# Environmental & Social Impact Assessment (ESIA) and Environmental & Social Management Plan (ESMP)

## Swargate to Katraj

## (South Extension of Phase 1)


**MAHARASHTRA METRO RAIL CORPORATION LIMITED**

Pune Metro Rail Project, A2, A3 Block Civil Court Interchange Metro Station, Nyaymurti Ranade Path, Shivajinagar, Pune-411005, Maharashtra, Website: https://www.punemetrorail.org


## IND: Pune Metro Rail Project

**(Final Report - October, 2025)**


Prepared by **MITCON Consultancy & Engineering Services Limited** for **Maharashtra Metro Rail Corporation Limited, Pune Metro Rail Project (PMRP) Phase 1 Extension** under the Funding of **European Investment Bank (EIB)**

# TABLE OF CONTENTS

TABLE OF CONTENTS ..... ii
LIST OF TABLES ..... iv
LIST OF FIGURES ..... v
LIST OF ANNEXURES ..... vii
ABBREVIATIONS ..... viii
EXECUTIVE SUMMARY ..... xi
A. PROJECT OVERVIEW ..... xi
B. OBJECTIVES OF THE ESIA-ESMP ..... xi
C. FINDINGS AND IMPACTS ..... xi
D. CONCLUSION AND RECOMMENDATIONS ..... xii
Chapter 1. INTRODUCTION ..... 1
A. BACKGROUND ..... 1
B. OBJECTIVE OF THE STUDY ..... 2
C. SCOPE OF THE ESIA-ESMP STUDY ..... 2
D. ESIA ESMP CONSULTANT ..... 3
E. ENVIRONMENTAL& SOCIAL IMPACT ASSESSMENT ..... 4
Chapter 2. POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK ..... 7
A. NATIONAL ENVIRONMENTAL LAWS, POLICIES AND REGULATIONS ..... 7
B. INTERNATIONAL AND REGIONAL AGREEMENTS AND CONVENTIONS ..... 12
C. APPLIED STANDARDS ..... 29
Chapter 3. PROJECT DESCRIPTION ..... 31
A. RATIONALE ..... 31
B. DESCRIPTION OF SWARGATE TO KATRAJ (PHASE-1 EXTENSION) PROJECT ..... 31
C. CONSTRUCTION ACTIVITIES & METHODOLOGY ..... 61
D. IMPLEMENTATION PLAN & CONSTRUCTION SCHEDULE ..... 67
E. DETAILED PROJECT COST ESTIMATE ..... 67
F. ASSOCIATED FACILITIES ..... 69
Chapter 4. ENVIRONMENTAL AND SOCIAL BASELINE DATA ..... 70
A. INTRODUCTION ..... 70
B. DATA COLLECTION METHODOLOGY ..... 70
C. ENVIRONMENTAL PARAMETERS ..... 72
D. PHYSICAL / LAND ENVIRONMENT ..... 72
E. AMBIENT ENVIRONMENT ..... 84
F. WATER ENVIRONMENT ..... 98
G. ECOLOGY AND BIODIVERSITY ..... 108
H. SOCIO ECONOMIC ENVIRONMENT ..... 127
Chapter 5. ANTICIPATED IMPACTS AND MITIGATION MEASURES ..... 133
A. METHODOLOGY ..... 133
B. IDENTIFICATION OF ENVIRONMENTAL COMPONENTS ..... 133
C. SCREENING OF IMPACTS ..... 136

D. IMPACTS PRIOR TO MITIGATION ..... 140
E. ANTICIPATED IMPACTS AND MITIGATION MEASURES ..... 141
F. POSITIVE IMPACTS OF SWARGATE TO KATRAJ (PMRP PHASE 1 EXTENSION) ALIGNMENT ..... 176
G. CARBON CREDIT STUDY ..... 177
Chapter 6. ANALYSIS OF ALTERNATIVES ..... 179
A. PROJECT PURPOSE ..... 179
B. PUBLIC TRANSPORT PLAN IN CMP ..... 179
C. SCREENING CRITERIA FOR IDENTIFIED ALTERNATIVES ..... 183
D. "DO NOTHING" SCENARIO ..... 185
Chapter 7. PUBLIC CONSULTATIONS AND INFORMATION DISCLOSURE ..... 186
A. CONSULTATIONS ..... 186
B. IDENTIFICATION OF STAKEHOLDERS ..... 187
C. SCOPE OF WORK ..... 188
D. METHODOLOGY ..... 188
E. DISCUSSION WITH LOCAL PEOPLES ..... 189
F. STAKEHOLDER ENGAGEMENT ..... 192
G. PLAN FOR FUTURE PUBLIC CONSULTATIONS ..... 199
H. INFORMATION DISCLOSURE ..... 199
Chapter 8. GRIEVANCE REDRESSAL MECHANISM ..... 200
A. INTRODUCTION ..... 200
B. CONSTITUTION OF GRIEVANCE REDRESS COMMITTEE (GRC) ..... 200
Chapter 9. ENVIRONMENTAL & SOCIAL MANAGEMENT PLAN (ESMP) ..... 203
A. INTRODUCTION ..... 203
B. OBJECTIVES OF ENVIRONMENTAL MANAGEMENT PLAN ..... 203
C. INSTITUTIONAL ARRANGEMENT ..... 203
D. ESMP FOR SWARGATE TO KATRAJ (PHASE-1 EXTENSION): ..... 206
E. ESMP BUDGET ..... 253
F. DEVELOPMENT AND IMPLEMENTATION OF SUB-PLANS ..... 253
G. ENVIRONMENTAL MONITORING PLAN (EMOP) ..... 256
H. GENERAL CONDITIONS FOR E&S WELFARE ..... 260
I. TRAINING AND CAPACITY BUILDING PROGRAMS ..... 261
Chapter 10. CONCLUSION AND RECOMMANDATION ..... 262

# LIST OF TABLES

Table 1-1: Description of Swargate to Katraj (Phase-1 Extension) ..... 2
Table 1-2: Structure of the ESIA-ESMP Report ..... 6
Table 2-1: Applicable Permissions and Clearances for Swargate to Katraj (Phase-1 extension) project ..... 8
Table 2-2: Summary of Applicable Legislation for Swargate to Katraj (Phase-1 Extension) ..... 9
Table 3-1 Swargate to Katraj (Phase-1 Extension) with chainage ..... 32
Table 3-2 Design Value Summary ..... 33
Table 3-3 Area Chart ..... 56
Table 3-4 Standards of Signalling System ..... 57
Table 3-5: Power Demand Estimation (MVA) Existing Corridor 1 (PCMC to Swargate) ..... 57
Table 3-6: Incremental Power Demand Estimation of Swargate to Karaj ..... 58
Table 3-7 Summary of Parking Management strategies ..... 65
Table 3-8 Proposed Project Implementation Plan (As per DPR) ..... 67
Table 3-9 Capital Cost Estimate of Swargate - Katraj (July '21 Price Level) ..... 68
Table 3-10: Infrastructure Facilities: Hill Park View Depot ..... 69
Table 3-11: Infrastructure Facilities: Range Hill Depot ..... 69
Table 4-1 Environmental Parameters and Frequency of Monitoring ..... 72
Table 4-2 Generalized Stratigraphy of Pune District ..... 75
Table 4-3 Soil Sampling Locations for Swargate to Katraj (Phase-1 Extension) ..... 77
Table 4-4 Results of Soil Sampling locations in study area ..... 80
Table 4-5 Land Use in the Study Area (Cumulative) ..... 81
Table 4-6 Affected structures / places due to discharge of Mutha River in the vicinity of project site ..... 83
Table 4-7 Average of Meteorological Data from RMC – IMD Pune ..... 85
Table 4-8 Measurement Techniques ..... 87
Table 4-9 Justification for selection of AAQ locations ..... 87
Table 4-10 Ambient Air Quality Stations monitored in Project Study Area ..... 87
Table 4-11 Summary of Results of Ambient Air Quality monitoring ..... 90
Table 4-12 National and International Ambient Air Quality Standards ..... 90
Table 4-13 Noise Sampling Locations of Swargate to Katraj (Phase-1 Extension) ..... 91
Table 4-14 Summary of Noise Monitoring Results ..... 93
Table 4-15 Guidelines/Standards with respect to Noise ..... 93
Table 4-16 Vibration Sampling Locations of Swargate to Katraj (Phase-1 Extension) ..... 94
Table 4-17 Baseline Vibration levels at various locations ..... 96
Table 4-18 CMFRI guidelines w.r.t. Vibration ..... 96
Table 4-19 Directorate General of Mines Safety (DGMS) guidelines w.r.t. Vibration ..... 96
Table 4-20 Monitoring Stations for Surface Water Quality Assessment ..... 102
Table 4-21 Monitoring Stations for Ground Water Quality Assessment ..... 102
Table 4-22 Summary of Surface Water Quality Analysis ..... 107
Table 4-23 Summary of Groundwater Quality Analysis ..... 107
Table 4-24 Summary of the Ecological Studies Carried Out ..... 108
Table 4-25 Girth-wise Summary of Trees to be Affected along Swargate-Katraj (PMRP Phase 1 extension) ..... 110
Table 4-26: Floral Diversity observed in the Project Study Area ..... 112
Table 4-27: Faunal Community of Study Area ..... 117
Table 4-28: Checklist of Mammal Diversity ..... 118
Table 4-29: Avian Diversity of study area ..... 118
Table 4-30: Herpetofauna Diversity in Study Area ..... 121
Table 4-31: Checklist of Butterfly Diversity ..... 122
Table 4-32: Checklist of Moth Diversity in Study Area ..... 122
Table 4-33 Checklist of Spider Diversity ..... 123
Table 4-34: Dragonfly and Damsel-Fly Diversity of Pune ..... 124
Table 4-35: List of Fish diversity in nearby waterbodies ..... 124
Table 4-36: List of Gardens nearest to Alignment ..... 126
Table 4-37: List of Nearest Protected and Environmentally Sensitive Areas ..... 126
Table 4-38: Demographics of Pune District ..... 128
Table 4-39: Number PAPs HHs Members ..... 130
Table-4-40: Social Categories of PAPs from affected HHs ..... 131
Table-4-41: Religious Categories of PAPs from the affected HHs ..... 131
Table-4-42: Vulnerable Categories of affected HHs ..... 131
Table-4-43: Income Level of PAPs ..... 131
Table-4-44: Educational Status of PAPs ..... 131

Table-4-45: Occupational Status of PAPs ..... 132
Table-4-46: School Going Status of Children ..... 132
Table-4-47: Major Sources of Income by Surveyed Families ..... 132
Table 4-48: Participation of Women in Decision Making ..... 132
Table 5-1: Sensitivity of VECs in the project area ..... 134
Table 5-2: Criteria for Rating the Significance of Adverse Impacts ..... 135
Table 5-3: Screening of Environmental Impacts ..... 137
Table 5-4 Average Noise Levels Generated by Various Construction Equipment ..... 143
Table 5-5 Actual Noise Levels Generated by Various Construction Equipment ..... 144
Table 5-6 Maximum Exposure Periods Specified by WBG-EHS guidelines ..... 145
Table 5-7 Features of rolling stock and track ..... 146
Table 5-8: Predicted Noise levels due to Metro Operation ..... 147
Table 5-9: Vibration Impacts on above-ground structures during Construction and their Mitigation Measures ..... 150
Table 5-10: Impacts at different stages of project cycle ..... 160
Table 5-11 Ownership Status of Affected Private Structures ..... 162
Table 5-12 Types and Usage of Affected Private Structures ..... 162
Table 5-13 Type of Construction of the Private Structure ..... 162
Table 5-14 Land Use Details of Affected Land ..... 163
Table 5-15 Organizations Responsible for Utilities and Services ..... 163
Table 5-16 Intensity of Impact on Land ..... 166
Table 5-17 Intensity of Impact on Structure ..... 166
Table 5-18 Details of Land Acquisition Requirement ..... 167
Table 5-19 Land Acquisition and Resettlement Impacts ..... 167
Table 5-20 Impact on Livelihoods ..... 169
Table 5-21 Loss of Community Property Resources ..... 169
Table 5-22 Salient features of the CDM for Carbon Credits ..... 178
Table 5-23 Carbon emission estimation ..... 178
Table 6-1: Mass Transport Systems with their respective Environmental & Social impacts ..... 179
Table 6-2: Weightage of Screening Criteria For Qualitative Evaluation ..... 183
Table 6-3 Comparative analysis of "Do Nothing" Scenario vs. With Project Scenario ..... 185
Table 7-1: Detailed list of Stakeholders involved in the project ..... 187
Table 7-2: Methodology for Public Consultations ..... 188
Table 7-3: Details of FGDs and Public Consultations ..... 189
Table 7-4: Summary & Findings of Public Consultations held as part of ESIA study ..... 189
Table 7-5: Stakeholders Engagement Methods ..... 193
Table 7-6: Stakeholders Engagement Strategy ..... 193
Table 7-7: Information Dissemination and Mode of Disclosure ..... 196
Table 9-1: Monitoring and Reporting for ESMP and ESMoP ..... 206
Table 9-2: Environmental and Social Management Plan (ESMP) Matrix ..... 207
Table 9-3 Summary of ESMP Budget for Swargate to Katraj (Phase-1 Extension) ..... 253
Table 9-4: Contractors' Sub-plans and Approval Requirements ..... 253
Table 9-5: ESMoP Swargate to Katraj (Phase-1 Extension) ..... 257
Table 9-6: General Conditions for Environment and Social Welfare ..... 260
Table 9-7: Tentative Schedule of the Training Programs for Environmental Engineers ..... 261

## LIST OF FIGURES

Figure 1-1: Pune Metro Phase 1 Extension project (Swargate to Katraj Alignment) ..... 3
Figure 1-2: Methodology followed in the present ESIA studies ..... 5
Figure 3-1 Alignment Map of Swargate to Katraj (Phase-1 Extension)) showing station locations ..... 32
Figure 3-2: Sequence of stations along Swargate to Katraj (PMRP Phase 1 extension) project ..... 36
Figure 3-3: Station 1 - Market Yard (Gultekadi) ..... 36
Figure 3-4: Station 2 - Bibwewadi ..... 37
Figure 3-5: Station 3 - Padmavati ..... 37
Figure 3-6: Station 4 - Balajinagar ..... 38
Figure 3-7: Station 5 - Katraj ..... 38
Figure 3-8: Station Market Yard, Gultekdi - Road Section ..... 41
Figure 3-9: Station Market Yard, Gultekdi - Plan ..... 42
Figure 3-10: Station Bibwewadi - Road Section ..... 43
Figure 3-11: Station Bibwewadi - Plan ..... 44
Figure 3-12 Station Padamavati - Road Section ..... 46
Figure 3-13: Station Padamavati - Plan ..... 47
Figure 3-14: Station Balajinagar- Road Section ..... 48

Figure 3-15: Station Balajinagar- Plan ..... 49
Figure 3-16 Station Katraj - Road Section ..... 50
Figure 3-17: Station Katraj - Plan ..... 51
Figure 3-18: Concourse Level Floor Plan ..... 53
Figure 3-19: Mezzanine Level Floor Plan ..... 54
Figure 3-20: Platform Level Floor Plan ..... 55
Figure 3-21 Typical Cross Section (TCS) of Proposed Metro Stations ..... 56
Figure 3-22: Typical Twin Tunnel Arrangement ..... 62
Figure 3-23: Excavation of Tunnels using TBM ..... 63
Figure 3-24: Ring Segment ..... 63
Figure 3-25 Typical Traffic Diversion Plan - One Way ..... 65
Figure 3-26 Typical Traffic Diversion Plan - Two Way ..... 65
Figure 4-1 Satellite map of the Swargate to Katraj (Phase-1 Extension) showing Project Study area ..... 71
Figure 4-2 DEM of the Core and Buffer study areas of Swargate to Katraj (Phase-1 Extension) ..... 74
Figure 4-3 Geology of Project Study Area of Swargate to Katraj (Phase-1 Extension) as per GSI – Pune DRM . 76
Figure 4-4 Photographs of Soil Sampling ..... 78
Figure 4-5 Soil sampling locations for Swargate to Katraj (Phase-1 Extension) ..... 79
Figure 4-6 Land Use / Land Cover in 500 m Core Study Area of Swargate to Katraj ..... 82
Figure 4-7 BMTPC Earthquake Hazard Map of Maharashtra ..... 84
Figure 4-8 Annual Wind-rose – Pune ..... 85
Figure 4-9 Climatological Norm at Pune ..... 86
Figure 4-10 Photographs taken during Air-sampling in the Project Study Area ..... 88
Figure 4-11 Ambient Air Quality Monitoring Locations ..... 89
Figure 4-12: Noise Monitoring Sampling Locations ..... 92
Figure 4-13 Vibration Sampling Locations ..... 95
Figure 4-14: Guidelines for Noise and Vibrations, RDSO India, Sept 2015 for General Assessment ..... 97
Figure 4-15 Caltrans Guidelines for Vibration Damage Potential Threshold Criteria ..... 97
Figure 4-16 Human Response to typical levels of Ground-Borne Vibration (GBV) ..... 97
Figure 4-17 Ground-Borne Vibration (GBV) and Ground-Borne Noise (GBN) Impact Criteria for General Assessment ..... 98
Figure 4-18: Drainage Pattern in 2km study area of Swargate to Katraj (Phase-1 Extension) ..... 99
Figure 4-19 Hydrology of Pune district ..... 100
Figure 4-20 Surface Water monitoring locations ..... 103
Figure 4-21 Groundwater monitoring locations ..... 104
Figure 4-22 Some Photographs Showing Surface Water Quality Monitoring ..... 105
Figure 4-23 Some Photographs Showing Groundwater Quality Monitoring ..... 106
Figure 4-24 Tree Surveys undertaken in Project Study Area ..... 110
Figure 4-25: Dominant genera (type of flora) found in the Project Study Area ..... 111
Figure 4-26: Bird Diversity - IUCN Status ..... 118
Figure 5-1: Typical Vibration Propagation Curve for Tunnel Boring Machine (TBM) ..... 149
Figure 5-2: Section showing the cross-section of underground track levels ..... 149
Figure 5-3: Vibration source levels for construction equipment (FTA) ..... 150
Figure 5-5 Process of Registering Carbon Credits ..... 177
Figure 5-6 How Carbon Markets work ..... 178
Figure 5-7 Types of Carbon Credit Markets ..... 178
Figure 8-1 Grievance Redressal Mechanism for Swargate to Katraj Project ..... 202

# LIST OF ANNEXURES


| | | |
|---|---|---|
| Annexure-1 | | NABET Certificate |
| Annexure-2 | | Ambient Air Quality and Noise Quality Analyses (Laboratory Reports) |
| Annexure-3 | | Water Quality Analyses (Laboratory Reports) |
| Annexure-4 | | Soil Quality Analyses (Laboratory Reports) |
| Annexure-5 | | Air Quality Modelling / Ground Level Concentrations (GLCs) Report |
| Annexure-6 | | List of Trees likely to be Affected |
| Annexure-7 | | Bidding documents for the design and construction of Swargate to Katraj project including Maha Metro's Safety, Health & Environment (SHE) Manual |
| Annexure-8 | | Terms of Reference (ToR) for External Monitoring Agency |
| Annexure-9 | | Guidelines/Tasks for GC in implementation of ESMP and EMoP |
| Annexure-10 | A | Guidelines for Site Selection and Management Plan |
| Annexure-10 | B | Muck Handling Plan |
| Annexure-11 | | Vibration Modelling Report |
| Annexure-12 | | List of Sensitive Receptors |
| Annexure-13 | | Public Consultation Report |
| Annexure-14 | | Noise Modelling Report |
| Annexure-15 | | Tunnel Worker Safety Assessment & Mitigation Plan |

# ABBREVIATIONS

| | | |
|---|---|---|
| AIDS | - | Acquired immunodeficiency syndrome |
| BGL | | Below Ground Level |
| BRTS | - | Bus Rapid Transit System |
| C&D | - | Construction and Demolition |
| CAWT | - | Coalition Against Wildlife Trafficking |
| CBD | - | Convention on Biological Diversity |
| CBR | - | Climate Bank Roadmap |
| CBSE | - | Central Board for Secondary Education |
| CGWA | - | Central Ground Water Authority |
| CGWB | - | Central Ground Water Board |
| CITES | - | Convention on International Trade in Endangered Species of Fauna and Flora |
| CMP | - | Comprehensive Mobility Plan |
| CMS | - | Convention on the Conservation of Migratory Species |
| CPCB | - | Central Pollution Control Board |
| CRZ | - | Coastal Regulatory Zone |
| CtE | - | Consent to Establish |
| CtO | - | Consent to Operate |
| DNAH | - | Do Not Significant Harm |
| DP or DP/s | - | Displaced Person/s |
| DRM | - | District Resource Map |
| E&S | - | Environmental & Social |
| EHS | - | Environmental, Health, and Safety |
| EIA | - | Environmental Impact Assessment |
| EIB | - | European Investment Bank |
| EMoP | - | Environmental Monitoring Plan |
| EMP | - | Environmental Management Plan |
| EMS | - | Environment Management System |
| EPR | - | Environment Protection Rules |
| ESF | - | Environment and Social Framework |
| ESHS | - | Environment, Social, Health and Safety |
| ESI | - | Employees State Insurance |
| ESIA | - | Environmental & Social Impact Assessment |
| ESMP | - | Environmental & Social Management Plan |
| ESP | - | Environment and Social Policy |
| FGD | - | Focus Group Discussions |
| FTA | - | Federal Transit Administration |
| GC | - | General Consultants |
| GI | - | Galvanised Iron |
| GoI | | Government of India |
| GoM | - | Government of Maharashtra |
| GRC | - | Grievance Redress Committee |
| GRM | - | Grievance Redress Mechanism |
| GTF | - | Global Tiger Forum |
| HCA | - | Host Country Approval |
| HIV | | Human immunodeficiency viruses |
| HT/HT line | - | High Tension / High Tension line |
| HW | - | Hazardous Waste |
| IFC-PS | - | International Finance Corporation – Performance Standards |
| ILO | - | International Labour Organization |
| IMD | - | Indian Meteorological Department |
| INR | - | Indian National Rupee/s |
| ITTC | - | International Tropical Timber Organization |
| IUCN | - | International Union for Conservation of Nature and Natural Resources |
| IWC | - | International Whaling Convention |
| KBA/s | - | Key Biodiversity Area/s |
| KLD | - | Kilo Litres Per Day |

| | | |
|---|---|---|
| LAP | - | Land Acquisition Plan |
| LRT | - | Light Rail Transit System |
| MDB/s | - | Multilateral Development Bank/s |
| MFD | - | Maharashtra Forest Department |
| MFR | - | Model Factories Rules |
| MMRDA | - | Mumbai Metropolitan Region Development Authority |
| MoEF&CC | - | Ministry of Environment, Forests and Climate Change |
| MPCB | - | Maharashtra Pollution Control Board |
| MRTS | - | Mass Rapid Transit System |
| MSEB | - | Maharashtra State Electricity Corporation Limited |
| MSW | - | Municipal Solid Waste |
| NA | - | Not Applicable |
| NAAQS | - | National Ambient Air Quality Standards |
| NBWL | - | National Board of Wildlife |
| NGT | - | National Green Tribunal |
| NTH | - | Non-title Holders |
| ODP | - | Ozone Depleting Potential |
| PAP/s | - | Project Affected Person/s |
| PC | - | Public Consultation |
| PCMC | - | Pimpri Chinchwad Municipal Corporation |
| PCR | - | Project Completion Report |
| PEB | - | Pre-Engineering Building |
| PIU | - | Project Implementation Unit |
| PMC | - | Pune Municipal Corporation |
| PMRP/-P1 | - | Pune Metro Rail Project / - Phase 1 |
| PRT | - | Personal Rapid Transit |
| RAP | - | Resettlement Action Plan |
| RDSO | - | Railway Design & Standards Organisation |
| RWH | - | Rainwater Harvesting |
| SAICM | - | Strategic Approach to International Chemicals Management |
| SEIAA | - | State Environment Impact Assessment Authority |
| SHE | - | Safety, Health & Environment |
| SHEO | - | Safety, Health and Environmental Officer |
| SIA | - | Social Impact Assessment |
| SPS | - | Safeguards Policy Statement |
| SPV | - | Special Purpose Vehicle |
| SWD | - | Solid Waste Disposal |
| TBM | - | Tunnel Boring Machine |
| TH | - | Title Holders |
| ToD | - | Transit oriented Development |
| TRAFFIC | - | The Wildlife Trade Monitoring Network |
| UNCCD | - | United Nations Convention to Combat Desertification |
| UNESCO | - | United Nations Educational, Scientific and Cultural Organization |
| UNFCCC | - | United Nations Framework Convention on Climate Change |
| UNFF | - | United Nations Forum on Forests |
| USD | - | United States Dollar |
| VEC | - | Valued Environmental Components |
| VOC | - | Volatile Organic Compounds |
| WB | - | World Bank |
| WBG-EHS | - | World Bank Group – Environment, Health and Safety |
| WHO | - | World Health Organization |

## WEIGHTS AND MEASURES

| | | |
|---|---|---|
| amsl / AMSL | - | above mean sea level |
| $^{o}C$ | - | degree Celsius |
| cu.m | - | cubic meters |
| dB(A) | - | decibel acoustic |
| ha. | - | hectare |
| km | - | kilometer |
| km/h, kmph | - | kilometer per hour |
| KLD | - | Kilo litre per day |
| kWe | - | kilowatt-electric |
| kV | - | Kilo volt(s) |
| kVA | - | kilo Volt-Amps |
| kW | - | kilowatt |
| m | - | meter |
| mm | - | millimetre |
| MLD | - | Million litre per day |
| msl / MSL | - | mean sea level |
| 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 |
| MT | - | metric tons |
| 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., FY2024 ends on 31 March 2024.

(ii) In this report, "$" refers to USD and “₹” refers to INR.

# EXECUTIVE SUMMARY

The Swargate to Katraj (Phase-1 Extension) of the Pune Metro Rail Project (PMRP) is a key infrastructure initiative to improve urban mobility in Pune. The 5.9 km fully underground extension covers five stations—Market Yard (Gultekdi), Bibwewadi, Padmavati, Balajinagar, and Katraj—and is financed by the European Investment Bank (EIB). The project responds to the city's growing transport demand, aiming to reduce congestion, air pollution, and reliance on private vehicles.
The Environmental and Social Impact Assessment (ESIA) and Environmental and Social Management Plan (ESMP) have been prepared in line with national regulations and the EIB Environmental and Social Standards.

## A. PROJECT OVERVIEW

Pune's rapid growth in population, industrialization, and private vehicle ownership has caused severe traffic congestion and deteriorating air quality. The Phase-1 extension from Swargate to Katraj forms part of the Pune Metro Master Plan, offering a sustainable, high-capacity public transport alternative.

## B. OBJECTIVES OF THE ESIA-ESMP

- Impact Assessment: Evaluate likely environmental and social impacts during construction and operation.
- Mitigation Planning: Identify measures to prevent, reduce, or offset adverse effects.
- Regulatory Compliance: Ensure conformity with national legislation and EIB safeguard requirements.
- Stakeholder Engagement: Incorporate views of affected communities through consultations and a grievance redress mechanism.

## C. FINDINGS AND IMPACTS

### *1. Environmental Impacts*

- **Air Quality:** Dust and emissions expected during construction. Mitigation through dust suppression, covered transport of materials, and monitoring.
- **Noise and Vibration:** Short-term elevation during tunneling and station works, particularly near sensitive receptors. Mitigation includes use of low-noise equipment, vibration control measures, and acoustic enclosures.
- **Water Resources:** Dewatering and tunneling activities may affect groundwater. Controlled pumping, recharge measures, and monitoring are recommended.
- **Ecology:** Tree cutting is unavoidable, with compensatory plantation proposed at a ratio greater than 1:3 as per updated ESMP. Impacts on fauna remain minimal.

### *2. Social Impacts*

- **Traffic Disruption:** Temporary traffic congestion due to construction activities along existing road corridors.
- **Community Impact:** Potential inconvenience to local businesses and restricted access to public services.
- **Worker Safety:** Occupational health and safety risks during construction phases.
- **Acquisition of Land from Land and structure owners:** The project requires permanent acquisition of approximately 6,193.23 sq.m of land, of which 40.37% (2,500.32 sq.m) is private land and the remaining 59.63% (3,692.91 sq.m) is government-owned. In addition, 40,692.01 sq.m of land will be temporarily used, primarily government-owned, with 6.76% (2,748.90 sq.m) being private. Land acquisition may lead to physical and economic displacement, particularly for owners of commercial structures, resulting in disruption to livelihoods and community dynamics. Private landowners will be compensated as per the RFCTLARR Act, 2013 or through the Maharashtra Direct Purchase Policy. Temporary land will be taken on lease with mutually agreed compensation, and is confirmed to be free from agricultural activity or informal occupation.
- **Resettlement:** As per the census survey, a total of 71 Project Affected Families (PAFs) will be impacted. Among these, 34 families face significant impact and are considered economically displaced, with most losing more than 50% of their commercial structures. This includes both titleholders and non-titleholders (NTHs), primarily operating commercial enterprises. Only one household is partially losing a secondary residential structure (boundary wall) and two families are losing secondary commercial boundary

walls, which do not require relocation. All economically displaced families will be eligible for relocation assistance in accordance with the project's entitlement matrix and EIB safeguard standards.

- **Loss of Livelihood:** The primary livelihood impacts are associated with displacement of commercial establishments such as retail shops, tea stalls, eateries, *paan* shops, and similar small-scale enterprises. There are no reported impacts on residential-cum-commercial structures or individuals engaged solely in wage employment. For those economically displaced, Maha Metro will provide compensation for lost income and access to livelihood restoration measures including skill training, linkage to government schemes, and support to restore or improve income levels and living standards.

### *3. Mitigation Measures*

To address the identified impacts, the ESMP outlines a comprehensive set of mitigation measures, including:

- **Air & Noise Control:** Dust suppression, noise barriers, low-emission machinery.
- **Water & Waste Management:** Safe disposal of wastewater, regulated muck and C&D waste disposal, hazardous waste handling.
- **Traffic Management:** Diversion plans, signage, and real-time monitoring.
- **Occupational Health & Safety:** Safety gear, training, and compliance with OHS standards.
- **Resettlement & Livelihood Restoration:** Compensation under RFCTLARR Act, Maharashtra Direct Purchase Policy, and livelihood restoration measures (skill training, government scheme linkages, income restoration).
- **Tree Plantation & Biodiversity:** Enhanced compensatory afforestation and green belt development.

### *4. Stakeholder Engagement and Public Consultation*

Public consultation has been an integral part of the ESIA process. Multiple consultations were conducted with local communities, government agencies, and other stakeholders. Feedback from these sessions has been incorporated into the project's design and management plan. Key concerns included traffic management, noise control, and timely project implementation. The project also established a **Grievance Redress Mechanism (GRM)** to address community grievances during construction and operation.

Consultations and discussions were held along the project corridor with the affected families and other stakeholders. All affected Families were consulted while interacting with them during the project census survey. Consultation meetings were organized to get wider public input from both the primary and secondary stakeholders. In addition to the individual consultation with all affected Families during census survey, a total of 66 including 28 males and 38 females were consulted in 5 consultation meetings/focused group discussions. Apart from this formal Public Consultations were conducted at two locations along the alignment in April 2025, a detailed report of which is presented in **Annexure-13**. The project has received acceptability among the local people as it is expected to provide smooth flow of traffic and reduce travel time, reduce fuel consumption and subsequently reduce air emissions. The project would bring positive socio-economic changes in the area.

### *5. Institutional Framework and Legal Compliance*

The project complies with relevant national legislation, including the **Environment (Protection) Act, 1986**, and the **Air and Water Pollution Acts**. It also aligns with the **EIB Environmental and Social Standards**. The **Metro Rail Policy 2017** guides the sustainable development of metro projects in India, ensuring integration with other urban transport systems.

The project does not require prior environmental clearance under India's Environmental Impact Assessment Notification, 2006, as metro rail systems are exempt from Environmental Clearance. However, necessary clearances for tree felling, waste management, and water usage will be obtained before construction.

## D. CONCLUSION AND RECOMMENDATIONS

The **Swargate to Katraj (Phase-1 Extension)** will significantly improve public transport accessibility, reduce traffic congestion, and promote sustainable urban development in Pune. While the project may

have moderate environmental and social impacts during construction, these can be effectively managed through the proposed mitigation measures.
The following recommendations are made for the successful implementation of the project:

1. **Strict Adherence to the ESMP:** Ensure continuous monitoring and compliance with mitigation measures.
2. **Enhanced Stakeholder Communication:** Maintain transparent communication with stakeholders throughout the project lifecycle.
3. **Capacity Building:** Conduct training programs for project staff on environmental and social safeguards.
4. **Grievance Redressal:** Strengthen the GRM to address community concerns promptly.

**In conclusion, the project will deliver substantial socio-economic benefits, supporting Pune's growth as a smart, sustainable city while minimizing environmental risks**.

# Chapter 1. INTRODUCTION

## A. BACKGROUND

1. The eighth largest metropolis in India, Pune is located in the state of Maharashtra. It is the second largest city in the state after Mumbai, and is an important city in terms of its economical and industrial growth. Once the hometown of the mighty Marathas and a centre of power for the Maratha Empire, the presence of the numerous edifices in Pune links to its rich and glorious past, and the city leads as the 'veritable heartland' of cultural Maharashtra. Pune also has made its mark as the educational epicentre winning itself the sobriquet, '*The Oxford of the East*'. Not just that, it has a growing industrial hinterland, with information technology, engineering and automotive companies sprouting. The city is known for cultural activities like classical music, spirituality, theatre, sports, and literature. Pune is a pleasant travel getaway destination to spend a quiet holiday.

2. Pune & Pimpri Chinchwad is the next largest urban conglomerate to Mumbai Metropolitan Region in Maharashtra. These cities are considered to be an educational hub due to the establishment of large number of educational institutes across the city. Pune & Pimpri Chinchwad have been experiencing tremendous growth in population and employment since the last two decades. The growth in various industries, particularly automobile, IT and IT enabled services, in and around Pune & Pimpri Chinchwad has added further impetus to the urban sprawl and increase in population and employment. Further urbanization of Pune & Pimpri Chinchwad will receive a big impetus in the next 30 years due to the ambitious development plan of the 7000 sq. km Pune Metropolitan Region.

3. At present, the public transport system in Pune & Pimpri Chinchwad consists mainly of buses, and a few services of Bus Rapid Transit (BRT) System and suburban rail. The public transport share has been completely overthrown by the tremendous growth in private vehicle transport. The vicious cycle of increase in private vehicle ownership (mostly two-wheelers and cars) has become unstoppable due to the increased transport demand and lack of convenient public transport options. In a nutshell, in the absence of augmentation of mass transit services, Pune may head towards unsustainable urban transport scenario. In order to augment public transport system to cater to the rapid increase in demand for transportation services and make urban transportation in Pune & Pimpri Chinchwad sustainable, the implementation of metro rail was envisaged, and Metro Master Plan was prepared by Delhi Metro Rail Corporation (DMRC) in 2008.

### 1. Swargate to Katraj (Phase-1 Extension)

4. In order to alleviate the transport-related problems in the city, CMP for Pune has been prepared in 2018. It identifies various short, medium and long-term measures of transport infrastructure in the city. CMP recommends mass transport systems along major travel corridors. Based on the proposals from CMP, an alternatives analysis has been carried out to find the most viable mass transit system along identified corridors. Alternatives analysis report recommends extension of mass transit swargate to katraj in order to meet the future traffic demand.

5. Maharashtra Metro Rail Corporation Ltd. (Maha Metro) is a joint venture company of the Government of India (GoI) and Government of Maharashtra (GoM) established under the Companies Act, 2013 for the purpose of implementation of Metro Rail projects within Maharashtra, excluding the Mumbai metropolitan area. Maha Metro as the implementing agency, will be responsible for implementing, operating, and maintaining the city's metro system.

### 2. Nature, Size and Location

6. The Phase 1 Extension of the Pune Metro Rail Project received the "In Principal" approval of Government of Maharashtra (GoM) in October 2013. These extensions, as part of the PMRP Phase 1 Extension project comprises the following two alignments:

- Extension of PMRP Phase 1 from PCMC to Nigdi in the North (North extension alignment);
- Extension of PMRP Phase 1 from Swargate to Katraj in the South (South extension alignment).

7. Swargate to Katraj (Phase 1 extension) project has also received "In Principal" approval from GoM in October 2013. Subsequently Technical Approval and Administrative Approval have also been obtained for the project from State Government. The project is proposed to be financed by the European

Investment Bank (EIB).

8. As per the updated Detailed Project Report (DPR) for Swargate to Katraj (Phase-1 Extension) dated Dec. 2022, the project covers around 5.9 km (5 underground stations) as summarised in **Table 1-1** and shown in **Figure 1-1**:.

*Table 1-1: Description of Swargate to Katraj (Phase-1 Extension)*[1]

| Corridor | Stations | | | Length (in Km) As per DPR | | |
|---|---|---|---|---|---|---|
| | Underground | At Grade | Total | Elevated | Underground | Total |
| Swargate to Katraj (Phase-1 Extension) | 5 | **0** | **5** | 0 | 5.9 | 5.9 |
| **Total** | **5** | **0** | **5** | **0** | **5.9** | **5.9** |

## B. OBJECTIVE OF THE STUDY

9. The objective of the Swargate to Katraj (Phase-1 Extension) project is to strengthen the need for augmenting the transport infrastructure in PMC region. Rapid urbanization and intense commercial development in the recent past have resulted in steep rise in travel demand, putting the existing city's transport infrastructure to stress.

10. The objectives of this ESIA study and ESMP is to, but not limited to, identify and assess any potential positive or negative impacts the project may have on the environmental and social areas, propose mitigation and management measures to either improve the positive impacts or to prevent, reduce or control the negative effects, while proposing also a monitoring program and management plans. In addition, the assessment intends to identify, monitor and manage any residual risks. The ESIA–ESMP studies also intend to raise awareness about development approaches that are ecologically sustainable.

## C. SCOPE OF THE ESIA-ESMP STUDY

11. The scope of work for the EISA study for entire stretch is given below:

(i) Undertake Environmental & Social Impact Assessment (ESIA) and prepare Environmental & Social Management Plan (ESMP) in accordance with international funding agency policies (e.g., EIB, World Bank, IFC) and relevant environmental standards and regulations.

(ii) Review national, state, and local environmental regulations and assess external factors for project compliance. Identify and describe all applicable laws, regulations, and necessary approvals/consents for the project.

(iii) Conduct field visits, reconnaissance survey and consultation with local stakeholders; develop an environmental screening framework and categorization system to assess project impacts.

(iv) Identify environmental hot spots and conduct habitat analysis, including ecological baseline assessments.

(v) Establish baseline environmental conditions by conducting air, noise and vibration, surface and ground water quality monitoring. Study existing surface and subsurface water conditions and assess project location sensitivity. Conduct inventory surveys of sensitive receptors and assess impacts on land use patterns.

(vi) Conduct comprehensive Public Consultations through focus group discussion (FGD), Questionnaire survey (QS) and other methods to ensure stakeholders/ affected people are consulted on the project and their views are as part of the design, construction and operation of the project.

(vii) Based on environmental baseline established, carry out impact identification for environmental parameters like air, noise, vibration (through necessary modelling), ecology and socioeconomic environment.

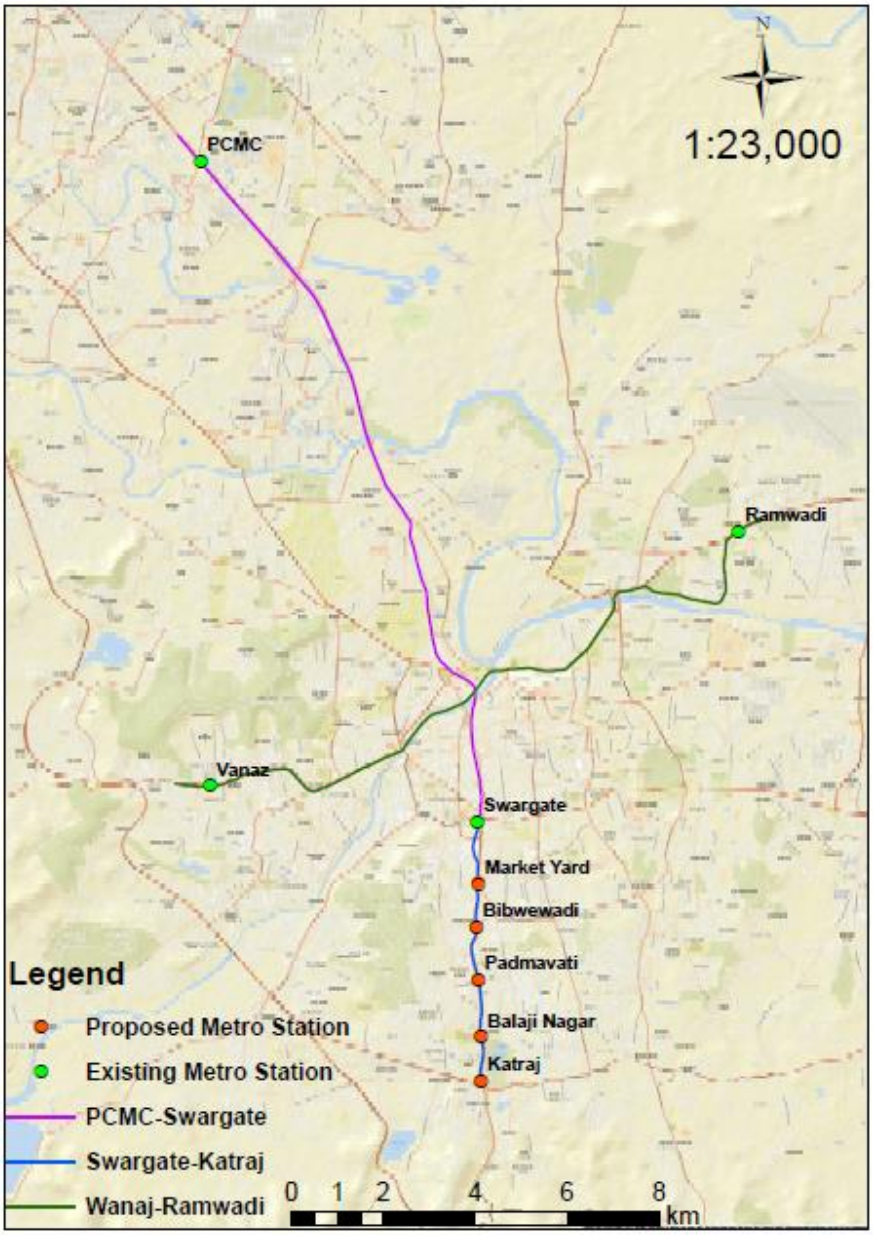
(viii) Describe and evaluate project alternatives considering technical, environmental, and social aspects.

(ix) Develop mitigation measures, environmental management, and monitoring plans,

[1] *Source: Revised Final Detailed Project Report (Swargate to Katraj) dated Dec 2022*

including public consultation and disclosure strategies, as per applicable national laws and international funding agency guidelines.

*Figure 1-1: Pune Metro Phase 1 Extension project (Swargate to Katraj Alignment)*[2]




## D. ESIA ESMP CONSULTANT

12. MITCON Consultancy & Engineering Services Ltd. is a rapidly growing ISO 9001-2015 certified consultancy company, promoted by ICICI, IDBI, IFCI, and state corporations of Maharashtra and public commercial banks. It was founded in 1982, with its Head Office at Pune and with supporting offices spread over the entire country including Mumbai, Delhi, Bangalore, Hyderabad, Chennai, Chandigarh, and Ahmadabad, etc. With experience, expertise and track record developed over the last almost three decades, MITCON provides diverse range of macro and micro consultancy services in the areas of environment management and engineering (EME), energy efficiency, biomass and co-gen power, agricultural business and bio-technology, infrastructure, market research, banking finance and securitization, micro enterprise development, IT training and education. EME division of MITCON serves various sectors like – GIS and RS, solid waste management, infrastructure, power, sugar, engineering, chemical, real estate, etc.

13. MITCON Consultancy & Engineering Services Ltd. is accredited from National Accreditation Board for Education and Training (NABET), Quality Council of India for EIA consultancy services in 14

[2] *Source: Revised Final Detailed Project Report (Swargate to Katraj dated Dec 2022)*

sectors; NABET Certificate (No.: NABET/EIA/24-27/RA 0343 valid till Feb 2027) is attached as **Annexure-1** of this report.

## E. ENVIRONMENTAL& SOCIAL IMPACT ASSESSMENT

### 1. Categorization

14. Based on preliminary assessment of significance of impacts borne out of field visits and secondary information, Pune Metro Rail Project Swargate to Katraj (Phase-1 Extension) will be expected to have significant impacts on noise, vibration, health and safety (mostly occupational), some air quality issues due to dust, etc. However, the proposed project will bring in many benefits to the project area.

15. The civil works of Swargate to Katraj (Phase-1 Extension) will entail construction of underground stations. Thus, the civil works may increase congestion and pose safety risks for traffic on the existing roads. Moreover, transport of large quantities of construction material and heavy equipment machinery may bring safety risks and inconvenience to the local communities in the project area. Thus, environmental risks associated with the Swargate to Katraj (Phase-1 Extension) Metro Project are significant in nature. However, these can be effectively reduced through the application of mitigation plan. Therefore, even if the project does not require an EIA/EMP report for clearance from Ministry of Environment, Forest and Climate Change (MoEFF&CC), Government of India (GoI) it is classified as **High Risk** for environmental and social safeguards as per the EIB Group Environmental and Social Policy (February 2, 2022).

.

16. Rail-based systems have been excluded from the scheduled list under the EIA Notification of 2006 and its subsequent amendments under the under the Environment (Protection) Act, 1986. Therefore, the proposed Swargate to Katraj (Phase 1 extension) metro project is not required to secure prior environmental clearance in the form of an approved EIA from the MoEF&CC, GoI as per national policies and regulations. Similarly, the metro stations and depots proposed along the metro rail corridor being part of Metro Rail project do not attract EIA Notification 2006, prescribing environmental clearance.

### 2. Purpose of the Environmental & Social Impact Assessment Report

17. This ESIA report documents the environmental impact and social impact assessment for Swargate to Katraj (Phase-1 Extension) project. In this report the different activities that are likely to take place during construction and operation have been analysed and the accompanying potential impacts, , have been discussed. The ESIA addresses the environmental management requirements of GoI as well as those of the international funding agencies. In general, the ESIA Report is outlined as below to address various aspects:

(i) Provide background of the project in terms of land use, existing metro rail network and the proposed Metrorail corridors, methodology of preparation of the report and its content;
(ii) Analysis of policy and legal framework within which environmental safeguards for the project will be recommended and implemented;
(iii) Provide information about the baseline environmental settings;
(iv) Provide information on potential environmental impacts of Swargate to Katraj (Phase-1 Extension) with its magnitude, distribution, and duration;
(v) Provide information on required mitigation measures with cost to minimize the impacts;
(vi) Analysis of the alternatives considering alternative locations, designs, management approaches, for selection of most feasible and environmental acceptable options;
(vii) Provide details of stakeholders' consultations;
(viii) Plans for stakeholders to communicate grievances and suggestions and for their redressal; and
(ix) Formulate environmental management and monitoring plan with institutional measures for effective implementation of mitigation measures proposed.

### 3. Approach and Methodology

18. As shown in **Figure 1-2** , the ESIA study shall follow a number of steps, viz.:

(i) Review of available baseline reports, DPR, and other technical reports / studies related

to Swargate to Katraj (Phase-1 Extension).

(ii) Conduct field visits to collect primary and / or secondary data relevant to Swargate to Katraj (Phase-1 Extension) to establish the environmental baseline;

(iii) Assess the potential impacts on environmental, social and health & safety attributes due to the location, design, installation and operation of Swargate to Katraj (Phase-1 Extension) through field investigations and data analysis;

(iv) Explore opportunities for; environmental and health and safety enhancement and identify measures.

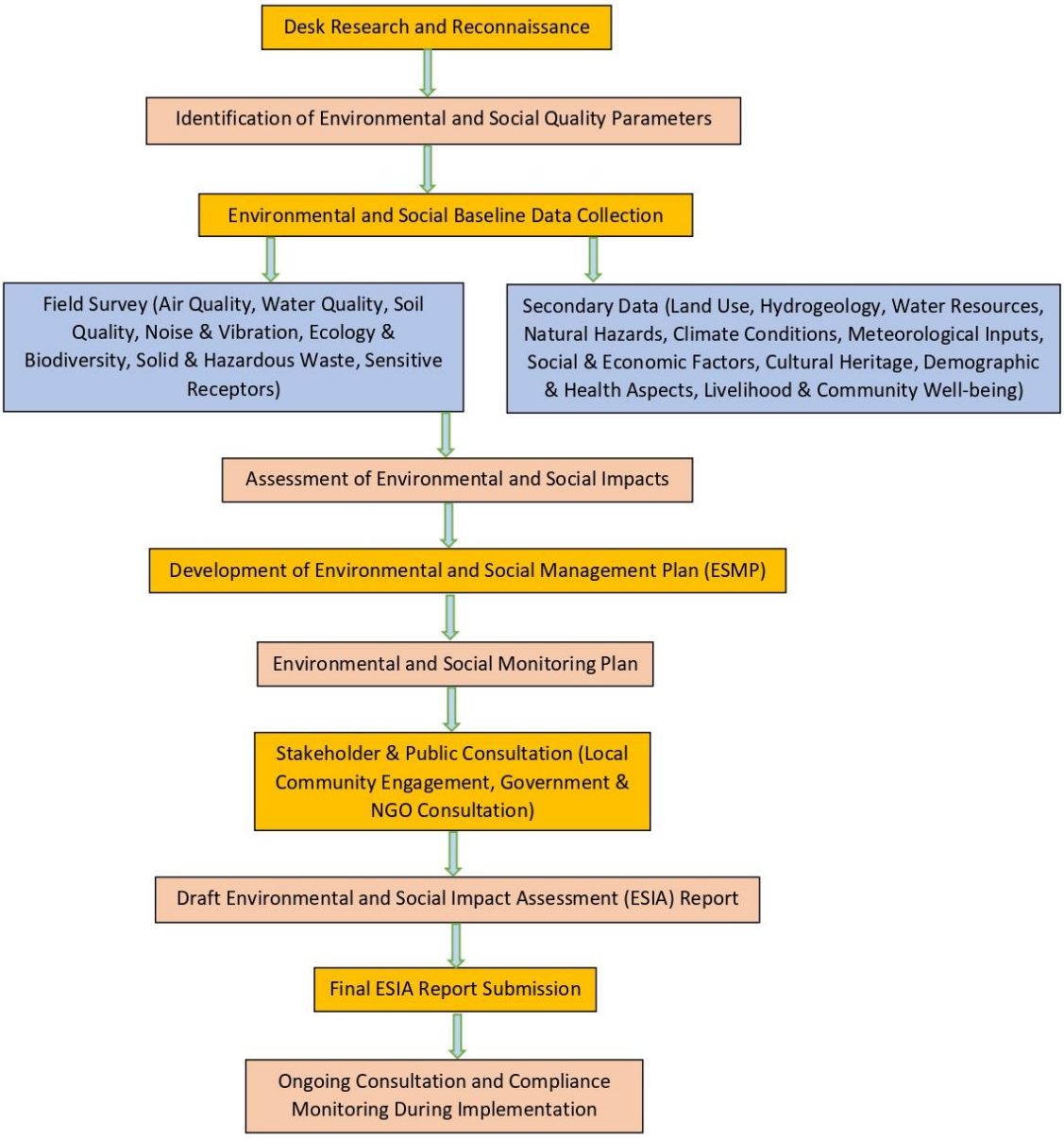
(v) Prepare an ESMP outlining the measures for mitigating the impacts identified, including the institutional arrangements;

(vi) Identify critical environmental parameters required to be monitored subsequent to the implementation of Swargate to Katraj (Phase-1 Extension) and prepare an EMoP;

(vii) Carry out consultation with key stakeholders and administrative authorities to identify their perception on Swargate to Katraj (Phase-1 Extension) by introducing project components and anticipated impacts; and

(viii) Disclose the draft ESIA at Maha Metro and EIB websites and prepare the executive

*Figure 1-2: Methodology followed in the present ESIA studies*




19. The baseline data for air, water and soil quality was collected in width 100 m distance on either side of proposed centre line of the Swargate to Katraj (Phase-1 Extension) alignment while noise and vibration in width 50 m on either side of alignment. Sensitive receptors located in width 100 m on either

side of centre line of alignment were identified according to the silence zone defined by the Central Pollution Control Board (CPCB). The structure of the ESIA report is summarised in **Table 1-2**:.

*Table 1-2: Structure of the ESIA-ESMP Report*

| No. | Item | Remarks |
|---|---|---|
| - | Executive Summary | Non-Technical Summary highlighting project details in terms of Environmental and social Impacts. |
| Chapter 1 | Introduction | Introduction about the project, objectives and scope of work. |
| Chapter 2 | Policies, legal and administrative framework | Provides over all legal frame work in relation to required regulatory compliance and institutional arrangement. |
| Chapter 3 | Project description | This chapter describes the details of the proposed metro corridors. |
| Chapter 4 | Environmental baseline | This chapter provides description on the present environmental setting of the project area. |
| Chapter 5 | Anticipated impacts and mitigation measures | This chapter describes the environmental impacts associated with the proposed project during construction and operation phases, as well as the suggested measures for mitigation of the same |
| Chapter 6 | Analysis of alternatives | This chapter provides a description of the qualitative and quantitative assessment of various alternatives considered. |
| Chapter 7 | Public consultations and information disclosure | This chapter explains in brief about the pubic consultations carried out for the project |
| Chapter 8 | Grievance redress mechanism (GRM) | Description of the GRM in place for the project is given in this chapter |
| Chapter 9 | Environmental & Social management plan (ESMP) | Environmental strategy to offset / mitigate the probable adverse impacts, including the environmental monitoring plan (EMoP), has been outlined in this chapter. |
| Chapter 10 | Conclusions and Recommendations | This chapter summarizes the conclusions of this EIA EMP Report and outlines specific recommendations, if any. |

# Chapter 2. POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK

20. India has a well-defined institutional and legislative framework with respect to its environment. The legislation covers all components of environment viz. air, water, soil, terrestrial & aquatic flora and fauna, natural resources, and sensitive habitats, etc. 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. The funding agencies involved in this project also have defined environmental and social policies in place. This chapter will describe the applicability of above laws and regulations, conventions, protocols, and safeguards with regards to the Swargate to Katraj (Phase-1 Extension).

21. 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:

(i) National (India) Environmental Legislation and Institutional Framework,
(ii) EIB environmental and social policies and standards, and
(iii) Summary of international treaties and applicability to the project.

## A. NATIONAL ENVIRONMENTAL LAWS, POLICIES AND REGULATIONS

22. GoI'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.

### 1. Metro Rail Policy 2017

23. Before the Metro Rail Policy 2017, the National Urban Transport Policy of 2006 governed urban transport in India. The policy included interventions such as Bus Rapid Transit System (BRTS), urban transit infrastructure, and financing for metro rail projects.

