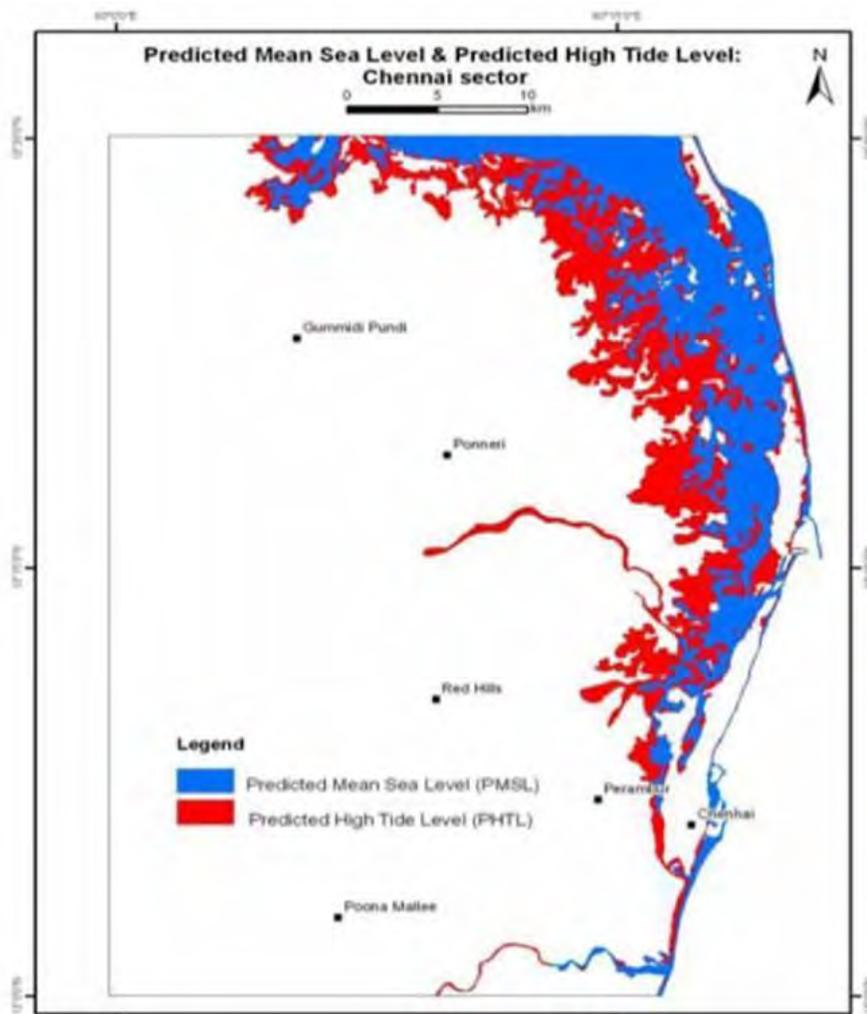
155. The vibration level limits at work sites adjacent to the alignment shall conform to the permitted values of PPV.

5.2.6 Climate Vulnerability

5.2.6.1 Sea level rise due to climate change

156. Vulnerability of project to rise in mean sea level (submergence) and high tide level (degradation) on the project is indicated in Figures 5.1 and 5.2. Belt of width approx. 0.5 km of beach and developed area on alignment between Lighthouse and Kutcheri Road is underground and can be subject to flooding disrupting operations. On Corridor 4, flooding gates and other adequate facilities will be made in terms of evacuation of flood water using pumps in Lighthouse, Foreshore Road stations. Disaster management plan will pay special attention to flooding.

Figure 5-1: Predicted MSL and HTL in Chennai Sector



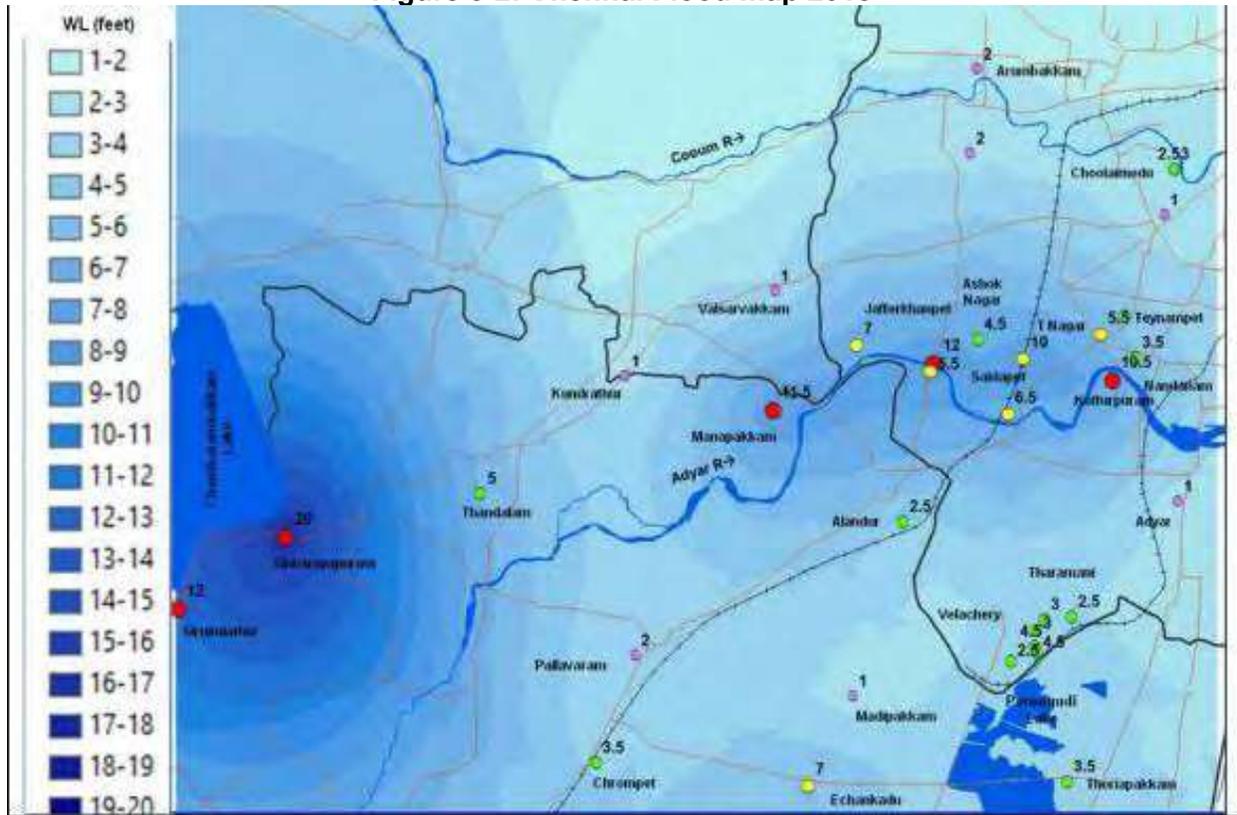
Source: Coastal Zones of India, SAC ISRO- MoEF&CC, 2012

5.2.6.2 Flooding resulting from Anomalous Heavy Rainfall

157. In year 2015 Chennai was flooded due to exceptionally heavy rainfall. Flooding was observed in areas adjoining Adyar river though lesser along Cooum river. Most of the alignment

of Corridor 4 is not located near these rivers¹⁶ and therefore flooding is not a likely impact. Figure 5.2 depicts the inundated areas.

Figure 5-2: Chennai Flood map 2015



Source: Chennai Floods, 2015 A Satellite and Field Based Assessment Study, Disaster Management Support (DMS) Division National Remote Sensing Centre (NRSC / ISRO) Hyderabad, India

5.2.6.3 Risk Due to Earthquake

158. Although Chennai is located in Moderate Seismic Zone, different parts of Chennai have variable potential for seismic hazard. Corridor 4 is located in moderately to above moderately vulnerable seismic micro zones.

159. Design of line structures – tunnel and viaduct – and station shall be done to facilitate robust safety and quicker evacuation. Stipulation of Bureau of Indian Standards engineering codes shall be met while designing the structures while taking into account micro zonation of Chennai in terms of seismic risk.

5.2.7 Operational Noise and Vibration

160. As part of the detailed design a noise and vibration modeling and assessment along the alignment should be conducted prior to start of construction by CMRL and contractor. At sensitive receptor locations within 50 m along the alignment (where operational stage noise level is expected to be higher than permissible limits). Appropriate mitigation measures including

¹⁶ Proposed Adyar gate Junction station is about 600 meters away from Adyar River, according to figure 5.2 that area had up to 3.5 feet of water during the 2015 floods.

possibilities of installing noise barriers at sensitive receptor locations shall be determined by CMRL and contractor and agreed by MDBs.

Residual impacts – Location and design

161. The following residual impacts are expected to derive from the pre-construction stage:

- Social impact. 34.23ha government land and 15.09ha of private land will be acquired and 1072 families will be impacted. The project affected people will be duly compensated as laid down in the Resettlement Plan for the project. Residual impact is expected to be minimal negative.
- Loss of trees and impact on ecosystem. An estimated 536 trees will be felled for the project. Compensatory plantation will be done in a ratio of 12 saplings against each tree felled. However because of the time it will take for the saplings to mature the short term residual impact will be minimal negative. Once the saplings have matured the residual impact will be positive.
- Impact on utilities. A great amount of issues with the utility system/infrastructure facilities already existing within the alignment is expected to be encountered. However by adjusting span and pile arrangement of the viaduct and temporarily or permanently diversion of utilities in those sections where the alignment cannot be fine-tuned, the residual impact can be reduced to nil.
- Heritage assets. Three assets are located within 75 meter of the alignment. In order to reduce the risk of damage to the assets the contractor shall perform pre-construction structural integrity inspections and prepare a monitoring scheme for monitoring subsidence and vibration level for these locations prior to construction. Residual risk is expected to be minimal negative.
- Flooding due to sea level rise. Part of the underground section is within 500m from the sea and can be subject to flooding disrupting operations. Flood gates and other adequate facilities will be made in terms of evacuation of flood water using pumps in Lighthouse station. Disaster management plan will pay special attention to flooding. With these additional measures the residual impact will be minimal negative.
- Flooding due to rainfall. Most of the alignment is not located near rivers and therefore flooding due to rainfall is not considered a big risk. In order to minimize the impact of potential flooding the entry structures of the metro are envisaged to be raised to 0.6 – 1 m above high flood level. With these measures in place the residual risk of flooding due to rainfall will be minimal negative.
- Earthquake risk. Corridor 4 is located in moderately to above moderately vulnerable seismic micro zones. Design of tunnel, viaduct and station shall be done to facilitate robust safety and quicker evacuation. Stipulation of Bureau of Indian Standards engineering codes shall be met while designing the structures. Residual risk will be minimal negative.
- Alignment, Architecture and Station Planning. 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. Since a low profile would cause the least intrusion, the basic elevated section has been optimized at this stage itself. Residual impact is expected to be minimal negative.
- Use of energy, water and materials. The project will use large amounts of construction material and thus will deplete construction material sources to a certain extent. Materials shall be sourced from the nearest source and from legalized and approved quarries. Requirement of electricity will be optimized by proper use of natural day/night light. Full height platform screen doors will be implemented so as to conserve energy for ventilation

and air conditioning in underground stations. Green Building features will be implemented in station design. Residual impact is considered minimal negative.

- Location of construction yards and muck disposal sites. Locations will be sought that are away from residential areas, water bodies and environmentally or ecologically sensitive areas. It cannot be ruled out that construction yards and muck disposal sites could cause a change in drainage patterns around the sites. When sites are carefully selected the residual impact will be minimal negative.

5.3 Impacts and Mitigation Measures During Construction Phase

162. 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:

- Storm water drainage and topsoil erosion
- Traffic diversion and risk to existing building
- Air pollution due to dust generation
- Noise and vibrations
- Increased energy demand and impacts on Water
- Impact due to supply of construction material
- Disposal of construction and demolition waste
- Disposal of Hazardous Waste
- Dewatering of Excavations
- Ground subsidence
- Dewatering
- Impacts due to batching plant and casting yard
- Impacts of labour camps
- Health and Safety

5.3.1 Soil Erosion Impact

163. 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 groundwater pollution.

164. Corridor 4 will have elevated track and there are 12 elevated stations. Soil excavation will be required for piling activities for metro piers. Muck from tunneling containing Bentonite would also be generated in the project.

165. Mitigation measures: The excavated soil would be used for refilling at station site but muck from piling work will be disposed at locations/sites approved by Tamil Nadu Pollution Control Board. Responsibility of disposal of this soil will lie with contractor and will be regulated by TNPCB rules. Disposal of Bentonite would be at designated landfill site.

166. The construction activities will cause 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.

167. Subject to specifications issued by CMRL in the works contracts, the earth excavated during cut and cover and tunneling and displaced during piling will be used as backfill on the project. Such backfill will result in estimated surplus quantity of 0.94 million cum from Corridor 4. If this muck is not contaminated by hazardous substances such as heavy metals or POPs¹⁷, the contractor will be permitted to sell it as fill for activities outside the project; in case of hazardous contamination it will be disposed at permitted sites by licensed vendors.

168. Sites for muck disposal will be decided by CMRL before start of construction in consultation with TNPCB, Municipal Corporation/Municipalities and CMDA. The sites will be located away from residential areas, water bodies and ecologically sensitive locations as to avoid disrupting natural drainage.

169. Material will be stabilised by watering or other accepted dust suppression techniques. The muck shall be filled in the dumping site in layers and compacted mechanically. Suitable slopes will be maintained on the stockpile. Once the filling is complete, it will be protected by low walls, provided with a layer of good earth on the top and covered with vegetation. A muck disposal plan will be prepared by Contractor, which will be approved by CMRL.

5.3.2 Traffic Diversion and Risk to Existing Buildings

170. During construction period, complete/partial traffic diversions on road will be required, as most of the construction activities are along the road. In order to retain satisfactory levels of traffic flow during the construction period, traffic management and engineering measures need to be taken. They can be road widening, traffic segregation, one-way movements, traffic diversions, acquisition of service lanes, etc.

171. Preparation of Traffic management Plan and maintenance of diverted roads in good working condition to avoid slow down and congestion shall be a prerequisite during construction period.

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

- The requirement would be mainly along the central verge/ side of the road
- As regards to the alignment cutting across a major traffic corridor, 'Box Girder Construction Technology' would be applied to prevent traffic hold-ups or diversions of any kind
- Cut and cover at underground stations will be employed to ensure that traffic impedance is minimized

173. **Traffic Management Guidelines:** The basic objective of the following guidelines is to lay down procedures to be adopted by contractor to ensure the safe and efficient movement of traffic and also to ensure the safety of workmen at construction sites. The Contractor shall develop detailed and robust traffic management plans consistent with the Indian Roads Congress (IRC) on Traffic Management in work zones (IRC:SP:55-2014), prior to mobilization for respective sections with site- or station-specific plans and measures to minimize the overall impact on traffic throughout the construction and operation periods.

- All construction workers should be provided with high visibility jackets with reflective tapes as most of viaduct and station works are on the right-of-way. The conspicuity of workmen at all times shall be increased so as to protect from speeding vehicular traffic.

¹⁷ Methods Manual of Soil Testing in India from Ministry of Agriculture or any other internationally recommended guideline/standards will be used for the soil investigation.

- Warn the road user clearly and sufficiently in advance.
- Provide safe and clearly marked lanes for guiding road users.
- Provide safe and clearly marked buffer and work zones
- Provide adequate measures that control driver behaviour through construction zones.
- The primary traffic control devices used in work zones shall include signs, delineators, barricades, cones, pylons, pavement markings and flashing lights.
- Advance traffic updates/ information on communication systems for users of affected roads.
- Efforts will be given to divert traffic to roads wide enough to accommodate extra traffic.
- Incorporation of community safety considerations into plan design, especially at locations such as Kutchery Road where buildings are close to the construction site.

174. Corridor 4 does not pose any serious risk to existing buildings since there is safe distance between buildings and proposed alignment 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.

5.3.3 Air Pollution

175. The major sources of ambient air pollution are demolition of structures to be removed; operation of construction equipment; installation of earth retaining structures, pile driving where cast-in-situ is not feasible, blasting in rock; movement of vehicles transporting construction materials, muck and waste. The pollution is in terms of fugitive dust and emissions from trucks.

176. Trucks are required to transport raw material to casting yards and Ready Mix Concrete (RMC) plants; from pre-cast yards and batching plants to construction site and between construction site and muck/waste disposal site. Vehicular emission is estimated as in Table 5.4.

Table 5-4: Emissions due to truck movement during demolition and

Pollutant	Emission (ton)
Carbon Monoxide (CO)	63.00
PM _{2.5}	2.0
Hydro-Carbons (HC)	2.0
Nitrogen Oxide (NO _x)	131.0
VOC	20.0
Carbon dioxide (CO ₂)	8145

177. Emissions from DG sets, pollution at sites of waste disposal and muck disposal during unloading and stacking, emissions from fuel and other hazardous chemicals are among other sources of air pollution.

178. Air pollution from road based vehicles especially particulate is found to cause diseases of brain, heart, lungs and kidneys.

179. Mitigation measures which will be adopted to reduce the air pollution are listed below:
- Contractor's transport vehicles and other equipment shall conform to emission standards. The Contractor shall carry out periodical checks and undertake remedial

- measures including replacement, if required, so as to operate within permissible norms.
- Procedure for truck maintenance, including selection of service providers considering environmental aspects, application of low-Sulphur fuel, no idling of trucks, routine maintenance (including assurance of proper engine operations related to emissions and noise), and disposal of used oil and other fluids, batteries, and tires etc. □ DG sets compliant with emission standards will be used □ The following dust protection methods will be used:
 - Dust screens during excavation and demolition near sensitive receptors
 - Dust filters atop cement silos
 - Wet suppression for aggregate crushing and screening
 - Good quality project roads with added petroleum emulsions and adhesives, speed control, traffic control.
 - Material of specifications as per contract will be procured by Contractor from Government-approved quarries
 - The Contractor will ensure that trucks carrying loads of sand and aggregate required in construction being transported to construction yards are covered and loaded with sufficient free - board to avoid spills--within the largest compartment of tanker truck. Transportation will be scheduled by time and route to minimize air pollution in habitat areas.
 - The Contractor will ensure that the authorized vendor covers loads of construction and demolition (C&D) waste and hazardous waste being transported from construction sites. All trucks carrying loose material should be covered and loaded with sufficient free - board to avoid spills through the tailboard or sideboards. Containers carrying hazardous waste are loaded onto trucks with due care to avoid escape of fumes or spillage enroute. Transportation of muck and waste will be scheduled by time and route to minimize air pollution in habitat areas. The contractor will implement similar safeguards while transporting muck.
 - The temporary muck storage areas will be maintained by the Contractor at all times until the excavate is re-utilized for backfilling or as directed by GC. Dust control activities will continue even during any work stoppage. 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 lying area where it is necessary.
 - The Contractor will provide a wash pit or a wheel washing and/or vehicle cleaning facility at the exits from construction depots and batching plants. At such facility, highpressure water jets will be directed at the wheels of vehicles to remove all spoil and dirt.
 - Construction yards with aggregate crushing and screening, pre-casting, material and fuel storage and GC plants will be located away from habituated or ecologically sensitive areas.
 - Labour residing in camps will be provided with LPG fuel for cooking.

5.3.4 Noise and Vibrations

180. Noise is a contributing factor to degradation of human health. The noise pollution will be generated by construction activities, mainly due to demolition of structures to be removed; installation of earth retaining structures; pile driving where cast-in-situ is not feasible; blasting in rock etc., and also due to the construction equipment 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. Corridor 4 construction is equipment intensive.

5.3.4.1 Noise Due to Operation of Construction Equipment

181. The major sources of noise during construction phase are due to operation of various construction equipment. Permitted number of impacts (example piling) at various noise levels is prescribed under Model Rules of the Factories Act, 1948. Actual noise from construction equipment (Lmax) measured at 50 feet distance (*Construction Noise Handbook August 2006, FHWA, USA*) ranged from 76 dB(A) to 84 dB(A); vibratory pile driver at 101 dB(A). The noise levels generated by various construction equipment are given in Table 5.5.

Table 5-5: Average Noise Levels Generated by Operation of Various Construction Equipment

Equipment	Typical Noise Level (dBA) at 50 ft from source
Air Compressor	81
Backhoe	80
Ballast Equalizer	82
Ballast Tamper	83
Compactor	82
Concrete Mixer	85
Concrete Pump	82
Concrete Vibrator	76
Crane Derrick	88
Crane Mobile	83
Dozer	85
Generator	81
Grader	85
Impact Wrench	85
Jack Hammer	88
Loader	85
Paver	89
Pile Driver (Sonic)	96
Pneumatic Tool	85
Pump	76
Rock Drill	98
Roller	74
Scraper	89
Shovel	82
Truck	88

Source: FTA Transit Noise and Vibration Guidance Handbook, May 2006

Equipment	Actual Lmax Noise Level (dBA) at 50 ft from source
Auger drill rig *	84
Compressor *	78
Dump truck *	76

Equipment	Actual Lmax Noise Level (dBA) at 50 ft from source
Excavator *	81
Flatbed truck *	74
Front end loader *	79
Vibratory Pile driver *	101
Press Pile	70
Batching Plant	90
Booster pump	80

* Source: Construction Noise Handbook, US FHWA, Aug 2006

5.3.4.2 Noise due to increased vehicular movement

182. 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. 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. During construction phase, the increase in vehicular movement is expected to increase up to a maximum of 5 to 6 trucks/hour. Table 5.6 presents the typical increase in ambient noise level due to increased vehicular movement if the background noise level is at 36dB(A).

Table 5-6: 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

5.3.4.3 Impacts of Noise on Labour

183. 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 5.7).

Table 5-7: 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

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

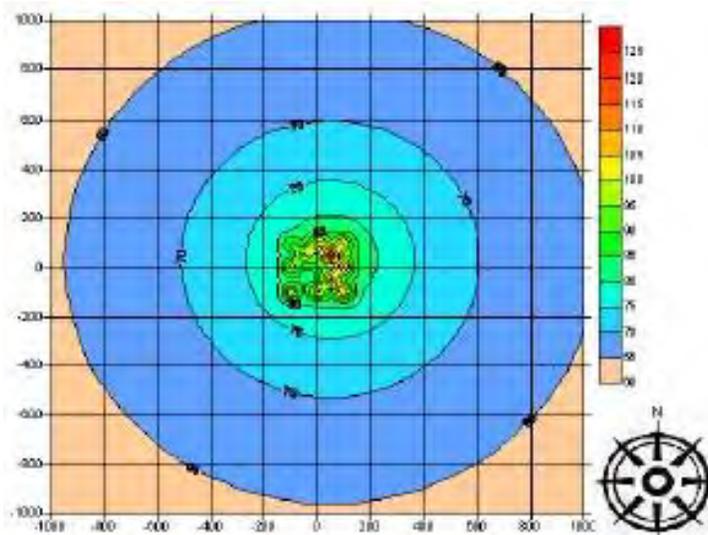
184. To reduce the harmful effects, personnel working at high noise levels would be provided with noise protective gears such as ear muffers, sound barriers etc. Vehicles used for transportation of construction materials would be equipped with silencers. Careful planning has been made to operate the construction equipment to have minimal disturbances. The construction equipments will be in use during the daytime and their noise levels would be monitored as per CPCB standards. Besides other measures such as use of low-noise equipment and ensuring good maintenance, trying to avoid using high-noise equipment simultaneously at the same section etc. will also be implemented to minimize construction noise.

185. Exposure of workers to high noise levels will be minimized by measures such as the following:

- Personal protective equipment such as passive or active ear-muffs
- Use of electric instead of diesel powered equipment
- Use of hydraulic tools instead of pneumatic tools
- Acoustic enclosures for noise generating construction equipment like DG sets
- Scheduling work to avoid simultaneous activities that generates high noise levels
- Job rotation
- Sound-proof control rooms
- Automation of equipment and machineries, wherever possible.

5.3.4.4 Predicted Noise Level during Construction Stage

Figure 5-3: Spatial Variation of Construction Equipment Noise Levels dB(A)



186. Noise modelling during construction phase was carried out using CPCB/ MoEF&CC approved noise model “DHWANI” assuming that all the equipment emit noise simultaneously considering as worst-case scenario. The spatial variation of the predicted noise levels at an interval of 5 dB(A) without control around the project site on the area of 1 km x 1 km are shown in Figure 5.3. Modelling result shows that noise level meets the Ambient Noise Quality Standards (ANQS) 55 dB(A) (average between 6 am to 10 pm) at a distance of about 900m. Uncontrolled noise levels generated from construction equipment, in the range of 94-124 dB(A) have been considered for prediction purpose. However, the CPCB standards specify to limit the construction equipment to ensure that noise emission specifications for such equipment should not exceed 75 dB(A). The noise levels predicted here is without mitigation measures. It is assumed that with the adoption of the mitigation measures noise levels will be further restricted within very short distances from the source. With respect to occupational exposure, the permissible threshold is 90 dB(A) (continuous exposure over 8 hours). Thus, based on the modelling results it can be concluded that all sensitive receptors (i.e. labour colonies) should be located beyond 125 meters from the noise generating source location during construction activities.

187. Further noise modelling will be conducted, based on the detailed engineering design to inform the incremental impacts and suggest the mitigations accordingly.

5.3.4.5 Vibration during Construction Stage

188. Pile driving for viaduct piers and buildings and tunnel driving generate vibrations. Apart from distance from the alignment, age and condition of buildings adjacent to the alignment determines extent of damage to such buildings due to vibration. Continuous effect of vibration on the buildings can cause damage to buildings. Buildings subjected to the vibration of more than 150 VdB might be subjected to structural damage. Historic buildings are more susceptible to vibration effect due to type of building material and design. Corridor 4 is located in moderately to above moderately vulnerable seismic micro zones.

189. In order to evaluate the construction stage vibration levels from the project construction activities, the Construction Vibration Damage Criteria set by FTA for different building category is referred in Table 5.8 below.

Table 5-8: Construction Vibration Damage Criteria as per FTA guidelines

Building Category	PPV (in/s)	PPV (mm/s)	Approximate Lv, RMS velocity in decibels (VdB) re 1 µin/s.
I. Reinforced-concrete, steel or timber (no plaster)	0.5	12	102
II. Engineered concrete and masonry (no plaster)	0.3	7.6	98
III. Nonengineered timber and masonry buildings	0.2	5	94
IV. Buildings extremely susceptible to vibration damage	0.12	3	90

190. During construction of the underground section, TBM will be used. With a tunnel depth of approximately 25 m (vertical distance between tunnel top and floor of building above ground), the expected vibration level during operation of the TBM is approximately 99VdB in conditions of sandy and clay soil which is dominant in the project area. Attenuation of vibration is expected to

be about 16 VdB resulting in a net vibration at the ground floor of the building above ground to be about 83 VdB.

191. According to the FTA manual the threshold level of vibration for beginning to cause annoyance to human beings is about 75VdB and for causing damages to extremely fragile structure is about 90 VdB. Given that the expected vibration level at the ground floor is about 83 VdB, people living in the ground floor of houses located immediately above the tunnel will feel the vibration and may get annoyed when the TBM is operational. However, it is unlikely that any structural damages will take place.

192. In the case of vibrations from road traffic and pile driving, very deep barriers (in excess of 10 m) were found to reduce vibration. In-ground barriers are trenches that are either left open or filled with a material (such as bentonite or concrete) that has stiffness or density significantly different from that of the surrounding soil. However, trenches may be too costly for situations involving houses. They could perhaps be justified for larger buildings with strict vibration limits, such as operating theatres of hospitals or high-tech factories with sensitive processes. An economical alternative to trenches in a residential area could be a row of lime or cement piles of diameter 0.5 m to 1 m and a depth of 15 m in the right-of-way adjacent to the road. However, the effectiveness of such pile-walls has not yet been demonstrated¹⁸. Cast-in-situ piling will be deployed at locations with sensitive receptors so as to reduce vibration. At locations where the alignment is close to sensitive receptors, the contractor shall implement:

- The detailed noise and vibration analysis (mathematical modelling) at sensitive receptors based on final engineering designs should be carried out, based on which, a set of mitigations should be prepared and shared with all lenders for review, prior to commencement of construction
- Pre-construction structural integrity inspections, including visual inspections of buildings of cultural or historical significance
- The sensitive receptors 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
- Information dissemination about the construction method, probable effects, quality control measures and precautions
- Monitoring during construction

193. Further vibration modelling will be conducted, based on the detailed engineering design to inform the incremental impacts and suggest the mitigations accordingly.

5.3.5 Increased Energy Demand and Impacts on Water

5.3.5.1 Increased Energy Demand

194. Construction employs energy intensive equipment round the clock. High illumination lighting and minor tools and equipment impose increased demand on energy consumption due to construction.

195. The contractor shall use and maintain equipment so as to conserve energy and shall be able to demonstrate the abovementioned upon request of CMRL. Measures to conserve energy

¹⁸ NRC-CNRC Construction Technology Update No. 39, 2000, Vibrations in Buildings by Osama Hunaidi and A review on the effects of earth borne vibrations and the mitigation measures, BOO Hyun Nam et al, IJR International Journal of Railway, Sept 2013.

include maintenance of energy efficient tools, plant and equipment of; lamps and DG sets to comply with TNPCB norms; Promoting awareness through energy saving trainings.

5.3.5.2 Increased Water Resource and Quality

196. 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 from CMWSSB supply, or treated effluent from ETPs located nearby or seawater or surface run off in view of the quality requirements of construction based contractor-defined estimated volumes. Water consumption during construction is of the order of 433 KLD for Corridor 4.

197. Construction materials, oils and greases from construction sites; used water from the RMC plant; water used for dust suppression at aggregate crushers are sources of pollution of surface water bodies or groundwater. Sewage from labour camp can also pollute surface water bodies or groundwater. Groundwater which seeps into excavations can get contaminated by chemicals used in construction and consequently pollute groundwater outside the excavations upon dewatering. This water will be treated to meet CPCB standards and added to groundwater to recharge.

198. Wastewater from labour camps, construction sites and construction yards will be treated by means including precipitation chambers before disposal into sewage system. Dewatered water will be used for dust suppression purpose, and the remaining will be suitably treated before recharging groundwater or discharging into storm water drain.

5.3.6 Impact Due to Supply of Construction Material

199. Corridor 4 construction is a material intensive activity. Huge quantity of different construction materials will be required for construction of elevated section and stations. 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.

5.3.7 Disposal of Construction and Demolition Waste

200. Waste construction material, demolition waste and hazardous waste from construction equipment and construction vehicles can pollute air, water and soil. The procedure of demolition will be conducted as per the demolition plan prepared by the Contractor in consultation with CMRL. The existing structures should be demolished one after another cautiously.

201. C&D waste is part of solid waste that results from land clearing, excavation, construction, demolition, remodeling and repair of structures, roads and utilities. C&D waste has the potential to save natural resources (stone, river sand, soil etc.) and energy, its bulk which is carried over long distances for just dumping, its occupying significant space at landfill sites and its presence impedes processing of bio-degradable waste as well as recyclable waste. C&D waste generated from metro construction has potential use after processing and grading. The contractor will segregate and temporarily store the C&D waste till the vendor takes it away for recycling and disposal at authorized facilities.

202. Mitigation Measures: The C&D waste would be handled and disposed of to waste processing facility or for back filling of low lying areas only if the area is covered afterwards with a good quality layer of topsoil of sufficient thickness, leaving no significant impact on environment. Bentonite slurries used in diaphragm wall construction should be reconditioned and reused wherever practicable. The disposal of residual used bentonite slurry should follow the international good practice.

5.3.8 Disposal of Hazardous Waste

203. Hazardous waste would mainly arise from the maintenance of equipment which may include used engine oils, hydraulic fluids, waste fuel, spent mineral oil/cleaning fluids from mechanical machinery, scrap batteries or spent acid/alkali, spent solvents etc.

204. The disposal of the hazardous waste should be as per the requirements given in the Hazardous Waste Management Rules 2016. The contractor will ensure that hazardous wastes from construction activity and equipment are labeled, recorded, stored in impermeable containment and for periods not exceeding mandated periods and in a manner suitable for handling storage and transport. The contractor shall maintain a record of sale, transfer, storage of such waste and make these records available for inspection. The contractor shall get Authorized Recyclers to transport and dispose Hazardous Waste, under intimation to the Project Authority.

5.3.9 Ground Subsidence

205. Tunnel roof caving could cause ground subsidence above the tunnel resulting in settlement damage to structures on ground.

206. Proposed track depth is 18m to 20m; water table is between 1m to 10m; rock is available deeper than 20m between Kutchery Road and Thirumayilai stations, Adyar gate to Alwarpet, Kodambakkam suburban and Vadapalani and less than 20m depth at other locations on Corridor 4; soil is pervious (*source: geotechnical investigations along Corridor 4 in year 2016 and scheduled groundwater monitoring by Central Groundwater Board in years 2014 to 2016*).

207. During tunneling, material under pressure might come out of open borewells in the vicinity of the tunnel site resulting in ground subsidence beneath nearby structures (in case of Phase 1 Metro those within 16.5 m on either side of centerline of tunnel); therefore artesian wells and borewells in path of tunnel will be sealed. They will be permitted at least 3m on either side of the tunnel width, as in case of Phase 1 Chennai Metro.

208. Ground subsidence around tunnel sections could occur during tunneling due to ground water seeping into tunnel resulting in groundwater drawdown around the tunnel zone: such seepage along with existing water in tunnel will be removed ('dewatering'). Similar groundwater loss could occur during construction of underground stations by cut and cover. Groundwater drawdown will also temporarily reduce availability of groundwater for domestic consumption.

209. Groundwater extraction adjacent the metro project could lead to subsidence under non-metro structures as well as settlement of metro tunnel and stations between Kutchery Road and Thirumayilai stations, Adyar gate to Alwarpet, Kodambakkam suburban (rock deeper than track level). Therefore, it is recommended that locations of boreholes need to be rationalized to avoid groundwater extraction near tunnel.

210. Groundwater drawdown can be minimized by sealing joints in tunnel lining. In addition, where required adjacent structures will be given additional supports. Sides of deep excavations at stations will be supported by walls which minimize water seepage. In open areas where side support walls in excavations are feasible, such walls will help prevent caving and thereby settlement of adjacent structures; in built up areas where side walls are not feasible, adjacent structures will be provided additional supports.

211. Subsidence under nearby structures could occur due to strata disturbance and loss of bearing capacity of soil under foundations of nearby buildings: this shall be monitored and where required the structures will be provided additional support.

212. Caving of tunnel will be prevented by placing pre-cast concrete segments in soft soils and rock bolts or arch ribs in rock. Subsidence above tunnel due to removal of material and water beneath will be prevented by such tunnel support

5.3.10 Dewatering of Excavations

213. Table 5.9 shows groundwater levels up to 10m below ground in pre-monsoon as well as post-monsoon seasons and rise in water level of up to 4m in 80% to 90% of observation wells in Chennai district between pre-monsoon and post-monsoon months. It indicates that significant dewatering of excavations might be required.

Table 5-9: Ground water level in Chennai District

Month/year	% of observation wells in each range of water level (m) below ground level			Rise (m) in water level	Fall (m) in water level
	0 to 2	2 to 5	5 to 10		
May 2013	8	54	38	60% wells <2m, 30% wells 2m to 4m	100% wells <2m
January 2014	36	36	29		
May 2014	14	33	53	50% wells <2m, 30% wells 2m to 4m, 20% wells >4m	Zero
January 2015	56	25	19		
May 2015	14	50	36	60% wells <2m, 30% wells 2m to 4m, 10% wells >4m	Nil
January 2016	41	47	12		
May 2016	24	59	17	83% wells <2m	86% wells <2m
January 2017	14	79	7		

(CGWB Yearbooks for Tamil Nadu and Puduchery)

214. The dewatering of tunnel muck will be conducted prior to transportation to the muck disposal site. The muck disposal plan will contain detailed requirements of such activity.

215. Chemicals used in tunneling could result in pollution of seepage water and further contaminate the groundwater or surface water into which this water is discharged: polyurethane resin used to seal water leaks through tunnel segments is toxic to aquatic life with long lasting effects (ECHA). Bentonite used to seal infiltration of water through soil is not classified as harmful. Polymers are used to facilitate tunneling in clayey soils. This water will be treated and added to groundwater to recharge.

5.3.11 Impacts Due to Batching Plant and Casting Yard

216. 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 CMRL away from habitation. If possible, these facilities will be located at least 500 m away from habitations and at least 1 km away from environmentally or ecologically sensitive area.

217. 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 for different aspects, such as the soil and groundwater quality baseline shall be collected by contractor prior to mobilization and shall be monitored during construction, have been elaborated in EMP.

5.3.12 Impacts of Labour Camps

218. During the progress of the work, the construction contractors work activities provides the erection and to maintain the necessary (temporary) living habitats and allied facilities for the workforce up to their living standards and scales up to be approved by CMRL. Improper disposal of municipal solid waste generated by labour camps can pollute surface water bodies and groundwater. Burning of waste can cause air pollution. Construction workers are more prone to infectious diseases due to unsafe sexual activity and lack of sanitation facilities (water supply and human waste disposal) and insect vectors. Problems could arise due to cultural differences between workers from outside and local residents.

219. Per Building & Other Construction Workers (BOCW Regulation of Employment and Conditions of Service) Act, 1996 the employer (contractor) is liable to arrange for sanitation, health care facilities of labours, free of charge. Labour camps will be in full compliance of BOCW Act.

220. It is estimated that about 4,284 persons will work during peak construction activity on 50% sections of the corridors on site, in casting yards and depots. Estimated total population in the labour camps will be 4,284. The water requirement at camps will be 578 KLD, wastewater generation 492 KLD & municipal solid waste generation 1.3 ton per day. This is tentative and will vary depending on the construction schedule during construction.

- **Water supply:** Uncontaminated water for drinking, cooking and washing, health care.
- **Sanitation Facilities:** Construction sites and camps shall be provided sanitary latrines and urinals. Sewerage drains should be provided for the flow of used water outside the camp. Drains and ditches should be treated with bleaching powder on a regular basis. The sewage system for the camp must be properly designed by providing septic tanks, built and operated so that no health hazard occurs and no pollution to the air, ground or adjacent watercourses takes place. Garbage bins must be provided in the camp and regularly emptied and the garbage disposed in a hygienic manner. Labour camps should also be provided with proper ventilations and air cooling system.
- **Solid Waste Management:** Solid waste generated will have to be disposed in compliance with Municipal Solid Waste (Management & Handling) Rules, 2000, as amended to date. Municipal solid waste will be collected and taken away and disposed by municipality. Solid waste management facilities will be arranged by the construction contractors.

5.3.13 Health and Safety (H&S)

5.3.13.1 Occupational H&S

221. The construction works shall be undertaken in accordance with all applicable legislation and Indian statutory requirements and guidelines-OHSAS 18001-2007: Occupational Health and Safety Management System/ ISO 45001:2018 and ISO 14001-2015: Environmental Management Systems.

222. Construction works shall be executed as laid down in the Environment, Social, Health and Safety (ESHS) Requirements applicable to Chennai Metro Phase 2. (**Annexure 5**)

223. While complying with this ESHS Requirements, site-specific and construction workspecific procedures for occupational health, safety and environment shall be prepared by the Contractor and approved by CMRL.

224. The mandatory requirements are as follows:

225. Legal requirements; Contractor`s organisation and interfaces with CMRL; procedures to identify hazards and estimate risk, hazard mitigation measures; emergency response plan; arrangements for training, inspection, communication, compliance, reporting, documentation and audit; complaint address.

226. Guidance on occupational health, safety and environmental practices involved in construction on elevated, at-grade and underground works, with special focus as below,

- **Health care awareness and clinics:** Construction workers are more prone to Infectious diseases such as HIV/AIDS. It should be prevented by following actions: Counselling, community events, clinic, and coordination with local health authorities.
- **First aid facilities:** At every workplace, a readily available first-aid unit including an adequate supply of sterilized dressing materials and appliances shall be provided. Suitable transport shall be provided to facilitate taking injured and ill persons to the nearest hospital.
- **Day Crèche Facilities:** At every construction site, provision of a day crèche shall be worked out so as to enable women to leave behind their children. At construction sites where 25 or more women are ordinarily employed, at least a hut shall be provided for use of children under the age of 6 years belonging to such women. Huts shall be provided with suitable and sufficient openings for light and ventilation. Size of crèches shall vary according to the number of women workers employed.
- **Shelter at Workplace:** At every workplace, shelter shall be provided free of cost, separately for use of men and women labourers. Sheds shall be maintained in proper hygienic conditions.
- **Canteen Facilities:** A cooked food canteen on a moderate scale shall be provided for the benefit of workers wherever it is considered necessary. The contractor shall conform generally to sanitary requirements of local medical, health and municipal authorities and at all times adopt such precautions as may be necessary to prevent soil pollution of the site. Mobile anaerobic toilets (bio-digester based) will be provided.

5.3.13.2 Community H&S

227. During construction impacts on community H&S due to exposed to traffic, noise, dust and vibration disturbance and the risk of road traffic accidents are anticipated.

228. To prevent community H&S issues during construction, contractor on coordination with implemented measures such as provide the construction camps with facilities such as health care clinics, places of worship, and occasional entertainment, preparation of implementation of traffic management plan during construction, access to buildings, awareness and information sharing, and implementation of CMRL SHE Manual.

229. In case of road closure or traffic diversion, the Contractor will ensure that information on the timing of construction works and notifications of road closure (if any) is provided via local media (radio, TV, newspaper etc.) or through the local community heads.

5.3.13.3 COVID-19 Pandemic

230. WHO has declared COVID-19 as a pandemic which has affected entire world including India. In view of the prevailing COVID-19 pandemic, the Contractor and workers would need to take additional measures to avoid the spread of the disease and shall follow various guidelines/guidance notes issued by the national/state government, WHO, ILO, World Bank/IFC from time to time. As described in these guidelines, the Contractor shall undertake a COVID-19 risk assessment of project area and prepare a COVID-19 Response and Management Plan (C-R&MP) and submit to CMRL and GC for approval. A brief guidance on “To Do” List prepared from these documents is provided in the **Annexure 8**. Furthermore, the Standard Operating Procedures (SOPs) and Guidelines for Construction Sites for COVID-19 Outbreak developed by National Real Estate Development Council will be mandatory for contractors to follow.

Residual impacts – Construction

In most cases, negative impacts resulting from construction work will end with the completion of the works. However the following residual impacts might remain after construction:

- Surface and ground water Quality: In case of insufficient treatment of waste water or accidental spillages a minimal negative residual impact might occur;
- Land degradation: Since it will take some time for soil to settle after the construction works a minimal negative residual impact for soil erosion and ground subsidence might exist, especially at muck disposal sites. Although contractor has to take every effort to prevent contamination of construction yards and waste disposal sites, a certain degree of pollution cannot be ruled out. Therefore a minimal negative residual impact exists, especially if the contractor’s liability for any pollution that has arisen is insufficiently covered.

5.4 Impacts and Mitigation Measures during Project Operation Phase

231. Positive Impacts: Key positive benefits are i) reduced air pollution, ii) increased employment opportunities, iii) improved economy, iv) mobility safety and reduced accidents, v) traffic congestion reduction, vi) reduced fuel consumption, vii) reduction in number of motorized vehicles, and viii) improvement of quality of life.

232. Negative Environmental Impacts: Along with many positive impacts, the following negative impacts during operation are anticipated:

- Noise and Vibrations
- Water supply and sanitation at stations
- Energy consumption at stations

- Pedestrianization and visual issues
- Health and Safety

5.4.1 Noise and Vibrations

233. Operation phase is extremely important from environmental issue viz. noise 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 breaking of rolling stocks 2. Rolling stock leaving from station, 3. During its travel between two stations and 4. Announcements on the Metro station.

234. The vibration is generally caused from rail-wheel interaction. This can be reduced by minimizing any surface irregularities on the wheel and rail. 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.

235. 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 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.

236. In addition to the above mitigation measures, the roughness of running surfaces will be reduced through regular maintenance of wheels and tracks and will be considered for replacing traditional jointed track with continuously welded rail. Also, noise controls at the source will be installed for improved sound-proofing and other noise reducing features will be installed such as engine enclosures and shielding of wheels with vehicle-mounted shrouds.

237. These noise generations for metro operation activities have been recorded from past experience from existing metro railways 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 2m distance from the rail alignment is about 73 dB(A) which is higher than the CPCB permissible limit of 65 dB(A), and is much higher than the 50 dB (A) daytime limit for silence zone. The noise level reduces with distance logarithmically. Refer Tables 5.10 and 5.11.

Table 5-10: 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 Platform (Max)	84.0± 1.5
3	Train leaving the Platform (Max)	84.0± 0.5
4	Train stopping in Platform	79.0± 0.0
5	Train stationary in Platform	76.0± 0.5
6	Train starting from Platform	78.5± 1.0
7	Train braking	86.0± 0.0
8	Announcement	74.0± 0.5

S. No	Description	Average Noise Levels dB(A)
		Elevated tracks
Overall		76.0± 7.0

Table 5-11: Interior Noise Levels in Metro Trains

S.No	Description	Average Noise Levels dB (A)
		Elevated tracks
1	Train stationary	62.0±1.0
2	Train starting	62.0±1.0
3	Train motoring	70.0±2.5
4	Train coasting	72.0±2.0
5	Train at max. speed	78.0±1.0
6	Train decelerating	69.0±0.5
7	Train stopping	64.4±1.0
8	Train braking	74.5±1.0
9	W/R Noise	75.0±1.5
10	Door operations (max.)	-
Overall		69.0±5.0

Source: Studies carried out by Central Road Research Institute (CRR) for metro projects in India 232. Noise barriers are recommended with noise reduction possibilities in Table 5.12.

Table 5-12: Noise Barrier for Noise Reduction

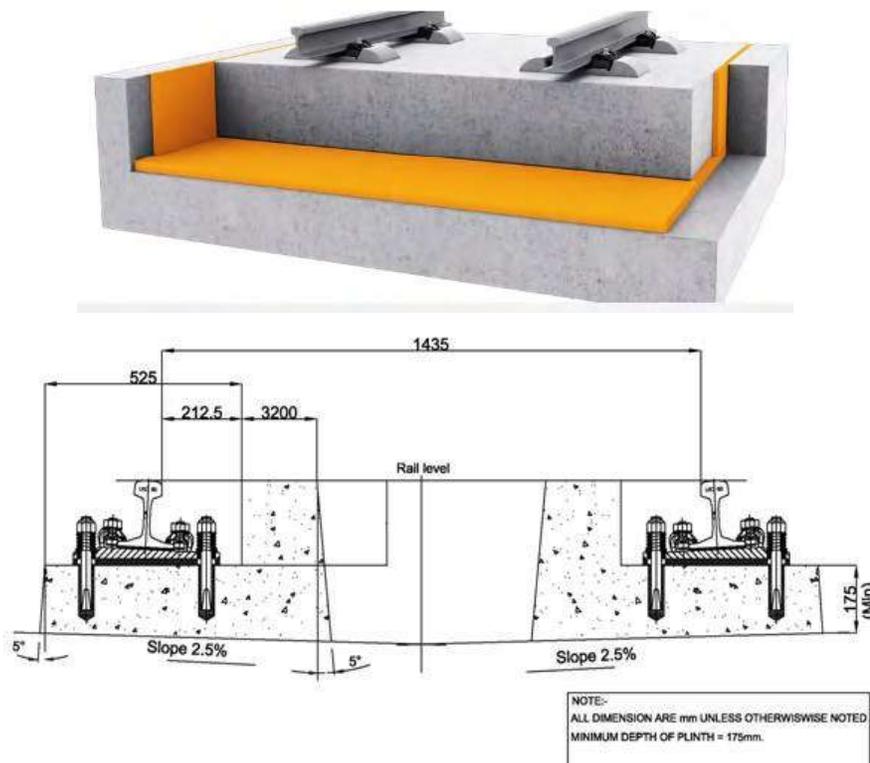
Place of Noise Barrier	Height of noise barrier	Noise reduction
On the viaduct in front of yard	4m (3.5m Absorptive+0.5m transparent) green color	15 dB(A)
On washing yard (s curve)	5m (Aluminium foam noise barrier) yellow color	17 dB(A)
On the back side boundary wall	3m (100% absorptive) blue color)	13 dB(A)
On the both sides of metro yard shade	3m (100% absorptive) blue color)	13 dB(A)

238. The study found that noise reduction is possible from 13-17 dB(A) after installation of noise barrier. Therefore, study suggested that noise barrier is the best option to reduce the instantaneous noise generated by metro; tree plantation is not a scientific option for reduction of noise levels.

239. Furthermore, the noise barriers consisting of 15mm thick UV coated clear transparent polycarbonate sheets meeting the criteria for acoustic performance as per EN 1793 and mechanical and structural performance as per EN 1794 including necessary structural galvanized steelwork and rubber gasket all around, have been included in the tender document. The sound transmission class rating corresponding to sound attenuation of 30dB or above is required.

240. Elastic pad between seat of the rail and the track slab as well as between track slab and the superstructure beneath it will reduce vibration transmitted from the track and superstructure. Indicative pictures are shown in Figure 5.4.

Figure 5-4: Vibration Damping Devices in Track



Source: Getzner Werkstoffe

241. The detailed analysis (computer modeling) of noise and vibration will be conducted based on the detailed engineering design, and will be finalized prior to contractor's mobilization. The analysis will form the supplementary study of this EIA.

5.4.2 Water and Sanitation Requirements at Stations

242. 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 Air Conditioning. Water Demand for alignment is calculated and presented in Table 5.13. The water requirement for the stations will be met through the public water supply system.

Table 5-13: Water Demand

S. No.	Particular	Water Demand at Each Station (KLD)	Total Water Demand (KLD)
1	In Underground stations with softening plant	85.0	1,020
2	In Elevated stations	16.6	298.80
	Total		1,318.80

243. Thus there would be total water requirement of 1,318.8 KLD in 30 stations. Arrangement of water will have to be made at each station separately with proper drainage system for wastewater. CMWSSB water supply will be supplemented by rainwater harvesting along viaduct and rooftop of elevated stations. Sewage of 1,121 KLD will be generated. Wastewater will be led into municipal sewage system.

244. Solid waste generation from passengers at stations is likely to be 342 ton per day. Non-hazardous solid waste generated in stations will be collected and transported to the disposal sites by Chennai municipal corporation.

245. Mitigation Measures: Wastewater generated will be collected and discharged into municipal drains after proper treatment to meet the CPCB standards. Efforts should be made conserve the water by recycling water in the system. Also, as an environmental conservation measure, to conserve and augment the storage of groundwater, it is proposed to construct rainwater harvesting structure of suitable capacity at the elevated stations and in the elevated alignment. Each pillar can have inbuilt downpipes to collect the rainwater from the viaduct and rooftop of elevated stations and then led into underground tanks through layers of sand and gravel. At annual rainfall of 1,541mm, potential for rainwater harvesting is 2.80 lakh cum per year on Corridor 4.

5.4.3 Energy Consumption at Stations

246. Stations impose significant demands on energy. In addition, traction, rolling stock and train control systems also require reliable sources of grid and standby power, high intensity energy, as well as efficient equipment. Table 5.14 presents the power demand of alignment during operation.

Table 5-14: Power Demand

Load	2025		2035		2045		2055	
	Normal	Emergency	Normal	Emergency	Normal	Emergency	Normal	Emergency
3 km from Kilpauk GSS-Panagal Park RSS (Chainage -255 to 7436) 7.691km								
Traction	2.45	8.39	3.62	12.41	4.40	15.10	5.36	18.38
Auxiliary	11.67	19.95	14.58	24.40	16.32	27.46	17.49	29.62
Total	14.12	28.34	18.20	36.81	20.72	42.56	22.85	48.00
3.5 km from Koyambedu GSS-Avichi School RSS (Chainage -7436 to 25829) 18.38km								
Traction	5.94	8.39	8.79	12.41	10.70	15.10	13.02	18.38
Auxiliary	8.28	19.95	9.82	24.40	11.14	27.46	12.13	29.62
Total	14.22	28.34	18.61	36.81	21.84	42.56	25.15	48.00

247. Requirement of electrical energy for climate control, lighting and other facilities at stations will be optimized by proper use of natural day/night light and design of passenger flow inside stations and on streets outside stations. Installations for solar power will be implemented in stations where feasible. Full height platform screen doors will be implemented so as to conserve energy for ventilation and air conditioning in underground stations, which will also ensure passenger safety just as half height screen doors.

248. **Green Buildings.** In accordance with the GRIHA (version 2015) norms, the following measures will be implemented to a feasible degree in the stations and depots.

- Control annual heat gain through favourable orientation and design of facades
- Site planning according to contours
- Site plan designed to preserve existing vegetation/ existing water bodies / other topographical features like boulders etc.
- Manage storm water on site through rainwater harvesting
- Mitigate heat island effect by ensuring that building surface visible to sky is shaded by trees. Ensure zero SWD post-construction by means of ground water recharge and recharge of groundwater aquifers by rainwater. The building shall be designed to incorporate low ODP materials, indoor air quality and comfort, low-VOC paints and

adhesives, reduced landscape water demand, sustainable building materials and renewable energy utilization etc.

- For the utilization of renewable energy, wherever feasible, installations for solar power can be implemented on roof of elevated stations. Installation and maintenance of solar power infrastructure is proposed to be awarded to developer along with Power Purchase Agreement (PPA). The power shall be purchased by CMRL on the basis of the unit rate specified by PPA.

249. In conformity to other corridors in Chennai, the following design elements are proposed which increase energy efficiency and safety:

- High voltage electric traction which have ability to carry high traffic at a reduced cost with higher efficiency of operation
- Rolling Stock is of light weight stainless steel / aluminium resulting in energy efficiency and improved life thus improving resource utilization and environmental quality. Standard Gauge rolling stock results in recurring saving in energy consumption during operation as for the same passenger carrying capacity, gross weight of a metro coach is lower.

5.4.4 Visual Issues

250. 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.

251. During design stage, the stakeholder engagement will be conducted to disclose the station designs and to incorporate the feedbacks.

5.4.5 Health and Safety

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

253. Detailed specification of equipment e.g. power cables, rectifiers, transformer, E&M equipment etc. shall be framed to reduce conducted or radiated emissions as per appropriate international standards. The Metro system as a complete vehicle (trains, signaling & telecommunication, traction power supply, E&M system etc.) shall comply with the Electromagnetic compatibility (EMC) requirements of international standards viz. EN50121-31, EN50123, IEC61000 series etc. EMC requirements of international standards for whole railway system to the outside world shall comply with EN50121-2.

254. 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, signaling, and telecommunications, fire-fighting system, lift operation, and tunnel ventilation.

255. 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.

256. 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 operation control center.

257. In view of the potential hazards from system failure resulting to accidents, both on-site and off-site emergency measures will be implemented. All trains will have public address systems to warn the passengers of any emergency situation.

5.5 Impacts and Mitigation Measures Due to Depot

258. One major maintenance depot is planned on Poonamallee Bypass. Impacts and mitigation measures include:

- Water Supply
- Sewage/Effluent Treatment
- Rainwater Harvesting
- Rooftop solar power
- Oil Pollution Control
- Solid waste disposal
- Cutting of trees and Green Belt.

5.5.1 Water Supply

259. Water required for operation of depot shall be sourced from municipal supply. This shall be supplemented by rainwater harvesting. Treated sewage will be used for horticulture and non-drinking purposes in operational facilities and staff quarters if any. Train washing requires 22 KLD by year 2055, generating 19 KLD sewage. Water demand will be 70 KLD for domestic purpose including staff quarters at Poonamallee depot resulting sewage will be 63 KLD.

260. To conserve and augment the storage of groundwater, it has been proposed to construct rainwater harvesting structures in the proposed depots to receive runoff from sloping roof of the depot as well as recharge of ground water in uncovered land area. On Depot potential for rainwater harvesting is 0.77 lakh cum per year from roof of structures in the depots. In addition, estimated quantity of 1.57 lakh cum per year will be available for ground water recharge

5.5.2 Sewage Treatment and Effluent Treatment

261. Sewage will be generated from depot which could be treated up to the level so that it could be used for horticulture and non-drinking purposes in the Depot. For Poonamallee Bypass depot Sewage Treatment Plant (STP) and Effluent Treatment Plant (ETP) are proposed. The wastewater from depot will have oil, heavy metals grease and detergent as main pollutants. This has to be treated as per requirement of Tamil Nadu State Pollution Control Board.

5.5.3 Solar Plant

262. Rooftop solar panels on covered part of depots are proposed. As per Ministry of renewable Energy (MNRE) template, 5% of rooftop area of depot can generate 3.51 lakh kWh per year in Poonamallee Bypass depot.

5.5.4. Oil Pollution Control

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

5.5.5 Solid Waste Disposal

264. The solid waste generated from the Depot will be taken by the cleaning contractor weekly and disposed to the municipal waste disposal sites. It is estimated that municipal solid waste of about 0.18 ton per day will be generated from Poonamallee Bypass depot.

5.5.6 Cutting of Trees

265. About 396 trees in Poonamallee Bypass depot are likely to be cut. 4,752 trees will be replanted to offset the tree loss of depot.

5.5.7 Noise and Vibrations

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

5.6 Chance Finds

267. Corridor 4 alignment is in urban areas and there may be possibilities that some artifacts could be found during piling and excavation work.

268. Mitigation Measures: before start of civil work the contractor and CMRL will coordinate with State Archeological department to reconfirm that there is presence of buried artifacts along the metro line alignment. No piling or excavation will be allowed unless cleared by the Archeological Department.

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

270. 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 CMRL.

271. 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 GC, 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.

Residual impacts – Operation

During operational phase of the metro the following residual impacts are expected:

- **Noise and vibration:** Operation of the metro will generate a certain amount of noise and vibration. The detailed design will incorporate features to reduce the noise and vibration levels. Detailed analysis (computer modeling) of noise and vibration will be conducted based on the detailed engineering design and will be finalized prior to contractor's mobilization. It is expected the detailed mitigation measures will be able to reduce the noise to an extent that the increase is less than 3dB(A) and will be able to reduce vibration to levels under the human annoyance threshold. However a minimal negative residual impact will remain.
- **Energy Demand:** Energy saving features of the metro such as regenerative braking, lightweight coaches and efficient power equipment and green buildings reduce the negative impact of increased energy demand. The residual impact will therefore be minimal negative and will be reduced even further when more grid electricity is produced by renewable energy sources.
- **Water quality:** The stations will have an impact on the amount of sewage to be treated throughout the operational phase and, in case of insufficient treatment, indirectly have an impact on the water quality. Temporary leakages of the sewerage at the stations cannot be ruled out completely. Therefore a minimal negative residual impact will exist.
- **Water quantity:** Water demand at stations will impact the availability of this commodity which cannot be completely mitigated through rainwater harvesting. A minimal negative residual impact will therefore remain.
- **Health and Safety:** Although both occupational and public health and safety risks can be mitigated to a large extent through proper equipment, ppe's, procedures and education, a chance remains the procedures may not always be followed in full. Therefore a moderate negative residual impact remains.
- **Impacts due to depot:** The Poonamallee depot is to a certain extent expected to have impact on noise, vibration, water quantity and quality, soil quality and energy demand. With proper design and maintenance these impacts will have a minimal negative residual impact.
- **Economy:** Corridor 4 will have a moderate positive residual impact on the local economy. In operation phase about 913 people will be employed for operation and maintenance of the system. In addition, more people would be indirectly employed in allied activities. Also, the project will facilitate movement of people from different parts of Chennai. Corridor 4 will yield benefits in terms of growth in economic activity due to better accessibility, savings in fuel consumption, corresponding reduction in cost of road construction and maintenance, reduction in vehicle operating costs, savings in travel time, and improvement in quality of life and reduction in loss of productivity due to health disorders resulting from pollution.
- **Air quality:** Through modal shift from fossil-fuel driven transport to electric public transport the metro will have a long-lasting high positive residual impact on the air quality. The magnitude of the beneficial impact of metro will increase with increasing ridership.

5.7 Expected Benefits from Corridor 4

272. 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 summarize the benefits of a metro rail system:

- **Reduced Air Pollution:** Reduction in air pollution level is the single most important indications due to metro rail alignment.

- **Increased Employment Opportunities** During the period of construction manpower will be needed for various project activities. In post-construction phase, about 913 people will be employed for operation and maintenance of the system. In addition, more people would be indirectly employed in allied activities.
- **Improved Economy:** The project will facilitate movement of people from different parts of Chennai. Corridor 4 will yield benefits in terms of growth in economic activity due to better accessibility, savings in fuel consumption, corresponding reduction in cost of road construction and maintenance, reduction in vehicle operating costs, savings in travel time, improvement in quality of life and reduction in loss of productivity due to health disorders resulting from pollution.
- **Mobility Safety and Reduced Accidents:** The metro network increases the mobility of people at faster rate. The proposed corridor will provide more people connectivity to other parts of the city. Metro journey is safe and result in reduced accidents on roads.
- **Reduced Fuel Consumption:** Based on number of daily vehicle kilometre reduction, daily reduction in fuel (diesel and petrol) consumption has been estimated. The reduction has been estimated based on retiral - without addition - of pre-BS VI vehicles from year 2020 onwards; in accordance with the report commissioned by Niti Aayog, 100% of 3 wheelers and buses and 40% of private 2 wheelers and cars have been assumed to be electric from year 2030 onwards. The benefit is an interplay between shift from road modes to Metro and shift from more polluting pre-BS VI road vehicles to less polluting BS VI road vehicles. The estimated daily vehicle-kilometre that will be reduced due to operation of Corridor 4 is given in Table 5.15. Reduction in fuel consumption is reported in Table 5.16. The reduction of air pollution is presented in Table 5.17. Net reduction in CO₂ has been estimated as result of trade-off between ambient reduction due to operation of metro rail and increase due to grid power used to operate the Metro.

Table 5-15: Reduction in Daily Vehicle kilometers

Mode	Daily vehicle km Reduced due to Corridor 4		
	2025	2035	2045
Bus	1,065,268	1,429,592	1,614,089
2 wheeler	225,656	528,539	804,727
Car	135,548	379,296	476,847
3 Wheeler	60,562	137,509	201,331

Source: Detailed Project Report for Corridor 4 Chennai Metro Phase 2, Oct. 2018

Table 5-16: Reduction in Fuel Consumption (million litre per year)

Mode/Year	2025	2035	2045
Diesel	96.30	0.20	0.30
Petrol	2.90	3.50	4.70

Table 5-17: Pollution Reduction (ton/year)

Pollutant	2025	2035	2045
CO	2,581	195	276
PM	57	1	1
HC+NO _x	2,475	32	45
CO ₂ (net)	180,839	71,809	53,834
Treatment cost (Rs million per year)	602	59	59

6. ANALYSIS OF ALTERNATIVES

6.1 Introduction

273. This section presents the symmetrically compared feasible alternatives to Corridor 4. Alternatives such as other sources of transport (road, mono-rail, suburban rail), proposed design etc. have been considered and analyzed for its likely impacts on various environmental parameters. Additionally, an evaluation of potential environmental impacts in terms of 'with' and 'without' project situation has been considered for the justification of the project. This section also presents a discussion on how environmental parameters were assigned due importance and considered in the analysis of alternatives.

6.2 Different Modes of Transport and Need to Increase Public Transport Share

274. The urban transport model was developed as part of Feasibility Study for travel demand assessment and to arrive at influential mass rapid transit corridors. The need for quantum increase in transport capacity of the current network by means of rapid transit along proposed corridors is indicated by inadequacy of road capacity. Major roads along the proposed project alignment are forecast to function beyond respective design service volume in absence of the Corridor. The study estimated Peak Hour Peak Direction Traffic (PHPDT) of 17,200 for Corridor 4 with a daily ridership of 4.1 lakh passengers in horizon year 2035.

275. The Comprehensive Mobility Plan (CMP) for CMA, February 2018 forecasts that these major roads e.g., Venkatanarayana Road, Arcot Road, Kalamman Koil Street, Mt. Poonamallee Road will carry traffic load which is beyond their capacity. The CMP identified 8 mass transport corridors which are forecast to carry peak hour peak direction traffic ranging from 11000 to 35000 which is more than capacity of bus transport in form of discrete buses. One of these 8 corridors is from Lighthouse to Poonamallee via Porur.

276. The development of the two scenario starts with estimating the traffic and the modal share in these scenarios for the system. As per travel demand forecast on revised network in DPR 2018, Corridor 4 will cater daily boarding of 5.5 Lakh in 2025 and 11.4 Lakh in 2055; maximum sectional PHPDT on Corridor 4 will correspondingly increase from 11,707 to 29,940.

6.3 Analysis With and Without Project Scenario

277. In case Corridor 4 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

278. Benefit in terms of reduction in air pollution due to operation of Metro is estimated in Chapter 5. 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.