24. The Union Cabinet, Government of India (GoI) 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 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. Required Clearances and/or Permissions

25. Railway/ Metro Rail projects in India are not listed among activities requiring prior environmental clearance in GoI's EIA Notification 2006 and therefore Swargate to Katraj (Phase-1 Extension) project does not require environmental clearance from MoEF&CC. However other milestones which need attention in this context, w.r.t Infrastructure projects in India, are briefly mentioned here:

(i) In 1992, in case of Konkan Railway, the Bombay High Court held that Environment Act 1986 had no application in respect of works undertaken under Railway Act 1989, which supersedes the same;
(ii) In February 2015, in case of Signature Road bridge in Delhi, the NGT held that construction of a 'bridge' or similar activity covering a built-up area ≥ 1,50,000 sq.m and/or covering an area of ≥ 50 hectares, would be covered under Entry 8(b) of Schedule to the EIA Notification 2006 and ordered the project proponent to obtain environmental clearance. environmental clearance was applied for and subsequently granted in February 2017.
(iii) In March 2016, in the case of Pune Metro (Phase I) as well as that of Mumbai Metro (9 Metro rail corridors in MMRDA), the MoEF&CC clarified that construction of buildings within Metro Rail projects for commercial purposes such as a mall, offices or residential buildings, etc. having built-up area equal to or more than 20,000$m^2$ will require prior environmental clearance from SEIAA and that the project has to incorporate green building features, rain water harvesting system, energy efficiency, water conservation, sewage and/or effluent treatment and/or disposal, solid waste management, vehicle parking, etc.

(iv) In May 2016, the National Green Tribunal (NGT) held that Metro construction from Noida to Greater Noida is a project covered under 8(b) of the Schedule to the Notification of 2006 as per the area of construction and directed project proponent to obtain environmental clearance. In September 2016 Supreme Court stayed NGT order which required prior environmental clearance for railway and Metro rail projects.

(v) In June 2017, ToR was issued for prior environmental clearance in the redevelopment of Anand Vihar railway station under section 8(b) of Schedule to EIA Notification 2006.

26. In light of the above, prior environmental clearance is not required for Swargate to Katraj (Phase-1 Extension), if commercial development equal to or above threshold of 20,000 sq.m is not proposed. As all 5 proposed metro stations have built-up areas lesser than 20,000 sq.m, no environmental clearance is required for the same. Since Environmental Clearance is not required for Metro Projects hence Public Consultation is also not required. However, Public consultations have been conducted to meet out the EIB E&S Requirement. Moreover, before the start of civil works for any section of Swargate-Katraj (Phase-1 Extension), Maha Metro through the contractor, must obtain necessary clearances and/or permissions related to environment and labour safeguards from statutory authorities of GoI, as applicable these have been summarized in **Table 2-1**.

*Table 2-1: Applicable Permissions and Clearances for Swargate to Katraj (Phase-1 extension) project*

| Sl | Permissions / Clearances | Acts / Rules / Notifications / Guidelines | Concerned Agency and approx. Timeline | Responsibility |
|---|---|---|---|---|
| **A.** | **Pre-Construction / Design Stage** | | | |
| 1. | Permission for felling of trees | Procedural Guidelines developed by the Department of Environment, GoM; Maharashtra (Urban Area) Protection of Trees Act, 1975 | Tree Authority – Tree Authority Pune Municipal Corporation (PMC), to be obtained before felling | Contractor engaged by Maha Metro |
| **B.** | **Construction Stage** | | | |
| 2. | Consent to Establish (CtE) & Consent to Operate (CtO) for Ready Mix Concrete plant & Casting Yards | Air (Prevention and Control of Pollution) Act 1981 | MPCB, to be obtained before installation (if applicable) | Contractor engaged by Maha Metro |
| 3. | Permission for withdrawal / dewatering of groundwater[3] | Environment (Protection) Act, 1986; Groundwater Survey and Development Authority (GSDA), GoM; Guidelines / Criteria for evaluation of proposals / requests for groundwater abstraction (With effect from 16.11.2015) | CGWA, 3 months (to be obtained before start of construction) | Contractor engaged by Maha Metro |
| 4. | Authorization for storage and disposal of Hazardous Waste | Petroleum Rules, 2002 and amendments Hazardous and Other Wastes (Management& Transboundary Movement) Amendment Rules, 2019 | MPCB, 3 months, to be obtained before installation | Contractor engaged by Maha Metro |
| 5. | Pollution Under Control (PUC) Certificate for various vehicles used during construction phase | Central Motor and Vehicle Act, 1988 | Transport Department, Govt. of Maharashtra – Authorized Testing Centres, to be obtained before start of construction / project implementation) and regularly updated | Contractor engaged by Maha Metro |
| 6. | Employing Labour / workers | The Building and Other Construction Workers (Regulation of Employment and Conditions of Service) Act, 1996 | District Labour Commissioner, 1 month, to be obtained before start of construction / project implementation | Contractor engaged by Maha Metro |
| 7. | Roof Top Rainwater Harvesting (RWH) | Central Groundwater Authority (CGWA) Guidelines | CGWA, 3 months, to be obtained before installation | Contractor engaged by |

[3] *The Contractor will avoid extraction of groundwater as much as possible. If unavoidable, the required permission will be obtained prior to abstraction.*

| Sl | Permissions / Clearances | Acts / Rules / Notifications / Guidelines | Concerned Agency and approx. Timeline | Responsibility |
|---|---|---|---|---|
| | | | | Maha Metro |
| 8. | Authorization for Disposal of Construction and Demolition (C&D) Waste | Construction and Demolition Waste Management Rules, 2016 | PMC, 2 months, to be obtained before installation | Contractor engaged by Maha Metro |
| 9. | Consent to Establish pre-casting and material yards, batching plant, etc. | Air (Prevention and Control of Pollution) Act 1981 and amendments;<br>The Noise Pollution (Regulation and Control) Rules, 2000 and amendments;<br>Water (Prevention and Control of Pollution) Act 1974 and amendments | MPCB, 3 months, to be obtained before installation | Contractor engaged by Maha Metro |
| 10. | Consent for C&D waste (muck) disposal | Construction and Demolition Waste Management Rules, 2016 Solid Waste Management Rules, 2016 | MPCB, 2 months, to be obtained before installation | Contractor engaged by Maha Metro |
| 11. | Installation and operation of DG sets at stations | Air (Prevention and Control of Pollution) Act, 1981 amended 1987; CPCB Notification April 1994 of National Ambient Air Quality Standards | MPCB, 2 months, to be obtained before installation | Maha Metro |

## 3. Legislations Relevant to the Project

27. The policies and requirements which are most relevant in the context of this Corridor are provided in **Table 2-2**: below:

*Table 2-2: Summary of Applicable Legislation for Swargate to Katraj (Phase-1 Extension)*

| Legislation | Objective | Responsible Institution |
|---|---|---|
| - Environment (Protection) Act (1986) and Rules (1986);<br>- National Conservation Strategy and Policy Statement on Environment and Development of 1992;<br>- National Environment Policy of 2006 | To protect and improve the overall environment | Ministry of Environment, Forests, and Climate Change (MoEF&CC) |
| Environmental Impact Assessment (EIA) under EIB's Environmental and Social Standards (updated in February 2022) | To provide guidance on environmental clearance requirements and clarification on related specific technical issues | European Investment Bank (EIB) Environmental and Social Standards (2022) |
| 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 Control Board (CPCB) |
| 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 |
| 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 | Central Pollution Control Board (CPCB) |
| The Maharashtra Prevention of Water Pollution Act, 1969 (Amended 1981) | | Maharashtra Pollution Control Board (MPCB) |
| The Air (Prevention and Control of Pollution) Act, 1981(Amended 1987) and Rules 1982 | To provide for the prevention, control and abatement of air pollution, and for the establishment of Boards to carry out these purposes | CPCB and Road Authorities |
| Policy Statement for Abatement of Pollution of 1992 | To provide for the prevention, control and abatement of pollution | CPCB |
| - Municipal Solid Waste (MSW) Rules, 2000;<br>- Solid Waste Management Rules, 2016 | Provisions for collection, storage segregation, transportation, processing and disposal of municipal solid wastes | MPCB |
| 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 | MPCB |
| Construction and Demolition Waste Management Rules, 2016 | Large generators (which generate more than 20 tons or more in one day or 300 tons per project in a month) will submit waste management plan and get | MPCB |

| | | |
|---|---|---|
| | appropriate approvals from the local authority before starting construction or demolition or remodelling work | |
| Guidelines on Environmental Management of Construction and Demolition (C&D) Waste, March 2017 | Hazardous wastes / toxic wastes streams, including asbestos, should be kept separately from other wastes to avoid further contamination, their disposal to be done in consultation with SPCBs/PCCs under HW Management Rules 2016. The concerned authorities shall examine the Demolition Plan submitted by the applicant to assess if there are any HW streams. | MPCB |
| The Mines and Minerals (Development and Regulation) Act, 1957 | To protect the environment from quarry operation | State Department of Mines and Geology |
| Central Motor Vehicle Act (1988) and Rules (1988) | To control vehicular air and noise pollution. To regulate development of the transport sector, check and control vehicular air and noise pollution | State Transport Department |
| - Indian Treasure Trove Act, 1878 (as modified up to September 1949);<br>- Ancient Monuments and Archaeological Sites and Remains Act (1958) | Conservation of Cultural and historical remains found in India (Chance finds, if any, during construction) | Archaeological Survey of India (ASI), GoI |
| - National Policy on HIV/AIDS and the World of Work<br>- National Policy on Safety, Health and Environment at Workplace | To regulate the safety, health and environment at workplace | Ministry of Labour and Employment |
| A. Building and Other Construction Workers (Regulation of Employment and Conditions of Service) Act, 1996<br>B. Maharashtra Building and Other Construction Workers (Regulation of Employment and Conditions of Service) Rules, 2007.<br>C. The Contract Labour (Regulation & Abolition) Act, 1970<br>D. Employees State Insurance Act, 1948 (ESI);<br>E. Minimum Wages Act, 1948, The Payment of Wages Act, 1936, amended in 2005;<br>F. The Maharashtra Labour Welfare Act & Rules, 1953<br>G. The Equal Remuneration Act 1976;<br>H. 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 | Ministry of Labour and Employment |
| Interstate Migrant Workmen (Regulation of Employment and conditions of Service) Act 1979 | In case workers and labourers working at the project sites are migrants from other states during construction | Ministry of Labour and Employment |
| Child and Adolescent Labour (Prohibition and Regulation) Act, 1986 | To regulate the employment of children including age limits, type of employment, timing of work, information disclosure and health and safety | Ministry of Labour and Employment |
| Schedule – XIV of the Model Factories Rules 120 (MFR 120) under Section 87 of the Factories Act (1984) | Handling and processing of Asbestos, manufacture of any article of Asbestos and any other process of manufacture or otherwise in which Asbestos is used in any form. | Ministry of Labour & Employment (GoI), Directorate General Factory Advice Service & Labour Institute. |
| | | |
| Occupational Safety, Health and Working Conditions Code, 2020 (OHSWC Code) | Laws regulating the occupational safety, health and working conditions of the persons employed in an establishment applicable in case of contract labour employed through contractor. | Ministry of Labour and Employment |

## 4. Institutional Framework

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

### (a) Ministry of Environment, Forests and Climate Change

29. The Ministry of Environment Forest and Climate Change (MoEF&CC) is the nodal agency in the administrative structure of the GoI for planning, promotions, co-ordination and overseeing the implementation of India's environmental and forestry policies and programs. The MoEF&CC is mainly responsible for protection and enforcement of laws and regulations. In view of the growing importance of environmental affairs, the GoI 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. The major responsibilities of MoEF&CC include:

(i) Environmental resource conservation and protection, including environmental impact assessment, clearance of developmental projects;
(ii) Co-ordination with the other ministries and agencies, voluntary organizations and professional bodies for environmental action plans;
(iii) Promotion of research and development, manpower planning and training and creation of environmental awareness;
(iv) Liaison and coordination with international agencies involved in environmental matters.
(v) Developmental project proponents are also required to submit environmental impact statements and/or 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 and/or assessments and approves the project from the environmental angle.

### (b) Central Pollution Control Board

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

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

31. The SPCB in consultation with the CPCB may establish norms for air quality, gaseous emissions, noise levels, etc.

### (c) Maharashtra Pollution Control Board

32. The Maharashtra Pollution Control Board (MPCB) was established on 7 September, 1970 under the provisions of Maharashtra Prevention of Water Pollution Act, 1969. The Water (P&CP) Act, 1974 is a central legislation that was adopted in Maharashtra on 01.06.1981. Accordingly, the MPCB was formed under the provisions of Section 4 of Water (P&CP) Act, 1974. The Air (P&CP) Act, 1981 was adopted in the state in 1983. The Board is also functioning as the State Board under section 5 of the Air (P&CP) Act, 1981. The prime objective of 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.

### (d) The National Green Tribunal

33. The National Green Tribunal (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.

34. 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 an 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 while the other four are Bhopal, Pune, Kolkata and Chennai.

### (e) Directorate of Industrial Safety and Health[4]

35. The Directorate of Industrial Safety and Health (DISH) (formerly known as Factory Inspectorate) is administrative machinery set up by Govt. of Maharashtra with an objective of enforcing the Factories Act, 1948 & Maharashtra Factories Rules, 1963 made there under so as to ensure Safety, Health and Welfare of the workers employed in the factories. With the growing industrialization amendments were made in the Factories Act, 1948 & Maharashtra Factories Rules, 1963 made there under from time to time.

### (f) Ministry of Labour and Employment[5]

36. The Ministry of Labour & Employment is one of the oldest and important Ministries of the Government of India. The main responsibility of the Ministry is to protect and safeguard the interests of workers in general and those who constitute the poor, deprived and disadvantage sections of the society, in particular, with due regard to creating a healthy work environment for higher production and productivity and to develop and coordinate vocational skill training and employment services.

### (g) Archaeological Survey of India[6]

37. Archaeological and historical pursuits in India started with the efforts of Sir William Jones, who put together a group of antiquarians to form the Asiatic Society on 15th January 1784 in Calcutta. The major activities of the ASI are maintenance, conservation and preservation of centrally protected monuments/sites and remains.

## B. INTERNATIONAL AND REGIONAL AGREEMENTS AND CONVENTIONS

38. India is member of almost all major Multilateral Environmental Agreements (MEAs), under four clusters, as given below:

| | |
|---|---|
| **A.** | **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 Organization) |
| 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** |
| 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** |
| 1. | UNFCCC (United Nations Framework Convention on Climate Change) |

[4] https://mahadish.in/
[5] https://labour.gov.in/about-ministry
[6] https://asi.nic.in/HQ/history-view

| | |
|---|---|
| 2. | Kyoto Protocol |
| 3. | UNCCD (United Nations Convention to Combat Desertification) |
| 4. | Montreal Protocol (on Ozone Depleting Substances) |
| 5. | Paris Agreement |
| **D. Marine environment** | |
| 1. | International Whaling Convention (IWC) |
| E. **Human Resources** | |
| 1. | International Labour Organization (ILO) Conventions: 8 conventions covering a wide area of social and labour issues |
| 2. | UNESCO (United Nations Educational, Scientific and Cultural Organization) |

39. The Nature conservation (A) and Atmospheric Emissions (Climate Change) agreements will be applicable to this Project.

### 1. Requirements of ESIA study as per EIB EHS (Feb 2022)[7]

40. This section discusses the processes and contents of the ESIA which ensure that the assessment meets requirements of EIB's Environmental and Social Standards, pertaining to the proposed Swargate to Katraj (Phase-1 Extension) project. EIB's Environmental and Social Standards (updated in February 2022).

#### (a) Standard 1: Environmental and Social Impacts and Risks

41. This Standard promotes an integrated approach to impact assessment and risk management by ensuring that environmental, climate, social and human rights considerations are addressed and considered in the decision-making processes. It recognises the importance of the promoters' commitment to effective and sustained environmental and social performance through the establishment of an environmental and social management system commensurate with the identified impacts and risks.

42. This Standard outlines the promoter's responsibilities with regard to the process of assessing the potential environmental, climate and/or social impacts and risks associated with the project, and developing and implementing procedures for managing and monitoring these impacts and risks throughout the EIB's project cycle, specifically:

(i) Identifying, describing and assessing in an appropriate manner, the likely significant effects covering the direct effects and any indirect, secondary, positive and negative effects, as well as any cumulative and transboundary effects associated with the project and its ancillary/associated works/facilities, where appropriate;

(ii) Applying the mitigation hierarchy through the identification of measures to avoid, prevent and reduce any significant adverse effects and, if required, remedy/compensate any residual effects on project-affected people, communities and workers, as well as on the environment;

(iii) Ensuring respect for human rights by integrating human rights impacts and risks into the impact assessment process as described in this Standard;

(iv) Identifying measures to maximise the positive effects of the projects and considering the establishment of project benefit-sharing and/or community development programmes, where appropriate;

(v) Systematically following up and monitoring the implementation of agreed prevention, reduction and, if required, remedial/compensatory measures, as well as measures to further enhance the environmental, climate and social performance of the projects.

43. This Standard applies to all projects likely to have significant environmental, climate and/or social impacts and risks. These impacts and risks need to be considered at the earliest possible stage of planning and decision-making processes, including to ensure consistency with "Do Not Significant Harm" (DNSH) and "Minimum Safeguards" (MS) principles and requirements.

44. In order to enhance the efficiency of the ESIA at project level, promoters are encouraged to use the SEA-type approach to ensure that environmental, climate and social considerations and alternatives are addressed as early as possible in plans or programmes that establish the framework for the development of specific projects, whenever relevant. The SEA should address direct and indirect effects, as well as the cumulative impacts. The ESIA process may involve some or all of the following steps: (i) the determination of the need for an ESIA; (ii) the scope and level of details of the assessment;

---

[7] *Source: European Investment Bank Environmental and Social Standards (2 Feb. 2022) [https://www.eib.org/en/publications/eib-environmental-and-social-standards].*

and (iii) the preparation of an ESIA report and an environmental and social management plan (ESMP). Engagement with the project stakeholders is an integral part of this process.

(i) determining the need for an ESIA:
  a. An environmental and/or social impact assessment is required for projects listed in Annex I to the ESIA Directive and/or when an ESIA is required by national legislation or based on the determination carried out according to paragraphs 18 and 19 of this Standard.
  b. For those projects listed in Annex II to the ESIA directive and/or in the national legislation, the need to carry out an environmental and/or social impact assessment is determined through a case-by-case examination and considering the criteria specified in Annex 1a of this Standard.
  c. In determining the need for an ESIA, the promoter collects and provides the EIB with the information specified in Annex 1b of this Standard. The information should be comprehensive enough to provide the basis for the promoter's determination. The outcomes of the determination, including its justification, are communicated to the EIB and considered in its due-diligence process.

(ii) Where an ESIA is required, the promoter shall prepare a report that considers all relevant stages of the project and includes, at a minimum, the information specified in Annex 2a of this Standard.

(iii) The ESIA will be conducted in accordance with provisions of EIB Environmental and Social Practices (Feb 2022) which are relevant to this Project

### (b) Standard 2: Stakeholder Engagement

45. This Standard recognises the importance of stakeholder engagement, as a means to ensure respect for the rights to[8]: (i) access to information; (ii) public participation in decision-making processes; and (iii) access to justice. Stakeholder engagement is an inclusive and iterative process that involves, in varying degrees, the identification and analysis of stakeholders, engagement planning, information disclosure, meaningful consultation, and a mechanism ensuring access to grievance procedures and remedy. Stakeholder engagement is essential for the effective assessment, management and monitoring of environmental, climate and/or social impacts and risks, and contributes to the overall sustainability and better outcomes of projects. It enhances relevant stakeholders' benefits and understanding and, therefore, their support for projects.

46. This Standard outlines the promoter's responsibilities for the implementation of transparent and continuous engagement with project stakeholders, with the key objectives of:

(i) Adopting an inclusive and systematic approach to engaging constructively with stakeholders, namely persons and/or communities who are directly or indirectly affected by a project, or those who may have interests in a project and/or the ability to influence its outcome, either positively or negatively;

(ii) Ensuring that stakeholders have timely access to information on the project's environmental, climate and/or social risks and impacts in a manner that is culturally appropriate and understandable to all stakeholders, including those needing special measures or assistance;

(iii) Promoting and enabling the meaningful and free participation and input of stakeholders in project-related decision-making processes that may affect them, thereby seeking to build mutual trust and improving project outcomes;

(iv) Providing rights-holders with effective means to raise grievances and access remedies, and promoting organisational accountability and continuous learning and improvement.

47. This Standard applies to a specific project, when its relevance is determined during the environmental impact assessment/ environmental and social impact assessment (EIA/ESIA) process (as outlined in Standard 1), based on its likely environmental, climate, and/or social impacts and risks. Depending on such impacts and risks, specific requirements of this Standard apply throughout the EIB project cycle. The nature and extent of the stakeholder engagement shall be commensurate to the project's likely environmental, climate and/or social impacts and risks, considering the type and complexity of the project, sector and country context.

---

[8] *In line with the spirit and principles of the United Nations Economic Commission for Europe (UNECE)'s Aarhus Convention on access to information, public participation in decision-making and access to justice in environmental matters.*

48. This Standard shall be read in conjunction with the requirements set out in the other EIB environmental and social standards whenever applicable, paying special attention to engagement with vulnerable, marginalised, and/or discriminated-against groups, Indigenous Peoples, workers and their representatives, as well as engagement in the context of involuntary resettlement and/or economic displacement, or emergency preparedness and response.

49. Public participation in environmental decision-making processes is not limited to the requirements of the EU ESIA Directive and includes, where relevant, engagement in the planning and/or permitting processes, e.g. Directive 2001/42/environmental clearance on the assessment of the effects of certain plans and programmes on the environment (SEA Directive), the Industrial Emissions Directive), Directive 92/43/EEC on the conservation of natural habitats and wild fauna and flora (Habitats Directive), as amended; Directive 2000/60/environmental clearance establishing a framework for Community action in the field of water policy, as amended; Directive 2008/56/environmental clearance establishing a framework for community action in the field of marine environmental policy, as amended.

50. The specific requirements of this Standard for projects located in rest of the world other than EU, EFTA, Candidate and potential Candidate countries, is that the Promoter shall carry out a stakeholder engagement process that is proportionate to the nature and scale of the project and its potential impacts & risks, involving the following processes:

(i) the identification and analysis of the stakeholders;
(ii) the establishment and/or maintenance of a grievance mechanism, as well as some or all of the following elements to varying degrees as deemed necessary by the EIB;
(iii) engagement planning;
(iv) disclosure of information;
(v) meaningful consultation; and
(vi) monitoring and reporting.

**(c) Standard 3: Resource Efficiency and Pollution Prevention**

51. This Standard outlines the promoter's responsibilities to ensure an integrated approach to resource efficiency, pollution prevention and control of emissions to air, water and land, noise pollution, radiation, prevention of accidents, as well as waste management and the safe use of hazardous substances and pesticides, avoiding the shift of pollution from one environmental medium to another, ensuring consistency with the "Do Not Significant Harm" principle.

52. This Standard applies to a specific project when its relevance is determined during the EIA/ESIA process (as outlined in Standard 1) and additionally to EIB-financed projects associated with modifications and/or extensions of existing activities/facilities, for which the promoter shall determine the appropriate requirements.

53. The following processes are involved as per the specific requirements of this Standard for projects located in rest of the world other than EU, EFTA, Candidate and potential Candidate countries:

(i) **Resource efficiency and circular economy.** The promoter assesses the effectiveness and efficiency of the project's use of materials and natural resources (e.g. land, soil, water, biodiversity), as well as energy, in particular in production processes, and the impacts on the environment resulting from resource use over the lifetime of the project and life cycle of any products produced. Based on the outcome of such life cycle assessment, the promoter, on a best effort basis, undertakes preventive and mitigating measures to protect natural resources and avoid any significant harm in order to preserve their long-term availability for human activity.
(ii) **Pollution prevention and control.** The promoter shall implement all environmental conditions attached to the decision(s) the measures envisaged to avoid, prevent or reduce and, if possible, offset significant adverse effects on the environment, as well as where appropriate, monitoring measures.
(iii) **Emergency prevention, preparedness and response.** The promoter shall be prepared to respond to any incident, accident and emergency by setting up effective management systems and implementing control measures for ensuring prevention, preparedness and adequate response to major accidents in line with the applicable legal framework and international good practices.
(iv) **Management of waste.** For projects involving the production of waste with significant environmental impact, the promoter shall include, as part of the EIA/ESIA Report a waste management plan containing measures planned to mitigate such impacts and feasible goals and objectives for waste prevention, reuse, recycling and recovery, in line with the waste

hierarchy principle. Where applicable, the plan shall include life cycle assessment methods and indicators in order to identify and assess the environmental impacts associated with its products, processes, or activities by quantifying raw materials, energy and waste the project releases into air, water and soil. The promoter shall record and report on a regular basis the waste quantities generated, as well as their off-site transfer, as required by the national and/or EU legislation, the relevant international treaties and good practices. When third parties provide for the final disposal of waste and hazardous waste, the promoter shall ensure the use of licenced contractors.

(v) **Sound management of hazardous substances and materials.** The promoter shall seek to avoid, reduce or eliminate the use and storage of hazardous substances and materials of high concern and consider replacing them by less hazardous substitutes, where suitable economically and technically viable alternatives are available. Furthermore, the promoter is also encouraged to develop projects that lead to the innovative development and use of sustainable substitutes.

(vi) **Pesticide use and management.** When the activity includes the use of pesticides, the promoter shall implement the general standards of the sustainable use of pesticides. The promoter shall pay particular attention to avoiding pollution of surface water or groundwater by acting appropriately and reducing, as far as possible, or eliminating, if appropriate, the use of pesticides in sensitive areas (e.g. areas designated for abstraction of drinking water, on sealed or very permeable surfaces) that can lead to higher risk of pollution of the aquatic environment.

### (d) Standard 4: Biodiversity and Ecosystems

54. This Standard recognises that protecting and conserving biodiversity & ecosystems and maintaining the ecological functions and processes of such ecosystems are fundamental to environmental and social sustainability. It recognises that growing pressures on natural resources and ecosystems lead to unprecedented biodiversity losses, which are exacerbated by the adverse impacts of climate change, and that the degradation of ecosystems may have a disproportionate impact on poor rural households and vulnerable and indigenous communities who depend on ecosystem services for their livelihoods and well-being. Therefore, the EIB promotes a holistic and human rights-based approach to the conservation and protection of biodiversity and ecosystems as well as to the sustainable use of natural resources.

55. This Standard applies to a specific project when its relevance is determined during the EIA/ESIA process (as outlined in Standard 1), and specifically to EIB financed projects which may entail a significant impact and risk affecting: (i) biodiversity and ecosystems; (ii) ecosystem services, including the communities whose access to or use of ecosystem services may be affected by project activities; (iii) protected areas or recognised areas of high biodiversity value; and (iv) critical habitats. The Standard also applies to projects that involve primary production and/or the procurement of living natural resources.

56. As a general requirement of this Standard, for all projects, the promoter shall identify, assess and manage the impacts and risks that could potentially affect biodiversity and ecosystems, either positively or negatively, directly or indirectly, and on which the project may depend on for its success.

57. Specific requirements of this Standard involve the following processes and considerations:

(i) Assessment of significant impacts and risks affecting biodiversity and ecosystems: As part of the EIA/ESIA as set out in Standard 1, the promoter shall consider the direct, indirect, cumulative and in-combination impacts of the project and ancillary and/or associated works and/or facilities, where relevant, when assessing the significance of the impacts and risks on habitats, species and ecosystems. This assessment shall also include, as a minimum, the threats to biodiversity and ecosystems such as the loss, degradation and fragmentation of habitats, the loss of species diversity and abundance, the loss of genetic diversity, the degradation of ecosystem services, pollution and incidental take, as well as project-related climate change impacts. Stakeholder engagement forms a key part of the assessment of impacts and risks affecting biodiversity and ecosystems, whether to obtain relevant data, understand the uses, values and benefits associated with biodiversity or develop acceptable mitigation strategies.

(ii) Protection and conservation of high-value biodiversity: Where the assessment identifies that

the project could have significant, adverse and irreversible impacts on high-value biodiversity, the promoter shall not implement any project-related activities unless:

(a) it is demonstrated that no other viable alternatives exist for the development of the project in areas of lesser biodiversity value;
(b) the project is permitted to go ahead under applicable environmental legislation, recognising the biodiversity features that are of conservation importance;
(c) meaningful consultation with relevant experts and stakeholders has been carried out; and
(d) appropriate measures are put in place through the application of the mitigation hierarchy to ensure no loss and, where required, a Net Positive Impact on biodiversity features and the habitats that support them so as to achieve positive measurable conservation outcomes.

(iii) Protection and conservation of critical habitat: Critical habitat is the most sensitive of the high-value biodiversity features and is defined as comprising one of the following:

(a) A highly threatened and/or unique ecosystem;
(b) A habitat of priority and/or significant importance to critically endangered, endangered or vulnerable species, as defined by the IUCN red list of threatened species and in relevant national legislation;
(c) A habitat of priority and/or significant importance to a population, range or distribution of endemic or restricted-range species, or highly distinctive assemblages of species;
(d) A habitat required for the survival of migratory species and/or congregatory species;
(e) Biodiversity and/or an ecosystem of significant social, economic or cultural importance to local communities and indigenous groups;
(f) A habitat of key scientific value and/or associated with key evolutionary processes.

(iv) In areas of critical habitat, the promoter shall not implement any project activities unless all of the following conditions are met:

(a) No other viable alternatives for the project exist either in terms of location or design, and there is rigorous justification of overriding public interest based on human health, public safety considerations and/or beneficial consequences of primary importance for the environment;
(b) The project does not lead to measurable adverse impacts that will result in any detrimental effect on the ecological and conservation status of the critical habitat, and impacts are avoided and minimised to the extent possible through changes in footprint or design;
(c) The project does not lead to a net reduction in the population of any vulnerable, endangered or critically endangered species over a reasonable period of time;
(d) Stakeholders are consulted in accordance with Standards 2 and 7;
(e) Positive conservation outcomes (Net Positive Impact) and continued ecological functionality are achieved though appropriate compensation measures for residual impacts that would otherwise occur despite impact avoidance, minimisation and restoration measures; and
(f) A robust, appropriately designed and long-term biodiversity monitoring and evaluation programme aimed at assessing the status of the critical habitat is integrated into the promoter's adaptive management programme.

(v) Compensation and offsets: As a last resort and in response to residual impacts, compensation measures may be implemented to reach a minimum of no loss of biodiversity overall. If the project is taking place in an area of critical habitat, a net positive impact on biodiversity and ecosystem services must be achieved. Compensation or offsets shall not be used as a mechanism to achieve no loss or a net positive impact until other forms of mitigation have been implemented to the fullest extent possible. Where a project is expected to have impacts that would compromise the viability of a critical habitat and/or a habitat of high biodiversity value or their associated features regardless of any proposed compensation or offset, the promoter shall undertake to redesign the project to avoid the need for such compensation/offset.

(vi) Legally protected areas and/or internationally recognised areas of biodiversity value: The EIB shall only finance a project within a protected area, or within a nationally or internationally designated or recognised or candidate area for biodiversity conservation, if the promoter is able to demonstrate that the proposed development in the area is legally permitted and that the design of the project is consistent with a recognised management plan for the protected or designated conservation area. In the absence of a recognised plan, the project should be compatible with the achievement of the relevant conservation objectives used to designate the area in question.

(vii) Invasive alien species: The promoter shall take into consideration the risks associated with

the accidental or deliberate introduction of invasive alien species throughout the project's life cycle and take account of those risks when assessing the impacts on biodiversity and ecosystems and in the biodiversity management plan. The promoter shall identify mitigation measures that control, or attempt to control, the spread of invasive species into areas where they currently are not established. In areas over which the promoter has management control, measures should be implemented to limit the spread of invasive species, or, if possible, to eliminate them.

(viii) Ecosystem services assessment: The identification of the project's impacts and risks that affect ecosystem services, as part of the EIA/ESIA process described in Standard 1, should be carried out by the promoter in collaboration with relevant stakeholders and local communities and Indigenous Peoples that depend on these services. A gender-sensitive approach should be taken, where feasible, acknowledging that men and women may place different values on ecosystems, and derive different benefits from them. Where practical and feasible, a screening of the levels of dependence on these services should be included as part of the assessment process. Ecosystem services critical to the viability of a proposed project should also be identified.

(ix) Supply chains: The promoter shall identify and assess the impacts and risks affecting biodiversity and ecosystems that are caused by its primary suppliers as part of the supply chain. Any mitigation measures identified through the assessment should ensure sustainable outcomes. Where the promoter is procuring living natural resource commodities, such as food, timber and fibre, that are known to be produced in regions where there is a risk of significant conversion or degradation of high-value biodiversity and/or critical habitat, the promoter shall contract with companies/suppliers in the sector that abide by recognised standards or certification schemes for sustainable management, where relevant. For commodities other than living natural resources, promoters involved in the purchasing, processing or trading of such commodities should seek to identify their supply chain risks in relation to adverse impacts on high-value biodiversity and/or critical habitats and assess their operational and reputational exposure to such risks. In situations where such concerns are identified, promoters shall find solutions in order to address them in a manner commensurate with their degree of control and influence and consistent with the requirements of this Standard.

(x) Sustainable management and use of living natural resources: Renewable natural resources shall be managed in a sustainable manner. Sustainable resource management is the management of the use, development, and protection of resources in a way, or at a rate, that enables people and communities, including Indigenous Peoples, to provide for their current social, economic and cultural well-being while also sustaining the potential of these resources to meet reasonably foreseeable needs of future generations.

### (e) Standard 5: Climate Change

58. This Standard recognises the importance and urgency of combating climate change, which poses a major global threat and is a common concern of humankind, as rising temperatures increasingly result in severe, pervasive and irreversible negative impacts for people, economic activities, ecosystems and the regenerative capacity of the planet. This Standard further recognises the role of finance in supporting low-carbon and climate-resilient development, i.e. in (i) addressing climate change by reducing greenhouse gas (GHG) emissions; and (ii) building the resilience and adaptive capacity of people, nature and assets to cope with current and future climate change-induced impacts.

59. This Standard promotes the alignment of projects supported by the EIB with the goals and principles of: (i) the Paris Agreement[9] and (ii) the Sustainable Finance Action Plan. It does so by stipulating that climate change mitigation and adaptation considerations must be explicitly addressed and incorporated by promoters in the decision-making process of the projects that the EIB supports, in accordance with the approaches established in the EIB Group Climate Bank Roadmap (adopted on 11 November 2020 by the EIB Board of Directors) and the EIB Climate Strategy (Update adopted on 11 November 2020 by the EIB Board of Directors).

60. This Standard outlines the responsibilities of the promoter with regard to assessing, managing and monitoring project-related (i) GHG emissions and transition climate risks and (ii) physical climate

[9] *Adopted on 12 December 2015 at the 21st session of the Conference of the Parties to the UN Framework Convention on Climate Change (COP 21) in Paris.*

risks. More specifically, the promoter's responsibilities involve:

(i) Assessing GHG emissions at the project level and the project's alignment with pathways to limit global warming to 1.5° C above pre-industrial levels and options to reduce transition risks;

(ii) Assessing the project's resilience to physical climate risks, its alignment with climate-resilient development pathways, and the options to reduce physical climate risks to the project, its natural environment and the people that may be affected by it.

61. As part of the General Requirements of this Standard, all projects shall comply with the EIB's alignment framework, as set out in the EIB Group Climate Bank Roadmap (CBR), including to ensure consistency with the "Do No Significant Harm" principle to climate change mitigation or adaptation objectives, as defined by the EU Taxonomy Regulation. The promoter shall provide the EIB with information establishing the project's impact on GHG emissions and its vulnerability to physical climate change risks, as well as its alignment with relevant low-carbon and climate-resilient pathways.

62. When applying Standard 5, the promoter shall consider relevant environmental and social, including gender, aspects in line with the requirements outlined in other EIB standards, in particular: Standard 2 "Stakeholder Engagement", Standard 7 "Vulnerable Groups, Indigenous Peoples and Gender", and Standard 10 "Cultural Heritage".

63. Specifically following considerations / processes are required as part of this Standard:

(i) **Assessment and minimisation of GHG emissions**. The promoter shall provide to the EIB all relevant information on the nature and magnitude of the project's GHG emissions and/or sequestration, as required by the EIB in order to conduct its assessment. The promoter shall demonstrate, on request, that due consideration has been given to alternatives to minimise project-related GHG emissions. These measures may include, but are not limited to: the use of best available techniques (BAT) and/or any emerging techniques, energy efficiency, resource efficiency, adoption of less carbon-intensive or renewable energy sources, or the reduction of fugitive emissions.

(ii) **Physical climate risk assessment and minimisation.** The promoter shall provide to the EIB all relevant information relating to physical climate risks associated with a project as required by the EIB in order to determine a project's alignment with the EIB Group Climate Bank Roadmap (CBR), including consistency with the "Do No Significant Harm" principle to climate change adaptation objectives, as set out in the EU Taxonomy Regulation. Where a project is determined by the EIB to be at risk from physical climate hazards, the promoter shall carry out a Climate Risk and Vulnerability Assessment (CRVA), in line with the approach adopted by the EIB and other relevant EIB Standards. The CRVA shall (i) assess how climate change may affect the project and the system in which the project takes place, including the natural environment and the people potentially affected, and (ii) identify commensurate adaptation measures to reduce the risks posed by climate change to the project and the system in which it takes place.

(iii) **Climate-related aspects of economic analysis.** The promoter shall, on request, provide the EIB with climate-related information relevant to assessing the economic case for the project. This may include:

a) Climate change mitigation aspects: (i) the volume of GHG emitted per relevant time period, with and without the project; and (ii) the unit value and conceptual basis for the cost of carbon emissions;

b) Climate change adaptation aspects: (i) the change in exposure to physical climate risk per relevant time period, with and without the adaptation measures of a project; and (ii) the economic valuation of this change in risk;

c) For projects motivated primarily by climate considerations, when practical and feasible, the economic analysis should include an assessment of climate-related project impacts on different groups in society, with a particular focus on vulnerable groups.

64. For all projects listed in Annex I and Annex II of the ESIA (Environmental & Social Impact Assessment) Directive, in respect of which the relevant competent authorities have concluded that an ESIA is required, the promoter shall ensure that the information relevant to the assessment of climate change mitigation and adaptation and its conclusions are clearly distinguishable and identifiable in the ESIA report.

### (f) Standard 6: Involuntary Resettlement

65. Involuntary resettlement refers to displacement that occurs as a direct result of project-related land acquisition or restriction on land use. It includes: (a) physical displacement (i.e. physical relocation,

loss of residence or loss of shelter); and/or (b) economic displacement (i.e. loss of assets, or access to assets, that leads to the loss of income sources or means of livelihood). Resettlement is involuntary when affected individuals or communities do not have the right to refuse such displacement. Involuntary resettlement can have severe negative effects on the economic, social and cultural well-being of rights-holders (affected persons and host communities). Income sources can be temporarily or permanently lost, persons can be relocated to environments where their skills may be less applicable and compensation may not be sufficient to prevent long-term hardship or disadvantage.

66. Since there is no involuntary resettlement involved in the Swargate to Katraj (Phase-1 Extension) project, this Standard shall not be applicable.

### (g) Standard 7: Vulnerable Groups, Indigenous Peoples, and Gender

67. Within the context of EIB projects, vulnerable or marginalised persons and groups are those that:

(i) are usually exposed to several risks and adverse impacts at once;
(ii) are more sensitive to those risks and impacts, often having been subject to pre-existing discrimination; and
(iii) have a weaker adaptive capacity for coping with those risks and recovering from those impacts, due to limited access or rights to required assets and/or resources. As a result, they can be disproportionately affected by project-related risks and impacts.

68. This Standard recognises that in some cases, certain individuals or groups are vulnerable, marginalised, systematically discriminated against or excluded on the basis of their socioeconomic characteristics. Such characteristics include, but are not limited to, sex, sexual orientation, gender, gender identity, caste, racial, ethnic, indigenous or social origin, genetic features, age, birth, disability, religion or belief, political or any other opinion, activism, membership of a national minority, affiliation to a union or any other form of workers' organisation, property, nationality, language, marital or family status, health status, or migrant or economic status.

69. These persons and groups are not inherently more vulnerable than others but due to discriminatory practices and norms, and therefore a less enabling environment, they often face additional barriers that limit their opportunity or ability to equally participate in decision-making related to the project and enjoy project benefits. Indigenous Peoples2 and ethnic minorities in particular have identities and aspirations that are distinct from dominant groups in national societies and are often disadvantaged by traditional models of development. Moreover, gender-based discrimination affects all societies and cuts across all other types of discrimination, often exacerbating vulnerability, exclusion, and/or marginalisation.

70. Importantly, discrimination, entrenched social and gender roles and attitudes, gender-based violence and lack of access to decision-making can weaken the resilience of the aforementioned individuals and groups and render them disproportionally vulnerable to adverse project impacts.

### (h) Standard 8: Labour Rights

71. This Standard outlines the promoter's responsibilities with regard to the assessment, management and monitoring of labour-related impacts and risks associated with projects. It recognises workers and employers as both rights-holders and duty-bearers.

72. The Standard specifies the requirements in alignment with the rights and principles of the Fundamental Conventions of the International Labour Organisation (ILO) and the European Pillar of Social Rights. The objective of this Standard is to set out minimum requirements that the project's policies and procedures shall address, including:

(i) ensuring the fair treatment, non-discrimination and equal treatment and opportunity of workers, especially vulnerable workers facing particular risks due to context-specific socioeconomic characteristics;
(ii) zero tolerance for the use of forced labour and child labour;
(iii) respecting the principles of freedom of association and collective bargaining;
(iv) protecting and promoting safety and health at work;
(v) promoting a sound worker-management relationship;

(vi) ensuring that accessible and effective means to raise and address workplace concerns are available to workers.

73. This Standard applies to all projects and the specific requirements that need to be addressed, including to achieve consistency with the "Minimum Safeguards" (MS) principles[10], are determined during the EIA/ESIA process (as outlined in Standard 1).

74. This Standard applies to project workers including full-time, part-time, temporary, seasonal and migrant workers. Throughout this Standard, the term "project worker" is used to refer to:

(i) people employed or engaged directly by the promoter (including the project proponent and the project implementing agencies) to work specifically in relation to the project (direct workers);

(ii) people employed or engaged through third parties to perform work related to core functions of the project, regardless of location (third-party workers).

75. Some of the specific requirements of this Standard relevant to the PMRP Phase-1 extensions project are listed here:

(i) **Management of working relationships.** The promoter shall develop and/or maintain written labour management policies and procedures that are commensurate to its size and workforce and applicable to the project. These shall be communicated in a culturally appropriate manner to the project workers. The labour management policies and procedures shall also describe how the promoter plans to comply with the requirements deriving from national labour and employment law, applicable collective agreements and the requirements of this Standard. Project workers shall not be employed informally and they shall all have valid written employment contracts. The employment contracts shall set out working conditions and terms of employment including entitlement to wages, working hours, overtime arrangements and overtime compensation, and any benefits (such as leave for illness, maternity/paternity or holiday). Any material changes to the terms and conditions of employment shall be communicated to the project workers in a culturally appropriate manner.

(ii) **Terms and conditions of employment.** The employment conditions of project workers (including wages, benefits, and working hours) shall not be less favourable than for the equivalent type of work in the relevant country/region of the operation and industry. The promoter shall ensure that wages paid are fair and in accordance with minimum thresholds under national legislation. The promoter shall ensure that project workers are paid on a regular basis as required by national law and labour management procedures. Working hours, including breaks and rest periods, shall comply with national legislation and any collective agreements.

(iii) **Child labour.** In line with the ILO Minimum Age Convention No.138 and the Worst Forms of Child Labour Convention No.182, the promoter shall not employ, use or benefit from child labour. The promoter shall comply with the minimum age requirements defined under the aforementioned ILO unless the national standards are more stringent. Children over the minimum age and under the age of 18 may be employed or engaged in connection with the project subject to an appropriate risk assessment prior to the work commencing and the regular monitoring of health, working conditions and working hours. Children shall not be employed informally, even when this is socially or culturally acceptable practice in the sector, country or region. If the practice of child labour is identified among the project workers (including all kinds of third-party workers), the promoter shall take immediate steps to correct and remedy them. The promoter shall also report to the EIB about such practices and the remedial measures taken. The promoter shall require its contractors to apply the same standards and practices with respect to child labour.

(iv) **Forced labour.** The promoter shall not employ forced or compulsory labour and shall ensure such labour does not take place in relation to the project, by its contractors and suppliers. Forced labour covers any kind of involuntary or compulsory labour, such as indentured labour, bonded labour, or similar labour-contracting arrangements as well as human trafficking. The promoter shall provide special attention to identifying which project workers might be at greater risk of trafficking due to certain socioeconomic characteristics such as age, disability, ethnicity and/or gender. Considering security concerns and the nature of the work, the promoter shall avoid any unnecessary restriction of the freedom of movement of its labour force during the course of their employment. Furthermore, the promoter shall not engage in or tolerate any form of corporal punishment, mental or physical coercion, or abuse of personnel. If the practice of forced labour is identified among the project workers (including all kinds of third-party

[10] *As defined in the EU Taxonomy Regulation (EU) 2020/852 of the European Parliament and of the Council of 18 June 2020 on the establishment of a framework to facilitate sustainable investment, and amending Regulation (EU) 2019/2088 [https://eur-lex.europa.eu/eli/reg/2020/852/oj].*

workers), the promoter shall take immediate steps to terminate the practice, offer conditions of work that are not coercive and refer the case to the competent law enforcement authorities. The promoter shall also report to the EIB about such practices and the remedial measures taken.

(v) **Migrant workers.** The promoter shall identify the employment of migrant project workers and shall ensure their treatment is not less favourable than that of non-migrant project workers undertaking similar functions. This includes equal remuneration and the enjoyment of the same rights, equal opportunities and equal treatment. The promoter shall not tolerate any physical or psychological coercion of migrant workers, including unnecessary restrictions on their movement or the retention of workers' identity documents, such as passports, or personal belongings. The promoter shall make best efforts to ensure that the project's primary suppliers uphold the same principles.

(vi) **Non-discrimination and equality of opportunity and treatment.** The labour management policies and procedures shall be non-discriminatory and shall observe equal opportunities. Employment-related decisions shall be based on professional skills and competencies. The treatment of project workers must be fair and equal in all its aspects, including equal pay for equal value, recruitment, promotion, termination of employment and disciplinary practices. The promoter shall put in place measures, including workplace policies and an appropriate mechanism, to effectively prevent and address any form of violence and harassment, bullying, intimidation, and exploitation, including any form of gender-based violence and harassment at project level.

(vii) **Grievance mechanism.** The promoter shall set up an effective, culturally appropriate and gender-responsive grievance mechanism for project workers (and their organisations, where they exist) to raise reasonable workplace concerns. The promoter shall inform project workers of the grievance mechanism at the time of hire and make it easily accessible to them. The mechanism shall address complaints in a timely and effective manner using a transparent process that allows project workers to raise concerns without fear of retribution. The mechanism shall include provisions for anonymous and confidential complaints, as well as special protection measures that may be required by project workers, such as in the case of sexual and/or psychological harassment, exploitation and abuse and any other form of gender-based violence or discrimination. The mechanism shall ensure workers' rights to be present and to participate directly in the proceedings and to be represented by a trade union or person of their choosing.

76. The promoter shall conduct regular monitoring and reviews of the project's workforce, including contractors and subcontractors as well as primary suppliers, to be able to identify any labour risks or violation of labour standards with which the project may be involved and implement effective measures to address such risks and violations, setting priorities for acting on and evaluating the results. The promoter shall report to the EIB about the results of the monitoring activity as part of its regular reporting requirements.

### (i) Standard 9: Health, Safety, and Security

77. The EIB recognises the need to safeguard the safety and health of workers, and to address rapid changes in the economy (notably the pathway towards green growth), demography and work patterns. This Standard recognises that project activities, equipment and infrastructure can expose workers and community to hazards, risks and impacts in terms of occupational and public health, safety and security.

78. The Standard requires promoters to use reasonable efforts to identify' these hazards, risks and impacts and to design and use of appropriate measures to avoid or mitigate adverse health and safety impacts associated with project activities on the rights-holders (project workers, supply chain workers, and affected people and communities).

79. This Standard recognises: (i) the right of workers to fair and just working conditions, and (ii) the right of workers and affected people and communities to life and to integrity. It also recognises the responsibilities of both workers and employers to securing a safe and healthy working environment.

80. This Standard, whilst acknowledging the role of relevant authorities in protecting and promoting the health and safety of workers and the public, outlines the promoter's responsibilities in assessing,

managing and monitoring occupational and public health, safety and security risks associated with projects supported by the EIB, and specifically the following:

(i) Promote, protect and monitor the health, safety and security of project workers (including third party workers i.e. contractors, subcontractors, brokers, agents or intermediaries) throughout the project life-cycle, by ensuring a safe, healthy, and secure working environment (including gender-based violence risks as recognised in ILO C190 Violence and Harassment Convention & accompanying Recommendation R206) and, where applicable, accommodation conditions, and effectively implementing a management system, or equivalent, commensurate to the risks and impacts associated with the project.

(ii) Identify, assess and manage risks to the health and safety of project-affected people and communities, (including to project-related gender-based violence risks including sexual harassment, exploitation and abuse) during the life-cycle of the project.

(iii) Require that the provision of private or public security to protect project workers, assets, communities and suppliers is consistent with international human rights standards and principles[11].

(iv) Provide that project workers and members of the public can effectively access the workers' grievance mechanism and the project grievance mechanism, respectively, in cases of health, safety or security concerns, risks or violations commensurate to the risks and impacts associated with the project.

81. Specific requirements of the Standard require that the project shall be designed and operated in compliance with the requirements of paragraphs 15 to 67 of this Standard. The promoter shall provide the EIB with satisfactory evidence18 and information on its practices (and, when relevant, those of its contractors and suppliers), both at the project appraisal stage and through regular monitoring, as per contractual obligations, and if and when requested. Processes and considerations of this Standard include:

(i) **Health and safety management.** The promoter shall put in place a well-defined Health and Safety Management System (HSMS) commensurate with the project risks for managing occupational and public health, safety and security including a Health and Safety Management Plan (HSMP), or equivalent which shall consider the hazards, risks and impacts of the project, as well as international best practice, such as ILO Guidelines on occupational safety and health management systems (ILO-OSH 2001). The HSMS shall have appropriate resources and expertise. Depending on the nature of work and size of the workforce, the promoter and/or the contractor shall assign a dedicated unit or team with the appropriate level of seniority for the above tasks. Already at the preliminary design stage, the promoter shall identify and assess occupational and public health and safety (including sexual harassment, abuse and exploitation) risks and impacts arising directly or indirectly from the project at any time during the life cycle of the project, including the use and storage of hazardous materials. The promoter shall ensure that appropriate attention is given to persons and groups that may be particularly exposed to or vulnerable to such risks based on their socio-economic characteristics. The promoter shall adopt a precautionary approach and apply adaptive management practices in which the implementation of mitigation and management measures are responsive to changing conditions and the results of project monitoring throughout the project lifecycle (for which risks assessments may be required). The adopted measures shall be commensurate with the nature and magnitude of the identified risks and impacts and shall be applied without discrimination, considering differences in risk exposure and the need to protect particularly sensitive risk groups against the dangers, which specifically affect them. The promoter shall provide to project workers as well as to the project-affected people and communities, relevant information, instructions and training in an accessible format. When providing such information, instructions and trainings, the promoter shall include individuals or groups within the workforce or communities that are traditionally excluded or discriminated against due to their socio-economic characteristics.

(ii) **Workplace.** When providing project workers with a safe and healthy workplace, the promoter shall consider the needs of women and men, any inherent risks in its particular sector and location, as well as hazards that may be present. The promoter shall pay attention to workplace mental health and wellbeing and work-related psychosocial risks. The working environment shall respect human dignity, comply with general hygiene norms, and consider & ensure the physical and mental integrity of project workers. The promoter shall address gender specific risks and requirements, including gender based and sexual violence. The promoter shall ensure

---

[11] *International human rights standards and principles include (i) the UN Basic Principles on the Use of Force and Firearms by Law Enforcement Officials, (ii) the UN Code of Conduct for Law Enforcement Officials, (iii) the Voluntary Principles on Security and Human Rights and (iv) the International Code of Conduct on Private Security Providers.*

that project workers get medical benefits and employment injury benefits (including for occupational diseases). The promoter shall require all project workers and all persons accessing the project site (including suppliers, supervisors, visitors), to abide and comply with the applicable health and safety plans.

(iii) **Personal protective equipment.** Based on the assessment referred to in point a. above, and considering the hierarchy of controls, project workers shall be provided with appropriate personal protective equipment **(**PPE), free of charge. Such equipment shall be certified and suitable for the tasks to be carried out. Consideration shall be given to the specific physical characteristics of project workers.

(iv) **Health and safety training for project workers.** The promoter shall take all necessary actions to ensure that project workers are made aware of all risks associated with their work and how to implement protective measures with regard to their health and safety. The promoter shall provide project workers with adequate, timely and regularly updated training and information material on health and safety issues and procedures. The promoter shall ensure that project workers carrying out any activity in the project site are both trained and qualified.

(v) **Community health and safety**. The promoter shall identify and assess project-related risks and adverse impacts to the health and safety of the potentially affected people and communities including those who, because of their particular circumstances, may be more vulnerable. The promoter shall develop protection, prevention and mitigation measures proportionate to the impacts and risks, and appropriate to the stage, size and nature of the project. The promoter shall cooperate and consult with the relevant authorities, the project-affected community and other stakeholders, as appropriate, on mitigation measures and plans.

(vi) **Risks associated with the influx of workers**. To the extent possible, the promoter shall take the necessary measures to avoid, mitigate and manage the risks and potential adverse impacts on public health and safety arising from the influx of workers. Such risks and impacts may be associated with changes in population composition, intangible cultural heritage, health implications and exposure to communicable diseases and the increased vulnerability of communities in the area of influence of the project due to increased pressure on already scarce natural resources. The promoter shall protect affected people, especially women and children, from sexual harassment, exploitation and abuse in the context of the project. Where appropriate, the promoter shall adopt specific measures to prevent and address gender-based violence risks, including the organisation of training and awareness programmes for the project workers and the provision of confidential channels for reporting incidents and providing support. Participation of project workers and their representatives in the development of such measures is recommended. The promoter shall further find alternative means for remedying significant stress on natural resources caused by the increased population numbers.

(vii) **Traffic and road safety.** For all types of projects, traffic and road safety shall be considered at project planning and design to prevent and mitigate risks and impacts throughout the project life cycle. The promoter shall identify, evaluate and monitor the potential traffic and road safety risks to workers, communities and all road users throughout the project life-cycle. To this end, the promoter shall take into consideration road and traffic safety management standards and where appropriate develop measures and plans to address these risks. The promoter shall routinely monitor incident and accident reports to identify and resolve problems or negative safety trends and amend relevant plans and systems as appropriately. For projects that operate machinery, plant or equipment on public roads, the promoter shall take the necessary measures to avoid and minimise hazards, risks and impacts to both project workers and members of the public.

(viii) **Natural hazards and natural hazards triggering technological disasters.** The promoter shall identify and assess and minimize the potential health and safety risks caused by natural hazards or extreme weather events, such as, but not limited to, floods, droughts, heat waves, landslides, hurricanes, typhoons or earthquakes as relevant to the project. The promoter shall consider the interaction between natural disasters and industrial accidents (NaTech or Natural Hazard Triggering Technological Disasters) and the prevention of, preparedness for and response to industrial accidents including those capable of causing transboundary effects. Preventative measures include land use planning and siting, modification of hazardous activities, disaster risk reduction, emergency preparedness through contingency planning, and the resilience of project-affected communities to natural and technological disasters.

(ix) **Exposure to diseases.** During the ESIA process, the promoter shall identify the risk of exposure to occupational and communicable diseases by both project workers and the people affected by the project and communities. To this end, the promoter shall consider the

differentiated exposure to and/or higher sensitivity of workers and certain groups depending on their age, gender, health status and other factors that may lead to higher vulnerability to hazards. To the extent possible, and with the support of OHS professionals, the promoter shall take measures to contribute to avoid or contain the spread of pandemics, epidemics, and any transmission of communicable diseases associated with the influx of workers, such as SARs-CoV-2, malaria, tuberculosis, sexually transmitted diseases (including HIV/AIDS) etc. To this end, the promoter shall organise training and awareness programmes, and ensure that codes of conduct (for workers and people living in labour camps, if any) are implemented. Furthermore, the promoter shall endeavour to work with public authorities and other stakeholders (such as NGOs) and build upon existing measures to implement public programmes and policies that shall raise public's awareness and understanding of communicable and preventable diseases effectively countering their spread.