6.4 Comparison of Alternative High Capacity Modes

279. Table 6.1 presents comparison of unit life cycle costs of Metro, Light Rail Transit (LRT) and Bus Rapid Transit (BRT). The costs pertain to traffic demand forecast on MDBs project corridors and are based on data for such systems operating or evaluated for Indian conditions.

Table 6-1: Cost Comparison of urban mass transit systems

S.No	MDB project Corridor	Forecast traffic demand in year 2055 PHPDT (length of section)	Life Cycle Cost (Rs lakh per seat) rounded off		
			Metro elevated	Light Rail elevated	BRT at grade
1	Lighthouse to Poonamallee bypass (25.4km)	Lighthouse to Nandanam Underground 6.18km	>80 to 36 *	>80 to 33 ** 2c	>36 to 25 ** 2b
2		Nandanam to Meenakshi College Underground 3.08 km, Meenakshi College to Porur Junction elevated 7.97km	>29 to 23 ** 4c	33 to 20 ** 4c	25 to <22 ** 2b
3		Porur Junction to Poonamallee Bypass elevated 8.2km	24 to 18 ** 6c	19 to 15 * 6c	21 to 19 *
Assumed Capacity per coach/bus			270	242	80

* Section 9.3, Life Cycle Cost Analysis of Five Urban Transport Systems, IUT (India), 2012.

** Section 9.4, Life Cycle Cost Analysis of Five Urban Transport Systems, IUT (India), 2012, 4c: 4 car set. Average speed: Metro 35kmph, LRT or BRT 25kmph; average station/stop spacing: Metro 1km, LRT or BRT 0.75km, headway: Metro or LRT 2.5minutes, BRT 0.60 minutes

280. The above tabular statement shows that BRT has significantly lower unit life cycle cost from Lighthouse to Nandanam. LRT shows no significant advantage to Metro on other sections.

281. Road right of way is not adequate to operate BRT. Therefore, it is considered that continuity of Metro on the project corridors is preferable. In terms of reduced air pollution, benefit of Metro on the project corridors is estimated in Chapter 5 of this report; BRT adds to ambient pollution in comparison to Metro.

282. Screening distance recommended for vibration induced by rubber tyred vehicles is 16m against 67m and 50m respectively for rapid rail and light rail (Transit Noise and Vibration Impact Assessment, US FTA, May 2006): this indicates that exposure zone of BRT buses will be smaller than Metro.

283. Screening distance recommended for noise generated by bus on BRT is 70m against 233m and 116m respectively for rapid rail and light rail (Transit Noise and Vibration Impact Assessment, US FTA, May 2006): this indicates that noise exposure zone due to BRT buses will be smaller than Metro.

6.5 Selection of Alignment, Stations and Depot Locations

284. While fixing the alternatives on proposed corridor, following requirements/ constraints have been kept in view:

- To remain on corridor of the existing road or Government premises/land to the extent feasible.
- To utilize the existing road Right of Way to the maximum extent in order to minimise the land acquisition and also length of diversions.
- To avoid dismantling of existing structures/buildings etc. to the extent feasible.
- To avoid private built up areas, villages, habitation and religious structures etc. to the extent feasible.
- To provide adequate clearance from existing Railway/ Highway structures.
- To satisfy the requirements of sound economic engineering practices
- To rationalise the location of proposed stations and underground ramps

7. PUBLIC CONSULTATIONS AND INFORMATION DISCLOSURE

7.1 Consultations

285. MDBs' 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.

286. Public consultation and participation are 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 manages the expectation of 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.

287. Public consultation/information is an integral part of the Chennai metro project cycle. Public consultations with the people of different sections of the society along the project alignment, shopkeepers, and influential persons of the project area were made. Potential vulnerable people like, squatters, encroachers, schedule caste, and other backward section of society were consulted to make them aware and identify adverse impacts of the project.

288. The consultation process started early in 2017. CMRL held extensive consultation with the local community to share information of potential impacts and mitigation measures etc.

7.2 Identification of Stakeholders

289. Key stakeholders at central, state, district and local level will be consulted as part of the consultation process. This will be documented in the updated EIA prior to the contractors' mobilization.

- Ministry of Environment, Forests and Climate Change,
- Central Pollution Control Board,
- Tamil Nadu State Pollution Control Board,
- State Environmental Impact Assessment Authority
- Tamil Nadu Coastal Zone Management Authority

- State Traffic Police Department
- Municipal Corporation
- State Archaeology Department
- Central Ground Water Authority
- District Forest Office
- Indian Meteorological Department
- Non-government organizations
- Women groups
- Shopkeepers associations

7.3 Public Consultations – EIA

290. During the field surveys that were carried out between November 2016 and November 2018 while updating preliminary SIA as part of Detailed Project Report (DPR), interviews of head of individual PAFs to elicit their socio-economic characteristics were conducted in addition to consultation meetings with groups of stakeholders and community. The opinions of the community and stakeholders were obtained during these consultations and summarised in **Table 7.1**.

Table 7-1: Public Consultations at Station Locations Onsite 2016 to 2018

Place	Date	No. of participants	Issue	Suggestion/opinion
Alwarpet	03.11.2016	6	Compensation	Adequate compensation for structures should be paid to help re- start life
			Fare	Fare should be comparable with other modes of travel
			Bore wells	Bore wells in station areas will be affected
			Building damage	Should be taken care
			Tenancy	After construction we want tenancy at this place a same rate
			Livelihood	Livelihood will get affected
Luz, Thirumayilai	29.05.2017		Solve traffic issues and increase connectivity	Metro will reduce the traffic jam. The long-distance travel will be easy and metro will increase the connectivity.

Place	Date	No. of participants	Issue	Suggestion/opinion
		7	Old area; building may collapse due to tunnelling work	Underground track may not be suitable for Mylapore as it is a very old area with heritage buildings- temples, church etc. Many buildings/ residents are century old; therefore, there is a great risk of collapse.
			Business loss due to construction activity	If construction activities go long more than expected, then it incurred loss to commercial/ shops.
			Fare	Fare should be less.
Poonamalle Depot	20.11.2018	8	Time Saving	Time will be saved in comparison with other means of transport.
			Loss of livelihood	The loss of livelihood for small enterprises is a major issue for employees or working class
			Traffic and pollution during construction of the project	There is a possibility of pollution and traffic problem during construction of the metro project.
			Reduction of road pollution	Metro train will reduce the existing high level of pollution both noise and air.
			Safety and Security	The lady respondents said that the proposed metro project will be helpful for her because metro offers special a special compartment for ladies only.
			Loss of Trees and land	Loss of trees is another major concern according to the respondents. Tree plantation shall be taken care of.
			High ticket cost	The minimum metro ticket price in Chennai metro is Rs.50. The poor and middle class citizens will not be able to afford that money on a regular basis. So, they are using the bus services mostly.

Place	Date	No. of participants	Issue	Suggestion/opinion
Vadapalani	11.11.2016	10	Road congestion	Operation of metro to reduce congestion on road
			Fare	Metro should be less expensive
			Loss of livelihood	Being a small shop owner, our livelihoods will totally loss. There has to be adequate provision of compensation.
			Reduction in pollution	Metro will reduce the existing traffic load and reduce the level of pollution.
			Metro reduce road side accidents	Metro will reduce the traffic and reduced in road accidents.
Vadapalani	26.05.2017	7	Travel time	Travel time by metro will be lesser
			Congestion and Pollution	Congestion and Pollution due to road traffic will reduce
Poonamale Bus Terminus	03.07.2018	12	Compensation	Due to metro train, other facilities and infrastructure will develop, but affected structures/people should get adequate compensation in order to re-instate their life.
Poonamalle Bus Terminus	03.07.2018	12	Loss of livelihood	Being a small shop owner, our livelihoods will totally loss. There has to be adequate provision of compensation.
			Reduction in Pollution	Metro will reduce the traffic and road accidents.
			Construction resulting Traffic Jam	Construction activity will result traffic jam. As this place is fully commercial, metro construction may disrupt the traffic flow
			Green Cover	The metro train might reduce the green cover and it needs to be taken care of.

Place	Date	No. of participants	Issue	Suggestion/opinion
			Area development	Due to metro train, other facilities will come such as infrastructure development. Local economy will boost up.
Iyappanthal Bus depot	03.07.2018	12	Time Save	The metro train facility in Chennai will save time to reach the destinations in comparison with other means.
			Comfortable Travel	It would be easy to reach to the destinations due to the proposed metro project.
			Better connectivity	Metro may improve connectivity with speedy travelling.
			Reduction in pollution and accidents on road and overall	There would be reduced pollution and no accidents while travelling in metro train
			Loss of livelihood	Local vendors located very close to the project site will be affected badly
			Fare	The metro fare should be as less as possible considering paying power of the people
			Employment	Metro will increase jobs especially for engineers

Source: DPR Corridor 4 SIA January 2019 & Comprehensive DPR March 2019

291. Public Consultations were conducted on site at station locations in 2018 and 2019 after the DPR was finalized. The outcome of these consultations is summarized in Table 7.2. Public consultations during construction and operation will form part of semi-annual monitoring reports sent by CMRL to MDBs. These consultations will focus on the impact mitigation measures being implemented and their efficacy.

Table 7-2: Public Consultations at Station Locations Onsite 2018 and 2019

Location	Date	Number of Participants	Issue	Suggestion / Opinion of Participants
Bharathidasan Road	8/9/2018	10	Adverse impacts	Loss of Livelihood, income, house/shop

Location	Date	Number of Participants	Issue	Suggestion / Opinion of Participants
			Benefits	Increase in property values, employment; decrease in travel time, congestion, accidents, GHG
Vadapalani	8/9/2018	12	Adverse impacts	Loss of Livelihood and income, house/shop, income, loss of house/shop,
			Benefits	Increase in property values, employment; decrease in travel time, accidents
Valasaravakkam	24/12/2018	8	Adverse impacts	Loss of income; migration
			Benefits	Increase in property values, decrease in travel time and GHG
Alapakkam	24/12/2018	5	Adverse impacts	Loss of customer, income, house/shop
			Benefits	Decrease in travel time and GHG
Iyyapanthangal Bus Depot	12/1/2019	7	Adverse impacts	Loss of livelihood, house/shop
			Benefits	Increase in property values, decrease in travel time, GHG
Kattupakkam	12/1/2019	11	Adverse impacts	Loss of income, migration
			Benefits	Increase in economic activity; decrease in travel time, accidents, GHG

7.4 Information Disclosure

292. Information disclosure will follow the procedure and disclosure requirements of MDBs' policies for category A projects. As per ADB's SPS 2009, the EIA shall be disclosed 120 days prior to ADB's Board Approval.

293. All environmental documents are subject to public disclosure, and therefore, will be made available to the public. This EIA and the Executive Summary (in both English and Tamil) will be disclosed on CMRL and MDBs' websites. The hard copies of EIA will be made available at CMRL

office as well as at other locations accessible to stakeholders. CMRL will ensure that meaningful public consultations, particularly with project affected persons' are undertaken throughout the design, construction and operation stages.

8. GRIEVANCE REDRESS MECHANISM

294. 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, rehabilitation and resettlement, compensation etc. will be acknowledged, evaluated, and responded to the complainant with corrective action proposed using understandable and transparent processes that are gender responsive, culturally appropriate, and readily accessible to all segments of the affected people. Records of grievances received, corrective actions taken, and their outcomes will be properly maintained and form part of the bi-annually environmental monitoring report to MDBs.

295. Many minor concerns of peoples are addressed during public consultation process initiated at the beginning of the project. However the most common reason for delay in implementation of projects in urban areas is grievances of people losing their land and residential and commercial structures. Resolving such cases in the Court of Law will be a very time consuming process. Considering this and based on CMRL's past experiences of dealing with PAP grievances, a GRM has already been put in place in order to address the grievances of project affected persons. Such a redress mechanism available at the project level itself will mean that the complainants do not necessarily have to directly approach a Court of Law although availability of Grievance Redress Committee (GRC) mechanism will not bar them from doing so.

296. GRM will be in two layers: a) executing engineer from Project Implementation Unit (PIU) and b) GRC. The first level of interaction of GRM with the stakeholders will be the Executing Engineers from PIU to resolve ground level grievances including construction nuisances with support from contractor GRM focal. Issues should be resolved within 14 days. Those that cannot be resolved by PIU will be escalated to be examined by the GRC. Alternately complainants aggrieved by inadequacy of actions taken by the executing engineer can escalate to the GRC.

297. The Environmental Health and Safety Expert on the CMRL PIU who is an environmental engineer will coordinate the GRC which will report to MD, CMRL and Director Projects, CMRL. The other members of the GRC will be:

- CMRL Project Manager of the package/section
- EMP implementation teams from CMRL and GC
- EMP Manager from construction contractor
- Assisting NGO
- PAPs and representatives
- With a view to Affirmative Action to enhance women inclusivity, one-woman representative of local community from each 5km section of the alignment will be members of the Environmental and Social Grievance Redressal Committee. The representative(s) from the location(s) to which the grievance(s) pertain(s) shall be invited to deliberations of the Committee.

298. Records of the following stages will be maintained on website of CMRL throughout the life of the project:

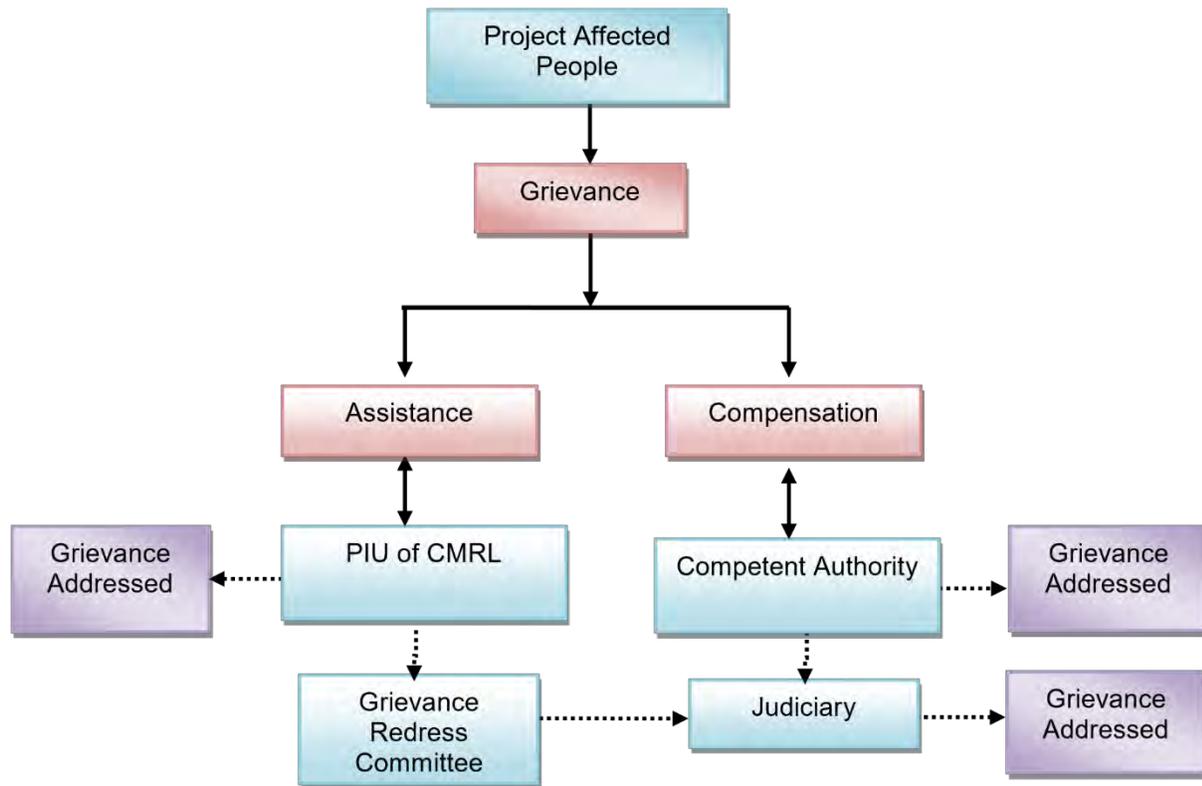
- Complaints received

- Acknowledgement of receipt of complaint by executing engineer PIU
- Actions taken by executing engineer and their efficacy
- Escalation by executing engineer or by aggrieved parties
- Records of further action and closure of complaints.

299. Complaints and escalation by aggrieved parties can be done by paper mode as well as through email. The GRC will deliberate upon time limits for each of the above stages; the time limits will be placed on website of CMRL.

300. The flow chart of GRM is presented in Figure 8.1.

Figure 8-1: Grievance Redress Mechanism



301. The following process is followed for consideration of various cases by GRC:

- GRC function independently
- All grievances are received in written form by GRCs and a separate record of the same, including contact details, is maintained
- A separate file / processing document is created for each case, based on its category (project, location etc.) and all observations and documents related to the case are maintained in such file
- Cases related to environment pollution, noise, eligibility, entitlements, disputes etc. are promptly handled after consultation with relevant authorities
- GRCs can seek necessary record / information (such as survey details, past written communication etc.)

- Written notices are sent to the aggrieved persons and respondents to appear for hearing along with documents, and further dates are provided in case of genuine inconvenience to the party about the appointed date
- Multiple hearings are conducted as per the requirements of cases and aggrieved persons (including their representatives) and respondents are heard and are provided opportunities to submit further documents / proofs
- Site visit documents submitted by the parties are verified from appropriate sources, as may be considered necessary
- In normal circumstances (excluding those requiring information from external agencies) the entire process is carried out in a time bound manner (On an average, it takes about 1-2 months for disposal of each case in GRC)
- After due consideration of the cases, written and reasoned orders are passed under the signature of Head of concerned GRC
- Any fatality accident should be reported to GRC and MDBs immediately

302. In addition to the above GRM for addressing complaints from the local community, a separate GRM will be constituted by contractor for addressing the issues of the workers, forming part of the bidding document for CMRL to review and clear. The clauses in the tender include the following:

- Enquiries, complaints and requests for information can be expected from a wide range of individuals and organisations both private and government. The majority of complaints is likely to be received by CMRL, although the site offices are also likely to be contacted.
- The objective of complaint process is to ensure that public and agency complaints are addressed and resolved consistently and expeditiously.
- The Contractor's Project Manager will be notified immediately on receipt of complaint that may relate to environmental impacts. The Project Manager will immediately inform the Employer's Representative.
- Field investigation should determine whether the complaint has merit, and if so action should be taken to address the impact.
- The outcome of the investigation and the action taken shall be documented on a complaint Performa prepared by the Contractor and submitted for notice by the Employer's Representative in advance of the works.
- Where possible, a formal response to each complaint received shall be prepared by the Contractor within seven days in order to notify the concerned person(s) that action has been taken.
- Grievance log should be prepared and documented in the monitoring report with the resolution details.
- GRM for workers shall be established as early as possible to function no later than construction commencement.
- The GRM information and focal should be disseminated to public.

9. ENVIRONMENTAL MANAGEMENT PLAN

9.1 Introduction

303. The Environmental Management Plan (EMP) consists of a set of mitigation, monitoring and institutional measures to be taken for Corridor 4 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 EMP are:

- Mitigation of potentially adverse impacts;
- Environmental monitoring;
- Emergency response procedures;
- Institutional arrangements and reporting mechanism;
- Implementation Schedule;
- Training and capacity building; and
- Cost estimates.

9.2 Objectives of Environmental Management Plan

304. The main objectives of this EMP are:

- To ensure compliance with MDBs' applicable policies, and regulatory requirements of GoTN and GoI;
- To formulate avoidance, mitigation measures for anticipated adverse environmental 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.

9.3 Institutional Arrangement

9.3.1 Executing Agency

305. GoTN created a SPV for implementing the Chennai Metro Rail Project. This SPV named as "Chennai Metro Rail Limited" was incorporated on December 03, 2007 under the Companies Act. It has now been converted into a Joint Venture of GoI and GoTN with equal equity holding.

306. GoTN and GoI will be the Executing Agency (EA) of the proposed Corridor 4 (Phase-II).

9.3.2 Implementing Agency

307. CMRL will be the Implementing Agency responsible for implementation of the metro rail project. Managing Director, CMRL will be in charge of the overall project activities. CMRL will be accountable to the GoTN (i.e. the EA).

308. PIU, CMRL headed by the Project Director (PD) is responsible for the overall execution of the project and implementation of the EMP. The PIU will be assisted by General Consultant (GC). The safeguard role of GC is to assist CMRL in review of documentation and monitoring of implementation of EMP and monitoring plan during construction and operation by means of scheduled inspections, meetings and reports submitted to CMRL. The terms of reference are attached as **Annexure 6**.

9.3.3 Implementation of EMP

309. CMRL: EMP will be committed by CMRL as part of its agreement with MDBs. The responsibility to implement the EMP including Grievance Redressal rests with CMRL. Environment clearances related to locations and design of the project will be secured before start

of construction. Permissions/certifications required during operation of the project. Environment monitoring during operation.

310. Contractors: Permits required during construction and those directly related to construction. The EMP will be implemented by the contractors of different packages based on the contract agreement. The contractor environmental team will be headed by senior Manager assisted by qualified and trained safety professionals and environment engineers along with onsite junior field personnel. This team will be assisted by:

- electrical and mechanical engineers qualified in safety evaluation;
- environment engineer;
- traffic engineer; and
- professionals in occupational health and labour welfare.

311. The Employer Requirements for ESHS have been prepared for Corridor 4; they will be issued to the Contractor as part of the contract documentation for construction.

312. CMRL and GC: Supervision and review of implementation will be the responsibility of GC. With assistance from GC, CMRL will also be responsible for reviewing and approving any specific documents/plans that have to be provided by contractors (traffic management plan, waste management plan, muck disposal plan etc.). Implementation of EMP will be continuously monitored by the ESHS team of GC and CMRL. The CMRL-GC team will be common for all sections of the project with a view to facilitate unified approach and knowledge enhancement.

313. The CMRL's ESHS team will be headed by senior Manager assisted by qualified and trained mid-level safety professionals, environment engineers, traffic engineer, labour welfare officer. The Manager ESHS for the project in CMRL will report directly to Director (Works) and Managing Director, CMRL.

314. GC will contribute,

- Specialists from fields of safety, environment, traffic engineering, occupational and community health, ecology, noise and vibration □ Onsite junior field personnel, at least one site each.
- The visits and review meetings will comprise:
 - Weekly site visits independently by CMRL and jointly with contractor;
 - Weekly review meetings by CMRL and contractor;
 - Quarterly monitoring reports to CMRL; ○ Bi-annual monitoring reports to MDBs.
- Orientation and training of CMRL team in implementation of EMP and environmental monitoring will be undertaken at the beginning of the project.

315. MDBs: Disclosure of all latest safeguard documents on their websites. Implementation of the EMP will be monitored half yearly by MDBs through their specialists.

316. External Monitor: An external monitor will be engaged by CMRL in consultation with MDBs to evaluate the environmental performance of abovementioned parties with the listed responsibilities as below. The agency will report to CMRL who in turn report it to MDBs. The terms of reference are attached as Annexure 7.

- To conduct third party monitoring of environmental compliance under the project;
- To ensure that the Project will be implemented in conformity with the policies of Gol, GoTN, as well as MDBs' policies;

- To Identify any safeguard related implementation issues and necessary corrective actions and reflect these in a time-bound corrective action plan for CMRL to implement;
- Capturing social, environmental and economic benefits and particular potential benefits to the poor and vulnerable groups in the corridor;
- Involving users and stakeholders in the monitoring process; and
- Strengthening the capacity of the CMRL to manage and replicate third-party monitoring with rail users and stakeholders.

317. The reporting line of all relevant parties is, Contractor → PIU → CMRL and GC → MDBs. The external monitor will conduct independent monitor to inform CMRL any remediation actions to ensure the safeguard compliance.

318. An EMP Matrix is presented in Table 9.2.

9.4 Environmental Monitoring and Reporting Program

319. Environmental Monitoring Plan (EMoP) is a companion document of the EMP. 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

320. 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 9.3.

321. Monitoring and Reporting Frequency for implementation of the EMP is shown in Table 9.1.

Table 9-1: Monitoring and Reporting for EMP and EMoP

Particulars	Frequency of reporting	Reporting by / Reporting to	Review by/ Monitoring by
Starting from deployment of construction contractor from site selection period a) Implementation of EMP and EMoP b) Monitoring of implementation of EMP and EMoP c) Grievance Redressal	Monthly till completion of construction	a) Contractor / GC b) GC / CMRL SH&E team, CMRL SH&E team/MD, CMRL c) CMRL SH&E team/MD, CMRL	CMRL

Particulars		Frequency of reporting	Reporting by / Reporting to	Review by/ Monitoring by
a)	Implementation of EMP, EMoP and Grievance Redressal and their internal (CMRL) monitoring	Bi-annually till completion of construction	All by CMRL / MDBs	<ul style="list-style-type: none"> • MDBs • TNPCB
b)	Outcome of continuing public consultations			
Evaluate implementation and internal monitoring of EMP, EMoP, Grievance Redressal and their efficacy		Semiannually during construction	External Expert / CMRL	MDBs
a)	Implementation of EMP by CMRL and EMoP by external agency	Semiannually during first 2 years of operation & maintenance	a) and b) <ul style="list-style-type: none"> • EMoP Agency / GC • GC / CMRL SH&E team • CMRL SH&E team/MD, CMRL c) CMRL SH&E team/MD, CMRL	CMRL
b)	Monitoring of EMoP			
c)	Grievance Redressal			
a)	Implementation of EMP, EMoP and Grievance Redressal and Internal (CMRL) monitoring	Semiannually during first 2 years of operation & maintenance	CMRL / MDBs	<ul style="list-style-type: none"> • MDBs • TNPCB
b)	Outcome of continuing public consultations			
Evaluate implementation and EMP, EMoP, Grievance Redressal and their efficacy		Annually during first 2 years of operation & maintenance	External Expert / CMRL	MDBs

Table 9-2: Environmental Management Plan Matrix

Note: This EMP Matrix will form part of the contract document together with CMRL's SHE Manual for all contractors. This EMP has been aligned with the SHE Manual wherever possible, and in places, cross referencing has been resorted to.

SI. No.	Activity	Aspect / Parameter affected	Impact	Mitigation measures	Responsibility	
					Implementation	Supervision
Planning and Design Phase						
1.	Land Acquisition	Social	As per DPR October 2018, permanent acquisition of 5.7 ha private land. The final size of land to acquired will be updated based on the optimization of project design.	<ol style="list-style-type: none"> 1. Compensation and Resettlement benefits as well as livelihood restoration measures are under approval, 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. 2. Land Acquisition is being carried out as per the provision of GoTN and GoI policies. The affected people will be compensated and assisted as per the provisions of Resettlement Action Plan. 	CMRL	GoTN
2.	Change in Land use	Land	Land use will be slightly changed	<ol style="list-style-type: none"> 1. CMRL developed the Comprehensive Mobility Plan for CMA in 2015 to identify the present and future mobility patterns of Chennai Metropolitan Area, including development of Corridor 4. 2. Proper clearance/permission/consents will be sought from competent authority before construction. 	CMRL	GoTN
3.	Contractor Management	EHS	EHS accidents Reputational Risk	<ol style="list-style-type: none"> 1. Integration of EHS contractor management into broader project management, procurement, human resources, legal, and financial management. 2. "Prevention through design": assessment of what prime contractor does versus what subcontractors do; contractor prequalification (when, if, and for what); use of information technology tools (identification cards and tracking and reporting systems for personnel and training). 3. Prime contractor will be responsible for EHS practices of the subcontractor including human resource policy which complies with applicable labour legislations, including 	GC	CMRL

Sl. No.	Activity	Aspect / Parameter affected	Impact	Mitigation measures	Responsibility	
					Implementation	Supervision
				decisions on material supplies and equipment given environmentally friendly priorities, and prepare subcontract agreements accordingly. 4. Contractor management incorporates “adaptive management” to monitor and adapt over time; integration with sustainable procurement approach or concepts. 5. Building culture and commitment by demonstrating the importance of EHS management to the president or director of project-implementing agency and president or director of subcontractor; including EHS aspects in routine senior management project contractor meetings and reports, reflecting both criticisms or suggestions and praise; designating responsibilities of EHS staff (for example, work stoppage); requiring strong and consistent training and participation of managers; acknowledging managers’ participation in on-site supervision and resolution of issues; and providing awards, recognition, and incentives. 6. Training and quality control plans.		
4.	Contractor Preparatory Works (Upon issuance of Notice to Proceed)	EHS	Non-compliance with contract conditions and regulatory requirements.	1. The Contractor shall complete the following activities no later than 30 days upon issuance of Notice to proceed, (a) appoint contractor’s Safety, Health and Environmental Officer (SHEO); (b) SHEO will engage GC-Environment Specialist to discuss EMP, seek clarification and recommend corresponding revisions if necessary; (c) SHEO will agree with GC the monthly monitoring template and deadlines for submission; (d) SHEO will submit for GC’s approval an work 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	Contractor / GC	CMRL

Sl. No.	Activity	Aspect / Parameter affected	Impact	Mitigation measures	Responsibility	
					Implementation	Supervision
				vehicles. Arrangements to link with government health programs on hygiene, sanitation, and prevention of communicable diseases will also be included in the action plan; (e) SHEO will submit for GC's approval of the construction camp layout and management plan before its establishment; and (f) SHEO will update EIA (in consultation with GC, in case of design changes) and also prepare site-specific EMPs.		
5.	Labour Management	Labour	Labour right	<ol style="list-style-type: none"> 1. Compliance with Gol labor legislation, ratified International Labour Organization conventions. 2. Prohibition of child labor, including prohibition of persons under 18 years old from working in hazardous conditions (which includes construction activities) and from working at night; medical examinations required to determine that persons above 18 years old are fit to work. 3. Elimination of discrimination with respect to employment and occupation, to be defined as any distinction, exclusion, or preference based on race, gender, religion, political opinion, trade union affiliation, national extraction, or social origin. 4. Human resource policy or plans that establish (a) the rights and responsibilities of project company employees and any contractor employee working in the project regarding remuneration, working conditions, benefits, disciplinary and termination procedures, occupational safety and health, promotion procedures, and training and (b) the rights, responsibilities, and requirements in contractor or subcontractor agreements related to worker rights. 5. Grievance Redress Mechanism for workers should be established as early as possible to function no later than construction commencement. 6. There will be provision for group accidental insurance for the workers. 	Contractor	CMRL / GC

Sl. No.	Activity	Aspect / Parameter affected	Impact	Mitigation measures	Responsibility	
					Implementation	Supervision
		Health and Safety	Accidents	<ol style="list-style-type: none"> 1. Prepare the Health and Safety Plan for each site and assign a safety officer to monitor the compliance. 2. Make mandatory the use of safety gears (helmets, safety belts, masks, gloves, Ear plugs/ muffs and boot) by workers depending on nature of work. 3. Necessary planning and safety approach will be made for rescue during emergency. 4. Use of dust controls (exhaust ventilation) for dust control 5. Workers will be provided with first aid and health facilities at the site. 6. There should have facility to deal with medical aspects of HIV/AIDS treatment with specialized services. 7. GC to conduct Health and Safety Audit. 	Contractor	CMRL / GC
			COVID-19 response	<ol style="list-style-type: none"> 1. Taking cognizance of situation at time of mobilisation, the Contractor shall undertake a COVID-19 risk assessment of project area and prepare a COVID-19 Response and Management Plan (C-R&MP) and submit to CMRL and GC for approval. 2. The preparation of C-R&MP shall consider guidance of GoI, especially the Standard Operating Procedures and Guidelines for Construction Sites for COVID-19 Outbreak, other guidelines of WHO, International Labour Organisation, International Financial Corporation and World Bank's interim guidance note etc. The key points on COVID-19 Response and Management measures is at Annexure 8. 3. The contractor shall submit a weekly monitoring and progress report to CMRL and GC. 	Contractor	CMRL / GC
6.	Obtaining Clearance, Permission and Consents	Regulatory Compliance	Delay of obtaining CRZ clearance, Tree felling permission, Consents to establish labour camps, pre-casting and material yards, depots, establish and	<ol style="list-style-type: none"> 1. Consultation and coordination with relevant authorities to prepare the documents to obtain clearance, permission and consents. 2. Conditions set in CRZ clearance, other permission and consents to be incorporated into the site-specific EMPs, with dedicated officers to maintain the regulatory 	CMRL / Contractor	GoTN / TNCRZMA / TNPCB

Sl. No.	Activity	Aspect / Parameter affected	Impact	Mitigation measures	Responsibility	
					Implementation	Supervision
			operate hot mix plant, crushers, batching plant, DG sets etc. muck/waste disposal.	compliance tracker.		
7.	Site Clearance and Demolition	Tree felling	About 536 trees will be affected at alignments, stations and depot area. Additionally, in some areas, pruning will be required. Ecological Impacts on Panagal park	<ol style="list-style-type: none"> 1. CMRL and Contractor need to conduct a final tree inventory survey(number, type, height) with the final designs of alignment and station. Trees with conservation value should be transplanted. Plan to avoid cutting patrimonial trees, including adjustments in project design to minimize effect on such trees. 2. Revisit the works in public parks or green spaces and potential tree removal, especially involving patrimonial trees of special significance, so minimize the impacts as much as possible. 3. If unavoidable, implementation of acceptable plans for transplanting (to the extent technically and economically viable) or replacing such trees and for their short-term maintenance and care. 4. Adequate coordination with applicable government regulatory authorities. As alignment passes through built land use, green belt development along elevated section is not feasible. Compensatory plantation of 12 saplings for every tree felled will be done in sites to be identified. CMRL to allocate sufficient tree replantation budget. 5. Stakeholder communication to avoid or minimize public concerns or protests. 6. Exploration of restoration options for Panagal park enhancements, to offset negative impacts, accelerate ecosystem recovery and promote the health and longevity of the Panagal Park. Contractor and CMRL will work out an ecological restoration plan with a process of assisting the recovery of the ecosystem that will have been degraded, damaged or destroyed due to the construction of Corridor 4. Passive restoration actions may include fencing and signing sensitive areas during 	CMRL / Contractor	GoTN

Sl. No.	Activity	Aspect / Parameter affected	Impact	Mitigation measures	Responsibility	
					Implementation	Supervision
				<p>construction, which will minimize construction impacts. Active restoration actions include soil decompaction, revegetation, removal formal or informal trails out of sensitive area.</p> <p>7. Definition of adequate budget and contingencies as well as financial resources to cover all related costs. This will be finalized before work on relevant section is commenced between CMRL and Contractor.</p>		
		Noise	Noise will be generated the use of hand tools such as jackhammers, sledgehammers and picks etc.	<ol style="list-style-type: none"> 1. The procedure of demolition will be conducted as per the demolition plan prepared by the Contractor in consultation with CMRL. 2. The existing structures should be demolished one after another cautiously. 	Contractor	GC / CMRL / TNPCCB
		Physical Cultural Resources	Historic and Cultural Value Loss	<ol style="list-style-type: none"> 1. Contractor to conduct pre-construction structural integrity inspections if there are known or a significant likelihood of archeological and/or culturally valuable sites or finds in the project's direct area of influence. 2. Prepare a monitoring scheme prior to construction based on the above inspections, with a focus at locations where Tunnel Boring Machine will pass close to or under, to prevent the construction delay in case structural damage occurs during tunneling. 3. Compliance with applicable legislation (permits and procedures) and good international practice. 4. Adaptive management in site-specific EMP during final design, including site locations (stations, emergency exits, ventilation shafts, and construction staging areas). 5. Chance finds procedure to be prepared by Contractor and reviewed by GC/CMRL before submitting to all lenders. 	Contractor	GC / CMRL / GoTN
		Olive Ridley Turtle	Potential Habitat Loss	<ol style="list-style-type: none"> 1. CMRL engaging an ecologist to conduct a turtle nesting ground survey prior to mobilization. 2. Consultation with TNCRZMA to prepare the turtle conservation and monitoring plan during construction. 	Contractor / GC / CMRL	TNCRZMA

Sl. No.	Activity	Aspect / Parameter affected	Impact	Mitigation measures	Responsibility	
					Implementation	Supervision
				<ol style="list-style-type: none"> 3. GoI legislation, IFC/WB guidelines and international best practices should be integratedly followed. 4. Assessment of actual and potential disturbance effects of project activities and develop the Biodiversity Management Plan (BMP) to ensure no net loss of any target species including Olive Ridley Turtle. The BMP will outline the actions required by the contractor to conserve or enhance biodiversity during site works particularly during piling and construction work. The BMP will be reviewed by lenders prior to contractor's mobilization. 		
8.	Severance of utilities	Social EHS	The proposed alignments will cross drains and utility services such as sewer, storm water drains, water and wastewater pipes, roadside lights, telephone cables, electricity power lines, electric poles, natural gas lines and traffic signals etc.	<ol style="list-style-type: none"> 1. Assets and utilities will be maintained without affecting and damages by shifting temporary/ permanently where it is necessary. 2. Based on utility maps and network information, CMRL and Contractor in collaboration with utility owners oversees an investigation of existing utility supply infrastructure using trial pits or mix of 3D imaging and trial pits where pits pose safety hazards in built areas. CMRL and Contractor to conduct on-site inspections and a topographic survey. Even when utilities are far enough below the surface, to avoid damage from construction, they may need to be diverted so that their maintenance will not affect the safe and efficient operations of the train system once construction is completed. Utility owners will be involved in providing any new utilities needed for the rail system and in designing the necessary diversions and protection measures to minimize the risk to existing utilities from ground movement and surface settlement. 3. For gas pipeline, Contractor will conduct the hazardous operation study to ensure the smooth and safe shifting. 4. Utility shifting plan will be developed by CMRL and Contractor in coordination with concern authorities and shifting of utilities will be done as per agreed utility 	CMRL Contractor	/ GoTN

Sl. No.	Activity	Aspect / Parameter affected	Impact	Mitigation measures	Responsibility	
					Implementation	Supervision
				shifting plan prior to construction commenced. The plan will include required EHS management measures, supervision and monitoring of implementation, and final report and confirmation that construction works will be properly closed (for example, all waste will be removed or re-pavement will be completed as required).		
9.	Noise and Vibration Impacts Related Design	Environmental Nuisance	Noise and vibration from construction and train operation	<ol style="list-style-type: none"> 1. The detailed noise and vibration analysis (mathematical modeling) at sensitive receptors based on final engineering designs should be carried out, based on which, a set of mitigations should be prepared and shared with all lenders for review, prior to commencement of construction. 2. Additional assessments of vibration, such as visual inspections of buildings and baseline monitoring in areas with sensitive buildings of cultural or historical significance. 3. 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 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. 	Contractor	CMRL / GC
10.	Coordinate with the Traffic Department on Traffic Management Plan	Land Occupational safety Community safety	Nuisance from traffic congestion	<ol style="list-style-type: none"> 1. The Contractor shall develop detailed and robust traffic management plans consistent with the Indian Roads Congress (IRC) on Traffic Management in work zones (IRC:SP:55-2014), prior to mobilization for respective sections with site- or station-specific plans and measures to minimize the overall impact on traffic throughout the construction and operation periods. 2. At congested sections, the temporary traffic coordinators will be engaged by CMRL to facilitate the traffic management. 3. At the minimum, the traffic management plan will have 	Contractor	GC/ CMRL/ Traffic Police

Sl. No.	Activity	Aspect / Parameter affected	Impact	Mitigation measures	Responsibility	
					Implementation	Supervision
				<p>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> <p>4. Strengthening impact and risk prevention measures, such as establishing construction site works to minimize the entrance and exit of vehicles at stations during peak traffic.</p> <p>5. The logistics should be considered to manage transport materials from storage areas outside of the dense urban core to worksites and to return excavated soil and other materials to disposal locations. If needed, construction traffic may be confined to certain routes (based on infrastructure capacity) or restricted to certain off -peak hours (that is, to reduce noise pollution at night or to avoid commuting and school hours during the day).</p> <p>6. Any diversions of traffic will cause considerable confusion for pedestrians and drivers as they rearrange their itineraries, hence, to minimize the effects of the diversion or reorganization, it is necessary to conduct communication campaigns and disseminate appropriate information to urban residents and taxi and bus drivers in advance of disruptions. Efforts will be given to divert traffic to roads wide enough to accommodate extra traffic. Compliance with scheduled deadlines for the detour is essential. If necessary, bus service and other public and private transport services in the area should be improved to meet residents' transportation needs.</p> <p>7. Incorporation of community safety considerations into plan design, especially at locations such as Kutchery Road where buildings are close to the construction site.</p>		

Sl. No.	Activity	Aspect / Parameter affected	Impact	Mitigation measures	Responsibility	
					Implementation	Supervision
				8. CMRL and local authorities continue to play an oversight role in approving these plans during construction, evaluating their cumulative impact with other infrastructure projects in the region, and ensuring their dissemination to all relevant stakeholders.		
11.	Construction method, construction material and sites selection	Environment	Pollution and nuisance	<ol style="list-style-type: none"> 1. Contractor is committed to use environmentally friendly construction methods and materials, including cement, asphalt, and base materials etc. 2. Construction material shall be sourced from legalized and approved quarries. 3. Energy saving technologies will be embedded into the Project design wherever possible. For instance, solar panels, rainwater harvesting. Bureau of Energy Efficiency (BEE) certified/ Energy efficient LED lights, automatic signaling, etc., 4. Update of plan based on final contractor-defined estimated volumes and timing for groundwater pumping with intension of minimizing the groundwater consumption. The primary objective shall be to avoid extraction of groundwater for construction. However use of groundwater which has been generated by dewatering of excavations can be used in construction activities. In those instances where extraction of groundwater becomes unavoidable, contractor shall, with consent of CMRL, resort to such extraction. In such instances contractor-defined estimated volumes and timing for groundwater pumping with intention of minimizing the groundwater consumption. 5. Procedures for minimizing waste segregation, reuse, temporary storage, recycling, donation, and disposal. 6. Selection of waste disposal service providers (transport, recycling, and disposal) based on EHS criteria (including compliance with all regulatory requirements, no documented EHS issues related to materials at operation or site facilities, and agreement to provide 	Contractor CMRL	/ CMRL / GC

Sl. No.	Activity	Aspect / Parameter affected	Impact	Mitigation measures	Responsibility	
					Implementation	Supervision
				<p>access for site visits to discuss EHS management).</p> <p>7. Final selection of disposal or reuse sites for extracted soils from construction and assessment and determination of truck routes from project sites to disposal or reuse site.</p> <p>8. Focus will be placed on reuse of the extracted soil for enhancement of green space, waste recycle, and storm water runoff.</p> <p>9. Construction yards with aggregate crushing and screening, pre-casting, material and fuel storage and ready-mix concrete plants will be located away from habituated or ecologically sensitive areas. Locations will be decided by CMRL and cleared by MDBs before construction commencement in consultation with Municipal Corporation/Municipalities and CMDA.</p> <p>10. The muck disposal sites shall be identified by Contractor and will be decided by CMRL before start of construction in consultation with TNPCB, Municipal Corporation/Municipalities and CMDA, to ensure a safe distance from residential areas, water bodies and ecologically sensitive locations as to avoid disrupting natural drainage. The muck shall be filled in the dumping site in layers and compacted mechanically. Suitable slopes will be maintained on the stockpile. Once the filling is complete, it will be protected by low walls, provided with a layer of good earth on the top and covered with vegetation. A muck disposal plan will be prepared by Contractor.</p>		
12.	Climate Designs	Health and Safety	Natural disasters generated health and safety accidents Maintenance Cost	1. Belt of width approx. 0.5 km of beach and developed area on alignment between Lighthouse and Kutchery Road is underground and can be subject to flooding disrupting operations. On Corridor 4, flooding gates will be installed, and adequate facilities will be made in terms of evacuation of flood water using pumps in Lighthouse, Foreshore Road and any other stations with flooding	Contractor / GC	CMRL

Sl. No.	Activity	Aspect / Parameter affected	Impact	Mitigation measures	Responsibility	
					Implementation	Supervision
				<p>risks. Disaster management plan will pay special attention to flooding and other natural disaster to facilitate robust safety and quicker evacuation, to adapt the disruption of road level access to stations due to rise in mean sea level.</p> <ol style="list-style-type: none"> Other climate adaptation designs will be embedded in the final design, such as (a) improving adaptability to seasonal thermal variations in the stations through the use of large open spaces for unrestricted air movement, cross-ventilation and ensuring that enclosed areas are well ventilated; (b) designing for better adaptability to rising sea level/high tide/heavy flooding through the use of higher plinth levels and check valves for sewer lines in flood-prone areas and the use of resilient materials that can get wet and then dry out with minimal damage; and (c) rainwater harvesting through gutters and pipes together harvesting pits or for groundwater recharge. Climate change mitigation measures will be considered, such as solar panels on station buildings and roofs to reduce the extensive use of grid-generated electricity supplied to the station for operation and maintenance. 		
13.	Site-specific Environmental Baseline Collection and Assessment	Environment	Benchmark of assessing project impacts	<ol style="list-style-type: none"> Prior to mobilization, contractor to collect a full set of baseline data of air, water (surface and ground), noise, soil quality. Additional investigations in areas identified as having contaminated soil or groundwater to define the degree and extent of contamination and alternatives for soil and groundwater disposal. Assessment of potentially contaminated soil at site locations where soil work and excavations will be performed to examine the site situation. If there is a reasonable likelihood of contamination, then a specific management plan that includes (a) monitoring during construction consisting of visual inspections, on-site and in-situ monitoring to detect and confirm levels of contamination (and 	Contractor	CMRL / GC

Sl. No.	Activity	Aspect / Parameter affected	Impact	Mitigation measures	Responsibility	
					Implementation	Supervision
				<p>supplemented as needed by laboratory analysis), (b) on-site temporary storage and treatment, (c) final disposal (both for water and soil), and (d) worker health and safety procedures.</p> <ol style="list-style-type: none"> Assessment and site-specific measures for controlling noise, dust, and illumination during construction (for example, when working 24 hours a day). Confirmation of potential uses of groundwater and pumping impacts (for example, settlement or subsidence). Efforts on minimizing the groundwater consumption. Contractor to prepare site-specific EMPs for CMRL to approve before mobilization. Based on detailed construction work plan and associated occupational health and safety risks, strengthening the contractor health and safety management system in site-specific EMPs. CMRL and GC to provide EMP orientation to contractor. 		
14.	Documents Review and Information Disclosure	Environment	Unanticipated impacts management	<ol style="list-style-type: none"> With the assistance of GC, CMRL will review the above said data collections, surveys and pre-construction plans prepared by Contractor. CMRL will submit to all lenders to review the documents and disclose in a timely and meaningful manner prior to construction. 	GC	CMRL
15.	Establishment of Grievance Redress Mechanism	EHS	Complaints not resolved in time	<ol style="list-style-type: none"> Grievance Redress Mechanism for workers and project affected people should be established as early as possible to function no later than ground work commencement. The Grievance Redress Mechanism information and focal should be disseminated to public. 	CMRL	GoTN
16.	Community Liaison	Social	Complaints	<ol style="list-style-type: none"> To ensure that Grievance Redress Mechanism to function effectively for affected people on construction nuisance at ground level with grievance log well documented. 	Contractor	GC/ CMRL/ GRC

Sl. No.	Activity	Aspect / Parameter affected	Impact	Mitigation measures	Responsibility	
					Implementation	Supervision
				2. Contractor to develop a community communication plan per the construction plan, including important measures to reduce community risk, such as fence and related protection around work sites (including strength and visual protection), education and awareness signs and information, and placement of safety risks (explosive and flammable materials, generators).		
Construction Phase						
17.	Construction Monitoring	ESH	Breach of legislation, EIA, EMP, Contracts Accidents	<ol style="list-style-type: none"> 1. Contractor to collect and monitor the Ambient environmental data of air, water (surface and ground), noise & vibration, soil quality and submit monitoring reports to GC / CMRL on monthly basis. 2. GC / CMRL to review the data compared to baseline data and urge Contractor to take immediate actions over any project generated pollution / contamination. 3. GC to submit monitoring reports on quarterly basis to CMRL. 4. If any unanticipated EHS impacts arise during construction, implementation or operation of the Project that were not considered in the EIA / EMP, Contractor and GC to promptly inform CMRL of the occurrence of such risks or impacts, with detailed description of the event and proposed corrective action plan. CMRL will report to all lenders accordingly. 5. CMRL to engage qualified and experienced third party monitor to verify information produced through the Project monitoring process, and facilitate the carrying out of any verification activities by such third party monitor. 6. CMRL to submit the semi-annual monitoring reports (GC's and third party's) using the agreed template to all lenders. 7. CMRL to report all lenders any actual or potential breach of compliance with the measures and requirements set forth in the EMP promptly after becoming aware of the 	Contractor / GC / CMRL	GoTN (clearance /permission /consents compliance) / CMRL

Sl. No.	Activity	Aspect / Parameter affected	Impact	Mitigation measures	Responsibility	
					Implementation	Supervision
				breach.		
		Biodiversity	Breach of legislation and BMP	<ol style="list-style-type: none"> 1. Apart from the abovementioned measures for EHS monitoring, CMRL to ensure the BMP implementation monitoring and wildlife monitoring. If any wildlife species are found in the construction site, they will be carefully transferred to safe locations within the Coastal Zone or Marsh under the guidance of the biodiversity expert and the local forestry/wildlife agency. 2. Monitor noise level to minimize the impacts, for instance, use of rotary drilling rigs which generates less noise in comparison to impact hammer. The Construction Method Statement will follow the Good International Industry Practice. 3. Monitoring habitat enhancement to deliver net benefit to any Critical Habitat species. 	Contractor / GC / CMRL	Forest Department GoTN / CMRL
18.	Community Liaison	Social	Complaints	<ol style="list-style-type: none"> 1. To ensure that ongoing timely consultations / communications with communities are provided on the progress of the project together with feedbacks on the environmental management performance of the project. 2. Grievance Redress Mechanism for affected people should function effectively with grievance log well documented. 	Contractor	GC/ CMRL/ GRC

Sl. No.	Activity	Aspect / Parameter affected	Impact	Mitigation measures	Responsibility	
					Implementation	Supervision
				<ol style="list-style-type: none"> 3. 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), CMRL will undertake consultations. 4. Adaptive management that monitors, adjusts, or adds measures to reflect actual community risks. 5. Important measures to reduce community risk, such as fence and related protection around work sites (including strength and visual protection), education and awareness signs and information, and placement of safety risks (explosive and flammable materials, generators). 		
19.	Truck and Driver Management	Environment Social	Community disruption Accidents Reputational risk	<ol style="list-style-type: none"> 1. Contractor's transport vehicles and other equipment shall conform to emission standards. 2. Control, inspection, and documentation of trucks prior to leaving site, including removal of soil on tires. Contractor will provide a wash pit or a wheel washing and/or vehicle cleaning facility at the exits from construction depots and batching plants. At such facility, high-pressure water jets will be directed at the wheels of vehicles to remove all spoil and dirt. 3. Definition of allowable routes, speeds, and times (day or week). 4. Driver requirements and controls, including prework medical (and blood tests) and physical inspections, ongoing monitoring (of visual and alcohol or drug use), driver training, daily total allowable work time, and allowable deviations. 5. Driver contracts with clearly specified requirements and remedies for noncompliance. 6. Use of electronic monitoring (GPS), driver training, and 	Contractor	CMRL / GC

Sl. No.	Activity	Aspect / Parameter affected	Impact	Mitigation measures	Responsibility	
					Implementation	Supervision
				<p>stops.</p> <p>7. Procedure for truck maintenance, including selection of service providers considering environmental aspects, application of low-Sulphur fuel, no idling of trucks, routine maintenance (including assurance of proper engine operations related to emissions and noise), and disposal of used oil and other fluids, batteries, and tires etc.</p>		
20.	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	<ol style="list-style-type: none"> Interim drainage system will be installed prior to construction. Where feasible, infiltration losses could be countered by installing Rainwater Harvesting pits away from construction site. 	Contractor	GC/ CMRL
21.	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	<ol style="list-style-type: none"> At sensitive locations, auger piling will be carried out in place of mechanical (by driven) piling which will generate less noise than mechanical piling (around 70-75 dB(A)). Also 2m high barricade of GI sheet will be installed 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. Efforts should be made to keep the noise levels under control by appropriate noise attenuation and adopting employee safety measures. Use of low-noise equipment and ensuring good maintenance, and trying to avoid using high-noise equipment simultaneously at the same section. Wherever baseline noise already exceeds the standards, only 3 dB of noise increase is allowed. Information dissemination to local residents and shop owners about the nature and duration of intended activities including the construction method, probable effects, quality control measures and precautions prior to 	Contractor	GC/ CMRL

Sl. No.	Activity	Aspect / Parameter affected	Impact	Mitigation measures	Responsibility	
					Implementation	Supervision
				<p>commencement and kept updated as to changes in the management and mitigation plan.</p> <p>6. Enclose especially noisy activities if above the noise limits and employ transportable noise screens between noise sources and identified noise sensitive areas for the duration of noisy construction activities.</p> <p>7. Monitoring required during construction, including field observations and measurements.</p>		
		Air	Construction will result into fugitive dust generation.	<p>1. Fugitive dust could be controlled using water sprinkling. Water sprinkling to be carried out by Contractor at regular interval (to be mutually decided by the contractor and CMRL).</p> <p>2. Every vehicle should be washed to remove any dusty materials from its body and wheels before leaving the construction sites.</p> <p>3. Imposition of speed controls for vehicles on unpaved site roads. Ten kilometers per hour is the recommended limit.</p>	Contractor	GC/ CMRL
		Waste	Soil and surface/ground water pollution	<p>1. Bentonite slurries used in construction should be reconditioned and reused wherever practicable.</p> <p>2. The disposal of residual used bentonite slurry should follow the international good practice.</p> <p>3. Segregation and storage of different types of waste in different containers, skips or stockpiles to enhance reuse or recycling of materials and their proper disposal.</p> <p>4. Nomination of an approved person, such as a site manager, to be responsible for good site practices, arrangements for collection and effective disposal to an appropriate facility, of all wastes generated at the site.</p>	Contractor	GC/ CMRL
		Vibration	Pile driving for viaduct piers and buildings and tunnel driving generate vibrations	<p>1. Cast-in-situ piling will be deployed at locations with sensitive receptors so as to reduce vibration.</p> <p>2. At locations where the alignment is close to sensitive receptors, the contractor shall implement the pre-construction structural integrity inspections.</p>	Contractor	GC/ CMRL

SI. No.	Activity	Aspect / Parameter affected	Impact	Mitigation measures	Responsibility	
					Implementation	Supervision
				<ol style="list-style-type: none"> 3. Contractor to ensure that vibration levels at historically and culturally sensitive Structures, and Structures in poor state condition will not exceed 2.0 mm/s. 4. Information dissemination to local residents and shop owners about the nature and duration of intended activities including the construction method, probable effects, quality control measures and precautions prior to commencement and kept updated as to changes in the management and mitigation plan. 5. Monitoring during construction including field observations and measurements. 		
		Physical Cultural Resources	Historic and Cultural Value Loss Conflicts with community	<ol style="list-style-type: none"> 1. Before start of piling and tunneling, Contractor and CMRL will coordinate with State Archeological department to reconfirm that there is presence of buried artifacts along the metro line alignment. No piling or tunneling will be allowed unless cleared by the Archeological Department. 2. Archeological monitoring during construction stage, including specialists in field with authority to stop work. 3. All workers will undergo a briefing with the Archaeology Department to ensure safeguarding of heritage resource and cultural/religious practices. 4. 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 CMRL. 5. Archeological rescue and protection in case of chance finds, follow specific measures (reporting, monitoring) recommended by UNESCO. 	Contractor	GC/ CMRL
		Health & Safety	Noise and vibration generated during piling will affect the health and safety of the workers Accidents	<ol style="list-style-type: none"> 1. Auger 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). 2. To reduce the harmful effects, personnel working at high noise levels would be provided with noise protective 	Contractor	GC/ CMRL

Sl. No.	Activity	Aspect / Parameter affected	Impact	Mitigation measures	Responsibility	
					Implementation	Supervision
				<p>gears such as ear muffers, sound barriers, job rotations per occupational exposure limits etc.</p> <p>3. Oversight of project safety is needed to ensure proper support and lining of excavated sections to avoid collapse.</p> <p>4. Where a site boundary adjoins a road, streets or other areas accessible to the public, hoarding should be provided along the entire length except for a site entrance or exit.</p> <p>5. Procedure to receive, evaluate, and compensate (if applicable) damages due to construction and establishment of financial resources to cover this expense.</p>		
22.	Diaphragm Wall Construction	Air	Construction of diaphragm wall will result into fugitive dust generation.	<p>1. Fugitive dust could be controlled using water sprinkling. Water sprinkling to be carried out by Contract at regular interval (to be mutually decided by the contractor and CMRL).</p> <p>2. Every vehicle should be washed to remove any dusty materials from its body and wheels before leaving the construction sites.</p> <p>3. Imposition of speed controls for vehicles on unpaved site roads. Ten kilometers per hour is the recommended limit.</p>	Contractor	GC/ CMRL
		Waste	Soil and surface/ground water pollution	<p>1. Bentonite slurries used in diaphragm wall construction should be reconditioned and reused wherever practicable.</p> <p>2. The disposal of residual used bentonite slurry should follow the international good practice.</p> <p>3. Segregation and storage of different types of waste in different containers, skips or stockpiles to enhance reuse or recycling of materials and their proper disposal.</p> <p>4. Nomination of an approved person, such as a site manager, to be responsible for good site practices,</p>	Contractor	GC/ CMRL

SI. No.	Activity	Aspect / Parameter affected	Impact	Mitigation measures	Responsibility	
					Implementation	Supervision
				arrangements for collection and effective disposal to an appropriate facility, of all wastes generated at the site.		
		Health and Safety	Accidents	<ol style="list-style-type: none"> To specify the number and length of shifts for each worker. Oversight of project safety is needed to ensure proper support and lining of excavated sections to avoid collapse. Tunnels have to be properly lit, drained, and ventilated to provide visibility, dry working conditions, and breathable air free of dust even in confined spaces. Where a site boundary adjoins a road, streets or other areas accessible to the public, hoarding should be provided along the entire length except for a site entrance or exit. 	Contractor	GC/ CMRL
23.	Excavation (The quantum of soil excavated soil will be about 12.31 lakh cubic meter)	Air	Excavation will result into fugitive dust generation.	<ol style="list-style-type: none"> Fugitive dust could be controlled using water sprinkling. Water sprinkling to be carried out by Contract at regular interval (to be mutually decided by the contractor and CMRL). Imposition of speed controls for vehicles on unpaved site roads. Ten kilometers per hour is the recommended limit. Every vehicle should be washed to remove any dusty materials from its body and wheels before leaving the construction sites. Excavation machinery will be topped up by low-Sulphur fuel. 	Contractor	GC/ CMRL
		Noise and Vibration	Nuisance	<ol style="list-style-type: none"> Efforts should be made to keep the noise levels under control by appropriate noise attenuation and adopting employee safety measures. Use of low-noise equipment and ensuring good maintenance, and trying to avoid using high-noise equipment simultaneously at the same section. 	Contractor	GC/ CMRL

Sl. No.	Activity	Aspect / Parameter affected	Impact	Mitigation measures	Responsibility	
					Implementation	Supervision
				<ol style="list-style-type: none"> 3. Wherever baseline noise already exceeds the standards, only 3dB of noise increase is allowed. 4. Information dissemination to local residents and shop owners about the nature and duration of intended activities including the construction method, probable effects, quality control measures and precautions prior to commencement and kept updated as to changes in the management and mitigation plan. 5. Enclose especially noisy activities if above the noise limits and employ transportable noise screens between noise sources and identified noise sensitive areas for the duration of noisy construction activities. 6. Monitoring required during construction, including field observations and measurements. 7. Provide timely notification of residents about tunneling works will limit the nuisance of noise and vibration due to Tunnel Boring Machine (TBM) operation. 8. Contractor to ensure that vibration levels at historically and culturally sensitive Structures, and Structures in poor state condition will not exceed 2.0 mm/s. 		
		Surface water	Dumping of construction waste like concrete, bricks, waste material etc. cause surface water pollution.	<ol style="list-style-type: none"> 1. Proper drainage systems using contour information will be constructed around active and large construction sites. The wastewater should be discharged after sedimentation in tanks. 2. To avoid water pollution and soil erosion due to flooding, earthwork will be limited during monsoon season. 	Contractor	GC/ CMRL
		Groundwater	Dewatering (if done) will adversely affect the groundwater regime.	<ol style="list-style-type: none"> 1. Dewatering will be done only when required Groundwater will be collected in sedimentation tanks and reused in non-potable uses. Refer to SHE (Addendum to this EIA report). 2. This water will be treated to meet CPCB standards before discharge. 3. Groundwater monitoring, including groundwater quality 	Contractor	GC/ CMRL

Sl. No.	Activity	Aspect / Parameter affected	Impact	Mitigation measures	Responsibility	
					Implementation	Supervision
				and aquifer status.		
		Soil	Excavation will adversely affect the soil	<ol style="list-style-type: none"> 1. 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 lying area where it is necessary. 2. The topsoil should be preserved (by storing it at appropriate places) so that same can be restored after completion of work. 	Contractor	GC/ CMRL
		Subsidence	Ground subsidence under existing structures during tunneling due to unanticipated weak pockets of substratum and unanticipated degree of groundwater drawdown, raising safety issues and possible damage to structures	<ol style="list-style-type: none"> 1. Plan showing location of construction site and affected structures. 2. Groundwater extraction adjacent the metro project could lead to subsidence under non-metro structures as well as settlement of metro tunnel and stations between Kutcheri Road and Thirumayilai stations, Adyar gate to Alwarpet, Kodambakkam suburban (rock deeper than track level). At abovesaid locations, the bore wells need to be rationalized to avoid groundwater extraction near tunnel. 3. Groundwater drawdown can be minimized by sealing joints in tunnel lining. In addition, where required adjacent structures will be given additional supports. Sides of deep excavations at stations will be supported by walls which minimize water seepage. In open areas where side support walls in excavations are feasible, such walls will help prevent caving and thereby settlement of adjacent structures; in built up areas where side walls are not feasible, adjacent structures will be provided additional supports. 4. Caving of tunnel will be prevented by placing pre-cast concrete segments in soft soils and rock bolts or arch 	Contractor	GC / CMRL

Sl. No.	Activity	Aspect / Parameter affected	Impact	Mitigation measures	Responsibility	
					Implementation	Supervision
				<p>ribs in rock. Subsidence above tunnel due to removal of material and water beneath will be prevented by such tunnel supports.</p> <ol style="list-style-type: none"> Monitoring records which include but not limited to, groundwater drawdown records from borewells, vibration records, geotagged photographs with date. Real-time monitoring of structures above tunneling operations and adjustments of TBM operation if required. Record sheet showing type, size and identification number of structure, time of occurrence, type of equipment in use before and when the damage was first noticed, the type of minor repair executed, number of occupants present and evacuated, time of evacuation, status of adjacent structures, type of rehabilitation implemented on each affected structure, date of resumption of construction activities, date of return of occupants. 		
		Physical Cultural Resources	Historic and cultural value loss Conflicts with community	<ol style="list-style-type: none"> Before start of excavation, Contractor and CMRL will coordinate with State Archeological department to reconfirm that there is presence of buried artifacts along the metro line alignment. No excavation will be allowed unless cleared by the Archeological Department. Archeological monitoring during construction stage, including specialists in field with authority to stop work. All workers will undergo a briefing with the Archaeology Department to ensure safeguarding of heritage resource and cultural/religious practices. 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 CMRL. Archeological rescue and protection in case of chance finds, follow specific measures (reporting, monitoring) recommended by UNESCO. 	Contractor	GC/ CMRL

Sl. No.	Activity	Aspect / Parameter affected	Impact	Mitigation measures	Responsibility	
					Implementation	Supervision
		Health and Safety	Accidents	<ol style="list-style-type: none"> 1. To specify the number and length of shifts for each worker. 2. Oversight of project safety is needed to ensure proper support and lining of excavated sections to avoid collapse. 3. Tunnels have to be properly lit, drained, and ventilated to provide visibility, dry working conditions, and breathable air free of dust even in confined spaces. 4. Where a site boundary adjoins roads, streets or other areas accessible to the public, hoarding should be provided along the entire length except for a site entrance or exit. 	Contractor	GC/ CMRL
		Aesthetics	Loss of aesthetics value due to excavation and related activities.	<ol style="list-style-type: none"> 1. The excavation sites will be barricaded on all sides using GI sheets. Hauling will be carried out in non-peak hours. 2. Aesthetic value of the site will be restored after completion of the works. 	Contractor	GC/ CMRL
24.	Blasting	Aesthetics	Blasting will raise aesthetics issues among local citizen	<ol style="list-style-type: none"> 1. Rock is found in lower part of tunnel or beneath track level and so blasting is not anticipated. Good housekeeping practice should be adopted. 2. In the unforeseen event that blasting is required, a site-specific EMP will be prepared by Contractor and approved by CMRL before blasting commencement. 	Contractor	CMRL/ GoTN
25.	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	<ol style="list-style-type: none"> 1. The traffic management plan will be stringently implemented with regular monitoring and inspections. 2. The trucks/dumpers carrying the excavated material will be covered using tarpaulin/similar covering materials. 3. Sprinkling of water should be carried out. 4. Truck tires will be washed to excess remove soil clinging to it. Contractor will provide a wash pit or a wheel washing and/or vehicle cleaning facility at the exits from construction depots and batching plants. At such facility, high-pressure water jets will be directed at the wheels of vehicles to remove all spoil and dirt. 5. Water for sprinkling and tire washing will be sourced 	Contractor	GC/ CMRL/ GoTN