(x) **Essential sanitary facilities**. The promoter shall ensure that all project workers have access to adequate, safe and hygienic basic welfare facilities [In line with the ILO Welfare Facilities Recommendation, 1956 (No. 102)]. The promoter shall provide basic occupational health services including drinking water, sanitation and washing facilities. The promoter shall provide qualified first-aid at all times. In certain cases, when the scale or the nature of the activity being carried out so requires, availability of medical care shall be provided based on the principles of non-discrimination and equal opportunity. In providing the above, the promoter shall consider any gender specific requirements alongside those of persons with disabilities.

(xi) **Workers' accommodation.** Where a promoter provides accommodation for project workers, the promoter shall put in place and implement policies governing the quality and management of the accommodation and provision of basic services which must be adequate, safe and hygienic. The accommodation services shall be provided in accordance with good industry practice, such as ILO Workers' Housing Recommendation 1961 (No. 115), and in a manner consistent with the principles of non-discrimination and equal opportunity. The promoter shall consider the specific requirements of women and persons with disabilities. The promoter shall ensure that above-mentioned provisions include safeguards against sexual harassment and exploitation and other forms of gender-based violence. Workers' freedom of movement to and from the promoter-provided accommodation shall not be unreasonably restricted.

(xii) **Security.** The promoter shall identify and assess the security risks and threats to the project assets, the workforce and the wider community, in connection with the project. The assessment should be part of the ESIA referred to in Standard 1. Where risks have been identified, legitimate and proportionate security arrangements shall be put in place. Such security arrangements shall be defined in the HSMP and implemented in accordance with good international practice. The promoter shall ensure that the security arrangements, whether privately outsourced or publicly provided, do not create security risks and impacts upon workers, suppliers, or local communities. Particular attention shall be given to persons or communities that are traditionally discriminated against, based on their socio-economic characteristics, in and surrounding the project area. The promoter is expected to comply with applicable law and to be guided by The Principle of Proportionality (which states that responses should be proportional to the good that can be achieved and the harm that may be caused) and legitimate use of force, and good international practice when hiring, training, equipping and monitoring security personnel as well as when setting the rules for their conduct. The promoter shall incorporate the requirements stated above in the contracts and other agreements to be signed with the security providers.

(xiii) **Information dissemination and consultation.** The promoter shall ensure that both project workers and project-affected people and communities have been properly identified, consulted and informed in an accessible format of their rights in terms of health, safety and security (pursuant to Standard 2 on Stakeholder Engagement). The promoter shall further ensure that they can freely convene and express their views on project risks, impacts and the proposed health and safety management plans. Due attention should be paid to reaching out to individuals or groups within the project-affected communities that are vulnerable, marginalised, systematically discriminated against or excluded on the basis of their socioeconomic characteristics and Indigenous Peoples in the local communities (in accordance with Standard 7) and ensuring that risks to them have been adequately identified and protective and mitigation measure communicated.

(xiv) **Grievance mechanism.** As considered in Standard 8 the promoter shall set up an effective, culturally appropriate and gender-responsive grievance mechanism for project workers (and their organisations, where they exist) to raise reasonable workplace concerns. The promoter shall also grant members of the project-affected communities free and easy access to an independent, effective and free of reprisals grievance mechanism in line with the requirements defined in Standard 2. Both mechanisms shall address their health and safety concerns in a

timely and effective manner and shall not impede access to other redress mechanisms, such as judicial, administrative and labour inspectorates or extrajudicial means of complaint. The promoter shall duly inform workers and project-community members of the existence of these grievance mechanisms. The promoter shall ensure that their grievance mechanisms can be used by affected communities and workers to report security concerns as well as allegations of abuses or unlawful acts by the security personnel. The promoter shall investigate such allegations, report to the public authorities when relevant and take appropriate measures to avoid reoccurrence.

(xv) **Accident and incident reporting system.** Before project construction and operation, the promoter shall establish project level procedures and systems for investigating, recording and reporting any type of accident and incident including those causing harm to people. These accidents can happen at the site, as well as within the project influence area, as a direct consequence of the construction works or project activities. Project related road and traffic accidents shall also be reported to the EIB.51 The mechanism shall address the health and safety concerns of the workers and member of the public in a timely and effective manner and shall not impede access to other redress mechanisms, such as judicial, administrative or extrajudicial means of complaint.

(xvi) **Third party workers.** The promoter shall ensure that the requirements of this Standard are applied to all workers, including those employed or engaged by contractors, subcontractors and any other third party or intermediary. The promoter shall put in place appropriate policies and procedures for managing and monitoring the performance of third-party employers. These policies and procedures should be commensurate with the size of the project and workforce.

(xvii) **Supply chain workers.** The promoter shall make reasonable efforts to assess if there are significant health and safety risks associated with the workers of the primary supplier of the goods and materials central to the core functions of the project. Where there are significant health and safety risks related to supply chain workers, the promoter shall resort to a primary supplier that can prove is compliant with this standard. The promoter shall require the relevant primary supplier to introduce procedures and mitigation measures to address such risks. The promoter shall periodically monitor and review the effectiveness of such procedures and mitigation measures.

### (j) Standard 10: Cultural Heritage

82. This Standard recognises that protecting and conserving cultural heritage, which is a source of valuable historical and scientific information, an asset for economic and social development and an integral part of people's cultural rights, identity and practices, is fundamental to environmental and social sustainability.

83. The objective of this Standard is to set out requirements applicable to EIB-financed projects that the promoter shall comply with. These requirements are intended to foster:

(i) the application of a precautionary approach to the management and sustainable use of cultural heritage;
(ii) the protection of cultural heritage from the potential adverse impacts of project activities;
(iii) the equitable sharing with local communities of financial and/or socioeconomic benefits derived from the commercialisation of cultural heritage; and
(iv) awareness, appreciation and enhancement of cultural heritage.

84. This Standard applies to a specific project, when its relevance is determined during the EIA/ESIA process (as outlined in Standard 1) and specifically to EIB-financed projects likely to have impact on known cultural heritage regardless of whether or not is legally protected and/or previously disturbed. This Standard also applies to projects under implementation that are likely to have a significant impact on cultural heritage but were not previously identified as such and for which chance find procedures shall be applied.

85. For the purpose of this Standard, cultural heritage includes both tangible and intangible heritage:

(i) Tangible cultural heritage[12] refers to monuments (Architectural works, works of monumental

[12] *The UNESCO 1972 Convention concerning the Protection of the World Cultural and Natural Heritage [https://whc.unesco.org/archive/convention-en.pdf].*

sculpture and painting, elements or structures of an archaeological nature, inscriptions, cave dwellings and combinations of features, which are of value to the local communities or peoples), individual buildings, groups of buildings (groups of separate or connected buildings which, because of their architecture, their homogeneity or their place in the landscape, are of value to the local communities or peoples) and sites (works of man or the combined works of nature and man, and areas including archaeological sites which are of value to the local communities or peoples).

(ii) Intangible cultural heritage[13] refers to practices, representations, expressions, knowledge and skills – as well as the instruments, objects, resources, artefacts and cultural spaces associated therewith – that rights-holders (communities, groups and, in some cases, individuals) recognise as part of their cultural heritage and which are transmitted from generation to generation.

86. This Standard applies also to natural heritage[14] recognised by the local communities and peoples as part of their history, values, beliefs, knowledge and/or traditions and which the communities and peoples consider valuable, and desires to sustain and transmit to future generations.

87. Where a project is likely to have significant impact on natural heritage, both cultural and biodiversity/ecosystem services aspects shall be considered and the requirements of Standard 4 shall apply in conjunction with the requirements presented in this Standard.

88. The promoter is responsible for locating and designing a project in such a manner that it will avoid significant adverse impacts on cultural heritage. When the promoter can demonstrate that impacts cannot be avoided for reasons other than cost considerations, the promoter shall adequately assess if any cultural heritage is likely to be significantly affected by the project and/or if there are indications of the likelihood of any chance finds. Where the project site may potentially prevent access to previously accessible cultural heritage, the promoter shall allow continued access to these sites or shall provide alternative access, during construction and operation. In doing so, the promoter shall engage with relevant national or local regulatory authorities entrusted with the protection of cultural heritage, local communities and other relevant stakeholders as appropriate.

89. The promoter shall ensure that the impact on cultural heritage is duly considered in the ESIA process by considering the views of key relevant stakeholders and engaging professionals with appropriate expertise, experience and qualifications in cultural heritage to assist in the preparation of the assessment.

90. The cultural heritage assessment as a standalone study or as part of the ESIA report shall provide information on at least:

(i) The description of the project and the reasonable alternatives studied during the project preparation phases with an indication of whether the impact on cultural heritage was considered in the selection of the chosen option;

(ii) A baseline study compiling a comprehensive inventory of cultural heritage assets supported by a full description of their cultural significance using both desk-based research and field surveys;

(iii) The prediction and evaluation of the significance of both direct impacts (direct loss, destruction or disturbance of an element of cultural heritage) and indirect impacts which may affect the preservation of cultural heritage, including visual impacts;

(iv) The application of a mitigation hierarchy by identifying measures to avoid, prevent and reduce significant adverse impacts on cultural heritage, outlined in a cultural heritage management plan;

(v) A cultural heritage management plan to ensure that the proposed mitigation measures are properly implemented and that the cultural heritage asset is preserved in the desired state.

91. When defining the mitigation measures, the following order should be considered:

(i) Minimise adverse impacts with appropriate technical and/or management measures specific to the cultural heritage asset to be protected;

---

[13] *The UNESCO 2003 Convention for the Safeguarding of the Intangible Cultural Heritage [https://ich.unesco.org/en/convention].*

[14] *Natural heritage refers to natural features consisting of physical and biological formations or groups of such formations, natural features, geological and physiographical formations, delineated areas that constitute the habitat of threatened species of animals and plants and natural sites of value from the point of view of science, conservation or natural beauty (Art. 2 of the UNESCO 1972 Convention concerning the Protection of the World Cultural and Natural Heritage).*

(ii) When minimisation is not possible, restore in situ after the adverse impacts have occurred to ensure full restoration of the functionality and significance of the cultural heritage for the affected communities;

(iii) When the promoter can demonstrate that minimisation and restoration are not feasible for reasons other than cost considerations, remedy/compensate for loss of cultural heritage in ways that are acceptable and have been agreed with the affected communities before any works affecting the cultural heritage have started.

92. Following processes and/or considerations are part of the specific requirements of this Standard:

(i) **Stakeholder engagement.** As a part of the Social Impact Assessment (SIA), Stakeholder Engagement Plan (SEP) has been prepared for the project to keep stakeholders informed and engaged on the project progress. The SEP shall also to establish a process that provides opportunities for stakeholders to express their views and concerns and allows Maha Metro to consider and respond to them. Stakeholders will be actively involved in decision making and project implementation processes throughout the project. The Stakeholders Engagement Plan (SEP) describes the planned stakeholder consultation and engagement process for the project. It outlines a systematic approach to stakeholder engagement that will help the project develop and maintain over time a constructive relationship with their stakeholders throughout the implementation period of the project. The SEP also supports a grievance redressal mechanism (GRM) for stakeholders to raise their concerns about the project. The SEP focusses on ensuring timely and ongoing flow of relevant information to the stakeholders so that they retain an accurate understanding of the project, its aims, timelines, progress, benefits, etc. The systematic approach to stakeholder engagement aims to improve and facilitate decision-making and create an atmosphere of understanding that actively involves project affected people and other stakeholders in a timely manner.

(ii) **Protected cultural heritage areas.** Legally protected cultural heritage areas are important for the safeguarding and conservation of cultural heritage and therefore, additional measures are needed for any projects that would be permitted in these areas under the applicable national law.

(iii) **Chance find procedures.** The promoter shall ensure that provisions for managing chance finds (defined as cultural heritage encountered unexpectedly during project construction) are in place and included in contracts, as appropriate. Such provisions shall include: notification of relevant competent authorities of found objects or sites; delivering training to the project personnel, including contractor and sub-contractor employees, on the procedures to follow if chance finds are discovered; and securing the area of finds to avoid any further disturbance or destruction. The promoter shall not disturb any chance finds until an assessment by a designated and qualified specialist is made and actions consistent with national legislation and this Standard are identified.

(iv) **Project's use of cultural heritage.** Where a project proposes to use, for commercial purposes, a local community's cultural resources, knowledge, innovations or practices that embody traditional lifestyles, the promoter shall disclose all relevant information in a timely and context-specific manner, in an accessible place, and in a form and language(s) understandable to the community The information provided shall include as a minimum: (i) its rights under national law; (ii) the scope and nature of the proposed commercial development; and (iii) the potential consequences of such development.

93. The promoter shall proceed with such commercialisation only when it:

(i) enters into a good faith negotiation with the affected local communities;

(ii) documents their informed participation and the successful outcome of the negotiation; and

(iii) provides for fair and equitable sharing with the affected local communities of benefits derived from commercialisation of such knowledge, innovations or practices, consistent with their customs and traditions.

94. Where a project proposes to use the cultural resources, knowledge, innovations or practices of Indigenous Peoples, the requirements of Standard 7 also apply.

## 2. International Finance Corporation (IFC) Performance Standards (PS) on Environmental & Social Sustainability

95. The Policy on Environmental and Social Sustainability describes International Finance Corporation (IFC) commitments, roles, and responsibilities related to environmental and social sustainability. The performance standards are directed towards clients, providing guidance on how to identify risks and impacts, and are designed to help avoid, mitigate, and manage risks and impacts as a way of doing business in a sustainable way, including stakeholder engagement and disclosure obligations of the client in relation to project level activities. Performance standards issued by IFC are given below:

- Performance Standard 1 : Assessment and Management of Environmental and Social Risks and Impacts
- Performance Standard 2 : Labour and Working Conditions
- Performance Standard 3 : Resource Efficiency and Pollution Prevention
- Performance Standard 4 : Community Health, Safety, and Security
- Performance Standard 5 : Land Acquisition and Involuntary Resettlement
- Performance Standard 6 : Biodiversity Conservation and Sustainable Management of Living Natural Resources
- Performance Standard 7 : Indigenous Peoples
- Performance Standard 8 : Cultural Heritage

## C. APPLIED STANDARDS

96. The project will follow national as well as international best practices and standards related to environment, health and safety, including the Environmental, Health and Safety Guidelines for Railways [IFC, April 30, 2007). When host country regulations differ from the levels and measures presented in the International Guidelines, projects are expected to achieve whichever is more stringent. Appropriate and less stringent levels or measures than those provided in the International Guidelines can be adopted if they are protective of human health and the environment [World Bank Group (WBG) Environmental, Health, and Safety (EHS) General Guidelines April 30, 2007]. Some international standards for environmental components are listed here:

**1. Air Quality**

(i) WHO air quality guidelines for particulate matter, ozone, nitrogen dioxide and sulphur dioxide [Global Update, 2005. (EHS Guidelines WBG April 2007)];
(ii) WBG EHS guidelines 2021; and
(iii) Environment (Protection) Seventh Amendment Rules 2009.

**2. Water Quality**

(i) Water Resources and Environment Technical Note D1, March 2003 WBG and EU standards for discharge from wastewater treatment plant;
(ii) Pollution Prevention and Abatement Handbook, WB 1998 / April 1999 for storm water;
(iii) General Standards of discharge for environmental pollutants Part A- Effluents, Schedule VI, Environmental Protection Rules 1986, MoEFCC, Government of India [In relation to Indian post-treatment inland surface water standards, WBG effluent discharge guideline values for toxic metals are more stringent; they prescribe coliform levels while Indian standards do not.];
(iv) Designated Best Use Classification of Surface water, CPCB 1978 for propagation of wildlife and fisheries;
(v) WHO Guidelines for Drinking Water Quality 2017; and
(vi) Drinking Water Specification IS 10500-2012, Bureau of Indian Standards (BIS); drinking water standards as per WHO cover fewer substances than Indian standards.

**3. Soil** (in terms of permissible content in foods)

(i) Environmental clearance Regulations 1881/2006, 629/2008 and 835/2011 cover toxic metals, nitrates, Persistent Organic Pollutants (POPs) and Polycyclic Aromatic Hydrocarbons (PAHs); and
(ii) In India, Prevention of Food Adulteration Rules 1955 prescribe permissible limits of lead, copper, arsenic, zinc, cadmium, mercury, chromium, nickel.

**4. Noise**

(i) WHO Guidelines for Community Noise ca. 1999;
(ii) The Noise Pollution (Regulation and Control) Rules, 2000 (Amended 2002);
(iii) EHS Guidelines WBG April 2007; and
(iv) Factories Act 1984 and the Model Rules under the Factories Act.

**5. Vibration**

(i) Transit Noise and Vibration Impact Assessment Manual, Federal Transit

Administration, September 2018;
(ii) Transit Noise and Vibration Impact Assessment, US FTA, May 2006; and
(iii) Metro Rail Transit System Guidelines for Noise and Vibrations, RDSO, Sept 2015.

**6. Biodiversity (IFC Performance Standard 6)**
(i) Consider direct and indirect project related impacts on biodiversity and ecosystem services and identify any significant residual impacts;
(ii) Consider relevant threats to biodiversity and ecosystem services, especially focusing on habitat loss, degradation and fragmentation, invasive alien species, overexploitation, hydrological changes, nutrient loading, and pollution;
(iii) Consider the differing values attached to biodiversity and ecosystem services by stakeholders;
(iv) Seek to avoid impacts on biodiversity and ecosystem services. When avoidance of impacts is not possible, measures to minimize impacts and restore biodiversity and ecosystem services should be implemented; and
(v) Adopt a practice of adaptive management in which the implementation of mitigation and management measures are responsive to changing conditions and the results of monitoring throughout the project's lifecycle.

**7. Asbestos Handling Waste and Management (IFC General EHS Guidelines - Hazardous Materials Management)**
(i) Use of Asbestos Containing Materials (ACM) should be avoided in new buildings or as a new material in remodelling or renovation activities.
(ii) Existing facilities with ACM should develop an Asbestos Management Plan which clearly identifies the locations where the ACM is present, its condition (e.g. whether it is in friable form with the potential to release fibres), procedures for monitoring its condition, procedures to access the locations where ACM is present to avoid damage, and training of staff who can potentially come into contact with the material, etc. to avoid damage and prevent exposure.

**8. Climate Change (EIB EHS 2022)**
(i) Expanding the use of clean energy;
(ii) Encouraging sustainable transport and urban development;
(iii) Managing land use and forests for carbon sequestration;
(iv) Promoting climate-resilient development; a
(v) Strengthening policies, governance and capacities.

**9. Occupational Health and Safety (WBG & EIB)**

**10. Community Health and Safety (WBG & EIB)**

# Chapter 3. PROJECT DESCRIPTION

## A. RATIONALE

97. India has experienced rapid growth in urbanization over several decades, with the share of the urban population from about 18% in 1960 to around 36% in 2022[15]. By 2030, Indian cities are projected to be home to another 250 million people[16]. The metropolitan areas are facing extremely high population densities and traffic congestion.

98. The Ministry of Urban Development (MoUD) formulated the National Urban Transport Policy (NUTP) in 2006 to create safe, affordable, quick, comfortable, reliable, and sustainable urban transport systems for Indian cities. 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. In July 2022 report, that was tabled in Lok Sabha, confirmed that around 743 km long metro rail line is operational in the country in a total of 19 cities. The 17th Lok Sabha report also confirmed that over 1,000 km of metro rail line is presently under construction in 27 cities of India.

99. With a population of 31.2 Lakh (2011 census), Pune city is the second most populated city in Maharashtra after Mumbai and the 9th most populated city in India. The total population of the Pune urban agglomeration is 51 Lakh in 2011. The city is considered to be an educational hub due to the establishment of large number of educational institutes across the city. Rapid urbanization and intense commercial developments in recent past have resulted in steep rise in travel demand putting Pune city's transport infrastructure to stress. To relieve this stress MRTs system i.e. Pune Metro is already under operation.

100. Maha Metro is a Special Purpose Vehicle (SPV) created for the smooth implementation and operations of the Pune Metro Rail Project and is an equal equity joint venture of Government of India (GoI) & Government of Maharashtra (GoM). PMRP shall be solely responsible for the successful and timely completion of the project & its operations subsequently.

101. Systra has carried out the investigation and studies for Pune Metro Rail Project Swargate to Katraj (Phase-1 Extension) and prepared a Detailed Project Report (DPR) in August 2021 & December 2021 respectively based on which the project is proposed to be implemented

## B. DESCRIPTION OF SWARGATE TO KATRAJ (PHASE-1 EXTENSION) PROJECT[17]

102. Proposed Swargate to Katraj (Phase-1 Extension) comprise of 5 Underground stations from Swargate to Katraj with a total length of 5.9 km.

103. Geotechnical investigations have been carried out along the proposed project to determine the strata, depth of foundation and safe bearing capacity of foundations required for the above proposed metro project. Drilling and sampling in soil and rock was carried out using rotary drilling rig. Borehole in soil was advanced using rotary drilling method.

104. Route Alignment: (Swargate to Katraj (Phase-1 Extension))

- Proposed alignment of Swargate and goes up to Katraj near Rajeev Gandhi Zoological Park. Total length of the corridor is 5.9 km which is completely underground
- This corridor is an extension of existing corridor 1 under Phase 1 i.e. PCMC to Swargate in the south.
- 5 Stations have been proposed in phase 1, all of which are underground stations. Summary of the section is given below

105. The proposed alignment of stations is an extension of Pune Metro Phase 1

106. Total 5 stations (underground) are proposed in this corridor are summarized as under **in Table**

---

[15] *Source: https://data.worldbank.org/indicator/SP.URB.TOTL.IN.ZS?locations=IN.*

[16] *Source: Urbanization beyond Municipal Boundaries : Nurturing Metropolitan Economies and Connecting Peri-Urban Areas in India (worldbank.org).*

[17] *Source: Revised Final Detailed Project report (Swargate – Katraj) December 2022.*

**3-1,** while Line 1 map if presented as **Figure 3-1.**

*Table 3-1 Swargate to Katraj (Phase-1 Extension) with chainage*

| Name of Stations | Chainage (m) | Type |
|---|---|---|
| Station 1 (Market Yard, Gultekdi) | 17483.933 | Underground |
| Station 2 (Bibwewadi) | 18421.761 | Underground |
| Station 3 (Padamavati) | 19594.22 4 | Underground |
| Station 4 (Balajinagar) | 20824.954 | Underground |
| Station 5 (Katraj) | 22030.539 | Underground |

*Figure 3-1 Alignment Map of Swargate to Katraj (Phase-1 Extension)) showing station locations*




107. The end of chainage of Phase 1 (PCMC- Swargate) is 16815.290 and the end of chainage of Swargate to Katraj (Phase-1 Extension) is 22282.933 for north bound track and 16821.530 and 22282.848 as start and end chainage for south-bound track. Thus, total length of corridor is 5.9 km, which is fully underground. Station – Near Padmavati has been proposed on the south side of road, whereas Station – Near Market Yard and Katraj Station has been proposed on the median of the road (when travelling from Swargate to Katraj). This is due non- availability of land at the respective locations. Scissor Crossover has been planned just before the terminal station i.e. Katraj Station, at chainage 21625.754 to 21765.705 and 21630.697 to 21770.632 on North Bound track and South Bound track respectively. Permanent Speed restriction of 25kmph, 15kmph and 5kmph may be required to be imposed progressively for safe degraded operation. Length of alignment post terminal station is 349.459m for North bound track and 364.625m for South-bound track.

## 1. Design Norms

### Alignment Definition

108. The geometrical design norms are based on international practices adopted for similar systems with standard gauge on the assumption that the maximum permissible speed on the section is limited to 80 kmph. Planning for any higher speed is not desirable as the shorter inter station distance will not lead to significant difference in running time.

109. The underground tracks will be carried on two parallel tunnels, generally spaced at constant centre to centre distance of 15.35m. The horizontal alignment and vertical alignment are dictated to a large extent by the geometry of the road and ground levels followed by the alignment

**Rolling stock assumptions for alignment study**

| Parameters | Rolling Stock |
|---|---|
| Basic Unit | 3 Car basic unit 2DMC and 1 TC.<br>Every coach should be fully interchangeable with any other coach of same type |
| Train Composition | 3- Car: DMC+TC+DMC<br>6- Car: DMC +TC +MC + MC + TC + DMC<br>Capable of GoA4 operation |
| Coach Dimensions | L= 22.6m, W=2.9m, H= 3.9m |
| Coach construction | Light weight Stainless Steel/Aluminum body |
| Axle load | ≤16 T |
| Braking System | Regenerative Braking |
| Propulsion system | 3 phase drive system with VVVF control |
| Type of traction supply | 25kV AC OHE/ROCS system[18] |

**Geometric design parameters**

110. The design parameters related to the metro system described herewith have been worked out based on a detailed evaluation, experience and internationally accepted practices. Various alternatives were considered for most of these parameters, but the best-suited ones have been adopted for the system as a whole.

**Transition Curves**

111. Due to change in gradients at various locations in the project, it is necessary to provide frequent vertical curves along the alignment. It is desirable that the vertical curves and transition curves of horizontal curves do not overlap. These constraints may lead to reduced lengths of transition curves at certain locations. The transition curves have certain minimum parameters

- Length of Transitions of Horizontal curves (m)
  - ✓ Minimum: 0.44 times actual cant or cant deficiency (in mm) whichever is higher
  - ✓ Desirable: 0.72 times actual cant or cant deficiency, (in mm), whichever is higher
- Overlap between transition curves and vertical curves not allowed
- Minimum straight between two transition curves: either 25m or nil
- Minimum curve length between two transition curves: 25 m

**Assumptions**

| | |
|---|---|
| Track gauge (between interior rails) | 1435mm |
| Spacing of rail lines (between axes of rails) | 1507mm |
| Maximum design speed* | 90 km/h |
| Maximum operating speed* | 80 km/h |

**Design value**

*Table 3-2 Design Value Summary*

| Parameters | Theoretical Formulae | Requirements to Comply with | |
|---|---|---|---|
| | | limiting | project's preferential |
| Theoretical equilibrium cant | 11.8V2/R | 225 mm | 195 mm |
| Cant | - | 125 mm | 110 mm |
| Cant deficiency | - | 100 mm | 85 mm |
| Cant Gradient (geometrical variation of the cant) | - | ≤ 1 in 500 | ≤ 1 in 750 |

*[18] ROCS is recommended for Swargate to Katraj Corridor whereas OHE is only used as a reference for calculation purpose*

| Parameters | Theoretical Formulae | Requirements to Comply with | |
|---|---|---|---|
| | | limiting | project's preferential |
| Rate of change of cant | - | 55 mm / s | 35 mm/s |
| Rate of change of cant deficiency | - | 55 mm / s | 35 mm/s |
| Minimum radius in Running Track | - | 120 m | 225 m |
| Minimum radius in Depot | - | 100 m | 190 m |
| Length of pure circular arc between transitions | - | 25 | 50 m |
| Length of Transition or Tangent Length | - | 15 m | 25 m |
| Minimum length of straight between reverse direction curves | - | 25m or 0m | 25 m |

**Vertical Alignment**

112. Vertical curves shall wherever possible be positioned such that coincidence with horizontal transitions is avoided. Where such coincidence is unavoidable, the largest practicable vertical curve radius shall be employed.

113. Vertical curves shall, for each location, be selected on the basis of the largest practicable vertical curve radius subject to the following limit:

- Minimum desirable radius 2500 m
- Absolute Minimum Radius 1500 m

114. The length of constant grade between consecutive vertical curves shall be as follows

- Desirable minimum 50 m
- Absolute minimum 25 m

115. At point and crossing work, vertical curves shall not coincide with any part of the overall length of switches or of cast crossings. At other point and crossing work vertical curves shall be avoided whenever possible. Where they cannot be avoided the vertical curve radius shall be 3000 m or more.

116. At station ends, the tangent point of the vertical curve shall be permitted to encroach within the length of the platform to a limited extent. This length of encroachment shall be such that the vertical offset of the curve from the station gradient at the platform end shall not exceed 15mm.

**Gradient**

117. For running lines, the desirable maximum gradient shall be 3% and where unavoidable shall be 4%. Where gradients of 1% or less are used they may be unrestricted in length. Gradients above 3.0% shall be kept as short as possible.

118. At stations, the track shall be level or of constant gradient not steeper than 0.2% throughout the platform length except for the limited lengths of vertical curves as specified in relevant clause under Vertical Alignment.

A drainage gradient shall be provided for all tunnel, other than at stations, as follows:

- Desirable minimum 0.5%
- Absolute minimum 0.25%

119. Sidings shall be level or shall fall away from the main line switch at a gradient not exceeding 0.25%. Train berths shall be level or shall fall towards the buffer stops at a gradient not exceeding 0.25%.

**Levels**

120. All levels shall be quoted in metres correct to three decimal places and shall be above mean sea level (MSL).

121. Rail level on canted track will refer to the level of the running edge of the lower rail.

**Points and crossings**

122. Whenever possible, points and crossing work shall not coincide with vertically or horizontally curved track.

123. Where it is not possible to avoid coincidence with vertical curves the switches and stock rails shall not be laid on vertical curves.

124. Points and crossing work shall not coincide with horizontal transitions.

125. No part of the switches operating gear or crossing nose shall be over a structural movement joint.

126. In case of unavoidable circumstances, if the coincidence with horizontal curve cannot be avoided, the same may be laid in curve having radius greater than 1000m with cant applied made zero.

127. Generally, 1 in 9 turnouts with 300m Radius (1 in 9 R300) is to be adopted in Main Line and 1 in 7 turnouts with 190m Radius (1 in 7 R190) is to be adopted in depot tracks.

**Scissors crossovers**

128. Scissors crossovers shall be based on a transitioned crossover with vertical rails.

129. The switch points and turnout radius shall be standard UIC or approved equivalent, designed to accommodate a minimum operational speed of 40 km/hr.

**Turnouts**

130. Turnouts shall be based on a transitioned turnout with vertical rails

- The speed through the turnout shall be 50 km/hr.
- Operational speed in the depot shall be 25 km/hr.

## 2. Stations

131. Stations have been located so as to serve major passenger destinations and to enable convenient integration with other modes of transport. However, effort has also been made to propose station locations such that the locations where maximum commuter travel.

132. This study comprises Swargate to Katraj (Phase-1 Extension) for which 5 numbers of Underground stations are proposed as given in **Table 3-1**. This section aims at presenting the stations locations, showing their sequencing and analysing their local catchment areas.

**General**

133. Stations have been located to serve major passenger catchment areas/destinations and to enable convenient integration with other modes of transport. The proposed route would have 5 numbers of underground stations, in continuation to the existing Metro Line (Phase 1), starting at Swargate station of Line 1, Phase 1 and terminating at Katraj. Stations vary in complexity along the route and have been located by an interactive process influenced by ridership forecasts, requirements with different modes of transport, station spacing, alignment, utilities, roads and pedestrian requirements, etc. **Figure 3-2** provides an overview of the proposed stations locations with their sequence.

*Figure 3-2: Sequence of stations along Swargate to Katraj (PMRP Phase 1 extension) project*

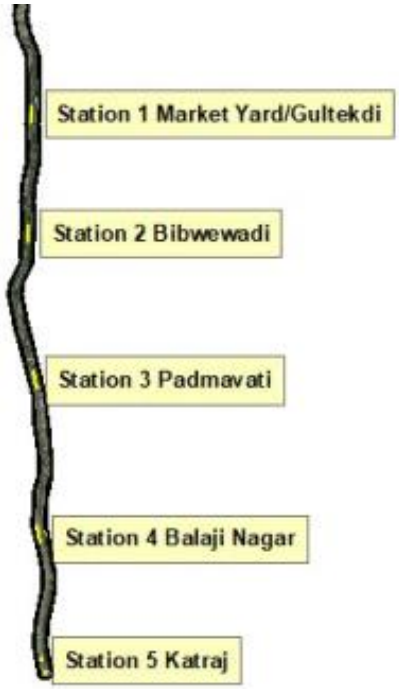



**Figure 3-3** through **Figure 3-7** below present the station-specific Area of Influence (AoI) for all the 5 proposed stations along the alignment, categorized into 250 m, 500 m, and 750 m buffer zones, with major habitations and sensitive receptors identified for environmental and social impact assessment.

*Figure 3-3: Station 1 - Market Yard (Gultekadi)*

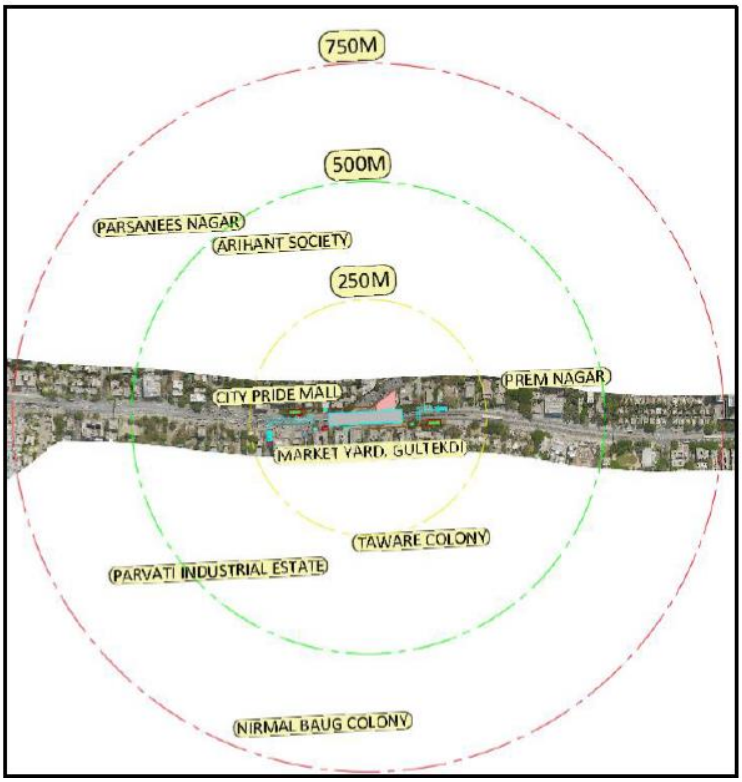


*Figure 3-4: Station 2 - Bibwewadi*

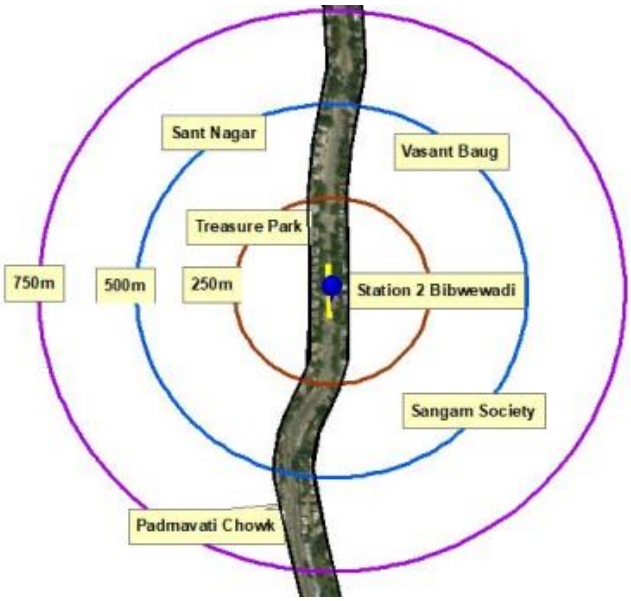



*Figure 3-5: Station 3 - Padmavati*

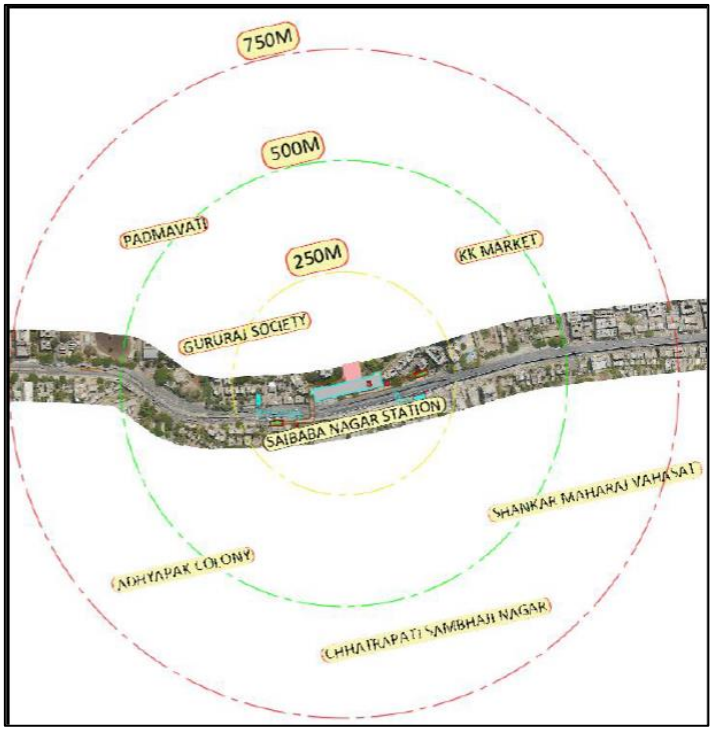
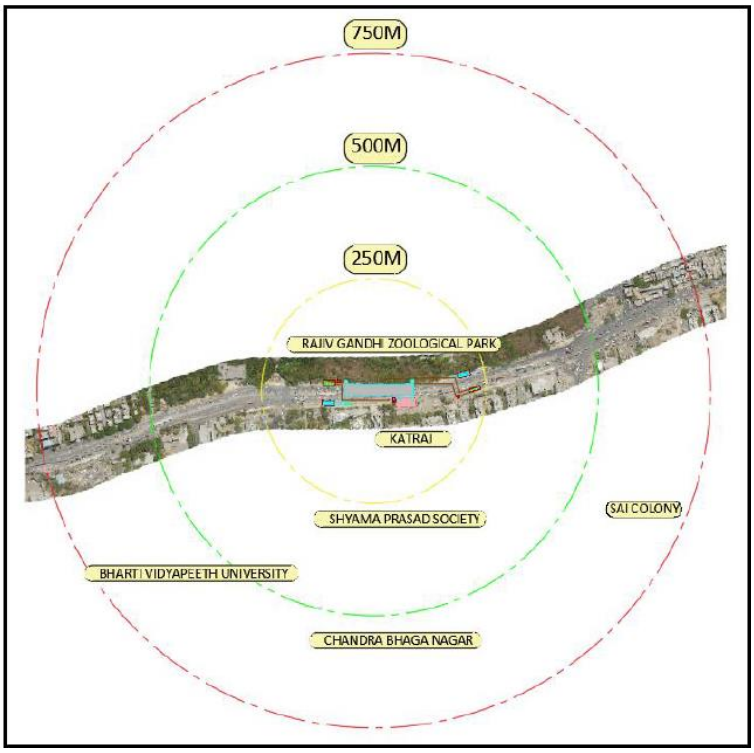


*Figure 3-6: Station 4 - Balajinagar*




*Figure 3-7: Station 5 - Katraj*




**Stations areas characteristics**

134. This section provides a general overview of the proposed station locations, existing and future local urban fabric, landmarks, access etc.;
For each station an analysis has been conducted regarding:

- The station location;
- The main roads to access the station;
- The land use around the station;
- The issues and concerns identified;
- The potential for improvements.

**Local area along corridor**

- This corridor is populated with Commercial, Residential as well as Recreational establishments and is crowded (both in terms of population density and road congestion).
- Road contains flyovers / underpasses.

**Areas covered by stations:**

- Stations at the proposed locations cover an existing Zoological Park, an educational campus, Residential Societies, places of worship and Commercial centres;
- Stations at the proposed locations also cover office areas as well as future developments proposed by respective local authorities.

**Access to stations:**

- Access to and egress from the stations will be guaranteed by the implementation of:
- Pick-up and drop-off areas for different modes of transport (bus stops when relevant, IPT modes and car)
- Pedestrians facilities (footpaths, pedestrian crossings, foot over bridge etc.)
- Bicycle tracks / cycle stands etc.

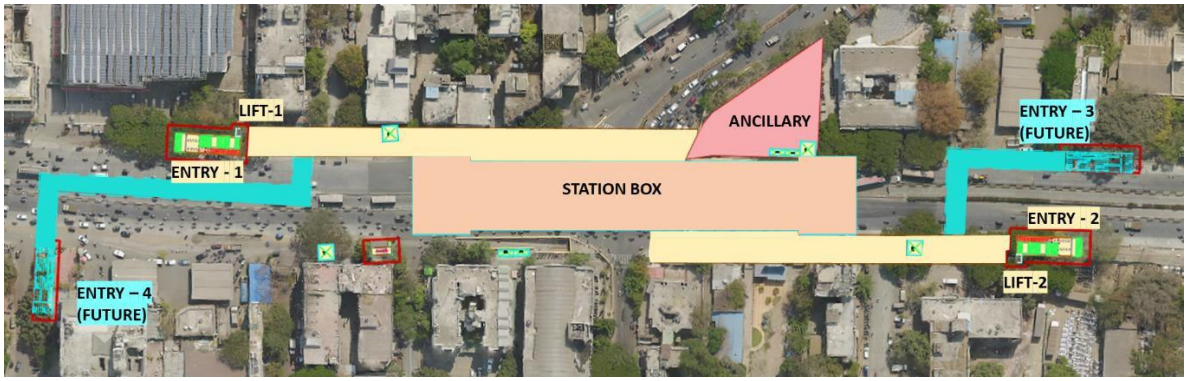
**General recommendations for access/egress to/from stations will also be made;**

- For optimal access to stations:
- Four (4) entries are proposed for all stations, out of four, two entries shall be future entries.
- Entries/exits are mostly proposed between service roads and highways;
- Entries shall be covered;
- Station entries shall be also used for crossing the road for safety purpose;
- The proposed stations shall be differently abled.

**Station 1: (Market Yard, Gutekdi)**

**INTRODUCTION:** This is the first station on the proposed extension of the Swargate-Katraj corridor. It is an underground station proposed on the Pune-Satara Highway near City Pride Mall. The major roads connecting the station are Bibwewadi Road and Bengaluru-Pune Highway. The station caters the public, semi- public, commercial, residential areas of Gultekdi and Maharshi Nagar, Walvekar Garden etc. There shall be four (4) entries to this station out of four, two entries shall be future entries.

| ISSUES & CONCERN | POTENTIAL FOR IMPROVEMENT |
|---|---|
| ● Lack of pedestrian facilities like footpath, pedestrian for crossing road along the road results in pedestrian spill-over on road;<br>● Improper street Parking leads to a reduction of effective road width which eventually slows down the traffic movement. | ● Dedicated pedestrian friendly footpath and FOB to ensure pedestrian safety.<br>● Proposal to have bicycle stands.<br>● Planning of dispersal activities through feeder modes will cater to a larger catchment. |




Station Box Size: 23.73m × 153.4 m

| | |
|---|---|
| **Entry No. 1**  | **Entry No. 2**  |
| **Entry No. 3**  | **Entry No. 4**  |

*Figure 3-8: Station Market Yard, Gultekdi - Road Section*

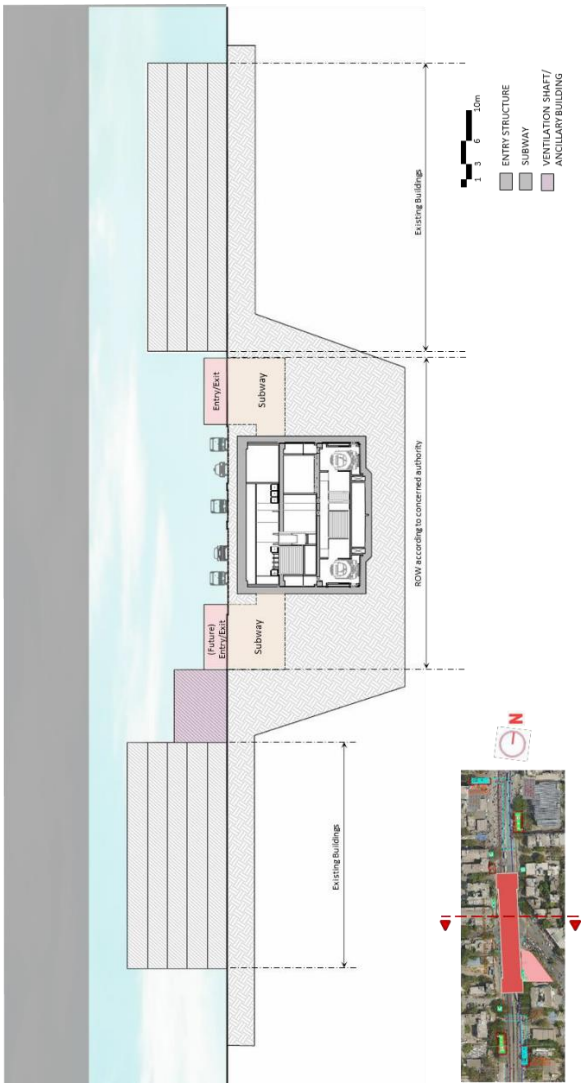
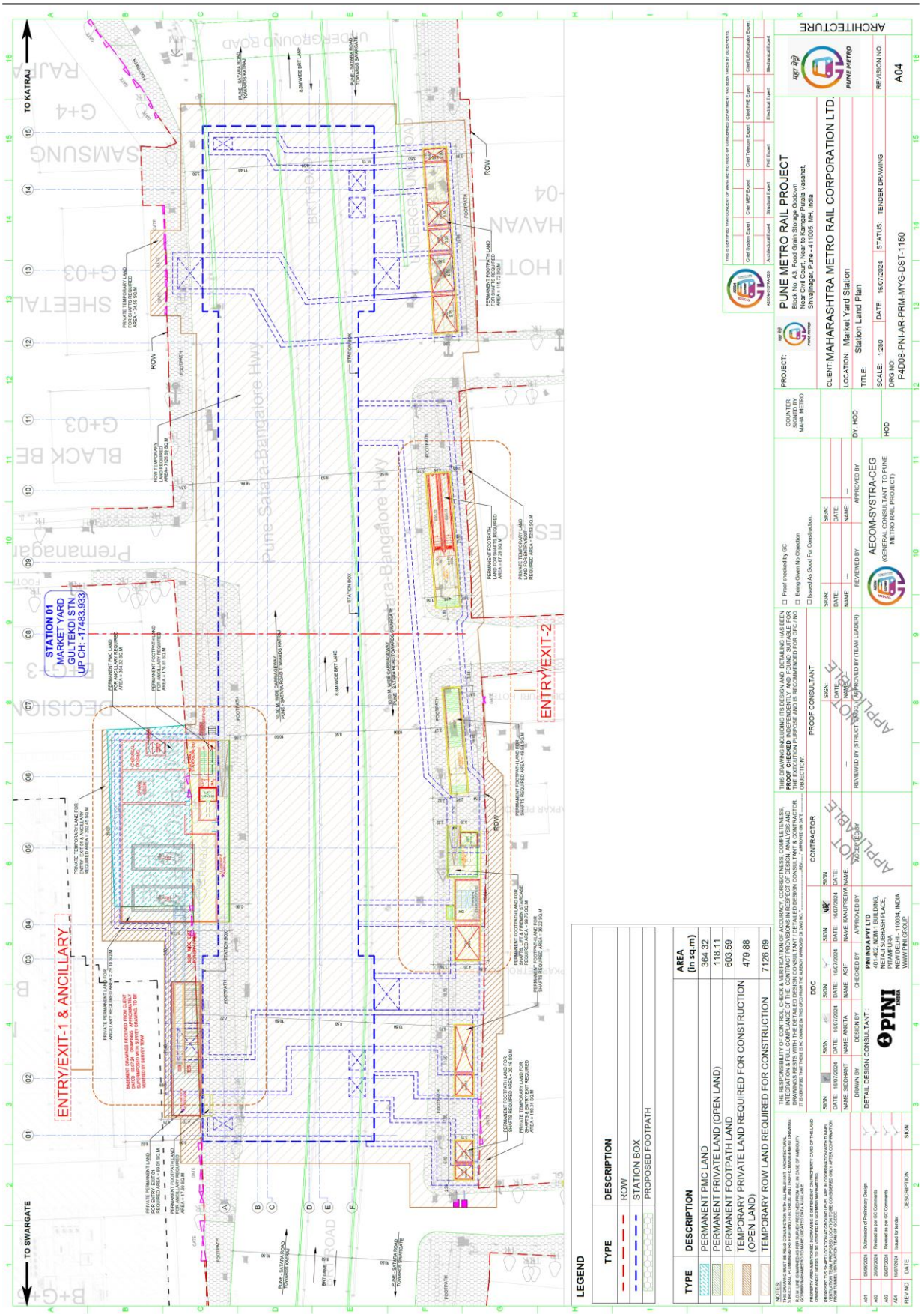


*Figure 3-9: Station Market Yard, Gultekdi - Plan*



**Station 2: (Bibwewadi)**

| **STATION INTRODUCTION:** This is the first station on the proposed extension of the Swargate-Katraj corridor. It is an underground station proposed on the Pune-Satara Highway near City Pride Mall. The major roads connecting the station are Bibwewadi Road and Bengaluru-Pune Highway. The station caters the public, semi- public, commercial, residential areas of Gultekdi and Maharshi Nagar, Walvekar Garden etc. There shall be four (4) entries to this station out of four, two entries shall be future entries. | |
|---|---|
| **ISSUES & CONCERN** | **POTENTIAL FOR IMPROVEMENT** |
| ● Lack of pedestrian facilities like footpath, pedestrian for crossing road along the road results in pedestrian spill-over on road;<br>● Improper street Parking leads to a reduction of effective road width which eventually slows down the traffic movement. | ● Dedicated pedestrian friendly footpath and FOB to ensure pedestrian safety.<br>● Proposal to have bicycle stands.<br>● Planning of dispersal activities through feeder modes will cater to a larger catchment. |

*Figure 3-10: Station Bibwewadi - Road Section*

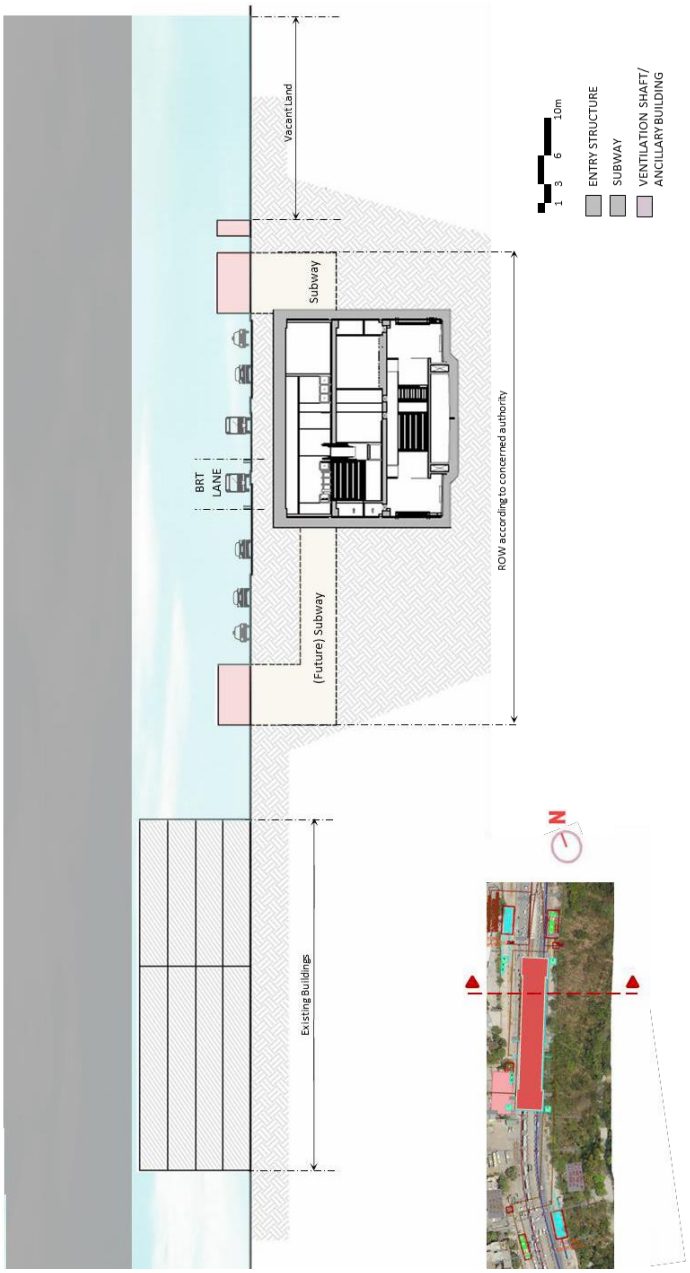
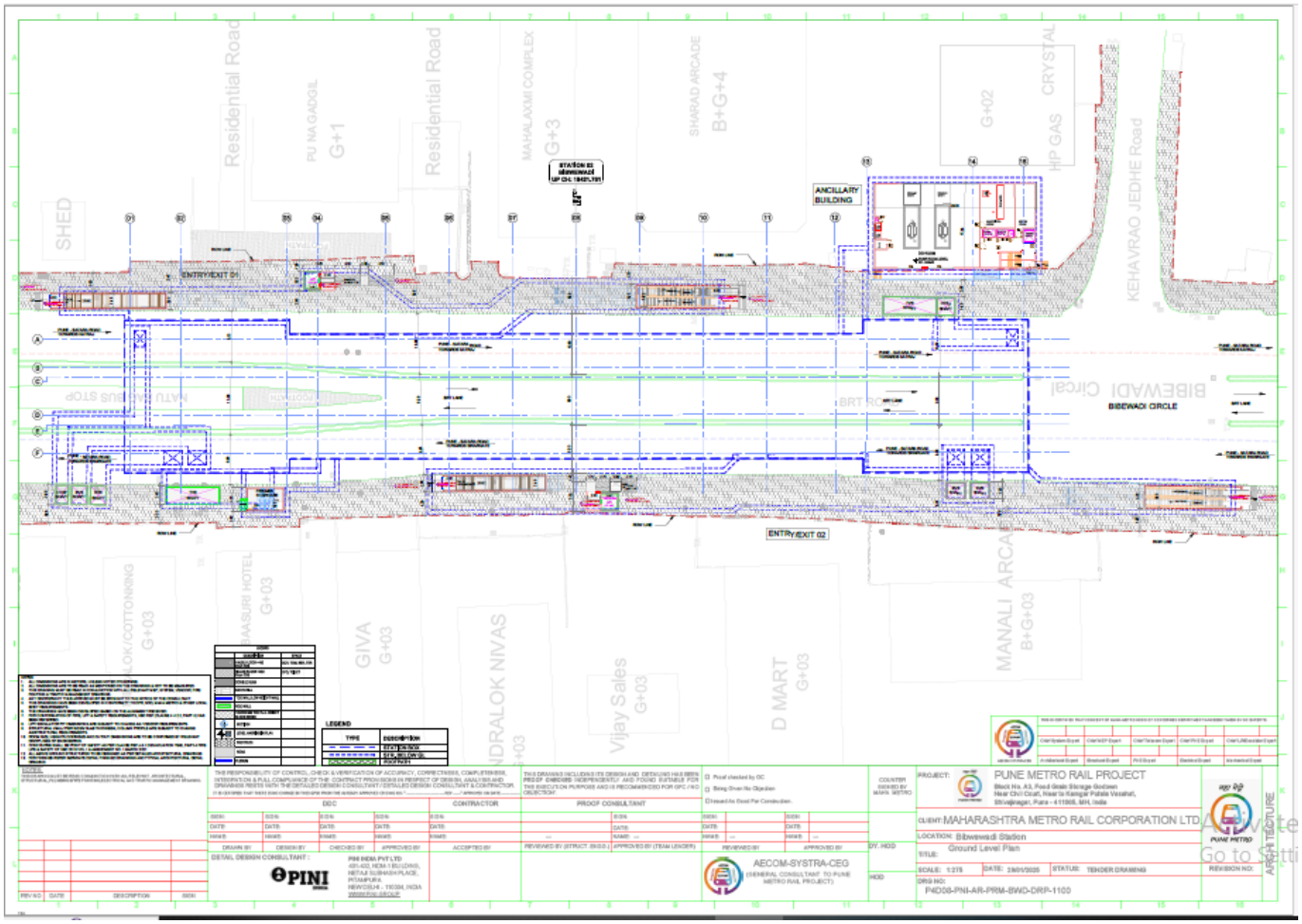
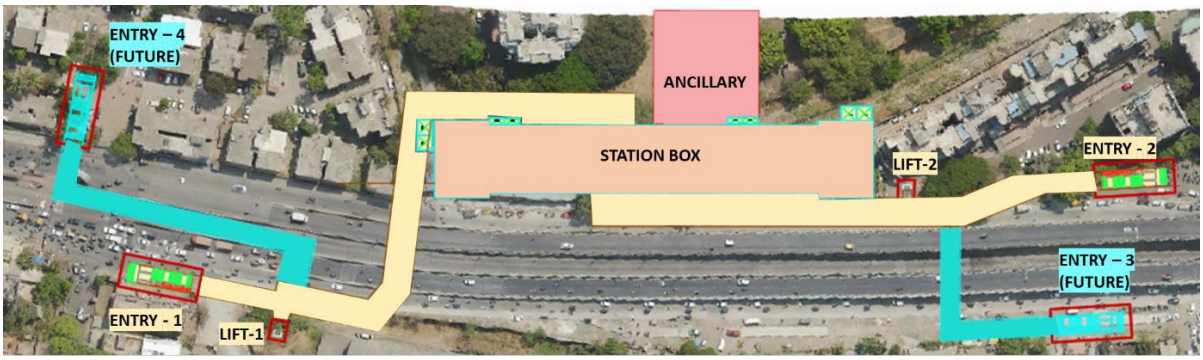


*Figure 3-11: Station Bibwewadi - Plan*




**Station 3 (Padamavati)**

| | |
|---|---|
| **STATION INTRODUCTION:** This is an underground station proposed on Pune-Satara Highway near Padmavati Chowk. The major roads connecting the station is Padmawati – Shahakar Nagar Road and the KK Market Road. The station provides dispersal connectivity to public, semi-public and the residential like Sant Eknath Nagar, Santosh society, Sahakar Nagar, KK Market, Padmavati. Meeta Nagar and Padmavati Mandir areas. There shall be four (4) entries to this station out of four, two entries shall be future entries. | |
| **ISSUES & CONCERN** | **POTENTIAL FOR IMPROVEMENT** |
| ● Lack of pedestrian facilities like footpath, pedestrian for crossing road along the road results in pedestrian spill over on road;<br>● Improper street Parking leads to a reduction of effective road width which eventually slows down the traffic movement. | ● Dedicated pedestrian friendly footpath to ensure pedestrian safety.<br>● Planning of dispersal activities through feeder modes will cater to a larger catchment.<br>● Removal of encroachments and optimal usage of ROW. |




Station Box Size: 23.73m X 153.4 m

ENTRY NO. 1



ENTRY NO. 2



ENTRY NO. 3



ENTRY NO. 4



*Figure 3-12 Station Padamavati - Road Section*

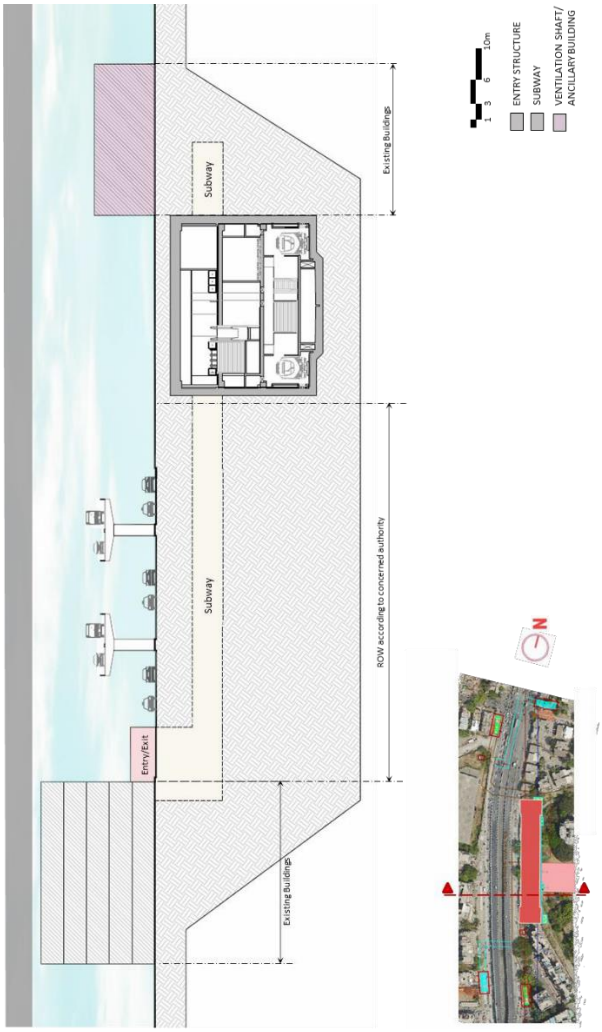
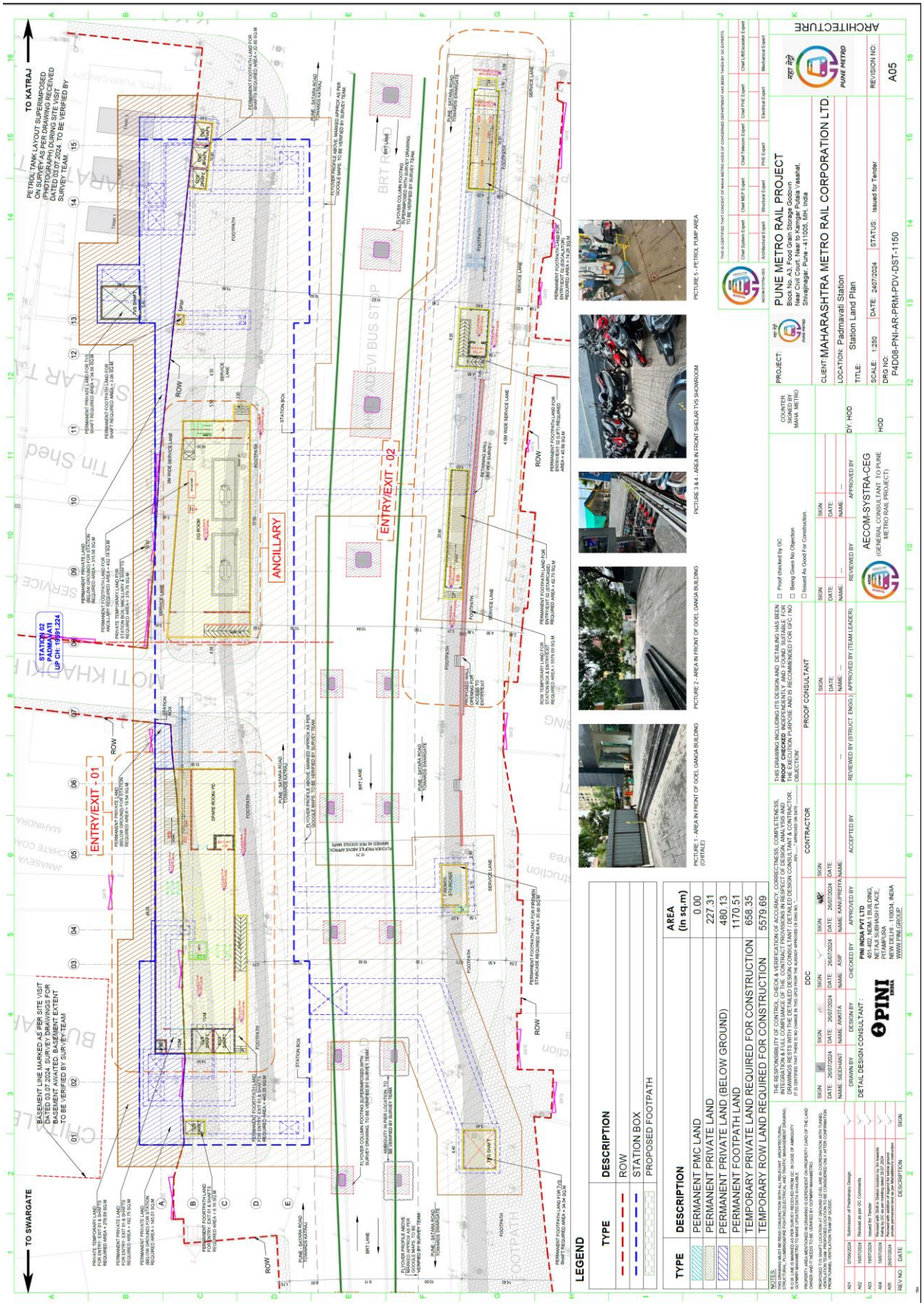


*Figure 3-13: Station Padamavati - Plan*




**Station 4 (Balajinagar)**

| **STATION INTRODUCTION:** This is an underground station proposed on Pune-Satara Highway near Padmavati Chowk. The major roads connecting the station is Padmawati – Shahakar Nagar Road and the KK Market Road. The station provides dispersal connectivity to public, semi-public and the residential like Sant Eknath Nagar, Santosh society, Sahakar Nagar, KK Market, Padmavati. Meeta Nagar and Padmavati Mandir areas. There shall be four (4) entries to this station out of four, two entries shall be future entries. | |
|---|---|
| **ISSUES & CONCERN** | **POTENTIAL FOR IMPROVEMENT** |
| ● Lack of pedestrian facilities like footpath, pedestrian for crossing road along the road results in pedestrian spill over on road;<br>● Improper street Parking leads to a reduction of effective road width which eventually slows down the traffic movement. | ● Dedicated pedestrian friendly footpath to ensure pedestrian safety.<br>● Planning of dispersal activities through feeder modes will cater to a larger catchment.<br>● Removal of encroachments and optimal usage of ROW. |

*Figure 3-14: Station Balajinagar- Road Section*

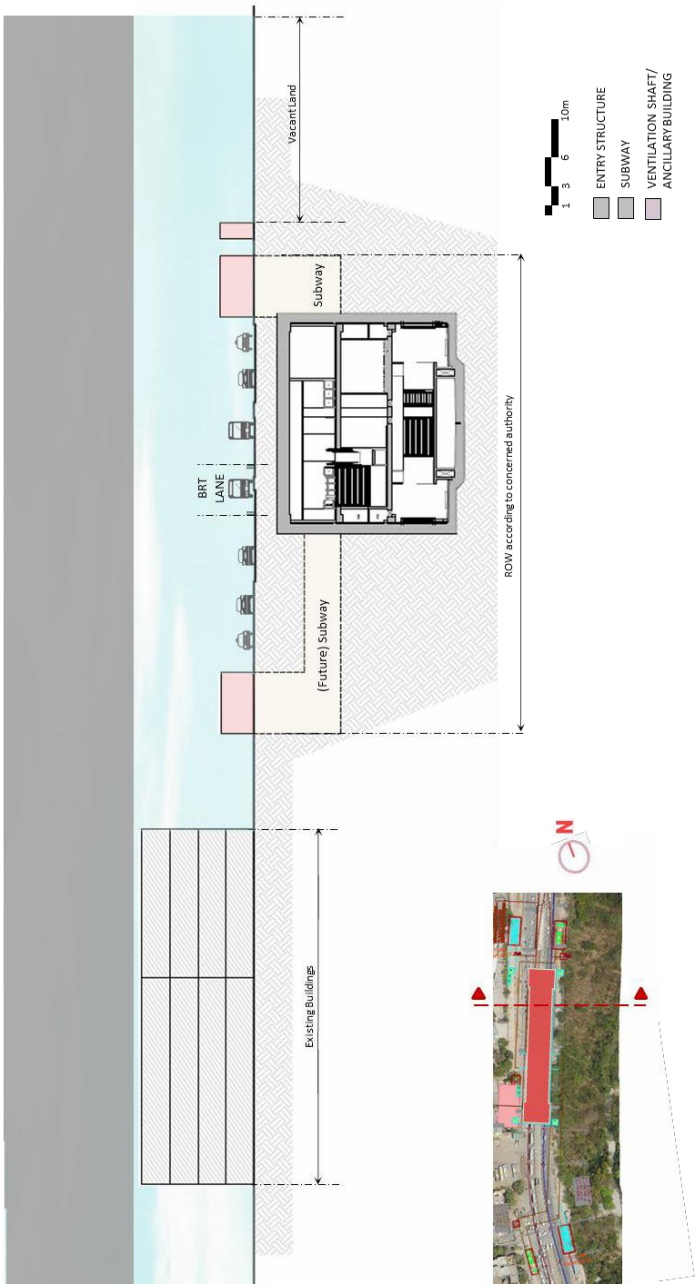
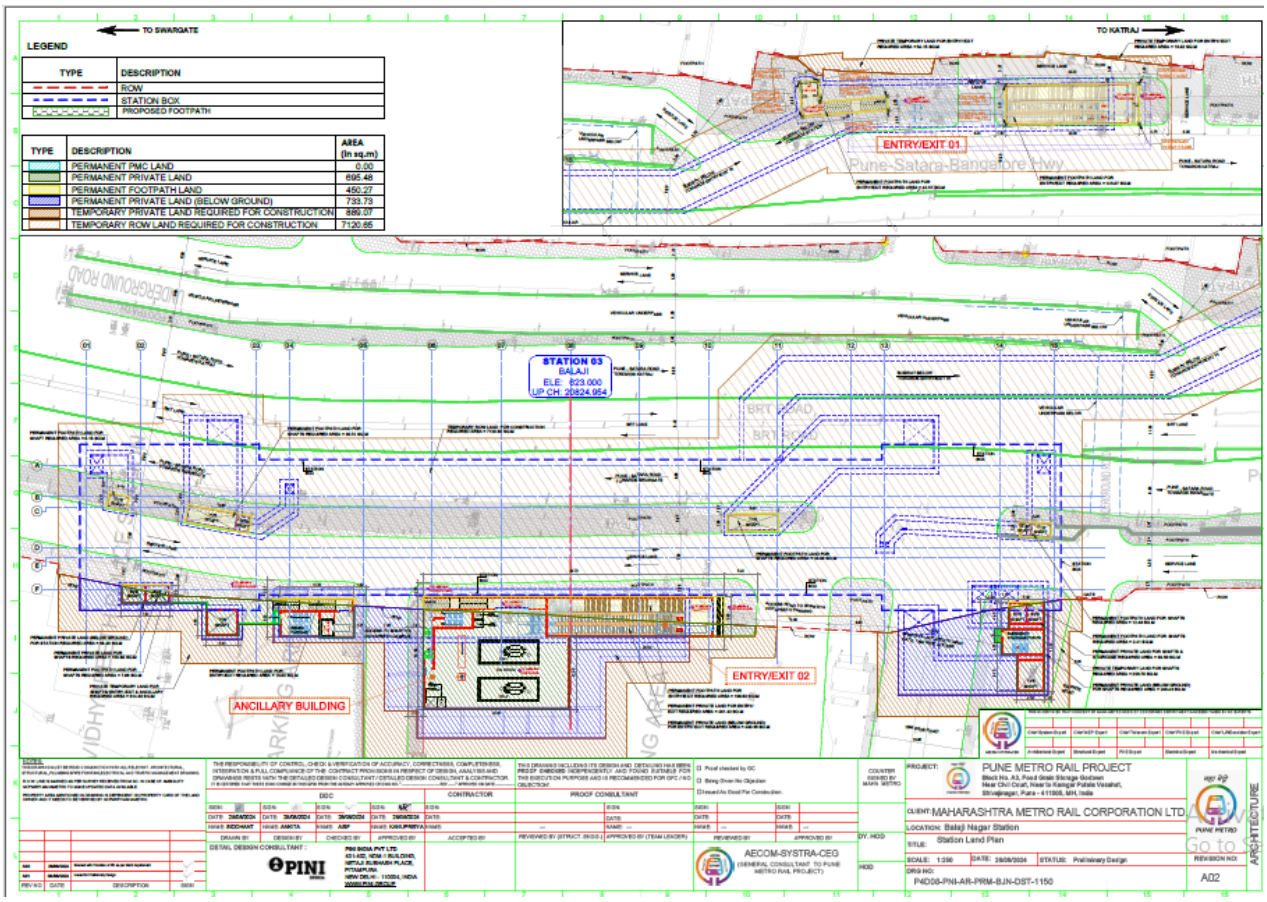


*Figure 3-15: Station Balajinagar- Plan*




**Station 5 (Katraj)**

| | |
|---|---|
| **STATION INTRODUCTION:** Like other stations on the proposed extenstion, Katraj will also be an Underground station. This will be a Terminal station proposed on the junction of Pune-Satara Highway and Pune-Mumbai bypass road near Rajiv Gandhi Zoological Park and wildlife rescue centre and Katraj Bus Station. The station provides dispersal connectivity but not limited to the residential areas of Katraj, Tanaji Nagar, Chaitraban and Kasat Nagar. There shall be four (4) entries to this station out of four, two entries shall be future entries. | |
| **ISSUES & CONCERN** | **POTENTIAL FOR IMPROVEMENT** |
| ● Due to the location of the station in close proximity of the Zoological Park and a Bus stations, and proximity to the cross junction of two Highways, there shall be heavy vehicular/pedestrain movement, pedestrian risk increases. | ● Dedicated non-motorized modes pedestrian friendly facilities like footpath and cycle stands.<br>● Planning of dispersal activities through feeder modes will cater to a larger catchment. |
| Station Box Size: 23.73 m × 153.4 m | |
| ENTRY NO. 1  | ENTRY NO. 2  |

| | | | |
|---|---|---|---|
| ENTRY NO. 3 |  | ENTRY NO. 4 |  |

*Figure 3-16 Station Katraj - Road Section*

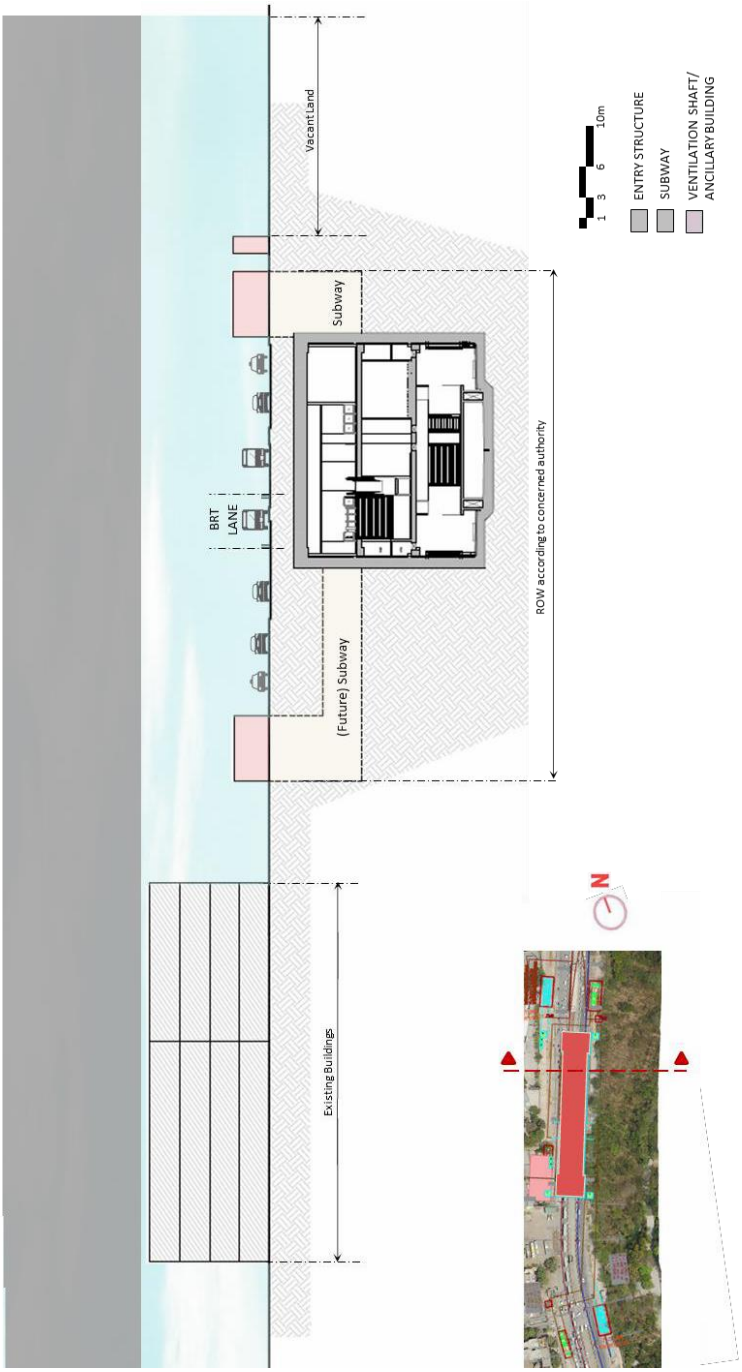
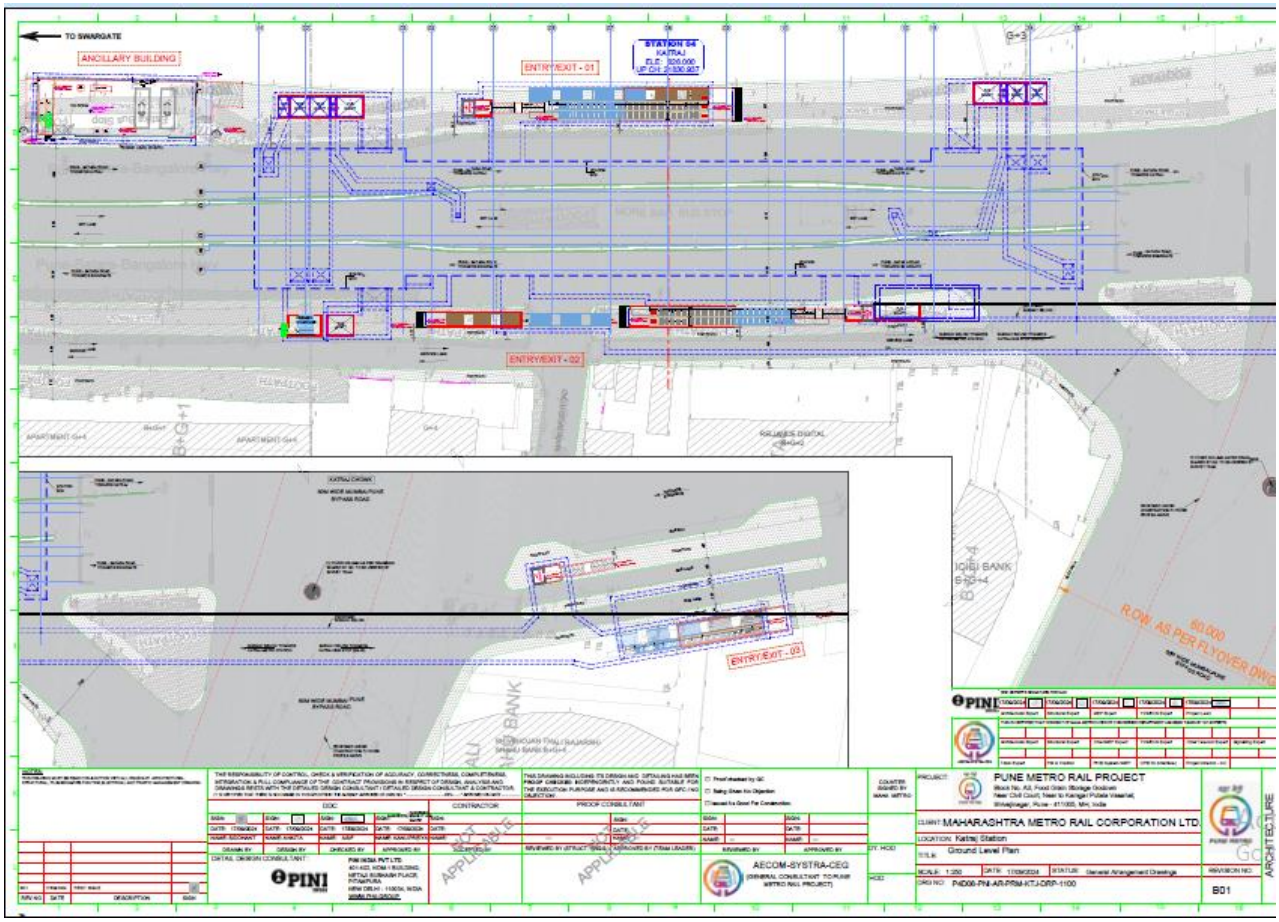


*Figure 3-17: Station Katraj - Plan*




## 3. Station Planning and Design

### Planning Parameters

135. The basic design of any station is based on Peak Hour loads. Single mode of authorization (token/card/ticket), which shall conform to the already existing Metro corridor of Line 1 of Phase 1, and would suffice to travel to any destination within the existing and proposed metro network shall be used.

The Station planning is dependent on the following factors:

- Underground stations are mostly planned around Island Platforms, in some cases based on the Alignment, the side platforms can also be designed.
- Ingress/egress and the boarding/alighting requirements.
- Structural requirements.
- Flexibility in design to allow stations to respond to site specific requirements.
- Station utilities like – Ventilation system
  - Firefighting system
  - Water supply & Sewage requirements
  - Other requirements
- Provisions for future expansions, if any.

136. A good station design comprises of adequate movement spaces from the station entrance to the platform and vice versa in a more logical way.

### Passengers experience

137. One of the main objectives of station planning and design is to maximize passenger's experience. This is done by ensuring at stations:

- **Attractiveness**: The station experience shall be positive;
- **Integration with urban realm**: The station will be well integrated with the existing street and its surroundings;
- **Intermodal integration**: Design will integrate the station entries with other modes of transport;
- **Passengers-oriented**: Patrons shall experience a simple system, easy to use and accessible;
- **Comfort**: The station atmosphere will be comfortable;
- **Safe and secure**: The station will be provided with sufficient safety features

**Salient Features of a Typical Station**

- Station entrances are located with particular reference to passenger catchment points which includes buses, IPTs, pick/drop by private modes.
- Following criterion have been considered while planning the stations
  a. Sizing of station passenger facilities.
  b. Stipulated design standards
  c. Emergency evacuation
  d. Passenger circulation, comfort, ease of use, safety and security.
  e. Accommodation of BOH areas.
  f. Electrical and Mechanical Plant and equipment space requirements.
- Concourse/Mezzanine shall form the link between streets and Platforms, all the passenger amenities are provided at this level.
- Plant room, operational rooms and offices are provided in the non-public areas of the station.
- The platform level shall be designed in a way to cater for the emergency scenario as well as to operate in normal conditions.
- The Ancillary spaces like DG, bore well pump house, water tanks (UG/overhead) must be preferably located at Ground level.

*Figure 3-18: Concourse Level Floor Plan*



*Figure 3-19: Mezzanine Level Floor Plan*

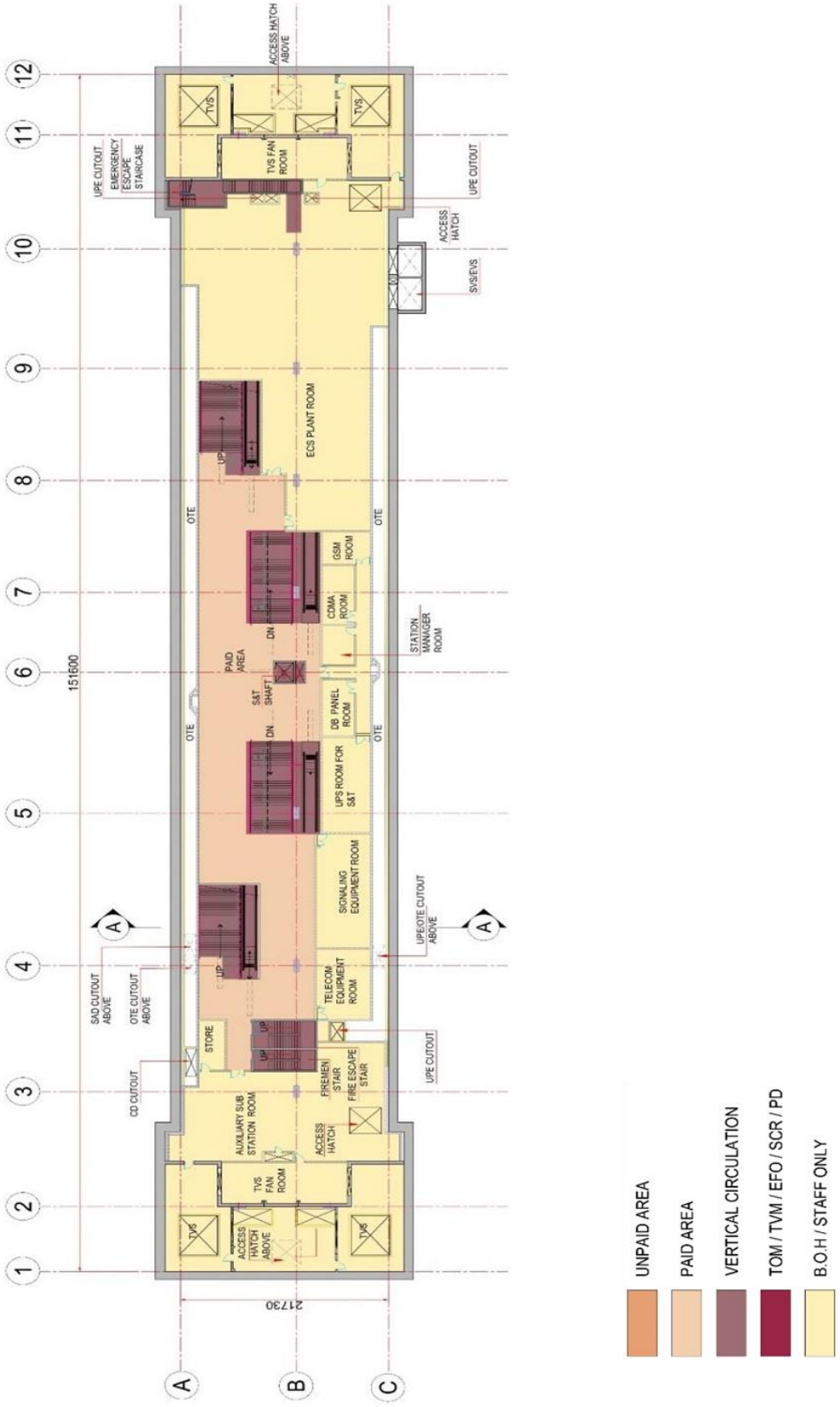


*Figure 3-20: Platform Level Floor Plan*

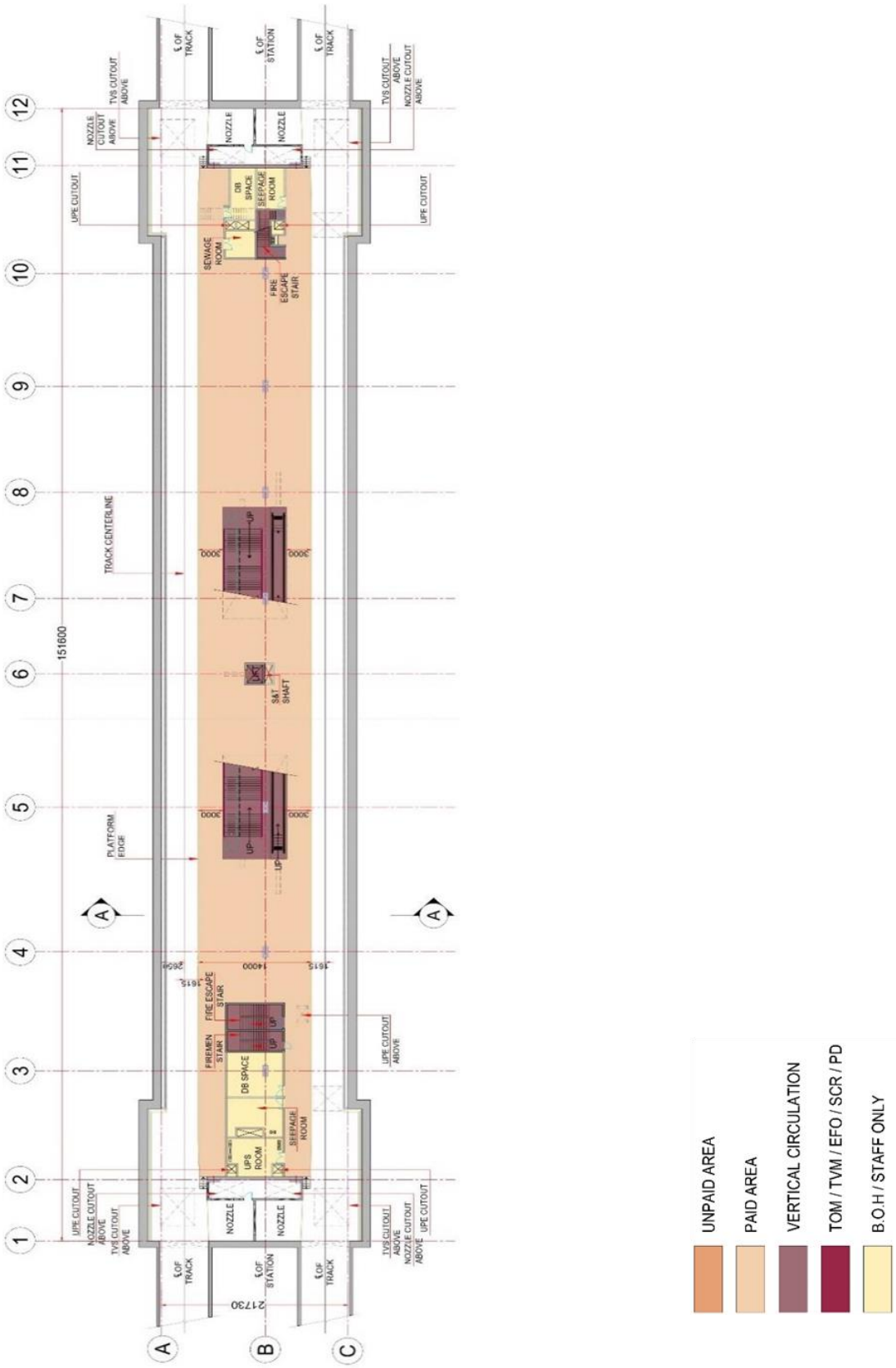


*Figure 3-21 Typical Cross Section (TCS) of Proposed Metro Stations*

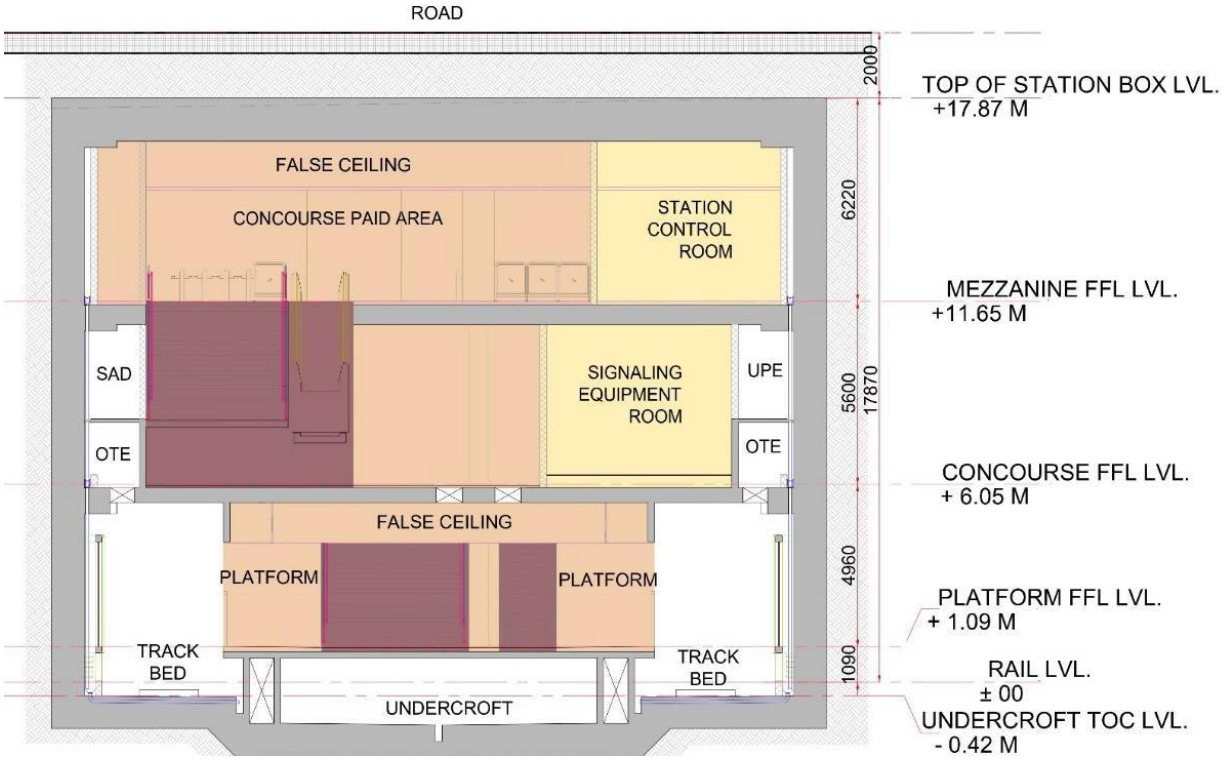



*Table 3-3 Area Chart*

| S.No. | Room Name | Area (SQM) |
|---|---|---|
| **AREA FOR UNDERGROUND STATION (MEZANNINE LEVEL)** | | |
| 1 | ECS Plant Room | 693 |
| 2 | Station Control Room (SCR) | 48 |
| 3 | Emergency Equipment Room | 26 |
| 4 | Security Room | 20 |
| 5 | First Aid Room | 20 |
| 6 | Staff/ Mess Room | 40 |
| 7 | ASS Room | 230 |
| 8 | Women's Toilet | 12 |
| 9 | Men's Toilet | 14 |
| 10 | Handicapped Toilet | 9 |
| 11 | Changing Room | 4 |
| 12 | Ticket Office Machine (TOM) | 18 |
| 13 | EFO | 10 |
| **AREA FOR UNDERGROUND STATION (CONCOURSE LEVEL)** | | |
| 1 | Auxiliary Sub Station Room | 267 |
| 2 | UPS Room for S&T | 60 |
| 3 | TER | 51 |
| 4 | Signaling Equipment Room (SER) | 81 |
| 5 | DB Panel Room | 24 |
| 6 | Station Manager Room | 16 |
| 7 | CDMA Room | 25 |
| 8 | GSM Room | 20 |
| 9 | ECS Plant Room | 668 |
| 10 | Store | 17 |
| **AREA FOR UNDERGROUND STATION (PLATFORM LEVEL)** | | |
| 1 | DB Space (1) | 20 |
| 2 | DB Space (2) | 38 |
| 3 | Seepage Room (1) | 17 |
| 4 | Seepage Room (2) | 29 |
| 5 | Sewage Room | 12 |
| 6 | UPS Room for S&T | 31 |

### 4. Signalling and Telecommunication

138. **Signalling system.** The signalling system shall provide the means of an efficient train control ensuring safety in train movements. It assists in optimization of metro infrastructure investment and running of efficient train services on the network. **Table 3-4** below shows the standards that have been adopted with regard to the Signalling system. Communication based Train Control (CBTC) System with adequate safety level of CENELEC SIL-4 (Safety Integrity Level) that permits an operational headway of 90 seconds with continuous automatic train control, shall be installed.

*Table 3-4 Standards of Signalling System*

| S/No. | Description | Standards |
|---|---|---|
| 1 | Interlocking | Computer based Interlocking adopted for station having switches and crossing. All related equipment as far as possible will be centralised in the equipment room at the station. The depot shall be interlocked except for lines mainly used for shunting, workshop/inspection shed areas. |
| 2 | Operation | With Direct current 110V D.C. point machines or 380 volts 3 phase, 50 Hz. AC point machines. |
| 3 | Train Detection | Primary train detection system to use bidirectional digital transmission of signal/data by radio transponder and to be provided on Main Line, sidings, test track and transfer track (Entry & Exit of Depot). Secondary train detection system to use Axle counters and to be provided at entry and exit of each station and in mid sections as required |

139. **Telecommunication system.** The telecommunication system acts as communication backbone for signalling and other systems and provides telecommunication services to meet operational and administrative requirements of metro network. The proposed telecom system and transmission media will have following sub-systems:

(i) IP, GE based Transmission System
(ii) Telephone Exchange
(iii) Mobile Radio Communication System
(iv) Public Address System (PAS)
(v) Centralized Clock System
(vi) Passenger Information Display System
(vii) Close Circuit Television (CCTV)
(viii) Central Voice Recording System (CVRS) and
(ix) Supervisory Control and Data Acquisition (SCADA) System
(x) Wi-Fi Services
(xi) LED Display Walls

### 5. Power Supply and Traction

140. For Traction System, it is standard practice in India to follow and to adopt 25 KV single phase AC Traction. In addition, it has the following merits:

- Lower initial cost;
- Lower operating and maintenance cost as in case of 25 KV ac traction the regeneration is up-to 30% and the line losses are around 0.5% in comparison to D.C. losses up-to 6 – 7%;
- A.C. system poses lesser Fire hazards as current levels are much lower than DC system.
- No Stray current problems and hence the corrosion is controlled.

141. As this is an extension of existing line, system with existing design or compatibility shall be used.

142. Keeping in view of the above norms, power demand estimation for existing Metro line along with the proposed Swargate to Katraj (Phase-1 Extension) alignment is given in **Table 3-5**:. Additional power demand estimation for the proposed Swargate to Katraj corridor is given in **Table 3-6**:.

*Table 3-5: Power Demand Estimation (MVA) Existing Corridor 1 (PCMC to Swargate)*

| Year | 2027 | 2037 | 2047 | 2057 |
|---|---|---|---|---|
| Traction | 8.5 MVA | 9.9 MVA | 10.9 MVA | 11.1 MVA |

| | | | | |
|---|---|---|---|---|
| **Auxiliary** | Auxiliary | 21.9 MVA | 21.9 MVA | 21.9 MVA |
| **Total** | **Total** | **30.4 MVA** | **31.8 MVA** | **32.8 MVA** |

*Table 3-6: Incremental Power Demand Estimation of Swargate to Karaj*

| Year | 2027 | 2037 | 2047 | 2057 |
|---|---|---|---|---|
| **Traction** | 1.1 MVA | 1.2 MVA | 1.2 MVA | 1.2 MVA |
| **Auxiliary** | 9.9 MVA | 9.9 MVA | 9.9 MVA | 9.9 MVA |
| **Total** | 11.0 MVA | 11.1 MVA | 11.1 MVA | 11.1 MVA |

(i) **Sources of power supply.** The high voltage power supply network of Pune City has only 220kV and 132kV network on the periphery of the city to cater to various types of power supply demand in vicinity of the proposed corridor. 220/132 kV substations are far away from the alignment and therefore, it involves substantial cable and it's laying cost.

(ii) For existing corridor PCMC- Swargate, both existing substations viz PCMC RSS and Depot RSS shall be provided with 2nos. (one as standby) 220/132/25 kV, 21.6 MVA single-phase traction transformers for feeding traction and 2nos. (one as standby) 220/132/33 KV, 20 MVA three phase transformers for feeding auxiliary loads. For Swargate – Katraj (Phase-1 Extension), 1 new Receiving Substation shall be provided near Swargate with area approximate 4000 sq.m GIS type with 2nos. (one as standby) 220/132/25 kV, 21.6 MVA single-phase traction transformers for feeding traction and 2 nos. (one as standby) 220/132/33 KV, 20 MVA three phase transformers for feeding auxiliary loads.

(iii) For the existing corridor, a total of three substations are presently in operation. These include the PCMC RSS and Range Hill Depot RSS, each with an installed capacity of 35 MVA, as well as the Vanaz Depot RSS with a capacity of 15 MVA. All these substations are currently operational and adequately catering to the existing power requirements of the system. In order to meet anticipated future demand and ensure uninterrupted power supply, one additional substation at Katraj is presently at the planning stage. This indicates that the substation is under conceptual consideration by MahaMetro as part of its long-term augmentation plan. It is not proposed for construction concurrently with the metro alignment works but will be taken up separately in the future, based on operational requirements observed after the commissioning of the metro extension. The proposed Katraj substation is envisaged to have a capacity of 22 MVA and will incorporate suitable technical provisions to support the growing network load and enhance operational efficiency of the corridor..

(iv) **Auxiliary supply arrangements and standby power supply.** Auxiliary supply arrangements for stations and depot Existing power supply arrangement at depot shall be considered for the extension line also as in the existing line the Auxiliary sub- stations (ASS) are envisaged to be provided at each station (1 ASS for elevated station and 2 ASS for underground Station) for stepping down 33 kV supply to 415 V for auxiliary applications. No extra ASS is required in depot for the extension line as the existing depot ASS can cater the 2.5 MW load in year 2057. The station ASS's will be located at mezzanine or platform level inside a room. The auxiliary load requirements have been assessed at 300kW for elevated / at-grade stations and 2500 kW for underground station for year 2027 to 2057. In order to meet the requirement of auxiliary power two dry type cast resin transformers (33/0.415kV) of 500 kVA capacity are proposed to be installed at the elevated stations (one transformer as standby) and two 2.5 MVA transformer for underground stations (one transformer as standby) also, two existing transformers of 2.5 MVA at Depot ASS.

(v) However, in the unlikely event of simultaneous tripping of all the input powers sources or grid failure to avoid interruption of power supply to stations as well as trains, as stand by DG set of 500 KV capacity will be installed at each station to cater the auxiliary load. Low-sulphur fuel will be used for D.G. sets, equipment, and vehicles during both operation and construction. This measure aims to reduce emissions and minimize environmental impact. Concerning the fuel to be used for the DG sets, as well as for any other equipment during both operation and construction, it will adhere to low sulphur content specifications in accordance with applicable environmental standards.

(vi) **Solar energy harnessing system.** The solar mission, which is part of the National Action Plan on Climate Change has been set up by Govt. of India to promote the development and use of solar energy for power generation and other uses with the ultimate objective of making solar energy competitive with fossil- based energy options. Considering the futuristic technology

and potential for solar power generation, Delhi Metro has recently implemented roof top grid connected solar power systems at selected locations of stations and maintenance depot. Metro Railways under implementation in different cities of the country viz. Jaipur, Lucknow, Nagpur etc are also exploring the possibilities of harnessing solar photovoltaic energy. With the downward trend in the cost of harnessing solar energy and appreciation for the need for development of solar power, provision of a grid connected solar photovoltaic power plant utilizing all possible areas viz. roof top of stations/sheds and buildings is proposed for MAHA MRTS.

**(vii)** **Solar PV Power Generation Potential:** The roof top on the elevated stations of Pune metro corridors and the different sheds and buildings of the depot viz. Stabling, Inspection and Heavy Repair Shed, Administrative Building, DCC/OCC Building etc is proposed to be used for SPV installation at suitable orientation and inclination to optimize the solar energy potential. The roof of the sheds should be south facing to maximize the Solar power generation in depot. The solar power would be used locally to the extent of load in the building and the generation over and above the requirement of the building would be fed into the grid.

(viii) The average raw sunshine available which can be harnessed for the power generation depends on the geometrical coordinates of the place. The intensity of solar radiation varies with time of the day. The combined effect of these factors and the additional complication of the wobble of the seasons is that the average raw power of sunshine per square meter of south-facing roof in India is roughly 100 to 120W/m2. The power generation depends upon various factors such as the intensity of the solar radiation, the net useable area available on the roof top, the obstructions due to shadow or the shading factor, the orientation of the solar panels, efficiency of the solar cells etc. The solar power generation potential in Pune metro corridors is required to be reviewed and finalized during detail design stage.

(ix) It is proposed that the solar PV installation for Pune metro shall be done on the basis of RESCO model which is also being followed by other metros in India. In the RESCO model, the MAHA Metro shall sublet the rooftop to the project developer who will be responsible for the solar PV installation. The power shall be purchased by MAHA metro on the basis of the unit rate specified by Power Purchase Agreement (PPA).

### 6. Permanent Way

143. **Choice of Gauge:** Standard Gauge (1435mm) is generally adopted for metro railways world-over. During the last decade, most of the new metros, constructed in various cities of the world have gone for Standard Gauge even though the national gauge for main-lines in some of the cases was different from Standard Gauge.

144. **Track Structure:** Track on Metro Systems is subjected to intensive usage with very little time for day-to-day maintenance. Thus, it is imperative that the track structure selected for Metro systems should be long lasting and requires minimum maintenance and at the same time, ensure highest level of safety, reliability and comfort, with minimum noise and vibrations. The track structure has been proposed keeping the above philosophy.

### 7. Rolling Stock

145. Rolling Stock proposed for the corridor will be similar to Phase-1. The specifications of the rolling stock and its procurement may be decided on the basis of the project implementation mechanism. The important criteria for selection of rolling stock are as under:

- Proven equipment with high reliability
- Passenger safety feature
- Energy efficiency
- Light weight equipment and coach body
- Optimized scheduled speed
- Aesthetically pleasing Interior and Exterior
- Low Life cycle cost
- Flexibility to meet increase in traffic demand

146. The controlling criteria are reliability, low energy consumption, lightweight and high efficiency leading to lower annualized cost of service.

### 8. Traction System

147. Traditionally, electric traction is used in Metro systems for requirement of high acceleration and pollution-free services in urban areas. There are three standard and proven systems of electric traction for use in suburban and metro lines, viz: - 750V DC third rail, 1500V DC overhead catenary and 25kV AC overhead catenary system. All these three systems are presently in use in India (750 V DC third rail

in Kolkata & Bangalore Metro, 1500V DC catenary in Mumbai suburban of Central & Western Railways and 25 kV AC catenary in Delhi, Jaipur, Chennai, Hyderabad Metro & Indian Railways). 1500 V DC system of Central and Western Railways in Mumbai suburban is currently being converted to 25 kV AC to meet increase traffic demand.

148. The 25kV AC overhead catenary system is being provided on the Phase-I corridor of Pune Metro. Thus, to ensure consistency with the existing system, 25kV AC overhead catenary system is proposed for the extension.

### 9. Fare Collection System

149. Mass Rapid Transit Systems handle a large number of passengers. Ticket issue and fare collection play a vital role in the efficient and proper operation of the system. To achieve this objective, ticketing system shall be simple, easy to use/operate, easy on accounting facilities, capable of issuing single/multiple journey tickets, amenable for quick fare changes and require overall lesser manpower. Automatic fare collection system meets these requirements.

150. Keeping in view Metro Railways Automatic Fare Collection System and the fact that Contactless card/ token technology proves to be cheaper than magnetic technology in life cycle cost due to reduced maintenance as it has less wear and tear and is less prone to dusty environment, computer based automatic fare collection system with contactless smart token/card type ticketing is obvious choice.

151. The proposed system shall be compatible with the existing Pune Metro Phase-I system for seamless operation & maintenance.

152. The System shall be capable for open loop transactions as well to further integrate the mobility solution with the advancements in technology and to allow for seamless transition from dedicated cards to common multi-use stored value fare media that can be used for financial transactions such as making purchases at shops etc. as well as a fare media in the system.

153. To accommodate the same, the system shall conform to the following standards as a minimum:

1. EMV (Euro Mastercard Visa)
2. PCI-DSS (Payment card Industry / Data Security Standard)
3. ISO-IEC 14443

154. The system shall be of open architecture to allow for the integration of multiple fare products and shall be capable of interfacing with cards from different vendors. Additionally, the system shall not be proprietary as far as possible to allow multiple types of fare media from multiple sources to be integrated into the system.

155. The proposed system shall offer high fare revenue protection and minimize fare revenue evasion and fare related fraudulent activities. The system shall be capable of detecting any irregularity and allow the authority to take action to correct the same.

### 10. Labour Camp

156. During execution of the project, manpower will be needed for various project activities. During construction phase, about 500 people are estimated to be employed, while in post-construction phase, about 150 people will be employed for operation and maintenance of the system. In addition to these, more people would be indirectly employed for allied activities.

157. The workers' camps will be developed by contractors as and where required. The accommodation, sanitation & other facilities required at camps shall be governed by Country labour laws as well as international standards like IFC/EBRD, Workers' Accommodation: Processes and Standards (ifc.org). These clauses are part of the civil contract works and will be obligatory to the contractors.

158. The governing part of the above-mentioned clauses are included in the Safety, Health & Environment Manual and Environmental & Social Management Plan (ESMP). These are the project specific documents that will be approved by the Funding Agencies and also part of contract document.

Following common facilities are to be broadly provided at the workers' camp as per IFC/EBRD, Workers' Accommodation: Processes and Standards (ifc.org).

(i) Room/dormitory facilities
   a. Ventilation & Light
   b. Water
   c. Bed arrangement & storage facilities
(ii) Sanitary and toilet facilities,
   a. Toilet facilities
   b. Waste water & Solid waste
   c. Bathrooms & other sanitary facilities
(iii) Canteen, cooking and laundry facilities
(iv) Ensuring good nutrition and food safety
(v) Leisure, social and telecommunication facilities
(vi) Medical facilities
   a. First Aid
   b. Other medical
(vii) Security of worker's accommodation
(viii) Workers' rights

159. Additionally, gender-specific facilities for women workers, if deployed by the contractors for construction work (depending on the number of women workers employed) shall broadly be divided into the following categories:

(i) Day crèche facility, as required
(ii) Separate bathing & toilet arrangements,
(iii) Separate access to female toilets,
(iv) Medical facilities in emergency cases,
(v) Job Security,
(vi) Safe lighting at work place and worker's colony,
(vii) Capacity development programs.

160. Community based specific policies/procedures and facilities for workers are as follows:

(i) HIV AIDS Policy,
(ii) Workers Grievance Redressal procedure, and
(iii) Equality in wages
(iv) Code of Conduct
(v) Sexual harassment and SGBV policy and procedures
(vi) Labour standards (As per Standard 8 of EIB E&S Policy 2022)

161. The above facilities will be part of the contract document and will be ensured by the Contractor. Checklist for worker's accommodation as per IFC/EBRD to be followed by contractors during construction phase Regular monitoring of the facilities and other issues will be ensured by the Workers welfare department of contractors and will be monitored by the Maha Metro through General Consultant (GC).

162. The monitoring & reporting will comprise of three-layer system which includes the Contractor, General Consultant and Maha Metro. The contractors have contractual binding to have Workers Welfare Officers Safety Managers and Environmental Managers, who will form the main execution team, with specific qualifications and experience as mentioned in the SHE Manual. Chief Safety Expert and Team of General Consultant shall be in a supervising and monitoring role in the project execution, while Maha Metro will review the works executed by Contractors & GC.

163. Contractors will have an efficient grievance redressal mechanism (GRM) in place. Regular reporting shall be ensured by the contractors in specific reporting formats. Monthly reporting shall be setup to ensure the timely monitoring and reform requirement.