Sl. No.	Activity	Aspect / Parameter affected	Impact	Mitigation measures	Responsibility	
					Implementation	Supervision
				<p>from treated effluent from ETPs located nearby or seawater or surface runoff. Groundwater will not be used in view of status in Chennai.</p> <p>6. Haul roads will be kept in good state of maintenance.</p>		
		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) at 10 m distance). The adverse impacts of noise will be most intense in the residential / urban areas.	<ol style="list-style-type: none"> 1. The routing, timing and logistics of the haul truck movement should be planned to have minimal impacts on noise level. 2. The route selection will avoid any sensitive receptors. 3. Efforts should be made to keep the noise levels under control by appropriate noise attenuation and adopting employee safety measures. 4. Wherever baseline noise already exceeds the standards, only 3dB of noise increase is allowed. 5. Information dissemination to local residents and shop owners about the nature and duration of intended activities including the construction method, probable effects, quality control measures and precautions prior to commencement and kept updated as to changes in the management and mitigation plan. 6. Enclose especially noisy activities if above the noise limits and employ transportable noise screens between noise sources and identified noise sensitive areas for the duration of noisy construction activities. 7. Monitoring required during construction, including field observations and measurements. 	Contractor	GC/ CMRL
		Social	Incessant movement of trucks could create social issues. This will have higher occurrences near depots.	<ol style="list-style-type: none"> 1. The local community has to be taken into confidence before the construction commences. Their advice must be taken and incorporated in decision making. 2. Grievance Redress Mechanism for affected people should function effectively with grievance log well documented. 	Contractor	GC/ CMRL
		Health & Safety	The movement of trucks will increase the traffic risk of the commuters.	<ol style="list-style-type: none"> 1. The routing, timing and logistics of the haul truck movement should be planned to have minimal impact on occupational and community health and safety. 	Contractor	GC/ CMRL

Sl. No.	Activity	Aspect / Parameter affected	Impact	Mitigation measures	Responsibility	
					Implementation	Supervision
26.	Dumping of excavated materials	Air	The dumping operation of excavated material will generate fugitive dust in the nearby areas	<ol style="list-style-type: none"> 1. Site of dumping shall be selected by Contractor in consultation with CMRL and authorities. 2. The disposal plan will be stringently implemented with site monitoring and inspections. 3. It will be located outside of urban habitation. 4. Sprinkling of water should be carried out. 	Contractor / GC	CMRL /CMDA/ Chennai Municipal Corporation
		Soil	Dumping may increase the height of the land and affect the natural drainage pattern of the area	<ol style="list-style-type: none"> 1. The dumping shall be done in pre-designated low lying areas which are to be identified by Contractor in consultation with CMDA, TNPCB, and CMRL for this specific purpose. 2. The disposal plan will be stringently implemented with regular monitoring and inspections. 3. Field inspections, monitoring, and documentation of dumping excavated materials. 	Contractor	GC/ CMRL
27.	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, on the project line which passes through busy urban areas. This may also result into traffic congestion and air pollution from stagnated vehicles in urban areas. Primary pollutants will be Nox, CO, NMHC, and VOCs.	<ol style="list-style-type: none"> 1. Permission from Chennai 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. 2. Adaptive management with field inspections and monitoring during plan implementation and adjustments, as needed, to reflect actual traffic congestion or related issues 3. The Contractor 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. 	Contractor	GC/ CMRL

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.	<ol style="list-style-type: none"> 1. Permission from 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. 2. Detour route selection to avoid sensitive receptors to noise. 3. Adaptive management with field inspections and monitoring during plan implementation and adjustments, as needed, to reflect actual traffic congestion or related issues. 	Contractor	GC/ CMRL
		Social	Traffic diversion (especially For public transport) will create inconvenience	<ol style="list-style-type: none"> 1. Implement the traffic management plan. 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. 2. Real-time communication to public prior to site-specific work (for example, via signs, radio, and newspaper) and during key periods of traffic interference or peak traffic. 3. Adaptive management with field inspections and monitoring during plan implementation and adjustments, as needed, to reflect actual traffic congestion or related issues. 	Contractor	GC/ CMRL
		Resource consumption	Detouring will increase the road length to be travelled by a car, thus, increasing the overall fuel consumption.	<ol style="list-style-type: none"> 1. 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	GC/ CMRL / GoTN
28.	Restricted pedestrian movement	Social	Restricted pedestrian movement will cause social uproar, esp. in people living near metro stations	<ol style="list-style-type: none"> 1. Safe passage for pedestrians with proper sunshade / fall protection and signage will be planned. Public consensus will be built. 2. Grievance Redress Mechanism for affected people should function effectively with grievance log well 	Contractor	GC/ CMRL

Sl. No.	Activity	Aspect / Parameter affected	Impact	Mitigation measures	Responsibility	
					Implementation	Supervision
				documented.		
		Health & Safety	Movement though constricted space may cause potential health & safety issues amongst pedestrians	1. Safe passage for pedestrians with proper fall protection and signage will be planned.	Contractor	GC/ CMRL
29.	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	<ol style="list-style-type: none"> 1. Muck disposal plan will be stringently implemented with regular monitoring and inspections. 2. The construction sites will be provided with garland drains with intercepting pits to trap silt & muck. 3. Muck will be stored in lined tanks / ponds (if such area is available). Or mechanically dewatered if such area is unavailable. After screening & detention, supernatant liquid from such tanks should be discharged into drainage lines adhering to CPCB standards. Such tank/ ponds could be covered during monsoon to control runoff. 4. The temporary muck storage areas will be maintained by the Contractor at all times until the excavate is re-utilized for backfilling or disposed of as directed by Employer. Dust control activities will continue even during any work stoppage 5. Transportation of muck will be scheduled by time and route to minimize air pollution in habitat areas. 	Contractor	GC/ CMRL
		Groundwater	Muck, spent bentonite & drill fluids may settle down from pond / tanks and will affect groundwater	<ol style="list-style-type: none"> 1. The tanks/ ponds holding muck will be lined to prevent infiltration into groundwater. 2. Groundwater quality monitoring. 	Contractor	GC/ CMRL
		Aesthetics	Muck generation will create an aesthetic issue	1. The construction site will be covered from all sides to reduce visual impacts.	Contractor	GC/ CMRL

Sl. No.	Activity	Aspect / Parameter affected	Impact	Mitigation measures	Responsibility	
					Implementation	Supervision
30.	Raft foundation	Soil	Construction of raft foundation will generate concrete spoils. This will have adverse effects on soil	1. Concrete spoils will be collected manually and will be disposed in proposed disposal grounds.	Contractor	GC/ CMRL
31.	Steel structure preparation	Soil	Steel structure preparation will create steel scraps	1. Steel scrap will be collected, sorted by diameter and sold to scrap dealers on later date.	Contractor	GC/ CMRL
		Health & safety	Bar bending & other activities (including Working at heights) might pose a H&S threat to workers	1. Workers will be provided appropriate hand gloves and personal protective equipment (PPE). 2. Skilled workers working at height or doing hot work will be required to seek permission from site	Contractor	GC/ CMRL
32.	Stacking & warehousing of raw material	Surface water	Washed out raw material could pose serious threat to surface water bodies	1. Small dikes and garlanding drains along the periphery of the yard and ploy boundary could be constructed. This will control runoff and washing out of finer material.	Contractor	GC/ CMRL / GoTN
		Soil	Spillage of materials / mix products on the ground could pollute soil	1. Proper care will be taken. Such spills will be cleared by scraping and disposing the products as road sub-grade material.	Contractor	GC/ CMRL
		Health & Safety	Fine products like cement/ silt/ sand could cause harm to respiratory system.	1. Cement and sand will be stacked under tarpaulin and secured by GI sheet barricading (working & wind break). Shorter work shift and daily medical checkups of workers will be implemented. 2. Dust filters atop cement silos, wet suppression for aggregate crushing and screening will be employed.	Contractor	GC/ CMRL
		Aesthetics	Stacking of raw material will cause aesthetic issues for residential areas located nearby	1. The height of walls between the residential area and RM yard / construction area will be raised using GI sheets.	Contractor	GC/ CMRL

Sl. No.	Activity	Aspect / Parameter affected	Impact	Mitigation measures	Responsibility	
					Implementation	Supervision
33.	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.	<ol style="list-style-type: none"> 1. Timing of using RCC pumps will be specified. 2. RCC pumps will be covered from all sides. 3. Bends and excessive head will be avoided. 4. Wherever baseline noise already exceeds the standards, only 3dB of noise increase is allowed. 	Contractor	GC/ CMRL
		Soil	Spillage from concrete pouring may contaminate soil	<ol style="list-style-type: none"> 1. The spoils from pouring concrete will be collected and reused as sub-grade material in road construction. 	Contractor	GC/ CMRL
		Aesthetics	Spoils from concrete pouring will create unpleasant looking visuals	<ol style="list-style-type: none"> 1. After each pouring cycle, the spoils will be manually collected and reused as sub-grade material in road construction. 	Contractor	GC/ CMRL
34.	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).	<ol style="list-style-type: none"> 1. 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 PPEs. 2. Wherever baseline noise already exceeds the standards, only 3dB of noise increase is allowed per IFC/WB guideline. 	Contractor	GC/ CMRL / GoTN
		Soil	During setting, spillage from cast could take place.	<ol style="list-style-type: none"> 1. The spoils from pouring concrete will be collected and reused as sub-grade material in road construction. 	Contractor	GC/ CMRL
35.	Curing of concrete (use of water)	Surface water	Curing water will drain to the low lying areas and pollute water courses	<ol style="list-style-type: none"> 1. Garland drainage is proposed to be constructed around the construction yard. This will intercept the runoff generated from site. Rainwater harvesting (as a compensatory measure) will be practiced. 	Contractor	GC/ CMRL / GoTN
		Groundwater	Curing water will drain to the low lying areas and pollute water courses	<ol style="list-style-type: none"> 1. In view of low groundwater levels and proximity of sea coast, use of groundwater will not be resorted to. 	Contractor	GC/ CMRL

Sl. No.	Activity	Aspect / Parameter affected	Impact	Mitigation measures	Responsibility	
					Implementation	Supervision
		Aesthetics	Curing will create water impounding and may lead to vector propagation	1. Garlanding drain will be constructed around the construction area. The curing water impounded will be reused for curing.	Contractor	GC/ CMRL
36.	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 ²⁰ has found that the average daily noise exposure was 145 dBA for heavy equipment, and 84 to 99 dB (A) for heavy equipment, and 74 to 97 dB (A) for the crane operators.	<ol style="list-style-type: none"> 1. 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. 2. Workers working inside or near construction equipment should be provided with proper PPEs like ear plugs / muffs complying with IS 4869. 3. Wherever baseline noise already exceeds the standards, only 3dB of noise increase is allowed. 4. Information dissemination to local residents and shop owners about the nature and duration of intended activities including the construction method, probable effects, quality control measures and precautions prior to commencement and kept updated as to changes in the management and mitigation plan. 5. Enclose especially noisy activities if above the noise limits and employ transportable noise screens between noise sources and identified noise sensitive areas for the duration of noisy construction activities. 	Contractor	GC/ CMRL
		Health & Safety	Cranes and launchers are a major safety concern.	1. As per SHE, 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.	Contractor	GC/ CMRL

²⁰ Legris, M., and P. Poulin: Noise exposure profile among heavy equipment operators, associated labourers and crane operators. Am. Ind. Hyg. Assoc. J, pp.774-778, 1998.

Sl. No.	Activity	Aspect / Parameter affected	Impact	Mitigation measures	Responsibility	
					Implementation	Supervision
37.	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	1. 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 or septic tanks should be provided where access to public sewers is not possible.	Contractor	GC/ CMRL
		Groundwater	Surface water on flat terrain could percolate and contaminate groundwater.	1. Contractor to collect the groundwater baseline data prior to construction. 2. Disposal in compliance with applicable regulatory requirements. 3. Groundwater quality monitoring. 4. Water abstracted must be measured/ recorded periodically. 5. After Construction, Contractor will conduct groundwater analysis and be obliged to reinstate the used sites no worse than the conditions of pre-construction.	Contractor	GC/ CMRL
		Soil	Solid waste generated from the labour camps will cause soil pollution	1. Contractor to collect the soil baseline data prior to construction. 2. Municipal solid waste will be collected and taken away and disposed by municipality. 3. Solid waste will have to be disposed in compliance with Municipal Solid Waste (Management & Handling) Rules, 2000, as amended to date. 4. After Construction, Contractor will conduct soil analysis and be obliged to reinstate the used sites no worse than the conditions of pre-construction.	Contractor	GC/ CMRL
		Social	Influx of non-local labours will create a social issue	1. Mixing of skilled non-local labours with local unskilled people will reduce social frictions. 2. To avoid labor influx risk, sensitizing of local community and the non-local workers separately as well as jointly will be done regularly.	Contractor	GC/ CMRL
		Health & safety	Living in congested condition, make-shift temporary arrangement; the labours are prone to	1. Regular counselling, medical checkups and treatment at separate clinics, coordination with local health authorities will be conducted. 2. Per Building & Other Construction Workers (BOCW	Contractor	GC/ CMRL

Sl. No.	Activity	Aspect / Parameter affected	Impact	Mitigation measures	Responsibility	
					Implementation	Supervision
			diseases.	Regulation of Employment and Conditions of Service) Act, 1996 the employer (contractor) is liable to arrange for sanitation, health care facilities of labours, free of charge. Labour camps will be in full compliance of BOCW Act.		
		Resources	Labours will consume resources like wood for cooking	<ol style="list-style-type: none"> Liquid petroleum Gas cylinders will be made available free of cost to the labourers by the Contractor. Labour camps shall be provided with canteen facility. 	Contractor	GC/ CMRL
38.	Loading /unloading of construction material	Air	Loading & unloading of construction material will generate fugitive dust	<ol style="list-style-type: none"> The traffic management plan will be stringently implemented with regular monitoring and inspections. The trucks/dumpers carrying the material will be covered using tarpaulin/similar covering materials. Fugitive dust could be controlled using water sprinkling. Contractors should carry out water sprinkling. Truck tires will be washed to excess remove soil clinging to it. Contractor will provide a wash pit or a wheel washing and/or vehicle cleaning facility at the exits from construction depots and batching plants. At such facility, high-pressure water jets will be directed at the wheels of vehicles to remove all spoil and dirt. 	Contractor	GC/ CMRL
		Noise	Loading & unloading of construction material will generate noise	<ol style="list-style-type: none"> The RM storage yard will be separately built and enclosed from all sides. This will reduce noise generation at site. Concrete preparation will only take place in casting yards (away from habitation). Wherever baseline noise already exceeds the standards, only 3dB(A) of noise increase is allowed. Information dissemination to local residents and shop owners about the nature and duration of intended activities including the construction method, probable effects, quality control measures and precautions prior to commencement and kept updated as to changes in the management and mitigation plan. 	Contractor	GC/ CMRL

Sl. No.	Activity	Aspect / Parameter affected	Impact	Mitigation measures	Responsibility	
					Implementation	Supervision
				5. Enclose especially noisy activities if above the noise limits and employ transportable noise screens between noise sources and identified noise sensitive areas for the duration of noisy construction activities.		
		Health & safety	Fugitive dust and noise generation will have potential health & Safety implications.	1. Cement and sand will be stacked under tarpaulin and secured by GI sheet barricading (working & wind break). Shorter work shifts and regular health checkups will be implemented. 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	GC/ CMRL
39.	Use of batching plant	Air	Loading & unloading of construction material into batching plant will generate fugitive dust	<ol style="list-style-type: none"> High GI sheet screens and water sprinkling will be employed. Batching plant / casting yard shall be barricaded and made as a compulsory PPE zone. This will effectively reduce the fugitive dust generation. 	Contractor	GC/ CMRL
		Noise	Operation of batching plant will generate noise	<ol style="list-style-type: none"> GI sheet barricading around batching area and worker PPE like ear muffs will be used. Batching plant / casting yard shall be barricaded and made as a compulsory PPE zone. This will reduce the impacts of noise generation. Wherever baseline noise already exceeds the standards, only 3dB of noise increase is allowed. 	Contractor	GC/ CMRL
		Soil and Groundwater	Runoff of waste can contaminate soil and groundwater	<ol style="list-style-type: none"> Contractor to collect baseline soil and groundwater quality data prior to operate the plants. Municipal water will be used. In view of fragile groundwater status, extraction will be avoided. The construction sites will be provided with drains with intercepting pits in which the cement and sand will settle. After screening & detention, liquid will be discharged into 	Contractor	GC/ CMRL

Sl. No.	Activity	Aspect / Parameter affected	Impact	Mitigation measures	Responsibility	
					Implementation	Supervision
				<p>drainage lines. Disposal in compliance with applicable regulatory requirements.</p> <p>4. Soil and Groundwater quality monitoring.</p> <p>5. After Construction, Contractor will conduct soil and groundwater analysis and be obliged to reinstate the used sites no worse than the conditions of pre-construction.</p>		
		Hazardous waste	Health impacts and soil and groundwater pollution from hazardous water at batching/casting yards	<ol style="list-style-type: none"> 1. The use and storage of hazardous materials at the casting yard and batching plant should adhere to TNPCB requirements. 2. The transport, handling and storage of hazardous waste will be done in accordance with the provisions of Hazardous Chemicals (Management & Handling) Rules. Hazardous wastes from construction activity and equipment are labeled, recorded, stored in impermeable containment and for periods not exceeding mandated periods and in a manner suitable for handling storage and transport. 3. The contractor shall maintain a record of sale, transfer, storage of hazardous waste and make these records available for inspection. 4. The contractor shall get Authorized Recyclers to transport and dispose Hazardous Waste. 5. Proper collection and storage facilities will be provided especially for hazardous waste. 	Contractor	GC/ CMRL

Sl. No.	Activity	Aspect / Parameter affected	Impact	Mitigation measures	Responsibility	
					Implementation	Supervision
		Resources	If the batching plant will get its power from DG sets, substantial diesel will be consumed. (A 30 m ³ /hr. batching plant will require 150 ignali. 60 KW/hr. (or, 150 ignali. 75 KVA, assuming PF = 0.8) energy. In most cases the Contractor has used DGsets (from 100 – 250 kVA) for batching plant & ancillary facilities. Thus, the diesel req. will range from 30 – 45L/hr, at 100% load)	<ol style="list-style-type: none"> 1. If power from the grid is used, permission from power supply company must be obtained by the Contractor. 2. 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). 3. The required permissions from local Environmental Authorities/Pollution Control Board/ CEIG or any other relevant Authority shall be obtained by the Contractor for using DG sets for power supply. 4. Diesel storage if done beyond threshold limit (1000 L) permission should be obtained. Diesel should be stored on pukka platforms and spillages should be avoided. 5. Refer to Activity 42 "Use of DG sets" and Activity 44 "Storage of Diesel" for further measures. 	Contractor	GC/ CMRL
40.	Casting of segments and I-beams	Groundwater	Casting will require use of water	<ol style="list-style-type: none"> 1. Chennai Metropolitan Water Supply and Sewerage Board /Municipal water will be used. In view of fragile groundwater status, extraction will be avoided. 2. The construction sites will be provided with drains with intercepting pits in which the cement and sand will settle. After screening & detention, liquid will be discharged into drainage lines. Disposal in compliance with applicable regulatory requirements. 3. Groundwater quality monitoring. 	Contractor	GC/ CMRL
		Resources	Casting (incl. operation of gantry and hydraulic pre-stressing units) will consume lot of energy	<ol style="list-style-type: none"> 1. Pre-stressing and casting are basic requirements. However, most of the power should be drawn from approved lines, not from DG sets. 	Contractor	GC/ CMRL
41.	Curing of segments & I-beams	Groundwater	Curing will require a significant amount of water	<ol style="list-style-type: none"> 1. Wastages from curing could be collected separately and reused if possible. Stagnation of water (and resultant vector propagation) should be avoided. 2. Groundwater quality monitoring. 3. Disposal in compliance with applicable regulatory 	Contractor	GC/ CMRL

Sl. No.	Activity	Aspect / Parameter affected	Impact	Mitigation measures	Responsibility	
					Implementation	Supervision
				requirements 4. Groundwater will not be used. Water will be sourced from municipal supply or treated effluent from ETPs or treated surface runoff.		
42.	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	<ol style="list-style-type: none"> 1. The traffic management plan will be stringently implemented with regular monitoring and inspections. 2. The trucks/dumpers carrying the excavated material will be covered using tarpaulin/similar covering materials. 3. Sprinkling of water should be carried out. 4. Truck tires will be washed to excess remove soil clinging to it. Contractor will provide a wash pit or a wheel washing and/or vehicle cleaning facility at the exits from construction depots and batching plants. At such facility, high-pressure water jets will be directed at the wheels of vehicles to remove all spoil and dirt. 5. Haul roads will be kept in good state of maintenance. 	Contractor	GC/ CMRL
		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	<ol style="list-style-type: none"> 1. The routing, timing and logistics of the haul truck movement should be planned to have minimal impacts on noise level. The route selection will avoid any sensitive receptors. 2. Efforts should be made to keep the noise levels under control by appropriate noise attenuation and adopting employee safety measures. 3. Wherever baseline noise already exceeds the standards, only 3dB of noise increase is allowed. 4. Information dissemination to local residents and shop owners about the nature and duration of intended activities including the construction method, probable effects, quality control measures and precautions prior to commencement and kept updated as to changes in the management and mitigation plan. 5. Enclose especially noisy activities if above the noise limits and employ transportable noise screens between noise sources and identified noise sensitive areas for the 	Contractor	GC/ CMRL

Sl. No.	Activity	Aspect / Parameter affected	Impact	Mitigation measures	Responsibility	
					Implementation	Supervision
				duration of noisy construction activities. 6. Monitoring required during construction, including field observations and measurements.		
		Social	Incessant movement of trucks could create social issues	1. The local community has to be taken into confidence. Their advice has to be taken and incorporated in decision making.	Contractor	GC/ CMRL
		Health & safety	The movement of trucks will increase the traffic risk of the commuters	1. The routing, timing and logistics of the haul truck movement will be planned to have minimal impacts on occupational and community health and safety.	Contractor	GC/ CMRL
		Aesthetics	Movement of trucks will create an aesthetic problem	1. Proper housekeeping activities have to be undertaken near the casting yard and nearby areas.	Contractor	GC/ CMRL
43.	Use of DG sets	Air	Emission of NO _x , SO _x , CO, PM ₁₀ , PM _{2.5} from DG sets will create air pollution problems	<ol style="list-style-type: none"> 1. Primary power source will be power distribution company, DG sets will be used only for power back-ups for stations. 2. The required permissions from local Environmental Authorities/Pollution Control Board/ CEIG or any other relevant Authority shall be obtained by the Contractor if using DG sets for power supply. DG sets compliant with CPCB norms will be used. 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. 3. Stack height of DG sets will be as per CPCB requirement [stack ht. = 0.2*(rating in kVA)0.5] 4. Stack monitoring will be conducted monthly of the criteria pollutants. 5. Compliance monitoring will be done to the regularly and check the monitoring instruments. 6. Fuels used for DG will be High Speed Diesel with low-sulfur content. 	Contractor	GC/ CMRL

Sl. No.	Activity	Aspect / Parameter affected	Impact	Mitigation measures	Responsibility	
					Implementation	Supervision
		Noise & Vibration	Noise & vibration will be generated from the use of DG sets	<ol style="list-style-type: none"> 1. DG sets compliant with CPCB norms will be used. 2. Wherever baseline noise already exceeds the standards, only 3dB of noise increase is allowed. 3. Monitoring required during construction, including field observations and measurements. 4. DG sets will be enclosed type, with noise level approx. 75 dB (A) at a distance of 1m in compliance with GSR371(E) dt. 17-05-2002. 5. Noise will be controlled using acoustic enclosure. 6. The DG sets will be mounted on damping skids, which will reduce the vibration generated from DG sets. 	Contractor	GC/ CMRL
		Resources	DG sets will consume Diesel (and in effect reduce the levels of a non-renewable resource)	<ol style="list-style-type: none"> 1. DG sets should always be used as a power back up, and not the primary sources of power. This should be made mandatory for all Contractors. 2. Refer to Activity 44 "Storage of Diesel" for further measures. 	Contractor	GC/ CMRL
		Aesthetics	Operation of DG sets will cause an aesthetic issue	<ol style="list-style-type: none"> 1. Enclosures will be used to keep them off from public views. 2. 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. 	Contractor	GC/ CMRL
44.	All Construction Activities	Environment	Construction and Demolition (C&D) waste results from land clearing, excavation, construction, demolition, remodeling and repair of structures, roads and utilities	<ol style="list-style-type: none"> 1. Records of movement and loading/unloading of C&D waste and records of waste loaded by vendors. 2. C&D waste will be reused/recycled as it has the potential to save natural resources (stone, river sand, soil etc.) and energy. C&D waste generated from metro construction has potential use after processing and grading. 3. The contractor will segregate and temporarily store the C&D waste till the vendor takes it away for recycling and disposal at authorized facilities. 4. Contractor will adhere with the C&D Waste Management 	Contractor	GC/ CMRL

Sl. No.	Activity	Aspect / Parameter affected	Impact	Mitigation measures	Responsibility	
					Implementation	Supervision
				Rules.		
		Occupational Health and Safety	Accidents All parties' reputation	<ol style="list-style-type: none"> 1. Worker safety is important on all construction projects. It is important to consider the effects of staffing on worker safety and to provide appropriate training in safety awareness for all labor. 2. For underground construction, it is very important to conduct a fatigue assessment and to specify the number and length of shifts for each worker. Oversight of project safety is needed to ensure that tunneling is completed in suitable soil and drainage conditions and with proper support and lining of excavated sections to avoid collapse. Apart from the stringent inspection, tunnels have to be properly lit, drained, and ventilated to provide visibility, dry working conditions, and breathable air free of dust even in confined spaces. 3. The use of hearing protection should be enforced actively when the equivalent sound level over 8 hours reaches 85 dB(A), the peak sound levels reach 140 dB(C), or the average maximum sound level reaches 110dB(A). Hearing protective devices provided should be capable of reducing sound levels at the ear to at least 85 dB(A). 	Contractor	GC/ CMRL
45.	Storage of Diesel	Groundwater	Diesel spillage (from underground or above ground storage facility) will affect groundwater quality adversely	<ol style="list-style-type: none"> 1. Before it percolates into the groundwater, contaminated runoff water can be run through adsorbents such as bentonite to remove the diesel. The diesel will be quickly collected into steel trays and disposed to authorized recyclers. 2. All bulk diesel tanks shall be properly supported in an elevated position to facilitate gravity discharge. They 	Contractor	GC/ CMRL

Sl. No.	Activity	Aspect / Parameter affected	Impact	Mitigation measures	Responsibility	
					Implementation	Supervision
				<p>shall stand within a bund constructed to contain a volume of 110% of the volume of the tank. There shall be no breaches in the bund wall, no material shall be stored within the bund and rain water collecting in the bund shall be regularly removed to prevent build-up.</p> <p>3. Spillage will be controlled using methods mentioned in the environmental contingency plan.</p> <p>4. Groundwater quality monitoring.</p>		
		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	<p>1. Proper onsite emergency plan will be prepared and will be approved through CMRL.</p> <p>2. If the diesel storage crosses the threshold limits permissions, proper fire protection norms have to be undertaken as per National Building Code, 2005 (if building)/ Oil Industry Safety Directorate Standard 117 (if installation).</p>	Contractor	GC/ CMRL
46.	Cleanup Operations, Restoration and Rehabilitation	Environment	Aesthetics	1. The clean-up and restoration operations are to be implemented by the Contractor prior to demobilization. All spaces excavated and not occupied by the foundation or other permanent works shall be refilled with earth up to surface of surrounding ground.	Contractor	GC/ CMRL
Operational Phase						

Sl. No.	Activity	Aspect / Parameter affected	Impact	Mitigation measures	Responsibility	
					Implementation	Supervision
47.	Operation of metro trains	Noise and Vibration	The most significant source of noise will be rolling noise from contact between wheel and rail including noise from contact between the brake pad and wheel, followed by engine noise and aerodynamic noise.	<ol style="list-style-type: none"> 1. To minimize operation stage impacts measures such as 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 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. 2. In addition to the above mitigation measures, the roughness of running surfaces will be reduced through regular maintenance of wheels and tracks and will be considered for replacing traditional jointed track with continuously welded rail. Also, noise controls at the source will be installed for improved sound-proofing and other noise reducing features will be installed such as engine enclosures and shielding of wheels with vehicle-mounted shrouds. 3. Considering that the train generate a rolling noise of approx. 85 dB(A) at a ht. of approx. 8-12 m, the additional noise level will be approx. 55 - 60 dB(A) at a ht. of 1.5 m on ground. The noise level will be further reduced due to directivity, and conversion of frictional energy. The noise level at the bottom of the line will be insignificant and could be marginally different from ambient (traffic) noise. Since the rakes will be air conditioned and enclosed from all side, the impacts of noise on the travelers will be nominal. 4. Noise barriers will be installed at locations based on final design noise prediction analysis. 5. Wherever baseline noise already exceeds the standards, only 3dB of noise increase is allowed. 6. The mitigations suggested based on the detailed noise and vibration analysis carried out prior to commencement of construction, should be strictly followed. 	GC / CMRL	GoTN

		Health and Safety	Accidents Reputational risks	<ol style="list-style-type: none">1. Detailed specification of equipment e.g. power cables, rectifiers, transformer, E&M equipment etc. shall be framed to reduce conducted or radiated emissions as per appropriate international standards.2. The Metro system as a complete vehicle (trains, signaling & telecommunication, traction power supply, E&M system etc.) shall comply with the Electromagnetic compatibility (EMC) requirements of international standards viz. EN50121-3-1, EN50123, IEC61000 series	GC / CMRL	GoTN
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Sl. No.	Activity	Aspect / Parameter affected	Impact	Mitigation measures	Responsibility	
					Implementation	Supervision
				<p>etc. EMC requirements of international standards for whole railway system to the outside world shall comply with EN50121-2.</p> <ol style="list-style-type: none"> 3. A standby silent type DG set of adequate capacity at underground stations will sustain the following: essential lighting, signaling, and telecommunications, fire-fighting system, lift operation, and tunnel ventilation. 4. Automatic Train Protection and Automatic Train Supervision sub-systems will be installed to provide a high level of safety. 5. CCTV system will be installed for local and centralized monitor of operation. 6. In view of the potential hazards from system failure resulting to accidents, both on-site and off-site emergency measures will be implemented. All trains will have public address systems to warn the passengers of any emergency. 7. Emergency team, ambulance, contact number and hospital should be available. Emergency response plan should be implemented during operation periods. 		
		Aesthetics	Metro rail will increase the aesthetics of Chennai	1. A proper housekeeping routine will be followed to enhance the aesthetics of metro rail station & depot.	GC / CMRL	GoTN
48.	Maintenance of trains in Depot	Resources	Train washing will consume water and energy	<ol style="list-style-type: none"> 1. To save water resource, rainwater harvesting structures will be constructed at Depot to receive runoff from sloping roof of the depot as well as recharge of ground water in uncovered land area. 2. Rooftop solar panels on covered part of depots are proposed. As per Ministry of renewable Energy template, 5% of rooftop area of depot can generate 3.51 lakh kWh per year in Poonamallee Bypass depot. 3. DG sets will be used as a standby power. If used, refer to Activity 48 "Use of DG sets" for further measures. 	GC / CMRL	GoTN

Sl. No.	Activity	Aspect / Parameter affected	Impact	Mitigation measures	Responsibility	
					Implementation	Supervision
		Surface /ground water Soil contamination	The wastewater discharges from workshops will have high oil & grease, high COD & TSS content	<ol style="list-style-type: none"> 1. No direct discharge to the municipal sewer system, the Sewage Treatment Plant (STP) and Effluent Treatment Plant (ETP) are planned at Depot. 2. The wastewater will be pretreated to meet regulatory requirements before being disposed in municipal sewer system. 3. Sewage will be generated from depot which could be treated up to the level so that it could be used for horticulture and non-drinking purposes in the Depot. 4. Oil spilled in Depot should be trapped in oil and grease trap and disposed to authorized collectors so as to avoid any underground/ surface water contamination. Oil that is mixed in water shall be removed in the ETP. 5. The solid waste generated from the Depot will be taken by the cleaning contractor weekly and disposed to the municipal waste disposal sites. 	GC / CMRL	GoTN
49.	Track repair	Environment	Spill accidents	<ol style="list-style-type: none"> 1. CMRL to ensure no illegal disposal of solid waste or wastewater. 	GC / CMRL	GoTN
50.	Use of DG sets	Air	Emission from DG sets will create air pollution problems	<ol style="list-style-type: none"> 1. DG sets compliant with CPCB norms will be used. 	GC / CMRL	GoTN
		Noise	Noise & vibration will be generated from the use of DG sets	<ol style="list-style-type: none"> 1. DG sets compliant with CPCB norms will be used. 2. Noise enclosures will be used. 3. Wherever baseline noise already exceeds the standards, only 3dB of noise increase is allowed. 	GC / CMRL	GoTN
		Groundwater	Diesel spillage (from underground or above ground storage facility) will affect groundwater quality adversely	<ol style="list-style-type: none"> 1. Diesel should be stored in designated sites prior to final relocation. 2. Oil that is mixed in water will be removed in the ETP. 	GC / CMRL	GoTN
		Health & safety	Storage of Diesel will attract the provisions of Hazardous	<ol style="list-style-type: none"> 1. Diesel should be stored in designated sites prior to final disposal. 	GC / CMRL	GoTN

Sl. No.	Activity	Aspect / Parameter affected	Impact	Mitigation measures	Responsibility	
					Implementation	Supervision
			Chemicals (Management & Handling) Rules and Petroleum Rules; as amended to date. It could cause serious damage to health & safety of workers / property if ignited	<ol style="list-style-type: none"> 2. Fire fighter is equipped at storage site. 3. Proper onsite emergency plan will be prepared by GC and will be approved through CMRL. 		
		Resources	DG sets will consume Diesel (and in effect reduce the levels of a non- renewable resource)	1. DG sets compliant with CPCB norms will be used only as backup.	GC / CMRL	GoTN
		Aesthetics	Operation of DG sets will cause an aesthetic issue	1. Enclosures will be used.	GC / CMRL	GoTN
51.	Development of feeder routes	Social	Along with Metro routes, metro feeder routes will be developed. This will have a positive impact in terms of enhanced connectivity and inclusion in the social mainstream	1. CMRL will work with bus operators to implement metro feeder routes 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.	GC / CMRL	GoTN
		Health & safety	Better & frequent transport system will reduce risk of traffic accidents	1. The new feeder routes should (a) follow proper timetable; (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 CMRL.	GC / CMRL	GoTN

Sl. No.	Activity	Aspect / Parameter affected	Impact	Mitigation measures	Responsibility	
					Implementation	Supervision
		Aesthetics	Better designed coaches will enhance ride pleasure and aesthetics	1. The buses should be properly maintained from time to time in order to enhance the aesthetic value.	GC / CMRL	GoTN
52.	Generation of employment	Social	The proposed project will result into generation of employment	1. The project will cause direct and indirect employment generation. Economic activity will be stimulated by easier movement of passengers thus leading to indirect employment generation.	GC / CMRL	GoTN
53.	Ancillary development along metro route	Land	Ancillary developments will take place along with metro corridor	1. Provision for increased density of development along project corridor is available through existing byelaws as well as new ToD norms. Mixed land use of ToD tends to reduce non-work trip length and its higher density promotes increased use of metro for work trips on long distances. 2. Implementation of increased densities is decided by State Government and managed by CMDA in accordance with demand.	GC / CMRL	GoTN
		Social	Ancillary development along the metro alignment will have positive effect on the social environment	1. There should be positive participation of the common people in the ancillary development process. An open, transparent & people-centric outlook has to be adopted.	GC / CMRL	GoTN

Table 9-3: Environmental Monitoring Plan

Environmental Features	Aspect to be Monitored	Standard to be complied with	Time and Frequency of Monitoring	Location	Estimated cost (USD)
Pre-Construction stage					
Air	Emission of dust and particulate matter as PM _{2.5} and PM ₁₀ , NO _x and SO _x , CO	Gol and WHO/IFC whichever stringent	Once, 24 hours continuously	Each station, batching plant and casting yard, Muck disposal site	4,667

Environmental Features	Aspect to be Monitored	Standard to be complied with	Time and Frequency of Monitoring	Location	Estimated cost (USD)
Water (Surface and Ground)	DO, Turbidity, Conductivity, pH, Heavy metals, E.Coli, TSS, Oil and Grease, VOCs and Volatile Chlorinated Hydrocarbons (groundwater only) and TDS	Gol and WHO/IFC whichever stringent	Once, 3 samples each location	Groundwater at batching plant and casting yard, Muck disposal site, construction camps and 30 excavation sites Surface water at wherever waterbody located within 100m from sites	11,400
Soil	pH, Sulphate (SO ₃), Chloride, ORP, water Soluble salts EC, Organic Matter (Oil), Heavy metals, Poly-Aromatic Hydrocarbons (PAH), Moisture Content	Gol and WHO/IFC whichever stringent	Once, 3 samples each location	At batching plant and casting yard, Muckdisposal site, construction camps and 30 excavation sites	11,100
Noise, vibration b) Building condition survey	Noise levels in dB(A) Vibration PPV mm/s Building condition survey	Gol and WHO/IFC whichever stringent FTA Guideline Standards or any other internally recognized standards	a) Once Hourly basis for 24 hours (noise and vibration) b) Vibration: Once, X, Y and Z axis with a high accuracy triaxial sensor. Frequency range from 1 to 315Hz. Hourly basis for 24 hours b) Building Condition Survey: height	a) At key structure locations b) Key sections of line	a) 6,800 b) 178,091

Environmental Features	Aspect to be Monitored	Standard to be complied with	Time and Frequency of Monitoring	Location	Estimated cost (USD)
			measurements, crack survey, detailed photographic records etc.		
Sub-total					212,058
Construction stage					
Air	Emission of dust and particulate matter as PM _{2.5} and PM ₁₀ , NO _x and SO _x , CO	Gol and WHO/IFC whichever stringent	24 hours continuously every month	For each station until civil works completed batching plant and casting yard, Muck disposal site throughout construction phase	163,200
Water (Surface and Ground)	DO, Turbidity, Conductivity, pH, Heavy metals, TN, TP, E.Coli, TSS, Oil and Grease, VOCs (groundwater only) and TDS	Gol and WHO/IFC whichever stringent	Quarterly, 3 samples each location	Groundwater at batching plant and casting yard, Muck disposal site, construction camps throughout construction phase, and excavation sites stations until civil works completed Surface water at wherever waterbody located within 100m from sites	132,000
Soil	PH, Sulphate (SO ₃), Chloride, ORP, water Soluble salts EC, Organic Matter (Oil), Heavy metals, PAH, Moisture Content	Gol and WHO/IFC whichever stringent	Quarterly, 3 samples each location	At batching plant and casting yard, Muckdisposal site, construction camps throughout construction phase 30 excavation sites-once during construction, once post-construction	30,000

Environmental Features	Aspect to be Monitored	Standard to be complied with	Time and Frequency of Monitoring	Location	Estimated cost (USD)
Noise, and Vibration Subsidence	a) Noise levels in dB(A) b) Vibration PPV mm/s c) Deformation monitoring	Gol and WHO/IFC whichever stringent FTA Guideline Standards or any other internally recognized standards	a) Monthly or when complaint is received Hourly basis for 24 hrs (noise) b) Continuous monitoring when the TBM is within 10meters from the structure (vibration) c) Subsidence: building conditions, crack sensors, tilt sensors, continuous height measurement etc.	At key structure locations	a) and b)12,960 c) To be included by Construction contractor in his bid
Occupational and Community Health and Safety	As specified in project ESHS plan prepared by Contractor Sub-section F of Section VII and Part D of PCC	IFC General and Sector EHS Guidelines or any other international recognized guidelines	Weekly	Project Site	NA
Sub-total					338,160
Operation Stage					
Air	Emission from DG sets (PM ₁₀ , PM _{2.5} NO _x and SO _x), Odor	Gol and WHO/IFC whichever stringent	At least 2 times in a year for the first year, annually for another 2 years	Ventilations of UG Stations, DG sets of all stations and Depot	16,533
Groundwater	DO, Turbidity, Conductivity, pH, Heavy metals, TP, TN, E.Coli, TSS, Oil and Grease, VOCs and TDS	Gol and WHO/IFC whichever stringent	At least 2 times in a year for the first year, annually for another 2 years	Groundwater at Station locations and depot	12,400
Noise	Noise levels in dB(A)	Gol and WHO/IFC whichever stringent	At least 2 times in a year for the first year, annually for another 2 years	Alignment, Stations, Depot	3,733
Vibration	PPV mm/s	FTA Guideline Standards or any other internally recognized	At least 2 times in a years for the first year, annually for another 2 years	At key structure locations	16,000

Environmental Features	Aspect to be Monitored	Standard to be complied with	Time and Frequency of Monitoring	Location	Estimated cost (USD)
		standards			
Occupational Health and Safety	As specified in project EMP and CMRL's SHE Manual	IFC General and Sector EHS Guidelines or any other international recognized guidelines	Monthly for 3 years	Station and Depot	20,000 *
Sub-total					68,666
Grand total					618,884

During construction:

Noise: 2 construction yards on Bypass and Santhome Basilica and 4 locations between Saraswathi school to Government Hospital;
 Vibration: 3 receptors from underground section namely St Thomas Basilica, Rosary Church and Our Lady of Light Shrine which are all heritage structures; and Baseline Building Condition Survey from Foreshore Estate station to Thirumayilai station and Bharathidasan Road station to Panagal Park station.

During operation:

Occupational Health and Safety safeguards during operation are not spelt out in the SHE document. Based on experience on other railways, health issues relevant to Chennai metro can be as follows: a) Musculo-skeletal disorders and fatigue, eye strain due to Display Screens impacting drivers, train controllers and ticketing staff: Well-designed workstations, lighting, posture advice and regular health checkups. b) Stress impacting drivers and Train controllers: Risk assessment, changes to job design, task allocation, training, and supervision; emotional resilience training; counselling for recovery and rehabilitation.

** Lumpsum provision Group Insurance premium excluding surgeries and loss of life or limb: Rs five lakh per year*

9.5 Emergency Preparedness and Response System

322. An Emergency Preparedness and Response System has been prepared as shown in Table 9.4.

Table 9-4: Emergency Preparedness and Response System

Emergency Situations	Community or individuals impacted	Response procedure	Equipment and resources	Responsibilities	Training need	Accident and emergency records
Damage to utilities: Damage to one of the utilities water supply, sewage,	Community In case of live gas lines, the	<ul style="list-style-type: none"> The potential for disruption of utilities during line construction is low as long as proper pre-dig verification procedures are followed. Disruption could range 	<ul style="list-style-type: none"> ➤ For gas utilities • Fire engines to dispense water and foam • Portable 	Notification: Contractor to CMRL and utility agency CMRL to utility agency	<ul style="list-style-type: none"> • Mock drills • Use of extinguishers, fire suits, breathing 	<ul style="list-style-type: none"> • Utility location and diversion plans • Record sheet showing type, size and identification number of

Emergency Situations	Community or individuals impacted	Response procedure	Equipment and resources	Responsibilities	Training need	Accident and emergency records
gas pipelines; electric and telecommunication cables while other utilities are being diverted due to lack of clarity in their location or unexpectedly poor state of their maintenance. Damage while additional geotechnical investigations are in progress or during pile driving/in-situ casting.	project workforce could also be impacted	<p>from cable or phone outage to customers, to explosion in gas line with potential risk to human health and life.</p> <ul style="list-style-type: none"> • Contact utility to clear utility related safety hazard (like deactivating the utility). • Seek assistance of the utility to assess damage • Coordinate with un-impacted utilities. • Vital services and infrastructure recovery activities. 	<p>extinguishers</p> <ul style="list-style-type: none"> • Fire protection suits • Breathing apparatus, helmets, goggles and face shield, first aid kits, stretchers, torches, ladders, emergency lighting on standby power <p>➤ For water and sewage utilities</p> <ul style="list-style-type: none"> • Quick water sealants 	Remedial Action by: utility agency	apparatus, first aid kits, water sealants	<p>utility, time of occurrence, time of notifying utility agency, status of other utility lines at the locations, time of repair and resumption of construction activities</p> <ul style="list-style-type: none"> • Geotagged photographs with date
Ground subsidence due to unanticipated degree of groundwater drawdown	Community	<p>The base document available with the ER Team shows the location of structures which are at risk of subsidence as assessed at start of construction.</p>	<ul style="list-style-type: none"> • Helmets, first aid kits, stretchers, torches, ladders, emergency lighting on standby power, tents 	<p>Notification: Contractor to CMRL</p> <p>Remedial Action by: Contractor</p>	<ul style="list-style-type: none"> • Mock drills • Use of first aid kits 	<ul style="list-style-type: none"> • Plan showing location of construction site and affected structures • Groundwater drawdown records from borewells • Vibration records • Record sheet showing type, size and identification number of structure, time of occurrence, type of equipment in use
Ground subsidence under existing structures during tunneling due to unanticipated weak pockets of substratum	Community	<p>In the event of subsidence, move occupants of structures affected as well as those in their proximity to safer locations. Arrange for their temporary relocation till the structures are rehabilitated.</p>		<p>Notification: Contractor to CMRL</p> <p>Remedial Action by: Contractor</p>		

Emergency Situations	Community or individuals impacted	Response procedure	Equipment and resources	Responsibilities	Training need	Accident and emergency records
Collapse or severe degree of damage to existing structures due to unanticipated vibration during construction	Community	<ul style="list-style-type: none"> The base document available with the ER Team shows the location of structures which are at risk of damage due to vibration as assessed at start of construction. In case of those structures where damage is expected to be major especially due to age or condition of building, move occupants affected as well as those in their proximity to safer locations <i>before work is started at those locations</i>. Arrange for their temporary relocation till the structures are rehabilitated. In the event of minor damage to non-structural elements of the buildings, the same will be repaired. In case of <i>unforeseen damage</i> endangering structural soundness, move occupants of structures affected as well as those in their proximity to safer locations. Arrange for their temporary relocation till the structures are rehabilitated. 		Notification: Contractor to CMRL Remedial Action by: Contractor	<ul style="list-style-type: none"> Mock drills 	before and when the damage was first noticed, the type of minor repair executed, number of occupants present and evacuated, time of evacuation, status of adjacent structures, type of rehabilitation implemented on each affected structure, date of resumption of construction activities, date of return of occupants <ul style="list-style-type: none"> Geotagged photographs with date
Premature activation of blasting, collapse	Project workforce			Notification: Contractor to CMRL	<ul style="list-style-type: none"> Mock drills Air quality 	<ul style="list-style-type: none"> Record sheet showing location and time of occurrence,

Emergency Situations	Community or individuals impacted	Response procedure	Equipment and resources	Responsibilities	Training need	Accident and emergency records
of weak rock strata				Remedial Action by: Contractor	monitoring • First Aid • Use of Breathing apparatus, fire suit	type and configuration of explosive, number of personnel present and evacuated • Geotagged photographs with date
Fire and explosion of flammable gases, flooding during underground works	Project workforce	<ul style="list-style-type: none"> • The source of fire and explosions could be fuel stored underground or gas pockets. Use fire water and foam to combat fires of oil. Immediately cool the construction equipment and any gas containers to avoid explosion. • Headcount • Search and Rescue • Administer first aid • Gas monitoring • Block tunnel to prevent unauthorized personnel from entering the tunnel to facilitate rescue and reduce exposure to secondary explosions. • Lay ventilation ducts and send fresh air to reduce gas concentration. • Grouting, foam injection for gassy outburst and water inflow. 	<ul style="list-style-type: none"> • Emergency Lighting on standby • Power Equipment and Rescue Equipment • Breathing apparatus • Gas detector • Fire Proximity suit • First Aid Kit • Stretchers • Torches and Ladders • Ambulance • Standby non-sparking ventilation fans to evacuate gases and smoke from the underground works. • Standby high power pumps to evacuate flood water from the underground works 	<p>Notification: Contractor to CMRL and Fire Department, Police, hospitals and Tamil Nadu Pollution Control Board</p> <p>Remedial Action by: Contractor</p>	<ul style="list-style-type: none"> • Water seal • Evacuation • Search and Rescue 	<ul style="list-style-type: none"> • Plan of construction yards and sites showing designated men assembly areas, Emergency Vehicle parking areas and roads • Air and gas sample test reports • Record sheet showing location and time of occurrence, number of personnel present and evacuated • Geotagged photographs with date

Emergency Situations	Community or individuals impacted	Response procedure	Equipment and resources	Responsibilities	Training need	Accident and emergency records
			<ul style="list-style-type: none"> • Quick water sealants • Safety Equipment • Gum Boots • Safety Helmets • Rubber Hand Gloves • Goggles and face shield • Wind Direction Indicator • Ropes and harnesses ➤ Depending on the number of workers underground, one or two rescue teams – one at jobsite and one near the site. 			
<p>Fire accidents at electric installations, fuel storage and fueling facilities</p>	<p>Community and project workforce</p>	<ul style="list-style-type: none"> • Transformer or Substation fire requires equipment be de-energised. • Use fire water and foam to combat fires of oil. • Immediately cool the equipment and any containers to avoid explosion. • Follow designated standoff distance and stand down period. • Administer first aid 	<ul style="list-style-type: none"> • Fire engines to dispense water and foam • Portable extinguishers • Fire protection suits • Breathing apparatus, helmets, goggles and face shield, 	<p>Notification: Contractor to CMRL and Fire Department, Police, hospitals and Tamil Nadu Pollution Control Board</p> <p>Remedial Action by: Contractor</p>	<ul style="list-style-type: none"> • Mock drills • First Aid • Use of fire extinguishers, fire suits, breathing apparatus • Evacuation • Search and Rescue 	<ul style="list-style-type: none"> • Fuel and vapour sample test reports • Maintenance reports of electric and fuel installations • Record sheet showing location and time of occurrence, number of personnel present and evacuated • Geotagged

Emergency Situations	Community or individuals impacted	Response procedure	Equipment and resources	Responsibilities	Training need	Accident and emergency records
			first aid kits, stretchers, torches, ladders, Emergency lighting on standby power			photographs with date
Road accident hazard due to leakage of hazardous waste such as waste fuels, lubricants during transport by vendors	Community and project workforce	<ul style="list-style-type: none"> • Even if grievous hurt and loss of life to workers and community and property is not caused, if incident occurred in public area posing a hazard, notify Police and alert Pollution Control Board. • Control the leak/flow • Arrange for sampling of any water pollution or potential pollution 	<ul style="list-style-type: none"> • First aid kits, stretchers, torches, ladders, emergency lighting on standby power 	<p>Notification:</p> <ul style="list-style-type: none"> • Contractor to CMRL • CMRL to Traffic Police and Tamil Nadu Pollution Control Board. <p>Remedial Action by: Contractor</p>	<ul style="list-style-type: none"> • Mock drills • First Aid • Use of fire extinguishers, fire suits, breathing apparatus 	<ul style="list-style-type: none"> • Waste identification report • Record sheet showing location and time of occurrence, number of personnel present and evacuated • Geotagged photographs with date
Air pollution due to leakage and fire of flammable gases from muck disposal site slope failure of muck stack at disposal site	Community and project workforce	<ul style="list-style-type: none"> • Even if grievous hurt and loss of life to workers and community and property is not caused, if incident occurred in public area posing a hazard, notify Police and alert Pollution Control Board. • Use fire water 	<ul style="list-style-type: none"> • Fire engines to dispense water and foam • Portable extinguishers • Fire protection suits • Breathing apparatus, gas detectors, helmets, goggles and face shield, first aid kits, stretchers, torches, ladders, Emergency lighting on standby power 	<p>Notification:</p> <ul style="list-style-type: none"> • Contractor to CMRL and Fire Department • CMRL to Tamil Nadu Pollution Control Board <p>Remedial Action by: Contractor</p>	<ul style="list-style-type: none"> • Mock drills 	<ul style="list-style-type: none"> • Gas sample test reports • Record sheet showing location and time of occurrence, number of personnel present and evacuated • Geotagged photographs with date
Failed launching of pre-cast girders or	Community and project	<ul style="list-style-type: none"> • Administer first aid • Organise lifting equipment and 	<ul style="list-style-type: none"> • Lifting equipment and gas 	<p>Notification:</p> <ul style="list-style-type: none"> • Contractor to CMRL 	<ul style="list-style-type: none"> • Mock drills • First Aid 	<ul style="list-style-type: none"> • Structural drawings of failed elements

Emergency Situations	Community or individuals impacted	Response procedure	Equipment and resources	Responsibilities	Training need	Accident and emergency records
segments	workforce	gas cutters <ul style="list-style-type: none"> • Even if grievous hurt and loss of life to workers and community and property is not caused, but if collapse occurred in public area posing a hazard, notify Police. 	cutters <ul style="list-style-type: none"> • First aid kits, stretchers, torches, ladders, emergency lighting on standby power 	CMRL to Police and district labour Commissioner Remedial Action by: Contractor	<ul style="list-style-type: none"> • Search and Rescue 	<ul style="list-style-type: none"> • Record sheet showing location and time of occurrence, type of lifting equipment used, number of personnel present and evacuated • Geotagged photographs with date
Collapse of temporary works such as scaffolding and excavation support	Community and project workforce	In case of injured worker suspended from his harness, wait for trained emergency personnel.		Notification: Contractor to CMRL CMRL to Police and district labour Commissioner Remedial Action by: Contractor	<ul style="list-style-type: none"> • Mock drills • First Aid 	<ul style="list-style-type: none"> • Structural drawings of failed temporary works • Record sheet showing location and time of occurrence, number of personnel affected • Geotagged photographs with date
Health and safety impacts due to failure of ventilation in underground station	Metro Passengers and employees	<ul style="list-style-type: none"> • Notify Operational Control Centre (OCC) and suspend boarding and alighting in affected station; let trains pass through. • Administer first aid • Close entry of passengers into affected stations • Evacuate passengers. 	<ul style="list-style-type: none"> • Standby non-sparking ventilation fans to ventilate • Breathing apparatus for vulnerable passengers • Maintenance equipment, spares and personnel 	Notification: CMRL to Emergency Action Committee Remedial Action by: CMRL	<ul style="list-style-type: none"> • Mock drills • First Aid • Use of breathing apparatus • Evacuation 	<ul style="list-style-type: none"> • Ventilation system readings • Ventilation system maintenance reports • Record sheet showing location and time of occurrence, number of persons affected • Geotagged photographs with date
Service disruption and unplanned congestion due to failure of platform	Metro Passengers	<ul style="list-style-type: none"> • As soon as duration of failure approaches disruption period allowed in station design, notify OCC and suspend boarding and 	Maintenance equipment, spares and personnel	Notification: CMRL to Emergency Action Committee	<ul style="list-style-type: none"> • Mock drills 	<ul style="list-style-type: none"> • PSD and rolling stock usage log • PSD and rolling stock maintenance

Emergency Situations	Community or individuals impacted	Response procedure	Equipment and resources	Responsibilities	Training need	Accident and emergency records
screen doors or rolling stock doors		alighting at affected station <ul style="list-style-type: none"> • close entry of passengers into affected stations • Trains arriving in affected duration will pass without stopping • Affected trains will passthrough to maintenance depot for attention 		Remedial Action by: CMRL		reports <ul style="list-style-type: none"> • Record sheet showing location and time of occurrence, number of services affected • Geotagged photographs with date
Service disruption and unplanned congestion due to failure of traction power supply or signaling during operation of the Metrorail	Metro Passengers	<ul style="list-style-type: none"> • In case of traction power failure, affected trains reach nearest station on battery. • In case of signalling failure, stop affected trains at nearest station. • Suspend operation of trains bound to pass through affected stations or section; stop trains at stations outside affected section • Close entry of passengers into affected stations 	Maintenance equipment, spares and personnel	Notification: CMRL to Emergency Action Committee Remedial Action by: CMRL	<ul style="list-style-type: none"> • Mock drills 	<ul style="list-style-type: none"> • TPS and S&T log • TPS and S&T maintenance reports • Record sheet showing location and time of occurrence, number of services affected • Geotagged photographs with date
Unplanned congestion in stations due to failure of general power through grid supply for lighting, communication etc	Metro Passengers	<ul style="list-style-type: none"> • As soon as standby supply is activated, notify OCC and suspend boarding and alighting in affected station; let trains pass through. • Close entry of passengers into affected stations • Switch on battery-powered high-power lamps which have been fixed to stations structure • Use portable hailers to address passengers and employees • Use portable lamps to locate 	<ul style="list-style-type: none"> • Handheld 2 way radios and hailing loudspeakers • Portable handheld lamps • Maintenance equipment, spares and personnel 	Notification: CMRL to Emergency Action Committee Remedial Action by: CMRL	<ul style="list-style-type: none"> • Mock drills 	<ul style="list-style-type: none"> • Standby system maintenance reports • Record sheet showing location and time of occurrence • Geotagged photographs with date

Emergency Situations	Community or individuals impacted	Response procedure	Equipment and resources	Responsibilities	Training need	Accident and emergency records
		and evacuate passengers and employees.				
Fire in underground section		<ul style="list-style-type: none"> • In case of manual or semi-automatic ventilation systems, operator to activate ventilation upon detection of fire In case of fire in station: <ul style="list-style-type: none"> • Suspend operation of trains bound to pass through affected stations or section: stop trains at stations upstream and downstream of affected station. • Render First Aid • Close entry of passengers into affected station In case of fire in train: <ul style="list-style-type: none"> • Drive the train on fire to the platform of the next station without stopping at intermediate sections to evacuate the passengers and carry out fire-fighting activities there. • Once notified by the driver of the train on fire, the OCC will direct the train in front of the train on fire to proceed to the next station and the train running behind the train on fire to stop. Trains running on the opposite track will also be directed not to access or stop at the station where the train on fire arrives. • If the train on fire stops at the station or the station is burning, 	<ul style="list-style-type: none"> • Fire protection suits • Breathing apparatus, gas detectors, helmets, goggles and face shield, first aid kits, stretchers, torches, ladders 		<ul style="list-style-type: none"> • Mock drills • First Aid • Use of fire suits, breathing apparatus • Evacuation • Search and Rescue 	<ul style="list-style-type: none"> • Record sheet showing location and time of occurrence, number of services affected • Geotagged photographs with date

Emergency Situations	Community or individuals impacted	Response procedure	Equipment and resources	Responsibilities	Training need	Accident and emergency records
		<p>the train dispatcher shall direct other trains not to approach this station.</p> <ul style="list-style-type: none"> • In case evacuation becomes necessary while train is in tunnel, passengers will be asked to exit through side doors onto the inspection gallery in the tunnel. 				
<p>Flooding of underground stations due to unanticipated sea level rise or failure of pumping equipment</p>	<p>Metro Passengers</p>	<ul style="list-style-type: none"> • At times of extreme sea level rise based on alerts from meteorological department, deploy trained rescue teams at vulnerable stations • As soon as flooding is imminent, notify Operation Control Centre to suspend operation of trains bound to pass through affected stations or section; stop trains at stations outside affected section • Administer first aid • Notify nearby hospitals for ambulances • Evacuate trains which have been stopped • Close entry of passengers into affected stations • Switch on battery-powered high-power lamps which have been fixed to stations structure • Disconnect grid and standby DG power supply with turnstiles in default open mode. • Use portable hailers to address 	<ul style="list-style-type: none"> • Trained rescue teams at vulnerable stations • Inflatable life jackets • Portable lamps and hailers • 2 way radios • Battery-powered high-power lamps fixed to station structure 	<p>Notification: CMRL to Emergency Action Committee, Police, State Government</p> <p>Remedial Action by: CMRL</p>	<ul style="list-style-type: none"> • Mock drills • First Aid • Use of breathing apparatus, life jackets • Evacuation • Search and Rescue 	<ul style="list-style-type: none"> • Maintenance records of pumps • Record sheet showing location and time of occurrence, number of services affected • Geotagged photographs with date

Emergency Situations	Community or individuals impacted	Response procedure	Equipment and resources	Responsibilities	Training need	Accident and emergency records
		passengers and employees • Use portable lamps to locate and evacuate passengers and employees.				
Service disruption, Grievous hurt, loss of life due to natural disasters such as unanticipated earthquakes	Community and Metro Passengers	<ul style="list-style-type: none"> • Notify Operation Control Centre to suspend operation of trains bound to pass through affected stations or section; stop trains at stations outside affected section • Administer first aid • Notify nearby hospitals for ambulances and to standby • Evacuate trains which have been stopped • Close entry of passengers into affected stations • Switch on battery-powered high-power lamps which have been fixed to station structure • Disconnect grid and standby DG power supply with turnstiles in default open mode. • Use portable hailers to address passengers and employees • Use portable lamps to locate and evacuate passengers and employees. 	<ul style="list-style-type: none"> • Trained rescue teams • Emergency battery fixed lighting • Hand torches • First Aid Kits • Safety helmets • Ropes and safety harnesses • Stretchers • Ladders • Ambulance • Rail-cum-road Vehicles 	Notification: CMRL to Emergency Action Committee, hospitals, Police, State Government, Commissioner Metro Rail Safety (CMRS) * Remedial Action by: CMRL	<ul style="list-style-type: none"> • Mock drills • First Aid • Evacuation • Search and Rescue 	<ul style="list-style-type: none"> • Magnitude and epicenter of earthquake • Seismic design adopted in design of structures • Record sheet showing location and time of occurrence, number of persons affected • Geotagged photographs with date
Unplanned congestion in stations due to terrorism or sabotage or law and order	Community, Metro Passengers and employees	<ul style="list-style-type: none"> • Notify Operation Control Centre to suspend operation of trains bound to pass through affected stations or section; stop trains at stations outside affected 	<ul style="list-style-type: none"> • First Aid Kits • Stretchers • Ambulance 	Notification: CMRL to Emergency Action Committee, hospitals, Police, State Government		<ul style="list-style-type: none"> • Record sheet showing location and time of occurrence, number of persons affected

Emergency Situations	Community or individuals impacted	Response procedure	Equipment and resources	Responsibilities	Training need	Accident and emergency records
situations on Metro project or outside Metro project		section <ul style="list-style-type: none"> • Administer first aid • Notify nearby hospitals for ambulances and to standby • Evacuate trains which have been stopped • Close entry of passengers into affected stations 		Remedial Action by: CMRL		• Geotagged photographs with date
Grievous hurt, loss of life and property due to terrorism or sabotage or law and order situations on Metro project				Notification: CMRL to Emergency Action Committee, hospitals, Police, State Government, CMRS* Remedial Action by: CMRL	<ul style="list-style-type: none"> • Mock drills • First Aid • Evacuation • Search and Rescue 	
Acts of suicide or murder or hurt	Perpetrators and victims	<ul style="list-style-type: none"> • Notify OCC and suspend operation of trains on affected platform; stop trains at stations outside affected section • Administer first aid • Notify nearby hospitals for ambulance and to standby 	<ul style="list-style-type: none"> • First Aid Kits • Stretchers • Ambulance 	CMRL to Emergency Action Committee, hospitals, Police, State Government, CMRS* Remedial Action by: CMRL	<ul style="list-style-type: none"> • Mock drills • First Aid • Evacuation 	

* Metro Railway (Operations and Maintenance) Act, 2002 requires reporting of a) collision or derailment of trains or b) accidents attended or usually attended by loss of life or grievous hurt

9.6 Training and Capacity Building Programs

323. CMRL's current capacity in monitoring of metro projects is inadequate. However it is proposed to conduct a training program for CMRL as well as general consultant and contractors environmental, health and safety officials particularly on MDBs' monitoring and reporting requirements. External monitor will undertake training and capacity building activities. Training modules will be discussed and confirmed by CMRL and MDBs. A budget has been allocated in the EMP for the same.