## C. CONSTRUCTION ACTIVITIES & METHODOLOGY

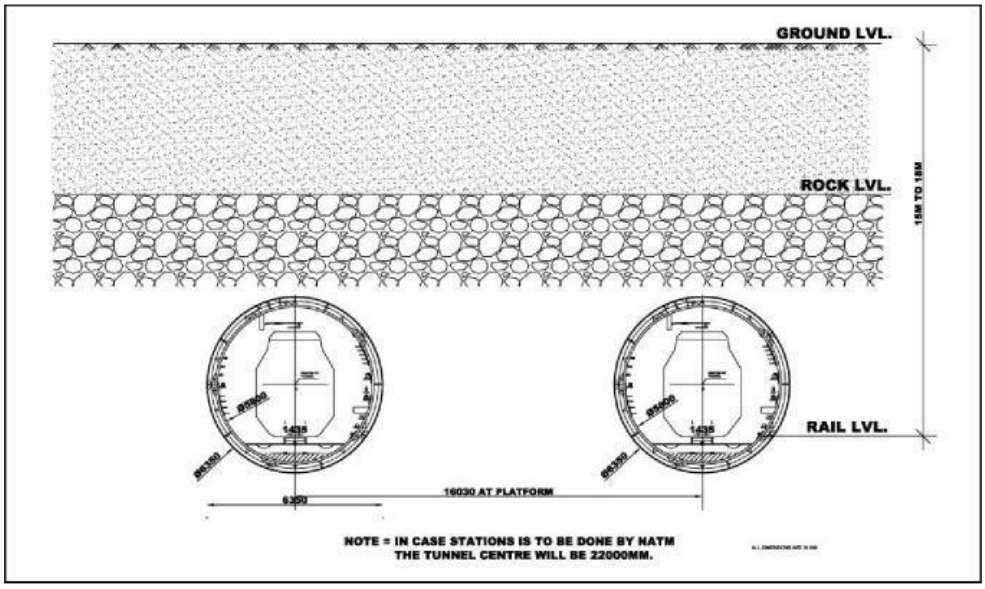
164. For underground alignment, tunnelling arrangements are decided based upon following objectives

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

tunnelling.
- ❖ Economy in tunnelling costs.

165. Use of Tunnel Boring Machine (TBM) is the prime method of tunnelling. Locations where deployment of TBM is not possible (tunnelling of short length, cross passages, underground stations which are not possible by cut and cover method etc.) are tackled by NATM method

*Figure 3-22: Typical Twin Tunnel Arrangement*




166. Suitable TBM for this project shall be the mixed shield can be run in open or closed mode as per geology which includes

- ❖ Earth-pressure type TBM
- ❖ Mud-pressure type TBM
- ❖ Slurry type TBM

167. In the underground stretch of 5.9 km, five UG stations are proposed i.e. Market Yard near Gultekdi, Padmavati, Balajinagar and Katraj. Tentative arrangement for TBM movement.

168. The following construction sequence is necessary before assembly of TBM can be taken up
- ❖ Construction of Head Wall & Installation of rubber seal ring
- ❖ Construction of Cradle
- ❖ Construction of Reaction Frame

169. Following steps are involved in the assembly of TBM
1) Lowering of the shield,
2) Lowering of Cutter Head and fixing the same to the shield,
3) Fixing Segment erector and screw conveyor erection,
4) Lowering and Assembly of back up gantries.

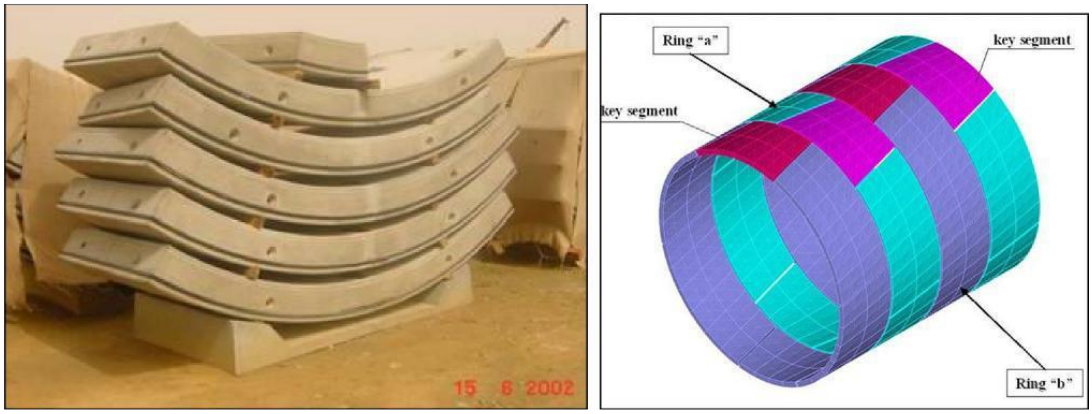
170. Excavation - A belt weighing device will be included on conveyor belt. This measures the weight of the excavated material as it is transported on the conveyor belt.

*Figure 3-23: Excavation of Tunnels using TBM*




171. Ring Erection - As the machine advances, the construction of the permanent lining takes place behind the excavation face of the machine and typically consists of 6 segments which makes one ring.

*Figure 3-24: Ring Segment*




172. Settlement Control - To ensure settlement do not occur due to the annulus ring not being filled by grout, the following actions will be carried out:

- Grouting system based on pressure control.
- Recording of grout volumes & pressure by TBM data logger.
- Tabulation of grout volumes to be done weekly showing running 10 ring averages. Grout pressure will be adjusted as necessary

173. Grouting and Waterproofing - After ring installation, theoretical void distance between the excavated radius and the external radius of the precast ring needs to be filled up.

174. TBM in Station Area - Cradle will be installed to drag the TBM in station area and again drive to the other end of the station by cutting Head wall. One end of the station is receiving chamber and the other end is launching chamber.

175. **New Austrian Tunnelling Method (NATM)** - This method, first coined by Rabcewicz in 1962, evolved from experience in Austrian Alpine tunnelling and was first applied in soft ground at Frankfurt Metro in 1969. The method focuses on achieving safe and economical tunnel support by providing flexible primary lining using shotcrete, wire mesh, rock bolts, and lattice girders. In weaker rock masses, pipe forepole / roofing may be used for crown support, minimizing over-break and ensuring construction safety. NATM's key feature is its dynamic, observation-based design, adapting support measures according to in-situ rock mass classification and observed deformation. This method is particularly suitable for complex and variable geological conditions, where forecasting rock behaviour is difficult.

176. The DPR indicates that NATM is recommended for underground sections with challenging geology, including cross passages between stations. Cross passages are planned in accordance with NFPA 130 standards (maximum 244 m spacing). Key construction steps include:

- Use of SGI segments to strengthen the lining where necessary.

- Ground treatment via jet grouting from surface and supplementary grouting from within the tunnel.
- Careful dismantling of segment lining, excavation with lagging or shotcreting, and subsequent structural works.

Thus, NATM is planned to be used in the project for underground tunnels and cross passages where geological conditions are complex.

- **Construction of Underground Stations:** In Swargate to Katraj – All Five UG stations are proposed to be constructed using cut and cover method i.e. Market Yard near Gultekdi, Bibwewadi, Padmavati, Balajinagar and Katraj.
- **Muck Disposal -** Construction of underground tunnel for metro projects is a specialized and complex task. The construction activity involves tunnelling, cut and cover, foundation, fill and embankment in which large quantity of muck needs to be disposed of.
- The Muck Handling Plan for the Pune Metro Rail Project – Swargate to Katraj (Phase-1 Extension) ensures safe, systematic, and environmentally responsible management of approximately 9.09 lakh tonnes of excavated material generated from tunnelling and underground works. The plan, aligned with ESIA/ESMP, MoEF&CC and EIB Environmental Standards, emphasizes reuse of suitable muck for backfilling and safe disposal of the remaining quantity at approved sites with proper drainage, dust suppression, covered transportation, and afforestation measures. It also ensures strict compliance with Safety, Health, and Environment (SHE) requirements through PPE usage, controlled vehicle movement, and continuous environmental monitoring. The detailed Muck Handling Plan is attached as **Annexure-10B**.

177. Excavated material (muck) generated during underground construction will be managed through a combination of disposal and re-use strategies. Depending on its type, quality, and contamination level, muck will be:

- **Temporarily stored** at designated sites with proper bunds, covering, and drainage to prevent environmental contamination.
- **Transported** using covered vehicles along pre-planned routes to avoid sensitive areas such as schools, hospitals, and residential zones.
- **Disposed** at designated quarry site.
- **Re-used** in construction activities such as backfilling, embankments, land reclamation, road construction, and landscaping, following technical and environmental guidelines.

178. During the construction of the 5.9 km underground metro line, a twin-tunnel arrangement with an excavation width of 6.7 m for each tunnel will generate a substantial quantity of excavated material. Based on the tunnel dimensions, the cross-sectional area of each tunnel will be approximately 35.24 $m^2$, resulting in a total excavation volume of around 208,000 $m^3$ per tunnel. Considering both tunnels, the cumulative excavation volume will be about 416,000 $m^3$, which corresponds to approximately 790,000 tonnes of muck, assuming an average soil/rock density of 1.9 t/$m^3$. In addition to tunnel excavation, cut-and-cover stations, shafts, and other underground structures are expected to generate additional muck, which could increase the total volume by approximately 10–15%, bringing the estimated overall excavation volume to around 460,000–480,000 $m^3$. This means that the project will create approximately 909,000 tonnes of muck (790,000 tonnes plus give and take 15%). This material will be temporarily stored, transported, and either disposed at approved sites or re-used for backfilling, embankments, land reclamation, road construction, and landscaping, following technical and environmental guidelines to minimize environmental impacts.

- **Identification of existing services/utilities -** Organizations/Departments with concerned utility services in Pune are mentioned in below.

| S. No | Organization/Department | Utility Service |
|---|---|---|
| 1. | Pune Municipal Corporation. | Surface water drains, nallahs, Water supply pipelines, Sewerage and drainage conduits, street lights. |
| 2. | Telecommunication Department | Telecommunication cables, junction boxes, telephone posts, O.H. lines, etc. |
| 3. | Traffic Police | Traffic signal posts, junction boxes and cable connections, etc. |
| 4. | Electricity Board | OH & underground electric cables and electric poles |

| | | |
|---|---|---|
| 5. | BSNL | Optical Fibre |
| 6. | Maharashtra Natural Gas Limited | Gas Pipe Lines |

Number of overground utilities affected due to metro alignment, as identified during the physical survey are given below:

| S.No | Utilities | Location | Units |
|---|---|---|---|
| 1 | Light Poles | At Station and Entry Exits | 31 |
| 2 | Traffic Signals | At Station | 5 |
| 3 | Sign Boards | At Entry Exits | 31 |
| 4 | Hoarding Boards | At Station and Entry Exits | 5 |
| 5 | Electric Poles | At Station and Entry Exits | 23 |
| 6 | Trees | At Station and Entry Exits | 146 |
| | | **TOTAL** | **241** |

**Traffic management plan during construction.** The aim of the traffic management measures is to relieve, wherever possible, or minimize the (short term) disruption to normal traffic likely to be caused by the construction works of the metro. The traffic management measures would need to cope, in safety, with all aspects of traffic. The typical traffic diversion plans have been prepared based on two scenarios as under:

Scenario 1: Two way at stations
Scenario 2: One way at stations

- The traffic will be diverted on both sides or one side depending upon the available ROW near the proposed station, during construction. The typical traffic diversion plan for such stations is shown in **Figure 3-25 a**nd **Figure 3-26** respectively.

*Figure 3-25 Typical Traffic Diversion Plan - One Way*

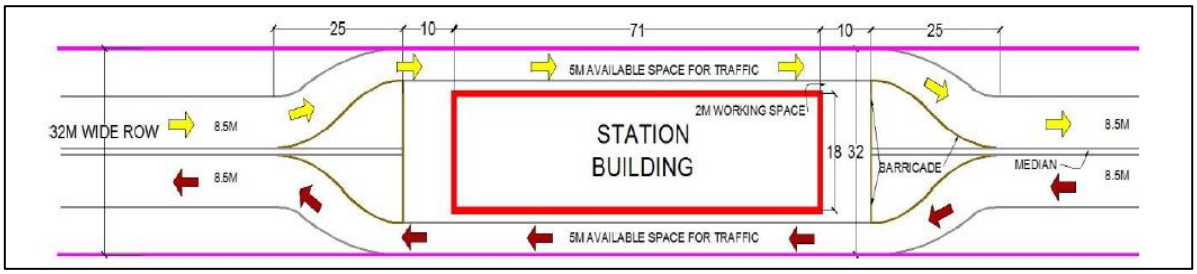
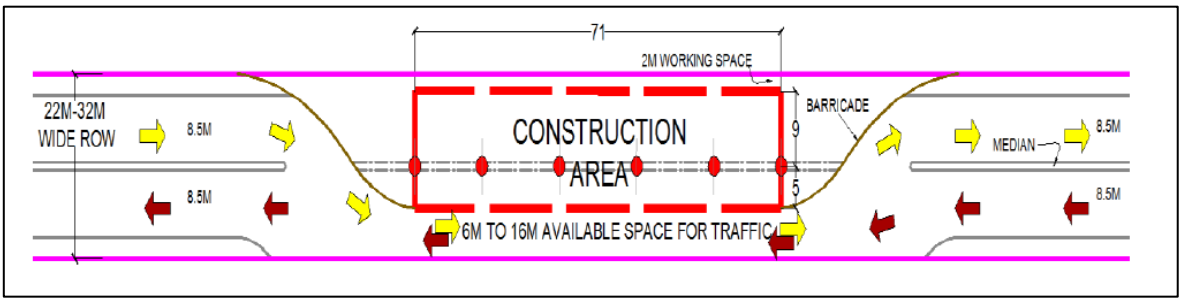



*Figure 3-26 Typical Traffic Diversion Plan - Two Way*




- Summary of Parking Management strategies is given in **Table 3-7**.

*Table 3-7 Summary of Parking Management strategies*

| Method | Advantage | Disadvantage |
|---|---|---|
| **Pricing and Regulatory Strategies** | | |
| Regulate curb-side parking (loading zones, 1-hour limits, etc.) for priority | Low implementation costs | Enforcement requirements |
| | Flexible- can be quickly changed or apply to specific times | Generates no revenue |
| | | Does little to reduce overall vehicle travel demand |
| | | May shift traffic to other locations |
| Imposing parking prices | Generates revenue | Enforcement requirements |

| Method | Advantage | Disadvantage |
|---|---|---|
| | Reduces travel demand | Risk of fraud |
| | Allows higher priority, uses more convenient spaces | May shift traffic to other locations |
| | Moderate implementation cost | |
| Require vehcile owners to have an off-street parking space | Reduces on-street parking congestion | Difficult to enforce (some residents may register their vehicles elsewhere) |
| | May reduce vehicle ownership | |
| | Low implementation costs | |
| Tax parking | Generates revenue | May shift traffic to other locations |
| | May reduce vehicle travel demand | Risk of fraud |
| **More efficient use of parking facilities** | | |
| Share parking facilities | Cost effective | Reduces parking convenience |
| | Can reduce parking requirements | Requires new administrative arrangements |
| | Flexible | Depends upon circumstances |
| More accurate parking supply | Cost effective | May create future parking/ congestion problems |
| | Can reduce parking requirements | |
| Reduce parking requirements for mobility management programs | Cost saving | Limited guidance available |
| | Can reduce parking requirements | Requires ongoing management |
| | Create incentives for employee trip reduction programs | |
| Transportation management association | Can reduce parking requirements | Requires new administrative arrangements |
| | Can provide many services to business, employees and customers | |
| Control complementary Parking Passes | Reduce vehicle travel demand | Requires review and enforcement |
| | Can increase revenue | |
| Cash out free parking | Can reduce vehicle travel demand and parking needs | Requires new administrative arrangements |
| | Gives employers a way to reduce parking demand | Risk of fraud |
| Unbundle parking | Reduce vehicle travel demand | Requires new administrative arrangements |
| | Can reduce parking requirements | Risk of Fraud |
| | Increases customer choices | |
| **Other strategies** | | |
| Location efficient development | Supports land use objectives | Slow to achieve benefits |
| | Reduce vehicle travel demand | |
| | Can reduce parking requirements | |
| | Increases customer choices | |
| Response to spill over problems | Avoid problems | Requires new administrative arrangements |
| | Is equitable | |
| Over flow parking plans | Reduce vehicle travel demand | Requires new administrative arrangements |
| | Can reduce parking problems | |
| | Is equitable | |
| Parking maximums | Saves money | May lead to future parking problems |
| | Supports land use objectives | |
| | Reduce vehicle travel demand | |
| | Can reduce parking problems | |
| In Lieu fees | Saves money | Requires new administrative arrangements |
| | Results in more efficient use of parking facilities | May lead to future parking problems |
| | Reduce vehicle travel demand | |
| Bicycle parking | Saves money (compared with automobile parking) | Only effective where people want to bicycle |
| | Support bicycle travel | May lead to future parking problems |
| | Is equitable | |
| Improve parking facility design | Addresses many problems | May increase cost |
| | | Require new design guidelines |

179. No new quarry will be proposed for the Project requirements only existing, live, licensed quarries will be used as sources of aggregates. It will be ensured the aggregates procured during construction stage will be from the authorized or licensed suppliers.

180. The sources of construction materials are available in ample way in the vicinity of Pune city. Environmental impacts from such activities are dust pollution due to loading & unloading and during transport of materials. Vehicles delivering materials will be covered to reduce spills and dust blowing off the load. (Material to be obtained from third party quarry)

181. **Location of Casting Yards / Batching Plants** as per the contract conditions, land required for casting yards for casting of girders, etc. is to be arranged by the prospective contractors. Its terminals are located in PMC area having several pockets of non-agriculture / vacant land. In addition of above, option of utilization of existing casting yards especially constructed for existing metro alignment shall be preferred.

182. Contractors can use the same casting yards or may establish an alternate casting yard of their choice, on approval by Maha Metro. Criteria to be used for site Selection and management of labour camp, construction yards, batching plant, construction waste disposal area etc. have outlined and attached as an **Annexure-10A.** In case the existing casting yards will be used, an environment audit of the used casting yards needs to be conducted and submitted to PIU/EIB for review as per EIB E&S Policy (2022) requirements for existing facilities.

183. Prior to the start of the works the environmental baseline at the casting yards will be established, based on the pollutants that can be expected from the works at site. Contractor will be required to submit Environmental Management and Restoration Plan to GC/Maha-Metro. Environmental monitoring will be carried out monthly at all casting yards, which will be ensured by the contractor in the monthly environment monitoring reports. The casting yard site will be restored in its original state by the Contractor, after completion of works, proving that the works have not led to any pollution at the sites.

## D. IMPLEMENTATION PLAN & CONSTRUCTION SCHEDULE

### 1. Project Implementation Plan

184. The appointment of interim and general consultants may be initiated for project management including preparation of tender documents – as soon as DPR is approved by Government of Maharashtra (GoM), and Maha Metro. The possible dates of important milestones are given in **Table 3-8**.

*Table 3-8 Proposed Project Implementation Plan (As per DPR)*

| S. No. | Tasks | Timelines | Status ( September-25) |
|---|---|---|---|
| 1 | Final Approval by GoI | 04.09.2024 | Approved |
| 2 | Packaging and Invitation of Bids | 09.04.2025 | Bids Under Evaluation |
| 3 | Commencement of Civil Work | December 2025 | Independent on Issue of LOA |
| 4 | Commencement of Operation | 42 Months from the Commencement of Civil Work | Independent on Commencement of Civil Work |

### 2. Implementation Structure

185. Effective institutional arrangements are needed to enable the metro project to be implemented without any loss of time and cost over-run. The Government of Maharashtra has created a Special Purpose Vehicle (SPV) for implementing the Pune Metro Rail Project Phase 1. This SPV named as "PMRCL" was incorporated on 18th February, 2015 under the Companies Act and subsequently the name was changed to Maharashtra Metro Rail Corporation on 22nd January, 2017. It is a 50:50 jointly owned company of GoI and GoM responsible for implementation of all metro projects in the state of Maharashtra outside Mumbai Metropolitan region including Pune Metro Rail project Phase 1 and its current extension Swargate to Katraj.

## E. DETAILED PROJECT COST ESTIMATE

186. **Capital cost estimate.** In order to arrive at realistic cost of various items, costs of the project have been derived from similar executed project in similar scenario in India. Rates are also adopted based on Report for Benchmarking for cost estimation of Metro Rail Projects issued by MoHUA, GoI in February, 2019.

*Table 3-9 Capital Cost Estimate of Swargate - Katraj (July '21 Price Level)*

| S.No | Item | Unit | Rate | Quantity | Amount (in INR Cr) |
|---|---|---|---|---|---|
| **1** | **Alignment & Formation** | | | | |
| 1.1 | Underground Section - Twin Tunnel | R. Km. | 210.00 | 5.01 | 1,052.10 |
| 1.2 | Viaduct for Stabling Line/Depot | R. Km. | 41.81 | 0.9 | 37.63 |
| | **Sub Total - Alignment & formation** | | | | **1,089.73** |
| **2** | **Station Buildings including Architectural Finishes, Lifts & Escalators** | | | | |
| 2.1 | Station Building - Cut & Cover | Each | 190.00 | 3 | 570.00 |
| 2.2 | E&M tunnel ventilation incl. Lifts & Escalators | Each | 56.50 | 3 | 169.51 |
| 2.3 | Ventilation Shaft between Station 2 & Station 3 | Each | 50.00 | 1 | 50.00 |
| | **Sub- total Station Building** | | | | **789.51** |
| **3** | **Stabling Lines** | | | | |
| 3.1 | Civil works, OHE, Signalling, Telecom, etc., | LS | 11.72 | 1 | 11.72 |
| | **Sub-total Depot** | | | | **11.72** |
| **4** | **Permanent Way** | | | | |
| 4.1 | Ballastless track for Main Line | R.Km | 7.46 | 5.9 | 40.75 |
| 4.2 | Ballastless track for Depot/Stabling Line | T.Km | 7.46 | 0.9 | 6.71 |
| | **Sub-total Permanent Way** | | | | **47.47** |
| **5** | **Traction & power supply incl. OHE, ASS etc. Excl. lifts & Escalators** | | | | |
| 5.1 | Underground Section | R. Km. | 13.00 | 5.9 | 71.01 |
| 5.2 | HT Cabling 132 KV - Single core | KM | 1.69 | 15 | 25.42 |
| 5.3 | RSS | Each | 50.85 | 1 | 50.85 |
| | **Sub-total Traction and Power Supply** | | | | **147.28** |
| **6** | **Signalling and Telecom** | | | | |
| 6.1 | **Signalling** | | | | |
| a | Main Line | R.Km | 4.97 | 9 56 | 27.17 |
| b | On Board Equipment | Per train | 1.92 | 14.00 | 26.90 |
| | **Sub-total Signalling** | | | | **54.06** |
| 6.2 | **Telecommunication** | | | | |
| a | Station | Per station | 5.09 | 3.00 | 15.26 |
| | **Sub-total Telecom** | | | | **15.26** |
| **7** | **Environment Cost** | | | | |
| 7.1 | Environmental Cost | | | | 3.32 |
| | **Sub-total Environment** | | | | 3.32 |
| **8** | **Misc. utilities etc.** | | | | |
| 8.1 | Civil works | R. Km. | 3.39 | 5.9 | 18.52 |
| 8.2 | Electrical Works | R. Km. | 3.39 | 5.9 | 18.52 |
| | **Sub-total Misc** | | | | **37.05** |
| **9** | **Security** | | | | |
| 9.1 | Civil works | Per Station | 0.42 | 3.00 | 1.25 |
| | **Sub-total Security** | | | | **1.25** |
| **10** | **AFC** | Per Station | 3.96 | 0.00 | 0.00 |
| | **Sub-total AFC** | | | | **0.00** |
| **11** | **Platform Screen Doors (PSD)** | Per Station | 3.39 | 3.00 | 10.17 |
| **12** | **Multimodal Integration and Last mile connectivity** | Per station | 3.39 | 3.00 | 10.17 |
| **13** | **Rolling Stock** | Per coach | 9.04 | 18.00 | 162.73 |
| **14** | **Total Cost at July '21 price level (Excluding Land, R&R, General Charges, Contingencies, Central & State Taxes)** | **2379.72** | | | |
| **15** | **General Charges @ 5%** | 118.99 | | | |
| **16** | **Contingencies @ 3 % on Sr. No.14 i.e. on basic cost** | 71.39 | | | |
| **17** | **Total Cost at July '21 price levels incl. General Charges and Contingencies (Excluding Land, R&R, Central & State Taxes)** | **2570.10** | | | |
| **18** | **Central and State Taxes @ July '21 Price Level** | 376.96 | | | |
| **19** | **Total Cost incl. General Charges, Contingencies, Central and state Taxes @ July '21 Price Levels (Excl. Land and R&R)** | **2947.05** | | | |
| **20** | **Land** | 111.30 | | | |
| **21** | **R&R** | 45.52 | | | |
| **22** | **Total Cost incl. General Charges, Contingencies, Central and state Taxes @ July '21 Price Levels (Incl. Land and R&R)** | **3103.87** | | | |

| | | | | | |
|---|---|---|---|---|---|
| **23** | **Escalation at 5 % per annum on the above (S. No: 22)** | 512.44 | | | |
| **24** | **Total Completion Cost inc Land and R&R Costs** | **3616.31** | | | |
| **25** | **Interest During Construction (IDC)** | 30.29 | | | |
| **26** | **Total Completion cost including IDC** | **3646.60** | | | |
| **27** | **PPP component (AFC) incl. escalation & taxes** | 17.26 | | | |
| **28** | **Total Completion Cost** | **3663.86** | | | |

*Note: July '21 Price Level is considered and the prices are escalated till the completion period to arrive at the completion cost.*

## F. ASSOCIATED FACILITIES

187. As per EIBs E&S Policy (2022) Associated facilities are those which are

(i) assets and facilities directly owned or managed by the promoter that relate to the project activities to be financed.

(ii) supporting activities, assets and facilities owned or under the control of parties contracted for the operation of the promoter's business or for the completion of the project (such as contractors);

(iii) associated facilities or businesses that are not funded by the EIB as part of the project and may be separate legal entities yet whose viability and existence depend exclusively on the project or whose goods and services are essential for the successful operation of the project.

188. The PMRP Phase 1 which is already under operation in some sections and nearly completing construction in others, constitutes one of the main Associated Facilities to this project. Many of the components of PMRP Phase 1 including the two maintenance depots at Hill View Park and at Range Hill are planned on being used for the proposed Swargate to Katraj (Phase-1 Extension).

189. **Maintenance depots.** Existing depots will be used.The depots would include administrative buildings and occupy a large area for undertaking maintenance of the rolling stock. As per EIA notification (2006) Section 8(a), prior Environmental Clearance is not required for Metro rail projects. However, as per MoEF&CC letter vide F.No.19-130/2015-IA.III dated 1st March 2016, metro projects having Station building (if built for commercial purposes like mall, offices or residential buildings etc.) with built-up area more than 20000 sq.m. need prior environmental clearance from Competent Authority.

190. It has been planned to use the already existing depots at Hill View Park and at Range Hill for the proposed Swargate to Katraj (Phase-1 Extension). Both existing depots have infrastructure to maintain the rakes with necessary facilities viz. stabling lines, scheduled inspection lines, workshop for overhaul, unscheduled maintenance including major repairs, wheel profiling, heavy interior/under frame/roof cleaning etc. for the rolling stock operational on the corridor as well as maintenance facilities for Civil – track, buildings, water supply; Electrical – Traction, E&M; Signalling & Telecomm.; Automatic Fare Collection etc. The major infrastructure facilities at both Depot are respectively summarized in **Table 3-10** and **Table 3-11**.

*Table 3-10: Infrastructure Facilities: Hill Park View Depot*

| Facility | Existing | Proposed |
|---|---|---|
| Stabling Lines | 3 lines of 6 car length | 3 lines of 6 car length |
| Inspection Lines | 3 lines of 3 car length | |
| Workshop Lines | 2 lines of 3 car length | |

*Table 3-11: Infrastructure Facilities: Range Hill Depot*

| Facility | Existing | Proposed |
|---|---|---|
| Stabling Lines | 3 lines of 6 car length | 8 lines of 6 car length |
| Inspection Lines | 3 lines of 3 car length | |
| Workshop Lines | 2 lines of 3 car length | |

191. The construction and operation of Swargate to Katraj (Phase-1 Extension) project 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, signalling & telecom, firefighting etc. and workshops, depots 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.

# Chapter 4. ENVIRONMENTAL AND SOCIAL BASELINE DATA

## A. INTRODUCTION

192. The baseline status of environmental quality in the vicinity of project site serves as a basis for identification and prediction of impact. This chapter illustrates the description of existing environmental status of the study area with reference to the prominent environmental attributes. The data were collected from both primary and secondary sources.

193. Field monitoring was done for primary data collection of various environment components such as air quality, water quality, soil quality, noise & vibration. Also, secondary data such as micrometeorology, flora and fauna, socio-economics, hydro-geological data, traffic study etc. was collected from authenticated sources was used as a guideline and reference material. The entire data has been collected through actual physical surveys and observations, literature surveys, interaction with locals, government agencies and departments.

194. Baseline studies began with site visits and reconnaissance survey in the study area. Monitoring locations fixed for the primary data collection on the basis of environmental setting, meteorology and potential probable impacts of the project. Required secondary data was obtained from various Government agencies and research paper etc.

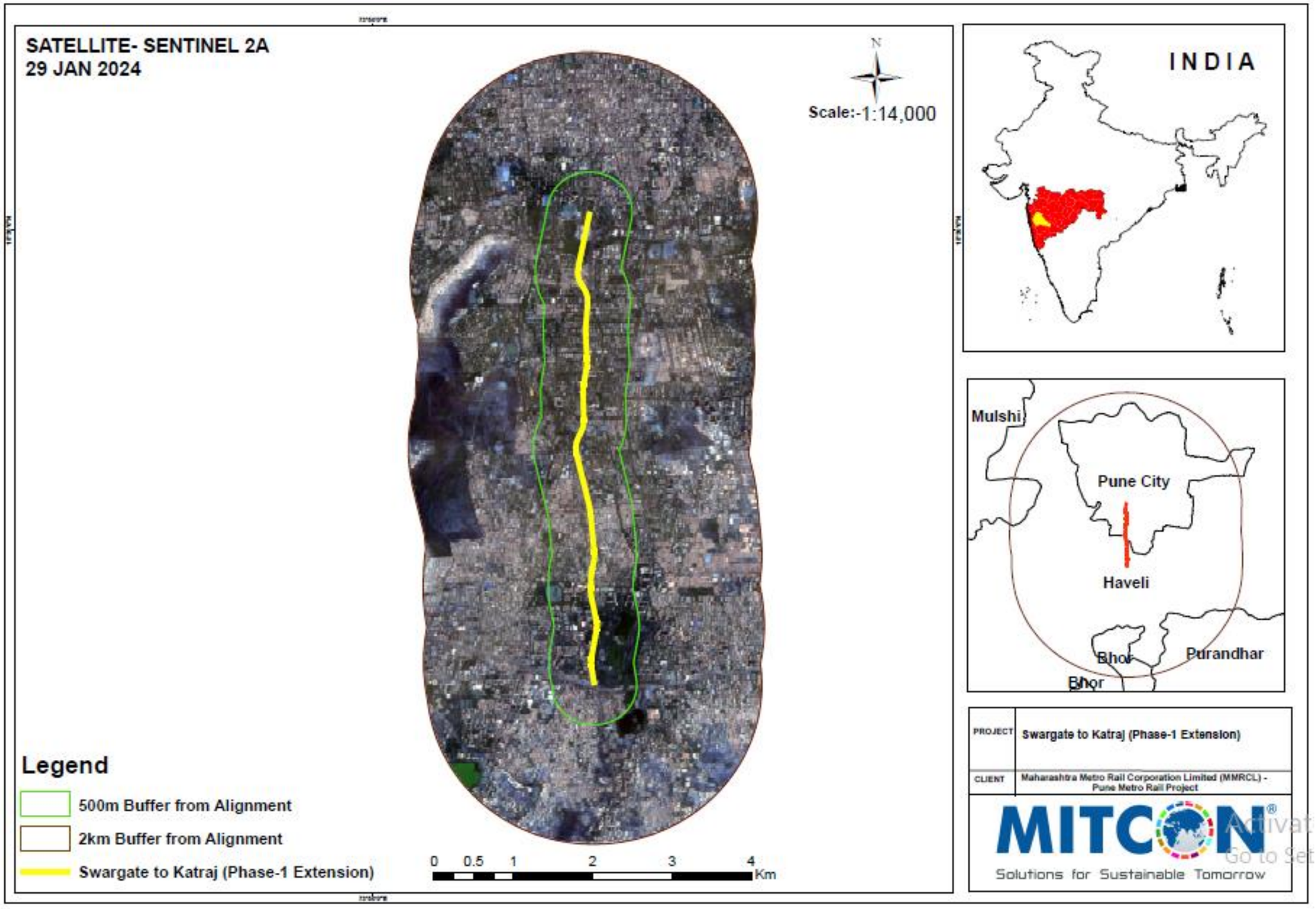
## B. DATA COLLECTION METHODOLOGY

195. One reconnaissance visits were conducted to Swargate to Katraj (Phase-1 Extension) on 6$^{th}$ July, 2024 and Baseline survey was conducted in July 2024. During the visits, sampling sites were identified and finalized for monitoring of environmental parameters.

196. The study Area for the proposed project has been divided into two parts, viz. 500m radial distance around each alignment is designated as the Core Project Study area, while 2 km radial distance around each alignment is considered as Buffer Project Study Area. Satellite maps showing locations of the Swargate to Katraj (Phase-1 Extension) along with Core and Buffer study areas around each alignment, are presented as **Figure 4-1**.

197. As a requirement of the ESIA process, primary baseline data for prominent environmental attributes like ambient air, noise, water (groundwater and surface water), soil, data on socio-economics at the Project corridors, as well as within ‘Core and Buffer Study Areas’ were collected through surveys and data on ecology & biodiversity (terrestrial, aquatic and riparian) was collected through field monitoring conducted in July 2024.

*Figure 4-1 Satellite map of the Swargate to Katraj (Phase-1 Extension) showing Project Study area*



## C. ENVIRONMENTAL PARAMETERS

198. Details of environmental parameters that were monitored and respective frequency of monitoring are presented in **Table 4-1**.

*Table 4-1 Environmental Parameters and Frequency of Monitoring*

| Components | Parameters | Frequency | Methodology adopted |
|---|---|---|---|
| Meteorology | Wind Speed & Wind Direction, Temperature, Relative Humidity and Rainfall | Secondary data like average annual meteorological data was collected from IMD – Pune | IMD data and data |
| Ambient Air Quality | As per the NAAQS dated 16th November 2009: $PM_{2.5}$, $PM_{10}$, $SO_2$, $NO_X$, CO | Ambient air quality samples are monitored at 6 locations for 24 hours once during the study period. | $PM_{10}$ / $PM_{2.5}$: Gravimetric method<br>$SO_2$: Modified West and Gaeke Method. (IS: 5182, Part II)<br>NOx: Jacobs and Hochheiser Method. (IS 5182 Part VI)<br>CO: IS: 5182 (Part-X) & CPCB Guidelines |
| Ambient Noise | Noise levels in dB(A) | Continuous 24 – hourly monitoring at 6 locations once during the study period. | IS: 4954 as adopted by CPCB. |
| Vibration | | Continuous 24 – hourly monitoring at 10 sensitive receptor locations once during the study period. | |
| Water quality | Physical, Chemical and Biological parameters. | Sampling was done once during the study period at 4 locations for groundwater quality and 4 locations for surface water quality. | Standard methods for Examination of Water and Wastewater' published by American Public Health Association (APHA) |
| Soil | Physico-chemical parameters as per BIS standards | Sampling at 5 locations in the project study area during the study period. | BIS specifications |
| Land use pattern | Land use for different categories | 500 m radius, based on data published in Primary Census Abstract and satellite imagery Sentinel | Toposheets and Satellite imagery |
| Geology and Hydrogeology | Lithological types, drainage basins, etc. | Field observations in study area and from secondary data from authenticated sources like GSI, SoI, etc. | Authenticated published data. |
| Ecology | Flora & Fauna within study area (Terrestrial & Aquatic) | Field survey conducted in 10 km Study area, once during the study period and secondary data.<br>Actual tree count survey of trees likely to be affected along the alignment of the Swargate to Katraj (Phase 1 Extension) | Listing of floral and faunal species. |
| Socio-economic Data | Socio-economic characteristics of the local population in the Study Area. | Based on data collected from the year 2011 Census Abstract and actual random consultations with locals. | Public Consultation. |

## D. PHYSICAL / LAND ENVIRONMENT

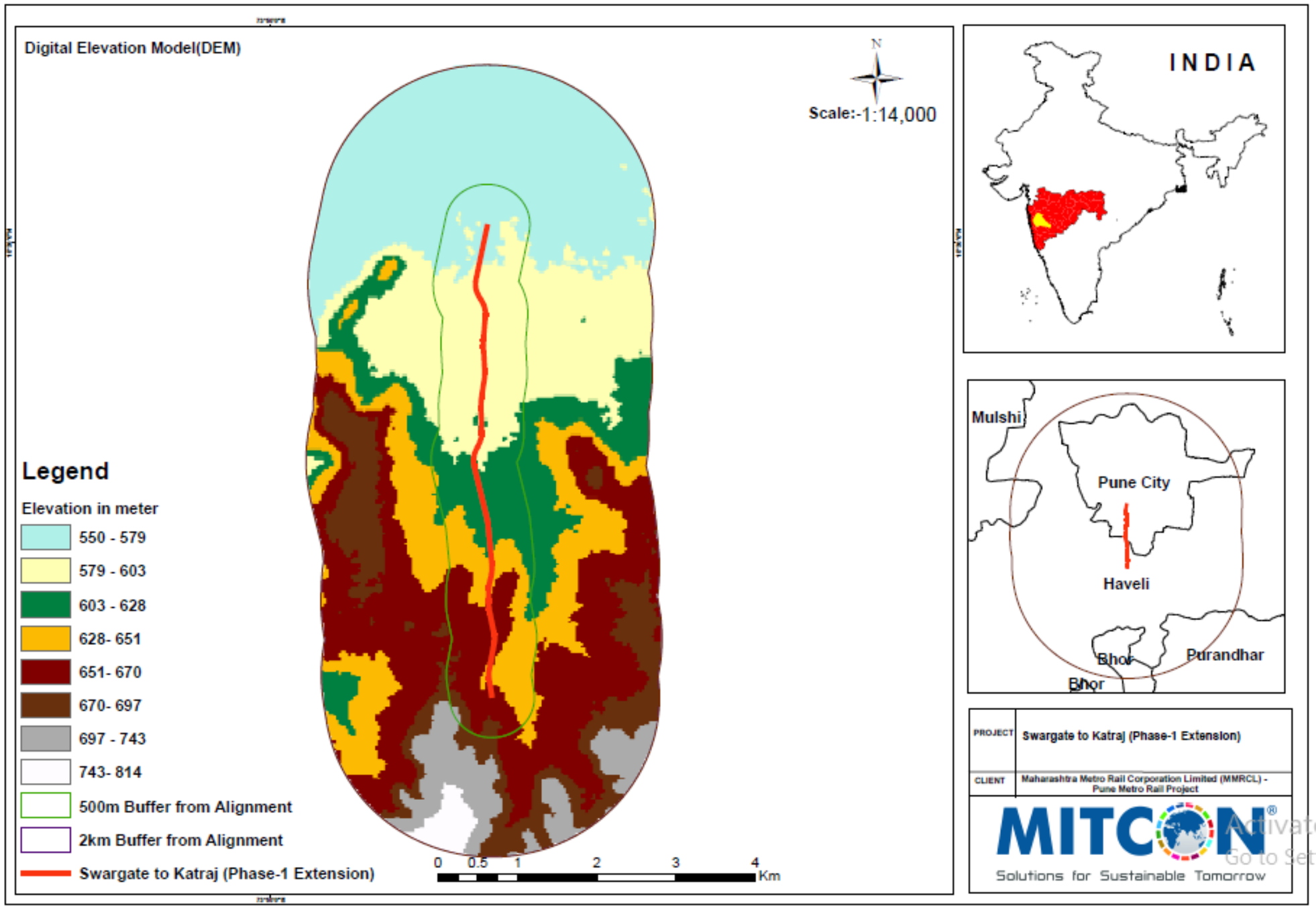
### 1. Physiography and Geomorphology

199. The Pune district, part of the Western Ghats and Deccan Plateau, is divided into three distinct belts: (1) The western belt, 16 to 31 km east of Sahyadri, characterized by rugged terrain with deep valleys and intersecting hill ranges; (2) The central belt, extending 30 km east of the western belt, marked by small hills, valleys, and large spurs forming plateaux; and (3) The eastern belt, featuring rolling topography with low hills gradually transitioning into plains with broader valleys. These features give rise to four major landforms: hills and Ghats, foothills, plateaux, and plains. The district has three

major drainage systems: (i) Bhima-Ghod, with the Bhima River (355 km) and Ghod River (196 km); (ii) Mula-Mutha, covering 242 km; and (iii) Nira, with a total length of 231 km. Other significant rivers include Andhra, Karna, Shivganga, Pushpavati, Pavna, and Indrayani. The semi-dendritic drainage pattern is dense, and the district is divided into 71 watersheds based on geomorphology and drainage.

200. Digital Elevation Modelling (DEM) maps of the Core and Buffer study areas of of the Swargate to Katraj (Phase-1 Extension) is presented as **Figure 4-2.**

*Figure 4-2 DEM of the Core and Buffer study areas of Swargate to Katraj (Phase-1 Extension)*



## 2. Geology

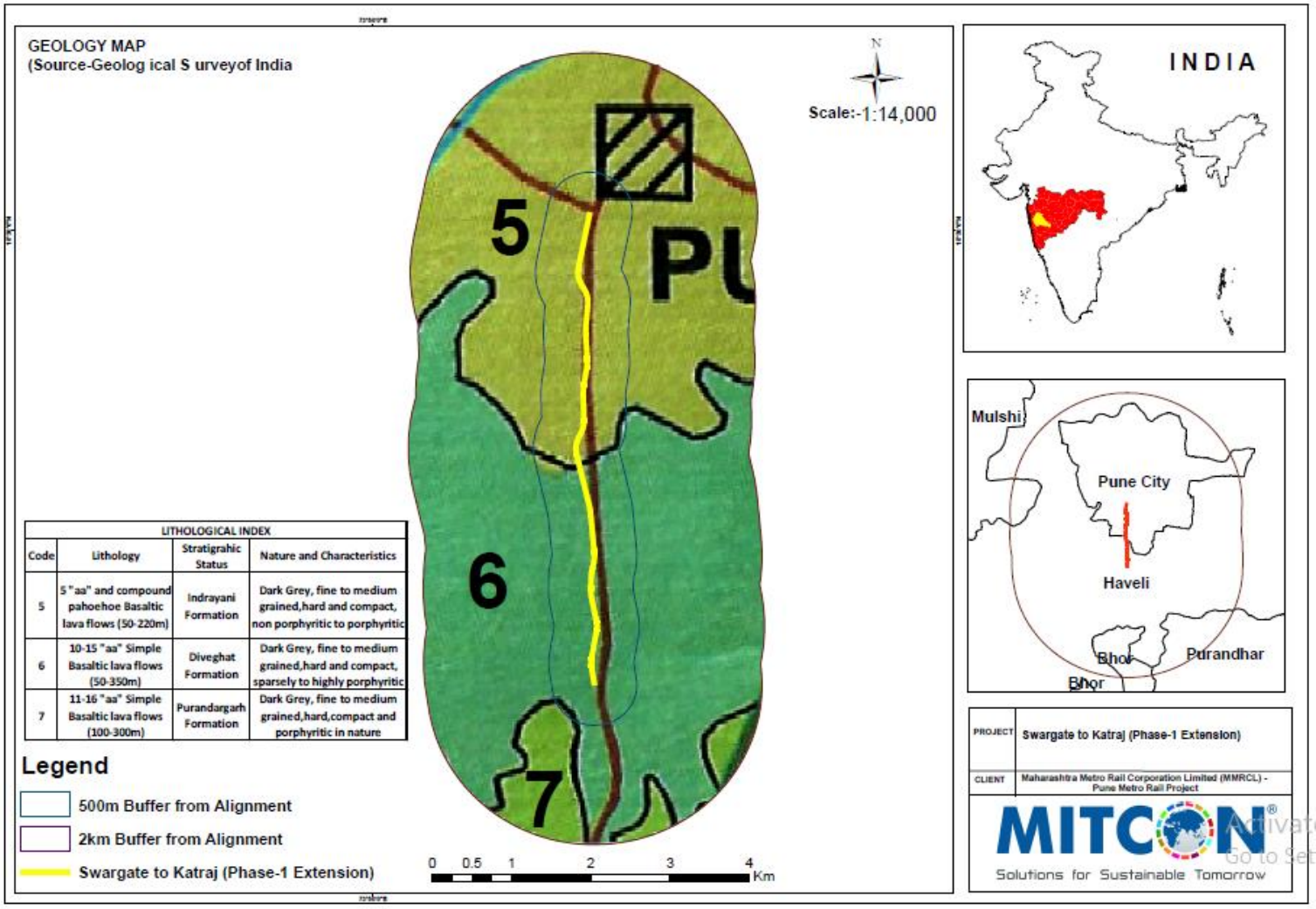
201. Almost the entire district is underlain by Deccan Volcanic Basalts belonging to Sahyadri Group of Upper Cretaceous to Eocene age, comprises of various lava flows, which can be classified in the field into two types as simple and compound flows. The compound flows occur at lower elevations whereas the simple flows are confined to the elevation above 680 m. The compound flows although vesicular and amygdaloidal in nature, hard and compact in their middle sections. They are fractured and jointed, and show moderate degree of weathering at places. Each individual lava flow consists of lower massive part becoming vesicular /amygdaloidal towards top, ranges in their individual thickness from a few centimetres to tens of meters. The flows have wide variation in colour and texture especially when they are amygdaloidal in nature with secondary mineral infillings such as Zeolites, calcite, and Agate and Chalcedony etc. The red /green/black bole beds constituting the marker horizons separating the two flows were discontinuous and generally inconsistent. The basalts are intruded by dykes and are found commonly in pahoehoe flows in the area. The generalised stratigraphy of Pune district is shown as ***Table 4-2***, and map showing geological formations in Pune district is shown as **Figure 4-3**

*Table 4-2 Generalized Stratigraphy of Pune District19*

| Age | Group | Sub-group | Formation | Thickness (m) | Lithology |
|---|---|---|---|---|---|
| Quaternary (Recent to Sub-recent) (> 1 mya) | Sahyadri Group (Deccan Trap Super Group) | -- | Alluvium | (Various) | Poorly sorted arenaceous to rudaceous sediments (sand, silt & clay) |
| Upper Cretaceous to Eocene (30-60 mya) | | Diveghat | Purandargad | 300 | Deccan Trap basalt with intertrappeans: Simple flows, aphyric to plagioclase micro-phyric |
| | | | Diveghat | 350 | Deccan Trap basalt with intertrappeans: Simple / Aa flows, aphyric |
| | | Lonavala | Karla | 250 | Deccan Trap basalt with intertrappeans: Fine-grained, aphyric, 'Pahoehoe' flows. |
| | | | Indrayani | 125 | Deccan Trap basalt with Intertrappeans: a thick succession of 'Aa' flows - Aphyric to sparsely phyric |
| | | Kalsubai | Upper and Lower Ratangad | 250 | Deccan Trap basalts: compound 'Pahoehoe' flows and Megacryst lava flows |

[19] *Source: CGWB - Aquifer Maps and Ground Water Management Plan, Pune District, Maharashtra (2018).*

*Figure 4-3 Geology of Project Study Area of Swargate to Katraj (Phase-1 Extension) as per GSI – Pune DRM*



202. Deccan basalts are hydrogeologically in-homogeneous rocks. The weathered and jointed / fractured parts of the rock, as also permeable inter-flow beds constitute the zone of ground water storage and flow. The existence of multiple aquifers is characteristic of basalt and exhibits wide variation in the joint/fracture intensity. The yields of well is function of the permeability and transmissivity of aquifer and it depends upon the degree of weathering and topographic setting of the aquifer. Due to wide variation in secondary openings, the potential areas for ground water are generally localized. In general, ground water occurs under phreatic/unconfined to semi-confined conditions in basalts. Two Aquifer systems have been delineated: Aquifer I from 9 to 30 m (Weathered /Jointed Basalt); and Aquifer II from 48 to 175 m (Jointed/fractured basalt). Shallow Aquifer generally tapped by the dug wells of 9 to 30 m depth, have water levels ranging from 2.1 to 25.0 m BGL and yield varies from 10 to 100 m3/day. The deeper Aquifer is being tapped by bore-wells with depth ranging from 50 to 180 m BGL and the water level from 6 to 45 m BGL.

### 3. Soils

203. 'Soil' means the uppermost layer of the earth's crust, which contains the organic as well as mineral matter necessary for the growth of plants. There are six types of soils found in Pune district as described below:

(i) **Laterite Soil:** Predominantly found in the western parts of the district, particularly in the Sahyadri hills and adjacent areas. This soil is rich in iron and aluminium but is generally poor in organic matter and nutrients, making it less fertile**.**

(ii) **Red Soil:** Commonly found in the hilly and plateau regions. Red soils are well-drained, slightly acidic, and rich in iron, but they are low in nitrogen, phosphorus, and organic matter.

(iii) **Black Soil (Regur Soil):** Found mainly in the eastern parts of the district. This soil is clayey, deep, and has good water retention capacity, making it ideal for growing crops like cotton, sugarcane, and sorghum. It is rich in minerals like calcium carbonate, magnesium, potash, and lime but has poor nitrogen content.

(iv) **Alluvial Soil:** Found in the river valleys, particularly along the banks of rivers like Bhima, Ghod, and Nira. This soil is fertile, with a good mix of sand, silt, and clay, making it suitable for diverse agricultural activities.

(v) **Brownish Soil:** Present in the plains and low-lying areas. This soil type has moderate fertility and is used for growing crops such as cereals, pulses, and oilseeds.

#### (a) Methodology

204. Soil sampling was undertaken to ascertain the type and quality of soil present in the Project study area. Methodology followed for the same is as follows:

(i) Manual sample was collected from the surface to plough depth (0-22 cm) using hammer and container bags for collecting undisturbed top soil.

(ii) Locations such as recently fertilized farms, old bunds, marshy spots, spots near trees, compost heaps and farm sheds, etc. were avoided.

(iii) Each collected Sample was a uniformly thick 2 cm slice of soil from the exposed soil face from a V-shaped hole dug in the ground.

#### (b) Locations & Frequency of Monitoring

Soil samples were collected once from 5 different locations within the study area, as shown in **Table 4-3**. The locations are taken at proposed stations, chosen randomly, so as to provide a representative of the soils present in the project study area. **Figure 4-4** shows some photographs taken during Soil sampling in the Project Study area. Soil Sampling locations for Swargate to Katraj is shown as **Figure 4-5**.

*Table 4-3 Soil Sampling Locations for Swargate to Katraj (Phase-1 Extension)*

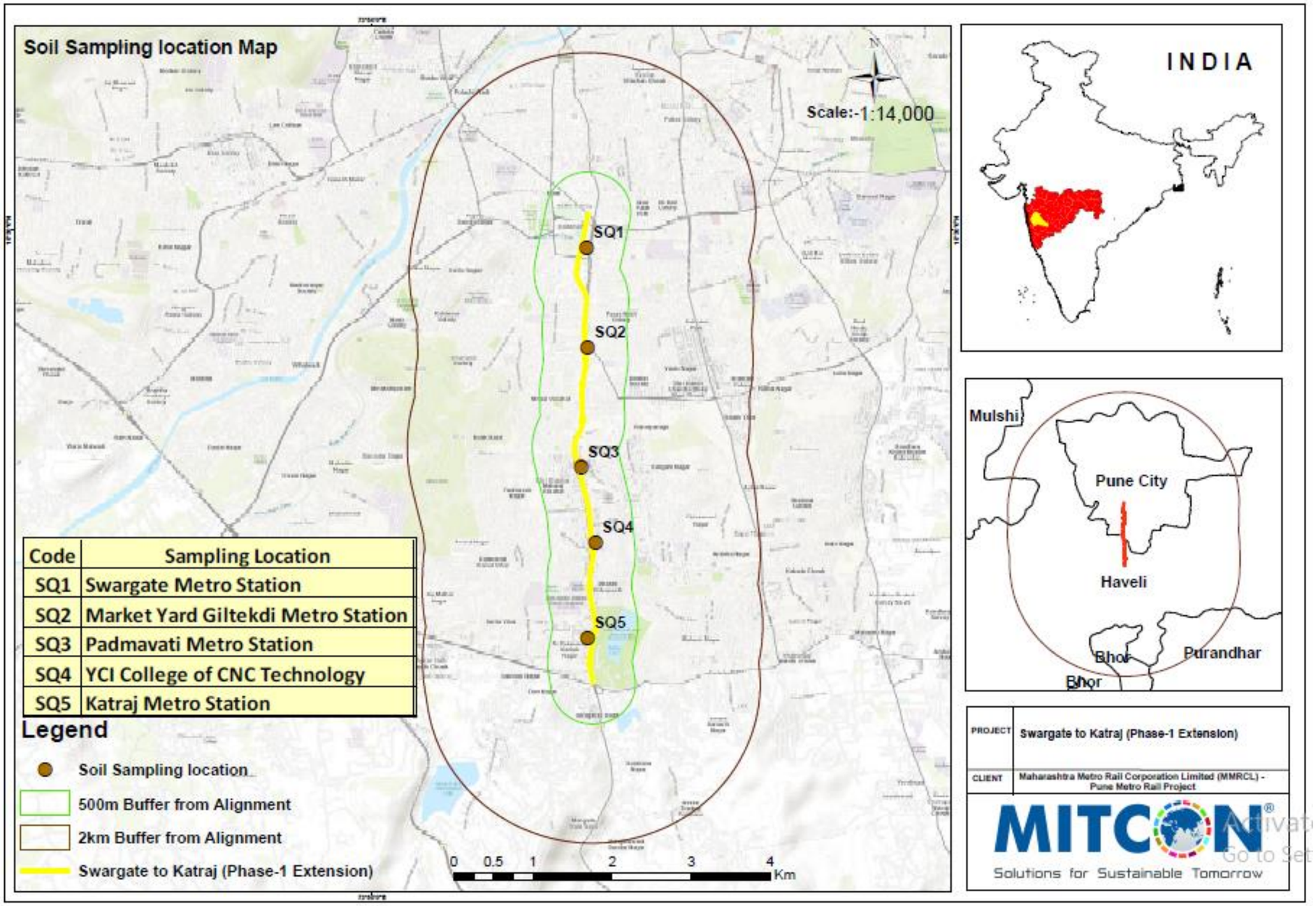
| Sampling Code | Sampling Location | Latitude | Longitude |
|---|---|---|---|
| S1 | Swargate metro station | 18°29'52.76"N | 73°51'27.57"E |
| S2 | Market yard gultekdi metro station | 18°29'11.78"N | 73°51'28.12"E |
| S3 | Padmavati Metro station | 18°28'23.07"N | 73°51'25.38"E |
| S4 | YCI College of CNC Technology | 18°27'52.14"N | 73°51'31.28"E |
| S5 | Katraj Metro station | 18°27'12.93"N | 73°51'28.08"E |

*Figure 4-4 Photographs of Soil Sampling*





*Figure 4-5 Soil sampling locations for Swargate to Katraj (Phase-1 Extension)*



### (c) Soil Sampling Results

205. Soil analysis results of all 5 soil samples collected in the project area are comparatively summarized in **Table 4-4**. Detailed results of Soil sampling are given as **Annexure-3**.