324. Environmental Safeguards Specialist has been added to PIU: he will supervise work on all MDB corridors. The CMRL core Environment Safeguards team will be responsible for all corridors: it will be supported during construction by 2 junior CMRL environmental engineers who are assigned and charged to each corridor, assisted by safety, environmental, traffic, labour welfare professionals deployed by GC. During operation of metro, the core team will continue to monitor implementation of EMP by the metro operations contractors and EMoP by external environment monitoring agencies.

9.7 Environmental Management Budget and Resources

325. 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 is estimated as below. This cost estimate is exclusive of land acquisition and resettlement & resettlement cost.

Table 9-5: Cost of EMP and EMoP Implementation*

Sl. No.	Item/Particular	Cost (Rs in Lakh)
1.	Rainwater Harvesting	451.89
2.	Air, Noise, vibration, Water, Soil monitoring during construction and operation *	464.16
3.	Environment Division	97.80
4.	Tree Plantation	101.30
5.	Sewage Treatment Plant	33.79
6.	Effluent Treatment Plant	45.00
7.	Training and capacity building	55.94
8.	Rooftop Solar Plant	886.32
	Total	2,136.20

* Does not include cost of monitoring of building condition survey during construction and ecological monitoring. The Noise barriers will be part of civil work cost. Adequate budget for tree transplantation and mitigation measures other than those in Table 9-5 will be allotted by CMRL

10. CONCLUSION AND RECOMMENDATION

326. The alignment of the proposed Chennai Metro Corridor 4 and depot area are carefully selected to avoid most of the sites having historical/cultural significance. Three religious structures/ churches shall have vibration impact, however appropriate management measures has been given in the EMP for mitigating the same. Some impacts are anticipated due to cutting of about 536 public trees for which compensatory afforestation in the ratio of 1:12 has been proposed. Nearly 1342m length of alignment traverses through CRZ area (410m of CRZ IA and 932m of CRZ II), for which CRZ clearance shall be obtained and the given conditions in the clearance shall be strictly adhered to. Ecological restoration plan has been suggested for Panagal Park. Other necessary clearance/ NOCs/ permissions for construction shall be obtained by the contractor under the supervision of the GC and CMRL.

327. Significant adverse impacts of `medium to high` risk and `likely to definite` likelihood are a) social impacts due to involuntary resettlement, b) loss of trees, c) utility diversion, d) air, noise, vibration, muck and waste disposal, labour safety, water demand, ground subsidence due to construction; and e) noise, vibration and ground subsidence due to operation. Measures to mitigate adverse impacts have been recommended In the EMP, which shall also forms part of the bid document. Further noise and vibration study will be conducted based on the detailed engineering design, in order to inform the incremental impacts and suggest the mitigations. This will be completed as part of the supplementary study of this EIA by contractors' mobilization.

328. Benefits include reduced air pollution and road accident, increased benefits to economy and commuters on metro and road. Major roads along the proposed alignments are forecast to function beyond respective design service volume in year 2035 in absence of the project lines. BRT has significantly lower unit life cycle cost but road right of way is not adequate to operate BRT on Corridor 4. Therefore continuity of Metro is required. Requirement of acquisition of property was minimized by fine-tuning of locations and footprint of stations.

329. Public consultations highlighted opinions of participants on benefits of Metro in terms of easing connectivity, pollution, congestion, accidents and travel on roads and safe travel for women; and apprehensions about impact of tunneling on existing buildings and loss of green cover; suggestions for moderate metro fare compensation for impacted shops and other properties. Public consultations during construction and operation will form part of periodic reports sent by CMRL to MDBs. These consultations will focus on the efficacy of mitigation measures being implemented.

330. Grievance Redress Mechanism will be developed to assist the citizens, users of the Metro and other stakeholders communicate their queries, complaints and suggestions in connection with implementation of EMP and EMoP. GRM for both workers and communities will be instituted during pre-construction phase to continue through different phases.

331. Institutional arrangement, EMP, reporting and record keeping, emergency response and environment monitoring plan have been developed. Budgetary cost estimate to implement the EMP and EMoP has been prepared.

332. 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 MDBs' applicable policies and standards. A semi-annual environmental and social monitoring report will be submitted to MDBs and will be disclosed publicly at the MDBs' websites. Environmental and

social benefits of the project and long-term investment program objectives outweigh the temporary negative impacts

Environmental Impact Assessment (Draft)

March 2021

India: Chennai Metro Rail Investment Project
Corridor 4

Annexure 1

This environmental impact assessment is a document of the borrower. The views expressed herein do not necessarily represent those of ADB's Board of Directors, Management, or staff, and may be preliminary in nature. Your attention is directed to the "terms of use" section on ADB's website.

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Annexure 1: Detailed Analysis Reports

Environmental Baseline

Ambient Noise Levels



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TEST REPORT

Accredited by NABL & NABET, Certified ISO 9001:2015 & ISO 14001:2015

Report No	: PCEI/TR-N-4105	Report Date	: 09.12.2019
ULR No	: ULR-TC/446190003126F		
Issued to	: M/s Chennai Metro Rail Limited CMRI, Depot, Admin Building, Poonamallee High Road, Koyambedu, Chennai - 600 107		
Sampling Method	: IS 9989 - 1981 (RA 2008)	LHS/RHS	: LHS
Sampled by	: Laboratory	Type of Sensitive Receptors	: College
Sample Collected Date	: 18.11.2019	Latitude	: 13°02'40.4"N
Name of the Sensitive Receptors	: Queen's Mary College	Longitude	: 80°16'44.5"E
Sample Description	: Noise Monitoring	Sample Reference No	: PCEI/N-019-12-19
Sample Condition	: Fit for Analysis	Sample Received On	: 19.11.2019
Category of Area	: Silence Zone	Test Commenced On	: 19.11.2019
Distance from the outer most proposed tracks (m)	: 94.57	Test Completed On	: 19.11.2019
Sampling Location	: Light House Station - Fore shore Estate Road		

Time	Day Time	Night Time
	Readings in dB(A)	
06:00 - 07:00	41.8	
07:00 - 08:00	42.5	
08:00 - 09:00	55.9	
09:00 - 10:00	56.4	
10:00 - 11:00	57.1	
11:00 - 12:00	55.8	
12:00 - 13:00	54.3	
13:00 - 14:00	53.7	
14:00 - 15:00	52.9	
15:00 - 16:00	51.6	
16:00 - 17:00	54.1	
17:00 - 18:00	56.8	
18:00 - 19:00	51.2	
19:00 - 20:00	49.9	
20:00 - 21:00	46.4	
21:00 - 22:00	42.8	
22:00 - 23:00		36.5
23:00 - 00:00		34.3
00:00 - 01:00		34.9
01:00 - 02:00		35.8
02:00 - 03:00		33.9
03:00 - 04:00		33.5
04:00 - 05:00		34.8
05:00 - 06:00		36.0
Day Time	Min	41.8
	Max	57.1
	Leq	53.5
	Day Limit	50 dB(A)
Night Time	Min	33.5
	Max	36.5
	Leq	35.1
	Night Limit	40 dB(A)

Note: CPCB Ambient Air Quality Standards in respect of Noise in Silence Zone Daytime 50 dB(A) & Night Time 40 dB(A)

*** End of Report ***
Page 1 of 1


Verified By




Authorized Signatory
Name: Krishnan G
Designation: Technical Manager

Note: 1.The test results are only to the sample submitted for test. 2.Any Correction of the test report in full or part shall invalidate the report 3.Sample will be retained for 15 days from the date of reporting except in case of regulatory samples or specifically instructed by client. 4.Perishable samples will be discarded immediately after reporting. 5.Under no circumstances lab accepts any liability or loss/damage caused by use or misuse of test report after invoicing or issued of test report



TEST REPORT

Accredited by NABL & NABET, Certified ISO 9001:2015 & ISO 14001:2015

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Web : www.pollucareindia.com

Report No	: PCEI/TR-N-4106	Report Date	: 09.12.2019
ULR No	: ULR-TC744619003127F		
Issued to	: M/s Chennai Metro Rail Limited CMRL Depot, Admin Building, Poonamallee High Road, Koyambedu, Chennai - 600 107		
Sampling Method	: IS 9989 – 1981 (RA 2008)		
Sampled by	: Laboratory		
Sample Collected Date	: 18.11.2019	LHS/RHS	: LHS
Name of the Sensitive Receptors	: St. Thomas Mount church	Type of Sensitive Receptors	: Church
Sample Description	: Noise Monitoring	Sample Reference No	: PCEI/N-N020-12-19
Sample Condition	: Fit for Analysis	Sample Received On	: 19.11.2019
Category of Area	: Silence Zone	Test Commenced On	: 19.11.2019
Distance from the outer most proposed tracks (m)	: 1.0	Test Completed On	: 19.11.2019
Sampling Location	: Light House Station - Fore shore Estate Road		

Time	Day Time	Night Time
	Readings in dB(A)	Readings in dB(A)
06:00 - 07:00	42.9	
07:00 - 08:00	42.5	
08:00 - 09:00	47.8	
09:00 - 10:00	48.3	
10:00 - 11:00	48.1	
11:00 - 12:00	47.8	
12:00 - 13:00	49.4	
13:00 - 14:00	45.4	
14:00 - 15:00	46.1	
15:00 - 16:00	44.9	
16:00 - 17:00	46.6	
17:00 - 18:00	47.8	
18:00 - 19:00	47.7	
19:00 - 20:00	43.8	
20:00 - 21:00	41.1	
21:00 - 22:00	39.2	
22:00 - 23:00		33.5
23:00 - 00:00		30.3
00:00 - 01:00		30.9
01:00 - 02:00		30.7
02:00 - 03:00		31.3
03:00 - 04:00		31.6
04:00 - 05:00		31.9
05:00 - 06:00		31.4
Day Time	Min	39.2
	Max	49.4
	Leq	46.4
	Day Limit	50 dB(A)
Night Time	Min	30.3
	Max	33.5
	Leq	31.6
	Night Limit	40 dB(A)

Note: CPCB Ambient Air Quality Standards in respect of Noise in Silence Zone Daytime 50 dB(A) & Night Time 40 dB(A)

*** End of Report ***

Page 1 of 1


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Authorised Signatory
Name: Krishnan G
Designation: Technical Manager

Note: 1.The test results are only to the sample submitted for test. 2. Any Correction of the test report in full or part shall invalidate the report. 3. Sample will be retained for 15 days from the date of reporting except in case of regulatory samples or specifically instructed by client. 4. Perishable samples will be discarded immediately after reporting. 5. Under no circumstances lab accepts any liability or loss/damage caused by use or misuse of test report after invoicing or issued of test report.



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Report No	: PCEI/TR-N-4107	Report Date	: 09.12.2019
ULR No	: ULR-TC7446190003128F		
Issued to	: M/s Chennai Metro Rail Limited CMRL Depot, Admin Building, Poonamallee High Road, Koyambedu, Chennai - 600 107		
Sampling Method	: IS 9989 - 1981 (RA 2008)	LHS/RHS	: LHS
Sampled by	: Laboratory	Type of Sensitive Receptors	: School
Sample Collected Date	: 19.11.2019	Latitude	: 13°02'04.6"N
Name of the Sensitive Receptors	: St. Bede's Anglo Indian Hr. Sec. School	Longitude	: 80°16'41.6"E
Sample Description	: Noise Monitoring	Sample Reference No	: PCEI/N-N021-12-19
Sample Condition	: Fit for Analysis	Sample Received On	: 20.11.2019
Category of Area	: Silence Zone	Test Commenced On	: 20.11.2019
Distance from the outer most proposed tracks (m)	: 71.16	Test Completed On	: 20.11.2019
Sampling Location	: Light House Station - Fore shore Estate Road		

Time	Day Time	Night Time
	Readings in dB(A)	Readings in dB(A)
06:00 - 07:00	55.8	
07:00 - 08:00	55.5	
08:00 - 09:00	59.7	
09:00 - 10:00	60.9	
10:00 - 11:00	59.8	
11:00 - 12:00	58.3	
12:00 - 13:00	56.6	
13:00 - 14:00	55.3	
14:00 - 15:00	52.9	
15:00 - 16:00	55.8	
16:00 - 17:00	58.9	
17:00 - 18:00	57.7	
18:00 - 19:00	52.8	
19:00 - 20:00	49.7	
20:00 - 21:00	48.6	
21:00 - 22:00	42.8	
22:00 - 23:00		36.5
23:00 - 00:00		38.3
00:00 - 01:00		37.1
01:00 - 02:00		33.1
02:00 - 03:00		34.2
03:00 - 04:00		34.1
04:00 - 05:00		32.1
05:00 - 06:00		31.4
Day Time	Min	42.8
	Max	60.9
	Leq	56.8
	Day Limit	50 dB(A)
Night Time	Min	31.4
	Max	38.3
	Leq	35.2
	Night Limit	40 dB(A)

Note: CPCB Ambient Air Quality Standards in respect of Noise in Silence Zone Daytime 50 dB(A) & Night Time 40 dB(A)

*** End of Report ***

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Authorised Signatory
Name: Krishnan G
Designation: Technical Manager

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Report No	: PCEI/TR-N-4108	Report Date	: 09.12.2019
ULR No	: ULR-TC7446190003129F		
Issued to	: M/s Chennai Metro Rail Limited CMRL Depot, Admin Building, Poonamallee High Road, Koyambedu, Chennai - 600 107		
Sampling Method	: IS 9989 - 1981 (RA 2008)	LHS/RHS	: LHS
Sampled by	: Laboratory	Type of Sensitive Receptors	: Church
Sample Collected Date	: 19.11.2019	Latitude	: 13°02'00.9"N
Name of the Sensitive Receptors	: Santhome Cathedral Church	Longitude	: 80°16'40.2"E
Sample Description	: Noise Monitoring	Sample Reference No	: PCEI/N-N022-12-19
Sample Condition	: Fit for Analysis	Sample Received On	: 20.11.2019
Category of Area	: Silence Zone	Test Commenced On	: 20.11.2019
Distance from the outer most proposed tracks (m)	: 6.32	Test Completed On	: 20.11.2019
Sampling Location	: Foreshore Estate Road - Kutchery Road		

Time	Day Time	Night Time
	Readings in dB(A)	Readings in dB(A)
06:00 - 07:00	41.6	
07:00 - 08:00	46.3	
08:00 - 09:00	46.5	
09:00 - 10:00	49.2	
10:00 - 11:00	47.3	
11:00 - 12:00	43.5	
12:00 - 13:00	47.6	
13:00 - 14:00	48.4	
14:00 - 15:00	48.1	
15:00 - 16:00	48.4	
16:00 - 17:00	46.1	
17:00 - 18:00	45.3	
18:00 - 19:00	48.6	
19:00 - 20:00	48.9	
20:00 - 21:00	47.3	
21:00 - 22:00	49.6	
22:00 - 23:00		36.1
23:00 - 00:00		31.6
00:00 - 01:00		31.5
01:00 - 02:00		31.6
02:00 - 03:00		32.4
03:00 - 04:00		31.1
04:00 - 05:00		32.5
05:00 - 06:00		31.9
Day Time	Min	41.6
	Max	49.6
	Leq	47.5
	Day Limit	50 dB(A)
Night Time	Min	31.1
	Max	36.1
	Leq	32.7
	Night Limit	40 dB(A)

Note: CPCB Ambient Air Quality Standards in respect of Noise in Silence Zone Daytime 50 dB(A) & Night Time 40 dB(A)

*** End of Report ***

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Authorized Signatory
Name: Krishnan G
Designation: Technical Manager

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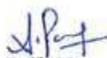
Report No	: PCEI/TR-N-4109	Report Date	: 09.12.2019
ULR No	: ULR-TC7446190003130F		
Issued to	: M/s Chennai Metro Rail Limited CMRL Depot, Admin Building, Poonamallee High Road, Koyambedu, Chennai - 600 107		
Sampling Method	: IS 9989 - 1981 (RA 2008)	LHS/RHS	: LHS
Sampled by	: Laboratory	Type of Sensitive Receptors	: Church
Sample Collected Date	: 20.11.2019	Latitude	: 13°02'02.6"N
Name of the Sensitive Receptors	: Rosary Church	Longitude	: 80°16'31.7"E
Sample Description	: Noise Monitoring	Sample Reference No	: PCEI/N-N023-12-19
Sample Condition	: Fit for Analysis	Sample Received On	: 21.11.2019
Category of Area	: Silence Zone	Test Commenced On	: 21.11.2019
Distance from the outer most proposed tracks (m)	: 1.0	Test Completed On	: 21.11.2019
Sampling Location	: Foreshore Estate Road - Kutchery Road		

Time	Day Time	Night Time
	Readings in dB(A)	Readings in dB(A)
06:00 - 07:00	45.9	
07:00 - 08:00	46.1	
08:00 - 09:00	48.2	
09:00 - 10:00	46.2	
10:00 - 11:00	41.6	
11:00 - 12:00	42.8	
12:00 - 13:00	47.6	
13:00 - 14:00	44.8	
14:00 - 15:00	43.6	
15:00 - 16:00	42.2	
16:00 - 17:00	41.1	
17:00 - 18:00	41.6	
18:00 - 19:00	42.8	
19:00 - 20:00	40.9	
20:00 - 21:00	40.3	
21:00 - 22:00	40.0	
22:00 - 23:00		30.1
23:00 - 00:00		29.3
00:00 - 01:00		31.0
01:00 - 02:00		30.1
02:00 - 03:00		32.1
03:00 - 04:00		30.2
04:00 - 05:00		29.6
05:00 - 06:00		30.4
Day Time	Min	40.0
	Max	48.2
	Leq	44.3
	Day Limit	50 dB(A)
Night Time	Min	29.3
	Max	32.1
	Leq	30.4
	Night Limit	40 dB(A)

Note: CPCB Ambient Air Quality Standards in respect of Noise in Silence Zone Daytime 50 dB(A) & Night Time 40 dB(A)

*** End of Report ***

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Authorized Signatory
Name: Krishnan G
Designation: Technical Manager

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Report No	: PCEI/TR-N-4110	Report Date	: 09.12.2019
ULR No	: ULR-TC7446190003131F		
Issued to	: M/s Chennai Metro Rail Limited CMRL Depot, Admin Building, Poonamallee High Road, Koyambedu, Chennai - 600 107		
Sampling Method	: IS 9989 - 1981 (RA 2008)	LHS/RHS	: LHS
Sampled by	: Laboratory	Type of Sensitive Receptors	: School
Sample Collected Date	: 20.11.2019	Latitude	: 13°02'03.8"N
Name of the Sensitive Receptors	: St. Raphael's Girls Hr.Sec. School	Longitude	: 80°16'34.6"E
Sample Description	: Noise Monitoring	Sample Reference No	: PCEI/N-0024-12-19
Sample Condition	: Fit for Analysis	Sample Received On	: 21.11.2019
Category of Area	: Silence Zone	Test Commenced On	: 21.11.2019
Distance from the outer most proposed tracks (m)	: 6.07	Test Completed On	: 21.11.2019
Sampling Location	: Foreshore Estate Road - Kutchery Road		

Time	Day Time	Night Time
	Readings in dB(A)	
06:00 - 07:00	59.6	
07:00 - 08:00	58.3	
08:00 - 09:00	58.1	
09:00 - 10:00	58.6	
10:00 - 11:00	54.3	
11:00 - 12:00	52.6	
12:00 - 13:00	57.9	
13:00 - 14:00	64.2	
14:00 - 15:00	65.6	
15:00 - 16:00	53.3	
16:00 - 17:00	63.6	
17:00 - 18:00	59.8	
18:00 - 19:00	55.7	
19:00 - 20:00	53.2	
20:00 - 21:00	49.6	
21:00 - 22:00	43.9	
22:00 - 23:00		37.8
23:00 - 00:00		31.2
00:00 - 01:00		31.4
01:00 - 02:00		33.8
02:00 - 03:00		33.1
03:00 - 04:00		32.1
04:00 - 05:00		33.4
05:00 - 06:00		34.6
Day Time	Min	43.9
	Max	65.6
	Leq	59.6
	Day Limit	50 dB(A)
Night Time	Min	31.2
	Max	37.8
	Leq	33.9
	Night Limit	40 dB(A)

Note: CPCB Ambient Air Quality Standards in respect of Noise in Silence Zone Daytime 50 dB(A) & Night Time 40 dB(A)

*** End of Report ***

Page 1 of 1


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Authorized Signatory
Name: Krishnan G
Designation: Technical Manager

Note: 1.The test results are only to the sample submitted for test. 2.Any Correction of the test report in full or part shall invalidate the report. 3. Sample will be retained for 15 days from the date of reporting except in case of regulatory samples or specifically instructed by client. 4.Perishable samples will be discarded immediately after reporting. 5.Under no circumstances lab accepts any liability or loss/damage caused by use or misuse of test report after invoicing or issued of test report



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Report No	: PCEI/TR-N-4111	Report Date	: 09.12.2019
ULR No	: ULR-TC7446190003132F		
Issued to	: M/s Chennai Metro Rail Limited CMRL Depot, Admin Building, Poonamallee High Road, Koyambedu, Chennai - 600 107		
Sampling Method	: IS 9989 - 1981 (RA 2008)	LHS/RHS	: LHS
Sampled by	: Laboratory	Type of Sensitive Receptors	: Mosque
Sample Collected Date	: 21.11.2019	Latitude	: 13°02'06.9"N
Name of the Sensitive Receptors	: Majood Jamal	Longitude	: 80°16'21.5"E
Sample Description	: Noise Monitoring	Sample Reference No	: PCEI/N-ND25-12-19
Sample Condition	: Fit for Analysis	Sample Received On	: 22.11.2019
Category of Area	: Silence Zone	Test Commenced On	: 22.11.2019
Distance from the outer most proposed tracks (m)	: -	Test Completed On	: 22.11.2019
Sampling Location	: Kutchery Road - Thirumayilai Metro		

Time	Day Time	Night Time
	Readings in dB(A)	Readings in dB(A)
06:00 - 07:00	41.2	
07:00 - 08:00	43.2	
08:00 - 09:00	44.5	
09:00 - 10:00	45.6	
10:00 - 11:00	47.3	
11:00 - 12:00	46.3	
12:00 - 13:00	47.1	
13:00 - 14:00	48.2	
14:00 - 15:00	45.9	
15:00 - 16:00	44.3	
16:00 - 17:00	48.2	
17:00 - 18:00	47.9	
18:00 - 19:00	46.6	
19:00 - 20:00	47.3	
20:00 - 21:00	45.6	
21:00 - 22:00	42.6	
22:00 - 23:00		35.8
23:00 - 00:00		33.4
00:00 - 01:00		31.9
01:00 - 02:00		32.6
02:00 - 03:00		34.5
03:00 - 04:00		33.7
04:00 - 05:00		32.5
05:00 - 06:00		31.8
Day Time	Min	41.2
	Max	48.2
	Leq	46.2
	Day Limit	50 dB(A)
Night Time	Min	31.8
	Max	35.8
	Leq	33.5
	Night Limit	40 dB(A)

Note: CPCB Ambient Air Quality Standards in respect of Noise in Silence Zone Daytime 50 dB(A) & Night Time 40 dB(A)

*** End of Report ***

Page 1 of 1

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Authorised Signatory
Name: Krishnan G
Designation: Technical Manager

Note: 1.The test results are only to the sample submitted for test. 2.Any Correction of the test report in full or part shall invalidate the report. 3.Sample will be retained for 15 days from the date of reporting except in case of regulatory samples or specifically instructed by client. 4.Perishable samples will be discarded immediately after reporting. 5.Under no circumstances lab accepts any liability or loss/damage caused by use or misuse of test report after invoicing or issued of test report



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Report No	: PCEI/TR-N-4112	Report Date	: 09.12.2019
ULR No	: ULR-TC7446190003133F		
Issued to	: M/s Chennai Metro Rail Limited CMRL Depot, Admin Building, Poonamallee High Road, Koyambedu, Chennai - 600 107		
Sampling Method	: IS 9989 - 1981 (RA 2008)	LHS/RHS	: LHS
Sampled by	: Laboratory	Type of Sensitive Receptors	: Mosque
Sample Collected Date	: 21.11.2019	Latitude	: 13°02'04.8"N
Name of the Sensitive Receptors	: Jumma Mosque	Longitude	: 80°16'11.6"E
Sample Description	: Noise Monitoring	Sample Reference No	: PCEI/N-N026-12-19
Sample Condition	: Fit for Analysis	Sample Received On	: 22.11.2019
Category of Area	: Silence Zone	Test Commenced On	: 22.11.2019
Distance from the outer most proposed tracks (m)	: 11.87	Test Completed On	: 22.11.2019
Sampling Location	: Kutchery Road - Thirumayilai Metro		

Time	Day Time	Night Time
	Readings in dB(A)	Readings in dB(A)
06:00 - 07:00	41.6	
07:00 - 08:00	42.8	
08:00 - 09:00	42.9	
09:00 - 10:00	43.6	
10:00 - 11:00	43.9	
11:00 - 12:00	44.8	
12:00 - 13:00	46.2	
13:00 - 14:00	45.4	
14:00 - 15:00	45.1	
15:00 - 16:00	44.3	
16:00 - 17:00	43.2	
17:00 - 18:00	45.3	
18:00 - 19:00	43.2	
19:00 - 20:00	41.8	
20:00 - 21:00	40.4	
21:00 - 22:00	42.1	
22:00 - 23:00		36.2
23:00 - 00:00		35.2
00:00 - 01:00		34.2
01:00 - 02:00		33.8
02:00 - 03:00		33.1
03:00 - 04:00		34.3
04:00 - 05:00		34.6
05:00 - 06:00		34.5
Day Time	Min	40.1
	Max	46.2
	Leq	43.7
	Day Limit	50 dB(A)
Night Time	Min	33.1
	Max	36.2
	Leq	34.6
	Night Limit	40 dB(A)

Note: CPCB Ambient Air Quality Standards in respect of Noise in Silence Zone Daytime 50 dB(A) & Night Time 40 dB(A)

*** End of Report ***

Page 1 of 1


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Authorised Signatory
Name: Krishnan G
Designation: Technical Manager

Note: 1.The test results are only to the sample submitted for test. 2.Any Correction of the test report in full or part shall invalidate the report 3.Sample will be retained for 15 days from the date of reporting except in case of regulatory samples or specifically instructed by client. 4.Perishable samples will be discarded immediately after reporting. 5.Under no circumstances lab accepts any liability or loss/damage caused by use or misuse of test report after invoicing or issued of test report



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Report No	: PCEI/TR-N-4113	Report Date	: 09.12.2019
ULR No	: ULR-TC7446190003134F		
Issued to	: M/s Chennai Metro Rail Limited CMRL Depot, Admin Building, Poonamallee High Road, Koyambedu, Chennai - 600 107		
Sampling Method	: IS 9989 - 1981 (RA 2008)	LHS/RHS	: LHS
Sampled by	: Laboratory	Type of Sensitive Receptors	: Church
Sample Collected Date	: 22.11.2019	Latitude	: 13°02'17.6"N
Name of the Sensitive Receptors	: Lux Church	Longitude	: 80°15'44.7"E
Sample Description	: Noise Monitoring	Sample Reference No	: PCEI/N-N027-12-19
Sample Condition	: Fit for Analysis	Sample Received On	: 23.11.2019
Category of Area	: Silence Zone	Test Commenced On	: 23.11.2019
Distance from the outer most proposed tracks (m)	: 76.43	Test Completed On	: 23.11.2019
Sampling Location	: Thirumayilai Metro - Alwarpet		

Time	Day Time	Night Time
	Readings in dB(A)	Readings in dB(A)
06:00 - 07:00	40.6	
07:00 - 08:00	44.3	
08:00 - 09:00	46.8	
09:00 - 10:00	43.4	
10:00 - 11:00	45.6	
11:00 - 12:00	46.1	
12:00 - 13:00	47.2	
13:00 - 14:00	48.5	
14:00 - 15:00	45.8	
15:00 - 16:00	46.9	
16:00 - 17:00	46.7	
17:00 - 18:00	44.9	
18:00 - 19:00	43.8	
19:00 - 20:00	42.0	
20:00 - 21:00	41.9	
21:00 - 22:00	38.7	
22:00 - 23:00		32.3
23:00 - 00:00		31.6
00:00 - 01:00		30.2
01:00 - 02:00		30.1
02:00 - 03:00		32.4
03:00 - 04:00		31.2
04:00 - 05:00		31.5
05:00 - 06:00		30.2
Day Time	Min	38.7
	Max	48.5
	Leq	45.2
	Day Limit	50 dB(A)
Night Time	Min	30.1
	Max	32.4
	Leq	31.3
	Night Limit	40 dB(A)

Note: CPCB Ambient Air Quality Standards in respect of Noise in Silence Zone Daytime 50 dB(A) & Night Time 40 dB(A)

*** End of Report ***

Page 1 of 1

Verified By



Authorised Signatory
Name: Krishnan G
Designation: Technical Manager

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Chennai - 600 077.
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Email: lab@pollucareindia.com
Web : www.pollucareindia.com

Report No	: PCEI/TR-N-4114	Report Date	: 09.12.2019
ULR No	: ULR-TC7446190003135F		
Issued to	: M/s Chennai Metro Rail Limited CMRL Depot, Admin Building, Poonamallee High Road, Koyambedu, Chennai - 600 107		
Sampling Method	: IS 9989 - 1981 (RA 2008)	LHS/RHS	: RHS
Sampled by	: Laboratory	Type of Sensitive Receptors	: Temple
Sample Collected Date	: 22.11.2019	Latitude	: 13°02'18.7"N
Name of the Sensitive Receptors	: Anjaneyar Temple	Longitude	: 80°15'31.5"E
Sample Description	: Noise Monitoring	Sample Reference No	: PCEI/N-N028-12-19
Sample Condition	: Fit for Analysis	Sample Received On	: 23.11.2019
Category of Area	: Silence Zone	Test Commenced On	: 23.11.2019
Distance from the outer most proposed tracks (m)	: 9.66	Test Completed On	: 23.11.2019
Sampling Location	: Alwarpet - Bharathidasan Road		

Time	Day Time	Night Time
	Readings in dB(A)	Readings in dB(A)
06:00 - 07:00	41.8	
07:00 - 08:00	42.6	
08:00 - 09:00	46.4	
09:00 - 10:00	45.1	
10:00 - 11:00	46.8	
11:00 - 12:00	45.1	
12:00 - 13:00	44.4	
13:00 - 14:00	43.8	
14:00 - 15:00	42.9	
15:00 - 16:00	41.6	
16:00 - 17:00	41.8	
17:00 - 18:00	41.3	
18:00 - 19:00	43.2	
19:00 - 20:00	43.9	
20:00 - 21:00	40.3	
21:00 - 22:00	39.4	
22:00 - 23:00		33.8
23:00 - 00:00		33.9
00:00 - 01:00		32.2
01:00 - 02:00		31.4
02:00 - 03:00		31.7
03:00 - 04:00		32.1
04:00 - 05:00		33.2
05:00 - 06:00		30.6
Day Time	Min	39.4
	Max	46.8
	Leq	43.6
	Day Limit	50 dB(A)
Night Time	Min	30.6
	Max	33.9
	Leq	32.5
	Night Limit	40 dB(A)

Note: CPCB Ambient Air Quality Standards in respect of Noise in Silence Zone Daytime 50 dB(A) & Night Time 40 dB(A)

*** End of Report ***

Page 1 of 1

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Authorized Signatory
Name: Krishnan G
Designation: Technical Manager

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Web : www.pollucareindia.com

Report No	: FCEI/TR-N-4115	Report Date	: 09.12.2019
ULR No	: ULR-TC7446190003136F		
Issued to	: M/s Chennai Metro Rail Limited CMRL Depot, Admin Building, Poonamallee High Road, Koyambedu, Chennai - 600 107.		
Sampling Method	: IS 9989 - 1981 (RA 2008)	LHS/RHS	: RMS
Sampled by	: Laboratory	Type of Sensitive Receptors	: Hospital
Sample Collected Date	: 25.11.2019	Latitude	: 13°02'19.0"N
Name of the Sensitive Receptors	: Trinity Hospital	Longitude	: 80°15'28.2"E
Sample Description	: Noise Monitoring	Sample Reference No	: PCEI/N-W029-12-19
Sample Condition	: Fit for Analysis	Sample Received On	: 26.11.2019
Category of Area	: Silence Zone	Test Commenced On	: 26.11.2019
Distance from the outer most proposed tracks (m)	: 7.58	Test Completed On	: 25.11.2019
Sampling Location	: Alwarpet - Bharathidasan Road		

Time	Day Time	Night Time
	Readings in dB(A)	Readings in dB(A)
06:00 - 07:00	48.2	
07:00 - 08:00	49.5	
08:00 - 09:00	53.2	
09:00 - 10:00	59.6	
10:00 - 11:00	52.4	
11:00 - 12:00	53.2	
12:00 - 13:00	54.8	
13:00 - 14:00	53.5	
14:00 - 15:00	52.4	
15:00 - 16:00	53.9	
16:00 - 17:00	50.7	
17:00 - 18:00	52.3	
18:00 - 19:00	48.2	
19:00 - 20:00	47.3	
20:00 - 21:00	46.0	
21:00 - 22:00	44.0	
22:00 - 23:00		42.5
23:00 - 00:00		40.6
00:00 - 01:00		40.7
01:00 - 02:00		35.3
02:00 - 03:00		34.8
03:00 - 04:00		33.0
04:00 - 05:00		32.5
05:00 - 06:00		31.2
Day Time	Min	44.0
	Max	59.6
	Leq	52.8
	Day Limit	50 dB(A)
Night Time	Min	31.2
	Max	42.5
	Leq	38.2
	Night Limit	40 dB(A)

Note: CPCB Ambient Air Quality Standards in respect of Noise in Silence Zone Daytime 50 dB(A) & Night Time 40 dB(A)

*** End of Report ***

Page 1 of 1

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Authorised Signatory
Name: Krishnan G
Designation: Technical Manager

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Web : www.pollucareindia.com

Report No	: PCEI/TR-N-4116	Report Date	: 09.12.2019
ULR No	: ULR-TC7446190003137F		
Issued to	: M/s Chennai Metro Rail Limited CMRL Depot, Admin Building, Poonamallee High Road, Koyambedu, Chennai - 600 107		
Sampling Method	: IS 9989 - 1981 (RA 2008)	LHS/RHS	: LHS
Sampled by	: Laboratory	Type of Sensitive Receptors	: Hospital
Sample Collected Date	: 25.11.2019	Latitude	: 13°02'20.2"N
Name of the Sensitive Receptors	: AVT Hospital	Longitude	: 80°15'26.6"E
Sample Description	: Noise Monitoring	Sample Reference No	: PCEI/N-N030-12-19
Sample Condition	: Fit for Analysis	Sample Received On	: 26.11.2019
Category of Area	: Silence Zone	Test Commenced On	: 26.11.2019
Distance from the outer most proposed tracks (m)	: 28.9	Test Completed On	: 26.11.2019
Sampling Location	: Alwarpet - Bharathidasan Road		

Time	Day Time	Night Time
	Readings in dB(A)	
06:00 - 07:00	52.7	
07:00 - 08:00	55.1	
08:00 - 09:00	57.3	
09:00 - 10:00	56.7	
10:00 - 11:00	57.6	
11:00 - 12:00	56.8	
12:00 - 13:00	54.9	
13:00 - 14:00	54.7	
14:00 - 15:00	52.7	
15:00 - 16:00	55.1	
16:00 - 17:00	54.3	
17:00 - 18:00	56.7	
18:00 - 19:00	55.9	
19:00 - 20:00	52.7	
20:00 - 21:00	51.5	
21:00 - 22:00	45.3	
22:00 - 23:00		37.7
23:00 - 00:00		37.7
00:00 - 01:00		36.8
01:00 - 02:00		36.1
02:00 - 03:00		35.6
03:00 - 04:00		36.7
04:00 - 05:00		36.1
05:00 - 06:00		37.1
Day Time	Min	45.3
	Max	57.6
	Leq	55.1
	Day Limit	50 dB(A)
Night Time	Min	35.6
	Max	37.7
	Leq	36.8
	Night Limit	40 dB(A)

Note: CFCB Ambient Air Quality Standards in respect of Noise in Silence Zone Daytime 50 dB(A) & Night Time 40 dB(A)

*** End of Report ***

Page 1 of 1


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Authorized Signatory
Name: Krishnan G
Designation: Technical Manager

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Report No	: PCEI/TR-N-4117	Report Date	: 09.12.2019
ULR No	: ULR-TC/446190003138F		
Issued to	: M/s Chennai Metro Rail Limited CMRI, Depot, Admin Building, Poonamallee High Road, Koyambedu, Chennai - 600 107		
Sampling Method	: IS 9989 - 1981 (RA 2008)	LHS/RHS	: LHS
Sampled by	: Laboratory	Type of Sensitive Receptors	: College
Sample Collected Date	: 26.11.2019	Latitude	: 130152.9N
Name of the Sensitive Receptors	: SIET College	Longitude	: 80°15'26.6"E
Sample Description	: Noise Monitoring	Sample Reference No	: PCEI/N-N031-12-19
Sample Condition	: Fit for Analysis	Sample Received On	: 27.11.2019
Category of Area	: Silence Zone	Test Commenced On	: 27.11.2019
Distance from the outer most proposed tracks (m)	: 31.17	Test Completed On	: 27.11.2019
Sampling Location	: Adyar Gate Junction to Nandanam		

Time	Day Time	Night Time
	Readings in dB(A)	Readings in dB(A)
06:00 - 07:00	55.6	
07:00 - 08:00	54.6	
08:00 - 09:00	58.5	
09:00 - 10:00	59.4	
10:00 - 11:00	58.1	
11:00 - 12:00	55.7	
12:00 - 13:00	54.2	
13:00 - 14:00	53.5	
14:00 - 15:00	58.3	
15:00 - 16:00	53.4	
16:00 - 17:00	62.7	
17:00 - 18:00	60.4	
18:00 - 19:00	56.9	
19:00 - 20:00	54.3	
20:00 - 21:00	51.6	
21:00 - 22:00	52.3	
22:00 - 23:00		38.6
23:00 - 00:00		37.4
00:00 - 01:00		36.2
01:00 - 02:00		34.5
02:00 - 03:00		34.2
03:00 - 04:00		33.8
04:00 - 05:00		30.4
05:00 - 06:00		31.7
Day Time	Min	51.6
	Max	62.7
	Leq	57.3
	Day Limit	50 dB(A)
Night Time	Min	30.4
	Max	38.6
	Leq	35.3
	Night Limit	40 dB(A)

Note: CPCB Ambient Air Quality Standards in respect of Noise in Silence Zone Daytime 50 dB(A) & Night Time 40 dB(A)

*** End of Report ***

Page 1 of 1


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Authorised Signatory
Name: Krishnan G
Designation: Technical Manager

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Report No	: PCEI/TR-N-4118	Report Date	: 09.12.2019
ULR No	: ULR-TC/446190003139F		
Issued to	: M/s Chennai Metro Rail Limited CMRL Depot, Admin Building, Poonamallee High Road, Koyambedu, Chennai - 600 107		
Sampling Method	: IS 9989 - 1981 (RA 2008)	LHS/RHS	: RHS
Sampled by	: Laboratory	Type of Sensitive Receptors	: Hospital
Sample Collected Date	: 26.11.2019	Latitude	: 1301476.7N
Name of the Sensitive Receptors	: Venkateshwara Hospital	Longitude	: 801438.8E
Sample Description	: Noise Monitoring	Sample Reference No	: PCEI/N-N032-12-19
Sample Condition	: Fit for Analysis	Sample Received On	: 27.11.2019
Category of Area	: Silence Zone	Test Commenced On	: 27.11.2019
Distance from the outer most proposed tracks (m)	: 38.23	Test Completed On	: 27.11.2019
Sampling Location	: Nandanam to Natesan Park		

Time	Day Time	Night Time
	Readings in dB(A)	Readings in dB(A)
06:00 - 07:00	47.5	
07:00 - 08:00	48.2	
08:00 - 09:00	49.6	
09:00 - 10:00	55.2	
10:00 - 11:00	53.6	
11:00 - 12:00	52.4	
12:00 - 13:00	53.6	
13:00 - 14:00	53.4	
14:00 - 15:00	54.9	
15:00 - 16:00	51.6	
16:00 - 17:00	52.3	
17:00 - 18:00	50.3	
18:00 - 19:00	48.6	
19:00 - 20:00	47.6	
20:00 - 21:00	45.6	
21:00 - 22:00	44.1	
22:00 - 23:00		41.3
23:00 - 00:00		39.8
00:00 - 01:00		37.5
01:00 - 02:00		37.3
02:00 - 03:00		35.9
03:00 - 04:00		36.7
04:00 - 05:00		34.3
05:00 - 06:00		35.8
	Min	44.1
	Max	55.2
	Leg	51.6
	Day Limit	50 dB(A)
	Min	34.3
	Max	41.3
	Leg	37.9
	Night Limit	40 dB(A)

Note: CPCB Ambient Air Quality Standards in respect of Noise in Silence Zone Daytime 50 dB(A) & Night Time 40 dB(A)

*** End of Report ***
Page 1 of 1


Verified By




Authorized Signatory
Name: Krishnan G
Designation: Technical Manager

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Report No	: PCEI/TR-N-4119	Report Date	: 09.12.2019
ULR No	: ULR-TC7446190003140F		
Issued to	: M/s Chennai Metro Rail Limited CMRL Depot, Admin Building, Poonamallee High Road, Koyambedu, Chennai - 600 107		
Sampling Method	: IS 9989 - 1981 (RA 2008)	LHS/RHS	: RHS
Sampled by	: Laboratory	Type of Sensitive Receptors	: College
Sample Collected Date	: 27.11.2019	Latitude	: 130156.6N
Name of the Sensitive Receptors	: Government Arts College	Longitude	: 801421.3E
Sample Description	: Noise Monitoring	Sample Reference No	: PCEI/N-NO33-12-19
Sample Condition	: Fit for Analysis	Sample Received On	: 28.11.2019
Category of Area	: Silence Zone	Test Commenced On	: 28.11.2019
Distance from the outer most proposed tracks (m)	: 18.48	Test Completed On	: 28.11.2019
Sampling Location	: Adyar Gate Junction to Nandanam		

Time	Day Time	Night Time
	Readings in dB(A)	Readings in dB(A)
06:00 - 07:00	56.7	
07:00 - 08:00	59.3	
08:00 - 09:00	61.6	
09:00 - 10:00	60.4	
10:00 - 11:00	61.8	
11:00 - 12:00	59.3	
12:00 - 13:00	55.7	
13:00 - 14:00	58.3	
14:00 - 15:00	50.9	
15:00 - 16:00	52.4	
16:00 - 17:00	51.1	
17:00 - 18:00	49.5	
18:00 - 19:00	47.3	
19:00 - 20:00	46.8	
20:00 - 21:00	43.6	
21:00 - 22:00	41.2	
22:00 - 23:00		35.4
23:00 - 00:00		35.1
00:00 - 01:00		34.8
01:00 - 02:00		32.6
02:00 - 03:00		31.3
03:00 - 04:00		32.9
04:00 - 05:00		31.7
05:00 - 06:00		31.0
Day Time	Min	41.2
	Max	61.8
	Leq	56.9
	Day Limit	50 dB(A)
Night Time	Min	31.0
	Max	35.4
	Leq	33.4
	Night Limit	40 dB(A)

Note: CPCB Ambient Air Quality Standards in respect of Noise in Silence Zone Daytime 50 dB(A) & Night Time 40 dB(A)

*** End of Report ***

Page 1 of 1


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Authorised Signatory
Name: Krishnan G
Designation: Technical Manager

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Report No	: PCEI/TR-N-4120	Report Date	: 09.12.2019
ULR No	: ULR-TC7446190003141F		
Issued to	: M/s Chennai Metro Rail Limited CMRL Depot, Admin Building, Poonamallee High Road, Koyambedu, Chennai - 600 107		
Sampling Method	: IS 9989 - 1981 (RA 2008)	LHS/RHS	: RHS
Sampled by	: Laboratory	Type of Sensitive Receptors	: School
Sample Collected Date	: 27.11.2019	Latitude	: 130208.6N
Name of the Sensitive Receptors	: Little Oxford Matriculation Higher Secondary School	Longitude	: 801412.8E
Sample Description	: Noise Monitoring	Sample Reference No	: PCEI/N-N034-12-19
Sample Condition	: Fit for Analysis	Sample Received On	: 28.11.2019
Category of Area	: Silence Zone	Test Commenced On	: 28.11.2019
Distance from the outer most proposed tracks (m)	: 73.81	Test Completed On	: 28.11.2019
Sampling Location	: Nandanam to Natesan Park		

Time	Day Time	Night Time
	Readings in dB(A)	Readings in dB(A)
06:00 - 07:00	46.8	
07:00 - 08:00	47.2	
08:00 - 09:00	49.8	
09:00 - 10:00	51.2	
10:00 - 11:00	53.4	
11:00 - 12:00	50.8	
12:00 - 13:00	49.9	
13:00 - 14:00	53.7	
14:00 - 15:00	54.8	
15:00 - 16:00	51.8	
16:00 - 17:00	49.4	
17:00 - 18:00	47.2	
18:00 - 19:00	45.2	
19:00 - 20:00	46.8	
20:00 - 21:00	47.2	
21:00 - 22:00	46.2	
22:00 - 23:00		37.1
23:00 - 00:00		34.6
00:00 - 01:00		36.5
01:00 - 02:00		35.9
02:00 - 03:00		34.3
03:00 - 04:00		32.8
04:00 - 05:00		31.1
05:00 - 06:00		30.5
Day Time	Min	45.2
	Max	54.8
	Leq	50.4
	Day Limit	50 dB(A)
Night Time	Min	30.5
	Max	37.1
	Leq	34.7
	Night Limit	40 dB(A)

Note: CPCB Ambient Air Quality Standards in respect of Noise in Silence Zone Daytime 50 dB(A) & Night Time 40 dB(A)

*** End of Report ***

Page 1 of 1

Verified By
A.P.T



Authorised Signatory
Name: Krishnan G
Designation: Technical Manager

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Report No	: PCEI/TR-N-4121	Report Date	: 09.12.2019
ULR No	: ULR-TC7446190003142F		
Issued to	: M/s Chennai Metro Rail Limited CMRL Depot, Admin Building, Poonamallee High Road, Koyambedu, Chennai - 600 107		
Sampling Method	: IS 9989 -- 1981 (RA 2008)	LHS/RHS	: LHS
Sampled by	: Laboratory	Type of Sensitive Receptors	: School
Sample Collected Date	: 28.11.2019	Latitude	: 130210.6N
Name of the Sensitive Receptors	: Thiyagarayar Higher Secondary School	Longitude	: 801413.9E
Sample Description	: Noise Monitoring	Sample Reference No	: PCEI/N-N035-12-19
Sample Condition	: Fit for Analysis	Sample Received On	: 29.11.2019
Category of Area	: Silence Zone	Test Commenced On	: 29.11.2019
Distance from the outer most proposed tracks (m)	: 22-45	Test Completed On	: 29.11.2019
Sampling Location	: Nandanam to Natesan Park		

Time	Day Time	Night Time
	Readings in dB(A)	
06:00 - 07:00	46.2	
07:00 - 08:00	47.5	
08:00 - 09:00	48.9	
09:00 - 10:00	55.6	
10:00 - 11:00	51.2	
11:00 - 12:00	50.1	
12:00 - 13:00	50.3	
13:00 - 14:00	48.9	
14:00 - 15:00	50.1	
15:00 - 16:00	49.5	
16:00 - 17:00	47.9	
17:00 - 18:00	49.1	
18:00 - 19:00	48.1	
19:00 - 20:00	47.3	
20:00 - 21:00	47.5	
21:00 - 22:00	46.7	
22:00 - 23:00		33.5
23:00 - 00:00		32.7
00:00 - 01:00		32.1
01:00 - 02:00		31.5
02:00 - 03:00		31.8
03:00 - 04:00		30.4
04:00 - 05:00		30.9
05:00 - 06:00		31.3
Day Time	Min	46.2
	Max	55.6
	Leq	49.8
	Day Limit	50 dB(A)
Night Time	Min	30.4
	Max	33.5
	Leq	31.9
	Night Limit	40 dB(A)

Note: CPCB Ambient Air Quality Standards in respect of Noise in Silence Zone Daytime 50 dB(A) & Night Time 40 dB(A)

*** End of Report ***

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Authorized Signatory
Name: Krishnan G
Designation: Technical Manager

Note: 1.The test results are only to the sample submitted for test. 2.Any Correction of the test report in full or part shall invalidate the report 3.Sample will be retained for 15 days from the date of reporting except in case of regulatory samples or specifically instructed by client. 4.Perishable samples will be discarded immediately after reporting. 5.Under no circumstances lab accepts any liability or loss/damage caused by use or misuse of test report after invoicing or issued of test report



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Web : www.pollucareindia.com

Report No	: PCEI/TR-N-4122	Report Date	: 09.12.2019
ULR No	: ULR-TC7446190003143F		
Issued to	: M/s Chennai Metro Rail Limited CMRL Depot, Admin Building, Poonamallee High Road, Koyambedu, Chennai - 600 107		
Sampling Method	: IS 9989 - 1981 (RA 2008)	LHS/RHS	: RHS
Sampled by	: Laboratory	Type of Sensitive Receptors	: Temple
Sample Collected Date	: 28.11.2019	Latitude	: 130209.7N
Name of the Sensitive Receptors	: Thirumala Thirupathi Devasthanam	Longitude	: 801412.1E
Sample Description	: Noise Monitoring	Sample Reference No	: PCEI/N-N036-12-19
Sample Condition	: Fit for Analysis	Sample Received On	: 29.11.2019
Category of Area	: Silence Zone	Test Commenced On	: 29.11.2019
Distance from the outer most proposed tracks (m)	: 25.6	Test Completed On	: 29.11.2019
Sampling Location	: Nandanam to Natesan Park		

Time	Day Time	Night Time
	Readings in dB(A)	Readings in dB(A)
06:00 - 07:00	53.4	
07:00 - 08:00	56.1	
08:00 - 09:00	54.9	
09:00 - 10:00	55.4	
10:00 - 11:00	54.9	
11:00 - 12:00	52.4	
12:00 - 13:00	50.9	
13:00 - 14:00	59.4	
14:00 - 15:00	57.4	
15:00 - 16:00	57.3	
16:00 - 17:00	56.1	
17:00 - 18:00	51.5	
18:00 - 19:00	49.7	
19:00 - 20:00	47.2	
20:00 - 21:00	43.6	
21:00 - 22:00	42.8	
22:00 - 23:00		53.6
23:00 - 00:00		52.1
00:00 - 01:00		51.3
01:00 - 02:00		49.7
02:00 - 03:00		47.3
03:00 - 04:00		44.7
04:00 - 05:00		42.5
05:00 - 06:00		31.3
Day Time	Min	42.8
	Max	59.4
	Leq	54.6
	Day Limit	50 dB(A)
Night Time	Min	31.3
	Max	53.6
	Leq	49.6
	Night Limit	40 dB(A)

Note: CPCB Ambient Air Quality Standards in respect of Noise in Silence Zone Daytime 50 dB(A) & Night Time 40 dB(A)

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[Signature]



Authorised Signatory
Name: Krishnan G
Designation: Technical Manager

Note: 1.The test results are only to the sample submitted for test. 2.Any Correction of the test report in full or part shall invalidate the report 3.Sample will be retained for 15 days from the date of reporting except in case of regulatory samples or specifically instructed by client. 4.Perishable samples will be discarded immediately after reporting. 5.Under no circumstances lab accepts any liability or loss/damage caused by use or misuse of test report after invoicing or issued of test report



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Report No	: PCEI/TR-N-4123	Report Date	: 09.12.2019
ULR No	: ULR-TC7446190003144F		
Issued to	: M/s Chennai Metro Rail Limited CMRL Depot, Admin Building, Poonamallee High Road, Koyambedu, Chennai - 600 107		
Sampling Method	: IS 9989 - 1981 (RA 2008)	LHS/RHS	: LMS
Sampled by	: Laboratory	Type of Sensitive Receptors	: Church
Sample Collected Date	: 29.11.2019	Latitude	: 130320.5N
Name of the Sensitive Receptors	: Rose of AC Church	Longitude	: 801347.5E
Sample Description	: Noise Monitoring	Sample Reference No	: PCEI/N-N037-12-19
Sample Condition	: Fit for Analysis	Sample Received On	: 30.11.2019
Category of Area	: Silence Zone	Test Commenced On	: 30.11.2019
Distance from the outer most proposed tracks (m)	: 180.34	Test Completed On	: 30.11.2019
Sampling Location	: Kodambakkam Metro to Meenakshi		

Time	Day Time	Night Time
	Readings in dB(A)	
06:00 - 07:00	46.2	
07:00 - 08:00	48.6	
08:00 - 09:00	49.2	
09:00 - 10:00	51.6	
10:00 - 11:00	52.1	
11:00 - 12:00	50.8	
12:00 - 13:00	51.2	
13:00 - 14:00	50.1	
14:00 - 15:00	49.8	
15:00 - 16:00	48.1	
16:00 - 17:00	47.2	
17:00 - 18:00	46.2	
18:00 - 19:00	46.1	
19:00 - 20:00	45.8	
20:00 - 21:00	45.0	
21:00 - 22:00	44.8	
22:00 - 23:00		39.8
23:00 - 00:00		37.4
00:00 - 01:00		36.6
01:00 - 02:00		36.3
02:00 - 03:00		35.1
03:00 - 04:00		34.3
04:00 - 05:00		37.2
05:00 - 06:00		38.6
Day Time	Min	44.8
	Max	52.1
	Leq	48.9
	Day Limit	50 dB(A)
Night Time	Min	34.3
	Max	39.8
	Leq	37.2
	Night Limit	40 dB(A)

Note: CPCB Ambient Air Quality Standards in respect of Noise in Silence Zone: Daytime 50 dB(A) & Night Time 40 dB(A)

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Authorised Signatory
Name: Krishnan G
Designation: Technical Manager

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Report No	: PCEI/TR-N-4124	Report Date	: 09.12.2019
ULR No	: ULR-TC7446190003145F		
Issued to	: M/s Chennai Metro Rail Limited CMRL Depot, Admin Building, Poonamallee High Road, Koyambedu, Chennai - 600 107		
Sampling Method	: IS 9989 - 1981 (RA 2008)	LHS/RHS	: LHS
Sampled by	: Laboratory	Type of Sensitive Receptors	: College
Sample Collected Date	: 29.11.2019	Latitude	: 130318.7N
Name of the Sensitive Receptors	: Meenakshi College for Women	Longitude	: 801337.6E
Sample Description	: Noise Monitoring	Sample Reference No	: PCEI/N-N038-12-19
Sample Condition	: Fit for Analysis	Sample Received On	: 30.11.2019
Category of Area	: Silence Zone	Test Commenced On	: 30.11.2019
Distance from the outer most proposed tracks (m)	: 120.9	Test Completed On	: 30.11.2019
Sampling Location	: Meenakshi College to Power House		

Time	Day Time	Night Time
	Readings in dB(A)	
06:00 - 07:00	56.9	
07:00 - 08:00	54.7	
08:00 - 09:00	55.1	
09:00 - 10:00	54.7	
10:00 - 11:00	51.5	
11:00 - 12:00	50.9	
12:00 - 13:00	51.3	
13:00 - 14:00	53.1	
14:00 - 15:00	52.9	
15:00 - 16:00	50.6	
16:00 - 17:00	52.5	
17:00 - 18:00	55.3	
18:00 - 19:00	49.7	
19:00 - 20:00	48.3	
20:00 - 21:00	47.0	
21:00 - 22:00	46.6	
22:00 - 23:00		40.9
23:00 - 00:00		35.3
00:00 - 01:00		35.8
01:00 - 02:00		35.4
02:00 - 03:00		34.1
03:00 - 04:00		32.9
04:00 - 05:00		30.4
05:00 - 06:00		30.9
Day Time	Min	46.6
	Max	56.9
	Leq	52.9
	Day Limit	50 dB(A)
Night Time	Min	30.4
	Max	40.9
	Leq	35.7
	Night Limit	40 dB(A)

Note: CPCB Ambient Air Quality Standards in respect of Noise in Silence Zone Daytime 50 dB(A) & Night Time 40 dB(A)

*** End of Report ***

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Authorised Signatory
Name: Krishnan G
Designation: Technical Manager

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Web : www.pollucareindia.com

Report No	: PCEI/TR-N-4125	Report Date	: 09.12.2019
ULR No	: LUR-TC7446190003146F		
Issued to	: M/s Chennai Metro Rail Limited CMRL Depot, Admin Building, Poonamallee High Road, Koyambedu, Chennai - 600 107		
Sampling Method	: IS 9989 - 1981 (RA 2008)	LHS/RHS	: LHS
Sampled by	: Laboratory	Type of Sensitive Receptors	: School
Sample Collected Date	: 02.12.2019	Latitude	: 13°03'05.8"N
Name of the Sensitive Receptors	: Chennai Higher Secondary School	Longitude	: 80°13'01.4"E
Sample Description	: Noise Monitoring	Sample Reference No	: PCEI/N-NO39-12-19
Sample Condition	: Fit for Analysis	Sample Received On	: 03.12.2019
Category of Area	: Silence Zone	Test Commenced On	: 03.12.2019
Distance from the outer most proposed tracks (m)	: 19.0	Test Completed On	: 03.12.2019
Sampling Location	: Power House to Vadapalani		

Time	Day Time	Night Time
	Readings in dB(A)	Readings in dB(A)
06:00 - 07:00	47.6	
07:00 - 08:00	51.4	
08:00 - 09:00	59.8	
09:00 - 10:00	59.1	
10:00 - 11:00	56.7	
11:00 - 12:00	52.1	
12:00 - 13:00	51.3	
13:00 - 14:00	59.5	
14:00 - 15:00	58.2	
15:00 - 16:00	56.9	
16:00 - 17:00	59.4	
17:00 - 18:00	56.8	
18:00 - 19:00	53.3	
19:00 - 20:00	51.7	
20:00 - 21:00	49.5	
21:00 - 22:00	47.9	
22:00 - 23:00		40.3
23:00 - 00:00		31.7
00:00 - 01:00		33.2
01:00 - 02:00		31.6
02:00 - 03:00		31.2
03:00 - 04:00		31.9
04:00 - 05:00		31.1
05:00 - 06:00		31.6
Day Time	Min	47.6
	Max	59.8
	Leq	56.2
	Day Limit	50 dB(A)
Night Time	Min	31.1
	Max	40.3
	Leq	34.3
	Night Limit	40 dB(A)

Note: CPCB Ambient Air Quality Standards in respect of Noise in Silence Zone Daytime 50 dB(A) & Night Time 40 dB(A)

*** End of Report ***

Page 1 of 1.


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Authorized Signatory
Name: Krishnan G
Designation: Technical Manager

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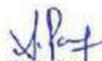
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Report No	: PCEI/TR-N-4126	Report Date	: 09.12.2019
ULR No	: ULR-TC7446190003147F		
Issued to	: M/s Chennai Metro Rail Limited CMRL Depot, Admin Building, Poonamallee High Road, Koyambedu, Chennai - 600 107		
Sampling Method	: IS 9989 - 1981 (RA 2008)	LHS/RHS	: LHS
Sampled by	: Laboratory	Type of Sensitive Receptors	: School
Sample Collected Date	: 02.12.2019	Latitude	: 13°03'02.6"N
Name of the Sensitive Receptors	: Saraswathi Vidyalaya Sr. Sec. School	Longitude	: 80°12'52.6"E
Sample Description	: Noise Monitoring	Sample Reference No	: PCEI/N-N040-12-19
Sample Condition	: Fit for Analysis	Sample Received On	: 03.12.2019
Category of Area	: Silence Zone	Test Commenced On	: 03.12.2019
Distance from the outer most proposed tracks (m)	: 12.79	Test Completed On	: 03.12.2019
Sampling Location	: Power House to Vadapalani		

Time	Day Time	Night Time
	Readings in dB(A)	Readings in dB(A)
06:00 - 07:00	46.8	
07:00 - 08:00	47.3	
08:00 - 09:00	53.5	
09:00 - 10:00	59.7	
10:00 - 11:00	58.9	
11:00 - 12:00	52.3	
12:00 - 13:00	51.2	
13:00 - 14:00	55.6	
14:00 - 15:00	53.4	
15:00 - 16:00	57.1	
16:00 - 17:00	58.7	
17:00 - 18:00	52.9	
18:00 - 19:00	51.7	
19:00 - 20:00	49.3	
20:00 - 21:00	46.5	
21:00 - 22:00	45.2	
22:00 - 23:00		37.5
23:00 - 00:00		31.9
00:00 - 01:00		34.5
01:00 - 02:00		32.7
02:00 - 03:00		30.4
03:00 - 04:00		33.5
04:00 - 05:00		30.2
05:00 - 06:00		30.0
Day Time	Min	45.2
	Max	59.7
	Leq	54.7
	Day Limit	50 dB(A)
	Min	30.0
Night Time	Max	37.5
	Leq	33.3
	Night Limit	40 dB(A)
	Min	30.0

Note: CPCB Ambient Air Quality Standards in respect of Noise in Silence Zone Daytime 50 dB(A) & Night Time 40 dB(A)

*** End of Report ***
Page 1 of 1


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Authorized Signatory
Name: Krishnan G
Designation: Technical Manager

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Report No	: PCEI/TR-N-4128	Report Date	: 09.12.2019
ULR No	: ULR-TC7446190003149F		
Issued to	: M/s Chennai Metro Rail Limited CMRL Depot, Admin Building, Poonamallee High Road, Koyambedu, Chennai - 600 107		
Sampling Method	: IS 9989 - 1981 (RA 2008)	LHS/RHS	: LHS
Sampled by	: Laboratory	Type of Sensitive Receptors	: School
Sample Collected Date	: 03.12.2019	Latitude	: 13°02'55.5"N
Name of the Sensitive Receptors	: Karthikeyan Matriculation School	Longitude	: 80°12'18.7"E
Sample Description	: Noise Monitoring	Sample Reference No	: PCEI/N-ND42-12-19
Sample Condition	: Fit for Analysis	Sample Received On	: 04.12.2019
Category of Area	: Silence Zone	Test Commenced On	: 04.12.2019
Distance from the outer most proposed tracks (m)	: 35.96	Test Completed On	: 04.12.2019
Sampling Location	: Vadapalani to Saligramam		

Time	Day Time	Night Time
	Readings in dB(A)	Readings in dB(A)
06:00 - 07:00	44.5	
07:00 - 08:00	46.2	
08:00 - 09:00	47.2	
09:00 - 10:00	52.6	
10:00 - 11:00	46.3	
11:00 - 12:00	45.9	
12:00 - 13:00	48.5	
13:00 - 14:00	53.2	
14:00 - 15:00	44.2	
15:00 - 16:00	45.8	
16:00 - 17:00	58.3	
17:00 - 18:00	42.7	
18:00 - 19:00	45.8	
19:00 - 20:00	46.1	
20:00 - 21:00	39.3	
21:00 - 22:00	36.8	
22:00 - 23:00		36.3
23:00 - 00:00		35.9
00:00 - 01:00		34.7
01:00 - 02:00		33.5
02:00 - 03:00		31.9
03:00 - 04:00		33.1
04:00 - 05:00		34.9
05:00 - 06:00		35.7
Day Time	Min	36.8
	Max	58.3
	Leq	49.8
	Day Limit	50 dB(A)
Night Time	Min	31.9
	Max	36.3
	Leq	34.7
	Night Limit	40 dB(A)

Note: CPCB Ambient Air Quality Standards in respect of Noise in Silence Zone Daytime 50 dB(A) & Night Time 40 dB(A)

*** End of Report ***
Page 1 of 1


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Authorized Signatory
Name: Krishnan G
Designation: Technical Manager

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Report No	: PCEI/TR-N-4127	Report Date	: 09.12.2019
ULR No	: ULR-TC7446190003148F		
Issued to	: M/s Chennai Metro Rail Limited CMRL Depot, Admin Building, Poonamallee High Road, Koyambedu, Chennai - 600 107		
Sampling Method	: IS 9989 - 1981 (RA 2008)	LHS/RHS	: LHS
Sampled by	: Laboratory	Type of Sensitive Receptors	: Hospital
Sample Collected Date	: 03.12.2019	Latitude	: 13°02'58.5"N
Name of the Sensitive Receptors	: Vijaya Hospital	Longitude	: 80°12'03.06"E
Sample Description	: Noise Monitoring	Sample Reference No	: PCEI/N-N041-12-19
Sample Condition	: Fit for Analysis	Sample Received On	: 04.12.2019
Category of Area	: Silence Zone	Test Commenced On	: 04.12.2019
Distance from the outer most proposed tracks (m)	: 15.70	Test Completed On	: 04.12.2019
Sampling Location	: Vadapalani to Saligramam		

Time	Day Time	Night Time
	Readings in dB(A)	Readings in dB(A)
06:00 - 07:00	48.2	
07:00 - 08:00	49.5	
08:00 - 09:00	50.2	
09:00 - 10:00	51.6	
10:00 - 11:00	52.4	
11:00 - 12:00	53.2	
12:00 - 13:00	54.8	
13:00 - 14:00	53.5	
14:00 - 15:00	52.4	
15:00 - 16:00	51.7	
16:00 - 17:00	52.1	
17:00 - 18:00	50.2	
18:00 - 19:00	48.2	
19:00 - 20:00	47.3	
20:00 - 21:00	44.0	
21:00 - 22:00	41.2	
22:00 - 23:00		41.5
23:00 - 00:00		39.6
00:00 - 01:00		40.2
01:00 - 02:00		39.9
02:00 - 03:00		39.1
03:00 - 04:00		37.2
04:00 - 05:00		36.1
05:00 - 06:00		36.5
Day Time	Min	41.2
	Max	54.8
	Leq	51.1
	Day Limit	50 dB(A)
Night Time	Min	36.1
	Max	41.5
	Leq	39.1
	Night Limit	40 dB(A)

Note: CPCB Ambient Air Quality Standards in respect of Noise in Silence Zone Daytime 50 dB(A) & Night Time 40 dB(A)

*** End of Report ***

Page 1 of 1


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Authorized Signatory
Name: Krishnan G
Designation: Technical Manager

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Email: lab@pollucareindia.com
Web : www.pollucareindia.com

Report No	: PCEI/TR-N-4129	Report Date	: 09.12.2019
ULR No	: ULR-TC7446190003150F		
Issued to	: M/s Chennai Metro Rail Limited CMRL Depot, Admin Building, Poonamallee High Road, Koyambedu, Chennai - 600 107		
Sampling Method	: IS 9989 - 1981 (RA 2008)	LHS/RHS	: LHS
Sampled by	: Laboratory	Type of Sensitive Receptors	: School
Sample Collected Date	: 04.12.2019	Latitude	: 13°02'46.4"N
Name of the Sensitive Receptors	: Narayanan E-Tecno School	Longitude	: 80°11'16.6"E
Sample Description	: Noise Monitoring	Sample Reference No	: PCEI/N-N043-12-19
Sample Condition	: Fit for Analysis	Sample Received On	: 05.12.2019
Category of Area	: Silence Zone	Test Commenced On	: 05.12.2019
Distance from the outer most proposed tracks (m)	: 14.17	Test Completed On	: 05.12.2019
Sampling Location	: Alwar Thirunagar to Valasarwakkam		

Time	Day Time	Night Time
	Readings in dB(A)	Readings in dB(A)
06:00 - 07:00	40.3	
07:00 - 08:00	41.5	
08:00 - 09:00	42.8	
09:00 - 10:00	55.4	
10:00 - 11:00	49.3	
11:00 - 12:00	45.9	
12:00 - 13:00	46.5	
13:00 - 14:00	46.8	
14:00 - 15:00	46.1	
15:00 - 16:00	47.5	
16:00 - 17:00	46.2	
17:00 - 18:00	45.2	
18:00 - 19:00	44.3	
19:00 - 20:00	43.5	
20:00 - 21:00	42.8	
21:00 - 22:00	41.9	
22:00 - 23:00		39.1
23:00 - 00:00		38.4
00:00 - 01:00		37.1
01:00 - 02:00		36.5
02:00 - 03:00		33.9
03:00 - 04:00		33.7
04:00 - 05:00		34.5
05:00 - 06:00		35.6
	Min	40.3
	Max	55.4
	Leq	47.3
	Day Limit	50 dB(A)
	Min	33.7
	Max	39.1
	Leq	36.5
	Night Limit	40 dB(A)

Notes: CPCB Ambient Air Quality Standards in respect of Noise in Silence Zone Daytime 50 dB(A) & Night Time 40 dB(A)

*** End of Report ***

Page 1 of 1


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Authorised Signatory
Name: Krishnan G
Designation: Technical Manager

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Report No	: PCEI/TR-N-4130	Report Date	: 09.12.2019
ULR No	: ULR-TC7446190003151F		
Issued to	: M/s Chennai Metro Rail Limited CMRL Depot, Admin Building, Poonamallee High Road, Koyambedu, Chennai - 600 107		
Sampling Method	: IS 9989 - 1981 (RA 2008)	LHS/RHS	: RHS
Sampled by	: Laboratory	Type of Sensitive Receptors	: School
Sample Collected Date	: 04.12.2019	Latitude	: 13°02'23.4"N
Name of the Sensitive Receptors	: The Holy Cross Matric Hr. Sec. School	Longitude	: 80°10'19.9"E
Sample Description	: Noise Monitoring	Sample Reference No	: PCEI/N-N044-12-19
Sample Condition	: Fit for Analysis	Sample Received On	: 05.12.2019
Category of Area	: Silence Zone	Test Commenced On	: 05.12.2019
Distance from the outer most proposed tracks (m)	: 87.30	Test Completed On	: 05.12.2019
Sampling Location	: Valasaravakkam to Karambakkam		

Time	Day Time	Night Time
	Readings in dB(A)	Readings in dB(A)
06:00 - 07:00	52.7	
07:00 - 08:00	55.1	
08:00 - 09:00	56.8	
09:00 - 10:00	52.9	
10:00 - 11:00	52.4	
11:00 - 12:00	56.8	
12:00 - 13:00	51.9	
13:00 - 14:00	49.5	
14:00 - 15:00	52.7	
15:00 - 16:00	50.3	
16:00 - 17:00	52.6	
17:00 - 18:00	51.3	
18:00 - 19:00	49.5	
19:00 - 20:00	48.2	
20:00 - 21:00	44.7	
21:00 - 22:00	39.1	
22:00 - 23:00		41.4
23:00 - 00:00		39.6
00:00 - 01:00		38.2
01:00 - 02:00		38.4
02:00 - 03:00		35.8
03:00 - 04:00		35.2
04:00 - 05:00		35.6
05:00 - 06:00		36.7
Day Time	Min	39.1
	Max	56.8
	Leq	52.6
	Day Limit	50 dB(A)
Night Time	Min	35.2
	Max	41.4
	Leq	38.1
	Night Limit	40 dB(A)

Note: CPCB Ambient Air Quality Standards in respect of Noise in Silence Zone Daytime 50 dB(A) & Night Time 40 dB(A)

*** End of Report ***

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Authorised Signatory
Name: Krishnan G
Designation: Technical Manager

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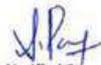
Report No	: PCEI/TR-N-4131	Report Date	: 09.12.2019
ULR No	: ULR-TC7446190003152F		
Issued to	: M/s Chennai Metro Rail Limited CMRL Depot, Admin Building, Poonamallee High Road, Koyambedu, Chennai - 600 107		
Sampling Method	: IS 9899 - 1981 (RA 2008)	LHS/RHS	: LHS
Sampled by	: Laboratory	Type of Sensitive Receptors	: Hospital
Sample Collected Date	: 05.12.2019	Latitude	: 13°2'17.6676" N
Name of the Sensitive Receptors	: Parvathy Hospital	Longitude	: 80°9'37.0152"E
Sample Description	: Noise Monitoring	Sample Reference No	: PCEI/N-N045-12-19
Sample Condition	: Fit for Analysis	Sample Received On	: 06.12.2019
Category of Area	: Silence Zone	Test Commenced On	: 06.12.2019
Distance from the outer most proposed tracks (m)	: 57.56	Test Completed On	: 06.12.2019
Sampling Location	: Alapakkam Junction - Porur Junction		

Time	Day Time	Night Time
	Readings in dB(A)	Readings in dB(A)
06:00 - 07:00	41.6	
07:00 - 08:00	42.5	
08:00 - 09:00	43.4	
09:00 - 10:00	48.6	
10:00 - 11:00	48.1	
11:00 - 12:00	47.3	
12:00 - 13:00	49.6	
13:00 - 14:00	47.5	
14:00 - 15:00	52.9	
15:00 - 16:00	50.3	
16:00 - 17:00	51.7	
17:00 - 18:00	49.5	
18:00 - 19:00	47.8	
19:00 - 20:00	46.3	
20:00 - 21:00	45.7	
21:00 - 22:00	43.1	
22:00 - 23:00		41.9
23:00 - 00:00		37.1
00:00 - 01:00		36.5
01:00 - 02:00		34.5
02:00 - 03:00		33.7
03:00 - 04:00		33.1
04:00 - 05:00		34.6
05:00 - 06:00		33.5
Day Time	Min	41.6
	Max	52.9
	Leq	48.3
	Day Limit	50 dB(A)
Night Time	Min	33.1
	Max	41.9
	Leq	36.7
	Night Limit	40 dB(A)

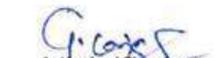
Note: CPCB Ambient Air Quality Standards in respect of Noise in Silence Zone: Daytime 50 dB(A) & Night Time 40 dB(A)

*** End of Report ***

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Report No	: FCEI/TR-N-4132	Report Date	: 09.12.2019
ULR No	: ULR-TC7446190003153F		
Issued to	: M/s Chennai Metro Rail Limited CMRL Depot, Admin Building, Poonamallee High Road, Koyambedu, Chennai - 600 107		
Sampling Method	: IS 9989 - 1981 (RA 2008)	LHS/RHS	: RHS
Sampled by	: Laboratory	Type of Sensitive Receptors	: Hospital
Sample Collected Date	: 05.12.2019	Latitude	: 13°2'13.4736"N
Name of the Sensitive Receptors	: Lakshmi Hospital	Longitude	: 80°8'18.312"E
Sample Description	: Noise Monitoring	Sample Reference No	: PCEI/N-M046-12-19
Sample Condition	: Fit for Analysis	Sample Received On	: 06.12.2019
Category of Area	: Silence Zone	Test Commenced On	: 06.12.2019
Distance from the outer most proposed tracks (m)	: 38.38	Test Completed On	: 06.12.2019
Sampling Location	: Ramchandra Hospital - Jyappanthangal Bus Depot		

Time	Day Time	Night Time
	Readings in dB(A)	
06:00 - 07:00	50.3	
07:00 - 08:00	46.8	
08:00 - 09:00	52.6	
09:00 - 10:00	52.9	
10:00 - 11:00	59.1	
11:00 - 12:00	55.4	
12:00 - 13:00	52.2	
13:00 - 14:00	56.9	
14:00 - 15:00	49.5	
15:00 - 16:00	52.4	
16:00 - 17:00	50.9	
17:00 - 18:00	49.5	
18:00 - 19:00	47.6	
19:00 - 20:00	46.8	
20:00 - 21:00	45.8	
21:00 - 22:00	45.1	
22:00 - 23:00		40.5
23:00 - 00:00		38.1
00:00 - 01:00		38.5
01:00 - 02:00		37.5
02:00 - 03:00		36.1
03:00 - 04:00		35.2
04:00 - 05:00		37.2
05:00 - 06:00		35.3
Day Time	Min	45.1
	Max	59.1
	Leq	52.7
	Day Limit	50 dB(A)
Night Time	Min	35.2
	Max	40.5
	Leq	37.6
	Night Limit	40 dB(A)

Note: CPCB Ambient Air Quality Standards in respect of Noise in Silence Zone Daytime 50 dB(A) & Night Time 40 dB(A)

*** End of Report ***

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Report No	: FCEI/TR-N-4133	Report Date	: 09.12.2019
ULR No	: ULR-TC7446190003154F		
Issued to	: M/s Chennai Metro Rail Limited CMRL Depot, Admin Building, Poonamallee High Road, Koyambedu, Chennai - 600 107		
Sampling Method	: IS 9989 - 1981 (RA 2008)	LHS/RHS	: RHS
Sampled by	: Laboratory	Type of Sensitive Receptors	: Hospital
Sample Collected Date	: 06.12.2019	Latitude	: 13°3'2.646"N
Name of the Sensitive Receptors	: Mangalam Hospital	Longitude	: 80°5' 45.4272"E
Sample Description	: Noise Monitoring	Sample Reference No	: PCEI/N-ND47-12-19
Sample Condition	: Fit for Analysis	Sample Received On	: 07.12.2019
Category of Area	: Silence Zone	Test Commenced On	: 07.12.2019
Distance from the outer most proposed tracks (m)	: 23.85	Test Completed On	: 07.12.2019
Sampling Location	: Mullai Thottam to Poonamallee Bus Terminus		

Time	Day Time	Night Time
	Readings in dB(A)	Readings in dB(A)
06:00 - 07:00	42.1	
07:00 - 08:00	45.9	
08:00 - 09:00	59.6	
09:00 - 10:00	55.2	
10:00 - 11:00	55.6	
11:00 - 12:00	56.3	
12:00 - 13:00	54.8	
13:00 - 14:00	52.6	
14:00 - 15:00	57.1	
15:00 - 16:00	56.8	
16:00 - 17:00	55.4	
17:00 - 18:00	51.7	
18:00 - 19:00	43.5	
19:00 - 20:00	42.8	
20:00 - 21:00	41.9	
21:00 - 22:00	39.3	
22:00 - 23:00		39.5
23:00 - 00:00		34.9
00:00 - 01:00		32.1
01:00 - 02:00		32.4
02:00 - 03:00		35.2
03:00 - 04:00		34.8
04:00 - 05:00		34.5
05:00 - 06:00		33.8
Day Time	Min	39.3
	Max	59.6
	Leq	54.1
	Day Limit	50 dB(A)
Night Time	Min	32.1
	Max	39.5
	Leq	35.3
	Night Limit	40 dB(A)

Note: CPCB Ambient Air Quality Standards in respect of Noise in Silence Zone Daytime 50 dB(A) & Night Time 40 dB(A)

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Report No	: PCEI/TR-N-4134	Report Date	: 09.12.2019
ULR No	: ULR-TC7446190003155F		
Issued to	: M/s Chennai Metro Rail Limited CMRL Depot, Admin Building, Poonamallee High Road, Koyambedu, Chennai - 600 107		
Sampling Method	: IS 9989 -- 1981 (RA 2008)	LHS/RHS	: LHS
Sampled by	: Laboratory	Type of Sensitive Receptors	: Hospital
Sample Collected Date	: 06.12.2019	Latitude	: 13°3'1.7136"N
Name of the Sensitive Receptors	: Government Hospital	Longitude	: 80°5' 57.7464"E
Sample Description	: Noise Monitoring	Sample Reference No	: PCEI/N-ND48-12-19
Sample Condition	: Fit for Analysis	Sample Received On	: 07.12.2019
Category of Area	: Silence Zone	Test Commenced On	: 07.12.2019
Distance from the outer most proposed tracks (m)	: 18.01	Test Completed On	: 07.12.2019
Sampling Location	: Mullai Thottam to Poonamallee Bus Terminus		

Time	Day Time	Night Time
	Readings in dB(A)	
06:00 - 07:00	56.9	
07:00 - 08:00	58.6	
08:00 - 09:00	57.1	
09:00 - 10:00	61.8	
10:00 - 11:00	63.4	
11:00 - 12:00	59.8	
12:00 - 13:00	56.1	
13:00 - 14:00	60.4	
14:00 - 15:00	64.2	
15:00 - 16:00	61.8	
16:00 - 17:00	57.9	
17:00 - 18:00	56.4	
18:00 - 19:00	55.1	
19:00 - 20:00	48.5	
20:00 - 21:00	44.3	
21:00 - 22:00	45.9	
22:00 - 23:00		44.7
23:00 - 00:00		43.2
00:00 - 01:00		42.3
01:00 - 02:00		41.6
02:00 - 03:00		38.3
03:00 - 04:00		39.4
04:00 - 05:00		36.7
05:00 - 06:00		40.8
Day Time	Min	44.3
	Max	64.2
	Leq	59.3
	Day Limit	50 dB(A)
Night Time	Min	36.7
	Max	44.7
	Leq	41.5
	Night Limit	40 dB(A)

Note: CPCB Ambient Air Quality Standards in respect of Noise in Silence Zone Daytime 50 dB(A) & Night Time 40 dB(A)

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Environmental Impact Assessment (Draft)

March 2021

India: Chennai Metro Rail Investment Project
Corridor 4

Annexure 2

This environmental impact assessment is a document of the borrower. The views expressed herein do not necessarily represent those of ADB's Board of Directors, Management, or staff, and may be preliminary in nature. Your attention is directed to the "terms of use" section on ADB's website.

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Annexure 2: Environmentally Sensitive Receptors on Corridor 4

Environmentally sensitive receptors located within 200m on either side of alignment

SN	Name of Sensitive Receptor	Location	Type of Sensitive Receptor	LHS/RHS	Distance from the outer most proposed tracks (m)	Latitude	Longitude
1	Queens Mary College	Light House Station - Fore shore Estate Road	College	LHS	94.57	13°02'40.4"N	80°16'44.5"E
2	Vinayagar Temple	Light House Station - Fore shore Estate Road	Temple	LHS	158.38	13°02'39.8"N	80°16'42.7"E
3	St. Thomas Mount church	Light House Station - Fore shore Estate Road	Church	LHS	1	13°02'00.9"N	80°16'40.2"E
4	St. Bede's Anglo Indian Hr. Sec. School	Light House Station - Fore shore Estate Road	School	LHS	71.16	13°02'04.6"N	80°16'41.6"E
5	Santhome cathedral church	Foreshore Estate Road - Kutchery Road	Church	LHS	6.32	13°02'00.9"N	80°16'40.2"E
6	TNPLC Secretariat Church	Foreshore Estate Road - Kutchery Road	Church	RHS	46.2	13°01'58.7"N	80°16'39.3"E
7	St. Thomas English School	Foreshore Estate Road - Kutchery Road	School	RHS	203.89	13°01'53.2"N	80°16'41.2"E
8	Santhome School	Foreshore Estate Road - Kutchery Road	School	RHS	190.47	13°01'55.0"N	80°16'35.8"E
9	Aashraya Hospital	Foreshore Estate Road - Kutchery Road	Hospital	RHS	5.27	13°02'01.1"N	80°16'33.1"E
10	Rosary Church	Foreshore Estate Road - Kutchery Road	Church	LHS	1	13°02'02.6"N	80°16'31.7"E
11	St. Raphael's Girls Hr. Sec. School	Foreshore Estate Road - Kutchery Road	School	LHS	6.07	13°02'03.8"N	80°16'34.6"E
12	ICAT Design & Media College	Foreshore Estate Road - Kutchery Road	College	LHS	140	13°02'05.7"N	80°16'37.4"E
13	Dominic Savio Matric Hr. Sec. School	Foreshore Estate Road - Kutchery Road	School	LHS	175.83	13°02'06.9"N	80°16'38.8"E
14	Rosary Matric Hr. Sec. School	Foreshore Estate Road - Kutchery Road	School	LHS	193.73	13°02'07.7"N	80°16'34.1"E
15	Bachawali Mosque	Foreshore Estate Road - Kutchery Road	Mosque	LHS	196.12	13°02'08.9"N	80°16'30.3"E
16	Thillai Vinayagar Temple	Foreshore Estate Road - Kutchery Road	Temple	LHS	98.62	13°02'06.6"N	80°16'26.3"E
17	Kabaleshwarar Temple	Kutchery Road - Thirumayilai Metro	Temple	RHS	182.99	13°02'02.2"N	80°16'11.9"E
18	Arulmigu Sivasakthi Salaiamman Temple	Kutchery Road - Thirumayilai Metro	Temple	RHS	173.35	13°01'58.1"N	80°16'22.8"E
19	Chellamal Vidhyalaya Hr. Sec. School	Kutchery Road - Thirumayilai Metro	School	RHS	203.41	13°01'58.3"N	80°16'18.6"E

SN	Name of Sensitive Receptor	Location	Type of Sensitive Receptor	LHS/RHS	Distance from the outer most proposed tracks (m)	Latitude	Longitude
20	Shree Jain Temple	Kutchery Road - Thirumayilai Metro	Temple	RHS	16.86	13°01'04.8"N	80°16'17.6"E
21	Majood Jamal	Kutchery Road - Thirumayilai Metro	Mosque	LHS		13°02'06.9"N	80°16'21.5"E
22	Masjid Fakhri	Kutchery Road - Thirumayilai Metro	Mosque	LHS	68.28	13°02'06.9"N	80°16'20.8"E
23	Mylai Angalamman Temple	Kutchery Road - Thirumayilai Metro	Temple	LHS	72.41	13°02'12.4"N	80°16'08.7"E
24	Jumma Mosque	Kutchery Road - Thirumayilai Metro	Mosque	LHS	11.87	13°02'04.8"N	80°16'11.6"E
25	VidhyaMandir School	Kutchery Road - Thirumayilai Metro	School	LHS	77.15	13°02'16.8"N	80°16'07.4"E
26	Majid Al Huda	Kutchery Road - Thirumayilai Metro	Mosque	LHS	49.1	13°02'12.9"N	80°16'06.9"E
27	Bharat Open University	Thirumayilai Metro - Alwarpet	College	LHS	119.47	13°02'19.4"N	80°15'52.6"E
28	NHN Clinic (Neuro, Head & Neck Clinic)	Thirumayilai Metro - Alwarpet	Hospital	RHS	8.75	13°02'14.7"N	80°15'41.0"E
29	St. Isabel's Hospital	Thirumayilai Metro - Alwarpet	Hospital	LHS	168.88	13°02'20.2"N	80°15'42.8"E
30	Luz Church	Thirumayilai Metro - Alwarpet	Church	LHS	76.43	13°02'17.6"N	80°15'44.7"E
31	Arulmigu Sri Pillayar Temple	Thirumayilai Metro - Alwarpet	Temple	RHS	115.99	13°02'12.7"N	80°15'37.1"E
32	Arulmigu Aapadbandava Perumal Temple	Thirumayilai Metro - Alwarpet	Temple	RHS	137.41	13°02'11.9"N	80°15'36.6"E
33	Our Lady of Light Shrine (Luz Church)	Thirumayilai Metro - Alwarpet	Church	LHS	199.63	13°02'21.4"N	80°15'45.5"E
34	Anjaneyar Temple	Alwarpet - Bharathidasan Road	Temple	RHS	9.66	13°02'18.7"N	80°15'31.5"E
35	Trinity Hospital	Alwarpet - Bharathidasan Road	Hospital	RHS	7.58	13°02'19.0"N	80°15'28.2"E
36	Anjaneyar Temple	Alwarpet - Bharathidasan Road	Temple	RHS	7.6	13°02'18.8"N	80°15'31.7"E
37	MCTM School	Alwarpet - Bharathidasan Road	School	RHS	42.73	13°02'16.7"N	80°15'32.5"E
38	Trinity Acute Care Hospital	Alwarpet - Bharathidasan Road	Hospital	RHS	31.73	13°02'18.3"N	80°15'29.7"E
39	MP Anandh School	Alwarpet - Bharathidasan Road	School	LHS	124.5	13°02'21.3"N	80°15'36.5"E
40	AVT Hospital	Alwarpet - Bharathidasan Road	Hospital	LHS	28.9	13°02'20.2"N	80°15'26.6"E
41	Apollo Spectra Hospital	Alwarpet - Bharathidasan Road	Hospital	RHS	165.62	13°02'10.2"N	80°15'25.9"E
42	Frontline Hospital	Bharathidasan Road - Adyar Gate	Hospital	LHS	47.05	13°02'56.9"N	80°15'06.1"E

SN	Name of Sensitive Receptor	Location	Type of Sensitive Receptor	LHS/RHS	Distance from the outer most proposed tracks (m)	Latitude	Longitude
43	Muthu Mariamman Temple	Bharathidasan Road - Adyar Gate	Hospital	LHS	139.59	13°02'00.2"N	80°15'05.4"E
44	Girishwari Hospital	Bharathidasan Road - Adyar Gate	Hospital	LHS	157.02	13°02'06.7"N	80°15'06.9"E
45	Poyya Varasakthi Vinayagar Alayam	Bharathidasan Road - Adyar Gate	Temple	RHS	11.82	13°01'44.9"N	80°15'00.5"E
46	Olive Heart Clinic	Bharathidasan Road - Adyar Gate	Temple	LHS	95.58	13°02'04.5"N	80°15'08.8"E
47	MM Dental Care	Bharathidasan Road - Adyar Gate	Hospital	LHS	188.66	13°02'04.7"N	80°15'06.9"E
48	Arulmigu Gangaiamman Aalayam	Adyar Gate Junction To Nandanam	Temple	LHS	11.05	130146.2N	801450.9E
49	Shiva Temple	Adyar Gate Junction To Nandanam	Temple	RHS	46.98	130144.7N	801448.3E
50	Arulmigu Shri Chaokkanathar Aalayam	Adyar Gate Junction To Nandanam	Temple	LHS	20.15	130149.3N	801428E
51	Om Shri Shakthi Samayapuram Temple	Adyar Gate Junction To Nandanam	Temple	LHS	40.19	130150.3N	801427.6E
52	Government College For Men	Adyar Gate Junction To Nandanam	College	RHS	138.33	130147.0N	801421.9E
53	SIET College	Adyar Gate Junction To Nandanam	College	LHS	31.17	130152.9N	801423.9E
54	Murugan Temple	Adyar Gate Junction To Nandanam	Temple	RHS	165.69	130142.9N	801434.7E
55	Venkateshwara Hospital	Nanadanam To Natesan Park	Hospital	RHS	38.23	1301476.7N	801438.8E
56	Government Arts College	Adyar Gate Junction To Nandanam	College	RHS	18.48	130156.6N	801421.3E
57	Bala Vinayagar Temple	Adyar Gate Junction To Nandanam	Temple	RHS	111.54	130142.9N	801448.5E
58	Grace Apostolic Church	Adyar Gate Junction To Nandanam	Church	LHS	100	130152.8N	801443.5E
59	WDEGPM	Adyar Gate Junction To Nandanam	Church	LHS	172.47	130156.5N	801441.7E
60	Holy Cross Church	Nanadanam To Natesan Park	Church	LHS	124.32	130200.4N	801412.1E
61	Aspire College Of Expense	Nanadanam To Natesan Park	College	LHS	129.23	13033840N	80.239203E
62	Shri Muthumariyamman Temple	Nanadanam To Natesan Park	Temple	RHS	12.51	130157.1N	801419.8E
63	Agriculture Engineering Department	Nanadanam To Natesan Park	College	RHS	42.77	130150.8N	801422.5E

SN	Name of Sensitive Receptor	Location	Type of Sensitive Receptor	LHS/RHS	Distance from the outer most proposed tracks (m)	Latitude	Longitude
64	Little Oxford Matriculation Higher Sec School	Nanadanam To Natesan Park	School	RHS	73.81	130208.6N	801412.8E
65	Samridi Ayurvedic Hospital	Nanadanam To Natesan Park	Hospital	LHS	152.4	130212.2N	801414.6E
66	Thyagarayar Higher Secondary School	Nanadanam To Natesan Park	School	LHS	22.45	130210.6N	801413.9E
67	Sakthi Vinayagar Temple	Nanadanam To Natesan Park	Temple	LHS	33.45	130152.0N	801424.5E
68	Ethnic Health Care Natural Fertility Centre	Nanadanam To Natesan Park	Hospital	LHS	185.26	130216.6N	801414.7E
69	Thirumala Tirupathi Devasthanam	Nanadanam To Natesan Park	Temple	RHS	25.6	130209.7N	801412.1E
70	Lions Hospital	Natesan Park To Panagal Park	Hospital	LHS	42.97	130223.3N	801404.9E
71	Shri Vetri Vinayagar Alayam	Natesan Park To Panagal Park	Temple	LHS	44.58	130217.0N	8014049.7E
72	Sringeri Bharathi Vidhyashram	Natesan Park To Panagal Park	School	LHS	42.71	130218.4N	801407.5E
73	Anuratha Maternity Centre	Natesan Park To Panagal Park	Hospital	RHS	193.5	13.03686N	80.233534E
74	Arulmigu Muppathamman Aalayam	Panagal Park To Kodambakakm	Temple	RHS	15.13	130255.3N	801351.E
75	Sri Kallapuri Amman Temple	Panagal Park To Kodambakakm	Temple	RHS	17.95	1300246.8N	801350.0E
76	Arulmigu Muthumariyamman Temple	Panagal Park To Kodambakakm	Temple	RHS	75.62	130255.3N	1347.9E
77	Anuradha Womens Speciality Centre	Panagal Park To Kodambakakm	Hospital	LHS	11.16	130258.2N	80135051.4E
78	Nagathamman Kovil	Panagal Park To Kodambakakm	Temple	RHS	74.65	13027.7N	801348.2E
79	Rose Of Sharon Ac Church	Kodambakkam Metro To Meenakshi	Church	LHS	180.34	130320.5N	801347.5E
80	Elim Glorius Revival Church	Kodambakkam Metro To Meenakshi	Church	RHS	22.21	130313.3N	801349.4E
81	JV Hospital	Kodambakkam Metro To Meenakshi	Hospital	RHS	119.19	130303N	801347.7E
82	Sri Karmugil Kanna Perumal Temple	Kodambakkam Metro To Meenakshi	Temple	LHS	2.74	130303.5N	801351.7E
83	Sharathambal Temple	Kodambakkam Metro To Meenakshi	Temple	LHS	35.68	130316.2N	801340.1E

SN	Name of Sensitive Receptor	Location	Type of Sensitive Receptor	LHS/RHS	Distance from the outer most proposed tracks (m)	Latitude	Longitude
84	Arulmigu Vinaitheertha Vinayagar Thirukoil	Kodambakkam Metro To Meenakshi	Temple	RHS	79.12	1303007.2N	801349.E
85	Vinayagar Temple	Kodambakkam Metro To Meenakshi	Temple	LHS	11.02	130308.4N	801355.9E
86	Venugopaldaswamy Temple	Kodambakkam Metro To Meenakshi	Temple	RHS	92.22	130310.1N	80336.8E
87	Meenakshi College For Women	Meenakshi College To Power House	College	LHS	120.9	130318.7N	801337.6E
88	Sansbound Networking School	Meenakshi College To Power House	School	RHS	88.09	1303103N	80133.3E
89	Dimensional Academy Of Engineering	Meenakshi College To Power House	College	RHS	124.55	1303050N	80132.45E
90	Koncept Hospital	Meenakshi College To Power House	Hospital	RHS	33.78	13308.4N	801307.3E
91	Dimensional Academy Of Engineering	Meenakshi College To Power House	College	RHS	90.15	130305.1N	801312.6E
92	New Born Baby Unit	Meenakshi College To Power House	Hospital	LHS	190.89	130314.8N	801309.7E
93	CSI Church	Meenakshi College To Power House	Church	RHS	100	130309.8N	801336.8E
94	Vadakasi Amman Temple	Meenakshi College To Power House	Temple	LHS	108.67	130310.4N	801305.5E
95	Full Gospel Pente Coastal Church	Meenakshi College To Power House	Church	LHS	47.74	130310.0N	801312.1E
96	Thiruveedhi Amman Temple	Meenakshi College To Power House	Temple	LHS	86.75	130312.5N	801315.5E
97	One Accord In Prayer Fellowship Church	Meenakshi College To Power House	Church	RHS	14.57	130308.6N	801314.1E
98	Yesuvin Vallamai Uliyam	Meenakshi College To Power House	Church	RHS	20.64	130308.3	801313.8E
99	Chennai Higher Secondary School	Power House to Vadapalani	School	LHS	19.00	13°03'05.8"N	80°13'01.4"E
100	Vinayagar Temple	Power House to Vadapalani	Temple	RHS	92.56	13°03'03.0"N	80°13'03.7"E
101	Vallaba Sathurthy Vinayagar Temple	Power House to Vadapalani	Temple	LHS	121.35	13°03'03.6"N	80°12'59.3"E
102	Sri Panduranga Ashrama	Power House to Vadapalani	Temple	LHS	181.79	13°03'09.4"N	80°12'56.2"E
103	Pillaiyar Kovil	Power House to Vadapalani	Temple	LHS	103.41	13°03'06.8"N	80°12'55.9"E

SN	Name of Sensitive Receptor	Location	Type of Sensitive Receptor	LHS/RHS	Distance from the outer most proposed tracks (m)	Latitude	Longitude
104	Sri Murugan Play School	Power House to Vadapalani	School	RHS	99.96	13°03'00.9"N	80°12'59.2"E
105	Sri Vinayagar Kovil	Power House to Vadapalani	Temple	RHS	105.60	13°03'59.5"N	80°12'55.9"E
106	Saraswathi Vidyalaya Hr. Sec. School	Power House to Vadapalani	School	LHS	78.98	13°03'05.0"N	80°12'52.8"E
107	Saraswathi Vidyalaya Sr. Sec. School	Power House to Vadapalani	School	LHS	12.79	13°03'02.6"N	80°12'52.6"E
108	Paranjothi Baba Temple	Power House to Vadapalani	Temple	LHS	133.75	13°03'05.3"N	80°12'48.8"E
109	Umar Bilali Home	Power House to Vadapalani	Mosque	LHS	113.91	13°03'04.0"N	80°12'45.4"E
110	Masjid E-Haqqani	Power House to Vadapalani	Mosque	LHS	56.20	13°03'02.2"N	80°12'45.8"E
111	New Life Mizpha Church	Power House to Vadapalani	Church	LHS	70.27	13°03'02.4"N	80°12'44.5"E
112	Kadumbadi Amman Temple	Power House to Vadapalani	Temple	RHS	132.20	13°02'57.3"N	80°12'51.9"E
113	Vangeeswarar Temple	Power House to Vadapalani	Temple	RHS	138.83	13°02'55.7"N	80°12'44.7"E
114	Sambhavnath Bagwam Jain Temple	Power House to Vadapalani	Temple	RHS	193.93	13°02'54.5"N	80°12'49.1"E
115	Pillaiyar Kovil	Power House to Vadapalani	Temple	RHS	181.69	13°02'53.8"N	80°12'41.7"E
116	Sri Dowbathi Amman Tirukoil	Power House to Vadapalani	Temple	RHS	36.47	13°02'58.3"N	80°12'40.4"E
117	SRM Hospital	Power House to Vadapalani	Hospital	LHS	166.34	13°02'05.3"N	80°12'42.0"E
118	SRM Institute of Science and Tech.	Vadapalani to Saligramam	College	LHS	197.50	13°02'05.7"N	80°12'37.4"E
119	Vijaya Hospital	Vadapalani to Saligramam	Hospital	LHS	15.70	13°02'58.5"N	80°12'03.06"E
120	Sri Alagar Perumal Kovil	Vadapalani to Saligramam	Temple	RHS	199.43	13°02'51.5"N	80°12'31.8"E
121	Navasakthi Vinayagar Tepmple	Vadapalani to Saligramam	Temple	RHS	197.70	13°02'52.0"N	80°12'32.8"E
122	Sri Ganapathi Temple	Vadapalani to Saligramam	Temple	LHS	6.00	13°02'57.3"N	80°12'27.9"E
123	Karthikeyan Matric School	Vadapalani to Saligramam	School	LHS	35.96	13°02'55.5"N	80°12'18.7"E
124	Hamithiya Jamiya Pallivasal	Saligramam to Avichi School	Mosque	LHS	18.83	13°02'52.6"N	80°12'10.4"E
125	Sri Devi Ponniamman Alayam	Saligramam to Avichi School	Temple	LHS	113.53	13°02'54.9"N	80°12'07.1"E

SN	Name of Sensitive Receptor	Location	Type of Sensitive Receptor	LHS/RHS	Distance from the outer most proposed tracks (m)	Latitude	Longitude
126	Vidyakshetram Matric Hr. Sec. School	Saligramam to Avichi School	School	LHS	94.42	13°02'54.7"N	80°12'08.9"E
127	LGJ AG Church	Saligramam to Avichi School	Church	LHS	62.20	13°02'52.8"N	80°12'04.9"E
128	AG Church	Saligramam to Avichi School	Church	LHS	57.50	13°02'52.7"N	80°12'04.1"E
129	AVM Rajeshwari's The School	Saligramam to Avichi School	School	LHS	198.30	13°02'57.4"N	80°11'51.2"E
130	Avichi Hr. Sec. School	Saligramam to Avichi School	School	LHS	198.30	13°02'55.3"N	80°11'52.1"E
131	VHS Hospitals Pvt. Ltd	Saligramam to Avichi School	Hospital	RHS	121.90	13°02'46.8"N	80°11'52.8"E
132	Brahmasthanam Temple	Saligramam to Avichi School	Temple	LHS	7.95	13°02'51.3"N	80°11'48.4"E
133	Sakthi Sandi Amman Tirukoil	Avichi School to Alwar Thirunagar	Temple	LHS	123.95	13°02'54.9"N	80°11'44.9"E
134	Saligramam Christian Assembly	Avichi School to Alwar Thirunagar	Church	LHS	23.31	13°02'51.6"N	80°11'42.8"E
135	Brother Mission Church	Avichi School to Alwar Thirunagar	Church	LHS	4.50	13°02'51.1"N	80°11'42.6"E
136	Radhe Krishna Temple	Avichi School to Alwar Thirunagar	Temple	LHS	167.75	13°02'54.9"N	80°11'38.0"E
137	Arulmigu Sri Kaliyamman Temple	Avichi School to Alwar Thirunagar	Temple	LHS	133.11	13°02'52.3"N	80°11'32.9"E
138	Sree Krishna Vidyalaya	Avichi School to Alwar Thirunagar	School	LHS	80.00	13°02'50.7"N	80°11'33.2"E
139	Santhoshi Madha Temple	Avichi School to Alwar Thirunagar	Temple	LHS	6.57	13°02'48.3"N	80°11'33.7"E
140	Shridi Saibaba Temple	Avichi School to Alwar Thirunagar	Temple	LHS	109.00	13°02'51.3"N	80°11'27.7"E
141	Vembuliamman Koil	Avichi School to Alwar Thirunagar	Temple	RHS	16.00	13°02'46.9"N	80°11'21.6"E
142	Sri Amman Temple	Avichi School to Alwar Thirunagar	Temple	RHS	123.36	13°02'43.0"N	80°11'20.5"E
143	Sri Reddamman Temple	Avichi School to Alwar Thirunagar	Temple	RHS	120.00	13°02'42.9"N	80°11'20.2"E
144	CSI Christ Church	Alwar Thirunagar to Valasarwakkam	Church	RHS	45.72	13°02'44.5"N	80°11'17.3"E
145	MAsjid E-Gowsia(Idgah)	Alwar Thirunagar to Valasarwakkam	Mosque	LHS	116.82	13°02'49.4"N	80°11'15.2"E
146	Glorius Zion Christian Assembly	Alwar Thirunagar to Valasarwakkam	Church	-	0.00	13°02'45.5"N	80°11'15.7"E
147	Narayanan E-Tecno School	Alwar Thirunagar to Valasarwakkam	School	LHS	14.17	13°02'46.4"N	80°11'16.6"E

SN	Name of Sensitive Receptor	Location	Type of Sensitive Receptor	LHS/RHS	Distance from the outer most proposed tracks (m)	Latitude	Longitude
148	St. Jhon's Matriculation School	Alwar Thirunagar to Valasarwakkam	School	LHS	168.70	13°02'51.3"N	80°11'14.2"E
149	Aditya Kamaraj Eye Hospital	Alwar Thirunagar to Valasarwakkam	Hospital	LHS	89.80	13°02'47.1"N	80°11'11.6"E
150	Hindu School	Alwar Thirunagar to Valasarwakkam	School	LHS	165.50	13°02'48.6"N	80°11'09.4"E
151	La Chatelaine Junior College	Alwar Thirunagar to Valasarwakkam	College	RHS	82.63	13°02'37.3"N	80°11'06.3"E
152	Blossom Peach Play School	Alwar Thirunagar to Valasarwakkam	School	RHS	160.60	13°02'29.9"N	80°10'57.9"E
153	Lamak School	Alwar Thirunagar to Valasarwakkam	School	LHS	30.50	13°02'35.7"N	80°10'54.9"E
154	Selliamman Temple	Alwar Thirunagar to Valasarwakkam	Temple	LHS	29.26	13°02'35.0"N	80°10'54.3"E
155	Panchamugam Vinayager Temple	Alwar Thirunagar to Valasarwakkam	Temple	LHS	109.00	13°02'36.2"N	80°10'50.7"E
156	Sri Navasakthi Vinagar Temple	Valasaravakkam to Karambakkam	Temple	LHS	115.50	13°02'35.8"N	80°10'48.6"E
157	CIT Nagar ECI Church	Valasaravakkam to Karambakkam	Church	LHS	183.28	13°02'37.5"N	80°10'47.2"E
158	Sivan Kovil	Valasaravakkam to Karambakkam	Temple	RHS	64.06	13°02'29.6"N	80°10'39.4"E
159	HOPE Church	Valasaravakkam to Karambakkam	Church	RHS	27.49	13°02'30.2"N	80°10'35.6"E
160	Calvary Tabernacle	Valasaravakkam to Karambakkam	Church	RHS	120.30	13°02'26.9"N	80°10'35.5"E
161	Sri Venkateswara Perumal Temple	Valasaravakkam to Karambakkam	Temple	RHS	182.56	13°02'22.8"N	80°10'28.1"E
162	Vishwaroopa Sai Baba Temple	Valasaravakkam to Karambakkam	Temple	RHS	186.28	13°02'33.1"N	80°10'21.0"E
163	The Holy Cross Matric Hr. Sec. School	Valasaravakkam to Karambakkam	School	RHS	87.30	13°02'23.4"N	80°10'19.9"E
164	Venkatasubramaniaswamy Temple	Valasaravakkam to Karambakkam	Temple	RHS	135.70	13°02'22.8"N	80°10'22.2"E
165	Sri Prasenna Venkatesha Perumal Kovil	Valasaravakkam to Karambakkam	Temple	LHS	150.82	13°02'31.6"N	80°10'19.1"E
166	Bilal Masjid	Valasaravakkam to Karambakkam	Mosque	LHS	98.20	13°02'29.1"N	80°10'17.9"E
167	Sharon Church	Valasaravakkam to Karambakkam	Church	LHS	51.08	13°02'27.1"N	80°10'17.3"E

SN	Name of Sensitive Receptor	Location	Type of Sensitive Receptor	LHS/RHS	Distance from the outer most proposed tracks (m)	Latitude	Longitude
168	Devi Academy Sr. Sec. School	Valasaravakkam to Karambakkam	School	LHS	96.43	13°02'28.2"N	80°10'16.3"E
169	Sri Vadapalani Vinayagar Temple	Valasaravakkam to Karambakkam	Temple	LHS	152.80	13°02'29.5"N	80°10'14.8"E
170	Majide Noor	karabakkam-Alapakkam Junction	Mosque	RHS	30.1	13° 2' 21.8652" N	80° 10' 13.1232" E
171	Amirtha Engineering School	karabakkam-Alapakkam Junction	College	LHS	101.2	13° 2' 24.2196" N	80° 10' 10.2576" E
172	Mother Teresa Modern school	karabakkam-Alapakkam Junction	School	LHS	103.6	13° 2' 25.836" N	80° 10' 11.6868" E
173	Kadambadi Amman Kovil	karabakkam-Alapakkam Junction	Temple	LHS	130.21	13° 2' 26.2752" N	80° 10' 10.5816" E
174	Kamatchi amman temple	karabakkam-Alapakkam Junction	Temple	RHS	101.72	13° 2' 14.7696" N	80° 9' 55.152" E
175	karumariamman Temple	Alapakkam Junction-Porur Junction	Temple	RHS	188.58	13° 2' 11.4684" N	80° 9' 49.5612" E
176	Kalyana ganapathy temple	Alapakkam Junction-Porur Junction	Temple	RHS	140.7	13° 2' 11.526" N	80° 9' 39.5064" E
177	Parvathy Hospital	Alapakkam Junction-Porur Junction	Hospital	LHS	57.56	13° 2' 17.6676" N	80° 9' 37.0152" E
178	Vinayagar Temple	Alapakkam Junction-Porur Junction	Temple	LHS	119.15	13° 2' 20.742" N	80° 9' 34.5348" E
179	Sai Baba Temple	Alapakkam Junction-Porur Junction	Temple	LHS	181.1	13° 2' 20.742" N	80° 9' 30.6828" E
180	Sri Angalaparameshwari Temple	Alapakkam Junction-Porur Junction	Temple	RHS	33.97	13° 2' 12.9912" N	80° 9' 30.6828" E
181	Jesus Savior Chruch	Alapakkam Junction-Porur Junction	Church	LHS	127.55	13° 2' 18.0636" N	80° 9' 30.2004" E
182	Masjid E-Mohamed	Porur Junction-Chennai Bypass Crossing	Mosque	LHS	16.94	13° 2' 10.2048" N	80° 9' 24.4332" E
183	Parvathy Hospital	Porur Junction-Chennai Bypass Crossing	Hospital	LHS	92.08	13° 2' 11.6124" N	80° 9' 23.6052" E

SN	Name of Sensitive Receptor	Location	Type of Sensitive Receptor	LHS/RHS	Distance from the outer most proposed tracks (m)	Latitude	Longitude
184	Masjid -ul-Ahad	Porur Junction-Chennai Bypass Crossing	Mosque	RHS	66.42	13° 2' 5.3952" N	80° 9' 15.5124" E
185	Sri Ramachandra college of physiotherapy	Porur Junction-Chennai Bypass Crossing	College	LHS	115.68	13° 2' 12.5268" N	80° 9' 14.0832" E
186	St.Mathew Church	Porur Junction-Chennai Bypass Crossing	Church	RHS	159.12	13° 2' 3.7392" N	80° 9' 12.8304" E
187	Sri Aadhigubara jalakanalayam	Porur Junction-Chennai Bypass Crossing	Temple	RHS	18.02	13° 2' 10.0608" N	80° 9' 6.7068" E
188	Fur Gospal Church	Porur Junction-Chennai Bypass Crossing	Church	RHS	76.6	13° 2' 8.142" N	80° 8' 46.5468" E
189	Muni subrat swami temple	Chennai Bypass Crossing-Ramchandra Hospital	Temple	LHS	73.22	13° 2' 12.9444" N	80° 8' 59.0172" E
190	House Church	Chennai Bypass Crossing-Ramchandra Hospital	Church	LHS	16.57	13° 2' 11.0904" N	80° 8' 47.9616" E
191	Sri Ramachandra Dental College	Chennai Bypass Crossing-Ramchandra Hospital	College	LHS	197.72	13° 2' 17.9376" N	80° 8' 41.0964" E
192	Vinayagar Temple	Chennai Bypass Crossing-Ramchandra Hospital	Temple	LHS	58.69	13° 2' 14.2008" N	80° 8' 35.3436" E
193	Sai Baba Temple	Chennai Bypass Crossing-Ramchandra Hospital	Temple	LHS	145.08	13° 2' 17.5884" N	80° 8' 30.3612" E
194	Naga Muthu Maariamman Temple	Chennai Bypass Crossing-Ramchandra Hospital	Temple	LHS	54.34	13° 2' 12.2676" N	80° 8' 52.6344" E
195	Ponnamman Temple	Ramchandra Hospital-Iyappanthalangal Bus Depot	Temple	RHS	155.97	13° 2' 19.698" N	80° 8' 19.3632" E
196	Chinthamani Dental Hospital	Ramchandra Hospital-Iyappanthalangal Bus Depot	Hospital	RHS	24.84	13° 2' 13.596" N	80° 8' 19.8672" E
197	Lakshmi Hospital	Ramchandra Hospital-Iyappanthalangal Bus Depot	Hospital	RHS	38.38	13° 2' 13.4736" N	80° 8' 18.312" E
198	Suyambu amsara amman temple	Ramchandra Hospital-Iyappanthalangal Bus Depot	Temple	LHS	31.1	13° 2' 15.9828" N	80° 8' 16.1088" E
199	Masjidul Hunda	Ramchandra Hospital-Iyappanthalangal Bus Depot	Mosque	RHS	42.2	13° 2' 13.6284" N	80° 10' 0.6276" E
200	Small Pillayar Temple	Ramchandra Hospital-Iyappanthalangal Bus Depot	Temple	LHS	7.89	13° 2' 16.4508" N	80° 8' 9.672" E

SN	Name of Sensitive Receptor	Location	Type of Sensitive Receptor	LHS/RHS	Distance from the outer most proposed tracks (m)	Latitude	Longitude
201	Sri Karumari Amman Temple	Ramchandra Hospital-Iyappanhangal Bus Depot	Temple	RHS	75.2	13° 2' 15.0612" N	80° 8' 6.0252" E
202	Sri Gangai Amman Temple	Ramchandra Hospital-Iyappanhangal Bus Depot	Temple	RHS	154	13° 2' 12.606" N	80° 8' 6.1692" E
203	Sri Durgai Amman Temple	Iyappanhangal Bus Depot-kattupakkam	Temple	LHS	10.6	13° 2' 21.7788" N	80° 7' 56.91" E
204	Adi Dravidar primary School	Iyappanhangal Bus Depot-kattupakkam	School	RHS	121.75	13° 2' 28.518" N	80° 7' 48.72" E
205	Theruveethi Amman Kovil	Iyappanhangal Bus Depot-kattupakkam	Temple	RHS	163.85	13° 2' 31.9992" N	80° 7' 43.4676" E
206	Vaidheeswaran temple	Iyappanhangal Bus Depot-kattupakkam	Temple	LHS	79.07	13° 2' 28.5864" N	80° 7' 31.9476" E
207	Ettiamman temple	Iyappanhangal Bus Depot-kattupakkam	Temple	RHS	139.11	13° 2' 26.9772" N	80° 7' 30.4032" E
208	Sri Muthumariamman temple	Iyappanhangal Bus Depot-kattupakkam	Temple	RHS	164.4	13° 2' 21.1992" N	80° 7' 42.312" E
209	Melmaruvathur Aadhi prasakthi temple	Iyappanhangal Bus Depot-kattupakkam	Temple	RHS	141.69	13° 2' 21.9336" N	80° 7' 42.528" E
210	Vaidheeswaran Temple	Kattupakkam To Kumanan Chavadi	Temple	RHS	64.75	13° 2' 28.6944" N	80° 2' 28.6944" E
211	Ettaiamman Temple	Kattupakkam To Kumanan Chavadi	Temple	RHS	129.74	13° 2' 26.97" N	80° 7' 31.0332" E
212	Sri LCVKS School	Kattupakkam To Kumanan Chavadi	School	RHS	127.96	13° 2' 27.564" N	80° 7' 29.4564" E
213	Temple Around us	Kattupakkam To Kumanan Chavadi	Temple	RHS	47.76	13° 2' 38.724" N	80° 7' 9.3576" E
214	Vinayagar Chathurthi	Kattupakkam To Kumanan Chavadi	Temple	LHS	82.71	13° 2' 35.9844" N	80° 7' 26.9328" E
215	Muneeshwaran Temple	Kattupakkam To Kumanan Chavadi	Temple	LHS	14.43	13° 2' 38.8392" N	80° 7' 14.2716" E
216	Selli Amman Koyil	Kattupakkam To Kumanan Chavadi	Temple	LHS	209.66	13° 2' 45.7908" N	80° 7' 13.9656" E
217	Sri Muthu Mariyamman Temple	Kumanan Chavadi To Karyan Chavadi	Temple	LHS	30.46	13° 2' 44.7108" N	80° 6' 51.2028" E

SN	Name of Sensitive Receptor	Location	Type of Sensitive Receptor	LHS/RHS	Distance from the outer most proposed tracks (m)	Latitude	Longitude
218	RD Music School	Kumanan Chavadi To Karyan Chavadi	School	LHS	181.17	13° 2' 50.4168" N	80° 6' 49.3632" E
219	Annamalai University Study Center	Kumanan Chavadi To Karyan Chavadi	College	LHS	18.94	13° 2' 48.2208" N	80° 6' 40.8312" E
220	The Pentacostal Mission	Kumanan Chavadi To Karyan Chavadi	Church	RHS	32.27	13° 2' 39.9624" N	80° 7' 7.5828" E
221	Abundant Life AG Church	Kumanan Chavadi To Karyan Chavadi	Church	RHS	32.79	13° 2' 41.2116" N	80° 6' 58.5288" E
222	Messiah Church	Kumanan Chavadi To Karyan Chavadi	Church	RHS	80.65	13° 2' 40.8084" N	80° 6' 51.8184" E
223	Arulmigu Sendur Sri Kandu Mariyamman Aalayam	Kumanan Chavadi To Karyan Chavadi	Temple	RHS	21.53	13° 2' 43.5012" N	80° 6' 49.2804" E
224	Bon Secours Convent	Kumanan Chavadi To Karyan Chavadi	School	RHS	113.2	13° 2' 42.4896" N	80° 6' 43.0848" E
225	Guanella Seminary	Kumanan Chavadi To Karyan Chavadi	School	RHS	82.35	13° 2' 45.0096" N	80° 6' 39.9672" E
226	Sacred Heart Seminary	Karyan Chavadi To Mullai Thottam	School	RHS	174.43	13° 2' 43.2672" N	80° 6' 36.558" E
227	Amman Temple	Karyan Chavadi To Mullai Thottam	Temple	RHS	60.59	13° 2' 47.5404" N	80° 6' 36.0324" E
228	Institute of Public Health	Karyan Chavadi To Mullai Thottam	Hospital	RHS	172.81	13° 2' 45.42" N	80° 6' 32.0688" E
229	Poonamalle Blind School	Karyan Chavadi To Mullai Thottam	School	RHS	29.95	13° 2' 55.6008" N	80° 6' 22.3416" E
230	Farm Apostolic Revival Church	Karyan Chavadi To Mullai Thottam	Church	RHS	168.75	13° 2' 51.9936" N	80° 6' 18.9" E
231	Rajathi Raja Sabai	Karyan Chavadi To Mullai Thottam	Church	RHS	165.89	13° 2' 53.8764" N	80° 6' 14.4216" E
232	Bala Vinayagar Temple	Karyan Chavadi To Mullai Thottam	Temple	RHS	108.68	13° 2' 55.8816" N	80° 6' 13.6188" E
233	Punitha Matha Statue	Karyan Chavadi To Mullai Thottam	Church	RHS	119.9	13° 2' 55.4604" N	80° 6' 13.8672" E
234	Zion Church	Karyan Chavadi To Mullai Thottam	Church	RHS	103.05	13° 2' 56.1012" N	80° 6' 12.5784" E

SN	Name of Sensitive Receptor	Location	Type of Sensitive Receptor	LHS/RHS	Distance from the outer most proposed tracks (m)	Latitude	Longitude
235	HOPE Church	Karyan Chavadi To Mullai Thottam	Church	RHS	103.46	13° 2' 54.7548" N	80° 6' 18.27" E
236	Maranatha Church	Karyan Chavadi To Mullai Thottam	Church	LHS	163.47	13° 2' 53.3616" N	80° 6' 40.752" E
237	Tamil Baptist Mission Church	Karyan Chavadi To Mullai Thottam	Church	LHS	21.24	13° 2' 54.2544" N	80° 6' 29.7396" E
238	Government High School	Karyan Chavadi To Mullai Thottam	School	LHS	121.82	13° 2' 58.1568" N	80° 6' 29.2356" E
239	District TB & MCH Centre	Karyan Chavadi To Mullai Thottam	Hospital	LHS	23.29	13° 2' 56.4216" N	80° 6' 25.5096" E
240	CSI Wesley Church	Karyan Chavadi To Mullai Thottam	Church	LHS	76.37	13° 3' 1.8396" N	80° 6' 13.2984" E
241	Poovai EBC Ministries	Karyan Chavadi To Mullai Thottam	Church	LHS	182.84	13° 3' 5.1408" N	80° 6' 15.5592" E
242	EBC Ministries	Karyan Chavadi To Mullai Thottam	Church	LHS	145.11	13° 3' 3.978" N	80° 6' 14.9616" E
243	CMF Church	Karyan Chavadi To Mullai Thottam	Church	LHS	204.72	13° 3' 5.3748" N	80° 6' 17.442" E
244	Indian Pentacostal Church	Karyan Chavadi To Mullai Thottam	Church	LHS	177.1	13° 3' 3.1572" N	80° 6' 21.3912" E
245	CSI St. Mary Magdalene Church	Karyan Chavadi To Mullai Thottam	Church	LHS	194.77	13° 3' 1.8" N	80° 6' 26.7732" E
246	Sarojini Varadappan Girls Hr. Sec. School	Karyan Chavadi To Mullai Thottam	School	LHS	179.18	13° 3' 2.6208" N	80° 6' 22.9896" E
247	Pannayatha Amman Koil	Mullai Thottam To Poonamalle Bus Terminus	Temple	RHS	14.62	13° 2' 58.9452" N	80° 6' 1.782" E
248	Sri Muthumariyamman Temple	Mullai Thottam To Poonamalle Bus Terminus	Temple	RHS	149.96	13° 2' 57.0912" N	80° 5' 53.3832" E
249	Sri Ankalamman Temple	Mullai Thottam To Poonamalle Bus Terminus	Temple	RHS	107.08	13° 2' 58.2432" N	80° 5' 54.6612" E
250	Mangalam Hospital	Mullai Thottam To Poonamalle Bus Terminus	Hospital	RHS	23.85	13° 3' 2.646" N	80° 5' 45.4272" E
251	Pillaiyaar Kovil	Mullai Thottam To Poonamalle Bus Terminus	Temple	RHS	101.4	13° 3' 0.198" N	80° 5' 44.5992" E

SN	Name of Sensitive Receptor	Location	Type of Sensitive Receptor	LHS/RHS	Distance from the outer most proposed tracks (m)	Latitude	Longitude
252	Sri Varasiddi Vinayaka Temple	Mullai Thottam To Poonamalle Bus Terminus	Temple	RHS	145.74	13° 2' 57.0336" N	80° 5' 54.7476" E
253	Poonamalle Mosque	Mullai Thottam To Poonamalle Bus Terminus	Mosque	RHS	23.36	13° 3' 0.5724" N	80° 5' 56.85" E
254	Sri Veera Anjaneyar Thiru Kovil	Mullai Thottam To Poonamalle Bus Terminus	Temple	RHS	183.24	13° 2' 57.5412" N	80° 5' 44.448" E
255	Poovirundhavalli Thayar Temple	Mullai Thottam To Poonamalle Bus Terminus	Temple	LHS	57.53	13° 3' 4.5" N	80° 5' 49.614" E
256	Be Well Hospital	Mullai Thottam To Poonamalle Bus Terminus	Hospital	LHS	11.68	13° 3' 1.9764" N	80° 5' 55.176" E
257	Sithar Adimai Koni Baba Temple	Mullai Thottam To Poonamalle Bus Terminus	Temple	LHS	66.37	13° 3' 3.5388" N	80° 5' 57.1848" E
258	Government Hospital	Mullai Thottam To Poonamalle Bus Terminus	Hospital	LHS	18.01	13° 3' 1.7136" N	80° 5' 57.7464" E
259	Annai Velankani Church	Poonamalle Bus Terminus To Poonamalle Bypass	Church	LHS	201.79	13° 3' 7.218" N	80° 5' 30.0552" E
260	The Way of Shine Church	Poonamalle Bus Terminus To Poonamalle Bypass	Church	LHS	129.32	13° 3' 4.6296" N	80° 5' 29.7744" E
261	Holy Crescent Matriculation Hr. Sec. School	Poonamalle Bus Terminus To Poonamalle Bypass	School	LHS	38.59	13° 3' 1.422" N	80° 5' 29.256" E
262	Arulmigu Jegannadha Eeshwarar Sidhdhar Aalayam	Poonamalle Bus Terminus To Poonamalle Bypass	Temple	LHS	157.39	13° 3' 8.5536" N	80° 5' 40.3476" E
263	St. Joseph Matriculation Hr. Sec. School	Poonamalle Bus Terminus To Poonamalle Bypass	School	LHS	179.42	13° 3' 9.2772" N	80° 5' 41.4312" E
264	Bharath Post Graduate College	Poonamalle Bus Terminus To Poonamalle Bypass	College	RHS	45.09	13° 3' 1.728" N	80° 5' 36.6504" E
265	Sakthi Nagathamman Aalayam	Poonamalle Bus Terminus To Poonamalle Bypass	Temple	RHS	7.14	13° 3' 1.1448" N	80° 5' 32.3952" E
266	Ajantha School of Arts	Poonamalle Bus Terminus To Poonamalle Bypass	College	RHS	207.29	13°02'53.5"N	80°05'30.4"E
267	Sri Ista Siddi Vinayagar Aalayam	Poonamalle Bus Terminus To Poonamalle Bypass	Temple	RHS	163.46	13°02'55.1"N	80°05'30.4"E

SN	Name of Sensitive Receptor	Location	Type of Sensitive Receptor	LHS/RHS	Distance from the outer most proposed tracks (m)	Latitude	Longitude
268	Siddi Buthi Vinayagar Aalayam	Poonamalle Bus Terminus To Poonamalle Bypass	Temple	RHS	99.81	13°02'56.5"N	80°05'28.5"E
269	Arulmigu Sri Dhirubathi Amman Temple	Poonamalle Bypass to End	Temple	RHS	7.58	13° 2' 51.234" N	80° 4' 55.6068" E
270	Govt. Hr. Sec. School	Poonamalle Bypass to End	School	LHS	107.15	13° 2' 57.8868" N	80° 5' 4.4232" E

Environmental Impact Assessment (Draft)

March 2021

India: Chennai Metro Rail Investment Project
Corridor 4

Annexures 3–4

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Annexure 3: Noise and Vibration

Acceptable Vibration Impact Criteria

Transit Noise and Vibration Impact Assessment, FTA, May 2006

Land Use Category	GBV Impact Levels (VdB re 1 micro-inch /sec)			GBN Impact Levels (dB re 20 micro Pascals)		
	Frequent Events ¹	Occasional Events ²	Infrequent Events ³	Frequent Events ¹	Occasional Events ²	Infrequent Events ³
Category 1: Buildings where vibration would interfere with interior operations.	65 VdB ⁴	65 VdB ⁴	65 VdB ⁴	N/A ⁴	N/A ⁴	N/A ⁴
Category 2: Residences and buildings where people normally sleep.	72 VdB	75 VdB	80 VdB	35 dBA	38 dBA	43 dBA
Category 3: Institutional land uses with primarily daytime use.	75 VdB	78 VdB	83 VdB	40 dBA	43 dBA	48 dBA

Notes:

- "Frequent Events" is defined as more than 70 vibration events of the same source per day. Most rapid transit projects fall into this category.
- "Occasional Events" is defined as between 30 and 70 vibration events of the same source per day. Most commuter trunk lines have this many operations.
- "Infrequent Events" is defined as fewer than 30 vibration events of the same kind per day. This category includes most commuter rail branch lines.
- This criterion limit is based on levels that are acceptable for most moderately sensitive equipment such as optical microscopes. Vibration-sensitive manufacturing or research will require detailed evaluation to define the acceptable vibration levels. Ensuring lower vibration levels in a building often requires special design of the HVAC systems and stiffened floors.
- Vibration-sensitive equipment is generally not sensitive to ground-borne noise.

Metro Rail Transit System Guidelines for Noise and vibrations, RDSO India, Sept 2015

Land Use Category	GBV Impact Levels (VdB ref 25.4 micro-mm /sec)			GBN Impact Levels (dB ref 20 micro Pascals)		
	Frequent Events ¹	Occasional Events ²	Infrequent Events ³	Frequent Events ¹	Occasional Events ²	Infrequent Events ³
Category 1: Buildings where vibration would interfere with interior operations.	65 VdB ⁴	65 VdB ⁴	65 VdB ⁴	N/A ⁴	N/A ⁴	N/A ⁴
Category 2: Residences and buildings where people normally sleep	72 VdB	75 VdB	80 VdB	35 dBA	38 dBA	43 dBA
Category 3: Institutional land uses with primarily daytime use.	75 VdB	78 VdB	83 VdB	40 dBA	43 dBA	48 dBA

Notes:

- "Frequent Events" is defined as more than 70 vibration events of the same source per day. Most rapid transit projects fall into this category.
- "Occasional Events" is defined as between 30 and 70 vibration events of the same source per day. Most commuter trunk lines have this many operations.
- "Infrequent Events" is defined as fewer than 30 vibration events of the same kind per day. This category includes most commuter rail branch lines.
- This criterion limit is based on levels that are acceptable for most moderately sensitive equipment such as optical microscopes. Vibration-sensitive manufacturing or research will require detailed evaluation to define the acceptable vibration levels. Ensuring lower vibration levels in a building often requires special design of the HVAC systems and stiffened floors.
- Vibration sensitive equipment is generally not sensitive to ground-borne noise. DIN 4150-2 can also be referred for guidelines values for evaluating human exposure to vibration in dwellings and similar spaces.