*Table 4-4 Results of Soil Sampling locations in study area*

| Sample Code | Parameter | Texture | Percentage of Different Components | | | Soil Moisture | Bulk Density | Water Holding Capacity | Organic Carbon | Calcium (as Ca) | Magnesium (as Mg) | Available Nitrogen | Phosphorous (as P) | Potassium (as K) | Sodium Absorption Ratio |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Sand | Silt | Clay | | | | | | | | | | |
| | **Station Units** | - | % | % | % | % | gm/cm$^2$ | % | % | mg/kg | mg/kg | kg/ha | kg/ha | kg/ha | - |
| S1 | Swargate metro station | Clay | 40 | 25 | 35 | 17.15 | 1.13 | 31.15 | 0.16 | 85.16 | 38.14 | 114.53 | 7.12 | 135.78 | 1.49 |
| S2 | Market yard gultekdi metro station | Sandy Loam | 25 | 20 | 55 | 13.15 | 1.08 | 43.6 | 0.18 | 75.16 | 55.37 | 114.37 | 8.92 | 116.37 | 1.32 |
| S3 | Padmavati Metro station | Silty loam | 19 | 35 | 46 | 18.12 | 1.1 | 61.45 | 0.16 | 78.54 | 38.33 | 105.14 | 5.23 | 118.73 | 1.57 |
| S4 | YCI College of CNC Technology | Loam | 44 | 22 | 34 | 14.23 | 1.07 | 55.65 | 0.18 | 91.27 | 41.2 | 90.16 | 5.43 | 102.18 | 1.53 |
| S5 | Katraj Metro station | Silty loam | 25 | 23 | 52 | 13.25 | 1.1 | 60.23 | 0.18 | 91.27 | 41.2 | 90.16 | 5.43 | 102.18 | 1.53 |
| **Average Value / Range** | | **-** | **-** | **-** | **-** | 13.15 to 18.12 | 1.10 | 50.42 | 0.17 | 75.16 to 91.27 | 38.14 to 55.37 | 90.16 to 114.37 | 5.23 to 8.92 | 102.18 to 135.78 | 1.49 |
| **Standard soil classification[20]** | | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **Less to Very Less** | **Very low** | **-** | **Good** | **Very Less** | **Very Less** | **Low Sodium** |

[20] *Source: Hand Book of Agriculture, ICAR, New Delhi)*

### (d) Inferences of Soil Sampling

206. The soil sample analyses results were compared with Bureau of Indian Standards (BIS). Conclusions from Soil sampling in the Study area during study period are summarised below:

| Sr. No. | Parameter | Range |
|---|---|---|
| 1 | Soil Moisture/Porosity | 13.15% – 18.12% |
| 2 | Water Holding Capacity | 31.15% – 61.45% |
| 3 | Organic Carbon | 0.16% – 0.18% |
| 4 | Nitrogen (N) | 90.16 – 114.53 kg/ha |
| 5 | Phosphorus (P) | 5.23 – 8.92 kg/ha |
| 6 | Potassium (K) | 102.18 – 135.78 kg/ha |

The soil sample analysis aimed to determine the presence of contamination. Based on the results, contamination was not found in the soil. Overall it is observed that, soil quality is poor for agriculture.

## 4. Land Use and/or Land Cover

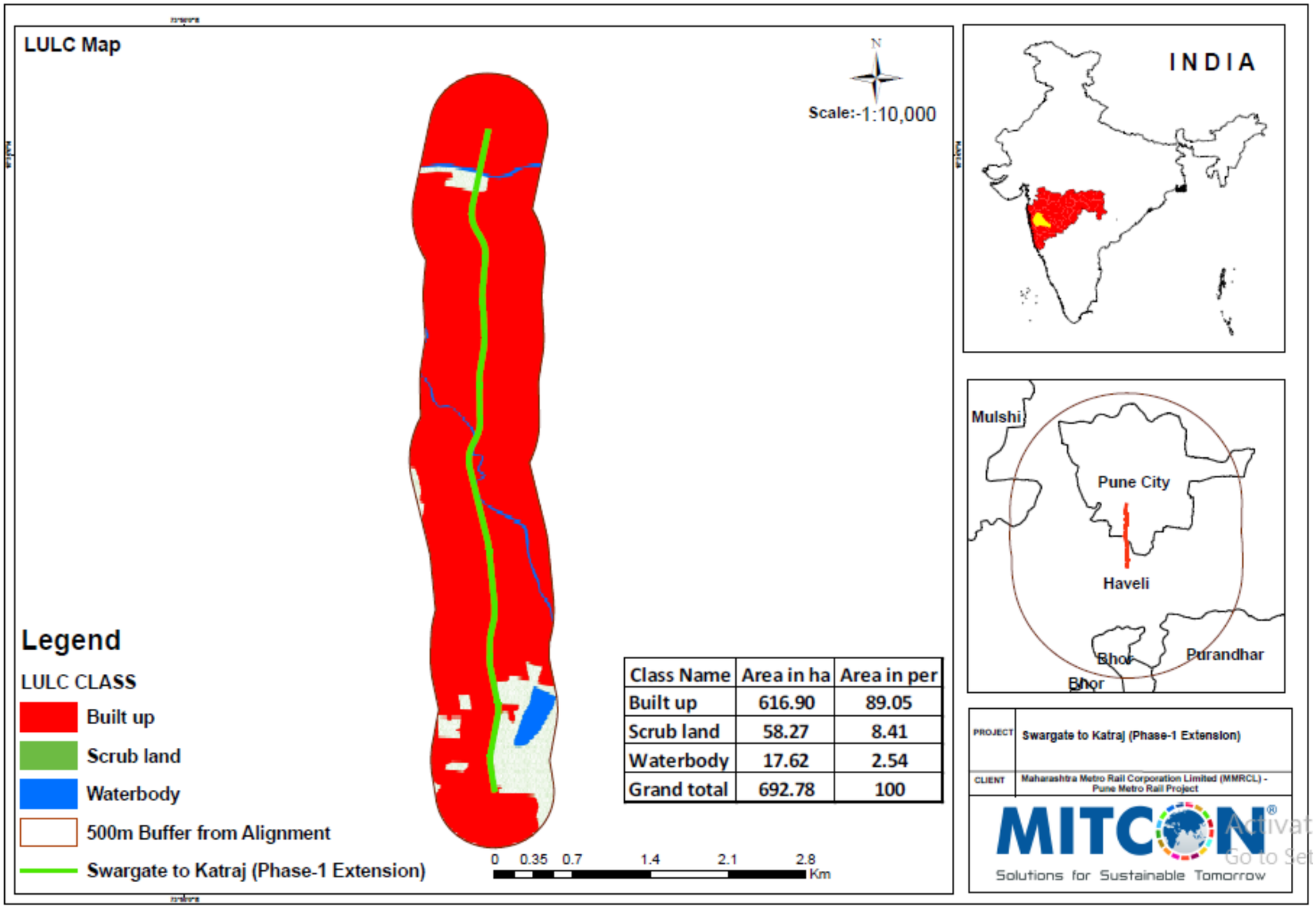
207. Land use is characterized by the arrangements, activities and inputs people undertake in a certain land cover type to produce, change, or maintain it. Land cover is the observed (bio-) physical cover on the earth's surface.

208. Land use / land cover for 500 m radius around the project alignment were delineated based on the Landsat ETM+ satellite data; the Land use / Land cover classes are categorized based on ground truthing and site visit. Land is classified as vegetation, barren land, built-up area, water bodies, etc. classes. Land use of the study areas varies, and is predominantly built up area (89.05%) which includes, residential, commercial, mixed-use structures also comprising sensitive receptors like schools, hospitals, religious establishments, etc., as seen from **Table 4-5**. Land Use in the alignment is shown in **Figure 4-6**.

*Table 4-5 Land Use in the Study Area (Cumulative)*

| Sr. No. | Classes | Area in Ha. | Area in sq. km | Area in % |
|---|---|---|---|---|
| 2 | Built-up | 616.90 | 6.169 | 89.05 |
| 3 | Scrubland | 58.27 | 0.5827 | 8.41 |
| 4 | Water bodies | 17.62 | 0.1762 | 2.54 |
| **Total** | | **692.78** | **6.9278** | **100** |

*Figure 4-6 Land Use / Land Cover in 500 m Core Study Area of Swargate to Katraj*



## 5. Natural Hazards

209. The district of Pune is prone to water related disasters like floods and droughts, as there are many perennial rivers flowing through the district. In addition, the uncontrolled residential and increased industrial development has worsened the floods events in the district. The existing physical infrastructure and social attributes have made the population vulnerable to urban floods.

210. Vulnerabilities to disaster / emergencies of chemical and biological, radiological and nuclear origin are also increasing due to expansion of industrial zone at the outskirt of the city at the same time rapid urbanization is moving towards the industrial clusters and these cluster are becoming the part of city thus leading the people vulnerable due to various hazards.

### (a) Floods

211. While discussing river floods, the word Return Period is often used. The amount of water flowing through each year often has large variation. It depends predominantly on the quantity of rain during monsoon season, which has a large spatial and temporal variation. The magnitude of maximum or the peak discharge also has a large variation. For designing a new dam, it is necessary to estimate the current and projected need of water for determining the storage capacity of dam in order to meet the annual requirement of water. If it is too small, the intended purpose will not be served. If it is too large, major part of the dam will remain empty and money for constructing larger dam will be wasted. Hence every dam has to be built for optimum storage capacity. The same consideration applies to the Maximum River Discharge in each year. Considering the geometry of the river on its both banks, the value of maximum flood discharge is used to decide the area of flood plain. All constructions need to be kept beyond the flood line. Analysis of maximum flood discharge data enables us to decide the Flood Frequency and its volume, which is expressed as the Return Period. The magnitude of flood is expressed as once in Ten years, once in fifty years, once in hundred years and so on.

*Table 4-6 Affected structures / places due to discharge of Mutha River in the vicinity of project site*[21]

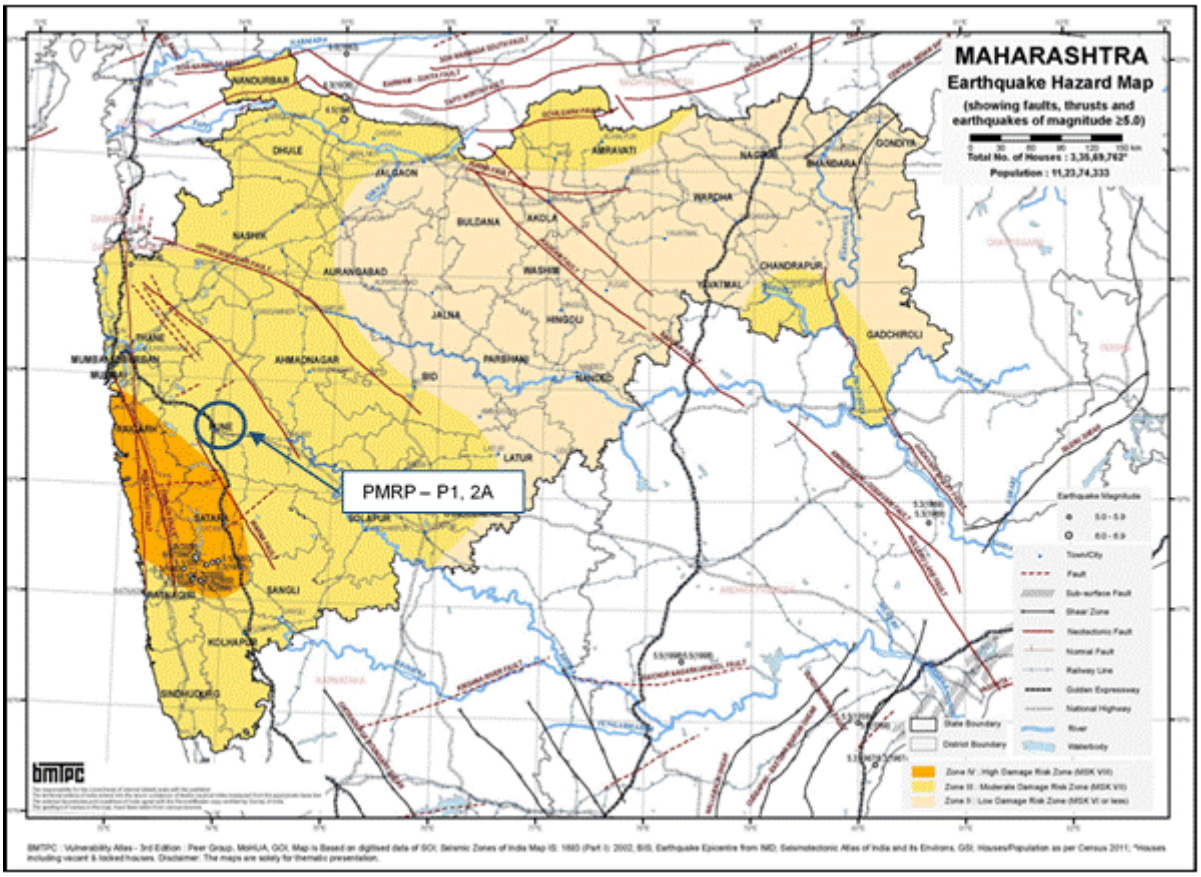
| Sr. No. | Discharge in Cusecs | Affected structure/place |
|---|---|---|
| 1 | 18,000 | Baba Bhide Bridge submerges |
| 2 | 28,000 | Water enters into the Khilare Wasti, near Abasaheb Garware College |
| 3 | 33,000 | Shitaladevi Temple at Deccan submerges |
| 4 | 54,000 | Jayantrao Tilak Pul (PMC Bhavan Bridge) submerges |
| 5 | 60,000 | Water enters into Patil Estate slum area |

### (b) Seismicity

212. Bureau of Indian Standards (BIS) has prepared a seismic zoning map of India based on tectonic features and records of past earthquakes. **Figure 4-7** shows the approximate project location marked on BMTPC Earthquake hazard map of Maharashtra state, showing location of Project site in Zone-II i.e. Low Damage Risk Zone (MSK VI or less).

[21] *Source: Flood Control and Disaster Management Action Plan, 2017-18, Pune Municipal Corporation*

*Figure 4-7 BMTPC Earthquake Hazard Map of Maharashtra*[22]




## E. AMBIENT ENVIRONMENT

### 1. Meteorology

213. Micro-meteorological data within the study area during the air quality survey period is an indispensable part of air pollution studies. The meteorological data recorded during the monitoring period is a useful tool for the interpretation of the baseline condition as well as for the input to predictive models for air quality dispersion.

#### (a) Methodology

214. The methodology adopted for monitoring surface metrological observations is as per the standard norms laid down by Bureau of Indian Standards, and the India Meteorological Department (IMD). The Regional Meteorological Centre – Indian Meteorological Department (RMC - IMD) in Pune is located at Shivaji Nagar, Pune. Secondary data was obtained from IMD Pune and is presented in this report.

#### (b) Average Meteorological Condition at IMD – Pune

215. The daily mean maximum & minimum temperature, monthly lowest minimum & highest maximum temperature, the total monthly rainfall, number of rainy days, mean wind speed and predominant wind direction, for the period - 1981 to 2010, was collected from Indian Meteorological Department, Ministry of Earth Sciences, GoI. The average of this meteorological data based on Climatological Normal (1981-2010) for the IMD Regional Meteorological Centre (RMC) at Pune is presented in **Table 4-7**.

[22] *Source: BMTPC Vulnerability Maps (3rd Edition)*

*Table 4-7 Average of Meteorological Data from RMC – IMD Pune[23]*

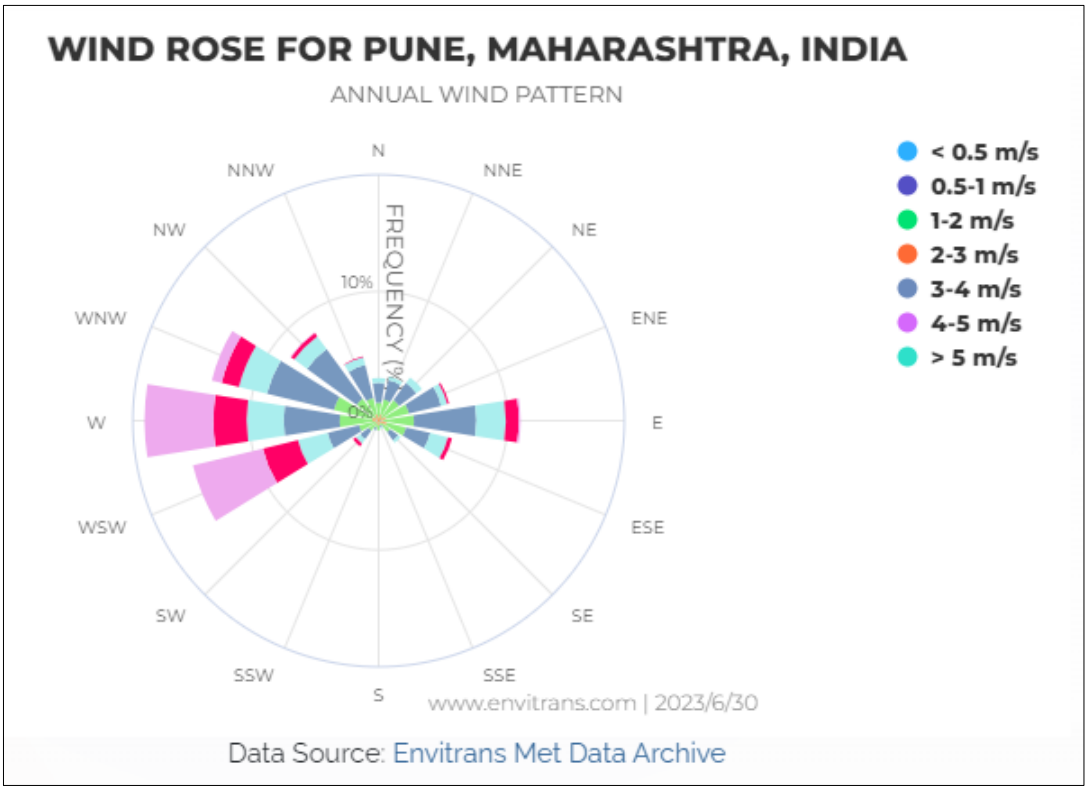
**Location:** In the compound of the Meteorological Office building at Shivajinagar, Agricultural College farm Pune. Wind instruments on terrace of the building; exposure good. (Latitude: 18º32'N, Longitude: 73º51'E)

**Elevation:** 559 m above MSL

| Month | Temperature (°C) | | Relative Humidity (%) | | Mean wind speed (Kmph) | Pre-dominant Wind Direction | Precipitation (mm) |
|---|---|---|---|---|---|---|---|
| | Highest | Lowest | Morning | Evening | | | |
| January | 35.3 | 1.7 | 85 | 34 | 2.5 | W | 1.1 |
| February | 38.9 | 3.9 | 72 | 26 | 3.2 | W | 0.3 |
| March | 42.8 | 7.2 | 55 | 21 | 4 | W | 2.2 |
| April | 43.3 | 10.6 | 48 | 24 | 5.4 | W | 8.5 |
| May | 43.3 | 13.8 | 59 | 37 | 8.5 | W | 26.8 |
| June | 41.7 | 17 | 77 | 66 | 9.1 | W | 173.4 |
| July | 36 | 18.9 | 83 | 76 | 9.2 | W | 181.4 |
| August | 35 | 17.2 | 86 | 79 | 8.2 | W | 145.2 |
| September | 36.1 | 13.2 | 84 | 73 | 5.4 | W | 146.1 |
| October | 37.8 | 9.4 | 79 | 53 | 2.9 | W | 86.3 |
| November | 36.1 | 4.6 | 76 | 43 | 2.7 | N | 25 |
| December | 35 | 3.3 | 82 | 39 | 2.5 | N | 7 |
| **Annual Total or Mean** | **43.3** | **1.7** | **74** | **47** | **5.3** | **W** | **803** |

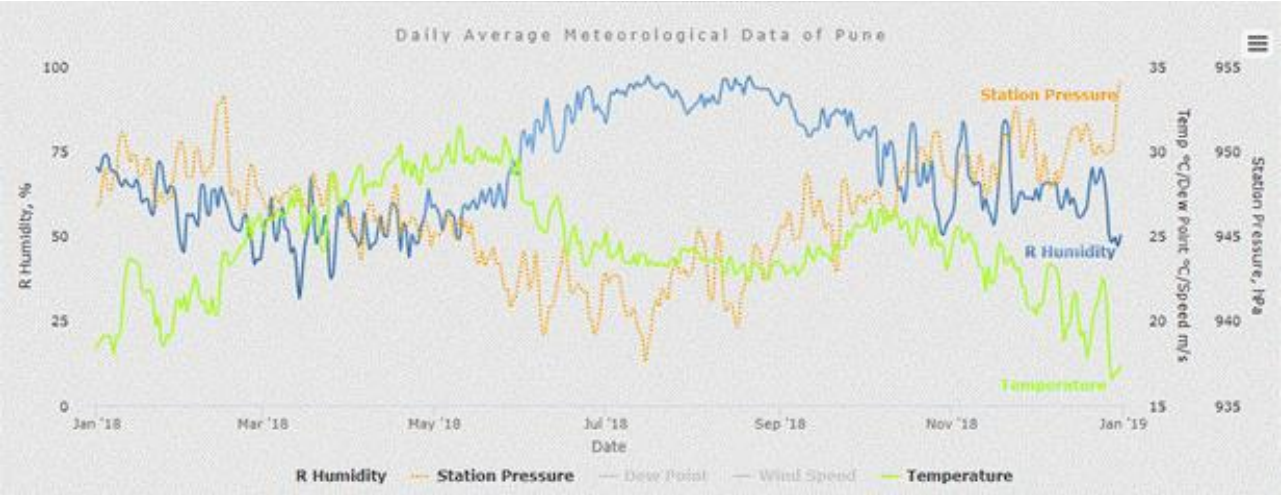
216. The Annual Wind-rose has been obtained from IMD Pune and shown as **Figure 4-8** and Daily Average Meteorological data (Climatological Norm) for Pune i.e. Temperature, Rainfall and Relative Humidity are shown as **Figure 4-9**.

*Figure 4-8 Annual Wind-rose – Pune24*




[23] *Source: GOI, Ministry of Earth Sciences, IMD, Climatological Tables 1981-2010*
[24] *Source: Indian Climate portal by envitrans – Pune Wind Pattern [https://www.indianclimate.com/wind-data.php]*

*Figure 4-9 Climatological Norm at Pune25*




## 2. Ambient Air Environment

217. Air quality is an important parameter of the baseline environment and its study is an indispensable tool for planning further development in the adjoining areas of the project. The extant air quality was studied to assess the current status of the same and to check the air quality status of the region vis-à-vis the air quality standards prescribed by the Central Pollution Control Board.

### (a) Methodology (Criteria for choice of Parameters for Air monitoring)

218. The Air Quality Index monitored in India comprises Particulate matter, carbon monoxide, sulphur dioxide, nitrogen dioxide, ammonia, lead and ozone. The US EPA list of criteria pollutants comprises all of the above except ammonia. As per WHO, concentrations of nitrogen dioxide are often strongly correlated with those of other toxic pollutants, and because it is easier to measure, it is often used as a surrogate for the pollutant mixture as a whole. Wide adverse effects of particulate matter (PM) are observed in both short-term and long-term exposures. It is possible to derive a quantitative relationship between the concentration of the pollutant as monitored in ambient air and specific health outcomes (usually mortality).

219. The biggest source of lead in air is petrol and mining: neither of them are present in Pune and so lead was not measured. Ammonia was not measured because it is highly reactive making it difficult for monitoring instruments to capture it; uncertainty surrounding sources; the gas can have a very short life span. Ozone is a secondary pollutant resulting from action of nitrogen oxides and VOCs; nitrogen oxides are measured as dioxide and therefore ozone was not measured.

220. The sampling and analysis of ambient air quality parameters was carried out as per the procedures detailed in relevant Parts of IS-5182 (Indian Standards for Ambient Air Quality Parameters).

221. The following air pollution parameters were monitored and measured by sampling:

(i) Particulate Matter less than 10µm ($PM_{10}$)
(ii) Particulate Matter less than 2.5µm ($PM_{2.5}$)
(iii) Sulphur dioxide ($SO_2$)
(iv) Oxides of nitrogen ($NO_x$)
(v) Carbon monoxide (CO)

### (b) Techniques for Measurement

222. The ambient air quality monitoring was undertaken once in the study period at all the proposed Swargate to Katraj (Phase-1 Extension) station locations alignments. Additionally, samples were collected at sensitive receptors like schools, colleges, hospitals, etc. situated with 100m of the alignments on either side. One set of 24-hour average samples were thus collected continuously at

[25] *Source: Indian Climate portal by envitrans – Pune Wind Pattern [https://www.indianclimate.com/wind-data.php*

each of these locations. Measurement techniques used for Air quality analysis are presented in **Table 4-8**.

*Table 4-8 Measurement Techniques*

| Parameter | Monitoring Equipment | Analytical Method | Minimum Detectable limit | Technical Protocol |
|---|---|---|---|---|
| $PM_{2.5}$ | Fine Dust Sampler | CPCB Guidelines for the measurement of Ambient Air pollutant Vol. I, 2011 | 10 µg/m$^3$ | Gravimetric method |
| $PM_{10}$ | Fine Dust Sampler | IS 5182 (Part 23) :2006, RA-2012 | 10 µg/m$^3$ | Gravimetric method |
| $SO_2$ | Gaseous sampler | IS 5182 (Part II) : 2001, RA-2012 | 5 µg/m$^3$ | Improved West and Geake method |
| $NO_x$ | Gaseous sampler | IS 5182 (Part VI) : 2006, RA-2012 | 5 µg/m$^3$ | Modified Jacob and Hochheiser method |
| CO | CO meter | IS: 5182 (Part-X) & CPCB Guidelines | - | Non-Dispersive Infra-Red (NDIR) spectroscopy |

### (c) Sampling Period, Frequency and Parameters

223. Ambient air quality monitoring was conducted at a total of 6 locations in the project study area for 24 hours at each location as shown in **Table 4-10**. Location maps showing Air sampling locations for Swargate to Katraj is presented as **Figure 4-11**. The monitoring locations have been selected primarily based on the predominant wind direction. The other factors considered while selection of the monitoring stations include accessibility, location of receptors and availability of power. Justification for selection of the locations for ambient Air quality monitoring in the Project Study area is summarised in **Table 4-9**.

*Table 4-9 Justification for selection of AAQ locations*

| AAQ locations | Crosswind Locations | Downwind Locations |
|---|---|---|
| 6 | 2 | 4 |

*Table 4-10 Ambient Air Quality Stations monitored in Project Study Area*

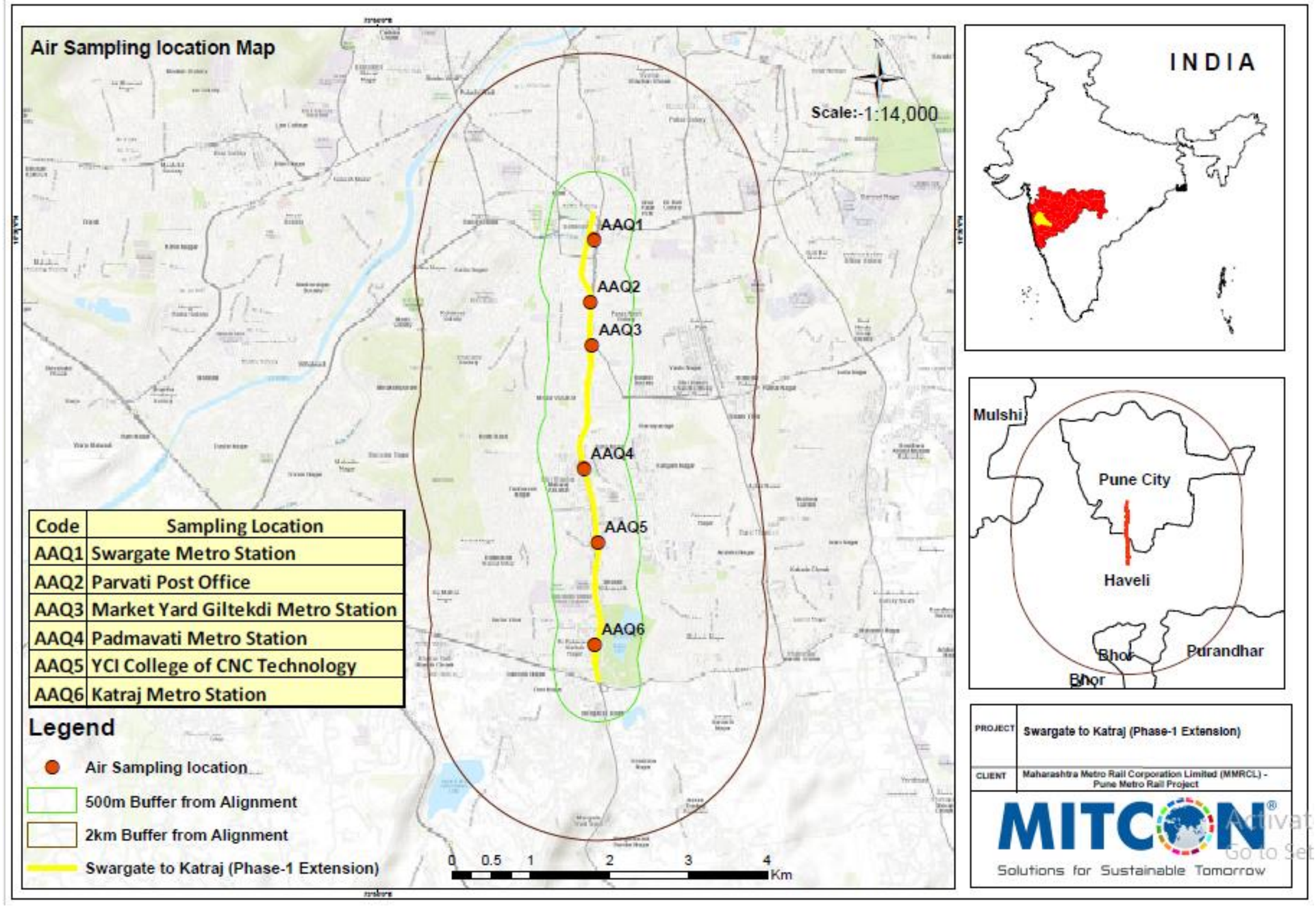
| Sampling Code | Sampling Location | Type of Sample | Latitude | Longitude | Wind type[#] |
|---|---|---|---|---|---|
| AAQ.1 | Swargate Metro Station | Commercial | 18°29'55.80"N | 73°51'28.55"E | CW |
| AAQ.2 | Parvati Post Office | Commercial | 18°29'30.35"N | 73°51'27.13"E | DW |
| AAQ.3 | Market Yard Gultekdi Metro Station | Commercial | 18°29'12.40"N | 73°51'27.66"E | DW |
| AAQ.4 | Padmavati Metro Station | Commercial | 18°28'21.87"N | 73°51'24.42"E | DW |
| AAQ.5 | YCI College of CNC Technology | Silent | 18°27'51.47"N | 73°51'30.11"E | DW |
| AAQ.6 | Katraj Metro Station | Commercial | 18°27'9.33"N | 73°51'28.83"E | CW |

[#] *DW – Down-wind; CW – Cross-wind.*

*Figure 4-10 Photographs taken during Air-sampling in the Project Study Area*



*Figure 4-11 Ambient Air Quality Monitoring Locations*



### (d) Ambient Air Quality Results

224. The air pollutants emitted by point and non-point sources are transported, dispersed or concentrated by meteorological and topographical conditions. **Table 4-11** shows a summary of the analytical results of Air Quality monitoring samples gathered in the Project Study Area. Detailed results of all parameters analysed are given in **Annexure-2**

*Table 4-11 Summary of Results of Ambient Air Quality monitoring*

| Sampling Location | $PM_{2.5}$ (60 µg/m³) | $PM_{10}$ (100 µg/m³) | $SO_2$ (80 µg/m³) | $NO_X$ (80 µg/m³) | CO (2 mg/m³) |
|---|---|---|---|---|---|
| **AAQ1** | 36.75 | 87.41 | 24.95 | 31.57 | 1.74 |
| **AAQ2** | 27.54 | 56.74 | 14.85 | 19.74 | 0.18 |
| **AAQ3** | 34.58 | 73.85 | 20.25 | 28.45 | 1.25 |
| **AAQ4** | 33.85 | 78.45 | 22.74 | 30.14 | 1.05 |
| **AAQ5** | 21.74 | 47.14 | <10 | 15.54 | 0.08 |
| **AAQ6** | 37.85 | 82.74 | 25.74 | 34.85 | 1.85 |

225. The 24-hour air quality monitoring results indicate that all parameters were within the permissible limits of the National Ambient Air Quality Standards (NAAQS). However, when compared with the WHO Air Quality Guidelines (2021 AQGs) and the World Bank Group – Environmental, Health and Safety (WBG-EHS) Guidelines (2007), it was observed that concentrations of PM10, PM2.5, and NOx exceeded the respective guideline values, while $SO_2$ exceeded the WBG-EHS guideline limit. The exceedances are mainly attributed to local vehicular emissions, road dust, and nearby anthropogenic activities. The measured parameters were compared against the NAAQS (CPCB), WHO guidelines, and WBG-EHS limits for ambient air quality, as presented in.**Table 4-12**.

*Table 4-12 National and International Ambient Air Quality Standards*

| Pollutant, Unit | Time Weighted Average | Concentration in Ambient Air[26] | | WHO Guidelines (2021 AQGs)[27] | WBG-EHS Guidelines (2007)[28] |
|---|---|---|---|---|---|
| | | Industrial, Residential, Rural, and Other Areas | Ecologically Sensitive Area (notified by Central Government) | | |
| Sulphur dioxide ($SO_2$), µg/m³ | Annual<br>**24 hours**<br>**80** | 50<br>**80** | 20<br>80 | -<br>**40** | **20** |
| Nitrogen dioxide ($NO_2$), µg/m³ | Annual<br>**24 hours**<br>1 hour | 40<br>**80** | 30<br>80 | 10<br>**25** | 200 |
| Particulate matter (<10 µm) or $PM_{10}$, µg/m³ | Annual<br>**24 hours** | 60<br>**100** | 60<br>100 | 15<br>**45** | **50** |
| Particulate matter (< 2.5 µm) or $PM_{2.5}$, µg/m³ | Annual<br>**24 hours** | 40<br>**60** | 40<br>60 | 5<br>**15** | **25** |
| Carbon monoxide or CO, mg/m³ | 24 hours<br>**8 hours**<br>1 hour | -<br>**2**<br>4 | -<br>2<br>4 | 4<br>**-**<br>- | |

## 3. Ambient Noise

### (a) Methodology

226. The methodology adopted for Noise Monitoring is outlined below:

(i) Ambient Noise is collected by continuous noise sampler (Lutron make, model SL-4033SD). The data collected is continuous 24-hourly data.

(ii) The instrument is mounted on a tripod which is placed around 2m from ground level in residential / commercial areas and sensitive receptors near to the project alignments,

---

[26] *Source: CPCB guidelines for AAQM (National Ambient Air Quality Standards or NAAQS, 2009)*

[27] *Source: WHO Global Air Quality Guidelines (AQGs) 2021 [https://documents1.worldbank.org/curated/en/157871484635724258/pdf/112110-WP-Final-General-EHS-Guidelines.pdfhttps://iris.who.int/bitstream/handle/10665/345329/9789240034228-eng.pdf?sequence=1]*

[28] *Source: WBG (IFC) General EHS Guidelines: Air Emissions And Ambient Air Quality (April 2007) [https://documents1.worldbank.org/curated/en/157871484635724258/pdf/112110-WP-Final-General-EHS-Guidelines.pdf].*

where available.

(iii) The noise measurement instrument is continuously supervised during the monitoring period (24 hours at each location).

(iv) In case of extraneous noise conditions like honking from passing vehicles, adverse meteorological conditions, if any, etc., the “Pause” function on the instrument can be used to exclude any such extra noise.

227. The noise monitoring locations are identified on the basis of following considerations:

(i) **Source.** The proximity of the settlement areas / sensitive receptors to the Project alignments. The closer the settlement areas / sensitive receptors are the severe would be the impact.

(ii) **Path.** The meteorology and the wind flow affect the impact on the receiver. The impact is higher during night time and lower in the daytime (for the same intensity produced by source). Likewise, the impact is high during inversion conditions or on locations lying at the downwind of the alignment.

(iii) **Receiver.** The impact is higher if the receiver is considered to be sensitive w.r.t the NAAQ Standards for noise. Sensitive receptors identified for Noise level assessment include hospitals, schools and colleges.

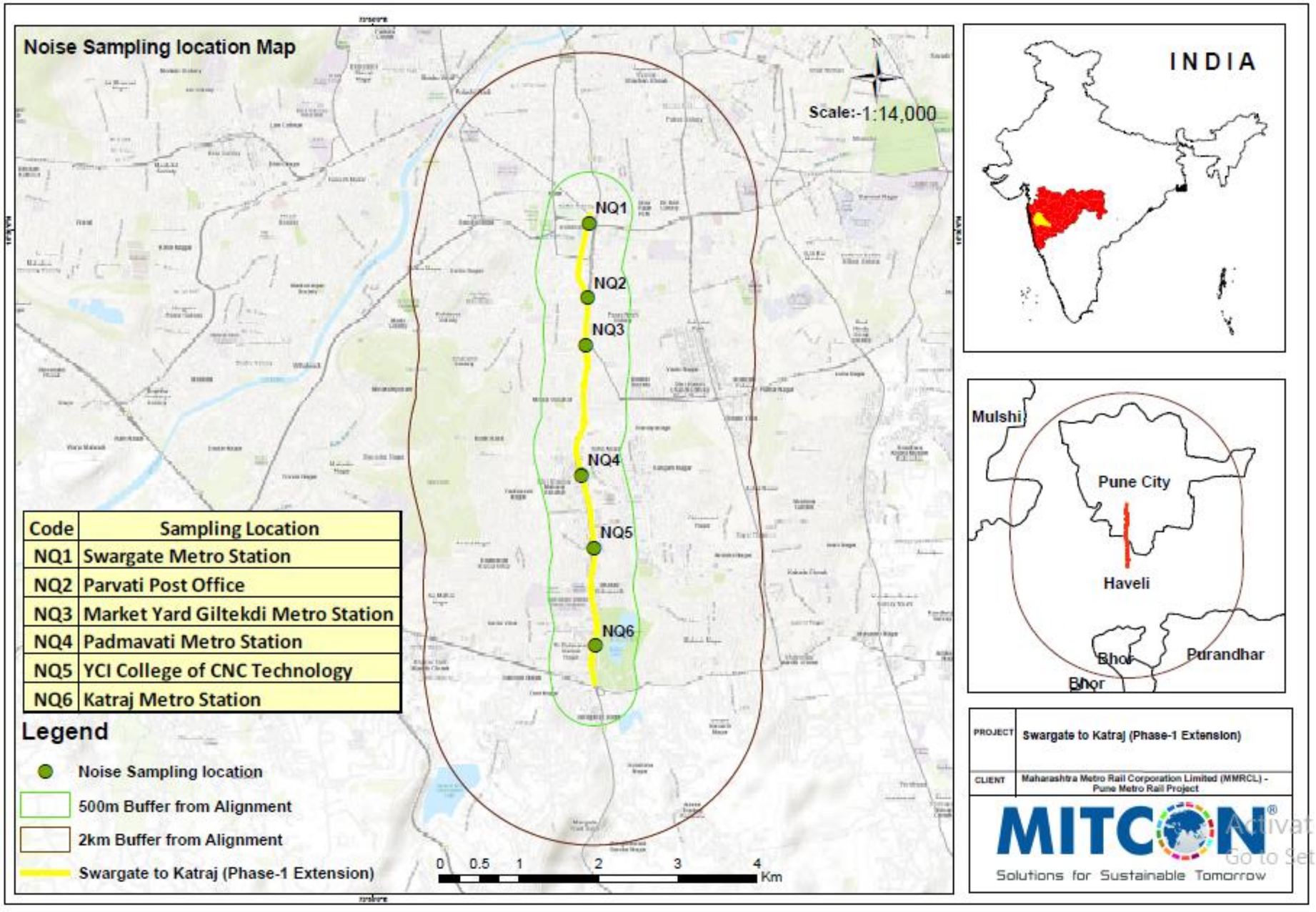
**(b) Sampling Period, Frequency and Parameters**

228. Ambient noise levels were monitored at 6 locations, identified during preliminary baseline survey within the study area, as shown in **Table 4-13**. Noise sampling locations is shown as **Figure 4-12**.

*Table 4-13 Noise Sampling Locations of Swargate to Katraj (Phase-1 Extension)*

| Sampling Code | Sampling Location | Significance / Zone | Latitude | Longitude |
|---|---|---|---|---|
| NQ1 | Swargate Metro Station | Proposed Station / Commercial | 18°30'2.68"N | 73°51'27.96"E |
| NQ2 | Parvati Post Office | Commercial | 18°29'32.32"N | 73°51'27.36"E |
| NQ3 | Market Yard Gultekdi Metro Station | Proposed Station / Commercial | 18°29'12.87"N | 73°51'26.61"E |
| NQ4 | Padmavati Metro Station | Proposed Station/ Commercial | 18°28'20.11"N | 73°51'24.83"E |
| NQ5 | YCI College of CNC Technology | College / Silent | 18°27'50.45"N | 73°51'29.95"E |
| NQ6 | Katraj Metro Station | Proposed Station / Commercial | 18°27'10.43"N | 73°51'30.59"E |

*Figure 4-12: Noise Monitoring Sampling Locations*



### (c) Noise Quality Sampling Results

229. Ambient Noise levels in the Project Study Area were measured by digital Noise meter. Summary of the results of Noise monitoring carried out in the Project Study area are given in **Table 4-14**. Details laboratory analyses report is attached as **Annexure-2**.

*Table 4-14 Summary of Noise Monitoring Results*

| Sample No. | Locations (Village) | Significance/ Category of Area / Zone | 24 hourly Average Noise Level Values [in $L_{eq}$ dB (A)] | |
|---|---|---|---|---|
| | | | Day | Night |
| NQ1 | Swargate Metro Station | Commercial | 64.2 | 53.7 |
| NQ2 | Parvati Post Office | Commercial | 46.8 | 42.1 |
| NQ3 | Market Yard Gultekdi Metro Station | Commercial | 64.7 | 54.2 |
| NQ4 | Padmavati Metro Station | Commercial | 63.5 | 54.3 |
| NQ5 | YCI College of CNC Technology | Silent | **52.7** | **45.2** |
| NQ6 | Katraj Metro Station | Commercial | 64.1 | 53.5 |

** values in **Bold** indicate exceedance of limits.*

### (d) Inferences

230. The Noise monitoring results most of the sampling locations are found to be within the prescribed standards (shown in ***Table 4-15***), except a one location and the exceedance is mainly due to nearby road traffic, honking, and peak-hour congestion. CPCB limits, which are more stringent for Commercial, Residential and Silence zones, while WBG-EHS limits for Industrial zones are used or comparing the baseline values.

*Table 4-15 Guidelines/Standards with respect to Noise*

| Area Code | Category | CPCB Limits[29] in dB(A) Leq | | WBG-EHS Limits[30] in LAeq dB | |
|---|---|---|---|---|---|
| | | Day Time* | Night Time* | Day Time## | Night Time## |
| A | Industrial Area | 75 | 70 | **70** | **70** |
| B | Commercial Area | **65** | **55** | 70 | 70 |
| C | Residential Area | **55** | **45** | 55 | 45 |
| D | Silence Zone** | **50** | **40** | - | - |

***Note:***

- ** **Day time** shall mean 6.00 a.m. to 10.00 p.m. and **Night time** shall mean from 10.00 p.m. to 6.00.a.m. as per The Noise Pollution (Regulation and Control) Rules, 2000 – CPCB guidelines. Day- and Night-times in the presented data are considered as per CPCB Guidelines*
- *## World Bank Group (WBG) EHS Guidelines - define day time as 7.00 a.m. to 10 p.m.*
- ***Silence zone is defined as an area comprising not less than 100 meters around hospitals, educational institutions, Courts of law and religious places or any others declared as such*
- *Mixed categories of areas may be declared as one of the four above-mentioned categories by the competent authority.*
- *dB(A) $L_{eq}$ denotes the time weighted average of the level of sound in decibels on scale A.*
- *Most stringent guidelines/limits are considered for*

## 4. Vibration Analysis

### (a) Methodology

231. Vibration consists of rapidly fluctuating motions of the particles without any net movement. 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. Vibration amplitudes are usually expressed as either Peak Particle Velocity (PPV) or the Root Mean Square (RMS) velocity. PPV is used to evaluate the potential for building damage, and is defined as the maximum instantaneous peak of the vibration

---

[29] *Source: CPCB guidelines for AAQM (National Ambient Air Quality Standards or NAAQS, 2009).*

[30] *Source: WBG (IFC) General EHS Guidelines: Environmental Noise Management (April 2007). [https://www.ifc.org/content/dam/ifc/doc/2000/2007-general-ehs-guidelines-noise-en.pdf]*

signal. PPV is not considered the appropriate measurement for evaluating the human response to vibration as it is typically used for construction noise monitoring. RMS is used to evaluate human response, since it takes some time for the human body to respond to vibration signals. The standard measurable units for velocity are in mm/s. Measuring the PPV is mostly used for representation of vibration when the pressure wave passes through the particles.

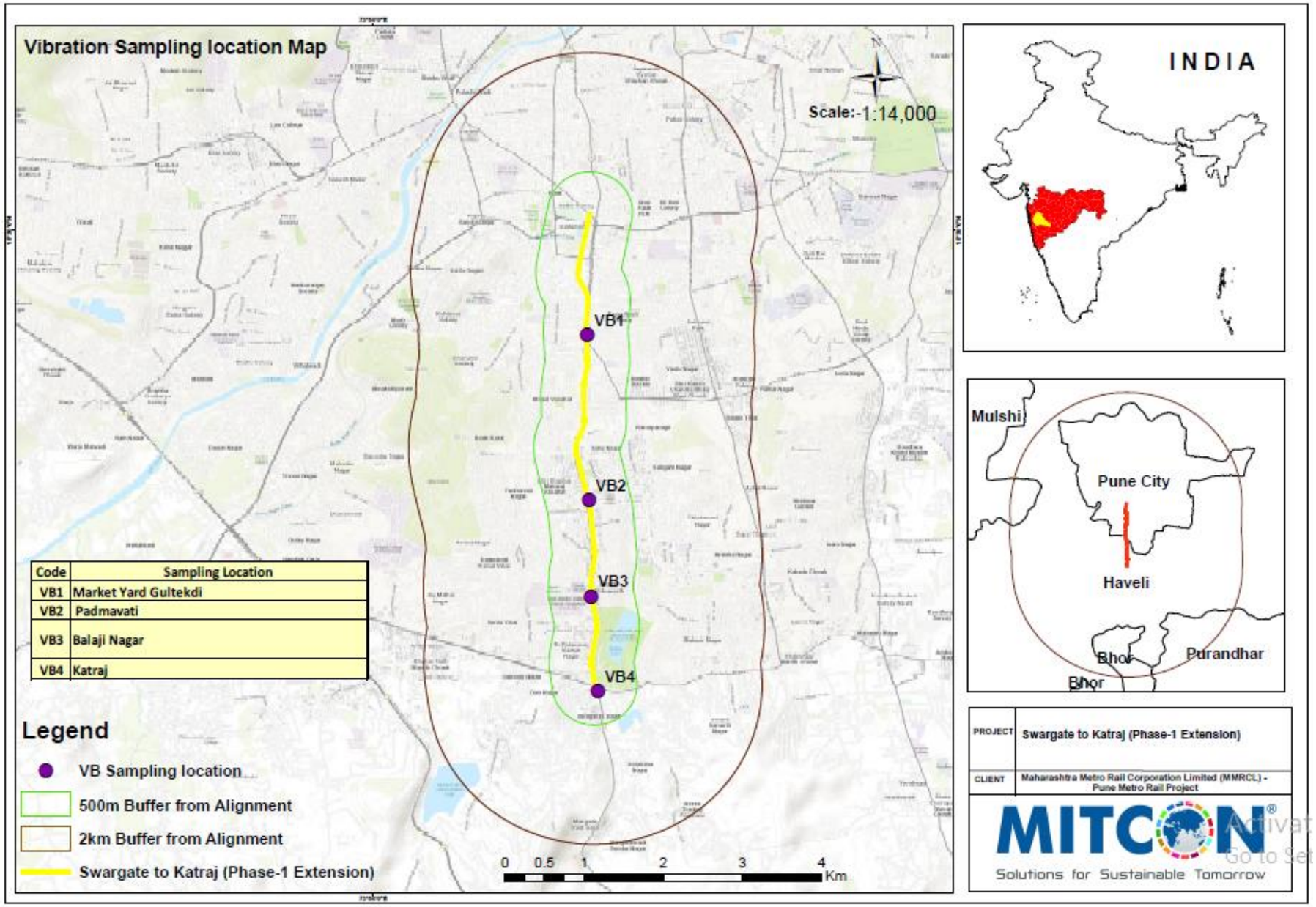
**(b) Sampling Period, Frequency, and Parameters**

232. The vibration measurement has been carried out at 4 locations (identified sensitive receptors) located near the alignments as shown in **Table 4-16.** Using portable Vibration Meter 2040. At each location vibration measurement was carried out for 15-20 minutes continuously during peak period of traffic. Measurement was taken in accordance with applicable standards IS11724 and international standards ISO 2372:1974, VDE 2056 of BS 4675 which specify the manner in which mechanical vibrations are to be measured. Five identified sensitive receptors on Swargate to Katraj, along with other locations are taken for Vibration monitoring, at Swargate to Katraj (Phase-1 Extension) is shown in **Figure 4-13**.

*Table 4-16 Vibration Sampling Locations of Swargate to Katraj (Phase-1 Extension)*

| Sampling Code | Sampling Location | Significance | Latitude | Longitude |
|---|---|---|---|---|
| VB1 | Market Yard Gultekdi | Metro Station | 18°29'16.95"N | 73°51'27.29"E |
| VB2 | Padmavati | Metro Station | 20°55'43.79"N | 73°51'27.96"E |
| VB3 | Balaji Nagar | Metro Station | 18°27'30.10"N | 73°51'28.82"E |
| VB4 | Katraj | Metro Station | 18°26'51.56"N | 73°51'31.59"E |

*Figure 4-13 Vibration Sampling Locations*



### (c) Vibration Sampling Results

233. The induced ground vibration levels measured are summarized in **Table 4-17**

*Table 4-17 Baseline Vibration levels at various locations*

| Sampling Code | Sampling Location | PPV (Maximum) in mm/s |
|---|---|---|
| VB1 | Market Yard Gultekdi | 0.4 |
| VB2 | Padmavati | 0.3 |
| VB3 | Balaji Nagar | 0.4 |
| VB4 | Katraj | 0.3 |

234. The observed levels at all 4 locations are well below the building vibration damage criteria for construction relevant to structures existing at those location (level of PPV 5 mm/sec has been mentioned in ESMP as the permissible upper level to be maintained by the contractor during construction, as per the guidelines of the Central Institute of Mining and Fuel Research (CMFRI or CMRI) w.r.t. Vibration as shown in **Table 4-18**. The measured levels are also below limits set by Directorate General of Mines Safety (DGMS), GoI as shown in **Table 4-19** (which are more relevant for blasting during construction). Other pertinent National and International standards, such as those by the Metro Rail Transit System Guidelines for Noise and Vibrations, (RDSO) India, September 2015 (**Figure 4-15**) based on the FTA Transit Noise and Vibration Impact Manual, September 2018 as given in **Figure 4-16**, the Caltrans Guidelines for Vibration Damage Potential Threshold Criteria given in the Transportation and Construction Vibration Guidance Manual, Caltrans, September 2013 and the Human Response to typical levels of Ground-Borne Vibration (GBV) given in the FTA Transit Noise and Vibration Impact Manual, September 2018, are also provided for reference.

*Table 4-18 CMFRI guidelines w.r.t. Vibration*[31]

| Type of structures | PPV (mm/s) | |
|---|---|---|
| | <24 Hz | >24 Hz |
| Domestic houses, dry-wall 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 : 70 mm/s | | |
| Hard rock conditions : 100 mm/s | | |

*Table 4-19 Directorate General of Mines Safety (DGMS) guidelines w.r.t. Vibration*[32]

| Type of structure | Vibration (mm/s) for dominant excitation frequency, Hz* | | |
|---|---|---|---|
| | < 8Hz | 8-25Hz | >25Hz |
| **(A) Buildings / structures not belonging to the owner** | | | |
| Domestic houses/structure (Kuchcha, bricks & cement) | 5 | 10 | 15 |
| Industrial Buildings (RCC & Framed structures) | 10 | 20 | 25 |
| Objects of historical importance & sensitive structures | 2 | 5 | 10 |
| **(B) Buildings belonging to the owner with limited span of life** | | | |
| Domestic house/structures (kuchcha, brick & cement) | 10 | 15 | 20 |
| Industrial buildings (RCC & framed structures) | 15 | 25 | 50 |

** PPV = 2πfA, in which f = frequency (Hz) and A = displacement (mm)*

[31] *Source: Central Institute of Mining and Fuel Research (CMFRI) guidelines w.r.t. Vibration (Dhar et al, 1993)*
[32] *Source: DGMS (Tech) (S&T) Circular No. 7 of 1997.*

*Figure 4-14: Guidelines for Noise and Vibrations, RDSO India, Sept 2015 for General Assessment*[33]

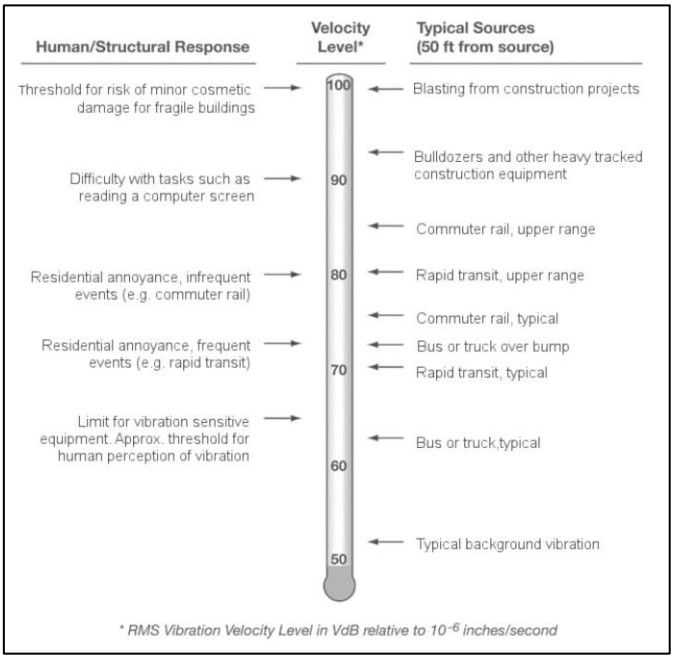
| Land use category | Ground-borne Vibration Impact Levels (VdB ref=25.4μ mm/s) | Ground-borne Noise Impact Levels ( dB ref 20 μ Pa) |
|---|---|---|
| **Category 1**: Buildings where vibration would interfere with interior operations | 65 VdB | N/A* |
| **Category 2**: Residences and buildings where people normally sleep | 72 VdB | 35 dBA |
| **Category 3**: Institutional land uses with primarily day time use | 75 VdB | 40 dBA |
| ibration sensitive equipment is not sensitive to ground-borne noise | | |

*Figure 4-15 Caltrans Guidelines for Vibration Damage Potential Threshold Criteria*[34]

| | Maximum PPV (in/sec) | |
|---|---|---|
| **Structure and Condition** | **Transient Sources** | **Continuous/Frequent Intermittent Sources** |
| Extremely fragile historic buildings, ruins, ancient monuments | 0.12 | 0.08 |
| Fragile buildings | 0.2 | 0.1 |
| Historic and some old buildings | 0.5 | 0.25 |
| Older residential structures | 0.5 | 0.3 |
| New residential structures | 1.0 | 0.5 |
| Modern industrial/commercial buildings | 2.0 | 0.5 |

Note: Transient sources create a single isolated vibration event, such as blasting or drop balls. Continuous/frequent intermittent sources include impact pile drivers, pogo-stick compactors, crack-and-seat equipment, vibratory pile drivers, and vibratory compaction equipment.