Annexure 4: Utility Network Information
Details of Sewer Lines of CMWSSB - Chennai

S. No	From Ch.	To Ch.	Affected Length (m)	LHS/RHS	Dia/Size	Depth	Position from Alignment	Metro Alignment	Diversion required
	(m)	(m)				(BGL in m)			
1	-120	770	890	LHS	0.4M	BGL-2.5M	PARALLEL	U/G	YES
2	500	500	30	CROSSING(LHS)	0.4M	BGL-2.5M	PERPENDICULAR	U/G	NO
3	730	730	30	CROSSING(LHS)	0.4M	BGL-2.5M	PERPENDICULAR	U/G	YES
4	11160	15560	4400	LHS	1.2M	BGL-6.0M	PARALLEL	ELEVATED	YES
5	11280	11280	30	CROSSING(LHS)	0.4M	BGL-2.5M	PERPENDICULAR	ELEVATED	NO
6	11775	11775	30	CROSSING(LHS)	0.4M	BGL-2.5M	PERPENDICULAR	ELEVATED	NO
7	13190	13190	30	CROSSING(RHS)	0.4M	BGL-2.5M	PERPENDICULAR	ELEVATED	NO
8	12510	12510	30	CROSSING(RHS)	0.5M	BGL-2.5M	PERPENDICULAR	ELEVATED	NO
9	13690	13690	30	CROSSING(LHS)	0.4M	BGL-2.5M	PERPENDICULAR	ELEVATED	NO
10	13690	13690	30	CROSSING(RHS)	0.4M	BGL-2.5M	PERPENDICULAR	ELEVATED	NO
11	13010	17415	4400	RHS	1.2 M	BGL-2.5M	PARALLEL	ELEVATED	YES
12	13110	13110	30	CROSSING(LHS)	0.4 M	BGL-2.5M	PERPENDICULAR	ELEVATED	YES
13	13459	13459	30	CROSSING(LHS)	0.4 M	BGL-2.5M	PERPENDICULAR	ELEVATED	YES
14	13560	13560	30	CROSSING(LHS)	0.4 M	BGL-2.5M	PERPENDICULAR	ELEVATED	YES
15	13560	13560	30	CROSSING(RHS)	0.4 M	BGL-2.5M	PERPENDICULAR	ELEVATED	YES
16	13665	13665	30	CROSSING(LHS)	0.4 M	BGL-2.5M	PERPENDICULAR	ELEVATED	YES
17	13665	13665	30	CROSSING(RHS)	0.4 M	BGL-2.5M	PERPENDICULAR	ELEVATED	YES
18	13741	13741	30	CROSSING(RHS)	0.4 M	BGL-2.5M	PERPENDICULAR	ELEVATED	YES
19	13898	13898	30	CROSSING(LHS)	0.4 M	BGL-2.5M	PERPENDICULAR	ELEVATED	YES

S. No	From Ch.	To Ch.	Affected Length (m)	LHS/RHS	Dia/Size	Depth	Position from Alignment	Metro Alignment	Diversion required
	(m)	(m)				(BGL in m)			
20	14210	14210	30	CROSSING(RHS)	0.6 M	BGL-2.5M	PERPENDICULAR	ELEVATED	YES
21	14240	14240	30	CROSSING(LHS)	0.6 M	BGL-2.5M	PERPENDICULAR	ELEVATED	YES
22	14360	14360	30	CROSSING(LHS)	0.6 M	BGL-2.5M	PERPENDICULAR	ELEVATED	YES
23	15220	15220	30	CROSSING(LHS)	0.6 M	BGL-2.5M	PERPENDICULAR	ELEVATED	YES
24	15510	15510	30	CROSSING(RHS)	0.4 M	BGL-2.5M	PERPENDICULAR	ELEVATED	YES
25	15640	15640	30	CROSSING(RHS)	0.4 M	BGL-2.5M	PERPENDICULAR	ELEVATED	YES
26	17006	17006	30	CROSSING(LHS)	0.4 M	BGL-2.5M	PERPENDICULAR	ELEVATED	YES
27	17115	17115	30	CROSSING(LHS)	0.6 M	BGL-2.5M	PERPENDICULAR	ELEVATED	YES
28	20340	20340	30	CROSSING(RHS)	0.6 M	BGL-2.5M	PERPENDICULAR	ELEVATED	YES
29	20340	21793	1453	RHS	1.2 M	BGL-2.5M	PARALLEL	ELEVATED	NO
30	21793	21793	30	CROSSING(RHS)	1.2 M	BGL-2.5M	PERPENDICULAR	ELEVATED	YES
31	20587	20587	30	CROSSING(LHS)	0.6 M	BGL-2.5M	PERPENDICULAR	ELEVATED	YES
32	20587	20790	203	LHS	0.6 M	BGL-2.5M	PARALLEL	ELEVATED	NO
33	20820	20820	30	CROSSING(LHS)	0.6 M	BGL-2.5M	PERPENDICULAR	ELEVATED	YES
34	20670	20670	30	CROSSING(RHS)	0.6 M	BGL-2.5M	PERPENDICULAR	ELEVATED	YES
35	21010	21010	30	CROSSING(RHS)	0.6 M	BGL-2.5M	PERPENDICULAR	ELEVATED	YES
36	21150	21150	30	CROSSING(LHS)	0.6 M	BGL-2.5M	PERPENDICULAR	ELEVATED	YES
37	21543	21543	30	CROSSING(LHS)	0.6 M	BGL-2.5M	PERPENDICULAR	ELEVATED	YES
38	23619	23619	30	CROSSING(LHS)	1.2 M	BGL-2.5M	PERPENDICULAR	ELEVATED	NO
39	23619	23619	30	CROSSING(RHS)	1.2 M	BGL-2.5M	PERPENDICULAR	ELEVATED	NO
40	23619	25200	1421	RHS	1.2 M	BGL-2.5M	PARALLEL	ELEVATED	NO
41	24090	24090	30	CROSSING(LHS)	0.6 M	BGL-2.5M	PERPENDICULAR	ELEVATED	YES
42	24240	24240	30	CROSSING(LHS)	0.6 M	BGL-2.5M	PERPENDICULAR	ELEVATED	YES

S. No	From Ch.	To Ch.	Affected Length (m)	LHS/RHS	Dia/Size	Depth	Position from Alignment	Metro Alignment	Diversion required
	(m)	(m)				(BGL in m)			
43	24240	24240	30	CROSSING(RHS)	0.6 M	BGL-2.5M	PERPENDICULAR	ELEVATED	YES
44	22000	25200	3200	LHS	1.2 M	BGL-2.5M	PARALLEL	ELEVATED	NO
45	22000	25200	3200	RHS	1.2 M	BGL-2.5M	PARALLEL	ELEVATED	NO
46	22500	22500	30	CROSSING(LHS)	0.6 M	BGL-2.5M	PERPENDICULAR	ELEVATED	YES
47	22520	22520	30	CROSSING(RHS)	0.6 M	BGL-2.5M	PERPENDICULAR	ELEVATED	YES

Details of Water Pipe Lines of CMWSSB - Chennai

S. No	From Ch.	To Ch.	Affected Length (M)	LHS/RHS	Dia/Size	Depth	Position from Alignment	Metro Alignment	Diversion required
	(m)	(m)				(BGL in m)			
1	5180	5180	30	CROSSING(LHS)	1.2M	BGL-2.5M	PERPENDICULAR	U/G	YES
2	5180	7680	2500	LHS	1.2M	BGL-2.5M	PARALLEL	U/G	YES
3	5600	5600	30	CROSSING(LHS)	0.5M	BGL-2.5M	PERPENDICULAR	U/G	NO
4	6760	6760	30	CROSSING(LHS)	0.3M	BGL-2.5M	PERPENDICULAR	U/G	NO
5	7180	7180	30	CROSSING(RHS)	0.6M	BGL-2.5M	PERPENDICULAR	U/G	NO
6	7680	7680	30	CROSSING(LHS)	1.2M	BGL-2.5M	PERPENDICULAR	U/G	NO
7	9370	9370	30	CROSSING(LHS)	1.2M	BGL-2.5M	PERPENDICULAR	U/G	NO
8	9370	11110	1740	LHS	1.2M	BGL-2.5M	PARALLEL	U/G	YES
9	9780	9780	30	CROSSING(LHS)	0.5M	BGL-2.5M	PERPENDICULAR	U/G	YES

S. No	From Ch.	To Ch.	Affected Length (M)	LHS/RHS	Dia/Size	Depth	Position from Alignment	Metro Alignment	Diversion required
	(m)	(m)				(BGL in m)			
10	10050	10050	0	CROSSING(LHS)	0.3M	BGL-2.5M	PERPENDICULAR	ELEVATED	YES
11	11110	11110	30	CROSSING(LHS)	1.2M	BGL-2.5M	PERPENDICULAR	ELEVATED	YES
12	11110	11110	30	CROSSING(RHS)	1.0M	BGL-2.5M	PERPENDICULAR	ELEVATED	YES
13	11110	13860	2750	RHS	1.0M	BGL-2.5M	PARALLEL	ELEVATED	YES
14	13860	14610	750	LHS	1.0M	BGL-2.5M	PARALLEL	ELEVATED	YES
15	14610	14610	30	CROSSING(LHS)	1.0M	BGL-2.5M	PERPENDICULAR	ELEVATED	NO

Details of Tamil Nadu Electricity Board HT/LT Lines

S N	From	To	Affected Length (M)	LHS/RHS	Voltage	Position from Alignment	Metro Alignment	Diversion required
	(m)	(m)						
1	13010	17355	4345	LHS	11KV	PARALLEL	ELEVATED	YES
2	17355	25200	7845	LHS	11KV	PARALLEL	ELEVATED	YES
3	13110	13110	30	CROSSING(LHS)	440V	PERPENDICULAR	ELEVATED	YES
4	13429	13429	30	CROSSING(LHS)	440V	PERPENDICULAR	ELEVATED	YES
5	13665	13665	30	CROSSING(LHS)	440V	PERPENDICULAR	ELEVATED	YES
6	13869	13869	30	CROSSING(LHS)	440V	PERPENDICULAR	ELEVATED	YES
7	14460	14460	30	CROSSING(LHS)	440V	PERPENDICULAR	ELEVATED	YES
8	14560	14560	30	CROSSING(LHS)	6.6 KV	PERPENDICULAR	ELEVATED	YES
9	14879	14879	30	CROSSING(LHS)	440V	PERPENDICULAR	ELEVATED	YES
10	15240	15240	30	CROSSING(LHS)	440V	PERPENDICULAR	ELEVATED	YES
11	15360	15360	30	CROSSING(LHS)	440V	PERPENDICULAR	ELEVATED	YES
12	15460	15460	30	CROSSING(LHS)	440V	PERPENDICULAR	ELEVATED	YES
13	15510	15510	30	CROSSING(RHS)	440V	PERPENDICULAR	ELEVATED	YES
14	15930	15930	30	CROSSING(RHS)	440V	PERPENDICULAR	ELEVATED	YES
15	16300	16300	30	CROSSING(LHS)	440V	PERPENDICULAR	ELEVATED	YES
16	16647	16647	30	CROSSING(LHS)	440V	PERPENDICULAR	ELEVATED	YES
17	18181	18181	30	CROSSING(LHS)	33 KV	PERPENDICULAR	ELEVATED	YES
18	18181	18181	30	CROSSING(RHS)	34 KV	PERPENDICULAR	ELEVATED	YES
19	19220	19220	30	CROSSING(LHS)	6.6 KV	PERPENDICULAR	ELEVATED	YES
20	19618	19618	30	CROSSING(RHS)	440V	PERPENDICULAR	ELEVATED	YES
21	19690	19690	30	CROSSING(LHS)	6.6 KV	PERPENDICULAR	ELEVATED	YES
22	20010	20010	30	CROSSING(LHS)	440V	PERPENDICULAR	ELEVATED	YES
23	20690	20690	30	CROSSING(LHS)	6.6 KV	PERPENDICULAR	ELEVATED	YES
24	20690	20690	30	CROSSING(RHS)	6.6 KV	PERPENDICULAR	ELEVATED	YES
25	21397	21397	30	CROSSING(LHS)	6.6 KV	PERPENDICULAR	ELEVATED	YES
26	21792	25200	3408	RHS	6.6 KV	PARALLEL	ELEVATED	NO
27	21963	21963	30	CROSSING(LHS)	6.6 KV	PERPENDICULAR	ELEVATED	YES
28	22410	22410	30	CROSSING(LHS)	6.6 KV	PERPENDICULAR	ELEVATED	YES
29	22410	22410	30	CROSSING(RHS)	6.6 KV	PERPENDICULAR	ELEVATED	YES
30	22621	22621	30	CROSSING(LHS)	440V	PERPENDICULAR	ELEVATED	YES
31	23340	23340	30	CROSSING(RHS)	440V	PERPENDICULAR	ELEVATED	YES
32	23955	23955	30	CROSSING(RHS)	440V	PERPENDICULAR	ELEVATED	YES
33	25200	25400	200	RHS	11KV	PARALLEL	ELEVATED	YES
34	22000	25200	3200	LHS	11KV	PARALLEL	ELEVATED	YES
35	22420	22420	30	CROSSING(LHS)	6.6 KV	PERPENDICULAR	ELEVATED	YES
36	22420	25200	2780	RHS	6.6 KV	PARALLEL	ELEVATED	YES
37	22500	22500	30	CROSSING(LHS)	440V	PERPENDICULAR	ELEVATED	YES
38	22670	22670	30	CROSSING(LHS)	6.6 KV	PERPENDICULAR	ELEVATED	YES
39	22670	22670	30	CROSSING(RHS)	6.6 KV	PERPENDICULAR	ELEVATED	YES
40	22800	22800	30	CROSSING(RHS)	440V	PERPENDICULAR	ELEVATED	YES
41	23350	23350	30	CROSSING(RHS)	440V	PERPENDICULAR	ELEVATED	YES
42	23600	23600	30	CROSSING(RHS)	440V	PERPENDICULAR	ELEVATED	YES
43	24350	24350	30	CROSSING(LHS)	440V	PERPENDICULAR	ELEVATED	YES

Environmental Impact Assessment (Draft)

March 2021

India: Chennai Metro Rail Investment Project
Corridor 4

Annexure 5

This environmental impact assessment is a document of the borrower. The views expressed herein do not necessarily represent those of ADB's Board of Directors, Management, or staff, and may be preliminary in nature. Your attention is directed to the "terms of use" section on ADB's website.

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Annexure 5: Environment, Social, Health and Safety Requirements

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1. Scope

1.1. The Employer's Requirements ESHS Volume 1 details the requirements of the Employer for Environment, Social, Health and Safety control measures associated with the Contractor and any other agency, to be practiced on all Chennai Metro Rail Limited (CMRL) construction sites or associated premises.

1.2. Application of this document

1.2.1. The Employer's Requirements ESHS Volume 1 applies to all aspects of the contractor's scope of work including that conducted by their appointed sub contractor's and other agencies on their behalf. There shall be no activity associated with the Chennai metro Rail Project, which exempted from the purview of this document.

1.2.2. The Employer's Requirement's ESHS Volume 1 is supplemented with a further 3 ESHS Volume for ease of reference. Their individual scope and applicability are as follows:

1.2.3. ESHS Volume 1 is the controlling document for all Contracts and is fixed throughout the term of the project. Compliance with the Employer's Requirements ESHS Volume 1 and the Project Health and Safety Manual (H&S) Volume 2 is mandatory. Volume 1 remains subject to revision by the Employer / Engineer in the event of new Legislation or changing circumstances

1.2.4. H&S Volume 2 provides Project Health & Safety Manual is mandatory applies to all aspects of the Contractor's scope of work, including that conducted by their appointed sub-Contractor's and other agencies on their behalf. The contents of H&S manual Volume 2 remains subject to revision by the Employer /Engineer in the event of new Legislation or changing circumstances.

1.2.5. ESHS Volume 3 provides Environmental guidance and procedural requirements for the project. Volume 3 remains subject to periodic revision and updating.

1.3. Purpose of this document

The purpose of this document, the Employer's Requirements, ESHS Volume 1 is to provide Contractors and other interested parties with the mandatory requirements relating to Health, Safety and the Environment practices and performance expectations on the Chennai Metro Rail Project.

This document:

- a) Describes the ESHS interfaces between the Employer, Engineer and the Contractor;
- b) Details the processes by which the Contractor shall manage ESHS issues while carrying out the works under the contract and;
- c) Describes by reference, the practices, procedures and requirements pertaining to the Chennai Metro Rail Project.

1.4. Chennai Metro Rail Limited ESHS Objectives

Chennai Metro Rail Limited has identified five principle objectives for attainment during the project. These long-term objectives shall be supported with quarterly, short and medium term objectives to enable structured advancement in overall performance. Our Short- and medium-term objectives also aim to facilitate effective monitoring and measurement to identify where a directional change may be necessary. Our Long term objectives are:

1. To eliminate or minimize the unwanted effects of hazards and risks to personnel, members of the public and other stakeholders who may be exposed to the undertakings associated with the construction of the Chennai Metro Rail project

2. Establish an effective and robust ESHS management system that will enable Contractors to achieve international recognition and registration to the ISO 45001:2018 Series.
3. Actively contribute to Contractors development through support, encouragement, determination in control and transfer of knowledge and skills in order to make the move from traditional compliance driven management through to risk managed processes.
4. To simplify the risk concept, to ensure a sensible approach to risk management and simplify hazard awareness training through adoption of the ALARP (As low as reasonably practicable) principles.
5. To practice 'Best Practice' within the construction industry - Establishing a work environment that conforms to international health & safety standards and make recommendation to improve effectiveness of regulations both nationally and locally.

2. Reference publications

ISO 9000:2005, *Quality management systems — Fundamentals and vocabulary*

ISO 9001:2015, *Quality management systems — Requirements*

ISO 14001:2015, *Environmental management systems — Requirements with guidance*

ISO 19011:2002, *Guidelines for quality and/or environmental management systems auditing*

OHSAS 18001:2007 *Health and safety management systems Requirements*

OHSAS 18002, *Health and safety management systems – Guidelines for the implementation of BS OHSAS 18001*

ISO 45001:2018 specifies requirements for an health and safety (H&S) management system and gives guidance for its use, to enable organizations to provide safe and healthy workplaces by preventing work-related injury and ill health, as well as by proactively improving its H&S performance.

PAS 99, *Specification of common management system requirements as a framework for integration*

International Labour Organization:2001, *Guidelines on health and safety management systems — ILO-OSH 2001*

Health & Safety Guidance (HSG) *Health and Safety Executive Publications United Kingdom*
 Safety and Health Administration(OSHA) *publications USA*

3. Terms and definitions

- 3.1 **Acceptable risk.** Risk that has been reduced to a level that can be tolerated by the organization having regard to its legal obligations and its own ESHS policy
- 3.2 **Accident.** Incident giving rise to injury, ill health or fatality
- 3.2 **ALARP** (As low as reasonably practicable) principles.
- 3.3 **Audit.** Systematic, independent and documented process for obtaining “audit evidence” and evaluating it objectively to determine the extent to which “audit criteria” are fulfilled
- 3.4 **BOCWA.** Building and Other Construction Workers (Regular Employment and Conditions of Service) Act, 1996
- 3.5 **BOCWR.** Building and Other Construction Workers (Regulation of Employment and Conditions of Service) Central Rules, 1998

- 3.6 **Chief Safety Expert.** An officer appointed by Employer / Engineer who is the overall responsible for monitoring all H&S functions prescribed in this document.
- 3.7 **CMRL.** Chennai Metro Rail Limited
- 3.8 **Competent person.** Person with the appropriate combination of skill, knowledge, qualifications and experience
- 3.9 **Continual improvement.** Recurring process of enhancing the ESHS management system in order to achieve improvements in overall ESHS performance consistent with the organization's ESHS policy
- 3.10 **Corrective action.** Action to eliminate the cause of a detected **nonconformity** or other undesirable situation
- 3.11 **Design Risk Assessments.** Used to record the actions of designers when reducing risks in construction and for future repairs and maintenance issues.
- 3.12 **Employer.** Chennai Metro Rail Limited (CMRL).
- 3.13 **Hazard.** Source, situation, or act with a potential for harm in terms of human injury or ill health, or a combination of these
- 3.14 **Hazard identification.** Process of recognizing that a **hazard** exists and defining its characteristics
- 3.15 **Health surveillance.** Monitoring health of employees to detect signs or symptoms of work-related ill health so that steps can be taken to eliminate, or reduce the probability of, further harm
- 3.16 **Ill health.** Identifiable, adverse physical or mental condition arising from and/or made worse by a work activity and/or work-related situation
- 3.17 **Incident.** Work-related event(s) in which an injury or **ill health** (regardless of severity) or fatality occurred, or could have occurred. An accident is an incident which has given rise to injury, ill health or fatality.
- 3.18 **Interested party.** Person or group, inside or outside the workplace, concerned with or affected by the ESHS performance of an organization
- 3.19 **Nonconformity.** Non-fulfilment of a requirement; A nonconformity can be any deviation from: relevant work standards, practices, procedures, legal requirements, etc. or ESHS management system requirements.
- 3.20 **ESHS management system.** Part of an organization's management system used to develop and implement its ESHS policy and manage its ESHS risks. A management system is a set of interrelated elements used to establish policy and objectives and to achieve those objectives. A management system includes organizational structure, planning activities (including for example, risk assessment and the setting of objectives), responsibilities, practices, procedures, processes and resources.
- 3.21 **ESHS objective.** ESHS goal, in terms of ESHS performance that an organization sets itself to achieve.
- 3.22 **ESHS performance.** Measurable results of an organization's management of its ESHS risks
- 3.23 **ESHS policy.** Overall intentions and direction of an organization related to its ESHS performance as formally expressed by top management
- 3.24 **Preventive action.** Action to eliminate the cause of a potential **nonconformity** (3.19) or other undesirable potential situation

- 3.25 **Procedure.** Specified way to carry out an activity or a process
- 3.26 **Record.** Document stating results achieved or providing evidence of activities performed
- 3.27 **Risk.** Combination of the likelihood of an occurrence of a hazardous event or exposure(s) and the severity of injury or **ill health** that can be caused by the event or exposure(s)
- 3.28 **Risk assessment.** Process of evaluating the **risk(s)** arising from a hazard(s), taking into account the adequacy of any existing controls, and deciding whether or not the risk(s) is acceptable
- 3.29 **Risk control.** Selection and application of suitable measures to reduce risk
- 3.30 **Shall.** Indicates a mandatory requirement within this document
- 3.31 **Stakeholders.** Those with a vested interest in an organization's achievements that includes, but is not limited to, internal and "outsourced" employees, customers, suppliers, partners, employees, distributors, investors, insurers, shareholders, owners, government and regulators.
- 3.32 **Status review.** Formal evaluation of the ESHS management system
- 3.33 **Top management.** Person or group of people who direct and control an organization at the highest level
- 3.34 **Worker representative.** Representative of employee health and safety
- 3.35 **High Risk** –A hazardous condition may cause frequency accidents which may result in catastrophic equipment losses or buildings, severe injury, illness, disablement or possible fatality.
- 3.36 **Medium Risk**-A hazardous condition resulting in injury /illness requiring absence from work or equipment damage.
- 3.37 **Low Risk**-A hazardous condition is unlikely to cause accidents, minor injury, and even fit does, result in only negligible damage.

4. ESHS management system requirements

4.1. General requirement

- 4.1.1. The Contractor shall define and document the scope of its Safety Health and Environmental (ESH) management system to meet legal requirements and the requirements of Chennai Metro Rail Limited as stated within this document.
- 4.1.2. The Contractor's ESH management system shall determine how the organisation shall document, implement, maintain and continually improve upon performance in accordance with the requirements of the International ISO45001:2018 Standard to which the Employer is committed.

4.2. CMRL ESH Policy Statement of Intent

Chennai Metro Rail Limited consider that health, safety and environmental is of equal importance in comparison to any other aspect of business management and as such is committed to promoting high standards of health, safety ,environmental and welfare on all of their sites and premises. To achieve this Chennai Metro Rail Limited shall:

- Constantly work towards improving the safety culture at all levels.
- Ensure compliance with all relevant legal duties in respect of health and safety at work legislation.

- Provide adequate resources for planning and controlling working conditions and safe systems of work.
- Work with our Contractors and suppliers to improve their safety performance, by measuring and monitoring their performance.

Responsibilities and performance requirements for health, safety and environmental are available on the Chennai Metro Rail Limited website. In summary: -

- All Contractors, employees, sub-Contractors, consultants, suppliers and visitors have A duty to play an active role in achieving our objectives through compliance with their legal obligations and this ESHS Policy.
- Participation and consultation are vital aspects of this Policy and to the achievement of our objectives. Contractors and Staff are encouraged and expected to:
 - Discuss health, safety and environmental matters with their managers, and company health, safety and environmental Representatives who will offer or obtain further expert advice, where necessary.
 - Co-operate at all times; contribute good ideas and improvements; report defects and short falls.

The correction of any breach of statutory provision or Chennai Metro Rail Limited requirements on health and safety shall take priority. Should appropriate action not be taken to meet the required standards, this will be taken seriously and may lead to disciplinary action being taken.

This Policy Statement shall be displayed prominently on all Chennai Metro Rail Limited sites and offices and will be kept under review to ensure its relevance.

Managing Director

Chennai Metro Rail Limited

4.3. Planning

4.3.1. Hazard identification, risk assessment and determining controls

4.3.1.1. The Contractor shall submit a procedure detailing the process in place for the identification of Hazards and Risks and the determination of control measures including the relevant standards as per clause 4.4.4.1 The Procedure shall incorporate the Employer's Requirements within this and other applicable ESHS Volumes.

4.3.1.2. Management of Change

4.3.1.2.1. All temporary and permanent changes to organisational, personnel, systems, procedures, equipment, products, materials or substances shall be evaluated by the Contractor and managed to ensure that health, safety and environmental risks arising from these changes remain at an acceptable level. Changes made by the Contractor are subject to submittal and notice of no objection by the Employer /Engineer prior to adopting change.

4.3.1.3. Risk Register & Hazard Log

4.3.1.3.1. The Contractor's Construction Health and safety Plan shall contain a detailed 'Risk Register' and 'Hazard Log' specific to the project. The register and log shall be assessed against the CMRL H&S Manual Volume 2.

4.3.1.3.2. The Hazard Log shall identify future method statement, risk assessment and operational procedures pertaining to specific equipment and operations in relation risk and local environmental constraints. Construction phase ESHS Plans shall not be accepted without a fully completed Hazard Log and Risk Register.

4.3.1.4. Method Statements and Lift Plan

4.3.1.4.1. Method statements are to be submitted to the Employer /Engineer a minimum of 28 days prior to task commencement to ensure sufficient time is available for review and notice of no objection.

4.3.1.4.2. Method statements shall contain the information requirements as prescript within the CMRL H&S Manual Volume 2.

4.3.1.4.3. Method statements shall incorporate the control measures within the process methodology as identified within the risk assessment.

4.3.1.4.4. A copy of the relevant method statement for the activity being undertaken shall be available on site for reference by all site management and supervisors.

4.3.1.4.5. Lift Plan are to be submitted to the Employer /Engineer a minimum of 28 days prior to task commencement to ensure sufficient time is available for review and notice of no objection.

4.3.1.4.6. Lift Plan shall contain the information requirements as prescript within the CMRL H&S Manual Volume 2

4.3.1.5. Risk Assessment production & submittal

4.3.1.5.1. Risk assessments shall contain as a minimum, the information as specified within the CMRL H&S Manual Volume 2. The Contractor may choose to use their own format however the risk tolerances, probability and consequences must be included.

4.3.1.5.2. Risk assessments shall be produced and submitted to the Employer /Engineer a minimum of 28 days prior to task commencement for notice of no objection. Risk assessments may be submitted independently or as part of a Method Statement.

4.3.1.5.3. Generic risk assessments other than routine activities of low risk shall not be accepted by the Employer/Engineer.

4.3.1.5.4. Risk assessments shall be regularly reviewed to ensure they remain suitable and sufficient. Risk assessment reviews shall be undertaken where an incident has

occurred and when a change in location may introduce additional risks from construction activities.

4.3.1.5.5. Substances hazardous to health shall be subject to assessment by the Contractor. Where Hazardous substances are identified for use within a process the assessment and determining controls shall be included within the relative method statement.

4.3.1.5.6. Designer's primary role includes to minimise the risk to health and safety of those who are going to construct, maintain, clean, repair, dismantle or demolish the structures and anyone else like adjoining road users/general public, who may be affected by the work.

4.3.1.5.7. When considering health and safety in designer's work, they shall be expected to do what is reasonable at the time the design is prepared. It may be possible for hazards, which cannot be addressed at the feasibility stage to be looked at during detailed design. In deciding what is reasonably practicable, the risk to health and safety produced by a feature of the design has to be weighed against the cost of excluding the feature. The overall design process does not need to be dominated by a concern to avoid all risks during the construction phase and maintenance. However, a judgement has to be made by weighing up one consideration against another so the cost is counted not just in financial terms, but also those of fitness for purpose, aesthetics, buildability or environmental impact. By applying these principles, it may be possible to make decisions at the design stage, which will avoid or reduce risks during construction work. In many cases, the large number of design considerations will allow a number of equally valid design solutions. What is important is the approach to the solutions of design problems. This should involve a proper exercise of judgement, which takes account of health and safety issues.

4.3.1.5.8. Designers shall need, so far as reasonably practicable, to avoid or reduce risks by applying a series of steps known as the hierarchy of risk control or principles of prevention and protection. The steps to be adopted shall include the following:

i. Consider if the hazard can be prevented from arising so that the risk can be avoided (e.g. alter the design to avoid the risk);

ii. If this cannot be achieved, the risk should be combated at source (eg, ensure the design details of items to be lifted include attachment points for lifting);

iii. Failing this, priority should be given to measures to control the risk that will collectively protect all people;

iv. Only as a last resort should measures to control risk by means of personal protection be assumed (E.g. use of safety harnesses).

4.3.1.5.9. In case of situations where the designers have carried out the design work and concluded that there are risks, which were not reasonably practicable to avoid, detailed information shall be given about the health and safety risks, which remain. This information needs to be included within the design assessment to alert others to the

risks, which they cannot reasonably be expected to know. This is essential for the parties who have to use the design information.

4.3.1.5.10. If the designers' basic design assumptions affect health or safety, or health and safety risks are not obvious from the standard design document, the designer shall provide additional information. The information shall include a broad indication of the assumptions about the precautions for dealing with the risks. The information will need to be conveyed in a clear manner; it shall be included on drawings, in written specifications or outline method statements. The level of detail to be recorded will be determined by the nature of the hazards involved and the associated level of risk.

4.3.1.5.11. Job Specific Risk assessment shall be submitted to the Employer /Engineer a minimum of 28 days prior to task commencement for notice of no objection. (Example- Manual Handling, PPE and Fire)

4.3.1.6. **Design Risk Assessment**

4.3.1.6.1. Design Risk Assessments shall be submitted to the Employer /Engineer for granting of no objection. Design risk assessments shall accompany all drawing submittals for operations involving;

- Temporary works,
- Formwork & false-work
- Heavy lifting equipment.

4.3.1.6.2. Drawings shall not be accepted by the Employers Representative without an accompanying design risk assessment.

4.3.1.7. **Employer/Engineer's approval**

4.3.1.7.1. Every structure like scaffold, falsework & Formwork, launching girder, Temporary work (shoring system), earth retaining structures etc. shall have its design calculations included in the method statements in addition to health and safety risks. The Employer /Engineer designer or his approved proof check consultants as applicable as per the contract conditions shall approve all these designs and issue a 'No Objection for Use'.

4.3.1.7.2. Any non-standard structures like trestles made up of re-bars or structures which are very old, corroded, repaired for many times etc. for which no design calculations can be made accurately from any national standards, shall not be allowed to be used at sites even for short duration.

4.3.1.7.3. If any of the above mentioned clauses are not adhered penalty shall be imposed depending upon the gravity of the unsafe act and or condition.

4.3.2. Legal and other requirements

4.3.2.1. Contractor shall comply with all legal obligations and the requirements of Chennai Metro Rail Limited as contained herein.

4.3.2.2. Indian statutory requirements

The Contractor shall abide by all national, state and local bye-laws. It is the duty of the Contractor to ensure that all sub-Contractors appointed also comply with their legal

obligations as listed below but not limited to:

- i. Indian Electricity Act 2003 and Rules 1956
- ii. Tamil Nadu Building and other construction Workers (regulations of Employment and conditions of service) Rules ,2006.
- iii. National Building Code, 2005
- iv. Factories Act, 1948,
- v. The Tamil Nadu Factories Rules, 1950
- vi. Motor Vehicles Act as amended in 1994, The Central Motor Vehicles Rules, 1989.
- vii. Indian Road Congress Code IRC: SP: 55-2001 'Guidelines on Safety In Road Construction Zones.
- viii. The Petroleum Act, 1934 and Rules 1976
- ix. Gas Cylinder Rules, 2003
- x. Indian Explosives Act. 1884, along with the Explosives substance Act 1908 and the explosives Rules 1983
- xi. The (Indian) Boilers Act, 1923
- xii. The Public Liability Insurance Act 1991 and Rules 1991
- xiii. Minimum Wages Act, 1948 and Rules 1950
- xiv. Contract Labour Act, 1970 and Rules 1971
- xv. Child Labour (Prohibitions & Regulations) Act, 1986 and Rules 1950
- xvi. Environment Protection Act, 1986 and Rules 1986
- xvii. Air (Prevention and control of Pollution) Act, 1981
- xviii. Water (Prevention and Control of Pollution) Act, 1974
- xix. The Noise Pollution (Regulation & Control) Rules, 2000
- xx. Notification on Control of Noise from Diesel Generator (DG) sets, 2002
- xxi. Recycled Plastic Usage Rules, 1998
- xxii. Notification, Central Ground Water Board, Act January 1997
- xxiii. Manufacture, Storage & Import of Hazardous Chemicals Rules, 1989
- xxiv. The Hazardous Waste (Management & Handling) Rules, 1989
- xxv. Hazardous Waste Management Rules 1989 (as amended in 1999)
- xxvi. Batteries (Management and Handling) Rules
- xxvii. Fly ash utilization notification, Sept 1999 as amended in August 2003
- xxviii. Workman Compensation Act, 1923 along with allied Rules
- xxix. The Mines Act 1952
- xxx. The Indian Wildlife (protection) Act 1972 and The Wildlife (Protection) Amendment Act 2002
- xxxi. Coastal Regulation Zones(CRZ) Rules 2011 amended on dt. 8.12.2014
- xxxii. Solid Waste Management Rules 2019
- xxxiii. Municipal Solid Waste Rules 2000.

4.3.2.3. **International Standards, Guidelines & ISO Certifications**

- 4.3.2.3.1. If the requirements stated in this document are in conflict or inconsistent with the requirements of applicable laws or the Employer's Requirements for the CMRL project, the more stringent requirements shall apply.
- 4.3.2.3.2. The works shall be undertaken in accordance with the applicable international guidelines, standards and specifications on ESHS and every Contractor shall actively pursue the achievement of:
- ISO 45001:2018 health and safety (H&S) management system
 - ISO 14001:2015 Environmental management systems
- 4.3.2.3.3. The process of international certification to ISO 45001:2018 and ISO 14001:2015 standard shall commence immediately after the award of Contract through appointment of ISO accrediting body for obtaining the certification. Should this not be undertaken by the Contractor within 3 months of the Contract award, the Employer /Engineer shall appoint at the Contractor's cost.
- 4.3.2.3.4. Should the Contractor already possess such certification, the scope of the CMRL project must be included on the Contractor's certification within 1 year of Contract commencement and proof of such attainment demonstrated to Chennai Metro Rail Limited.
- 4.3.2.3.5. If any of the above mentioned clauses are not adhered penalty shall be imposed as per details given under penalty clause 4.8. of this document.

4.3.3. **Objectives and programme(s)**

- 4.3.3.1. The Contractor shall maintain procedures to establish detailed ESHS objectives and performance criteria. Such objectives and performance criteria shall be developed to incorporate the Chennai Metro Rail policy and strategic ESHS objectives. The Contractor's objectives shall be quantified, wherever practicable, and identified with defined timescales. The Contractor is required to submit for notice of no objection their procedure and objectives as per clause 4.4.4.1 of this control document.

4.4. **Implementation and operation**

4.4.1. Resources, roles, responsibility, accountability and authority

- 4.4.1.1. The Contractor shall detail within the Construction Health, Safety and Environmental Plan the planned roles and resources allocated for the CMRL project. In addition to the staffing arrangements the Contractor shall prescribe the responsibilities specific to role, accountability and the authority under which they operate.
- 4.4.1.2. ESHS resources shall be provided by the Contractor as per the Contract value in table 1.

Table 1 Mandatory Contractor ESHS management resource requirement

	1	2	3	4	5	6	7
Awarded Contract value (in Cr.)	Chief ESHS Manager (Safety Manager) (Key Staff)	Senior ESHS Manager	Junior ESHS Manager	Safety Supervisor	Senior ESHS (Electrical) Manager	Junior ESHS (Electrical) Manager	Public Liaison Officer

	1	2	3	4	5	6	7
Upto 100	1	-	1	Refer Note 3	-	1	1
Upto 200	1	1	Refer Note 2		1	Refer Note 4	1
Upto 300	1	Refer Note 1			1		1
Upto 400	1				1		1
Upto 500	1				1		1
More than 500	1				2		2
	8			09	10		11
Awarded Contract value (in Cr.)	Health officer with Nurse (Refer Note 9)		Environmental Manager	Senior ESHS (Traffic) Engineer	Barricade Maintenance squad	House Keeping squad	Labour Welfare Officer
Upto 100	2 (PT)	1	1	Refer Note 7	Refer Note 8	1	
Upto 200	2 (FT)	1	2			2	
Upto 300	2 (FT)	1 with Support staff	2			2	
Upto 400	2(FT)	1 with Support staff	2			2	
Upto 500	2(FT)	1 with Support staff	2			2	
More than 500	2(FT)	1 with Support staff	2			2	

Note 1: Qualified Senior ESHS Manager as per table 2 ESHS Personnel Qualifications & Experience to be deployed at each worksite at each shift.

Note 2: Qualified Junior ESHS Manager as per table 2 ESHS Personnel Qualifications & Experience to be deployed at each worksite at each shift.

Note 3: Qualified Safety Steward as per table 2 ESHS Personnel Qualifications & Experience to be deployed at each worksite at each shift.

Note 4: Qualified Junior ESHS (Electrical) Manager as per table 2 ESHS Personnel Qualifications & Experience to be deployed at each worksite at each shift.

Note 5: (PT) means Part-Time and (FT) means Full-time.

Note 6: Senior ESHS (Traffic) Engineer Post and Barricade Manager Posts are applicable to contracts where the work has to be executed either below or over the right-of-way like Viaduct, Contracts wherein erection and maintenance of barricades are paramount important.

Note 7: One Barricade Manager supported by required supervisors and workmen at each worksite at each shift.

Note 8: One Housekeeping Manager supported by required supervisors and workmen at each worksite at each shift.

Note 9: Qualified Nurse as per table 2 ESHS Personnel Qualifications & Experience to be deployed at each worksite at each shift.

Note 10: The Chief ESHS Manager (Safety Manager)-Key Staff shall be a professional and experienced manager with at least fifteen (15) years' experience in the construction of metro rail Projects with at least 10 year's direct relevant experience in administering of ESHS of similar scope in professional experience in ESHS in international projects. The Chief ESHS Manager should have minimum five years' experience in similar position of similar works .

Note 11: No contractor shall engage ESHS manpower from any outsourcing agencies in which case the effectiveness would be lost. All ESHS manpower shall be on the payroll of the main contractor only and not on the payroll of any subcontractor or outsourcing manpower agencies etc. This condition does not apply to positions like traffic marshals who are engaged almost on a daily requirement basis.

Note 12: Environmental support staff shall be Govt. recognized PG Degree / Degree in Environmental Engineering / Science with minimum of two years of experience of similar scope of **work**.

Note 13: All the ESHS Personal Shall be in the payroll of the main contractor.

Note 14: The conduct and functioning of the contractor ESHS personnel shall be monitored by the Employer. Any default or deficiency shall attract penalty as per details given under penalty clause 4.8.3 of this document.

4.4.1.3. **Responsibility**

4.4.1.4. The Project Director or Project Manager of the Contractor is responsible and accountable for compliance with the conditions and clauses within this document.

4.4.1.5. The Project Director or Project Manager is responsible to ensure that the necessary resources are allocated and made available to meet the requirements as laid out within this document and other referenced materials to include Legal Requirements (4.3.2).

4.4.1.6. For all works carried out by the Contractor and appointed sub-Contractor's, the responsibility for ensuring ESHS resources remains with the main Contractor. Activities undertaken by the Contractor's Sub-Contractors shall be monitored by the Contractor at all times to ensure compliance with agreed safe systems of working.

4.4.1.7. All Contractor's ESHS personnel shall report to the Chief ESHS Manager who shall report directly to the Project Director or Project Manager or Corporate Safety manager of the Contractor's organisation. This shall be reflected in the Contractor's organisation charts within the ESHS plan and Quality Management Plan.

4.4.1.8. The Employer /Engineer shall monitor adherence to the provisions of Table 1. Where deviation is evident this shall be recorded as a non-conformance.

4.4.1.9. The Contractor shall provide all ESHS personnel with such facilities, equipment and information that are necessary to enable them to dispatch their duties effectively.

- 4.4.1.10. The Contractor's ESHS Managers are responsible for ensuring that reports on the performance of the ESHS management system are presented to top management for review and used as a basis for improvement of the ESHS management system.
- 4.4.1.11. The Contractor's ESHS Managers are responsible for independently monitoring the operations of the Contractor, where deficiencies are identified they are responsible to report their findings immediately to the Site Engineer in charge who then must take action as directed.
- 4.4.1.12. **Accountability**
- 4.4.1.13. In cases where the Contractor fails to provide the minimum required manpower as illustrated in Table 1, or fails to fill vacancies created within 30 days, the same may be provided by the Employer /Engineer at the Contractor's cost. Any administrative expenses involved in providing the same for example, vacancy advertisements or recruitment consultant charges, shall also be at the cost of Contractor.
- 4.4.1.14. No ESHS personnel shall be permitted to do any work which is unconnected to, inconsistent with or detrimental to the performance of the ESHS duties.
- 4.4.1.15. Supervisors must ensure that the employees under their direct supervision are working in compliance with the approved safe systems of working.
- 4.4.1.16. **Authority**
- 4.4.1.17. The Contractor's Safety Managers, Senior ESHS Manager and Junior ESHS Manager authority shall be stated within the Construction Health and Safety Plan and the authority level must be communicated to all Contractor's Staff including sub-Contractors.
- 4.4.1.18. The Contractor's Safety Managers, Senior ESHS Manager and Junior ESHS Manager Officers shall have the authority as assigned by the Project Director or Project Manager to suspend works where deviation from an approved method of working occurs that presents a risk of injury, equipment or property damage or "E&S" risks.
- 4.4.1.19. The Engineer shall have the right to stop the work at his/her sole discretion, if in his opinion the work is being carried out in such a way that a risk of injury, property and or equipment damage may exist. The Contractor shall not proceed with the work until remedial works have been complied with under the direction and satisfaction of the Employer. Should the Contractor continue to work without implementing the Engineers instruction, clause 4.4.2.2 shall be applied to the individual responsible for the decision to proceed.
- 4.4.1.20. The Contractor shall not be entitled to any damages or compensation for stoppage of work, due to safety reasons. The period of such stoppages of work shall not be taken as an extension of time for completion of the facilities and will not be the ground for waiver of levy of liquidated damages.
- 4.4.1.21. The contractor shall submit Daily Dairy report (FSAF 029-Volume 2 of H&S Manual) with the target date for the completion of the observation to the Employer /Engineer including any subcontractor activity of both shift. This reporting shall be the primary duty of the Chief ESHS Manager of the contractor and reporting shall be through email. The report should be submitted at the end of the day of shift. If the information is not received or delay in submission of report. Penalty shall be levied as per relevant clause.

4.4.2. Competence, training and awareness

- 4.4.2.1. The Contractor shall ensure that the recruitment, selection and placement processes shall be in place to ensure that personnel are qualified, competent, and physically fit for assigned tasks. The Contractor shall produce a procedure that shall be

made available to the Employer / Engineer for notice of no objection as per Clause 4.4.4.1 of this document. The procedure shall define the processes in place to ensure competence.

4.4.2.2. Whereby any person employed thereon, who in the opinion of the Employer /Engineer , misconducts himself or is incompetent or negligent or fails to conform with any particular provisions with regard to health , safety or environment which is set out in the Contractor's ESHS Plan or a requirement of the Contract, or persists in any conduct which is prejudicial to health, safety , shall be removed from site immediately, and such persons shall not be employed again upon the Works. The decision of the Employer /Engineer in this regard shall be final.

4.4.2.3. **The Contractor ESHS Personnel-Notice of No Objection from the Employer /Engineer.**

4.4.2.3.1. The name, educational qualifications and work experience for all ESHS persons intended for a Contractor's ESHS role shall be submitted to the to the Employer/Engineer Employer in the format prescribed (FSAF 30-Volume 2 of H&S Manual) for notice prior to employment. Only upon notice of no objection by the Employer /Engineer shall ESHS personnel be authorised to work on a CMRL site.

4.4.2.3.2. The Original certificate of degree, mark sheet, course completed certificate and work experience shall be maintained by the Contractor and be made available for inspection and upon request shall be submitted to the Employer/Engineer prior to employment.

4.4.2.3.3. **Age Limit:** Contractor's ESHS persons shall not be exceeding 55 years on the date of submission of proposal.

4.4.2.3.4. The conduct and functioning of the contractor ESHS personnel shall be monitored by the Employer/Engineer. Any default or deficiency shall attract penalty as per details given under penalty clause of this document.

4.4.2.3.5. The Contractor ESHS personnel permitted to work only specific contract package as per the Notice of No Objection issued by the Employer / Engineer.

4.4.2.3.6. Only approved by the Govt of India Degree from recognized university /Diploma in Safety Engineering from State board of Technical Education and Equivalent International Degree in Safety engineering shall be considered as the valid qualification.

4.4.2.3.7. The Project Director or Project Manager shall certify that the ESHS staff, original certificate of educational qualifications and work experiences are verified by him and found competent prior to the submittal to the Employer.

4.4.2.3.8. The minimum Employer's requirements of such facilities / equipment's to be provided for OSHE personnel are given in the GSAF-52 of Volume 2 of H&S Manual

4.4.2.3.9. The Contractor shall appoint the required ESHS personnel in accordance with the qualifications and experience as listed in Table 2.

Table 2 ESHS Personnel Qualifications & Experience

Item	Designation	Qualification	Experience (Years)
1	Chief ESHS Manager	The Chief ESHS Manager shall be qualified in any of the following qualifications i)M. E/ M.Tech. in Industrial Safety ii)B.E. in Fire and Safety Engg. iii)A recognised degree in any branch of engineering from recognized university with a Minimum one-year Full Time PG Diploma	15

Item	Designation	Qualification	Experience (Years)
		/Diploma from Central labour institute / Regional Labour Institute Mumbai / Chennai / Kolkata /Kanpur/ Diploma in Safety Engineering from State Board of Technical Education iv) A recognised degree in any branch of engineering from recognized university with International qualifications like CSP (Certified Safety Professional), Diploma in NEBOSH	
2	Senior ESHS Manager	The Senior ESHS Manager shall be qualified in any of the following qualifications i)M. E/ M.Tech. in Industrial Safety ii)B.E. in Fire and Safety Engg. iii)A recognised degree in any branch of engineering from recognized university with a Minimum one-year Full Time PG Diploma /Diploma from Central labour institute / Regional Labour Institute Mumbai / Chennai / Kolkata /Kanpur/ Diploma in Safety Engineering from State Board of Technical Education iv) A recognised degree in any branch of engineering from recognized university with International qualifications like CSP (Certified Safety Professional), Diploma in NEBOSH	12
3	Junior ESHS Manager	The Junior ESHS Manager shall be qualified in any of the following qualifications i)M. E/ M.Tech. in Industrial Safety ii)B.E. in Fire and Safety Engg. iii)A recognised degree in any branch of engineering from recognized university with a Minimum one-year Full Time PG Diploma /Diploma from Central labour institute / Regional Labour Institute Mumbai / Chennai / Kolkata /Kanpur/ Diploma in Safety Engineering from State Board of Technical Education iv) A recognised degree in any branch of engineering from recognized university with International qualifications like CSP (Certified Safety Professional), Diploma in NEBOSH v)Any Graduate with 8 years of work experience in full-fledged ESHS department of any Public Sector / Leading Private Sector / MNC / with prior approval of Employer /Engineer on a case to case basis	6 for Category (i) to (iv)
4	Safety Supervisor	i)Degree in Science / Diploma in Engineering with Govt. recognized safety diplomas from National and State Productivity Councils, Other State Technical Education Boards etc. ii)Any Graduate with 5 years of work experience in full-fledged ESHS department of any Public Sector / Leading Private Sector / MNC / with prior approval of Employer /Engineer on a case to	3 for Category (i)

Item	Designation	Qualification	Experience (Years)
		case basis	
5	Senior ESHS Electrical Manager	Degree in Electrical Engineering + Govt. Recognized Electrical "C" Licence holder	2
6	Junior ESHS Electrical Manager	Degree in Electrical Engineering + Govt. Recognized Electrical "C" Licence holder	1
7	Public Liaison officer	Any Degree with Govt. Recognized Degree / Diploma / P G Diploma in Labour Welfare related fields like Law, Personnel / Industrial Relations etc.	5
8	Health Officer	MBBS with Govt. recognized degree/diploma in Industrial/ health	1
9	Nurse	Any Degree with Govt. Recognized Degree / Diploma / P G Diploma in in Nursing	1
10	Environmental Manager	Govt. recognized PG Degree / Degree in Environmental Engineering / Environmental Science	5
11	Senior Traffic Engineer	Govt. recognized PG Degree / Degree / Diploma in Traffic/Transportation Engineering or Planning	1
12	House Keeping Manager	Any Diploma in Engineering	1
13	Barricade Manager	Any Diploma in Engineering	1
14	Labour Welfare Officer	Any Degree with Govt. Recognized Degree / Diploma / P G Diploma in Labour Welfare related fields like Law, Personnel / Industrial Relations etc.	5

Note: In some extraordinary cases where the candidate had earlier worked in CMRL Projects they can be considered for the following posts:

- i) Junior ESHS Manager
- ii) Safety Steward

depending upon the qualification and no. of years of experience on a case to case basis even if they do not possess the prescribed qualification as listed above.

4.4.2.3.10. Where a potential candidate has previously worked in a Metro Rail construction environment and does not possess the qualifications and or the necessary experience as listed in Table 2 for the particular role, the Employer/ Engineer may upon a successful interview of the candidate grant a waiver subject to successful completion of a probation period of 3 months..

4.4.2.3.11. In order to effectively interact on labour welfare matters with the Employer /Engineer and the statutory authorities enforcing the labour welfare legislations every Contractor shall employ a full time Labour Welfare Officer duly qualified and experienced as per clause

4.4.2.3.12. The Contractor shall ensure that all personnel working at the site receive an induction ESHS training explaining the nature of the work, reporting & communication routes the hazards that may be encountered during the site work and the particular hazards attached to their own

function within the operation. The training shall cover as a minimum the contents as directed within H&S Manual Volume 2.

- 4.4.2.3.13. Records of all inductions shall be maintained by the Contractor and be made available for inspection by the Employer /Engineer upon request.
- 4.4.2.3.14. The Contractor shall provide their workforce and management staff with an ESHS induction Handbook containing the information as per the induction training.
- 4.4.2.3.15. A condensed induction shall be given by the Contractor to all visitors. The induction briefing shall include the risk and hazards associated with the particular site and the operations being conducted.
- 4.4.2.3.16. All personnel shall be issued a temporary ID upon the completion of the Contractor's' induction. The temporary ID shall be signed by the Human Resource Manager or appointed representative and limited to a 2-week validity period at which time the temporary ID shall be replaced with a permanent ID including photograph.
- 4.4.2.3.17. Individuals found on site by the Employer /Engineer without-dated temporary ID cards shall be removed from site
- 4.4.2.4. **ESHS Training**
- 4.4.2.4.1. The Contractor shall assess the training requirements for all the employees, plan and initiate a training program to fulfil the training needs assessment. The assessment of training needs shall incorporate all levels of staff including Sub-Contractor's against an individual's role, responsibility, ability, language skill and risk.
- 4.4.2.4.2. The Contractor shall provide comprehensive training to all staff as mentioned in ESHS conditions of contract
- 4.4.2.4.3. The Training Plan shall provide a structured training programme to educate and train all the personnel of the contractor in Safety aspects of all Construction activities. The training plan can contain:
- I. Objective, syllabus, format, class size and duration of each training course;
 - II. Training facilities to be provided by the Contractor;
 - III. List of training materials and documentation to be included with the training course; and to be circulated in booklet format to each trainee
 - IV. Method of pre- and post- testing to be utilised;
 - V. Qualifications and experience level necessary for the trainees;
 - VI. Instructor's qualifications; and Course evaluation methods.
 - VII. Training shall be carried out in the medium of the Hindi, English & Local language and supplemented, if necessary, in other Language
 - VIII. Training shall consist of classroom (theory) training, and practical (hands on) training wherever necessary.
 - IX. To meet this need, the training agency shall supply competent trainers/instructors to carry out training to a high degree of proficiency in areas where the trainer has the specialised knowledge.
 - X. In order to ensure that satisfactory standards are met, the contractor's relevant Training Department will monitor all training.
- 4.4.2.4.4. The Contractor shall, at the conclusion of each training session, issue questionnaires to, and/or set practical tests for all trainees directed at determining the level of satisfaction with the course content and to assess the level of knowledge and understanding of the course content by each trainee. Five Questions from each training module are to be selected and assessment is to be conducted at the end of days training session.
- 4.4.2.4.5. The Contractor shall review the responses to questionnaires and the trainees' test results and forward a summary to the Employer /Engineer.

- 4.4.2.4.6. Trainees failing to achieve a minimum passing percentage of 40 percent will be regarded as fail and re-training will be again given to trainee
- 4.4.2.4.7. If the Employer /Engineer considers that the course has not achieved the required objectives, he will instruct the Contractor who shall then organise and implement appropriate re-training.
- 4.4.2.4.8. The Contractor shall, at the completion of each training course. A consolidated training record listing the training course title, date of training, name of all trainees, training result and other relevant information; and Issue an appropriate certificate to each trainee who has successfully completed the course. He should issue the sticker for each completion of Course.
- 4.4.2.4.9. The Contractor shall produce a 'Training Implementation Plan' to incorporate the findings of the needs assessment.
- 4.4.2.4.10. The training needs assessment together with Implementation Plan shall be submitted to the Employer /Engineer for notice of no objection within 4 weeks of commencement. The Employer /Engineer shall evaluate the assessment and plan against the base line training matrix contained within H&S Manual Volume 2.
- 4.4.2.4.11. Records of all training conducted shall be maintained and made available for inspection by the Employer /Engineer upon request.
- 4.4.2.4.12. Should the Contractor fail to provide the training identified within the Contractor's assessment, implementation plan and the Employer /Engineer Training matrix within the agreed timescales, this shall be reflected in the potential scores awarded within the monthly audit report.
- 4.4.2.4.13. Specific training with regard to the provisions of the Construction Safety Plan, and associated operational and system procedures shall be conducted by the Contractor for all persons with supervision responsibilities. Records of training including duration shall be maintained.
- 4.4.2.4.14. All the Management training should be completed within six months from the date of the contract awarded
- 4.4.2.4.15. Contractors and sub-contractors are responsible for providing ESHS training through CMRL approved agency shall conduct training as per the training Implementation Plan to all Staff and workers and for retention of records of such activities for inspection by the Employer /Engineer.
- 4.4.2.4.16. The Profile of the External ESHS Agency (Training, Inspection and Testing) ISO certifications, course details, the name, educational qualifications and experience for of the trainers are to be submitted to the Employer/Engineer a minimum 28 days before prior to appointment of the agency. Only upon notice of no objection by the Employer /Engineer shall be authorised to deliver ESHS Services on CMRL sites.

4.4.3. Communication, participation and consultation

4.4.3.1. Communication

- 4.4.3.1.1. The Contractor shall produce a 'High Quality' quarterly newsletter on a rotational basis with other Contractors. Rotation shall be announced within the Employer /Engineer ESHS Committee meetings.
- 4.4.3.1.2. All Contractors including the Employer /Engineer shall provide input into the rotational Contractor for the newsletter content such as details of accidents, incidents and near misses together with any lessons learned; specific safety initiatives; internal competitions and workforce awards etc.
- 4.4.3.1.3. The Employer /Engineer shall be issued the draft newsletter for review prior to the Contractor's publishing.
- 4.4.3.1.4. The ESHS Newsletters shall publicise all Contractors ESHS performances over the previous 3 months in relation to ESHS Audits and shall form the basis for the Employer /Engineer

Awards programme. Results of audits shall be provided by the Employer /Engineer for inclusion.

- 4.4.3.1.5. The quarterly newsletters shall be issued to all interested parties and be promulgated at site level. Where language barriers exist the contents of the newsletters shall be communicated by the Workforce Representative to ensure understanding.
- 4.4.3.1.6. At site level the Contractor shall erect pertinent awareness signage and posters. Posters shall be changed on a monthly basis to maintain impact.
- 4.4.3.1.7. Poster campaigns shall be discussed and agreed at the Employer /Engineer Committee Meeting to maintain a consistent improvement programme across all CMRL Sites.
- 4.4.3.1.8. Informational posters, banners etc shall be provided in Hindi, Tamil and English.
- 4.4.3.1.9. Toolbox talks and Method statement , Risk Assessment , Task briefings shall be carried out daily by the Contractor and correspond to the works activities being undertaken or to communicate a specific awareness initiative. Toolbox talks shall not replace professional training.
- 4.4.3.1.10. Records of all toolbox talks and Method statement, Risk Assessment , Task briefings undertaken together with the date, topic, participant's names and signatures shall be maintained and made available for inspection by the Employer /Engineer .
- 4.4.3.1.11. Method statement and risk assessment briefings shall be carried out prior to the commencement of a new task and or when a change to the method of working arises. Records of all such briefings shall be maintained by the Contractor.
- 4.4.3.1.12. Visitor information signage shall be posted at site entrances detailing where to report and contact information. Note: visitors shall be accompanied at all times by site security where office locations require walking through operational areas.
- 4.4.3.1.13. Job specific poster, ESHS policy statement, Employer's Liability Insurance certificate, Protective Equipment, Reversing Vehicles, Emergency procedure, Project Wages notice board, BOCWR registration Licence, Labour licences, Insurance policies and Site rules shall be displayed in the site entrance's and site office's
- 4.4.3.1.14. **Public Liaison**
- 4.4.3.1.15. Public informational signage and Contractor contact information shall be posted externally to the site.
- 4.4.3.1.16. The Contractor shall appoint an individual as a Public liaison Officer to communicate directly with members of the public regarding forthcoming operations, what to expect, noise expectancy, duration of operations etc. Contractor will conduct a full detailed analysis of noise and vibration prediction and submit to CMRL to clear. The analysis will be reviewed by lenders before mobilization.
- 4.4.3.2. **Participation and consultation**
- 4.4.3.2.1. The Contractor shall ESHS Committee within 4 weeks of commencement that shall be chaired by the Contractor's Project Director.
- 4.4.3.2.2. The Contractor shall notify the Employer /Engineer of the establishment of the Committee together with the committee members' names and designation. The Contractor's Chief Safety Manager, Senior Safety Manager, Plant & procurement Manager and Human Resources Manager shall form the minimum committee members. Site based personnel shall be represented within the Committee by the attendance of Site Manager(s) and the Workforce ESHS Representative. Workforce ESHS Manager shall be elected by the workers from among themselves.
- 4.4.3.2.3. The Employer /Engineer shall be invited to attend the Contractor's ESHS Committee meetings.

4.4.3.2.4. The Contractor's ESHS Committee shall meet on a monthly basis throughout the duration of the Contract.

4.4.3.2.5. The Terms of Reference for the Contractor's ESHS Committee shall be as follows;

- i) To establish company safety policies and practices
- ii) To monitor the adequacy of the contractor's site ESHS plan and ensure its implementation
- iii) To review ESHS training plan implementation
- iv) To review the contractor's monthly ESHS report.
- v) To identify probable causes of accident and non-compliance of ESHS practices in building or other construction work and to suggest remedial measures.
- vi) To stimulate interest of Employer/Engineer and building workers in ESHS by organizing ESHS week, ESHS competitions, talks and film-shows on safety, preparing posters or taking similar other measures as and when required or as necessary.
- vii) To tour round the construction site with a view to check unsafe practices and detect unsafe conditions and to recommend remedial measures for their rectifications including first-aid medical and welfare facilities.
- viii) Committee team members should perform a site inspection before every committee meeting and to monitor ESHS inspection reports.
- ix) To bring to the notice of the Employer /Engineer Employer the hazards associated with use, handling and maintenance of the equipment used during the course of building and other construction work.
- x) To suggest measures for improving welfare amenities in the construction site and other miscellaneous aspect of safety, health and welfare in building or other construction work.
- xi) To look into the health hazards associated with handling different types of explosives, chemicals and other construction materials and to suggest remedial measures including personal protective equipment.
- xii) To review the last safety committee meeting minutes and to take action against persons/sub-contractors for non-compliance if any.
- xiii) Shall note the grievance of the staff and shall take necessary steps to address them.

4.4.3.2.6. The inspection shall review progress regarding the achievement of short term targets. The Committee shall produce a report stating progress made together with any corrective actions required and issue to the Employer /Engineer within 7 days following the Inspection.

4.4.3.2.7. Minutes of the Committee meeting shall be issued within 2 days and promulgated to all members including the Employer /Engineer at least one week prior to CMRL's ESHS weekly meeting. The minutes of meeting shall also be posted on all sites within the workforce area. The minutes intended for site communication shall be in Hindi, Tamil and English.

4.4.3.3. **Employer /Engineer ESHS Committee**

- 4.4.3.3.1. An Environmental, Social, Health and Safety Committee shall be established by the Employer /Engineer. The Employers ESHS committee shall be formed out from the department of ESHS of CMRL and shall sit every month throughout the project period. **The Terms of Reference for the Employer's ESHS Committee shall be as follows;**
- i. To establish Environment Social Health and Safety policies and practices
 - ii. To monitor the adequacy of the contractor's site ESHS plan and ensure its implementation
 - iii. To review Contractors ESHS training plan and implementation
 - iv. To review the contractor's monthly ESHS report.
 - v. To monitor the causes of accident and non-compliance of ESHS practices in building or other construction work and to suggest remedial measures.
 - vi. To stimulate interest of Contractor and building workers in ESHS by organizing ESHS week, ESHS competitions, talks and film-shows on ESHS, preparing posters or taking similar other measures as and when required or as necessary.
 - vii. To check unsafe practices at site and detect unsafe conditions and to recommend remedial measures for their rectifications.
 - viii. To identify hazards associated with handling different types of explosives, chemicals and other construction materials and to suggest remedial measures including personal protective equipment.
 - ix. To review the last Health and Safety committee meeting minutes and to take action against persons/Contractors for non-compliance if any.
Review the grievance redressal mechanism of Contractor. Contractors shall be required to attend the monthly meetings who shall be represented by their Project director or Project Manager, Corporate Safety Manager and Chief Safety Manager.
- 4.4.3.3.2. The Committee shall review previous performances project wide and set short and medium term objectives and targets for achievement within the next reporting period.
- 4.4.3.3.3. The Employer /Engineer reserves the right to call an Emergency Meeting of the Committee members in the event of a serious incident that requires immediate change to the operational methods of working.
- 4.4.3.3.4. Minutes of the Employer /Engineer ESHS Committee shall be promulgated to all Contractor's within 3 days.
- 4.4.3.4. **Workforce Representation**
- 4.4.3.4.1. All workers shall have access to a Workforce ESHS Representative who is responsible to communicate directly with the labour force with regard to health and safety . The representative's name and contact number shall be posted on all sites externally to the site office.
- 4.4.3.4.2. The Workforce ESHS Representative shall be made a member of the ESHS Committee (FSAF 025 of H&S Manual -Volume 2) and attend all meetings.
- 4.4.3.4.3. The ESHS Representative shall meet the labour force on a monthly basis to discuss health, welfare, safety initiatives and or concerns the workforce may have. Minutes (FSAF 026 of H&S Manual -Volume 2) are to be produced by the Representative and issued formally within 2 days after the meeting date to the Contractor's Project Director or Project Manager and Employer /Engineer .
- 4.4.3.4.4. The chairman shall inform the members of any outstanding issues in the meeting and in case of repeated offence/ non-compliance by some members or other co/sub-contractors and propose suitable disciplinary action including provisions of monetary penalty as per the relevant contract clauses, the Engineer shall ensure that the same is implemented.
- 4.4.3.4.5. A lockable site suggestion box to which only the workforce ESHS Representative shall have access shall be installed on all sites and within any labour accommodation camps. The

suggestion box shall be located independent from any offices, in a public area and protected from bad weather. The ESHS Representative shall inform the workforce that the purpose of the suggestion box is to provide a means of participation, communicating ideas and initiatives and also for raising concerns without fear of reprisal.