*Figure 4-16 Human Response to typical levels of Ground-Borne Vibration (GBV)*[35]




[33] *Source: Metro Rail Transit System Guidelines for Noise and Vibrations, RDSO India, Sept 2015.*
[34] *Source: Transportation and Construction Vibration Guidance Manual, Caltrans, Sept 2013.*
[35] *Source: FTA Transit Noise and Vibration Impact Manual, September 2018.*

*Figure 4-17 Ground-Borne Vibration (GBV) and Ground-Borne Noise (GBN) Impact Criteria for General Assessment*[36]

| 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:**
1. "Frequent Events" is defined as more than 70 vibration events of the same source per day. Most rapid transit projects fall into this category.
2. "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.
3. "Infrequent Events" is defined as fewer than 30 vibration events of the same kind per day. This category includes most commuter rail branch lines.
4. 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.
5. Vibration-sensitive equipment is generally not sensitive to ground-borne noise.

## F. WATER ENVIRONMENT

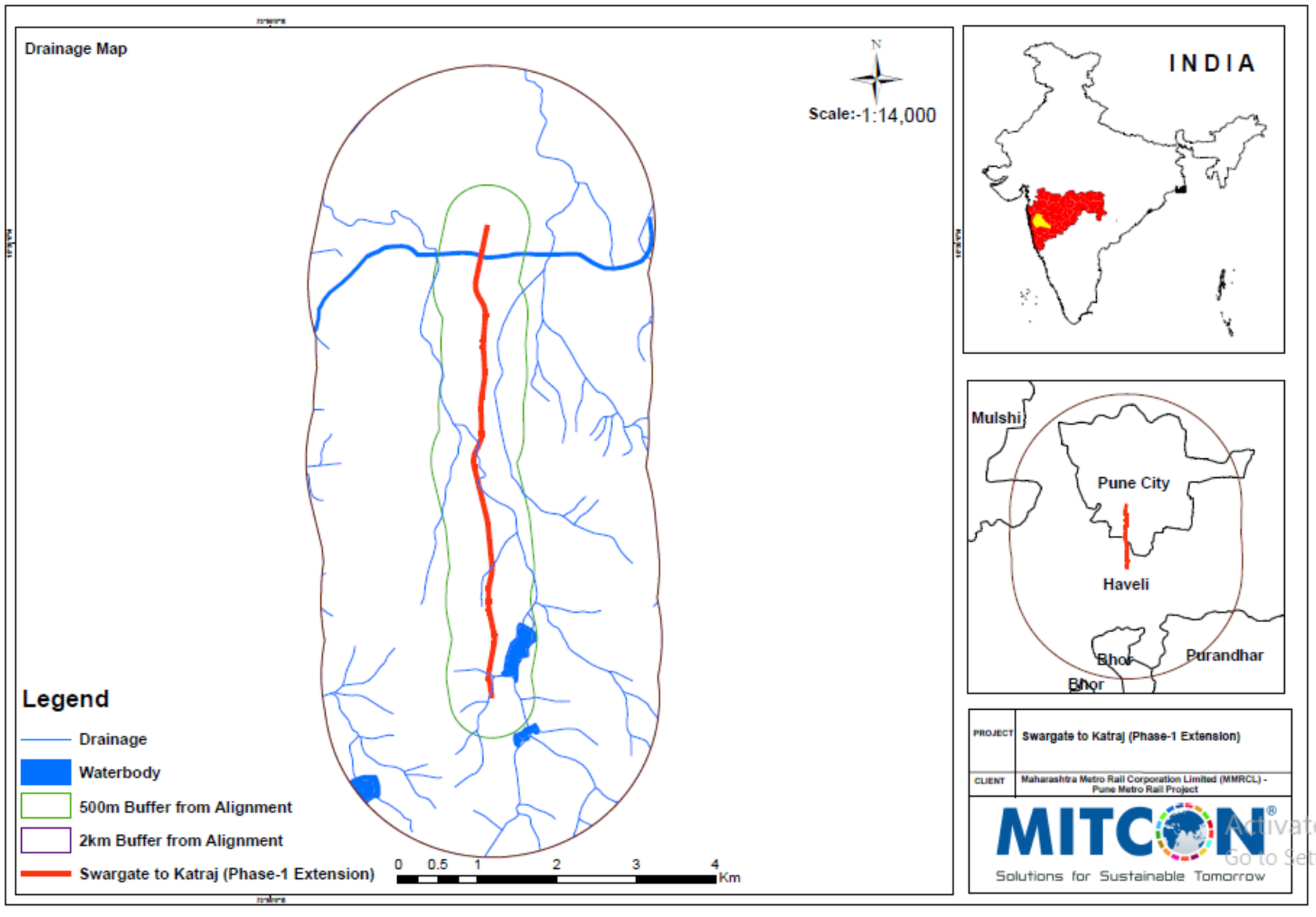
### 1. Hydrology / Drainage

235. Pune district's hydrology is primarily influenced by the Krishna and Bhima river basins, which play a crucial role in its water management and agricultural activities. These basins are equipped with numerous dams and an extensive network of canals that facilitate irrigation and manage water supply across the region. The monsoonal rainfall significantly impacts the flow in these rivers, making flood control an essential aspect of the district's hydrological management. To address these challenges, Pune has implemented various flood control measures, including regulated dam discharges and flood line markings, to manage the water flow during peak rainfall periods and minimize flood risks. The Maharashtra Water Resources Department provides detailed and real-time updates on dam storage, rainfall, and flood control strategies, ensuring effective water management in the district

236. The Swargate-Katraj alignment crossing Mula-Mutha Right Bank Canal near Swargate and *streams / nallahs* (Ambhil Odha) at Sangam hall near Padmavati. Most of the water bodies along or near the alignment, however, especially those in urban or residential areas, are found to be polluted at different levels because of anthropogenic activities.

[36] *Source: Transit Noise and Vibration Impact Assessment, US FTA, May 2006 and Transit Noise and Vibration Impact Assessment Manual, Federal Transit Administration, September 2018*

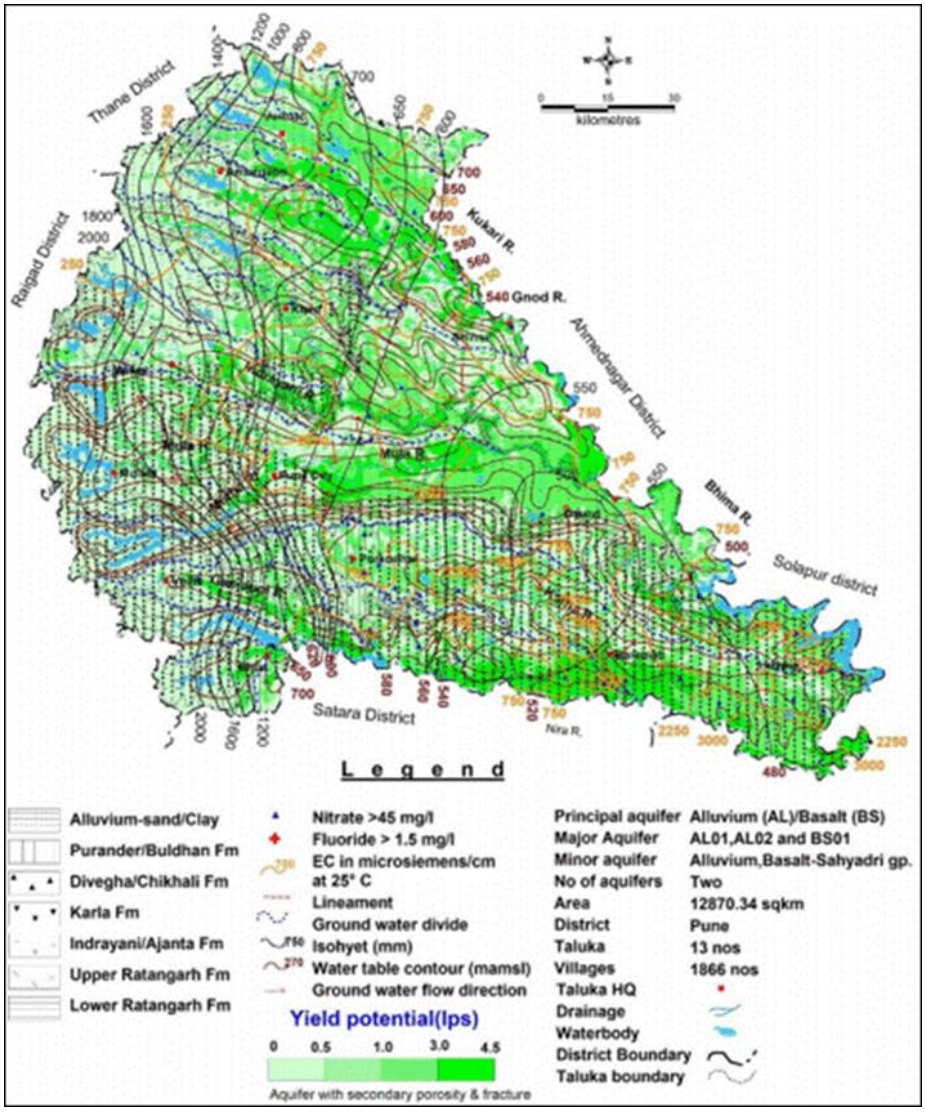
*Figure 4-18: Drainage Pattern in 2km study area of Swargate to Katraj (Phase-1 Extension)*



## 2. Hydrogeology and Groundwater[37]

237. Alluvium and Basalt aquifers are the main aquifers in the district. Two aquifer Systems in Basalt and one shallow aquifer in Alluvium (limed to river banks) are found to be prevailing in the district. Deccan Trap Basalt of upper Cretaceous to lower Eocene age is the major rock formation in the district, whereas only a very narrow belt confined to the banks of rivers is underlain by Recent Alluvium. A map depicting hydrogeological features of Pune district. In Alluvial deposits, inter pore spaces constitutes the potential water bearing zones and prevalence of sand and gravels renders them a high degree of porosity and permeability and make them a potential ground water reservoir. However, alluvium occurrence is restricted to narrow belts along the banks of major river courses and has limited depth. The older Alluvium, which is more clayey with thin horizons of sand and silt, forms a comparatively lesser potential aquifer. Ground water in Alluvium occurs mostly under water table and also under semi-confined to confined conditions in certain places. Shallow Aquifer occurs from 2 to 32 m BGL depth with shallow water levels. The yield varies from 50-300 $m^3$/day.

*Figure 4-19 Hydrology of Pune district*




### (a) Groundwater bearing Formations

238. **Deccan Trap Basalts:** Almost the entire district is underlain by Deccan Volcanic Basalts

[37] *Source: CGWB Groundwater Information Booklet for Pune District*

belonging to Sahyadri Group of Upper Cretaceous to Eocene age, comprises of various lava flows, which can be classified in the field into two types as simple and compound flows. The compound flows occur at lower elevations whereas the simple flows are confined to the elevation above 680 m. The compound flows although vesicular and amygdaloidal in nature, hard and compact in their middle sections. They are fractured and jointed, and show moderate degree of weathering at places. Each individual lava flow consists of lower massive part becoming vesicular /amygdaloidal towards top, ranges in their individual thickness from a few centimetres to tens of meters. The flows have wide variation in colour and texture especially when they are amygdaloidal in nature with secondary mineral infillings such as Zeolites, calcite, and Agate and Chalcedony etc. The red /green/black bole beds constituting the marker horizons separating the two flows were discontinuous and generally inconsistent. The basalts are intruded by dykes and are found commonly in pahoehoe flows in the area. The dykes vary in thickness from one or two meters to as much as 10 meters and extend for long distances. The dykes display the joints parallel to the walls, at right angle to the walls besides horizontal ones, with chilled margins. The dykes act as barrier or as water conduits / pathways for the movement of groundwater flow depending on intensity of fracturing in the dyke rock. The location and orientation of the dykes with respect to the groundwater flow are very important.

239. **Alluvium:** belonging to the Quaternary period forms a very productive aquifer in the district. The alluvial deposits are restricted as narrow belts along the banks of major river courses like Bhima and their tributaries. The alluvium occurs in patches in paleo-depressions. These shallow alluvium deposits comprise of loose or semi-consolidated medium to coarse grained sands, gravels, fine silt with admixture of clays resting directly on the massive, weathered or amygdaloidal zones of the basaltic lava flows.

**(b) Water Level Scenario**

240. In Pune District, the water table varies from 480 m amsl in south-eastern part of the area to about 700 m amsl in Northwest of study area, near river Bhima. The overall ground water movement in the area is from west to southeast and tends to flow towards surface drainages. It has been observed that the ground water flow direction follows the drainage and topography of the area. This indicates the topographic control for the ground water movement. The water level scenario in the district is shown below:

| | |
|---|---|
| Pre-monsoon Depth to Water Level (May-2017) | : 0.90 to 30.35 m BGL |
| Post-monsoon Depth to Water Level (Nov.-2017) | : Ground level to 25.20 m BGL |
| Pre-monsoon Water Level Trend (2008-2017) | : Rise: 0.0001 to 0.750 m/year |
| | : Fall: 0.0116 to 0.42 m/year |
| Post-monsoon Water Level Trend (2008-2017) | : Rise: 0.0012 to 1.588 m/year |
| | : Fall: 0.0028 to 0.6992 m/year |

**(c) Major Ground Water Problems and Issues:**

241. About 50 % area of Pune district falls under the ‘Rain Shadow’ zone. Long-term rainfall data analyses reveal that the eastern-, southern-, south-eastern, central- and north-central parts of the district around Indapur, Baramati, Jejuri, Daund, Talegaon Dhamdhare, Alandi, Shirur and Bhor talukas, covering about 50% geographical area, experiences drought conditions. Therefore, these areas are classified as ‘Drought Prone Areas’. Decadal pre-monsoon water level trend (2008-17) reveals that by and large, during pre-monsoon periods, 65 % of the area and during post monsoon periods, about 68 % of the area shows fall in water levels. Falling trend of water level is observed in major parts of Pune City, Haveli, Khed, Junnar, Daund, Indapur, Baramati, Purandhar, Bhor, Velhe, Mulsi and Maval Talukas of the district.

**(d) Groundwater Prospects & Block Categorisation:**

242. The prominent hill ranges, isolated hillocks, undulation etc. give rise to higher run off conditions in the district. The predominance of hard rock formation in the form of basaltic lava flows facilitates the run off rather than natural recharge due to the poor ground water storage and transmission capabilities. As such ground water development in the region is low to moderate. Most of the dug wells become dry during peak summer. The bore wells range in depth from 45 to 90 m BGL and have been drilled in most of the villages in the district.

## 3. Water Quality Analyses

### (a) Monitoring Stations for Water Quality Assessment

243. Water quality sampling was carried out in the month of **July 2024**. During the study period, few surface water bodies were found within the project study area i.e. in 2 km radius of the alignment.

244. The details of sampling locations for Surface water and Groundwater samples are shown in **Table 4-20** and **Table 4-21**, respectively. Sampling locations for Surface and Groundwater samples for Swargate to Katraj (Phase-1 Extension) are depicted in **Figure 4-20**, **Figure 4-21**, respectively.

*Table 4-20 Monitoring Stations for Surface Water Quality Assessment*

| Sampling Code | Sampling Location / Type | Latitude | Longitude |
|---|---|---|---|
| SW1 | Mutha Canal Swargate | 18°39'23.19"N | 73°46'14.59"E |
| SW2 | Ambil Odha D/S | 18°29'9.63"N | 73°51'10.15"E |
| SW3 | Ambil Odha U/S near Padmavati Metro Station | 18°28'19.75"N | 73°51'26.11"E |
| SW4 | Katraj Lake (NW side) | 18°26'40.93"N | 73°51'41.61"E |

*Table 4-21 Monitoring Stations for Ground Water Quality Assessment*

| Sampling Code | Sampling Location | Abstraction Structure |
|---|---|---|
| GW 1 | Swargate Metro Station | Hand-pump |
| GW 2 | Market Yard Gultekdi Metro Station | Hand-pump |
| GW3 | Padmavati Metro Station | Bore-well |
| GW4 | Katraj Metro Station | Bore-well |

*Figure 4-20 Surface Water monitoring locations*

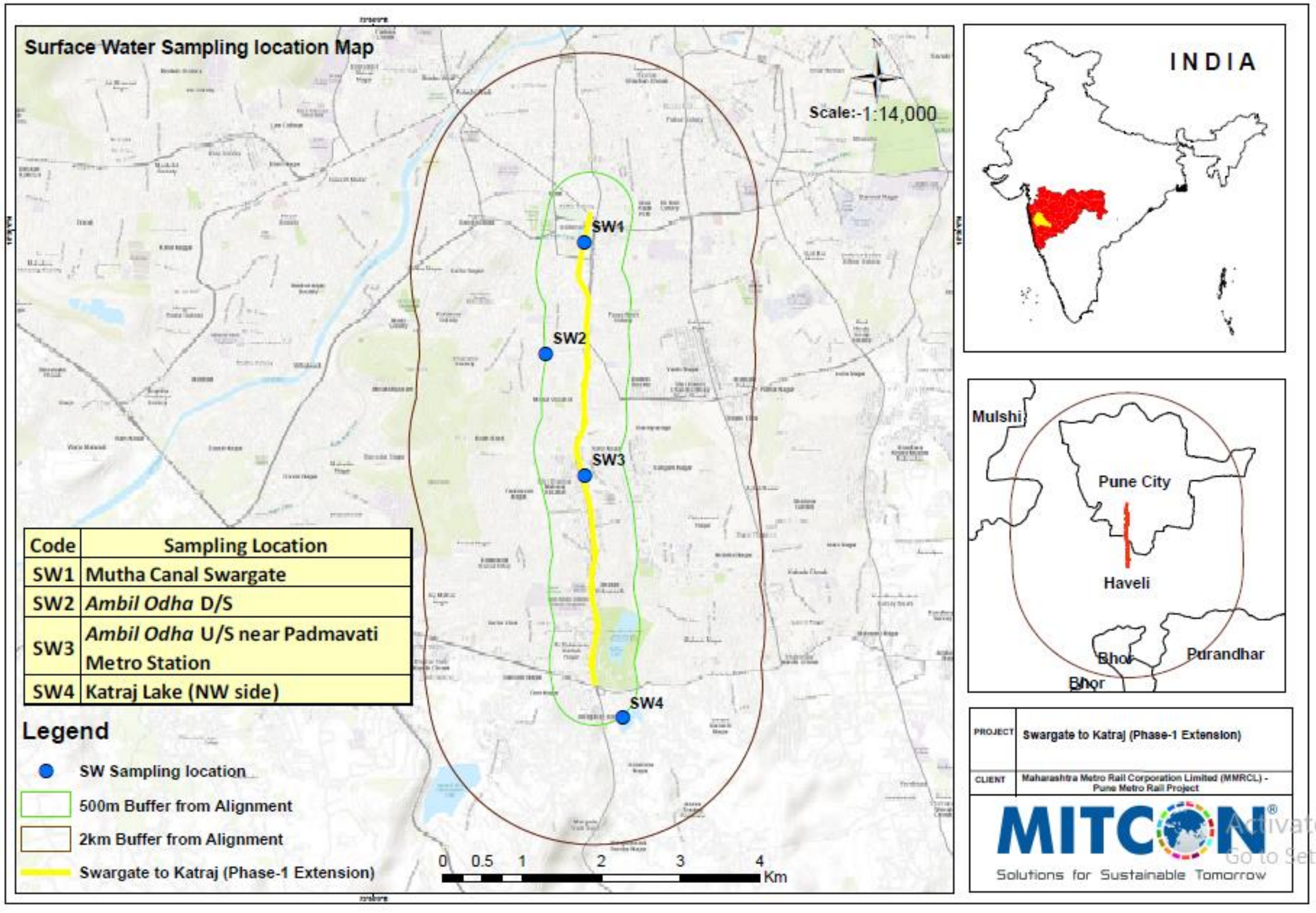
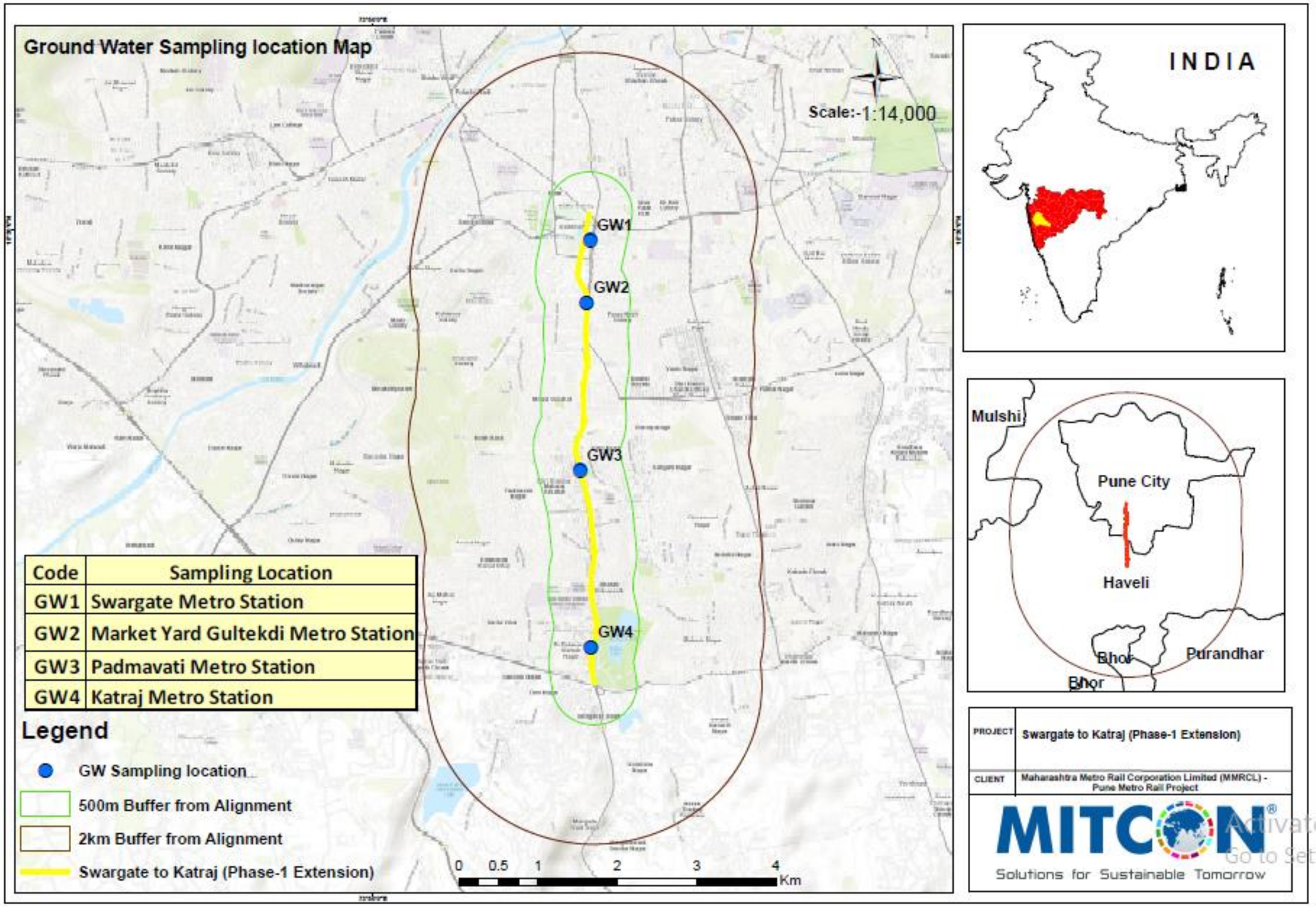


*Figure 4-21 Groundwater monitoring locations*



245. Some photographs taken during surface and groundwater quality, in the study area are presented in **Figure 4-22** and **Figure 4-23** respectively.

*Figure 4-22 Some Photographs Showing Surface Water Quality Monitoring*

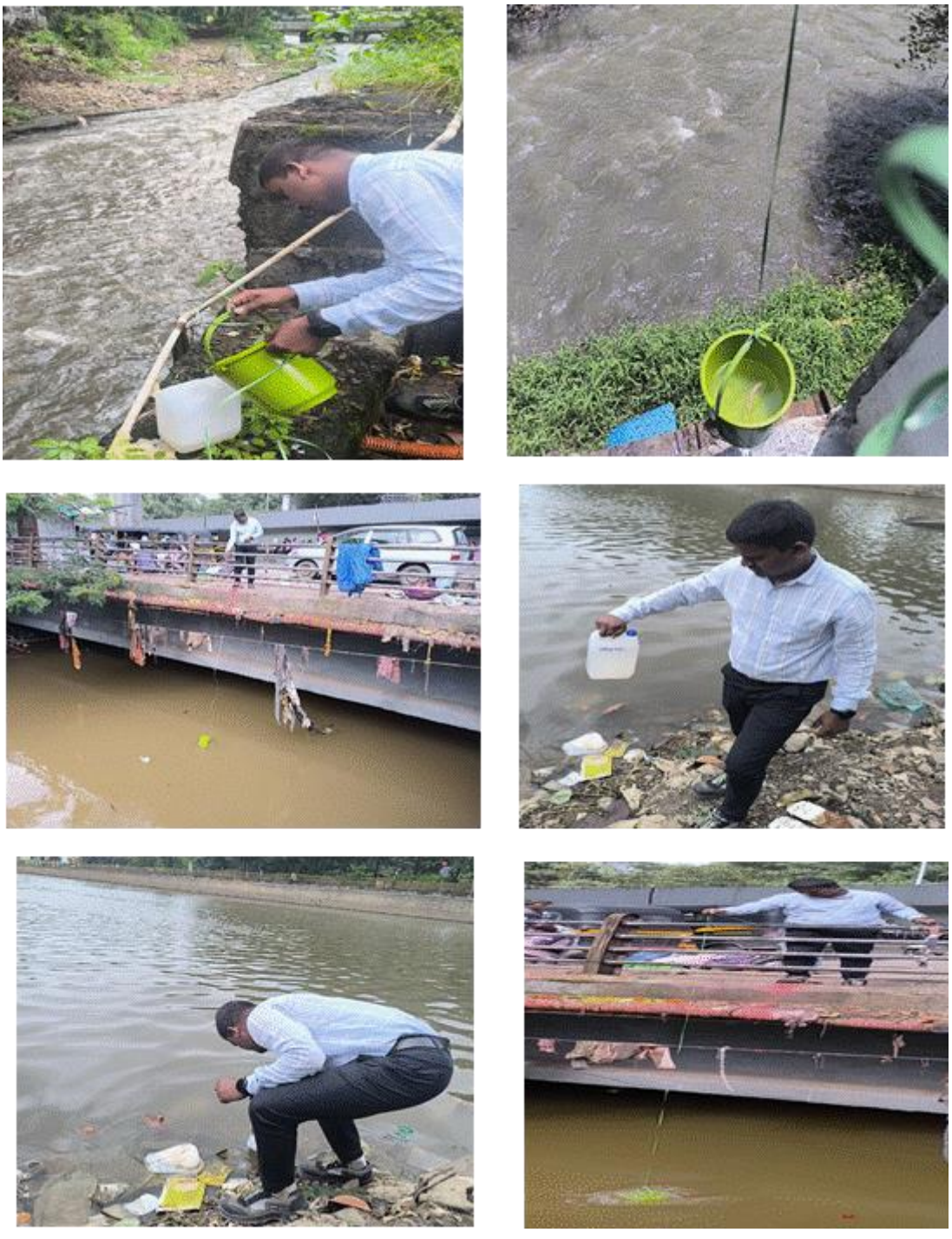
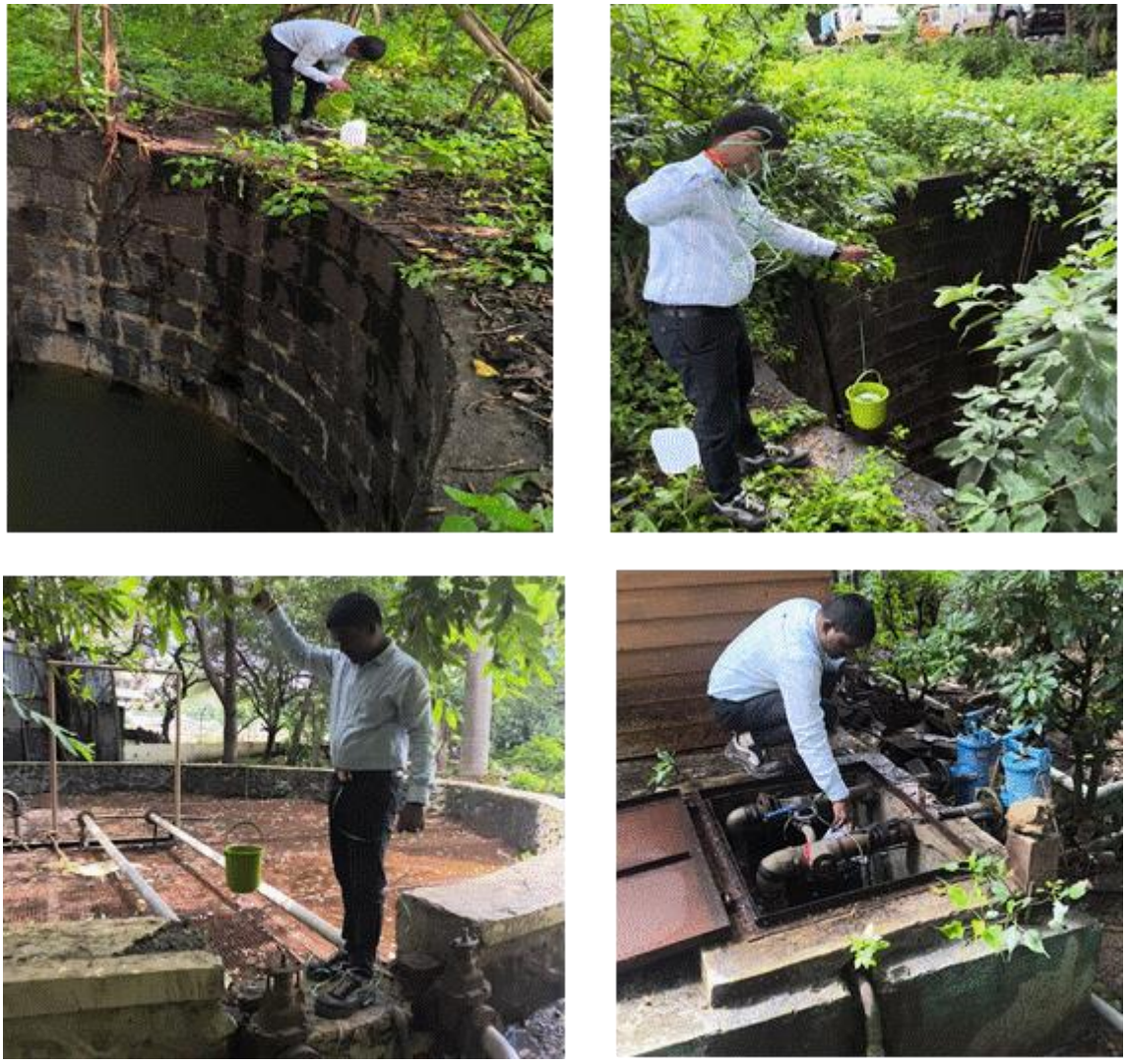


*Figure 4-23 Some Photographs Showing Groundwater Quality Monitoring*



### (b) Water Quality Analyses Results

246. Summary of the results of important Surface Water quality & Groundwater quality parameters are given in **Table 4-22** and **Table 4-23** respectively. Detailed results of all parameters analysed are given in **Annexure-3**.

*Table 4-22 Summary of Surface Water Quality Analysis*

| Sample Code | Potability | Chemical | | | | | | | | | | Bacteriological | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Parameter** | pH at 25 °C | Electrical Conductivity at 25 °C | Total Dissolved Solids | Total Solids | Total Hardness as $CaCO_3$ | Chloride as $Cl^-$ | Fluoride as F | BOD | COD | Dissolved Oxygen | Total Coliforms | E-coli |
| | **Units** | - | µS/cm | mg/l | mg/l | mg/l | mg/l | mg/l | mg/l | mg/l | mg/l | Per 100 ml | Per 100 ml |
| | | | | | | | | | | | | | |
| SW1 | Mutha Canal Swargate | 7.19 | 318.6 | 185 | 201 | 92.16 | 13.02 | <0.1 | 11 | 33 | 3.9 | Present | Present |
| SW2 | Ambil Odha D/S | 7.18 | 313.7 | 224 | 235 | 116.445 | 16.25 | <0.1 | 13 | 40 | 3.2 | Present | Present |
| SW3 | Ambil Odha U/S near Padmavati Metro Station | 7.32 | 345.5 | 185 | 193 | 95.78 | 14.56 | <0.1 | 10 | 32 | 4 | Present | Present |
| SW4 | Katraj Lake (NW side) | 7.25 | 313.7 | 207 | 213 | 103.28 | 23.25 | <0.1 | 4 | 14 | 5.1 | Present | Present |

| **Designated Best Use Water Quality Criteria:** | | |
|---|---|---|
| Drinking water source without conventional treatment but after disinfection | A | Total coliforms less than 50 MPN/100ml; pH between 6.5 and 8.5; DO 6 mg/ or more; BOD 2 mg/l or less |
| Outdoor bathing (organised) | B | Total coliforms less than 500 MPN/100ml; pH between 6.5 and 8.5; DO 5 mg/ or more; BOD 3 mg/l or less |
| Drinking water source after conventional treatment and disinfection | C | Total coliforms less than 5000 MPN/100ml; pH between 6 and 9; DO 4 mg/ or more; BOD 3 mg/l or less |
| Propagation of wildlife and fisheries | D | pH between 6.5 and 8.5; DO 4 mg/l or more; Free ammonia (as N) 1.2 mg/l or less |
| Irrigation, industrial cooling, controlled waste disposal | E | pH between 6 and 8.5; EC max. 2250 µS/cm; Sodium absorption ratio max. 26; Boron max. 2 mg/l |

*Table 4-23 Summary of Groundwater Quality Analysis*

| Sample Code | Potability | Chemical | | | | | | | Bacteriological | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **Parameter** | pH at 25 °C | Electrical Conductivity at 25 °C | Total Dissolved Solids | Total suspended Solids | Total Hardness as $CaCO_3$ | Chloride as $Cl^-$ | Fluoride as F | Total Coliforms | E-coli |
| | **Units** | - | µS/cm | mg/l | mg/l | mg/l | mg/l | mg/l | Per 100 ml | Per 100 ml |
| | **IS:10500:2012 Required Standards** | 6.50 to 8.50 | N.S. | ≤ 500 | N.S | ≤ 200 | ≤ 250 | ≤ 1.0 | Absent | Absent |
| GW 1 | **Swargate metro station** | 7.25 | 400.8 | 267 | <5 | 128.54 | 40.1 | <0.1 | Absent | Absent |
| GW 2 | **Market yard gultekdi metro station** | 7.19 | 389.6 | 174 | <5 | 137.15 | 42.16 | <0.1 | Absent | Absent |
| GW3 | **Padmavati Metro station** | 7.39 | 389.6 | 174 | <5 | 97.16 | 38.7 | <0.1 | Absent | Absent |
| GW4 | **Katraj metro station** | 7.27 | 271.5 | 142 | <5 | 82.52 | 39.15 | <0.1 | Absent | Absent |

### (c) Water Quality Inferences

247. For any water body to function adequately in satisfying the desired use, it must have corresponding degree of purity. Drinking water should be of highest purity. Each water use has specific quality need. Therefore, to set the standard for the desire quality of a water body, it is essential to identify the uses of water in that water body. In India, the CPCB has developed a concept of designated best use. According to this, out of the several uses of water of a particular body, the use which demands highest quality is termed its designated best use.

i. The pH values, ranging from 7.18 to 7.32, were within acceptable limits, but the Biochemical Oxygen Demand (BOD) levels exceeded the criteria for Class A water (drinking water) at all locations. This suggests the presence of organic pollution, which could be due to untreated wastewater or agricultural runoff. The Chemical Oxygen Demand (COD) and Dissolved Oxygen (DO) levels varied, with DO levels as low as 3.2 mg/l, which is below the threshold required for outdoor bathing (Class B), indicating potential oxygen depletion due to pollution. The bacteriological analysis revealed the presence of Total Coliforms and E. coli in all surface water samples, pointing to fecal contamination, which makes this water unsuitable for drinking or recreational purposes without extensive treatment

ii. For groundwater, the pH levels across various stations ranged from 7.19 to 7.39, indicating that the water is slightly alkaline, which is within the acceptable range of 6.5 to 8.5 as per IS:10500:2012 standards. The Total Dissolved Solids (TDS) concentrations varied between 142 mg/l and 267 mg/l, remaining well below the permissible limit of 500 mg/l. This suggests that the groundwater is of good quality and safe for consumption. Additionally, parameters like Total Hardness, Chloride, and Fluoride were also within acceptable standards, showing no significant chemical contaminants. Bacteriological analysis confirmed the absence of Total Coliforms and E. coli in all samples, indicating the water is microbiologically safe and free from harmful pathogens.

## G. ECOLOGY AND BIODIVERSITY

### 1. Introduction and Study Area

248. An ecological study is essential to understand the impact due to project development activities on flora and fauna of the area. The proposed project alignment does not pass through any reserve / protected forest in its entire stretch. Moreover, no protected areas / environmentally sensitive areas are found in the Indirect or Secondary Influence zone (10 km radial distance around both the alignment). Following was carried out as part of the detailed ecology and biodiversity study for proposed project. .

(i) **Vegetation Study.**
  (a) Listing of floral diversity
  (b) Listing of affected trees

(ii) **Faunal Study.** 10 km from alignment as per guidelines of MoEF&CC.

(iii) **Habitat Analysis Study.** 2 km buffer study area around each of the four alignments

### 2. Period of Studies

249. Ecology and Biodiversity studies were carried out in July 2024. The avian studies were conducted during the dawn and dusk period, the nocturnal studies during the night and the mammalian & butterfly studies were conducted during various period of the day. The below ***Table 4-24*** gives the summary of the period of study for all the ecological studies carried out.

*Table 4-24 Summary of the Ecological Studies Carried Out*

| Sl. No. | Type of Study / Faunal Class | Particulars | Methods | Sampling |
|---|---|---|---|---|
| 1 | Floral | | Listing | July & August 2024 |
| 2 | Mammals | Terrestrial | Listing and Encounter Survey | |
| 3 | Birds | Terrestrial and Aquatic | Listing & Visual Encounter Survey | |
| 4 | Reptiles | Terrestrial and Aquatic | Listing & Visual Encounter Survey | |

| Sl. No. | Type of Study / Faunal Class | Particulars | Methods | Sampling |
|---|---|---|---|---|
| 5 | Amphibians | - | Listing & Visual Encounter Survey | |
| 6 | Insects | Butterfly, Moth and Spiders, Dragonfly | Listing | |
| 7 | Fishes | - | Listing, Secondary data | |

### 3. Approach & Methodologies of the Studies

#### (a) Approach to the Study

250. Data collection on the status of flora and fauna in the project study area are mandatory and a primary requirement of ESIA studies. EB study was carried as per guidelines of MoEF&CC, CPCB, World Bank and suggestion given by ADB team. Type, location and characteristics of sensitive flora and fauna were studied. Studies on both terrestrial and aquatic ecology was carried out as described in this section.

#### (b) Methodology for Floral Studies

(i) Affected tree species were identified due to proposed alignment with GBH & GPS locations

(ii) Individual species were identified including trees, shrubs, herbs & climbers by observing the species randomly from the study area (i.e., 500 m radius form the alignments).

#### (c) Methodology for Aquatic Ecology Study

251. **Aquatic Flora.** Listing of aquatic floral diversity has been carried at various locations by random Sampling Method.

252. **Aquatic Fauna (Fish Survey).** Listing of fish diversity through market survey and consultations with fishermen has been carried out. Local fishermen were visited and discussion regarding the presence of fishes in the local ponds/Nallahs/streams/river was done. Also, discussion was carried out with the fish vendors regarding species found in the local ponds. Photographs of local fish varieties were taken.

#### (d) Methodology for Terrestrial Faunal Studies

253. Information has been gathered through the following sources:

(i) Desktop Study
   a. Scientific Literature search for biodiversity & ecological studies in the project region, on websites;

(ii) Field Study
   a. In absence of detailed secondary data availability within the project direct influence area, Primary Ecological & biodiversity surveys / studies have been conducted to collect up-to-date baseline data.

(iii) Discussions and meetings with following stakeholders
   a. Local Community
   b. Fishermen

#### (e) Methodology for Faunal Field Studies

254. For carrying out faunal surveys, sites were chosen based on the available access and to cover entire 10 km radius around proposed alignments.

255. Visual Encounter Survey Method: The survey to understand the presence of fauna like Mammals / Birds / Reptiles / Amphibians / Butterflies / Insects in the project area has been carried out using Visual Encounter Survey Method at various locations around the proposed alignments.

#### (f) Gardens in the Pune City

256. The nearest gardens from the proposed alignments have been identified. List of gardens in the

study area is also enumerated in **Table 4-36.**

### 4. Floral Studies

257. Summary of the Floral Diversity found in the Project study area is given as follows:

| | | |
|---|---|---|
| 1 | Floral Diversity | • Total 175 number of Trees likely to be affected during construction of the Project<br>• 310 species (211 trees, 32 Herbs, 27 Shrubs, 40 climbers) found in the Project study area |

#### (a) Trees likely to be affected

About 175 trees are likely to be affected during site construction activities along the Swargate to Katraj (Phase-1 Extension). Most of the trees exist along the LHS, RHS and Rajiv Gandhi Zoological Park and Wildlife Research Centre, Katraj. Around 30 of these are found near the start of the alignment near the existing Swargate metro station, where a vertical shaft will be constructed to access the underground alignment. Girth-wise summary of all trees likely to be affected along the entire project alignment is presented as **Table 4-25**, while a detailed list of all affected trees along with GBH, GPS location and photographs is attached as **Annexure-6.**

*Table 4-25 Girth-wise Summary of Trees to be Affected along Swargate-Katraj (PMRP Phase 1 extension)*

| Side of Alignment | Girth size (in cm) | | | | | | Total |
|---|---|---|---|---|---|---|---|
| | 0 – 30 | 31 – 60 | 61 – 90 | 91 – 120 | 121 – 150 | > 150 | |
| **LHS** | 6 | 14 | 19 | 12 | 6 | 23 | **80** |
| **RHS** | 4 | 19 | 20 | 7 | 4 | 14 | **68** |
| **Median** | 8 | 10 | 6 | 0 | 0 | 3 | **27** |
| **Total** | 21 | 68 | 83 | 51 | 17 | 29 | **175** |

*Figure 4-24 Tree Surveys undertaken in Project Study Area*

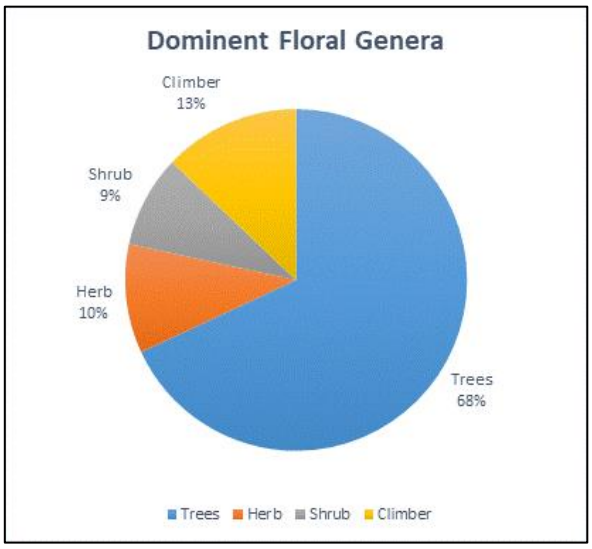





**(b) Floral Diversity**

258. Primary data were generated by preparing a general checklist of the trees around 10 km around the proposed alignment. The study recorded overall 310 species which included 211 species of Trees, 32 species of Herbs, 27 species of Shrubs and 40 species of Climbers. Dominant genera (type of flora) found in the study area is presented graphically as **Figure 4-25**.

*Figure 4-25: Dominant genera (type of flora) found in the Project Study Area*




259. As per IUCN classification, among the flora found in the project study area, two species namely *Aegle marmelos* and *Dalbergia melanoxylon* are categorised as Near Threatened (NT), three species

namely *Khaya senegalensis*, *Santalum album*, & *Saraca asoca* as Vulnerable (VU), and two species *Tectona grandis* (Linn. f.), *Ailanthus altissima* fall under Endangered (EN) category. The List of Floral Diversity in the study area is presented in **Table 4-26**.

*Table 4-26: Floral Diversity observed in the Project Study Area*

| Sr.No. | Scientific Name | Common Name | Habit |
|---|---|---|---|
| **Tree** | | | |
| 1 | *Adansonia digitata* L. | African baobab | Tree |
| 2 | *Adenanthera pavonina* L. | Coral Bean Tree | Tree |
| 3 | *Aegle marmelos* (L.) Correa. | Indian Bael | Tree |
| 4 | *Ailanthus excelsa* Roxb. | Maharuk | Tree |
| 5 | *Alangium salvifolium* (L.f.) Wangerin | Sage Leaved Alangium | Tree |
| 6 | *Albizia lebbeck* (L.) Benth. | Indian Siris | Tree |
| 7 | *Albizia procera* (Roxb.) Benth. | White Siris | Tree |
| 8 | *Alstonia macrophylla* Wall.ex G. Don | Mothi Saatveen | Tree |
| 9 | *Alstonia scholaris* (L.) R.Br. | Blackboard tree | Tree |
| 10 | *Annona muricata* L. | Soursop | Tree |
| 11 | *Annona reticulata* L. | Netted Custard Apple | Tree |
| 12 | *Annona squamosa* L. | Custard Apple | Tree |
| 13 | *Antiaris toxicaria* (J.F. Gmel.) Lesch. | Upas Tree | Tree |
| 14 | *Aphanamixis polystachya (Wall.) R. Parker* | Rohituka tree | Tree |
| 15 | *Aquilaria malaccensis* Lam. | Agarwood | Tree |
| 16 | *Areca catechu* L. | Areca Palm | Tree |
| 17 | *Artocarpus altilis* (Parkinson) Fosberg | Breadfruit | Tree |
| 18 | *Artocarpus heterophyllus* Lam. | Jackfruit | Tree |
| 19 | *Averrhoa carambola* L. | Star Fruit | Tree |
| 20 | *Azadirachta indica* A. Juss. | Neem Tree | Tree |
| 21 | *Barringtonia acutangular* (L.) Gaertn. | Indian Oak | Tree |
| 22 | *Bauhinia racemosa* Lam. | Bidi leaf tree | Tree |
| 23 | *Bauhinia variegata* L. | Orchid Tree | Tree |
| 24 | *Bergera koenigii* L | Curry Tree | Tree |
| 25 | *Bixa orellana* L. | Annatto | Tree |
| 26 | *Bombax ceiba* L. | Silk Cotton Tree | Tree |
| 27 | *Boswellia serrata* Roxb. | Indian frankincense | Tree |
| 28 | *Bursera penicillata* (Sesse & Moc. ex DC.) Engl. | Torote copal | Tree |
| 29 | *Butea monosperma* (Lam.) Kuntze | Palas | Tree |
| 30 | *Callicarpa candicans* (Burm.f.) Hochr. | Beautyberry Tree. | Tree |
| 31 | *Calophyllum apetalum* Willd. | Konkan Beauty Leaf Tree | Tree |
| 32 | *Calophyllum inophyllum* L. | Ball tree | Tree |
| 33 | *Camphora officinarum* Nees. | Camphor tree | Tree |
| 34 | *Canarium strictum* Roxb. | Black dammar | Tree |
| 35 | *Capparis grandis L. f.* | Tree Caper | Tree |
| 36 | *Careya arborea Roxb.* | Wild Guava | Tree |
| 37 | *Carica papaya L.* | Papaya | Tree |
| 38 | *Caryota urens L.* | Fishtail Palm | Tree |
| 39 | *Cassia fistula L.* | Golden Shower tree | Tree |
| 40 | *Casuarina equisetifolia L.* | Whistling Pine | Tree |
| 41 | *Catunaregam spinosa (Thunb.) Tirveng.* | Mountain Pomegranate, | Tree |
| 42 | *Cedrus deodara (Roxb. ex D.Don) G.Don* | Devdar | Tree |
| 43 | *Ceiba pentandra (L.) Gaertn.* | Kadop Tree | Tree |
| 44 | *Cinnamomum tamala (Buch. -Ham.) T. Nees & C.H. Eberm* | Indian Bay Leaf | Tree |
| 45 | *Cinnamomum verum J. Presl* | True cinnamon tree | Tree |
| 46 | *Citrus aurantium L.* | Sweet Orange | Tree |
| 47 | *Citrus limon L. Osbeck* | Lemon | Tree |
| 48 | *Citrus medica L.* | Citron | Tree |
| 49 | *Commiphora caudata (Wight & Arn.) Engl.* | South-Indian Commiphora | Tree |
| 50 | *Cordia dichotoma G. Forst.* | Indian cherry | Tree |
| 51 | *Cordia myxa L.* | Assyrian plum | Tree |

| Sr.No. | Scientific Name | Common Name | Habit |
|---|---|---|---|
| 52 | *Cordia sebestena L.* | Scarlet Cordia | Tree |
| 53 | *Cordia sinensis Lam.* | Long-Leaf Cordia | Tree |
| 54 | *Couroupita guianensis Aubl.* | Cannon Ball Tree | Tree |
| 55 | *Crateva magna (Lour.) DC.* | Large Garlic Pear | Tree |
| 56 | *Crescentia cujete L.* | Jicaro, | Tree |
| 57 | *Cycas revoluta Thunb.* | Japanese Sago Palm | Tree |
| 58 | *Dalbergia latifolia Roxb.* | Black Rosewood | Tree |
| 59 | *Dalbergia melanoxylon Guill. & Perr.* | African Blackwood | Tree |
| 60 | *Dalbergia sissoo Roxb.ex DC* | Indian Rosewood | Tree |
| 61 | *Dichrostachys cinerea (L.) Wight & Arn.* | Sickle Bush | Tree |
| 62 | *Dillenia indica L.* | Elephant Apple | Tree |
| 63 | *Diospyros blancoi A.DC.* | Butter Fruit | Tree |
| 64 | *Diospyros ebenum J. Koenig ex Retz.* | Indian Ebony | Tree |
| 65 | *Diospyros malabarica (Desr.) Kostel.* | Gaub | Tree |
| 66 | *Dolichandrone falcata (Wall.Ex DC.) \|Seem* | Medhshingi | Tree |
| 67 | *Donella lanceolata (Blume) Aubrev.* | Star Apple | Tree |
| 68 | *Ehretia aspera Willd.* | Chamror | Tree |
| 69 | *Ehretia laevis Sieber ex A.DC.* | Chamror | Tree |
| 70 | *Elaeocarpus serratus L.* | Ceylon Olive | Tree |
| 71 | *Erythrina × bidwillii Lindl.* | Coral Bean Tree | Tree |
| 72 | *Erythrina stricta Roxb.* | Indian Coral Tree | Tree |
| 73 | *Erythrina variegata L.* | Lenten tree | Tree |
| 74 | *Eucalyptus globulus Labill.* | Eucalyptus | Tree |
| 75 | *Euphorbia antiquorum L.* | Triangular Spurge | Tree |
| 76 | *Euphorbia tirucalli L.* | Pencil Tree | Tree |
| 77 | *Ficus benghalensis L.* | Banyan | Tree |
| 78 | *Ficus krishnae C. DC.* | Krishna Fig | Tree |
| 79 | *Ficus lacor Buch. -Ham.* | Java Fig | Tree |
| 80 | *Ficus longifolia Schott* | narrow leaf fig | Tree |
| 81 | *Ficus racemosa L.* | Cluster fig | Tree |
| 82 | *Ficus religiosa L.* | Pipul Tree | Tree |
| 83 | *Ficus tinctoria subsp. gibbosa (Blume) Corner* | Dye Fig | Tree |
| 84 | *Firmiana colorata (Roxb.) R. Br.* | Scarlet Sterculia | Tree |
| 85 | *Flacourtia ramontchi L'Hér.* | Indian plum | Tree |
| 86 | *Garcinia indica (Thouars) Choisy* | Kokum | Tree |
| 87 | *Garcinia xanthochymus Hook.f. ex T. Anderson* | Mysore Gamboge | Tree |
| 88 | *Garuga pinnata Roxb.* | Garuga, | Tree |
| 89 | *Gliricidia sepium (Jacq.) Kunth* | Gliricidia | Tree |
| 90 | *Gmelina arborea Roxb.ex Sm.* | Gamhar | Tree |
| 91 | *Grevillea robusta A. Cunn. ex R.Br.* | Silver oak | Tree |
| 92 | *Grewia tiliifolia Vahl* | Dhaman | Tree |
| 93 | *Helicteres isora L.* | East-Indian screw tree | Tree |
| 94 | *Heterophragma quadriloculare (Roxb.) K. Schum.* | Waras | Tree |
| 95 | *Holarrhena pubescens Wall.ex G. Don* | Indrajao | Tree |
| 96 | *Holigarna arnottiana Hook.f.* | Black Varnish Tree | Tree |
| 97 | *Holigarna grahamii (Wight) Kurz* | Blistering Varnish Tree | Tree |
| 98 | *Holoptelea integrifolia (Roxb.) Planch.* | Indian Elm | Tree |
| 99 | *Hydnocarpus pentandrus (Buch. -Ham.) Oken* | Jangli Almond | Tree |
| 100 | *Jatropha curcas L.* | Physic Nut | Tree |
| 101 | *Khaya senegalensis (Desv.) A. Juss* | African Mahogany | Tree |
| 102 | *Kigelia africana (Lamk.) Benth.* | Sausage Tree | Tree |
| 103 | *Knema attenuata (Wall. ex Hook.f. & Thomson) Warb.* | Wild Nutmeg | Tree |
| 104 | *Lagerstroemia speciosa (L.) Pers.* | Pride of India | Tree |
| 105 | *Leucaena leucocephala (Lam.) de Wit* | River tamarind | Tree |
| 106 | *Limonia acidissima L.* | Wood Apple | Tree |
| 107 | *Litchi chinensis Sonn.* | Lyche | Tree |
| 108 | *Macaranga peltata (Roxb.) Mull.Arg.* | Shield-Leaf Tree | Tree |
| 109 | *Machilus glaucescens (Nees) Wight* | Large-Flowered Bay Tree | Tree |
| 110 | *Madhuca indica J.F.Gmel.* | Mahua | Tree |