- 4.4.3.4.6. The contents of all suggestion boxes shall be collected and collated on a weekly basis. Where concerns or complaints regarding the standards of health, safety or welfare have been reported these shall be immediately reported to the Chief ESHS Manager and Project Manager who shall investigate the concern(s). Records of such investigations and resultant outcomes shall be maintained.
- 4.4.3.4.7. Ideas, suggestions and concerns raised by the workforce during the ESHS representative's on site monthly meetings shall form an agenda item within the Contractor's ESHS Committee meeting.
- 4.4.3.4.8. Where an idea or specific suggestion is subsequently adopted for use by the Contractor's ESHS Committee, the individual shall receive an ESHS award as determined by the Contractor.
- 4.4.3.4.9. Where Employee awards are issued this shall be notified to the Employer /Engineer to ensure inclusion within the Quarterly Newsletter.
- 4.4.3.5. **Contractor Awards**
- 4.4.3.5.1. The Employer/Employer's Representative shall recognize the effort, participation and commitment demonstrated by the Contractor by nominating awards. The award type shall be at the discretion of the Employer.
- 4.4.4. Documentation**
- 4.4.4.1. **Management System procedures**
- 4.4.4.1.1. The Contractor is required to submit for notice of no objection, the organisation's top tier Management System Procedures as listed in Table 3 that shall be adopted for use on the CMRL project.
- 4.4.4.1.2. System procedures shall be submitted to the Employer /Engineer within 4 weeks of commencement.
- 4.4.4.1.3. Construction works shall not commence until such time as a notice of no objection has been received; applicable to all management system procedures as listed in Table 3. Should the Contractor commence operations on site without notice, the Employer /Engineer shall award a 'Zero' audit score for every month of non-compliance with this clause.
- 4.4.4.1.4. The Employer /Engineer shall evaluate the suitability of the Contractor's system procedures against the ISO 45001:2018 and ISO 14001:2015 standards.
- 4.4.4.1.5. The submitted procedures shall be individually identified with a unique reference and detail in sequence the scope, purpose, referenced material and procedure processes.
- 4.4.4.1.6. Where such procedures as listed in Table 3 exist within other areas of the Contractor's organisational management systems such as quality management, these shall not be subject to replication if the procedure makes specific reference to Health , Safety and Environmental control.
- 4.4.4.1.7. Compliance standards against the Contractor's management system procedures shall be subject to audit by the Employer /Engineer.

Table 3 ESHS Management System Procedures

Hazard identification, risk	Communication, participation & consultation	Environmental Impact Aspect Assessment	Objectives and programme(s)
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assessment and determining controls			
Training, awareness and competence	Implementation and operation	Accident & Incident Investigation	Legal requirements
Documentation	Monitoring & Measurement	Emergency Preparedness	Change control
Procurement	Record keeping	Audit	Management review

4.4.5. Control of documents

- 4.4.5.1. All plans, procedures and method statements shall be controlled and subject to review and formal approval by the Contractor's Project Director prior to issue to the Employer /Engineer
- 4.4.5.2. All documents subject to review by the Employer /Engineer shall be signed by the Contractor's Construction Manager , Safety Manager and Project Director and issued formally.
- 4.4.5.3. Documents shall be issued as per the Employer /Engineer requirements regarding Quality Management.
- 4.4.5.4. ESHS Documents shall be issued, maintained, traceable and available for retrieval pursuant to the Contractor's ISO accredited Quality Management System.

4.4.6. Operational control

- 4.4.6.1. Operational control shall be maintained through the implementation of the provisions stated within the Contractor's site specific Construction Health , Safety and Environmental Plans, the contents of which are outlined in Health , Safety and Environmental Volumes 2 and 3 and EMP in PCC to which the Contractor shall comply.
- The Contractor shall submit the following plans which comprises the Contractors ESHS Plan as per the given time lines for approval of CMRL.

S.No.	Plan Description	Shall be submitted within
1.	Construction Safety Plan	28 days
2.	Social Impact mitigation plan	28 days
3.	Fire Evacuation plan	28 days
4.	Construction Health plan	28 days
5.	Construction contingency plan	28 days
6.	Traffic Management Plan	28 days
7.	Disaster Management Plan	28 days
8.	Site Environmental Plan	28 days

4.4.6.2. Construction Phase Safety Plan

- 4.4.6.2.1. The Contractor shall produce a Contract specific Construction Safety Plan and submit to the Employer /Engineer within 28 days of commencement.
 - 4.4.6.2.2. The Construction Safety Plan shall contain the informational requirements as per the CSP contents as prescript within the CMRL H&S Manual Volume 2, Safety Plan contents.
 - 4.4.6.2.3. The CHSP shall be assessed by the Employer /Engineer against the provisions as stated within H&S Manual Volume 2. Where deficiencies exist to an extent where an objection is raised, construction activities shall be suspended until such time as the deficiencies are subject to corrective action, re-submittal and notice of no objection by the Employer/Engineer.
 - 4.4.6.2.4. Delays incurred as a result of the Contractor failing to achieve a 'No objection' status from failing to submit within the specified timescale or non-compliance with ESHS Volume 2 shall be entirely at the Contractor's risk and cost.
 - 4.4.6.2.5. The Contractor shall undertake a monthly review of the CSP. The review shall be recorded and the Employer /Engineer notified of any updates.
 - 4.4.6.2.6. The Contractor shall produce a Contract Specific Fire Evacuation plan and submit to the Employer /Engineer within 28 days of commencement.
 - 4.4.6.2.7. The Contractor shall produce a Contract Specific Construction ESHS plan and submit to the Employer /Engineer within 28 days of commencement.
 - 4.4.6.2.8. The Contractor shall produce a Contract Specific Construction contingency plan and submit to the Employer /Engineer within 28 days of commencement.
 - 4.4.6.2.9. The Contractor shall produce a Contract Specific Construction Health Plan and submit to the Employer /Engineer within 28 days of commencement.
 - 4.4.6.2.10. The Contractor shall produce a Contract Specific Traffic Management Plan and submit to the Employer /Engineer within 28 days of commencement.
 - 4.4.6.2.11. The Contractor shall produce a Contract Specific Disaster Management Plan and submit to the Employer /Engineer within 28 days of commencement.
 - 4.4.6.2.12. The Contractor shall, from time to time and as necessary are required by the Employer/Engineer to produce supplements to the ESHS Plan such that it is at all times a detailed, comprehensive and contemporaneous statement by the Contractor of his site safety, industrial health and environment obligations, responsibilities, policies and procedures relating to work on Site. Any and all submissions of supplements to the ESHS Plan shall be made to the Employer /Engineer in accordance with the agreed procedures.
 - 4.4.6.2.13. If at any time the ESHS plan is, in the Employer /Engineer opinion, insufficient or requires revision or modification to ensure the security of the Works and the safety of all workmen upon and visitors to the Site, the Employer/Engineer may instruct the Contractor to revise the ESHS plan and the Contractor shall within 7 days submit the revised plan to the Employer/Engineer for review.
 - 4.4.6.2.14. Any omissions, inconsistencies and errors in the ESHS Plan or the Employer /Engineer acceptance or rejection of the ESHS Plan and/or supplements thereto shall be without prejudice to the Contractor's obligations with respect to site safety, industrial health and environment and shall not excuse any failure by the contractor to adopt proper and recognised safety practices throughout the execution of the Work.
 - 4.4.6.2.15. The Contractor shall adhere to the ESHS Plan and shall ensure, as far as practically possible, that all sub-contractors of all tiers require that contracting parties each have a copy of the Site ESHS Plan and comply with its provisions
- #### 4.4.6.3. Construction Phase Site Environmental Plan

- 4.4.6.3.1. The Contractor shall produce a Contract Specific Site Environmental Plan (SEP) and submit to the Employer /Engineer within 28 days of commencement.
- 4.4.6.3.2. The Site Environmental Plan (SEP) shall contain the informational requirements as per the contents as prescript within the CMRL Environmental Management Arrangements Volume 3, Environmental Plan contents.
- 4.4.6.3.3. The SEP shall be assessed by the Employer /Engineer against the provisions as stated within the Environmental Management Arrangements Volume 3. Where deficiencies exist to an extent where an objection is raised, construction activities shall be suspended until such time as the deficiencies are subject to corrective action, re-submittal and notice of no objection by the Employer /Engineer .
- 4.4.6.3.4. Delays incurred as a result of the Contractor failing to achieve a 'No objection' status from failing to submit within the specified timescale or non-compliance with Environmental Management Arrangements Volume 3 shall be entirely at the Contractor's risk and cost.
- 4.4.6.3.5. The Contractor shall undertake a monthly review of the SEP. The review shall be recorded and the Employer /Engineer notified of any updates.

4.4.6.4 Operational procedures

- 4.4.6.4.1 The Contractor shall identify within the Hazard Log and Risk Register the operational control procedures that shall be applicable for the CMRL project under their individual scope of works.
- 4.4.6.4.2 Operational procedures shall be submitted for review to the Employer /Engineer for notice of no objection together with the Construction Site Safety Plan within 4 weeks of commencement.
- 4.4.6.4.3 The operational procedures shall be evaluated by the Employer /Engineer against the requirements stated within H&S Manual Volume 2, Environmental Arrangements in Volume 3, EMP in PCC, international safety standards such as the International Labour Organisation, European Norms and British Standards where an equivalent Indian Standard does not exist.
- 4.4.6.4.4 Construction works shall not commence until such time as a notice of no objection has been received; applicable to all operational procedures as identified within Table 4 and the Contractor's Hazard Log, Grievances Log & Risk Register. Should the Contractor commence operations on site without notice, the Employer /Engineer shall award a 'Zero' audit score for every month of non-compliance with this clause.
- 4.4.6.4.5 The submitted procedures shall be individually identified with a unique reference and detail in sequence the scope, purpose, referenced material and procedure processes.
- 4.4.6.4.6 In the event that the Contractor is unable to comply with the 28 day timeframe for submittal of the minimum operational procedures as detailed within Table 4, the Contractor shall assign an individual identification reference for the outstanding procedure within the Construction Health, Safety & Environmental Plan together with the statement 'Under process'. The 'Under Process' procedure shall be required to be submitted for notice of no objection a minimum of 28 days prior to commencement of any activity that involves the application of the procedure.

Table 4 Operational Procedures

Lifting Operations & Lifting	Plant & Equipment	Health provisions	Emergency Medical Facilities & First	Environmental Pollutants
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Equipment			Aid	
Personal Protective Equipment	Permit to Work Systems	Site Electricity & Distribution	Welding & Cutting operations	Air
Incident Investigation	Traffic Management	Working at Height	Hazardous Substances	Waste Water
Site Security	Fire Safety	Manual Handling	Site Set-up	Solid Waste
Abrasive Wheels	Public Interface	Noise and Vibration	Welfare Arrangements	

Ecological Impacts	Potential Habitat loss for Olive Ridley Turtles	
Physical and Cultural Resources	Historic and Cultural Value Loss	
Community Liaison and Consultation	Important measures to reduce community risk.	
Grievance Redressal Mechanism	For workers and project affected people	4.
Monitoring	ESHS compliance of all abovementioned aspects Pollutants monitoring in line with Environmental Monitoring Plan in PCC	

The Contractor shall adopt the following colour code scheme across all CMRL Sites to ensure efficient recognition of relevant personnel

Safety Helmet Colour with Logo	Designation
White	CMRL Staff and Engineer
Violet	Contractor's Engineers & Supervisors
Blue	Sub-Contractor's Engineers & Supervisors
Red	All Electricians
Green	All ESHS personnel

Orange	Security Guards & Traffic Marshals
Yellow	General Workforce
White (With VISITOR Sticker)	Visitors

4.4.6.4.7 The PPE and safety appliances provided by the contractor shall be of the standard as prescribed by Bureau of Indian Standards (BIS). The contractor shall obtain prior approval by the Employer /Engineer Employer before procurement of PPE and safety appliances.

4.4.6.4.8 The contractor shall at all-time maintain a minimum of 10% spare PPE and safety appliance stock. Stocks are to be recorded and made available for the Employer /Engineer upon request. Failing to do so shall invite appropriate penalty as per the provisions of the contract.

4.4.7 Emergency preparedness and response

4.4.7.1 Emergency Response Plan

4.4.7.1.1 The Contractor shall prepare a project specific Emergency Plan and submit to the Employer /Engineer for notice of no objection. The Emergency Plan shall be submitted within 4 weeks of contract Commencement.

4.4.7.1.2 The plan must identify the potential for emergencies and the provisions for responding to such emergencies, particular to their environment and location. The Emergency planning arrangements shall be assessed as per the provisions in H&S Manual, Volume 2 Environmental Management Arrangements of Volume 3 and EMP in PCC for suitability.

4.4.7.1.3 The Contractor shall ensure that all persons including sub-Contractors on site are aware of the emergency procedure to follow in the event of an emergency. Awareness training shall commence at induction and thereafter through refresher training such as toolbox talks and monthly emergency drills. Records of refresher training and emergency drills shall be maintained.

4.4.7.1.4 Site signage shall be erected and detail the emergency process to follow and include emergency telephone numbers, fire, ambulance, police, nearest hospital etc.

4.4.7.1.5 Arrangements shall be made by the Contractor for casualty evacuation and emergency medical treatment. The Contractor shall enter into an agreement with a hospital to provide ambulance services. Alternatively, the Contractor shall provide a fully equipped ambulance on-site that shall be manned by a paramedic. This provision shall be subject to the Employer /Engineer audit.

4.5. Checking

4.5.1 Performance measurement and monitoring

4.5.1.1 The Contractor shall submit a Monthly ESHS Progress Report no later than 7th of each month to the Employer /Engineer . The Monthly ESHS Progress Report template to be prepared by Contractor for CMRL to clear 28 days prior to construction commencement. The Report shall contain the minimum information specified within H&S Manual Volume 2, Environmental Management Arrangements of Volume 3 and EMP in PCC. The report shall contain text, tables and colour photographs.

- 4.5.1.2 Site Inspection
- 4.5.1.3 Independent of the plant and equipment inspection, testing and maintenance regimes that shall be stated within the Contractor's Plant and Equipment Procedures, the Contractor shall carry out site monitoring exercises on a daily and weekly basis.
- 4.5.1.4 The Contractor shall ensure that all monitoring equipment is calibrated as per the manufactures requirements. The Employer /Engineer shall be provided with test certificates for such equipment
- 4.5.1.5 Site Engineers shall be required to participate in daily internal ESHS inspections to facilitate prompt communication and rectification of minor deviations. Records of such inspections and rectification needs shall be maintained at site level and made available for review by the Employer /Engineer other interested parties.
- 4.5.1.6 No loose electrical connections or tapped joints shall be allowed any where in the work site, office area, stores and other areas. Penalty as per relevant clause shall be put in case of observation of any tapped joints.
- 4.5.1.7 Formal site inspection reports shall be produced on a weekly basis by the Contractor's ESHS personnel for each site and submitted to the Project Director or project manager and copied to the Contractor's corporate safety manager. The corporate Safety Manager shall conduct site inspection on monthly basis and report shall be submitted to the Employer /Engineer.
- 4.5.1.8 The Contractor may choose inspection format of his/her choice, however format shall contain the minimum information as provided within FSAF-028 –H&S Manual Volume 2 regarding weekly inspection form by providing concise information and highlight the key non-compliance inspection findings on the very first page.
- 4.5.1.9 The Contractor's ESHS Personnel shall be accompanied during a formal site inspection by the Site Manager responsible for the particular site. The resulting inspection report shall be signed by both the Site Manager and the ESHS Manager.
- 4.5.1.10 The Engineer shall formally inspect and report the Contractor's site conditions against the compliance criteria set within the Contractor's operational procedures and the Engineer's requirements on a weekly basis. These inspections shall include batching plant and associated yards.
- 4.5.1.11 The Contractor shall undertake specific inspections at the Employer/Employer's Representative's request where concerns have been raised regarding the suitability of control measures and or plant or equipment condition as per the IS 13367-1 (1992), IS 4475-1(1997), ISO 12482-1:1995. The special assessment shall be carried out later than the following number of years after manufacture for:
- Tower cranes, loader cranes, mobile cranes: 10 years;
 - All other cranes: 20 years. Such inspections shall be carried out with immediate effect.
- 4.5.1.12 The Profile of the External Inspection agency, ISO certifications, the name, educational qualifications and experience in the field of testing and the certificate issued by Govt of Tamil Nadu for testing are to be submitted to the Employer/Engineer a minimum 28 days before prior to appointment of the agency. Only upon notice of no objection by the Employer /Engineer shall be authorised to deliver ESHS services on CMRL sites.
- 4.5.1.13 The First Generation Hydra crane shall not be strictly used in the CMRL projects.

- 4.5.1.14 The Second Generation Hydra crane shall not be used for any lifting and lowering operation. Second Generation Hydra can be used for the material handling as per the manufacture manual.
- 4.5.1.15 The Piling rig shall not be used as lifting equipment.
- 4.5.1.16 Water logging or bentonite spillage on roads shall not be allowed. If bentonite spillage is observed on road endangering the safety of road users, the contractor shall be penalised as per Table -6.
- 4.5.1.17 The contractor shall submit an electrical single line diagram, schematic diagram and the details of the equipment for all temporary electrical installation. These diagrams together with the temporary electrical equipment shall be submitted to the Employer /Engineer for necessary approval. Failure to do so shall invite penalty as per relevant clause
- 4.5.1.18 CCTV shall be installed in Administrative areas, Construction areas (general indoor, general outdoor and general underground work areas, mucking and scaling), Maintenance / Operating areas, Mechanical/electrical equipment rooms, Warehouses and storage rooms/area, Casting yard, Labour Colony, Health Centres and First aid stations and infirmaries, Parking areas, Visitor areas and Laboratories. The contractor shall submit the CCTV installation and monitoring plan to Employer /Engineer.
- 4.5.1.19 Request for inspection form all High risk activity shall be verified by the Chief ESHS Manager before submitting to the Employer.
- 4.5.1.20 Failure to do any of the above shall attract penalty from the Employer /Engineer as per relevant clause.
- 4.5.2 Evaluation of compliance**
- 4.5.2.1 The information submitted by the Contractor within the ESHS Monthly Progress Report together with the Engineers Reports shall be evaluated against the Employer's compliance requirements and ESHS objectives.
- 4.5.2.2 Inspection reports shall be evaluated against the Legal Requirements (4.3.2) to which the Contractor is bound to comply.
- 4.5.2.3 The Contractor's ESHS Committee shall formally evaluate reports and results of accidents and or injury on a monthly basis during the monthly meeting. The results of this evaluation such as identified changes to safe systems of working' shall be included with the Committee minutes
- 4.5.2.4 The Engineer shall evaluate 'Accident Injury Rates' and 'Frequency Rates' per individual Contractor and as a project to determine performance against the international rates. The international rates used to benchmark performance shall be promulgated to all Contractor's and other interested parties.
- 4.5.2.5 The ESHS monthly progress report shall be a part of Project Monthly Progress Report produced by the Engineer. Evaluation results shall be included within the relevant sections for Health Safety & the Environment.
- 4.5.2.6 The Contractor's External ESHS Audits (4.5.5) shall be evaluated by the Employer /Engineer against the internal Standards ISO 45001:2018 and ISO 14001:2015.
- 4.5.3 Incident investigation, nonconformity, corrective action and preventive action**
- 4.5.3.1 Incident investigation**
- 4.5.3.1.1 The Contractor shall undertake accident investigation for all fatal accidents, major injuries and dangerous occurrences as defined within the Employer's Project H&S Manual VOL 2.

- 4.5.3.1.2 In the event of a fatality, major injury or dangerous occurrence, the Contractor shall not disturb the accident scene or remove equipment beyond that required to make the area safe and/or for the treatment and/or removal of casualty(s) to hospital.
- 4.5.3.1.3 Should the Employer /Engineer find an accident scene disturbed beyond that reasonably expected with making an area safe, this shall be subject to thorough investigation by the Employer /Engineer .
- 4.5.3.1.4 The Employer /Engineer shall be informed immediately via Short Message Service or Email of all fatalities, major injuries or dangerous occurrences. Any delay in reporting to the Employer /Engineer may be subject to disciplinary action as per Table 6.
- 4.5.3.1.5 The Contractor is responsible to report accidents, incidents and dangerous occurrences to the relevant governing bodies as per their statutory obligations. The Contractor shall maintain responsibility for ensuring sub-Contractor's under their direct control also comply with this requirement.
- 4.5.3.1.6 A preliminary accident notification report shall be issued to the Employer /Engineer for all fatal and major injuries and or dangerous occurrences within 24 hours as per H&S Manual Volume 2. This shall be followed by the detailed investigation report shall be issued to the Employer /Engineer within 72 hours.
- 4.5.3.1.7 Any wilful delay in verbal or written reporting to the Employer /Engineer shall be penalised as per relevant clause.
- 4.5.3.1.8 Near misses and minor accidents should also be investigated by the Contractor and documented with time-bound corrective/preventive actions taken as soon as possible as they are signals that there are inadequacies in the safety management system.
- 4.5.3.1.9 In case of fatal accidents, major injuries or dangerous occurrences the Employer /Engineer shall conduct an independent investigation. The Contractor and his staff shall extend the necessary co-operation.
- 4.5.3.1.10 All persons summoned by the Employer /Engineer in connection to witnesses and statement recording shall obey the instructions without delay. Any wilful suppression of information by any person shall be removed from the site immediately and / or punishable as per relevant penalty clause
- 4.5.3.2 Nonconformity, corrective action and preventive action**
- 4.5.3.2.1 The Contractor shall conform to their internal procedures regarding nonconformity, corrective action and preventive action. The Contractor shall be audited by the Employer /Engineer for compliance with internal procedures.
- 4.5.3.2.2 Major and Minor non-conformances shall be raised by the Employer /Engineer as per the Employer's Quality Management requirements and the ESHS Audit criteria as defined within H&S Manual Volume 2, Volume 3 Environment management arrangement and EMP in PCC.
- 4.5.3.2.3 Open non-conformances shall be reflected in the Contractor's Monthly Audit Report and are subject to verification by the Employer /Engineer as detailed in ESHS Volume 2. Failure to successfully take corrective action and close out non-conformances will impact negatively on the Contractor's total quarterly audit score.
- 4.5.3.2.4 Where non-conformances have been raised by an External Auditor against the ISO 45001:2018 or ISO 14001 Standard, the Contractor shall produce and submit for review

within 2 weeks, an action plan of how and within what timescale shall the non-conformance(s) be closed-out.

4.5.3.2.5 Where the corrective action and preventive action identifies new or changed hazards or the need for new or changed controls, the proposed actions shall be taken through the risk assessment process. The associated method statement and risk assessment shall be amended and re-submitted to the Employer /Engineer for notice of no objection.

4.5.3.2.6 A change in work methodology shall be communicated to the workforce. Evidence of such communications shall be made available for inspection by the Employer /Engineer . The Employer /Engineer shall also make random enquiries at site level to establish workforce awareness.

4.5.3.2.7 The following table indicates the risk rating for the non-compliance of the requirements (unsafe acts/unsafe conditions).

Risk	Topic	Deductible amount
High	<p>Hazardous waste management, Explosive Handling and Blasting , Plant & Machinery (Examination certificate of Gantry crane, rope suspended powered platform, tractor mounted drilling rig ,No legal documents, Erection/lifting mast, wire rope/web sling/dog clamp/chain pulley, rope pulley , air compressor, Electrical trolley OTE duct installation) Equipment (Guarding arrangements), Excavations(Shoring, edge, material stored on the edge of the excavation protection) ,</p> <p>Work at Height(Edge protection, fall protection measures , Ladder , life line , working platform, safe access/egress, double layer net, provision of safety net, leading edge protection) ,</p> <p>Floor Opening , Emergency preparedness and response, emergency rescue basket ,emergency stop system in conveyors, Locomotive movement Quality of compressed air in working chamber, hyperbaric, Emergency Equipment, vibration, radiation, fire and smoke ,compressed air works, pressure vessels,) ,</p> <p>Public Interface, Traffic Management (Work area perimeter hoardings, public protection from site operations, Height barrier, Storage of material in public area, Vehicular Traffic),</p> <p>Lifting operations, Demolition, False</p>	<p>Any specific high risk activity non-conformance (unsafe act/unsafe condition) shall be immediately complied by taking corrective action by as low as reasonably practicable and specific high risk activity non-conformance work shall be suspended until the corrective actioned.</p>

Risk	Topic	Deductible amount
	<p>Work/Form Work, Piling, Work adjacent to live railways, Over Head Protection, Site Transport, HT Line, Material Falling Hazards, Building demolition,</p> <p>Diesel storage licence (statutory documents),</p> <p>Tandem Lifting, High risk activity method statement approval and implementation, lift Plan for high risk activity, harmful substances, Incident reporting and investigation. work adjacent to live railways, work adjacent to live roadways, launching operation, barricade / cover to voids, trench, bored holes and open edges of structure, site security.</p>	
Medium	<p>Working at height (Harness, guard rails and toe board),</p> <p>Welfare (Drainage arrangements, Rest Room, Toilet, washing Facilities, bathing facility, canteen. eating area ,fan, and light at rest room, cooking facility ,drinking water) ,</p> <p>Medical Facilities, Site Tidiness, Fire precautions(Labour camp) , PPE,</p> <p>House Keeping(Poor housekeeping ,</p> <p>Poor storage of material ,</p> <p>Muck disposal, poor stacking, slush not disposed, waste debris not removed , water logging , water stagnation) ,</p> <p>Gases , Fumes Etc. ,</p> <p>Training /Induction , Reporting of accidents and investigation , Sleeping at workplace , Electrical (Trailing cable-Trip Hazard Poor distribution board),Slippery Floor, Denailing, reporting of accident ,corrective and preventive action, Traffic management (Pedestrian walkway, barrier lighting),Highway cleanness, provision of silence equipment's , Power tool and condition of equipment's ,Plant , equipment and machinery (Back hoe loader , tyre condition, driving licence, material hoist opening concrete bucket, insurance certificate , safety sensor , ASLI, anemometer , safety devices, banksman ASLI calibration, dumpers),Access and egress, Disposal of waste, debris ,Fire(arc welding, gas cutting set ,hot work ,First aid facility, wheel washing facility, Mandatory contractor ESHS management</p>	Rs 10,000/-per specific activity NCR

Risk	Topic	Deductible amount
	resource, medical examination, Monthly audit report, Drilling machine, power tools , Manual Lifting and Carrying of excessive weight, Dangerous and harmful environment, Corrosive Substances, smoking , mobile phones ,radio's and audio equipment.	
Low	Specific activity standard operating procedure , Working at height (Scaffolding inspection, competent person, , Notice Display, COSHH , health Risk ,ESHS Register's , ESHS Documentation , Noise , Waste , Site ESHS Committees , Mobile phones , Radio , Audio Equipment , Dust and CCTV, Signage's(Emergency Exit, Warning , cautionary and information),Safety induction, Specific activity safe work procedure ,risk assessment ,RASI permit ,public liaison signage, IRC Signage's, PPE Examination certification, provision of skips and maintenance, ISO certification audit, competency training ,control of dust ,control of noise, COSHH, Display of ESHS policy and poster , CEIG Approval Site illumination ,permits system, Ambulance, External ESHS Training as per the Training Implementation plan , Quarterly External ESHS audit, first aid resources, ID card and First Day at Work, H&S Training, Labour licence, BOCW registration, contract labour licence, legal register, Name board display in crane boom, ESHS Hand book ,personal protective equipment ,Vehicle operator check, Inspection of Plant , Equipment and machinery by the contractor plant manager, Eye Wash Station, visitor (ID Card ,lock attendance register, medical records), H&S Submittal to the Employer, Monthly H&S Report.	Rs 5000/-per specific activity NCR

4.5.3.2.8 Non conformity compliance will be reviewed on periodical monthly basis and penalty clause imposing in the tender for Non-compliance of NCR for a) Medium Risk and b) Low risk as per below Table-5

Table-5

S.No	Risk	Days from the notice of the event within which the work should have are commenced duly mitigating the risk	Deductible amount
A	Medium	i)The contractor complied the specific activity NCR (unsafe act/unsafe condition) ≤24hours. ii) The contractor complied the specific activity NCR (unsafe	Fore item i) No deduction ii)Closure of the specific activity NCR Rs 7500/- per will be refunded and

S.No	Risk	Days from the notice of the event within which the work should have are commenced duly mitigating the risk	Deductible amount
		act/unsafe condition) more than 24hours ≤ 7days iii) The contractor failure to comply the specific activity NCR (unsafe act/unsafe condition) within the stipulated time period of 7days	Rs 2500/- will be a permanent deduction for each specific NCR. iii)Rs10,000 will be a permanent deduction for each specific NCR.
B	Low	i)The contractor complied the specific activity NCR (unsafe act/unsafe condition) ≤24hours. ii) The contractor complied the specific activity NCR (unsafe act/unsafe condition) more than 24hours ≤ 7days iii) The contractor failure to comply the specific activity NCR (unsafe act/unsafe condition) within the stipulated time period of 7days	Fore item i) No deduction iii) Closure of the specific activity NCR Rs 4000/- per will be refunded and Rs 1000/- will be a permanent deduction for each specific NCR. iii)Rs 5000 will be a permanent deduction for each specific NCR.

- 4.5.3.2.9 The High Risk Non –compliance (Unsafe act/Unsafe condition) shall be suspended the specific work activity immediately. The Contractor shall not proceed with the work until remedial works have been complied with under the direction and satisfaction of the Employer/Engineer. Request for inspection with the evidence of compliance shall be submitted to the Employer/ Engineer for the verification
- 4.5.3.2.10 The Contractor shall not be entitled to any damages or compensation for stoppage of work, due to safety reasons. The period of such stoppages of work shall not be taken as an extension of time for completion of the facilities and will not be the ground for waiver of levy of liquidated damages.
- 4.5.3.2.11 Any non-conformance of unsafe act should be treated as disciplinary action towards the person and department in charge and as well as recommended for tacking refreshment training on the specific task.
- 4.5.3.2.12 Closure of Non - conformance will be verified by the submission of photograph evidence or physical verification on satisfaction of the Employer/Engineer.

4.5.4 Control of records

- 4.5.4.1 The Contractor shall maintain all ESHS records in accordance with the Contactors ISO 9001 :2015 Quality Management System.
- 4.5.4.2 Records shall be made available to the Employer /Engineer upon request for the purpose of incident investigation and management review.

4.5.5 Audit

4.5.5.1 Monthly Audit Report (MAR)

- 4.5.5.1.1 The Contractor shall undertake an internal monthly audit using the process and audit report form (MAR) as prescribed within “FSAF-11 Monthly Audit Score Sheet” of H&S Manual Volume 2.
- 4.5.5.1.2 The Contractor shall submit the completed audit report no later than the 7th of each month within the Contractor’s monthly ESHS Report. Failure to submit the monthly audit report within the stipulated timescale shall result in the Employer / Engineer awarding a ‘Zero’ score for the month.
- 4.5.5.1.3 The audit scores awarded internally by the Contractor shall be subject to review and verification by the Employer / Engineer . The Employer / Engineer shall substantiate the awarded scores through making comparison with the results of a physical site inspection against the model audit scores criteria as provided within H&S Manual Volume 2.
- 4.5.5.1.4 The Employer / Engineer shall formally verify that the Contractor’s self-awarded scores comply with the audit scoring system and scoring criteria as defined within H&S Manual Volume 2. Where discrepancy exists the Employer / Engineer shall provide supporting evidence (Photographic) and instruct the Contractor to amend the initial awarded score. Following adjustment, the monthly audit report shall be re-submitted to the Employer / Engineer within 3 days.
- 4.5.5.1.5 The Contractor shall be required to achieve a minimum 65% overall audit score on a monthly basis .
- 4.5.5.1.6 If non-payment of the lump sum item in preliminaries occurs as a result of failing to achieve the required 65% over a single quarterly reporting period, the Employer/Engineer may reinstate the lump sum item at his discretion should the contractor achieve above 65% for the following six (6) consecutive monthly ESHS audits equating to two (2) quarterly reporting periods. This repayment shall not occur if the quarterly aggregate of Monthly audit scores is less than 50%.
- 4.5.5.1.7 In the event the Contractor fails to achieve a minimum of 65% on a monthly audit, an action plan shall be submitted together with the audit results detailing the actions that shall be taken within timescales.
- 4.5.5.1.8 Monthly audits as part of the monthly ESHS monitoring shall be conducted prior to the sitting of the Contractor’s ESHS Committee and shall form part of the agenda.
- 4.5.5.1.9 Contractor Recognizing
- 4.5.5.1.10 The Employer/Engineer’s shall recognize the effort if the contractor achieves above 75% for the following three (3) consecutive monthly ESHS audits of one quarterly reporting periods. Only for the preceding three (3) months deducted amount of ESHS NCR will be refunded.

4.5.5.2 External ESHS Audit

- 4.5.5.2.1 The Profile of the External ESHS Audit agency, the name, educational qualifications and experience for of the auditors are to be submitted to the Employer/Engineer a minimum 28 days before prior to appointment of the agency. Only upon notice of no objection by the Employer /Engineer shall be authorised to conduct audit on CMRL sites.
- 4.5.5.2.2 The External ESHS Audit template shall be submitted to the to the Employer/Engineer in the format prescribed (FSAF 31-Volume 2 of H& S Manual) a minimum 28 days before prior

to conducting of the audit. Only upon notice of no objection by the Employer /Engineer shall be authorised to conduct audit on CMRL sites.

- 4.5.5.2.3 The Contractor is required to conduct external audits by ISO accredited 3rd party agency as per the Indian Standards, ISO 45001 :2018 & ISO 14001:2015 international standards on a quarterly basis throughout the Contract period.
- 4.5.5.2.4 External audit and follow up audit reports shall be submitted to the Employer /Engineer for review within 7 days of audit completion.
- 4.5.5.2.5 Should the Contractor fail to undertake external audits within the 3-month period the Employer /Engineer shall appoint an ISO accredited 3rd party agency to conduct the audit at the Contractor's cost.
- 4.5.5.2.6 Where 'Major' non-conformances with international standards are identified, a follow-up external audit shall be carried out within 28 days for closing out of the non-conformance(s). Follow-up audits shall continue on a 28-day rotation until such time as Major non-conformances are closed to the satisfaction of the 3rd Party ISO accredited auditor.
- 4.5.5.2.7 In case of non-conformity of items identified by auditor, the Employer /Engineer shall take necessary steps including stoppage of work and or imposing of any penalty to ensure satisfactory execution.

4.6. Management review

- 4.6.1 Management Reviews shall be undertaken annually by the Employer /Engineer in compliance with ISO 9001:2015.
- 4.6.2 The template for management review report shall be submitted a prior for approval of CMRL. The Management Review Report shall make recommendations for improvement.
- 4.6.3 The Contractor shall carry out a formal Management Review on an annual basis as a minimum. The Management Review may form part of the review under the organisations Quality Management System.
- 4.6.4 The Contractor shall submit Management Review Report to the Employer /Engineer within 7 days after meeting completion together with the organisations new objectives.

4.7. External ESHS Agency

- 4.7.1 The Contractor's External ESHS Agency thereon, who in the opinion of the Employer /Engineer, incompetent or negligent or fails to conform with any particular provisions with regard to ESHS or the requirement of the contract or legal requirement, or persists in any conduct which is prejudicial to ESHS , shall be removed from site immediately, and such external ESHS agency shall not be employed again upon the Works. The decision of the Engineer in this regard shall be final.

4.8. Penalty

- 4.8.1 CMRL has built an image of safety conscious organisation meticulously over a period of nine years. Any reportable accident (fatality / injury) results in loss of life and/or property damage. These accidents not only result in loss of life but also damage the reputation of CMRL. Most of the accidents are avoidable and caused preliminary due to contractors' negligence. Hence CMRL shall recover the cost of damages from the contractors for every reportable incident (fatality / injury).
- 4.8.2 In addition every CMRL work site is exposed to public scrutiny as the work is executed just on the right-of-way. Any unsafe act / unsafe condition observed by public further damages our reputation. Because of the non-voluntary compliance of contractors to the Employer's ESHS requirements or Employer's direct instructions and project H&S manual, CMRL has

been forced to establish safety-enforcing organisation. The cost of established such organisation is to be recovered from contractors for all observed safety violations at sites.

4.8.3 The following table-6 indicates the Health, Safety and Environment violation (unsafe act / unsafe condition) and charges to be recovered from contractors.

Table-6

SI No	TOPIC	UNSAFE ACT/UNSAFE CONDITION	DEDUCTIBLE AMOUNT *
1	ESHS Policy & Plan	i) ESHS policy a) Non-compliance of CMRL ESHS Contract requirement b) Inadequate coverage, not signed c) Not displayed it at conspicuous places at work sites in Hindi and a local language understood by the majority of construction workers ii) ESHS plan: a) Not as per Employers' content and coverage b) Not submitted to the ER within 28days of commencement of work c) Not updated as per CMRL ESHS Contract requirement d) Copies not provided to all required supervisors / engineers e) Not implemented to a satisfactory and not recorded a monthly review of the construction ESHS plan f) Non submission of Utility shifting Plan. g) Non submission of any other work plans required in the EMP of PCC. h) Non submission of construction Camp Layout plan	For item i) and item ii) Rs. 1,000 per single violation, compounded to a maximum of Rs. 5,000 at any single instance.
2	ESHS Organisation	i) Not complying to the minimum manpower requirements as per CMRL ESHS Contract requirement ii) Not filling up the vacancies created due to ESHS personnel leaving the contractor within 30 days. iii) ESHS organisation not provided with required Audio-visual and other equipment's CMRL ESHS Contract requirement iv) Employing through outsourcing agencies and ESHS personal are not in the payroll of the main contractor v) Disobedience / Improper conduct of any ESHS personnel. vi) Chief ESHS Manager not reporting directly to PM of contractor. vii) Non-compliance of any rule of schedule VI of BOCWR within one month of commencement of work	For item i) and ii) Rs. 50,000 per month for first month and Rs.1,00,000 for subsequent months For items iii), iv), v), vi) and vii) Rs. 50,000 for first violation and Rs.1,00,000 for subsequent violations

SI No	TOPIC	UNSAFE ACT/UNSAFE CONDITION	DEDUCTIBLE AMOUNT *
3	ESHS committee	i) Failed to formulate or conduct ESHS Committee meeting for any month ii) Contractor and Sub-contractor representatives not attending ESHS Committee meetings iii) Failed to conduct Site inspection and send monthly monitoring reports including the inspection form before conducting ESHS Committee meeting iv) Failed to send ESHS Committee Meeting minutes or Agenda to Employer /Engineer in time v) A minimum period of 21 days not maintained between any two ESHS monthly committee meetings vi) Failed to formulate equal participants of management and non-management staff for ESHS committee meeting as per BOCWR	For item i) to vi) Rs. 1,000 for the first violation and Rs. 5,000 for the subsequent violations.
4	ID card	i) ID Card not provided to all staff and workers ii) Contractor not issued a personnel ESHS handbook to all staff and workers, which provides information on ESHS and emergency procedures that all personnel working on contract are required to know and the need to follow and ensured that this is distributed and its content introduced to all the personnel working at sites. iii) The contractor not ensure that all personnel working at the site receive an Induction ESHS training the nature of the work, the hazards that may be encountered during the site work and the particular hazards attached to their own function within the operation iv) All personnel no issued a photo identity of size 85mm x 55mm duly signed by the authorized representative of the contractor before they are engaged for any work	For item i) to iv) Rs. 1,000 for the first violation and Rs. 5,000 for the subsequent violations.
		Not complying to the requirements as mentioned in CMRL ESHS Contract requirement and Employer OHS manual with regard to: a) Induction training not given b) Supervisor/engineer/manager training not conducted CMRL ESHS Contract requirement c) Refresh ESHS training CMRL ESHS Contract requirement d) Tool-box talk not conducted e) Skill development training not conducted f) Daily Safety Oath not conducted	For item a) to j) Rs.5,000 for first violation on and Rs.10,000 for subsequent violations

SI No	TOPIC	UNSAFE ACT/UNSAFE CONDITION	DEDUCTIBLE AMOUNT *
5	ESHS Training	<p>g) Top management behaviour based ESHS training conducted</p> <p>h) Not submitted a Training implementation plan to be cleared by Employer</p> <p>i) Not able to produce adequate records as per the approved Training implementation plan</p> <p>j) Not able to conduct training on construction safety plan, operational and systems procedures with record of durations.</p>	
6	ESHS Inspection	<p>ESHS inspection</p> <p>a) Not complying to the requirements as mentioned in CMRL ESHS Contract requirement and Employer ESHS manual</p> <p>b) All inspection records and reports not properly kept and filed for audit purpose, inspection reports of Planned General Inspection and Routine Inspection not used for discussion during Safety Committee Meetings with MOM.</p> <p>c) Not conducted independent of the plant and equipment inspection, testing and maintenance, that has been stated in the Contractor's Plant and Equipment Procedures with records.</p> <p>d) Not calibrated any of the monitoring equipment's as per the manufacturing requirements</p> <p>e) Not conducting internal ESHS inspections.</p> <p>f) Site Engineers(contractors) not participating in internal ESHS inspections.</p> <p>g) Not submitting the Formal site inspection report for each site on weekly basis to Project director</p> <p>h) Formal site inspection report not to be signed by both the Site Manager and the ESHS officer</p>	For item a) to h) Rs.5,000 for first violation on and Rs.10,000 for subsequent violations
7	ESHS audit	<p>Internal Audit: MARS and Electrical Safety</p> <p>i) Not conducted as per ESHS Plan</p> <p>ii) Report not sent to Employer</p> <p>iii) Action not taken for any month</p> <p>iv) Fail to conduct MARS before the monthly ESHS meeting to form a part of agenda</p> <p>External H&S Audit</p> <p>v) Not conducted as per ESHS plan</p> <p>vi) Report not sent to Employer</p> <p>vii) Action not taken for quarter month</p> <p>viii) Fail to conduct external third-party audit as per BOCW Rule</p> <p>ix) Fail to conduct ISO certification audit for the scope of the CMRL project</p>	<p>For item i) to viii)</p> <p>Rs. 25,000 for first violation and Rs. 50,000 for subsequent violations.</p> <p>For item ix) Rs 3,00,000 for first violation and Rs.6,00,000 for subsequent violations.</p>

SI No	TOPIC	UNSAFE ACT/UNSAFE CONDITION	DEDUCTIBLE AMOUNT *
8	ESHS Communication	<p>i) Important days to be observed for ESHS awareness as furnished by Employer / Engineer not observed</p> <p>ii) Posters as furnished by Employer / Engineer not printed and displayed</p> <p>iii) Contractor failed to produce a 'High Quality' quarterly newsletter</p> <p>iv) Contractor failed to change signage and posters on a monthly basis to bring pertinent awareness</p> <p>v) Poster campaigns not discussed at the Engineer's Committee meeting and not recorded with improvement program</p> <p>vi) Informational posters, banners are not provided both in Tamil/Hindi and English</p> <p>vii) Records of all toolbox talks undertaken together with the date, topic, participant's names and signatures are not mentioned on daily basis</p> <p>viii) Not maintaining the records of briefings/communications of Method statement and risk assessment before commencement of a new task or when a change to the method of working arises</p> <p>ix) Public informational signage and Contractor contract information not posted externally to the site including all legal communication</p> <p>x) Non-function Grievance Redress Mechanism and no documentation of Grievance log</p>	For item i) to ix)Rs. 1,000 per single violation, compounded to a maximum of Rs. 5,000 at any single instance.
09	ESHS Submittals (Hazard identification, risk assessment and	<p>The contractor failure to submit the following submittals to the ER a minimum 28days prior of task commencement</p> <p>A.REPORTS:</p> <p>i) Risk Register & Hazard Log</p> <p>ii)Grievance Log</p> <p>iii) Operational Control Procedure not submitted</p> <p>iv)ESHS Monthly Report</p> <p>v)ESHS Inspection Report</p> <p>vi) Electrical safety audit</p> <p>vii)Daily reporting of total no of workmen</p> <p>viii)ESHS Audit reports</p> <p>ix)Monthly Audit Score (MARS) report</p> <p>x)Air and Noise Quality monitoring report</p> <p>xi) Specific Method statement</p> <p>xii)Changes in organizational, personnel, systems, procedures, equipment, products, materials, or substance not communicated by the Contractor</p> <p>B.PLANS:</p> <p>i) Specific Lift plan</p>	For item i) to xix)Rs. 1,000 per single violation, compounded to a maximum of Rs. 5,000 at any single instance.

SI No	TOPIC	UNSAFE ACT/UNSAFE CONDITION	DEDUCTIBLE AMOUNT *
	determining controls)	<ul style="list-style-type: none"> ii) ESHS Management System Procedure iii) Emergency Preparedness and Response plan iv) Traffic Management Plan v) Fire Plan vi) Health Plan vii) Onsite traffic Management plan 	
10	Injury and Incidence Reporting	<p>Injury and Incidence reporting</p> <ul style="list-style-type: none"> i) Fatal accidents or major injuries and dangerous occurrences not reported immediately to Employer ii) Injury accident iii) Abnormal delay in reporting accidents or wilful suppression of information about any accidents / dangerous occurrence iv) Delay in informing about any accidents / dangerous incidents. v) Not submitted a preliminary accident notification within 24 hours vi) Not submitted accident investigated report within 72 hours vii) Employers' independent incident investigation <ul style="list-style-type: none"> a) Contractor and his staff not extend necessary co-operation and do not testify about the accident. b) The contractor not take effort to preserve the scene of accident till the Employer / Engineer complete the investigation. c) All persons summoned by the Employer / Engineer in connection to witness recording not obey the instructions 	<p>For item i) Rs. 1,00,00,000(One Crore) for each fatality</p> <p>For item ii) Rs 20,00,000(Twenty lakhs) for each injury accident(Grievous Injury as defined by Workmen Compensation Act)</p> <p>For item iii) iv) and v) Rs 5,00,000(Five Lakhs) for each violations</p> <p>For items vi) and vii)</p> <p>Rs.50,000 for first violation and Rs.1,00,000 for subsequent violations</p>
		<ul style="list-style-type: none"> i) Emergency plan not cleared by Employer within 28 days of construction commencement i) The contractor not prepared an Emergency Response Plan for all the work sites as a part of the contractor ESHS Plan ii) The contractor not ensured that an Emergency Response Plan is prepared to deal with emergencies arising out of <ul style="list-style-type: none"> a) Fire and explosion b) Collapse of lifting applications and transport equipment c) Collapse of buildings, or structures etc d) Gas leakages or spillage of dangerous goods or chemicals e) Bomb threatening, Criminal or Terrorist attack f) Drowning of workers g) Landslides getting workers buried floods, Earthquake, storms and other natural calamities 	<p>For item i) to xiii)Rs.5,000 for first violation on and Rs.10,000 for subsequent violations</p>

SI No	TOPIC	UNSAFE ACT/UNSAFE CONDITION	DEDUCTIBLE AMOUNT *
11	Emergency preparedness Plan	<p>iii) Arrangements not made for emergency medical treatment and evacuation of the victim in the event of an accident or dangerous incident occurring, the chain of command and the responsible persons of the contractor with their telephone numbers and addresses for quick communication not adequately publicized and conspicuously displayed in the workplace</p> <p>iv) Contractor not tied-up with the hospitals and fire stations located in the neighbourhood for attending the casualties promptly and emergency vehicle kept on standby duty during the working hours for the purpose</p> <p>v) contractor not conducted onsite emergency mock drill once in every month for all his workers and his subcontractor's workers</p> <p>vi) Contractor not keep the Local Law & Order Authorities informed along with communication to ER, CMRL to mitigate the consequences of an emergency</p> <p>vii) Not submitting the project specific Emergency Plan within 4 weeks of Commencement of contract</p> <p>viii) Not provide training with records for emergency preparedness and response procedures on monthly basis with records</p> <p>ix) Not conducted the mock drilled Emergency preparedness and response procedures on monthly basis with records</p> <p>x) Not erected hording for Emergency Process flow charts on conspicuous places</p> <p>xi) Not erected hording for emergency telephone numbers like fire, ambulance, police, nearest hospital and any other legal relevant</p> <p>xii) The contractor not provided a fully equipped ambulance on-site as per legal requirement</p> <p>xiii) The ambulance van not maned by adequate number of paramedics</p>	
		<p>i) Housekeeping maintenance register not properly maintained up to date</p> <p>ii) Surrounding areas of drinking water tanks/taps not hygienically cleaned/maintained</p> <p>iii) Office, stores, toilet / urinals not properly cleaned and maintained.</p> <p>iv) Required dustbins at appropriate places not provided / not cleaned.</p> <p>v) Stairways, gangways, passageways blocked.</p>	<p>For item i) to xx)</p> <p>Rs. 10,000 per single violation Compounded to a maximum of Rs. 20,000 at any single instance for non-compliance of any of the clauses</p>

SI No	TOPIC	UNSAFE ACT/UNSAFE CONDITION	DEDUCTIBLE AMOUNT *
12	Housekeeping	vi)Lumber with protruding nails left as such vii)Openings unprotected viii)Excavated earth not removed within a reasonable time. ix)Truck carrying excavated earth not covered / tyres not cleaned. x)Vehicles / equipment's parked / placed on roads obstructing free flow of traffic xi) Unused surplus cables / steel scraps lying scattered xii)Wooden scraps, empty wooden cable drums lying scattered xiii)Water stagnation leading to mosquito breeding xiv)Water stagnation leading to mosquito breeding xv)Full height fence, barriers etc not installed at the site to preserve the surrounding area from excavated soil and rubbish xvi)Not maintained Drip pans for oil leakages and splits of suitable size while servicing of plants/equipment/machinery and disposed off generated waste in approved manner. xvii)Proper Housekeeping not carried out at work sites, labour camps, stores and offices with Housekeeping maintenance register xviii)Supervisors and Engineers working at the site not educated and trained on the necessity of good Housekeeping xix)Not treating still water once every week with oil in order to prevent mosquito breeding xx)Posters in both language and English not displayed prominently to draw attention for the dangers of permitting mosquito breeding	
		1)Work at Height/Ladders and Scaffolds i)Not using or anchoring Safety Belt ii)Not using Safety Net iii)Absence of life line or anchorage point to anchor safety belt iv)Using Bamboo ladders v)Painting of ladders vi)Improper usage (less than 1m extension above landing point, not maintaining 1:4 ratio) vii)Aluminium ladders without base rubber bush viii)Usage of broken / weak ladders x)Usage of re-bar welded ladders xi)Improper guardrail, toe board, barriers and other means of collective protection xii)Improper working platform	For item 1) to 7) Rs.10,000 per single violation Compounded to a maximum of Rs.1,00,000 at any single instance for non-compliance of any of the clauses

SI No	TOPIC	UNSAFE ACT/UNSAFE CONDITION	DEDUCTIBLE AMOUNT *
13	Working at Height / Ladders and Scaffolds	<p>xiii) Working at unprotected fragile surface xiv) Working at unprotected edges xv) Worker not passed Vertigo test xvi) Non-skilled worker working at height.</p> <p>2) Contractor not carried out risk assessments for all the work where workers or materials can fall from more than two meters 3) Not provided Edge protection to work above two meters as specified below a) A main Guard rail at least 1 meter above the edge b) A Toe board at least 200 mm high c) An intermediate guard rail or other barrier so that there is no gap more than 470 mm 4) All Scaffolds not inspected by a competent person at least in every three days after erection and not recorded 5) Tags not fitted to all scaffoldings to show they are safe for use or not and all safe for use tags not signed by senior site engineer 6) All scaffolds not constructed of sound materials and not free from patent defect 7) The measures not taken by contractor i) The scaffold not constructed for the correct use (Light or Heavy Duty) ii) Security not fixed to existing structures or adequately buttressed iii) The use of barrels, boxes, loose tiles or other unsuitable material used as supports for working platforms iv) All working platforms not fully boarded and not covered with net to prevent Height Phobia v) All working platforms not provided guard rails at one metre height and not provided an intermediate rail at half height vi) All working platforms not provided with Toe boards vii) All working platforms not kept free of unnecessary obstruction or rubbish viii) Secure ladder access shall be provided ix) Metal ladders used near or adjacent to overhead live power lines x) Non-usage of full body harness at safe working platform with secure anchorage points</p>	
		<p>i) Non-availability of fitness certificate ii) Documents not displayed on the machine or not available with the operator iii) Maximum Safe Working Load not written on the machine iv) Automatic safe load indicator not provided or not in working condition</p>	<p>For item i) to xxviii) Rs.10,000 per single violation Compounded to a</p>

SI No	TOPIC	UNSAFE ACT/UNSAFE CONDITION	DEDUCTIBLE AMOUNT *
14	Lifting appliances and gear	<p>v) Age of the operator less than 21 years or without any licence</p> <p>vi) Failure to submit Lift Plan</p> <p>vii) Person riding on crane.</p> <p>viii) Creating more noise and smoke</p> <p>ix) Absence of portable fire extinguisher in driver cabin</p> <p>x) No fencing of hoist rope movement area</p> <p>xi) Hoist platform not in the horizontal position</p> <p>xiv) Fail to guard hoist platform</p> <p>xv) No fencing of hoist rope movement area</p> <p>xvi) Hoist platform not in the horizontal position</p> <p>xvii) All lifting appliances, including synchronized mobile jacks, pit jacks, mobile cranes, lower cranes, gantry cranes, launching beams and lorry mounted cranes not inspected and not certified by competent person</p> <p>xviii) Competent person not approved by ER/CMRL</p> <p>xix)Lifting capacity of more than one ton not fitted with Automatic Safe Load Indicators, Anemometer and Audible warning devices with no proper records of inspection</p> <p>xx)Lifting appliances not maintained in accordance with manufacturer's instructions and irregular preventative maintenance program with available schedule</p> <p>xxi)All lifting appliances not inspected every six months by a third-party competent person with records</p> <p>xxii)The operators of lifting appliances not conducted daily record of inspections of their respective lifting appliances</p> <p>xxiii)Load slewed over public areas without stopping pedestrians and vehicles</p> <p>xxiv)Working closer to any live overhead power lines without the operation of a strict Permit to Work system being in place</p> <p>xxv)All lifting gear not properly stored and left lying on the ground</p> <p>xxvi)Untrained and unexperienced slingers and riggers deployed to give directions to crane operators</p> <p>xxvii)Untrained and unexperienced person deployed as Crane driver</p> <p>xxviii)While working near isolated overhead power lines, the lifting appliances not grounded to earth as a secondary precaution against accidental energization</p>	maximum of Rs.1,00,000 at any single instance

SI No	TOPIC	UNSAFE ACT/UNSAFE CONDITION	DEDUCTIBLE AMOUNT *
15	Launching operation	Non-adherence of any of the provisions mentioned in Employer's H&S manual Volume 2, (ii) Volume 3 Env mgmt. arrangement and (iii) EMP in PCC	Rs. 50,000 for first violation and Rs.1,00,000 for subsequent violations
16	Site Electrical safety	<p>Site Electrical Safety</p> <p>i)The contractor not deploy qualified and competent C Licence electrical personnel as per law</p> <p>ii)The main contractor not take consideration, the requirements of the sub/petty contractor's electrical power supply and arrive at the capacity of power supply from diesel supply from diesel generators, small capacity diesel generators allowed for whatever type of job to be executed under this contract</p> <p>iii)Unsafe noise making small capacity diesel generators are found used by sub/petty contractors</p> <p>iv)The contractor not submitted electrical single line diagram, schematic diagram and the details of the equipment for all the temporary electrical installation and those diagrams together with the temporary electrical equipment not submitted to the Employer's for necessary approval</p> <p>v)Cables not selected after full consideration of the condition to which exposed and the duties for which they are required. Supply cable up to 3.3 KV not in accordance</p> <p>vi)Damage to</p> <p>1.Civil utilities such as water pipe line, sewer pipeline, storm water pipe line, drainage pipe line and structures etc</p> <p>2.Electrical and telecom utilities such as all types of cable and installation, street lights, poles, and panels, Bus Q shelters, Joints, feeder pillars, cable ducts, junction boxes, transformers, ring main and structures provided for both telecom as well as telecom etc</p> <p>3.Traffic signal cables, CCTV cables and CCTV cameras and poles, LPG/LNG Gas pipelines, petroleum tanks/pipeline, dispensers etc</p> <p>vii)Inserting of wires directly into the sockets</p> <p>viii)Improper grounding for the electrical appliances</p> <p>ix) Electrical cables running on the ground</p> <p>x)The contractor not appointed an Electrical engineer with certificate to comply IE act</p> <p>xi)The name and contact telephone number of the electrical engineer not</p>	<p>For item i) to xviii)</p> <p>Rs.10,000 per single violation Compounded to a maximum of Rs.1,00,000 at any single instance</p>

SI No	TOPIC	UNSAFE ACT/UNSAFE CONDITION	DEDUCTIBLE AMOUNT *
		<p>displayed at the main distribution board for all temporary electrical installations, for approval</p> <p>xii) All electrical work not supervised or executed by qualified and suitably categorized electricians as per the law</p> <p>xiii) All cabling exposes a hazard or obstruction to people and equipment</p> <p>xiv) The installation on site not allow convenient access to authorized and competent operatives to work on the apparatus contained within</p> <p>xv) Voltages not adhered to for typical applications throughout the distribution systems like</p> <p>a) Fixed plant – 415V 3 Phase</p> <p>b) Movable plant fed by trailing cable – 415V</p> <p>c) Installations in Site buildings – 240V 1 Phase</p> <p>d) Fixed flood lightning – 240V 1 Phase</p> <p>e) Portable and hand-held tools – 110V 1 Phase</p> <p>f) Site lightning (other than flood lightning) – 110V 1 Phase; and</p> <p>g) Portable hand lamps (general use) – 110V 1 Phase</p> <p>xvi) Protection not provided for all main and sub-circuits against excess current, residual current, earth faults and short circuits by protective devices</p> <p>xvii) Earthing and bonding not provided for all electrical installations and equipment's to prevent the possibility of dangerous voltage rises cleared by installed circuit protection</p> <p>xviii) Maintenance of control apparatus and wiring distribution systems not carried out by an approved electrician on weekly basis with records</p> <p>xix) All portable electrical appliances not numbered with records of date of issue, date of last inspection carried out</p> <p>xx) Inserting of bare wires into the socket</p> <p>xxi) Improper grounding for the electrical appliances and metallic barricades</p> <p>xxii) Electrical live cables running on the ground as per the IE act</p> <p>xxiii) Not provided ELCB DP</p> <p>xxiv) Not providing adequate earthing as per IE act</p> <p>xxv) Electrical live cable immersed in water</p> <p>xxvi) Not maintain safe distance from HV on LV lines while working as per the law</p> <p>xxvii) Non-usage of rubber mat near HV or LV distribution panels and switches for DG sets and power utility</p>	

SI No	TOPIC	UNSAFE ACT/UNSAFE CONDITION	DEDUCTIBLE AMOUNT *
		xviii) Use of inadequate capacity fuse wire/HRC (High ruptured capacity fuse) as per the IE act xxix) Utility shifting plan not prepared and complied with.	
17	Hand tools and Power tools	The contractor not ensure that i) Electric tools are properly grounded or / and double insulated ii) GFCI's/RCCB's shall be used with all portable electric too operated especially outdoors or in wet condition iii) Before making any adjustments or changing attachments, his workers shall disconnect the tool from the power source iv) When operating in confined space or for prolonged period, hearing protection shall be required. The same shall also supply to working with equipment's which gives out more noise v) Tools is held firmly and the material is properly secured before turning on the tool vi) All drills shall have suitable attachments respective of the operation and powerful for ease of operation vii) When any work/operation need to be repeatedly or continuously, tools specifically designed for that work shall be used. The same is applicable to detachable tool bit also viii) Size of the drill shall be determined by the maximum opening of the chuck n case of drill bit ix) Attachments such as speed reducing screwdrivers and buffers shall be provided to prevent fatigue and undue muscle strain to his workers x) Stock should be clamped or otherwise secured firmly to prevent it from moving xi) Workers shall never stand on top of the ladder to drill holes in walls/ceilings, instead standing on fourth or fifth rung shall be recommended xii) Electric plane shall be not be operated with loose clothing or long scarf or open jacket xiii) Safety guards used on right angle head or vertical portable grinders must cover a minimum of 1800 of the whole wheel and the spindle/wheel specifications shall be checked xiv) All power tools/hand tools shall have guards at their nip points xv) Low profile safety chain shall be used in case of wood working machines and the saw shall run at high RPM when cutting	From item i) to xxii) Rs.1,000 per single violation Compounded to a maximum of Rs.5,000 at any single instance

SI No	TOPIC	UNSAFE ACT/UNSAFE CONDITION	DEDUCTIBLE AMOUNT *
		<p>and also correct chain tension shall be ensured to avoid “kickback”</p> <p>xvi) Leather aprons and gloves shall be used as an additional personal protection</p> <p>xvii) Push sticks shall be provided and properly used to hold the job down on the table while the heels move the stock forward and thus preventing kickbacks</p> <p>xviii) Air pressure is set at a suitable level for air actuated tool or equipment being used, before changing or adjusting pneumatic tools, air pressure shall be turned off</p> <p>xix) Only trained employees shall use explosive actuated tools and the tool shall also be unloaded when not in use</p> <p>xx) Usage of such explosive actuated tools shall be avoided in case of places where explosive/flammable vapours or gases may be present</p> <p>xxi) Explosive actuated tools and their explosives shall be stored separately and be taken out and loaded only before the time of immediate use</p> <p>xxii) Misfired cartridges of explosive actuated tools must be placed in a container of water and be removed safely from the project</p>	
		<p>Gas cutting and welding</p> <p>i) Wrong colour coding of cylinder.</p> <p>ii) Cylinders not stored in upright position.</p> <p>iii) Flash back arrester, non-return valve and regulator not present or not in working condition.</p> <p>iv) Fail to put cylinders in a cylinder trolley.</p> <p>v) Damaged hose.</p> <p>vi) Using domestic LPG cylinders</p> <p>vii) Fail to store cylinder 6.6m away from fire prone materials</p> <p>viii) Fail to use hose clamps</p> <p>ix) Fire extinguisher not placed in the vicinity during operation</p> <p>x) Contractor not issued work permit for welding over areas where others are working and areas with increased fire risks or hazardous environments.</p> <p>xi) All gas and welding equipment not inspected by a competent person with records on weekly basis</p> <p>xii) Welders not wear the correct PPE like face and eye protection with correct grade of shield, Gauntlet gloves Safety footwear</p> <p>xiii) Efficient ventilation and fume extraction system not provided in enclosed areas and pits</p> <p>xiv) Naked flames or high temperature surfaces allowed in the vicinity (within 6 meter) of volatile solvents</p>	<p>From item i) to xxxvi)</p> <p>Rs.1,000 per single violation Compounded to a maximum of Rs.5,000 at any single instance</p>

SI No	TOPIC	UNSAFE ACT/UNSAFE CONDITION	DEDUCTIBLE AMOUNT *
18	Gas Cutting and Welding	xv)Cylinders kept in enclosed areas (unventilated) with unsecure upright position xvi)Flash back arrestors not fitted to both the fuel gas and oxygen cylinders xvii)Non-return valves not fitted to the torch or cutting torch xviii)Screwed fittings and hoses are not screwed properly and sealed to free from contaminants xix)Daily checks for gas leaks not carried out by using soapy water xx)Not removed all torches from enclosed areas when not in use xxi)Firewatchers not present if there is a possibility of ignition unobserved by the operator xxii)The equipment earthing and work piece earthing is same xxiii)Duckboards or rubber protection is not used to avoid being in contact with water or wet floors when welding xxiv)Screens not provided to limit exposure of others to glare from area xxv)The correct codified eye and face protection with the correct filter glass is not issues	
		xxvi)Voltmeter and Ammeter not working xxvii)Improper grounding and return path. xxviii)Damaged welding cable xxix)Bare openings in the cable. xxx)Non-availability of separate switch in the transformer xxxi)Non-availability of main switch control to switch off power to the welding unit. xxxii)Usage of reinforcement rod as return conductor xxxiii)Damaged holder xxxiv)Fire extinguisher not placed in the vicinity during operatio xxxv)Site should be inspected for workers not wearing PPEs xxxvi)Workers of proper shift not in place. xxxvii) Audit findings not implemented	
		i)Smoking and open flames in fire prone area ii)Using more than 24V portable electrical appliances in the fire prone area iii)Not proper ventilation in cylinder storage area. iv)Absence of fire extinguisher v) Fire extinguisher not refilled once in a year. vi) Fire extinguisher placed in a not easily accessible location	From item i) to xxiii) Rs.1,000 per single violation Compounded to a maximum of Rs.5,000 at any single instance.

SI No	TOPIC	UNSAFE ACT/UNSAFE CONDITION	DEDUCTIBLE AMOUNT *
20	Fire precaution	<p>vii) The contractor not deployed specially trained personnel to deal with fires due to electrical causes, gas explosions etc as per the specified law or manual</p> <p>viii) Combustible scrap and other construction debris not disposed off from site on a regular basis with records</p> <p>ix) Signage not erected at prominent positions showing the correct use of portable first aid fire extinguishers</p> <p>x) Emergency plans and Fire Evacuation plans not prepared</p> <p>xi) Mock drills not conducted once in one months to ensure the effectiveness of the arrangements</p> <p>xii) Site clearly visible fire points not established for use in an emergency either with Dry powder type or water type extinguishers</p> <p>xiii) Recharging of fire extinguishers and their proper maintenance not done as per Indian National Standards</p> <p>xiv) Water not supplied for fire-fighting purposes in the form of static water tank of adequate capacity or a hydrant line with adequate water pressure at outlet points as per Indian National Standards</p> <p>xv) Sufficient number of fire hoses with branch pipes, emergency lights not provided at site as per Indian National Standards</p> <p>xvi) The Telephone Number of the site fire brigade not prominently displayed near each telephone on site</p> <p>xvii) Supervisors and workmen at the site not trained in the use of Firefighting equipment provided at the site as per Indian National Standards</p> <p>xviii) All flammable liquids without any leaks and proper stopper without marked "FLAMMABLE LIQUID"</p> <p>xix) Rags soaked in paints, kerosene and other flammable liquids not disposed of daily under supervision</p> <p>xx) All Diesel fuel storage tanks not bunded around in order to control any spillage or leakage</p> <p>xxi) "NO SMOKING" signs not prominently displayed at all areas of potential location of fire</p> <p>xxii) Lack of site inspection</p> <p>xxiii) Correction from Audit not implemented</p>	
21	Excavation	<p>Excavation</p> <p>i) The contractor not ensures</p>	For item (i) to (vii)

SI No	TOPIC	UNSAFE ACT/UNSAFE CONDITION	DEDUCTIBLE AMOUNT *
		<p>a) Whether any construction building worker engaged in excavation is exposed to hazard of falling or sliding material or article from any bank or side of such excavation which is more than 1.5m above his footing, such worker is protected by adequate piling and bracing against such bank or side</p> <p>b) Where banks of an excavation are undercut, adequate shoring is provided to support the material or article overhanging such bank</p> <p>c) Excavated material is not stored at least 0.65m from the edge of an open excavation or trench and banks of such excavation or trench are stripped of loose rocks and other materials which may slide, roll or fall upon a construction building worker working below such bank</p> <p>d) Metal ladders and staircases or ramps are provided, as the case maybe, for safe access to and egress from excavation where, the depth of such excavation exceeds 1.5m and such ladders, staircases or ramps comply with the relevant National Standards</p> <p>e) Trench and excavation are protected against falling of a person by suitable measures if the depth of such trench or excavation exceeds 1.5m and such protection is an improved protection in accordance with the design and drawing of a professional engineer, where such depth exceeds 4m</p> <p>ii) The contractor not ensure that</p> <p>a) Suitable warning signs or notices, required for the safety of building workers carrying out the work of an excavation, displayed or erected at conspicuous places in Hindi and in a language understood by majority of such building workers at such building excavation work</p> <p>iii) The integrity of the excavation and the support system not inspected prior to the commencement of any works on a daily basis with records of checklist</p> <p>iv) Emergency pumping sumps and ladders not placed for use in the event of an emergency evacuation</p> <p>v) The contractor not plan in excavation against the following:</p> <p>a) Collapse of the sides</p> <p>b) Materials falling onto people working in the excavation</p> <p>c) People and vehicles falling into the excavation</p> <p>d) People being struck by plant</p> <p>e) Undermining nearby structures</p>	<p>Rs. 10,000 per single violation Compounded to a maximum of Rs. 1,00,000 at any single instance.</p>

SI No	TOPIC	UNSAFE ACT/UNSAFE CONDITION	DEDUCTIBLE AMOUNT *
		f) Contact with underground services g) Fumes and h) Make sure the necessary equipment needed such as trench props vii) The contractor not taken following precautions a) The sides battering them to a safe angle or supporting them with timber, proprietary support systems b) Unsupported excavations c) In shallow trenches contractor need to provide support if the work involves bending or kneeling in the trench d) Prevention of materials falling in to the excavation e) Make sure the edges of the excavation are protected against falling materials f) Wear a hard hat when working in excavations g) Provide substantial barriers, e.g. guard rails and toe boards h) Keep vehicles away from excavations use brightly painted baulks or barriers i) Where vehicles have to tip materials into excavations, use stop blocks to prevent them from over-running. j) Supervising excavation work of contractor does not have service plans	
		Work permit system 1) A permit system is not taken for construction work a) Entry into confined spaces b) Wok in close proximity to overhead power lines and telecommunication cables c) Hot work d) To dig where under-ground services maybe located e) Work with heavy moving machinery f) Working on electrical equipment g) Work with radio-active isotopes h) Heavy lifting operation and lifting operations closure to live power line 2) Woking to any live overhead power line is permitted without the operation of a strict permit to work 3) The contractor not develop a permit - To-work system 4) The permit to work not issue for activities as per CMRL ESHS contract requirement 5) To permit-to-work system not covered a) How the system works b) The jobs it is to be used for c)The responsibilities and training of those involved d) How to check its operations	For item 1 to 10 Rs.1,000 per first violation and Rs.5,000 for subsequent violations

SI No	TOPIC	UNSAFE ACT/UNSAFE CONDITION	DEDUCTIBLE AMOUNT *
22	Work permit system	<p>6) The permit-to-work not forms the communication between everyone involved of respective site conditions and requirements</p> <p>7) The permit to work form does not contain as per the ESHS contract requirements.</p> <p>a) Authorised person for jobs (and any limits to their authority)</p> <p>b) Responsibilities for precautions (e.g. isolation, emergency arrangement, etc)</p> <p>c) Associated hazards</p> <p>d) Plant and diagram its location and limitations</p> <p>e) Precautionary measures</p> <p>f) Procedure to control or abandon in the case of an emergency</p> <p>g) Time limitations</p> <p>h) Job specific toolbox talk conducted by the supervisor</p> <p>8)A permit-to-work authorised more than a period of twenty-four hours</p> <p>9)A copy of each permit to work not displayed during its validity in a conspicuous location in close proximity to the actual works location to which it applies</p> <p>10)A pre-permit activation job specific toolbox-talk not conducted by the supervisor with following details</p> <p>a) All identified hazards are explained</p> <p>b) Risk mitigation process clarified</p> <p>c)Method of work explained stressing points (a &b above)</p> <p>d)Emergency response procedure is clarified and the person assigned tasks in the event of emergency</p> <p>f) Personnel Protective Equipment (PPE) requirements including PPE serviceability checks and training</p>	
		<p>Traffic Management</p> <p>i. The Contractor shall develop detailed and robust traffic management plans consistent with the Indian Guidelines on Traffic Management in work zones (IRC:SP:55-2014), prior to mobilization for respective sections with site- or station-specific plans and measures to minimize the overall impact on traffic throughout the construction and operation periods.</p> <p>ii. At congested sections, the temporary traffic coordinators will be engaged by CMRL to facilitate the traffic management.</p> <p>iii. At the minimum, the traffic management plans will have the</p>	<p>From item i) to xix)</p> <p>Rs. 10,000 per first violation and Rs.1,00,000 for subsequent violations</p>

SI No	TOPIC	UNSAFE ACT/UNSAFE CONDITION	DEDUCTIBLE AMOUNT *
23	Traffic Management	<p>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> <p>iv. At the minimum, the traffic management plans 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> <p>v. Strengthening impact and risk prevention measures, such as establishing construction site works to minimize the entrance and exit of vehicles at stations during peak traffic.</p> <p>vi. The logistics should be considered to manage transport materials from storage areas outside of the dense urban core to worksites and to return excavated soil and other materials to disposal locations. If needed, construction traffic may be confined to certain routes (based on infrastructure capacity) or restricted to certain off -peak hours (that is, to reduce noise pollution at night or to avoid commuting and school hours during the day).</p> <p>vii. Any diversions of traffic will cause considerable confusion for pedestrians and drivers as they rearrange their itineraries, hence, to minimize the effects of the diversion or reorganization, it is necessary to conduct communication campaigns and disseminate appropriate information to urban residents and taxi and bus drivers in advance of disruptions. Efforts will be given to divert traffic to roads wide enough to accommodate extra traffic. Compliance with scheduled deadlines for the detour is essential. If</p>	

SI No	TOPIC	UNSAFE ACT/UNSAFE CONDITION	DEDUCTIBLE AMOUNT *
		<p>necessary, bus service and other public and private transport services in the area should be improved to meet residents' transportation needs</p> <p>viii. Incorporation of community safety considerations into plan design, especially at locations such as Kutchery Road where buildings are close to the construction site.</p> <p>ix. CMRL and local authorities continue to play an oversight role in approving these plans during construction, evaluating their cumulative impact with other infrastructure projects in the region, and ensuring their dissemination to all relevant stakeholders.</p> <p>x) In all cases, the contractor not employ proper precautions. Wherever operation undertaken are likely to interfere with public traffic, specific traffic management plans not drawn up and implemented by the contractor in consultation with the approval of local police authorities and / or the concerned metropolitan/civil authorities /competent authorities</p> <p>xi) A warning not installed at all secondary road which merges with the primary road where the construction work is in progress at sufficient distance before it merges with the primary road regarding the 'Chennai Metro Work in Progress'</p> <p>xii) Traffic cones of 500mm, 750mm, and 1000mm high and 300mm to 500mm in diameter are in square shape at base and are often made of plastic or rubber and normally have retro-reflectorizes red and white band not used whenever required</p> <p>xiii) Drums about 800mm to 1000mm high and 300mm in diameter not used either as channelizing or warning devices</p> <p>xiv)The contractor not make arrangements keeping low away van/manpower to low away any break down vehicle in the traffic flow</p> <p>xv)The contractor not ensure the cleanliness of road and footpaths by deploying proper manpower for the same. The contractor not ensure proper grooming, cleaning washing of roads and footpaths on all the time</p> <p>xvii)All barricade not conspicuously seen in the dark/night time by the road users.</p> <p>lx)Conspicuously not ensured by affixing retro reflective stripes of required size and shape at appropriate angle at the bottom and middle portion of the barricade at a</p>	

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		<p>minimum gap of 1000mm. In addition, minimum one red light or red-light blinker not placed at the top of each barricade.</p> <ul style="list-style-type: none"> i) Barricade and pedestrian walkway <ul style="list-style-type: none"> a) Not Cleaned b) Not in alignment c) Not numbered d) Not painted e) Red lights / reflectors not working f) Damages not repaired g) Not secured properly h) Barricade inspector not employed i) Protruding parts / portions repaired j) Barricades maintaining register not properly maintained up to date ii) Contractor Vehicles <ul style="list-style-type: none"> a) Over loading of vehicles b) Unfit drivers or operators c) Unlicensed vehicles d) Absence of traffic marshals e) Absence of reversing alarm f) Absence of fog light (at winter) g) Power / hand brakes not in working condition. iii) Splashing of Bentonite on roads / non-cleaning of tyres of dumpers and transit mixers <ul style="list-style-type: none"> i) Mishandling of bentonite like splashing of bentonite outside specified width of barricading ii) Non-cleaning of tyres of dumpers and transit mixers before leaving the site and thereby creating a traffic safety hazard to road users. viii) Adequate and clear warning signs not displayed at appropriate distance before the commencement of the site working ix) Prior warning not given concerning the location of approaching site entry and exit points x) All traffic signs, barriers, cones, and lighting not kept maintained and cleaned xi) Regular inspection of the traffic management schemes not conducted by the contractors in both the day time and night time hours with records xii) The removal of excavated soil from the sites not done by licensed vehicle xiii) Unchecked medical examination of the drivers allowed for removal of excavated soil xiv) Overloaded vehicle allowed for movement excavated soil xv) Any vehicle leaving the sites carrying load produce air borne contaminants during transportation of the public highway 	

SI No	TOPIC	UNSAFE ACT/UNSAFE CONDITION	DEDUCTIBLE AMOUNT *
		xvi) Any vehicle revised without the control of trained banksman xvii) Vehicles prior to leaving the site shall did not wheels xviii) Any soil removed from the work sites disposed of at unauthorised dumping sites xix) Not maintained and painted all the traffic barriers on yearly basis	
24	Batching plant/Casting yard	i) Batching plant/Casting yard ii) The batching plant/casting yard not effectively planned for smooth flow of unloading and stacking the aggregates reinforcement and cement, batching plant, transport of concrete, casting the segment, stacking the segment, and loading the segment to the trucks iii) The batching plant/casting yard not barricaded and not made as compulsory PPE zone iv) Electrical system not suitably not planned for diesel-generator v) Drainage not effectively provided and waste water not disposed after proper treatment as per the law vi) Time office, canteen, drinking water, toilet and rest place not suitably located for the easy access to the workers vii) Manual handling of cement not avoided to a larger extent viii) The PPE's provided to the cement handling workmen not conform to international standard ix) Access roads and internal circulation roads not well laid and maintained properly at all time x) Material stacking is not provided xi) Not provide 50 Lux of illumination or as per law xii) Batching plant/Casting yard xiii) The contractor release dust due to their activities beyond the permissible limit as per the relevant law xiv) The waste treatment plant not provided and the ER/CMRL norms not followed xv) High GI sheet screens and water sprinkling will be employed. xvi) The use and storage of hazardous materials at the casting yard and batching plant should adhere to SPCB requirements.	From item i) to xxiii) Rs. 1,000 for single violation compounded to a maximum of Rs.5,000 at any single instant.

SI No	TOPIC	UNSAFE ACT/UNSAFE CONDITION	DEDUCTIBLE AMOUNT *
		<p>xvii) The transport, handling and storage of hazardous waste will be done in accordance with the provisions of Hazardous Chemicals (Management & Handling) Rules. Hazardous wastes from construction activity and equipment are labeled, recorded, stored in impermeable containment and for periods not exceeding mandated periods and in a manner suitable for handling storage and transport.</p> <p>xviii) The contractor shall maintain a record of sale, transfer, storage of hazardous waste and make these records available for inspection.</p> <p>xix) The contractor shall get Authorized Recyclers to transport and dispose Hazardous Waste.</p> <p>xx) Proper collection and storage facilities will be provided especially for hazardous waste.</p> <p>xxi) If power from the grid is used, permission from power supply company must be obtained by the Contractor.</p> <p>xxii) 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).</p> <p>xxiii) Diesel storage if done beyond threshold limit (1000 L) permission should be obtained. Diesel should be stored on pukka platforms and spillages should be avoided.</p>	
25	PPE	<p>PPE (Personnel Protective Equipment)</p> <p>i) Not having</p> <p>ii) Not wearing (or) using and kept it elsewhere</p> <p>iii) Using damaged one</p> <p>iv) Using wrong type</p> <p>v) Using wrong colour helmet or helmet without logo</p> <p>vi) Using for other operation (e.g. Using safety helmet for storing materials or carrying water from one place to other)</p> <p>vii) Not conforming to BIS standard</p> <p>viii) The contractor not pay cash amount in lieu of PPE to the workers/Subcontractors and expect them to buy and use during work</p> <p>ix) The contractor not at all time maintain a minimum of 10% spare PPE's and safety appliances and properly record and not</p>	<p>From item i) to vi).</p> <p>Rs.200 per single violation</p> <p>For item vii) to xi)</p> <p>Rs. 1,000 for first violation and Rs. 5,000 for subsequent violations for item</p>

SI No	TOPIC	UNSAFE ACT/UNSAFE CONDITION	DEDUCTIBLE AMOUNT *
		<p>showed to the Employer / Engineer during the inspections</p> <p>x) Adequate quantity of PPE's not kept always as the security post</p> <p>xi) The contractor not all times keep and maintain an adequate supply of suitable PPE for use at all times</p> <p>a) Safety helmets</p> <p>b) Hearing protection</p> <p>c) Respiratory protection</p> <p>d) Eye protection</p> <p>e) Protective gloves</p> <p>f) Safety footwear</p> <p>g) High visibility clothing</p> <p>xii) In all construction sites person identified other without HARD HAT or SAFETY BOOTS or both</p>	
26	Health and Safety	<p>Industrial Health, Safety and Welfare</p> <p>i) Fail to conduct Medical examination to workers</p> <p>ii) Absence of ambulance van & room</p> <p>iii) Workers not having ID card</p> <p>iv) Inadequate number of toilets</p> <p>v) Toilets not cleaned properly</p> <p>vi) Absence of water facilities for toilets and washing places</p> <p>vii) Toilet placed more than 500m from the work site</p> <p>viii) Absence of drinking water</p> <p>ix) Absence of first-aid person in work site.</p> <p>x) Absence or inadequacy of first-aid box.</p> <p>xi) Misuse of first-aid box.</p> <p>xii) First-aid box not satisfy the minimum Indian standard.</p> <p>xiii) Smoking inside the construction site</p> <p>xiv) Drink and drive or work</p> <p>xv) Excessive noise and vibration</p> <p>xviii) Creche not provided</p> <p>xix) Accommodation not provided as per BOCWA</p> <p>xx) Fumigation / insecticides not sprayed to prevent Mosquito breeding</p> <p>xxi) Contractor not maintain material safe data sheet (MSDS) for all substances at the point of inventory</p> <p>xxii) Contractor not conducted an assessment of the hazardous substances would be used in confined space with assessment record</p> <p>xxiii) For continuous exposure of noise, i.e. for eight hours in any one-day, the sound level exceeds 85DB</p> <p>xxiv) Contractor not introduced a noise control programme. If noise levels exceed above 90DN. The use of hearing protection should be enforced actively when the equivalent sound</p>	<p>From item i) to xxi)</p> <p>Rs.1,000 per single violation Compounded to a maximum of Rs.5,000 at any single instance</p>

SI No	TOPIC	UNSAFE ACT/UNSAFE CONDITION	DEDUCTIBLE AMOUNT *
		<p>level over 8 hours reaches 85 dB(A), the peak sound levels reach 140 dB(C), or the average maximum sound level reaches 110dB(A). Hearing protective devices provided should be capable of reducing sound levels at the ear to at least 85 dB(A)</p> <p>xxv) Contractor not introduced a noise control programme. If noise levels exceed above 90DN</p> <p>xv) The ventilation system not adequate to maintain circulation of following any one:</p> <p>a) Less than 19.5% oxygen by volume</p> <p>b) More than 0.05% carbon dioxide by volume</p> <p>c) More than 0.01% carbon monoxide by volume by volume</p> <p>d) More than 0.001% hydrogen sulphide by volume</p> <p>e) More than 0.005 oxides of nitrogen</p> <p>f) More than 0.0002% of aldehyde</p> <p>g) Any other poisonous gas in harmful amounts.</p> <p>xvi)The contractor not provided at least 6m³ of fresh air per minute per employee</p> <p>xvii)Regular checking of gas at the faces not done before each shift by using a multi gas detector</p> <p>xviii) Motive power other than electric or petrol used</p> <p>xix)Diesel engines used underground without filters to remove all carbon monoxide and oxides of nitrogen</p>	
27	Labour Welfare measures	<p>Labour welfare measures</p> <p>i)Compliance with GoI labor legislation, ratified International Labour Organization conventions</p> <p>i)Non-adherence of Labour welfare provisions of BOCWA</p> <p>ii)Fail to register establishment and display the registration certificate at workplace</p> <p>iii) Grievance Redress Mechanism for workers</p> <p>iii)Absence of workers register and records</p> <p>iv)Absence of muster roll and wages register</p> <p>v)Fail to display an abstract of BOCWA and BOCWR</p> <p>vi)Inadequate number of toilets</p> <p>vii)Toilets not cleaned properly</p> <p>viii)Absence of water facilities for toilets and washing places</p>	From item i) to xvi) Rs.1,000 per single violation Compounded to a maximum of Rs.5,000 at any single instance

SI No	TOPIC	UNSAFE ACT/UNSAFE CONDITION	DEDUCTIBLE AMOUNT *
		ix)Toilets placed more than 500m from the work site x) accommodation not provided as per BOCWA xi)Absence of drinking water xii)Excessive noise and vibration xiii)Canteen not provided xiv)Food stuff not served on no loss no profit basis	
28	Floor Openings	i)No Provision of Protection, ii)No Relevant Signage iii)work Permit Procedure not followed	From item i) to iii) Rs.10,000 per single violation Compounded to a maximum of Rs.1,00,000 at any single instance
29	Environmental Management	i)Tyre wash facility not provided ii)Spillage from vehicles not arrest iii)Air monitoring not practiced iv)Noise and vibration monitoring not practiced v)Surface and ground water monitoring not practiced. vi)The values of air monitoring and noise monitoring not within acceptable limits vii)Dust control measures at sites not practiced viii)Improper disposal of debris / residues ix)Detailed Analysis of vibration, such as visual inspections of buildings and baseline monitoring not conducted by contractor prior to construction. x)Non-compliance in legal provisions for water treatment and disposal and environmental loss. xi)Site-specific EMP and Environment monitoring plan not cleared by Employer.	From item i) to xi) Rs. 1,000 per single violation Compounded to a maximum of Rs. 5,000 at any single instance

Without limiting to the unsafe acts and or conditions mentioned above in the clause 4.8 the Employer /Engineer shall have the right to deduct charges for any other unsafe act and or condition depending upon the gravity of the situation on a case-to-case basis. The charges shall be in comparison with that of the similar offence indicated in the above table-6.

* Maximum cumulative amount deductible for items at S.No. 1 to S. No. 29 during the entire contract duration shall not exceed 1% of contract value.

Environmental Impact Assessment (Draft)

March 2021

India: Chennai Metro Rail Investment Project
Corridor 4

Annexure 6–8

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In preparing any country program or strategy, financing any project, or by making any designation of or reference to a particular territory or geographic area in this document, the Asian Development Bank does not intend to make any judgments as to the legal or other status of any territory or area.

Annexure 6: Terms of Reference of General Consultant in Implementation of EMP and EMoP

1. Review and update EIA including EMP and EMoP as appropriate; incorporate necessary technical specifications following design and contract documentation;
2. Assist CMRL in preparation of documents and taking necessary procedures in accordance with in the EIA Report for the Project, if any;
3. Assist CMRL in dissemination and explanation of additionally confirmed and identified environmental issues to public including holding public consultations;
4. Assist CMRL in obtaining necessary permits from relevant authorities and/or departments in accordance with the planned implementation schedule stated in the EIA Report;
5. During the preparation of bidding documents, clearly include environmental responsibilities as explained in the EIA Report and EMP as “Environmental Contract Specifications (ECS)”;
6. Ensure that designs and construction methods provide for, as per the EMP, environment-friendly building materials, reuse, resource saving and climate adaptation elements like natural ventilation, solar power installations and rain water harvesting; piling methods and track design which minimize noise and vibration;
7. Ensure the primary baseline data of environmental elements are in place prior to mobilization;
8. Assist CMRL in reviewing the Contractor’s Environmental Program (CEP) to be prepared by the contractor in accordance with EIA, EMP, ECC (Environmental Compliance Certificate) and ECS, relevant plans, conditions set out in relevant permits and clearances and Funding Agencies’ Environmental Policy and to make recommendations to CMRL regarding any necessary amendments for its approval;
9. Assist CMRL to implement the measures identified in the EMP;
10. Monitor the effectiveness of EMP and negative impacts on environment caused by the construction works and provide technical advice, including a feasible solution, so that CMRL can carry out improvement when necessary;
11. Monitor compliance with the requirements under EMP and Funding Agencies’ Environmental Policy. Submit the Environmental Monitoring Report to CMRL at every month after the commencement of the services until the completion of the Project. After the completion of the Project, the Report will be submitted **semi-annually for two (2) years**. The Environmental Monitoring as per Funding Agencies E&S templates will be filled and attached to the Report;
12. After verifying the Environmental Monitoring Report by CMRL, assist submitting the report to Funding Agencies as part of the Progress Status Report at every **three months** after the commencement of the services until the completion of the Project and **semi-annually for two (2) years** after the completion of the Project;
13. Assist CMRL in preparation of the answer to the request from Funding Agencies for environmental considerations if necessary;

14. Assist CMRL in facilitating stakeholder's participation (including focus group discussions for vulnerable PAPs) and providing feedbacks on their comments regarding EMP and EMoP;
15. Supervise Contractor's activities to check compliance with CEP and prepare periodic monitoring reports;
16. Assist CMRL to establish a multi-layer Grievance Redress Mechanism (GRM) including Grievance Redress Committee (GRC) to resolve the Grievances of environment, health and safety matters in a timely manner;
17. Assist CMRL in the capacity building of CMRL staff on environmental management through on-the-job training on environmental assessment techniques, mitigation measure planning and implementation, supervision and monitoring, and reporting;
18. At the completion of project, (a) undertake final environmental monitoring and evaluation against the set indicators, (b) evaluate sustainability of environmental benefits associated with the project, taking into account both positive and negative impacts associated with the project, and (c) prepare an evaluation report for the project.

Annexure 7: Terms of Reference for Engaging External Monitoring Agency/Expert

A. Background

1. **Project Description.** The Chennai Metro Corridor 4 from Lighthouse to Poonamallee Depot is 26.085km long upto depot entry, comprising underground length of 10.071km and elevated length of 16.014km, 12 underground stations and 18 elevated stations.
2. **Project Category.** The Project is assigned as category A for Environment and Involuntary Resettlement as the project is likely to have significant adverse environment and social (E&S) impacts. Chennai Metro Rail Limited (CMRL) will retain **external** monitor to conduct the third party monitoring and verify the monitoring information submitted by General Consultant (GC).

B. Objective(s) of the Assignment

1. To conduct third party monitoring of implementation of the E&S requirements under the project;
2. To ensure that the Project will be implemented in conformity with the policies of Government of India (GoI), Government of Tamil Nadu (GoTN), as well as the lenders' E&S policies; and
3. To identify any environment and social related implementation issues and necessary corrective actions and reflect these in a time-bound corrective action plan for CMRL to implement.
4. Capturing social, environmental and economic benefits and particular potential benefits to the poor and vulnerable groups in the corridor;
5. Involving users and stakeholders in the monitoring process; and
6. Strengthening the capacity of the CMRL to manage and replicate third-party monitoring with rail users and stakeholders

C. Scope of Services, Tasks and Expected Deliverables

1. **Scope of Services.** Monitor the implementation of the Environmental Management Plan (EMP), Resettlement Action Plan (RAP), Gender Action Plan (GAP), Vulnerable Communities Plan (VCP) / Indigenous Peoples Development Plan (IPDP) as applicable and monitoring activities by the respective contractors and supervision consultants. Provide technical guidance and feedback to the respective contractors and supervision consultants. Monitor operational stage and residual impacts during project implementation.
2. **The Tasks** include but not limited to the following,
 - (i) Review the Social Impact Assessment with a focus on (RAP), and the Environmental Impact Assessment (EIA) with a focus on EMP;
 - (ii) Review the Environmental, Health and Safety clauses included in the civil works contract agreement;
 - (iii) Review the internal E&S monitoring reports;
 - (iv) Undertake independent field inspections to verify the implementation of RAP GAP, VCP / IPDP and consult community and affected people;
 - (v) Review the Grievances register logs at project sites;

- (vi) Visit the project sites, oversee quantitative environmental monitoring activities of CMRL to confirm appropriate methodologies being used and results correctly interpreted, and consult potentially affected people about the environmental nuisances;
- (vii) Randomly interview the labors about health and safety compliance;
- (viii) Assess EMP implementation performance, qualitatively or by conducting additional quantitative environmental monitoring as required;
- (ix) Discuss findings of assessment with CMRL and provide recommendations to resolve any issues or problems on implementing EMP RAP, GAP and VCP / IPDP;
- (x) Prepare the external E&S monitoring reports, which should confirm the project's compliance with the EMP, RAP GAP, VCP / IPDP, and reflect in the time-bound corrective action plan for any non-compliances.

D. Deliverables. The following are the key outputs expected from the consultants:

1. External SMP monitoring reports:
 - (i) Once upon payment of compensation and entitlements
 - (ii) Implementation of livelihood restoration and its efficacy: semi-annually during construction stage
 - (iii) Implementation of gender action plan and its efficacy: annually during first 2 years of operation and maintenance
2. External EMP monitoring reports:
 - (i) Implementation of EMP, EMoP, Grievance Redressal and their efficacy: semi-annual during construction stage
 - (ii) Implementation of EMP, EMoP, Grievance Redressal and their efficacy: annually during operation & maintenance during first 2 years of operation and maintenance.

E. Team Composition & Qualification Requirements

1. One environmental expert and one social expert would be required with E&S related disciplines and with at least 10 years of work experience in E&S management of linear projects, preferably in transport sector.

Annexure 8: Guidance for Construction Workers/ Contractors in View of COVID-19

Ministry of Home Affairs and Ministry of Health and Family Welfare, GoI have issued various Guidelines to be followed during COVID:- (<https://www.mha.gov.in/notifications/circulars-covid-19>, https://www.mha.gov.in/sites/default/files/PR_ConsolidatedGuidelinesofMHA_28032020_0.pdf, <https://www.mohfw.gov.in/>). Further, amendments on COVID various orders are updated from time to time on <https://www.mha.gov.in/media/whats-new>, need to be followed in all operations. In addition, various guidelines / interim notes for construction sites have been prepared by institutions and organizations, some of which are listed below:

- a. ILO's Guidance: Considerations for employment intensive works in response to COVID 19 (April 12, 2020). https://www.ilo.org/wcmsp5/groups/public/---ed_emp/documents/publication/wcms_741669.pdf
- b. WB's ESF/Safeguards interim note: COVID-19 considerations in construction/civil works projects (April 7, 2020)
- c. WHO's guidelines: Getting your workplace ready for COVID-19 (March 03, 2020)<https://www.who.int/docs/default-source/coronaviruse/getting-workplace-ready-for-covid-19.pdf>; Water, sanitation, hygiene, and waste management for the COVID-19 virus (March 19, 2020)<https://www.who.int/publications-detail/water-sanitation-hygiene-and-waste-management-for-covid-19>; Rational use of personal protective equipment (PPE) for coronavirus disease (March 19, 2020)https://apps.who.int/iris/bitstream/handle/10665/331695/WHO-2019-nCov-IPC_PPE_use-2020.3-eng.pdf .
- d. IASC Interim Guidance: Scaling-Up Covid-19 Outbreak Readiness and Response Operations in Humanitarian Situations, Including Camps and Camp-Like Settings (March 17, 2020)<https://interagencystandingcommittee.org/other/interim-guidance-scaling-covid-19-outbreak-readiness-and-response-operations-camps-and-camp>
- e. IDB's Guidance for infrastructure projects on COVID-19<https://www.idbinvest.org/en/download/9625>
- f. IFC Guidance: Workers' accommodation: processes and standards (2009) <http://documents.worldbank.org/curated/en/604561468170043490/pdf/602530WP0worke10Box358316B01PUBLIC1.pdf>

Labor would continue to be the major player in corridor 4 construction activities. In view of the prevailing COVID-19 pandemic, the contractors and workers would need to take additional measure to avoid the spread of the disease. On the basis of above guidelines/guidance notes, a brief "To Do" list is summarized below (sl.no.in brackets refer to the above mentioned guidelines/guidance notes). For details and preparation of COVID Response and Management Plan, the above documents may be referred.

Brief 'To Do' List

Daily Drill:

- All workers to report some time earlier before the start of the shift. An attendance register is to be maintained for each shift. Social distancing of at least 2m to be followed in the holding area. The focal point to provide information update. (a, c, d)
- The workers need to wash their hands thoroughly (for at least 20-30 seconds) with soap or use sanitizers just before reporting screening. Adequate provision for hand washing, soaps, sanitizers needs to be made at the reporting location. (a, b, c)
- Health screening to be done for all workers in the shift - including temperature monitoring using a non-contact thermometer. Any worker reporting with temperature higher than 37.3°C shall be sent to the isolation quarters and periodic observation be made. (a, b, c, d)
 - In case the worker shows symptoms of the pandemic (including COVID-19), the procedures as laid down by the national and state laws need to be followed for testing, quarantine of at least 14 days or hospitalization, depending upon individual case.

- All the co-workers in the shift, and other persons with known contact history in the construction site should be quarantined for a period of at least 14 days, followed by regular checkups/ observation/ examinations as laid down by the national and state laws.
- The workers found fit need to proceed to work with all required personal protective equipment, e.g. masks, gloves, goggles, boots, helmets, harness, etc. (a, b, c)
- The workers be encouraged to avoid contact with co-workers as far as possible and wash their hands at regular intervals. (a, b, c)
- Lunch/meal break be staggered into two so that workers proceed for lunch/meal at different times (a).
- There needs to be a provision of separate drinking bottles/cups for each worker, and these need to be cleaned thoroughly after meals. (a)
- Proper hand washing arrangement (water/soaps/sanitizers) needs to be ensured at eating locations. Hand washing facilities are ideally to be located within 5m of toilets and at close range of eating space. (a, b)
- The workers returning to the shift after lunch/meal break need to thoroughly wash their hands and follow the same procedure as that followed at the start of the shift. (a, b)
- At the close of shift, the workers need to thoroughly wash their hands with soap/sanitizers etc. (a, b)
- The PPE should be thoroughly washed/cleaned/sanitized (depending upon the type of PPE) after the shift ends. (a)
- The meal timings should be phased in each shift during which the sensitive areas of the workplace should be cleaned / sanitized as far as possible. (b)
- The time between two shifts should be used for cleaning and sanitizing machines, hand tools and areas of regular contact – grab handles, control levers, steering wheels, control panels - shall be regularly cleaned, and at the end of shifts used across shifts (or continuous operations) where operators/helpers change. (a)

General Guidance for contractors:

- Site specific Risk assessment needs to be undertaken and COVID Response and Management Plan be prepared for all sites. (a, b, d, e)
- Protocols for medical treatment, etc. should be prepared/followed, including for reporting, referral, treatment and discharge as per national and state laws and other guidelines. (a, b, c, d)
- A health and safety officer to be deployed as the focal point at all project sites, and wherever, the same is not in place, urgent action needs to be taken by the contractor to recruit someone. (a, b)
- Register for all the workers needs to be maintained, along with their health records (a, b, d).
- Limit the number of workers on site at any one time to minimize contact, including exploring operations for multi-shift working rotation. (a, b, d)
- Entry/exit to the site should be documented. Transport vehicles used during construction activities to carry construction materials should be sanitized on regular basis (at least once a day). (a, b)
- Hygienic living conditions need to be ensured in the camp sites with regular/daily cleaning, adequate hand washing facilities. Adequate provision for solid waste management needs to be provided. (a, b, d, f)
- Provide health and safety training/orientation on COVID19, or any other pandemic, to all workers and staff.(a, b, d)
- Ensure adequacy of necessary supplies of energy, water, food, medical supplies, cleaning equipment, PPE (both for regular use and those for medical exigencies) etc. (a, b, c, d, f)
- Quarantine and isolation facilities should be established in the camps (WHO Guidelines). The isolation facilities should have separate and dedicated toilets with proper arrangement for cleaning and removal of faeces. (c)
- Any medical waste produced during the care of ill workers should be disposed as per the national and state laws or relevant guidelines (e.g. WHO guidelines from time to time). PPE used for medical treatment/care purposes should be stored securely and kept separate from other waste. Current WHO recommendations are to clean utility gloves or heavy duty, reusable plastic aprons with soap and water and then decontaminate them with 0.5% sodium hypochlorite solution after each use.

Single-use gloves (nitrile or latex) and gowns should be discarded after each use and not reused; (a, b, c)

- Incentivize workers lodging in the local community to move to site accommodation. (b)
- The community should be made aware, through posters etc., of procedures put in place at site to address issues related to COVID-19. This should include all measures being implemented to limit or prohibit contact between workers and the community. (a, b, c, d)

Environmental Impact Assessment (Draft)

March 2021

India: Chennai Metro Rail Investment Project
Corridor 4

Annexure 9

Prepared by the Chennai Metro Rail Limited (CMRL) for the Asian Development Bank.

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Public Consultations at Station Locations Onsite 2016-2018 (SIA for Corridor 4, Jan. 2019)

FORMAT FOR PUBLIC CONSULTATION

Location: Alwarpeth Station (line 4)

Date/Time: 3/11/2016

Perception about the project:

1. Do you think that Metro rail is necessary Chennai city? Yes/ No
 2. What impacts, both positive and negative of the project do you foresee?

S.N	Positive Impact	Remark	S.N	Negative Impact	Remark
1	Shorten the trip	✓	1	Land Acquisition	✓
2	Enhance local economy		2	Loss of livelihood	✓
3	Increase employment opportunity		3	Loss of income	✓
4	Increase facilities		4	Loss of house/shop	
5	Decrease in accident		5	Loss of customers & supplie	
6	Increase in property value		6	Disruption of social/cultural/economic	
7	Improvement in transportation system	✓	7	Increase in Crime Rates	
8	Decrease Greenhouse gas emission		8	Increase in Migration	
9	Increase educational level	✓	9	Disadvantage to the environment (damage of park, tree etc)	✓
10	Others (Specify) <u>many schools</u>		10	Other (Specify)	

3. Issues

Issues raised/ Discussed	Suggestion by Stakeholders	Remark
Land acquisition	if the structure can be demolished and in case if we want get adequate compensation, it will be difficult for us	
Transportation	Many school/colleges at nearby and it would facilitate widening of road is already there. if ticket charges are more we will not be able to travel though we loose our land.	
Compensation	Transportation will be easy, we really want to relocate but the thing is compensation need to be given adequate	

Borewell issue. Due to borewell metro station the local borewell may get affected.

Cracking Cracks. There is possibility of boundary cracks and need to take care of it.

Loss of tenancy	we are the tenants and due to metro, there will be price hike and we want to get place here at the same rate.	
Loss of livelihood	This is business area and all the nature of affected, it will be difficult for us.	

Name of Participant

Signature

Name of Participant

Signature

- | | |
|-----------------|---------------|
| ① Alok Trivedi | Alok Trivedi |
| ② Ashique Latoo | Ashique Latoo |
| ③ Majeer | Majeer |
| ④ Sadik | Sadik |
| ⑤ Khawaja | Khawaja |
| ⑥ Mohd. Ali | Mohd. Ali |

FORMAT FOR PUBLIC CONSULTATION

Location: Vadapalani (Kinot)

Date/Time: 11/11/2016

Perception about the project:

1. Do you think that Metro rail is necessary Chennai city? Yes/ No
 2. What impacts, both positive and negative of the project do you foresee?

S.N	Positive Impact	Remark	S.N	Negative Impact	Remark
1	Shorten the trip	✓	1	Land Acquisition	
2	Enhance local economy		2	Loss of livelihood	
3	Increase employment opportunity	✓	3	Loss of income	
4	Increase facilities		4	Loss of house/shop	
5	Decrease in accident		5	Loss of customers & supply	
6	Increase in property value		6	Disruption of social/cultural/economic	
7	Improvement in transportation system	✓	7	Increase in Crime Rates	
8	Decrease Greenhouse gas emission		8	Increase in Migration	
9	Increase educational level		9	Disadvantage to the environment (damage of park, tree etc)	
10	Others (Specify)		10	Other (Specify) <u>affect the business (auto</u>	

3. Issues

Issued raised/ Discussed	Suggestion by Stakeholders	Remark
Traffic Jam - Shorten the trip	Here, always there is traffic Jam, irrespective to of peak time No	
Costly transportation	Already so many transportation services, nearby metro & railway services. If reduced price applied it will be helpful	
Loss of existing place	Being a small shop owner, our livelihood would affect	
Reduce Pollution	Due to metro, there will be sharp reduction in pollution which is at higher priority	

costly charges of Metro	By reducing of metro ticket charges, we can increase the metro concensus & subsequently reduce the road accidents, & pollution & develop Chennai	
----------------------------	--	--

Name of Participant	Signature	Name of Participant	Signature
Mr. S. Kalidas	9962228780	S. Kalidas	[Signature]
Mr. Mami R. Vijayarani Palani Kumar B. [unclear]	8122797174 8220497820 97102 [unclear]	C. [unclear] R. [unclear] ASIDE MATHEMATICS	[Signatures]
N. Selva Pandi	9952816112	[unclear]	[Signature]
S. [unclear]	9444324959	[unclear]	[Signature]
S. RAMESH	9971708738	S. Ramesh	[Signature]
D. Kumar	9962811562	D. Kumar	[Signature]
S. [unclear]	[unclear]	[unclear]	[Signature]
Madhu PEBB	8939227757	Madhu PEBB	[Signature]
M. [unclear]	7092397912	M. [unclear]	[Signature]

FORMAT FOR PUBLIC CONSULTATION

Location: Vadapalani

Date/Time: 26/05/2017

Perception about the project:

1. Do you think that Metro rail is necessary Chennai city? Yes/ No
2. What impacts, both positive and negative of the project do you foresee?

S.N	Positive Impact	Remark	S.N	Negative Impact	Remark
1	Shorten the trip	✓	1	Land Acquisition	
2	Enhance local economy		2	Loss of livelihood	
3	Increase employment opportunity		3	Loss of income	
4	Increase facilities		4	Loss of house/shop	
5	Decrease in accident		5	Loss of customers & supplies	
6	Increase in property value		6	Disruption of social/cultural/economic	
7	Improvement in transportation system	✓	7	Increase in Crime Rates	
8	Decrease Greenhouse gas emission		8	Increase in Migration	
9	Increase educational level		9	Disadvantage to the environment (damage of park, tree etc)	
10	Others (Specify)		10	Other (Specify)	

3. Issues

Issues raised/ Discussed	Suggestion by Stakeholders	Remark
Time saving	Metro will save transportation time with comfort.	
Traffic Reduce	Due to vicinity of Vadapalani Bus stop, a lot of time there is huge traffic.	
Lessen the pollution	Metro will reduce the existing traffic load & start to lessen the pollution.	
Need of other modes of transportation	It is actually needed. All the IT offices are in SIPCOT, SIPCOT there is hardly frequency in bus.	

Low frequency of Buses in this route.	Metro is also needed in Polase, Panoramallo as the residents there are solely dependent on non frequent bus services.
Time saving	frequency of bus is too low for metro will abate the time. Traffic is too much, not only in peak hours for one there two
Reduce traffic	Metro will decrease the traffic load & reduce in accidents & pollution.

Name of Participant	Signature	Name of Participant	Signature
D. Arun Kumar		9840308309	
Mahesh		8675325099	
Padmitha		9470531986	
Sanitha vijay		9840531986	
Paul James Ali		9052196672	
A. Sathish		8157389868	
	A. Sathish	9894368407	

FORMAT FOR PUBLIC CONSULTATION

Location: Luz Junction, Mylapore, Thirumylai

Date/Time: 29/05/2017

Perception about the project:

1. Do you think that Metro rail is necessary Chennai city? Yes/ No Yes No
2. What impacts, both positive and negative of the project do you foresee?

S.N	Positive Impact	Remark	S.N	Negative Impact	Remark
1	Shorten the trip		1	Land Acquisition	
2	Enhance local economy		2	Loss of livelihood	
3	Increase employment opportunity		3	Loss of income	
4	Increase facilities		4	Loss of house/shop	
5	Decrease in accident		5	Loss of customers & supplies	
6	Increase in property value		6	Disruption of social/cultural/economic	
7	Improvement in transportation system		7	Increase in Crime Rates	
8	Decrease Greenhouse gas emission		8	Increase in Migration	
9	Increase educational level		9	Disadvantage to the environment (damage of park, tree etc)	
10	Others (Specify)		10	Other (Specify)	

3. Issues

Issues raised/ Discussed	Suggestion by Stakeholders	Remark
Increase Connectivity	Metro Good for all - Increase connectivity. long term it will	
Solve Traffic Jam	Too much traffic in this area Metro or rail reduce the traffic	
Old area & building may collapse during tunneling work.	It is very old area, if it is underground metro, the old building may collapse. Risk of building collapse.	many heritage building is nearby many building are coming old.
Tunneling Accident	This is the main area, if the similar accident, will be difficult & costly	
Reduce traffic	Traffic less. Due to vehicles there is huge traffic & pollution level is so high. Metro will solve the traffic issue.	

<p>Underground trade not suitable for Mysore - as it is a very old area with heritage buildings - temples, church, etc. Many buildings/residences are century old, therefore there is a great risk of collapses.</p> <p>Business to bs due to commercial activity</p>	<p>If construction activity go long more than expected, then commercial/slops their business will be affected.</p> <p>The commutation/transportation charges are higher. The charges should be less.</p>	
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Name of Participant

Signature

Name of Participant

Signature

Faizol - 9860742545

Dishad Ali - 9884835501

Croathann - 944464066

Leona -

Karthikeyan - 9790928875

SETAN - 9952399498

Venugopal - 9884375252

FAIZOL

DISHAD ALI

CROATHANN

LEONA

KARTHIKEYAN

SETAN

VENUGOPAL

PUBLIC CONSULTATION

Location: Poonamallee Bus Terminus
 Date/Time: 03/07/2018

Perception about the project:

1. Do you think that Metro rail is necessary for the city? Yes/ No
2. What impacts, both positive and negative of the project do you foresee?

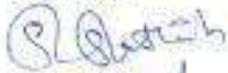
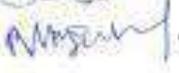
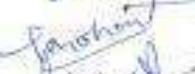
S.N	Positive Impact	Remark	S.N	Negative Impact	Remark
1.	Shorten the time/trip		1.	Land Acquisition	
2.	Enhance local economy		2.	Loss of livelihood/income	
3.	Increase employment opportunity		3.	Loss of house/shop	
4.	Increase facilities		4.	Loss of customers	
5.	Decrease in accidents		5.	Disruption of social/cultural/economic	
6.	Increase in property value		6.	Increase in Crime Rates	
7.	Improvement in transportation system		7.	Increase in Migration	
8.	Decrease Greenhouse gas emission		8.	Damage of park, tree etc.	
9.	Increase educational facilities		9.	Other(Specify)	
10.	Others(Specify)				

3. Issues

Issues raised/ Discussed	Suggestion by Stakeholders	Remark
Compensation	Due to metro train, other facilities and infrastructure will surely develop, but participants strongly suggested that the affected structure/people should get adequate compensation in order to re-instate the life of people.	
Loss of Livelihood	Being a small shop owner, our livelihoods will totally less. There has to be adequate provision of compensation.	

Reduction in pollution	Metro will reduce the existing traffic and reduce the level of pollution.
Reduced Road Accidents	Metro will reduce the traffic and reduced in road accidents.
Construction may result in traffic jam	Construction activity will result traffic jam. As this place is fully commercial metro construction may not disrupt the traffic flow.
Green House Effect	In Chennai city, the greenery is not that it is low and further infrastructure development will further will reduce the green cover and need to be taken care of.
Time will be reduced for travelling Area Development	The traffic is huge due to nearby colleges and commercial area nearby. Metro train will be helpful to reduce the traffic load. Due to metro train, other facilities will come such as infrastructure development. Local economy will boost up.

NO Requirement of Metro	We don't want a metro we want highways and overbridges only.	
Low metro fare fares are required	The existing transportation charges are too high unless it is less or decreased metro will not be successful fare must be reasonable.	

Name of Participant	Signature	Mobile No.
① Satish —		9884871117
② Niyamashakar. —		
③ Rajan —		
④ Ramesh —		
⑤ Mani. —		8428600820
⑥ V Anuram —		852506699
⑦ G. Mohan —		
⑧ K. Vignesh —		
⑨ Raja —		
⑩ Anuraj. —		- 9791011282
⑪ G. Ganeshkumar —		- 8428671189
⑫ Anur Kumar, P. V. S. —		- 9025034145

PUBLIC CONSULTATION

Location: G. V. Appanthanangal Bus Depot

Date/Time: 03/07/2018

Perception about the project:

1. Do you think that Metro rail is necessary for the city? Yes/ No
2. What impacts, both positive and negative of the project do you foresee?

S.N	Positive Impact	Remark	S.N	Negative Impact	Remark
1.	Shorten the time/trip	✓	1.	Land Acquisition	✓
2.	Enhance local economy		2.	Loss of livelihood/income	
3.	Increase employment opportunity	✓	3.	Loss of house/shop	✓
4.	Increase facilities	✓	4.	Loss of customers	
5.	Decrease in accidents	✓	5.	Disruption of social/cultural/economic	
6.	Increase in property value	✓	6.	Increase in Crime Rates	
7.	Improvement in transportation system	✓	7.	Increase in Migration	✓
8.	Decrease Greenhouse gas emission	✓	8.	Damage of park, tree etc.	✓
9.	Increase educational facilities		9.	Other(Specify)	
10.	Others(Specify)				

3. Issues

Issues raised/ Discussed	Suggestion by Stakeholders	Remark
Time Save	The respondents said that the metro facility in the city of Chennai will save their time to reach to the destinations, in comparison with other means.	
Traffic Issues and increase connectivity	The respondents suggested that the metro project will reduce traffic and commutation in the city. the long distance travel will be easy and metro will increase the connectivity.	

<p>Travel time will be reduce and the traffic.</p>	<p>The respondents said that the travel time will be reduce due to the proposed metro project.</p>	
<p>Convenient travel.</p>	<p>It would be easy to reach the destination.</p>	
<p>Pollution will be reduced.</p>	<p>There is ^{less} scope for air pollution. Metro will lessen limit the traffic and ultimately reduce the existing high level of pollution both noise and air.</p>	
<p>Traffic</p>		
<p>Reduced Road Accidents</p>	<p>There would be no accidents while travelling in metro.</p>	
<p>Travel time would reduce.</p>	<p>The metro facility in the city will save the time of the passengers.</p>	
<p>Employment Opportunity aspirant</p>	<p>There would be scope for job opportunity of fresh Engineers.</p>	

Loss of livelihood.	Local vendors would be affected badly.	
High cost of metro ticket. bargaining	The price of the metro fare should be as minimum as possible considering the bargaining power of the people.	

Name of Participant	Occupation	Signature	Mobile No.
① S. GUNA		S. GUNA	9566208259
② Saiphan		Saiphan	9894773228
③ S. Manoj		S. Manoj	- 9094521242
④ Susha (Lawyer)		S. Susha	7058247381
⑤ Srinivaran		S. Srini	9626982579
⑥ Mugesh		Mugesh	- 8940395189
⑦ Silambarasan		S. Silambarasan	
⑧ Harish (Engineer)		Harish	- 8056920895
⑨ Martin (Engineer)		Martin	- 7502158671
⑩ G. Karthikeyan		G. Karthikeyan	- 7299539796
⑪ R. Kumareavel (Employee) (Hyundai)		R. Kumareavel	- 7419606607
⑫ Chandru (Employee) (Hyundai car company)		Chandru	- 9500331658

PUBLIC CONSULTATION

Location: **DEPOT AREA - Consider- 4 Extension**

Date/Time: **20/11/2018, 12:34 P.M.**

Perception about the project:

1. Do you think that Metro rail is necessary for the city? Yes? No?
2. What impacts, both positive and negative of the project do you foresee?

S.N	Positive Impact	Remark	S.N	Negative Impact	Remark
1.	Shorten the time/trip		1	Land Acquisition	
2.	Enhance local economy		2	Loss of livelihood/income	
3.	Increase employment opportunity		3	Loss of house/shop	
4.	increase facilities		4	Loss of customers	
5.	Decrease in accidents		5.	Disruption of social/cultural/economic	
6.	Increase in property value		6	Increase in Crime Rates	
7.	Improvement in transportation system		7	Increase in Migration	
8.	Decrease Greenhouse gas emission		8	Damage of park, tree etc	
9.	Increase educational facilities		9	Other(Specify)	
10.	Others(Specify)				

3. Issues

Issued raised/ Discussed	Suggestion by Stakeholders	Remark
Time Saving	It will become easier for us to have convenient/easy transport system.	
Loss of livelihood/ Income	The respondent said that they will lose their livelihood/income if their work workplace/land gets acquired for the metro project.	
and traffic Pollution during construction of the project site.	The respondent said that there is a possibility to have pollution and traffic problem during the construction of the metro project.	

High Rate of Metro Ticket	<p>The minimum metro ticket price in Chennai metro is ₹50. The middle class citizens will not be able to afford that money on a regular basis. So, they are using the bus services mostly. The ticket rate is 50 from 1st to 2nd point but from the 2nd point to 3rd point the cost shall be less considering the longer distance and lesser ticket rate like the Indian Railway. As a result, the labourer class will be benefitted.</p>
Loss of pollution (Both air and noise).	<p>After the introduction of the metro project the air and noise pollution will decrease.</p>
Loss of land and small enterprises	<p>The loss of land and the small company is a major issue for the employees (small) belong to a lower middle class family. They will lose their source of livelihood.</p>
Safety and Security.	<p>The lady respondent said that the proposed metro project will be helpful for her because metro offers a special compartment for ladies only. She will travel</p>
<p>safe and secured rather than travelling in Bus.</p>	

<p>Loss of Taxes and Pondy Land (Green)</p>	<p>Loss of taxes in another major concern according to the respondents. The tree plantation needs to be taken care of and followed up by the competent authority.</p>
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Name of Participant	Signature	Mobile No.
1. Felix	P. Felix	7708681990
2. P. Sureshivel	P. Sureshivel	8939251236
3. K. Thennarasu	K. Thennarasu	7010436589
4. K. Kaleimena	K. Kaleimena	9566192663
5. Vined Kumar.	Vined Kumar	9884466936
6. Divakaran.	Divakaran	9840913199
7. Sudhakar.	Sudhakar	9566002497
8. Nagesh.	Nagesh	

Kutchery road



Alwarpet



Poonamallee Bus Terminal



Iyyappathangal Bus Depot



Proposed Metro Depot



Public Consultations at Station Locations **Onsite 2018 and 2019**

Bharathidasan Road



Chennai Metro Rail Limited

PUBLIC CONSULTATION

Location: *Bharathidasan Road*

Date/Time: *21/9/2018*

Perception about the project:

1. Do you think that Metro rail is necessary for your city? Yes/ No

Yes = 8

NO = 2

2. What impacts, both positive and negative of the project do you foresee?

S.N	Positive Impact	Remark	S.N	Negative Impact	Remark
1	Shorten the trip	✓	1	Land Acquisition	
2	Enhance local economy		2	Loss of livelihood	✓
3	Increase employment opportunity	✓	3	Loss of income	✓
4	Increase facilities		4	Loss of house/shop	✓
5	Decrease in accident	✓	5	Loss of customers & supply	
6	Increase in property value	✓	6	Disruption of social/cultural/economic	
7	Improvement in transportation system	✓	7	Increase in Crime Rates	
8	Decrease Greenhouse gas emission	✓	8	Increase in Migration	
9	Increase educational level		9	Disadvantage to the environment (damage of park, tree etc)	
10	Others (Specify)		10	Other (Specify)	

3. Issues

Issued raised/ Discussed	Suggestion by Stakeholders	Remark

S.No	Name	Age	Sex	Occupation	Signature
1	Sardar	43	Male	Food Shop (Hd)	<i>T. Sardar</i>
2	Krishnakumar	31	Male	Xerox Shop	<i>K. Kumar</i>
3	Kimbaradevi	24	Female	Nurses	<i>K. Kimbaradevi</i>
4	Thilak	30	Female	Saloon	<i>Thilak</i>
5	Swarna	31	Female	Dry cleaners	<i>Swarna</i>
6	Selva	29	Female	Station Shop	<i>Selva</i>
7	Srinisha	30	Female	Beverly Parlor	<i>Srinisha</i>
8	Pavithra	31	Female	Housewife	<i>Pavithra</i>
9	T. Ramesh	30	Male	Provision shop	<i>T. Ramesh</i>
10	Vasanthi.K.	23	Female	Business (Retail)	<i>Vasanthi</i>

Vadapalani



Chennai Metro Rail Limited

PUBLIC CONSULTATION

Location: Vadapalani

Date/Time: 3/9/2018

Perception about the project:

1. Do you think that Metro rail is necessary for your city?

Yes/ No

Yes - 7

No - 3

2. What impacts, both positive and negative of the project do you foresee?

S.N	Positive Impact	Remark	S.N	Negative Impact	Remark
1	Shorten the trip	✓	1	Land Acquisition	
2	Enhance local economy		2	Loss of livelihood	✓
3	Increase employment opportunity	✓	3	Loss of income	✓
4	Increase facilities		4	Loss of house/shop	✓
5	Decrease in accident	✓	5	Loss of customers & supply	
6	Increase in property value	✓	6	Disruption of social/cultural/economic	
7	Improvement in transportation system	✓	7	Increase in Crime Rates	
8	Decrease Greenhouse gas emission		8	Increase in Migration	
9	Increase educational level		9	Disadvantage to the environment (damage of park, tree etc)	✓
10	Others (Specify)		10	Other (Specify)	

3. Issues

Issues raised/ Discussed	Suggestion by Stakeholders	Remark

S.No	Name	Age	Sex	Occupation	Signature
1	V. Rajasekhar	37	Male	Business	[Signature]
2	Chandras	35	Male	Business	[Signature]
3	Selvaraj	42	Male	oil & iron shop	[Signature]
4	Uthayakumar	33	Male	Studio	[Signature]
5	Rajkumar	42	Male	Electronics Shop	[Signature]
6	Muthugan	43	Male	Bank shop	[Signature]
7	Rambhadrar	42	Male	Iron shop	[Signature]
8	Chandrasekhar	43	Male	Hotel	[Signature]
9	Seena	45	Female	Flower Shop	[Signature]
10	Vimal Raj	35	Male	Business	[Signature]
11	Alfonsa	41	Female	Gift Shop	[Signature]
12	Adarsh Raj	42	Male	Mobile Service	[Signature]

Chief Adarsh

Valasaravakkam



Chennai Metro Rail Limited

PUBLIC CONSULTATION

Location: Valasaravakkam

Date/Time: 20th / 12/2016

Perception about the project:

1. Do you think that Metro rail is necessary for your city? Yes/ No

Yes = 6
No = 2

2. What impacts, both positive and negative of the project do you foresee?

S.N	Positive Impact	Remark	S.N	Negative Impact	Remark
1	Shorten the trip	✓	1	Land Acquisition	
2	Enhance local economy		2	Loss of livelihood	✓
3	Increase employment opportunity		3	Loss of income	
4	Increase facilities	✓	4	Loss of house/shop	✓
5	Decrease in accident		5	Loss of customers & supply	
6	Increase in property value	✓	6	Disruption of social/cultural/economic	
7	Improvement in transportation system	✓	7	Increase in Crime Rates	
8	Decrease Greenhouse gas emission	✓	8	Increase in Migration	✓
9	Increase educational level		9	Disadvantage to the environment (damage of park, tree etc)	
10	Others (Specify)		10	Other (Specify)	

3. Issues

Issues raised/ Discussed	Suggestion by Stakeholders	Remark

S.No	Name	Age	Sex	Occupation	Signature
1	Vellaisamy	45	Male	Tea Shop	[Signature]
2	G. S. Kar	40	Male	Medical Shop	[Signature]
3	Sanjeevan	30	Male	Tea Shop	[Signature]
4	Srin Lal	35	Male	Electrostation	[Signature]
5	Mahesh	36	Male	Bakery	[Signature]
6	Pajareddy	41	Male	Sulcod	[Signature]
7	Dhyanraj	42	Male	Center	[Signature]
8	Jothi	33	Female	Garment Making	[Signature]

Alapakkam



Chennai Metro Rail Limited

PUBLIC CONSULTATION

Location: Alapakkam

Date/Time: 27/10/2018

Perception about the project:

1. Do you think that Metro rail is necessary for your city? Yes/No

YES = 9
NO = 3

2. What impacts, both positive and negative of the project do you foresee?

S.N	Positive Impact	Remark	S.N	Negative Impact	Remark
1	Shorten the trip	✓	1	Land Acquisition	
2	Enhance local economy		2	Loss of livelihood	
3	Increase employment opportunity		3	Loss of income	✓
4	Increase facilities		4	Loss of house/shop	✓
5	Decrease in accident		5	Loss of customers & supply	✓
6	Increase in property value		6	Disruption of social/cultural/economic	✓
7	Improvement in transportation system		7	Increase in Crime Rates	
8	Decrease Greenhouse gas emission	✓	8	Increase in Migration	
9	Increase educational level		9	Disadvantage to the environment (damage of park, tree etc)	
10	Others (Specify)		10	Other (Specify)	

3. Issues

Issues raised/ Discussed	Suggestion by Stakeholders	Remark

S.No	Name	Age	Sex	Occupation	Signature
1	Prabhakaran	38	Male	Town Shop	[Signature]
2	Eugene	37	Male	Electric Shop	[Signature]
3	Suliam	39	Male	Coptic	[Signature]
4	Sarthan	32	Male	Marketing	[Signature]
5	Taxi R	24	Female	Studying MBA	[Signature]

Iyyappathangal Bus Depot



Metro Rail Limited

PUBLIC CONSULTATION

Location: *Iyyappanthalangal Bus Depot* Date/Time: *12/1/2019*

Perception about the project:

1. Do you think that Metro rail is necessary for your city? Yes/ No

Yes = 1

No = 2

2. What impacts, both positive and negative of the project do you foresee?

S.N	Positive Impact	Remark	S.N	Negative Impact	Remark
1	Shorten the trip	✓	1	Land Acquisition	✓
2	Enhance local economy		2	Loss of livelihood	✓
3	Increase employment opportunity		3	Loss of income	
4	Increase facilities	✓	4	Loss of house/shop	✓
5	Decrease in accident		5	Loss of customers & supply	
6	Increase in property value	✓	6	Disruption of social/cultural/economic	
7	Improvement in transportation system	✓	7	Increase in Crime Rates	
8	Decrease Greenhouse gas emission	✓	8	Increase in Migration	
9	Increase educational level	✓	9	Disadvantage to the environment (damage of park, tree etc)	
10	Others (Specify)		10	Other (Specify)	

3. Issues

Issues raised/ Discussed	Suggestion by Stakeholders	Remark

S.No	Name	Age	Sex	Occupation	Signature
1	<i>Rajendran</i>	<i>25</i>	<i>Male</i>	<i>Vendor shop</i>	<i>Rajendran</i>
2	<i>Prasanna</i>	<i>33</i>	<i>Male</i>	<i>Freelance work</i>	<i>Prasanna</i>
3	<i>Aravindhan</i>	<i>24</i>	<i>Male</i>	<i>IT</i>	<i>Aravindhan</i>
4	<i>Sudhakar</i>	<i>24</i>	<i>Male</i>	<i>Software shop</i>	<i>Sudhakar</i>
5	<i>Disadvantage</i>	<i>25</i>	<i>Male</i>	<i>Business shop</i>	<i>Disadvantage</i>
6	<i>Almitia</i>	<i>25</i>	<i>Female</i>	<i>IT shop</i>	<i>Almitia</i>
7	<i>Prasanna</i>	<i>33</i>	<i>Male</i>	<i>Freelance work</i>	<i>Prasanna</i>

Kattupakkam



Chennai Metro Rail Limited

PUBLIC CONSULTATION

Location: Kattupakkam

Date/Time: 10/1/2019

Perception about the project:

1. Do you think that Metro rail is necessary for your city? Yes/No

Yes = 8

No = 3

2. What impacts, both positive and negative of the project do you foresee?

S.N	Positive Impact	Remark	S.N	Negative Impact	Remark
1	Shorten the trip	✓	1	Land Acquisition	✓
2	Enhance local economy	✓	2	Loss of livelihood	✓
3	Increase employment opportunity		3	Loss of income	
4	Increase facilities	✓	4	Loss of house/shop	
5	Decrease in accident	✓	5	Loss of customers & supply	
6	Increase in property value		6	Disruption of social/cultural/economic	
7	Improvement in transportation system	✓	7	Increase in Crime Rates	
8	Decrease Greenhouse gas emission	✓	8	Increase in Migration	✓
9	Increase educational level		9	Disadvantage to the environment (damage of park, tree etc)	
10	Others (Specify)		10	Other (Specify)	

3. Issues

Issues raised/ Discussed	Suggestion by Stakeholders	Remark

S.No	Name	Age	Sex	Occupation	Signature
1	Sivalingam	36	Male	Xi-tar Shop	[Signature]
2	Sarathnathan	50	Male	Mechanic	[Signature]
3	Kumar	48	Male	Business	[Signature]
4	Thangavel	57	Male	Laundry Shop	[Signature]
5	Mary	52	Female	House Keeping	[Signature]
6	Prasanna	45	Female	House Keeping	[Signature]
7	K. J. M.	42	Male	Brigade Shop	[Signature]
8	K. J. M.	42	Male	Brigade Shop	[Signature]
9	Aravind	29	Male	Chicken Shop	[Signature]
10	M. S. S.	30	Male	Freight Station	[Signature]
11	M. S. S.	30	Female	Freight Station	[Signature]