| Sr.No. | Scientific Name | Common Name | Habit |
|---|---|---|---|
| 111 | *Madhuca longifolia var. latifolia (Roxb.) A. Chev.* | Indian Butter Tree | Tree |
| 112 | *Magnolia champaca (L.) Baill. ex Pierre* | Champak | Tree |
| 113 | *Magnolia liliifera (L.) Baill.* | egg magnolia | Tree |
| 114 | *Mallotus philippensis (Lam.) Müll.Arg.* | Kamala Tree | Tree |
| 115 | *Mammea suriga (Buch. -Ham. ex Roxb.) Kosterm.* | Surangi | Tree |
| 116 | *Mangifera indica L.* | Mango | Tree |
| 117 | *Manilkara hexandra (Roxb.) Dubard* | Ceylon Iron Wood | Tree |
| 118 | *Manilkara zapota (L.) P. Royen* | Chikoo | Tree |
| 119 | *Mappia nimmoniana (J. Graham) Byng & Stull* | Stinking Tree | Tree |
| 120 | *Memecylon umbellatum Burm.f.* | Ironwood tree | Tree |
| 121 | *Mesua ferrea L.* | Indian rose chestnut | Tree |
| 122 | *Miliusa tomentosa (Roxb) Finet & Gagnep* | Woolly Miliusa | Tree |
| 123 | *Millettia peguensis* | Moulmein Rosewood | Tree |
| 124 | *Mimusops elengi L.* | Spanish cherry | Tree |
| 125 | *Mitragyna parvifolia (Roxb.) Korth.* | True Kadamb | Tree |
| 126 | *Monoon longifolium (Sonn.) B. Xue & R.M.K. Saunders* | Ashok | Tree |
| 127 | *Morinda citrifolia L.* | Noni | Tree |
| 128 | *Morinda coreia Buch. -Ham.* | Indian Mulberry | Tree |
| 129 | *Moringa oleifera Lam.* | drumstick tree | Tree |
| 130 | *Morus alba L.* | White Mulberry | Tree |
| 131 | *Muntingia calabura L.* | Jam tree | Tree |
| 132 | *Murraya paniculata (L.) Jack* | Orange Jasmine | Tree |
| 133 | *Myristica fragrans Houtt.* | Nutmeg | Tree |
| 134 | *Neolamarckia cadamba (Roxb.) Bosser* | Kadam | Tree |
| 135 | *Nyctanthes arbor-tristis L.* | Har singa | Tree |
| 136 | *Oroxylum indicum (L.) Kurz* | Indian Trumpet Flower | Tree |
| 137 | *Pandanus odorifer (Forssk.) Kuntze* | Kewda | Tree |
| 138 | *Peltophorum pterocarpum (DC.) Backer exK. Heyne* | Copperpod | Tree |
| 139 | *Persea americana Mill.* | Avocado | Tree |
| 140 | *Phoenix dactylifera L.* | Date Palm | Tree |
| 141 | *Phoenix sylvestris (L.) Roxb.* | Wild Date Palm, | Tree |
| 142 | *Phyllanthus acidus (L.) Skeels* | Star Gooseberry | Tree |
| 143 | *Phyllanthus emblica L.* | Indian gooseberry | Tree |
| 144 | *Piliostigma foveolatum (Dalzell) Thoth. (Syn. Bauhinia foveolata Dalzell)* | Pore Leaved Bauhinia | Tree |
| 145 | *Pimenta dioica (L.) Merr.* | Jamaica pepper | Tree |
| 146 | *Pithecellobium dulce (Roxb.) Benth.* | Madras Thorn | Tree |
| 147 | *Pongamia pinnata (L.) Pierre* | Pongam Tree | Tree |
| 148 | *Prosopis cineraria (L.) Druce* | Khejri Tree | Tree |
| 149 | *Prunus padus L.* | Himalayan Bird Cherry | Tree |
| 150 | *Psidium guajava L.* | Gauva | Tree |
| 151 | *Pterocarpus marsupium Roxb.* | Indian Kino Tree | Tree |
| 152 | *Pterocarpus marsupium subsp. acuminatus (Prain) Thoth.* | Indian Kino Tree | Tree |
| 153 | *Pterocarpus santalinus L.f.* | Red Sandalwood | Tree |
| 154 | *Pterospermum acerifolium (L.) Willd.* | Kanak Champa | Tree |
| 155 | *Pterospermum reticulatum Wight & Arn.* | South-Indian Kanak Champa | Tree |
| 156 | *Punica granatum L.* | Pomegranate | Tree |
| 157 | *Putranjiva roxburghii Wall.* | Lucky Bean Tree | Tree |
| 158 | *Radermachera xylocarpa (Roxb.) Roxb. ex K. Schum.* | Padri Tree | Tree |
| 159 | *Ricinus communis L.* | Castor bean | Tree |
| 160 | *Salix tetrasperma Roxb.* | Indian Willow | Tree |
| 161 | *Salvadora oleoides Decne.* | Bada Peelu | Tree |
| 162 | *Salvadora persica L.* | Toothbrush Tree | Tree |
| 163 | *Samanea saman (Jacq.) Merr.* | Monkey pod tree | Tree |
| 164 | *Santalum album L.* | Indian sandalwood | Tree |
| 165 | *Sapindus mukorossi Gaertn.* | Indian soapberry | Tree |
| 166 | *Saraca asoca (Roxb.) W.J.de Wilde* | Sita Ashok | Tree |

| Sr.No. | Scientific Name | Common Name | Habit |
|---|---|---|---|
| 167 | *Schleichera oleosa (Lour.) Oken* | kusum Tree | Tree |
| 168 | *Semecarpus anacardium L.f.* | dhobi nut tree | Tree |
| 169 | *Senegalia catechu (L.f.) P. J. H. Hurter & Mabb.* | Black Cutch Tree | Tree |
| 170 | *Senegalia chundra (Roxb. ex Rottler) Maslin* | Red Cutch Tree | Tree |
| 171 | *Senegalia polyacantha (Willd.) Seigler & Ebinger* | White Thorn | Tree |
| 172 | *Sesbania grandiflora (L.) Poir.* | Agati | Tree |
| 173 | *Shorea robusta C.F. Gaertn.* | Sal | Tree |
| 174 | *Simarouba glauca DC.* | Paradise Tree | Tree |
| 175 | *Spathodea campanulata P.Beauv.* | African tulip tree | Tree |
| 176 | *Spondias pinnata (L. f.) Kurz* | Wild Mango | Tree |
| 177 | *Sterculia foetida L.* | Java Olive | Tree |
| 178 | *Sterculia guttata Roxb.* | Spotted Sterculia | Tree |
| 179 | *Sterculia urens Roxb.* | Indian-tragacanth | Tree |
| 180 | *Stereospermum chelonoides (L.f.) DC.* | Fragrant Padri Tree | Tree |
| 181 | *Strychnos nux-vomica L.* | Nux Vomica | Tree |
| 182 | *Swietenia macrophylla King* | Big-Leaf Mahogany | Tree |
| 183 | *Symplocos racemosa Roxb.* | Lodh Tree | Tree |
| 184 | *Syzygium cumini (L.) Skeels.* | Jamun | Tree |
| 185 | *Syzygium salicifolium J. Graham* | Kath Jamun | Tree |
| 186 | *Tabernaemontana alternifolia L.* | Indian Moon-Seed | Tree |
| 187 | *Tamarindus indica L.* | Tamarind | Tree |
| 188 | *Tamilnadia uliginosa (Retz.) Tirveng. & Sastre* | Divine Jasmine | Tree |
| 189 | *Tecomella undulata (Sm.) Seem.* | Roheda | Tree |
| 190 | *Tectona grandis L.f.* | Teak | Tree |
| 191 | *Terminalia anogeissiana Gere & Boatwr.* | Axle Wood Tree | Tree |
| 192 | *Terminalia arjuna (Roxb. ex DC.) Wight & Arn.* | Arjun tree | Tree |
| 193 | *Terminalia bellirica (Gaertn.) Roxb.* | Baheda | Tree |
| 194 | *Terminalia catappa L.* | Indian Almond | Tree |
| 195 | *Terminalia chebula Retz.* | Chebulic Myrobalan | Tree |
| 196 | *Terminalia elliptica Willd.* | Black murdah | Tree |
| 197 | *Terminalia mantaly H. Perrier* | Madagascar Almond Tree | Tree |
| 198 | *Terminalia pendula (Edgew.) Gere & Boatwr. (Syn. Anogeissus pendula Edgew.)* | Buttontree | Tree |
| 199 | *Tetrameles nudiflora R.Br.* | False Hemp Tree | Tree |
| 200 | *Tetrapilus dioicus (Roxb.) L.A.S. Johnson* | Rose Sandalwood | Tree |
| 201 | *Theobroma cacao L.* | Cacao tree | Tree |
| 202 | *Thespesia populnea (L.) Sol. ex Correa* | Indian tulip tree | Tree |
| 203 | *Trema orientale (L.) Blume* | Indian Charcoal Tree | Tree |
| 204 | *Vachellia leucophloea (Roxb.) Maslin, Seigler & Ebinger* | White Bark Acacia | Tree |
| 205 | *Vachellia nilotica (L.) P. J. H. Hurter & Mabb.* | Babool | Tree |
| 206 | *Vateria indica L.* | White Damar | Tree |
| 207 | *Vitex negundo L.* | Chaste Tree | Tree |
| 208 | *Wrightia tinctoria (Roxb.) R.Br.* | Sweet Indrajao | Tree |
| 209 | *Zanthoxylum rhetsa (Roxb.) DC.* | Indian Prickly Ash | Tree |
| 210 | *Ziziphus jujuba Mill.* | Jujube | Tree |
| 211 | *Ziziphus rugosa Lam.* | Wild Jujube | Tree |
| **Shrub** | | | |
| 1 | *Abutilon indicum (L.) Sweet* | Indian Mallow | Shrub |
| 2 | *Alocasia macrorrhizos (L.) G. Don* | Gaint Taro | Shrub |
| 3 | *Ardisia sonchifolia Mez* | | Shrub |
| 4 | *Barleria cristata var. dichotoma L.* | Philippine violet | Shrub |
| 5 | *Barleria prionitis L.* | Porcupine Flower | Shrub |
| 6 | *Breynia androgyna (L.) Chakrab. & N.P. Balakr* | Star gooseberry | Shrub |
| 7 | *Bridelia retusa (L.) A. Juss.* | Cup Saucer Plant | Shrub |
| 8 | *Calotropis gigantea (L.) W.T. Aiton* | Crown Flower | Shrub |
| 9 | *Calotropis procera (Aiton) W.T.Aiton* | Giant Milkweed | Shrub |
| 10 | *Capparis zeylanica L.* | Indian caper | Shrub |
| 11 | *Carissa spinarum L.* | Wild Karanda | Shrub |
| 12 | *Cissus quadrangularis L.* | Veldt Grape | Shrub |

| Sr.No. | Scientific Name | Common Name | Habit |
|---|---|---|---|
| 13 | *Citronella apogon (Griseb.) R.A.Howard* | | Shrub |
| 14 | *Clerodendrum infortunatum L.* | Hill Glory Bower | Shrub |
| 15 | *Clerodendrum phlomidis L.f.* | Sage Glory Bower | Shrub |
| 16 | *Coffea arabica L.* | Mountain coffee, | Shrub |
| 17 | *Commiphora wightii (Arn.) Bhandari* | Indian bdellium-tree | Shrub |
| 18 | *Croton tiglium L.* | Purging Croton | Shrub |
| 19 | *Embelia tsjeriam-cottam (Roem. & Schult.) A. DC.* | Malabar Embelia | Shrub |
| 20 | *Gardenia gummifera L.f.* | Cambi gum tree | Shrub |
| 21 | *Glycosmis cochinchinensis (Lour.) Pierre ex Engl.* | Gin Berry | Shrub |
| 22 | *Glycosmis pentaphylla (Retz.) DC.* | Gin Berry | Shrub |
| 23 | *Grewia abutilifolia Vent ex Juss.* | Mallow-Leaved Crossberry | Shrub |
| 24 | *Hibiscus rosa-sinensis L.* | Chinese hibiscus | Shrub |
| 25 | *Indigofera tinctoria L.* | True Indigo | Shrub |
| 26 | *Ixora coccinea L.* | Jungle geranium | Shrub |
| 27 | *Ixora parviflora Lam.* | ixora | Shrub |
| **Climber** | | | |
| 1 | *Abrus precatorius L.* | Rosary pea | Climber |
| 2 | *Argyreia nervosa (Burm.f.) Bojer* | Elephant creeper | Climber |
| 3 | *Aristolochia littoralis Parodi* | Calico Flower | Climber |
| 4 | *Artabotrys hexapetalus (L.f.) Bhandari* | Hari champa | Climber |
| 5 | *Basella alba L.* | Malabar Spinach | Climber |
| 6 | *Bridelia stipularis (L.) Blume* | Climbing Bridelia | Climber |
| 7 | *Calamus rotang L.* | Common Rattan | Climber |
| 8 | *Cardiospermum halicacabum L.* | Balloon Vine | Climber |
| 9 | *Causonis trifolia (L.) Mabb. & J. Wen* | Bush Grape, | Climber |
| 10 | *Ceropegia bulbosa Roxb.* | Bulbous Ceropegia | Climber |
| 11 | *Cestrum nocturnum L.* | Night Blooming Jasmine | Climber |
| 12 | *Clematis hedysarifolia DC.* | Konkan Clematis | Climber |
| 13 | *Clitoria ternatea L.* | Butterfly Pea | Climber |
| 14 | *Cocculus hirsutus (L.) W. Theob.* | Broom Creeper | Climber |
| 15 | *Combretum albidum G.Don* | Piluki | Climber |
| 16 | *Cryptolepis buchananii R.Br. ex Roem. & Schult.* | Wax Leaved Climber | Climber |
| 17 | *Cryptostegia grandiflora Roxb. ex R.Br.* | Rubber vine | Climber |
| 18 | *Cuscuta reflexa Roxb.* | Giant Dodder | Climber |
| 19 | *Cynanchum viminale (L.) L.* | Sacred soma | Climber |
| 20 | *Decalepis hamiltonii Wight & Arn.* | Swallow-Root | Climber |
| 21 | *Dioscorea alata L.* | Water Yam | Climber |
| 22 | *Dioscorea bulbifera L.* | Aerial yam | Climber |
| 23 | *Diplocyclos palmatus (L.) C.Jeffrey* | Marble Vine | Climber |
| 24 | *Elaeagnus latifolia L.* | South Indian Silverberry | Climber |
| 25 | *Embelia ribes Burm.f.* | Vidanga | Climber |
| 26 | *Gloriosa superba L.* | Glory Lily | Climber |
| 27 | *Guilandina bonduc L. (Syn.* | Yellow Nicker | Climber |
| 28 | *Gymnema sylvestre (Retz.) R.Br. ex Sm.* | Gurmar | Climber |
| 29 | *Hemidesmus indicus (L.) R. Br.* | Indian Sarsaparilla | Climber |
| 30 | *Ipomoea batatas (L.) Lam.* | Sweet Potato | Climber |
| 31 | *Ipomoea cairica (L.) Sweet* | Cairo Morning Glory, | Climber |
| 32 | *Jasminum auriculatum Vahl* | Juhi | Climber |
| 33 | *Leptadenia reticulata (Retz.) Wight & Arn.* | Cork Swallow-Wort | Climber |
| 34 | *Mansoa alliacea (Lam.) A.H. Gentry* | Garlic Vine | Climber |
| 35 | *Moullava spicata (Dalzell ex Wight) Nicolson* | Candy Corn Plan | Climber |
| 36 | *Mucuna pruriens (L.) DC.* | Velvet bean | Climber |
| 37 | *Operculina turpethum (L.) Silva Manso* | White day glory | Climber |
| 38 | *Passiflora edulis Sims* | Passion Fruit | Climber |
| 39 | *Passiflora foetida L.* | Stinking passionflower | Climber |
| 40 | *Passiflora incarnata L.* | Purple passionflower | Climber |
| **Herb** | | | |

| Sr.No. | Scientific Name | Common Name | Habit |
|---|---|---|---|
| 1 | *Achyranthes aspera L.* | Prickly Chaff Flower | Herb |
| 2 | *Acmella oleracea (L.) R.K. Jansen* | Toothache plant, | Herb |
| 3 | *Acorus calamus L.* | Sweet Flag | Herb |
| 4 | *Ageratum conyzoides L.* | White weed | Herb |
| 5 | *Allium sativum L.* | Garlic | Herb |
| 6 | *Aloe vera (L.) Burm.f.* | Aloe vera | Herb |
| 7 | *Alternanthera sessilis (L.) DC.* | Tangle Mat | Herb |
| 8 | *Alysicarpus monilifer (L.) DC.* | | Herb |
| 9 | *Andrographis paniculata (Burm.f.) Nees* | Green chiretta | Herb |
| 10 | *Artemisia absinthium L.* | Common wormwood | Herb |
| 11 | *Asclepias curassavica L.* | Halad Kunku | Herb |
| 12 | *Asparagus racemosus Willd.* | Satavar | Herb |
| 13 | *Bacopa monnieri (L.) Wettst.* | Brahmi | Herb |
| 14 | *Balanites aegyptiaca (L.) Delile* | Indian thorny bamboo | Herb |
| 15 | *Bambusa bambos (L.) Voss* | Giant thorny bamboo | Herb |
| 16 | *Biophytum sensitivum (L.) DC.* | Little Tree plant | Herb |
| 17 | *Boerhavia diffusa L.* | Red Spiderling | Herb |
| 18 | *Boerhavia erecta L.* | Erect Spiderling | Herb |
| 19 | *Canna indica L.* | Indian Shot | Herb |
| 20 | *Cannabis sativa L.* | Indian hemp | Herb |
| 21 | *Caralluma adscendens (Roxb.) Haw.* | Caralluma | Herb |
| 22 | *Catharanthus roseus (L.) G. Don.* | Rosy periwinkle, | Herb |
| 23 | *Celosia argentea L.* | Silver Cockscomb, | Herb |
| 24 | *Centella asiatica (L.) Urb.* | Indian Pennywort | Herb |
| 25 | *Centratherum punctatum Cass.* | Larkdaisy | Herb |
| 26 | *Chamaecostus cuspidatus (Nees & Mart.) C.D. Specht & D.W. Stev.* | fiery costus | Herb |
| 27 | *Chlorophytum borivilianum Santapau & R.R. Fern.* | Musli | Herb |
| 28 | *Chromolaena odorata (L.) R.M. King & H. Rob.* | Bitter bush | Herb |
| 29 | *Chrysopogon zizanioides (L.) Roberty* | Khas, | Herb |
| 30 | *Coix lacryma-jobi L.* | Adlay Millet | Herb |
| 31 | *Coleus amboinicus Lour.* | Indian borage | Herb |
| 32 | *Coleus barbatus var. barbatus (Syn. Coleus forskohlii (Willd.) Briq.)* | Indian Coleus | Herb |

## 5. Faunal Studies

260. The baseline faunal surveys were carried out in July & August 2024 via visual encounters & available secondary data etc. as detailed out in the methodology section. A total of 305 various faunal species, as summarised in ***Table 4-27***, including 8 species of mammals, 117 species of birds, 6 species of Amphibian, 6 species of Reptiles, 21 species of butterflies 32 species of Moth, 9 species of dragonfly, 44 species of Spider, 62 species of Fish have been observed / recorded during the study.

*Table 4-27: Faunal Community of Study Area*

| Sl | Type (Class) of Fauna | Total Number of Species observed / recorded |
|---|---|---|
| 1 | Mammal | 8 |
| 2 | Avian species | 117 |
| 3 | Amphibian | 6 |
| 4 | Reptial | 6 |
| 5 | Butterfly | 21 |
| 6 | Moth | 32 |
| 7 | Dragonfly | 9 |
| 8 | Spider | 44 |
| 9 | Fishes | 62 |
| **Total** | | **305** |

### a) Mammals Diversity

261. Total 8 Mammal species recorded during the study period, while list of Mammal species found in study area is given in **Table 4-28.**

*Table 4-28: Checklist of Mammal Diversity*

| Sl | Zoological Name | Family | Common Name | IUCN Status | IWPA Status |
|---|---|---|---|---|---|
| 1 | *Pteropus giganteus giganteus* (Briinnich) | Pteropodidae | Indian Flying Fox | LC | Schedule II |
| 2 | *Presbytis entellus* | Cercopithecidae | Common Langur | Not Enlisted | Not Enlisted |
| 3 | *Lepus nigricollis* | Ochotonidae | Indian Hare | LC | Schedule II |
| 4 | *Vulpes bengalensis* | Canidae | Indian Fox | LC | Schedule I |
| 5 | *Canis lupus* Sykes | Canidae | Wolf | LC | Schedule 1 |
| 6 | *Funambulus palmarum* Linn | Scuiridae | Three Striped Palm Squirrel | LC | - |
| 7 | *Herpestes edwardsi* Geoffray | Viverridae | Common Mongoose | LC | - |
| 8 | *Sus scrofa* | Suidae | Wild Boar | LC | Schedule II |

**b) Avifaunal Diversity**

262. Total 117 bird species found in study Area. Bird diversity represented as IUCN Status is depicted in **Figure 4-26**:, while list of bird species found in and around Pune city is given in
263. **Table** 4-29.

*Figure 4-26: Bird Diversity - IUCN Status*

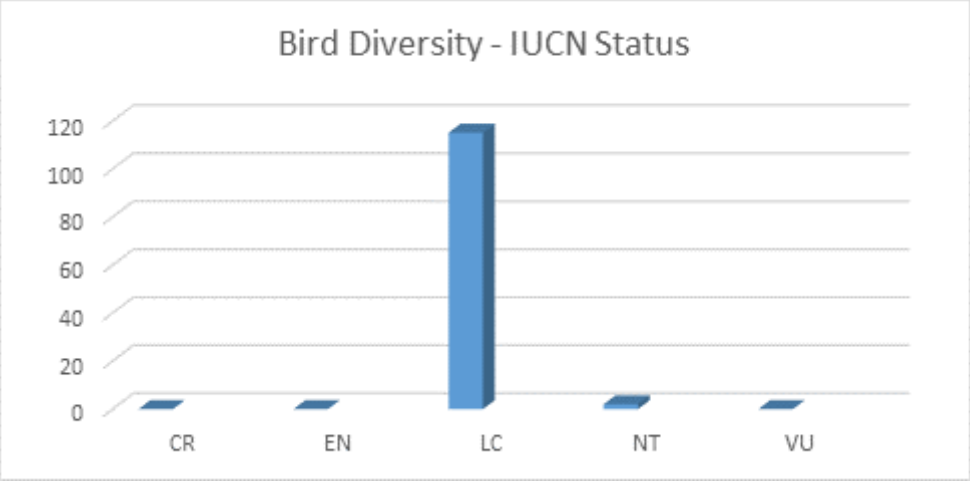



*Table 4-29: Avian Diversity of study area*

| Sr no | Family | Scientific name | Common name | IUCN Status | IWPA Status |
|---|---|---|---|---|---|
| 1 | Podicipedidae | *Tachybaptus ruficollis (Pallas, 1764)* | Little Grebe | LC | Sch II |
| 2 | Columbidae | *Columba livia (J.F. Gmelin, 1789)* | Rock Pigeon | LC | Sch II |
| 3 | Columbidae | *Streptopelia chinensis (Scopoli, 1786)* | Spotted Dove | LC | Sch II |
| 4 | Columbidae | *Streptopelia senegalensis (Linnaeus, 1766)* | Laughing Dove | LC | Sch II |
| 5 | Columbidae | *Treron phoenicopterus (Latham, 1790)* | Yellow-footed green pigeon | LC | Sch II |
| 6 | Apodidae | *Cypsiurus balasiensis (J.E. Gray, 1829)* | Asian palm swift | LC | Sch II |

| Sr no | Family | Scientific name | Common name | IUCN Status | IWPA Status |
|---|---|---|---|---|---|
| 7 | Apodidae | *Apus affinis (J.E. Gray, 1830)* | Little Swift | LC | Sch II |
| 8 | Cuculidae | *Centropus sinensis (Stephens, 1815)* | Greater Coucal | LC | Sch II |
| 9 | Cuculidae | *Clamator jacobinus (Boddaert, 1783)* | Pied Cuckoo | LC | Sch II |
| 10 | Cuculidae | *Eudynamysscolopaceus (Linnaeus, 1758)* | Asian Coucal | LC | Sch II |
| 11 | Cuculidae | *Cacomantis merulinus (Scopoli, 1786)* | Plaintive cuckoo | LC | Sch II |
| 12 | Cuculidae | *Hierococcyx varius (Vahl, 1797)* | Common hawk cuckoo | LC | Sch II |
| 13 | Rallidae | *Amaurornisphoenicurus (Pennant, 1769)* | White-Breasted Waterhen | LC | Sch II |
| 14 | Ardeidae | *Ardeola grayii (Sykes, 1832)* | Indian Pond Heron | LC | Sch II |
| 15 | Ardeidae | *Bubulcus ibis (Linnaeus, 1758)* | Cattle Egret | LC | Sch II |
| 16 | Charadriidae | *Charadrius dubius (Scopoli, 1786)* | Little Ring Plover | LC | Sch II |
| 17 | Charadriidae | *Vanellus indicus (Boddaert, 1783)* | Red-Wattled Lapwing | LC | Sch II |
| 18 | Charadriidae | *Vanellus malabaricus (Boddaert, 1783)* | Yellow-Wattled Lapwing | LC | Sch II |
| 19 | Rostratulidae | *Rostratula benghalensis (Linnaeus, 1758)* | Greater-painted snipe | LC | Sch II |
| 20 | Jacanidae | *Hydrophasianus chirurgus (Scopoli, 1786)* | Pheasant-tailed jacana | LC | Sch II |
| 21 | Scolopacidae | *Tringa glareola (Linnaeus, 1758)* | Wood Sandpiper | LC | Sch II |
| 22 | Scolopacidae | *Actitis hypoleucos (Linnaeus, 1758)* | Common sandpiper | LC | Sch II |
| 23 | Scolopacidae | *Tringa nebularia (Gunnerus, 1767)* | Common greenshank | LC | Sch II |
| 24 | Scolopacidae | *Gallinagogallinago (Linnaeus, 1758)* | Common snipe | LC | Sch II |
| 25 | Turnicidae | *Turnix suscitator (J.F. Gmelin, 1789)* | Barred buttonquail | LC | Sch II |
| 26 | Accipitridae | *Accipiter badius (J.F. Gmelin, 1788)* | Shikra | LC | Sch I |
| 27 | Accipitridae | *Milvus migrans (Boddaert, 1783)* | Black kite | LC | Sch II |
| 28 | Strigidae | *Athene brama (Temminck, 1821)* | Spotted owlet | LC | Sch II |
| 29 | Bucerotidae | *Ocyceros birostris (Scopoli, 1786)* | Indian grey hornbill | LC | Sch II |
| 30 | Upupidae | *Upupaepops (Linnaeus, 1758)* | Eurasian hoopoe | LC | Sch II |
| 31 | Picidae | *Dendrocoposmahrattensis (Latham, 1801)* | Yellow-crowned woodpecker | LC | Sch II |
| 32 | Ramphastidae | *Psilopogon haemacephalus* | Coppersmith barbet | LC | Sch II |
| 33 | Meropidae | *Merops orientalis (Latham, 1801)* | Asian green bee-eater | LC | Sch II |
| 34 | Coraciidae | *Coracias benghalensis (Linnaeus, 1758)* | Indian roller | LC | Sch II |
| 35 | Alcedinidae | *Halcyon smyrnensis (Linnaeus, 1758)* | White-throated kingfisher | LC | Sch II |
| 36 | Falconidae | *Falco tinnunculus (Linnaeus, 1758)* | Common kestrel | LC | Sch I |
| 37 | Psittaculidae | *Psittacula cyanocephala (Linnaeus, 1766)* | Plum-headed parakeet | LC | Sch II |
| 38 | Psittaculidae | *Psittacula krameri (Scopoli, 1769)* | Rose-ringed parakeet | LC | Sch II |
| 39 | Campephagidae | *Pericrocotuscinnamomeus (Linnaeus,* | Small minivet | LC | Sch I |
| 40 | Campephagidae | *Coracina javensis (Horsfield, 1821)* | Large Cuckooshrike | LC | Sch II |
| 41 | Vangidae | *Tephrodornis pondicerianus (J.F. Gmelin,* | Common Woodshrike | LC | Sch II |
| 42 | Oriolidae | *Oriolus oriolus (Linnaeus, 1758)* | Eurasian Golden Oriole | LC | Sch II |
| 43 | Aegithinidae | *Aegithina tiphia (Linnaeus, 1758)* | Common iora | LC | Sch II |

| Sr no | Family | Scientific name | Common name | IUCN Status | IWPA Status |
|---|---|---|---|---|---|
| 44 | Dicruridae | *Dicrurus macrocercus (Vieillot, 1817)* | Black Drongo | LC | Sch II |
| 45 | Laniidae | *Lanius vittatus (Valenciennes 1826)* | Bay-backed shrike | LC | Sch II |
| 46 | Laniidae | *Lanius schach (Linnaeus, 1758)* | Long-tailed shrike | LC | Sch II |
| 47 | Corvidae | *Dendrocitta vagabunda (Latham, 1790)* | Rufous treepie | LC | Sch II |
| 48 | Corvidae | *Corvus splendens (Vieillot, 1817)* | House crow | LC | Sch II |
| 49 | Corvidae | *Corvus macrorhynchos (Wagler, 1827)* | Large-billed crow | LC | Sch II |
| 50 | Nectariniidae | *Leptocomazeylonica (Linnaeus, 1766)* | Purple-rumped sunbird | LC | Sch II |
| 51 | Nectariniidae | *Cinnyris asiaticus (Latham, 1790)* | Purple Sunbird | LC | Sch II |
| 52 | Ploceidae | *Ploceus philippinus (Linnaeus, 1766)* | Baya weaver | LC | Sch II |
| 53 | Estrildidae | *Euodice malabarica (Linnaeus, 1758)* | Indian silverbill | LC | Sch II |
| 54 | Estrildidae | *Lonchura punctulata (Linnaeus, 1758)* | Scaly-breasted munia | LC | Sch II |
| 55 | Passeridae | *Passer domesticus (Linnaeus, 1758)* | House Sparrow | LC | Sch II |
| 56 | Motacillidae | *Anthus rufulus (Vieillot, 1818)* | Paddyfield pipet | LC | Sch II |
| 57 | Motacillidae | *Motacilla cinerea (Tunstall, 1771)* | Grey Wagtail | LC | Sch II |
| 58 | Motacillidae | *Motacilla citreola (Pallas, 1776)* | Citrine Wagtail | LC | Sch II |
| 59 | Motacillidae | *Motacilla alba (Linnaeus, 1758)* | White Wagtail | LC | Sch II |
| 60 | Motacillidae | *Motacilla maderaspatensis (J.F. Gmelin,* | White-browed Wagtail | LC | Sch II |
| 61 | Motacillidae | *Motacilla flava (Linnaeus, 1758)* | Yellow Wagtail | LC | Sch II |
| 62 | Fringillidae | *Carpodacus erythrinus erythrinus* | Common Rosefinch | LC | Sch II |
| 63 | Paridae | *Parus cinereus (Vieillot, 1818)* | Cinerious Tit | LC | Sch II |
| 64 | Paridae | *Machlolophus xanthogenys (Vigors, 1831)* | Yellow tit | LC | Sch II |
| 65 | Sylviidae | *Sylvia hortensis (Gmelin, 1789)* | Western Orphean warbler | LC | Sch II |
| 66 | Sylviidae | *Curruca curruca (Linnaeus, 1758)* | Lesser whitethroat | LC | Sch II |
| 67 | Alaudidae | *Ammomanesphoenicura (Franklin, 1831)* | Rufous tailed lark | LC | Sch II |
| 68 | Alaudidae | *Eremopterixgriseus (Scopoli, 1786)* | Ashy-crowned sparrow-lark | LC | Sch II |
| 69 | Alaudidae | *Mirafra erythroptera (Blyth, 1845)* | Indian bush lark | LC | Sch II |
| 70 | Cisticolidae | *Prinia socialis (Sykes, 1832)* | Ashy prinia | LC | Sch II |
| 71 | Cisticolidae | *Prinia inornata (Sykes, 1832)* | Plain Prinia | LC | Sch II |
| 72 | Cisticolidae | *Orthotomussutorius (Pennant, 1769)* | Common Tailorbird | LC | Sch II |
| 73 | Hirundinidae | *Cecropis daurica (Laxmann, 1769)* | Red-Rumped Swallow | LC | Sch II |
| 74 | Hirundinidae | *Hirundo smithii (Leach, 1818)* | Wire tailed Swallow | LC | Sch II |
| 75 | Hirundinidae | *Ptyonoprognerupestris (Scopoli, 1769)* | Eurasian crag martin | LC | Sch II |
| 76 | Hirundinidae | *Ptyonoprogneconcolor (Sykes, 1832)* | Dusky crag martin | LC | Sch II |
| 77 | Pycnonotidae | *Pycnonotus jocosus (Linnaeus, 1758)* | Red-whiskerd Bulbul | LC | Sch II |
| 78 | Pycnonotidae | *Pycnonotus cafer (Linnaeus, 1766)* | Red vented Bulbul | LC | Sch II |

| Sr no | Family | Scientific name | Common name | IUCN Status | IWPA Status |
|---|---|---|---|---|---|
| 79 | Pycnonotidae | *Pycnonotus luteolus (Lesson, 1841)* | White-browed Bulbul | LC | Sch II |
| 80 | Sylviidae | *Chrysomma sinense (J.F. Gmelin, 1789)* | Yellow-eyed Babbler | LC | Sch II |
| 81 | Zosteropidae | *Zosterops palpebrosus (Temminck,1824)* | Indian White eye | LC | Sch II |
| 82 | Leiothrichidae | *Argya malcolmi (Sykes, 1832)* | Large grey Babbler | LC | Sch II |
| 83 | Sturnidae | *Pastor roseus (Linnaeus, 1758)* | Rosy Starling | LC | Sch II |
| 84 | Sturnidae | *Sturnia pagodarum (J.F. Gmelin, 1789)* | Brahminy starling | LC | Sch II |
| 85 | Sturnidae | *Acridotheres tristis (Linnaeus, 1766)* | Common Myna | LC | Sch II |
| 86 | Muscicapidae | *Saxicoloidesfulicatus (Linnaeus, 1766)* | Indian robin | LC | Sch II |
| 87 | Muscicapidae | *Copsychus saularis (Linnaeus, 1758)* | Oriental magpie robin | LC | Sch II |
| 88 | Muscicapidae | *Cyornis tickelliae (Blyth, 1843)* | Tickells Blue Flycatcher | LC | Sch II |
| 89 | Muscicapidae | *Phoenicurus ochruros (S.G. Gmelin, 1774)* | Black redstart | LC | Sch II |
| 90 | Muscicapidae | *Monticola solitarius (Linnaeus, 1758)* | Blue rock thrush | LC | Sch II |
| 91 | Galliforms | *Pavo cristatus* | Indian Peafowl | LC | Sch II |
| 92 | Recurvirostridae | *Himantopus himantopus* | Black-winged stilt | LC | Sch II |
| 93 | Charadriidae | *Vanellus indicus* | Red–wattled lapwing | LC | Sch II |
| 94 | Threskiornithidae | *Threskiornis melanocephalus* | Black-headed ibis | NT | Sch II |
| 95 | Threskiornithidae | *Plegadis falcinellus* | Glossy ibis | LC | Sch II |
| 96 | Threskiornithidae | *Pseudibis papillosa* | Red-napped ibis | LC | Sch II |
| 97 | Ardeidae | *Bubulcus ibis* | Cattle egret | LC | Sch II |
| 98 | Ardeidae | *Ardea cinerea* | Grey Heron | LC | Sch II |
| 99 | Ardeidae | *Nycticorax nycticorax* | Black-crowned Night heron | LC | Sch II |
| 100 | Ardeidae | *Ardeola grayii* | Indian pond heron | LC | Sch II |
| 101 | Ardeidae | *Ardea purpurea* | Purple heron | LC | Sch II |
| 102 | Ardeidae | *Nycticorax nycticorax* | Black-crowned night heron | LC | Sch II |
| 103 | Ardeidae | *Egretta garzetta* | Little egret | LC | Sch II |
| 104 | Alcedinidae | *Alcedo atthis* | Common kingfisher | LC | Sch II |
| 105 | Alcedinidae | *Halcyon smyrnensis* | White-throated kingfisher | LC | Sch II |
| 106 | Anatidae | *Spatula querquedula* | Garganey | LC | Sch II |
| 107 | Anatidae | *Anas poecilorhyncha* | Indian spot-billed duck | LC | Sch II |
| 108 | Anatidae | *Tadorna ferruginea* | Ruddy shelduck | LC | Sch II |
| 109 | Anatidae | *Anas platyrhynchos* | Mallard | LC | Sch II |
| 110 | Phalacrocoracidae | *Phalacrocorax fuscicollis* | Indian cormorant | LC | Sch II |
| 111 | Motacillidae | *Motacilla flava* | Western yellow wagtail | LC | Sch II |
| 112 | Motacillidae | *Motacilla maderaspatensis* | White–browed wagtail | LC | Sch II |
| 113 | Motacillidae | *Motacilla alba* | White wagtail | LC | Sch II |
| 114 | Hirundinidae | *Hirundo smithii* | Wire tailed swallow | LC | Sch II |
| 115 | Ciconiidae | *Ciconia episcopus* | Woolly–necked stork | NT | Sch II |
| 116 | Rallidae | *Porphyrio porphyrio* | Purple Swamphen | LC | Sch II |
| 117 | Accipitridae | *Milvus Migrans* | Black kite | LC | Sch II |

### c) Herpatofaunal Diversity

264. 12 species of Herpetofauna faunal diversity have been recorded in study area and listed in **Table 4-30**.

*Table 4-30: Herpetofauna Diversity in Study Area*

| Sl | Zoological Name | Common Name | Family | IUCN Status | IWPA 1972 |
|---|---|---|---|---|---|
| 1 | *Duttaphrynus melanostictus (Schneider, 1799)* | Asian common Toad | Bufonidae | LC | - |

| Sl | Zoological Name | Common Name | Family | IUCN Status | IWPA 1972 |
|---|---|---|---|---|---|
| 2 | *Euphlyctis cyanophlyctis* | Indian Skipper Frog | Dicroglossidae | LC | Sch II |
| 3 | *Hoplobatrachus tigerinus* | Indian Bull Frog | Dicroglossidae | LC | - |
| 4 | *Zakeranasp.* | | Dicroglossidae | LC | - |
| 5 | *Microhyla ornata* | Ornate Microhylid | Microhylidae | LC | - |
| 6 | *Euphlyctis hexadactylus* | Indian Green Frog | Dicroglossidae | LC | Sch IV |
| 7 | *Xenochrophis piscator* | Checkered kellback | Colubridae | LC | - |
| 8 | *Hemidactylus frenatus* | Indian Garden Lizard | - | LC | - |
| 9 | *Naja naja* | Indian Cobra | Elapid | LC | Sch I |
| 10 | *Daboia russelii* | Russell's viper | Viperidae | LC | Sch I |
| 11 | *Ptyas mucosa* | Oriental Rat Snake | Colubrid | LC | Sch I |
| 12 | *Varanus bengalensis* | Bengal Monitor Lizard | Varanidae | NT | Sch I |

### d) Insects

265. Total 21 species butterflies, 32 species of Moth and 44 species of Spiders were recorded in the study area as given in **Table 4-31**.

*Table 4-31: Checklist of Butterfly Diversity*

| Sr no | Phylum | Family name | Scientific name | Common name | IUCN Status | IWPA Ststus |
|---|---|---|---|---|---|---|
| 1 | Arthropoda | Nymphalidae | *Euploea core* | Common Crow | LC | - |
| 2 | Arthropoda | Popilionidae | *Papilio polymnestor* | Blue Mormon | NL | - |
| 3 | Arthropoda | Lycaenidae | *Tajuria jehana* | Indian Plain Blue royal | NL | - |
| 4 | Arthropoda | Nymphalidae | *Tirumala liamniace* | Blue Tiger | NL | - |
| 5 | Arthropoda | Pieridae | *Pieris rapae* | Cabbage White | NL | - |
| 6 | Arthropoda | Nymphalidae | *Junonia iphita* | Chocalate Pancy | NL | - |
| 7 | Arthropoda | Nymphalidae | *Hypolimnas misippus* | Danaid eggfly | Sch II | Sch II |
| 8 | Arthropoda | Lycaenidae | *Zizina labradus* | Common Glass blue | NL | - |
| 9 | Arthropoda | Pieridae | *Eurema hecabe* | Common Glass Yellow | LC | - |
| 10 | Arthropoda | Popilionidae | *Papilo polytes* | Common Mormon | NL | - |
| 11 | Arthropoda | Pieridae | *Cepora nerissa* | Common Gull | NL | - |
| 12 | Arthropoda | Nymphalidae | *Neptis hylas* | Common Sailor | NL | - |
| 13 | Arthropoda | Pieridae | *Delias eucharis* | Common Jezebel | NL | - |
| 14 | Arthropoda | Nymphalidae | *Jenonia lemonia* | Lemon pansy | NL | - |
| 15 | Arthropoda | Nymphalidae | *Dannus plexippus* | Monarch Butterfly | NL | - |
| 16 | Arthropoda | Pieridae | *Lxias marianne* | Orange white tip | NL | - |
| 17 | Arthropoda | Nymphalidae | *Melanitis jeda* | Common Evening Brown | NL | - |
| 18 | Arthropoda | Pieridae | *Leptosia nina* | Psyche | NL | - |
| 19 | Arthropoda | Lycaenidae | *Telicada nyseus* | Red Pierot | NL | - |
| 20 | Arthropoda | Papilionidae | *Graphium agamemnon* | Tailed Jay | NL | - |
| 21 | Arthropoda | Nymphalidae | *Acraea terpsicore* | Tawny Coster | NL | - |

*Table 4-32: Checklist of Moth Diversity in Study Area*

| Sr No | Phylum | Family | Species |
|---|---|---|---|
| 1 | Arthropoda | Bombycidae | *Trilocha varians* |
| 2 | Arthropoda | Crambidae | *Eoophyla sejunctalis* |
| 3 | Arthropoda | Crambidae | *Parapoynx stagnalis* |
| 4 | Arthropoda | Crambidae | *Hendecasis duplifascialis* |

| Sr No | Phylum | Family | Species |
|---|---|---|---|
| 5 | Arthropoda | Crambidae | *Pyraustaphoenicealis* |
| 6 | Arthropoda | Crambidae | *Paliga machoeralis* |
| 7 | Arthropoda | Crambidae | *Haritalodes derogata* |
| 8 | Arthropoda | Crambidae | *Lygropia distorta* |
| 9 | Arthropoda | Crambidae | *Nosophora euryterminalis* |
| 10 | Arthropoda | Crambidae | *Eurrhyparodes bracteolalis* |
| 11 | Arthropoda | Crambidae | *Herpetogramma licarsisalis* |
| 12 | Arthropoda | Crambidae | *Hydriris ornatalis* |
| 13 | Arthropoda | Crambidae | *Lamprosema commixta* |
| 14 | Arthropoda | Crambidae | *Hymenia perspectalis* |
| 15 | Arthropoda | Crambidae | *Spoladea recurvalis* |
| 16 | Arthropoda | Crambidae | *Cirrhochrista brizoalis* |
| 17 | Arthropoda | Crambidae | *Conogethespunctiferalis* |
| 18 | Arthropoda | Crambidae | *Diaphania indica* |
| 19 | Arthropoda | Crambidae | *Endocrossis lavibasalis* |
| 20 | Arthropoda | Crambidae | *Glyphodes bivitralis* |
| 21 | Arthropoda | Crambidae | *Glyphodes onychinalis* |
| 22 | Arthropoda | Crambidae | *Marucavitrata* |
| 23 | Arthropoda | Crambidae | *Omiodes indicata* |
| 24 | Arthropoda | Crambidae | *Poliobotys ablactalis* |
| 25 | Arthropoda | Crambidae | *Synclera traducalis* |
| 26 | Arthropoda | Crambidae | *Talangasexpunctalis* |
| 27 | Arthropoda | Crambidae | *Tyspanodes linealis* |
| 28 | Arthropoda | Crambidae | *Sameodescancellalis* |
| 29 | Arthropoda | Crambidae | *Cnaphalocrocis medinalis* |
| 30 | Arthropoda | Crambidae | *Cnaphalocrocis poeyalis* |
| 31 | Arthropoda | Crambidae | *Chabula acamasalis* |
| 32 | Arthropoda | Crambidae | *Nausinoe geometralis* |

*Table 4-33 Checklist of Spider Diversity*

| Sr. No | Phylum | Family | Species |
|---|---|---|---|
| 1 | Arthropoda | Araneidae | *Argiopepulchela* |
| 2 | Arthropoda | Araneidae | *Araneus mitificus (Simon, 1886)* |
| 3 | Arthropoda | Araneidae | *Cyclosahexatuberculata* |
| 4 | Arthropoda | Araneidae | *Crytophoracicatrosa* |
| 5 | Arthropoda | Araneidae | *Crytophora citricola* |
| 6 | Arthropoda | Araneidae | *Eriovixia sp.* |
| 7 | Arthropoda | Araneidae | *Neoscona sanghi* |
| 8 | Arthropoda | Araneidae | *Neocona notice* |
| 9 | Arthropoda | Araneidae | *Neosconasp,1* |
| 10 | Arthropoda | Araneidae | *Neosconasp,2* |
| 11 | Arthropoda | Araneidae | *Neosconasp,3* |
| 12 | Arthropoda | Araneidae | *Neosconasp,4* |
| 13 | Arthropoda | Araneidae | *Neocona thesis* |
| 14 | Arthropoda | Araneidae | *Lycosidae* |
| 15 | Arthropoda | Araneidae | *Hippasasp.* |
| 16 | Arthropoda | Lycosidae | *Lycosa prolifica* |
| 17 | Arthropoda | Lycosidae | *Hippasapisaurina* |
| 18 | Arthropoda | Lycosidae | *Hipassasp,1* |
| 19 | Arthropoda | Lycosidae | *Hipassasp,2* |
| 20 | Arthropoda | Lycosidae | *Pardosa brimanica* |
| 21 | Arthropoda | Lycosidae | *Pardosa sumatrana* |
| 22 | Arthropoda | Lycosidae | *Pardosamukundi* |
| 23 | Arthropoda | Lycosidae | *Pardosasp,* |
| 24 | Arthropoda | Salticidae | *Marphissamandala* |
| 25 | Arthropoda | Salticidae | *Phidippus bhimrakshiti* |
| 26 | Arthropoda | Salticidae | *Plexippus paykulli* |
| 27 | Arthropoda | Salticidae | *Plexippus sp* |
| 28 | Arthropoda | Salticidae | *Tellimoniadimidiate* |

| Sr. No | Phylum | Family | Species |
|---|---|---|---|
| 29 | Arthropoda | Thomisidae | *Misumenopus sp,1* |
| 30 | Arthropoda | Thomisidae | *Xysticus bharatae* |
| 31 | Arthropoda | Thomisidae | *Xysticus sp,* |
| 32 | Arthropoda | Thomisidae | *Misumenopus sp,2* |
| 33 | Arthropoda | Tetragnathidiae | *Nephilasp.1* |
| 34 | Arthropoda | Tetragnathidiae | *Nephilasp.2* |
| 35 | Arthropoda | Pholcidae | *Pholcusphalangiodes* |
| 36 | Arthropoda | Uloboridae | *Uloborous sp.* |
| 37 | Arthropoda | Oxyopidae | *Oxyopes bharatae Gajbe, 1999* |
| 38 | Arthropoda | Pisauridae | *Nilus albocinctus (Doleschall, 1859)* |
| 39 | Arthropoda | Salticidae | *Plexippus sp.* |
| 40 | Arthropoda | Salticidae | *Tetragnathidae* |
| 41 | Arthropoda | Salticidae | *Leucauge decorata (Blackwall, 1864)* |
| 42 | Arthropoda | Salticidae | *Tetragnathasp* |
| 43 | Arthropoda | Thomisidae | *Runciniaroonwali Tikader, 1965* |
| 44 | Arthropoda | Uloboridae | *Zosis geniculata (Olivier, 1789)* |

### e) Damselflies and dragonflies

266. Total 9 species of dragonflies were recorded at study area as presented in **Table 4-34**.

*Table 4-34: Dragonfly and Damsel-Fly Diversity of Pune*

| Sr no | Phylum | Family name | Species (scientific name) | IUCN Status |
|---|---|---|---|---|
| 1 | Arthropoda | Libellulidae | *Orthetrumpruinosum (L)* | - |
| 2 | Arthropoda | Libellulidae | *Tramea limbata (L)* | LC |
| 3 | Arthropoda | Libellulidae | *Trithemis festiva (L )* | LC |
| 4 | Arthropoda | Libellulidae | *Bradinopyga geminata (L)* | LC |
| 5 | Arthropoda | Libellulidae | *Orthetrum glaucaum (L)* | - |
| 6 | Arthropoda | Libellulidae | *Diplocodes triviolis (L)* | - |
| 7 | Arthropoda | Libellulidae | *Orthetum caledonicum (L)* | - |
| 8 | Arthropoda | Libellulidae | *Orthetrum sabina (L)* | LC |
| 9 | Arthropoda | Libellulidae | *Trithemis aurora (L)* | LC |

### f) Fish Diversity

267. Various authors have recorded up to 62 species of freshwater fish at Mutha Mula River[38] belonging to 20 families. Mutha River lies about 2.15 km away from the alignment. List of fish diversity from the Study area from the Study area are given as **Table 4-35**.

*Table 4-35: List of Fish diversity in nearby waterbodies*

| Sr No | Family/Species | Abundance | IUCN status |
|---|---|---|---|
| | **Notopteridae** | | |
| 1 | *Notopterus notopterus (Pallas, 1769)* | C | LC |
| | **Cyprinidae** | | |
| 2 | *Catla catla (Hamilton, 1822)* | M | - |
| 3 | *Cirrhinus fulungee (Sykes, 1839)* | C | LC |
| 4 | *Cirrhinus reba (Hamilton, 1822)* | C | LC |
| 5 | *Cirrhinus mrigala (Hamilton, 1822)* | M | - |
| 6 | *Cyprinus carpio Linnaeus, 1758* | M | - |
| 7 | *Gonoproktopterus kolus* | - | - |
| 8 | *Gonoproktopterus thomassi* | - | - |
| 9 | *Labeo ariza* | A | EN |
| 10 | *Labeo boggut (Sykes, 1839)* | R | LC |
| 11 | *Labeo calbasu (Hamilton, 1822)* | M | LC |
| 12 | *Labeo porcellus (Heckel, 1844)* | R | LC |
| 13 | *Labeo rohita (Hamilton, 1822)* | M | LC |

[38] *Muley D. V. and Patil I. M., A Study of Water Quality and Fish Diversity of Pauna River, Maharashtra, J.Aqua.Biol.Vol. 21(1). 2006; 68-75*

| Sr No | Family/Species | Abundance | IUCN status |
|---|---|---|---|
| 14 | *Osteobrama cotio peninsularis Silas, 1952* | M | LC |
| 15 | *Osteobrama neilli (Day, 1873)* | R | LC |
| 16 | *Osteobrama vigorsii (Sykes, 1839)* | C | LC |
| 17 | *Osteochilichthys nashii* | - | - |
| 18 | *Puntius amphibius* | A | DD |
| 19 | *Puntius chola* | - | - |
| 20 | *Puntius jerdoni (Day, 1870)* | R | LC |
| 21 | *Puntius sarana subnasutus* | M | LC |
| 22 | *Puntius sophore (Hamilton, 1822)* | A | LC |
| 23 | *Puntius ticto (Hamilton, 1822)* | A | LC |
| 24 | *Rohtee ogilbii (Sykes, 1839)* | M | LC |
| 25 | *Amblypharyngodon mola* | A | LC |
| 26 | *Salmophasia boopis (Day, 1874)* | A | LC |
| 27 | *Salmophasia novacula* | C | LC |
| 28 | *Barilius bendelisis (Hamilton-Buchanan)* | - | - |
| 29 | *Danio aequipinnatus (McClelland)* | - | - |
| 30 | *Danio devario (Hamilton-Buchanan)* | - | - |
| 31 | *Rasbora daniconius (Hamilton, 1822)* | A | LC |
| 32 | *Crossocheilus cf. latius* | C | LC |
| 33 | *Garra mullya* | | - |
| | **Parapsilorhynchidae** | | |
| 34 | *Parapsilorhynchus tentaculatus* | M | LC |
| | **Balitoridae** | | |
| 35 | *Acanthocobitis mooreh (Sykes, 1839) g* | M | LC |
| 36 | *Nemachilichthys rueppelli* | M | LC |
| 37 | *Nemacheilus anguilla* | M | LC |
| 38 | *Schistura denisoni Day, 1867* | C | LC |
| | **Cobitidae** | | |
| 39 | *Lepidocephalus guntea* | - | - |
| | **Bagridae** | | |
| 40 | *Mystus cavasius* | | LC |
| 41 | *Mystus bleekeri (Day, 1877)* | M | LC |
| 42 | *Aorichthys seengala* | - | - |
| 43 | *Rita pavimentatus* | - | - |
| | **Siluridae** | | |
| 44 | *Ompok bimaculatus (Bloch, 1794)* | C | NT |
| 45 | *Wallago attu (Bloch & Schneider, 1801)* | R | NT |
| | **Schilbeidae** | | |
| 46 | *Proeutropiichthys taakree taakree* | | - |
| | **Sisoridae** | | |
| 47 | *Nangra itchkeea* | - | |
| 48 | *Glyptothorax madraspatanum* | R | EN |
| | **Heteropneustidae** | | |
| 49 | *Heteropneustes fossilis* | - | - |
| | **Belonidae** | | |
| 50 | *Xenentodon cancila (Hamilton, 1822)* | M | LC |
| | **Aplocheilidae** | | |
| 51 | *Aplocheilus lineatus* | - | - |
| | **Poeciliidae** | | |
| 52 | *Gambusia affinis* | - | |
| 53 | *Poecilia reticulata Peters, 1859* | A | LC |
| | **Ambassidae** | | |
| 54 | *Chanda nama Hamilton, 1822* | C | LC |
| 55 | *Parambassis ranga (Hamilton, 1822)* | M | LC |
| | **Cichlidae** | | |
| 56 | *Oreochromis mossambicus* | A | VU |
| | **Mugilidae** | | |
| 57 | *Rhinomugil corsula (Hamilton-Buchanan)* | - | - |
| | **Gobiidae** | | |
| 58 | *Glossogobius giuris (Hamilton, 1822)* | C | LC |
| | **Channidae** | | |
| 59 | *Channa marulius (Hamilton, 1822)* | M | LC |
| 60 | *Channa punctata (Bloch, 1793)* | C | LC |
| | **Mastecembalidae** | | |

| Sr No | Family/Species | Abundance | IUCN status |
|---|---|---|---|
| 61 | *Mastacembelus armatus* | C | LC |
| | **Belontiidae** | | |
| 62 | *Pseudosphromenus cupanus* | - | - |

### 6. Gardens

268. There are several parks in Pune locality. Most of the gardens are well maintained with beautiful arrangement of trees, shrubs & climbers with all the aspects. There are around 38 gardens present in and around project site. The list of gardens in the study area is as **Table 4-36**.

*Table 4-36: List of Gardens nearest to Alignment*

| Code | Name of Garden | Distance | Direction | Latitude | Longitude |
|---|---|---|---|---|---|
| 1 | Punyashlok Rajmata Ahilyadevi Holkar Udyan, More Baug Katraj | 183.5 | W | 18°27'1.78"N | 73°51'21.91"E |
| 2 | Jawaharlal Nehru Stadium | 240 | W | 18°30'8.37"N | 73°51'18.99"E |
| 3 | Rajiv Gandhi Zoological Park and Wildlife Research Center | 241 | E | 18°27'9.25"N | 73°51'38.15"E |
| 4 | Sarasbaug | 514 | W | 18°30'2.77"N | 73°51'10.84"E |

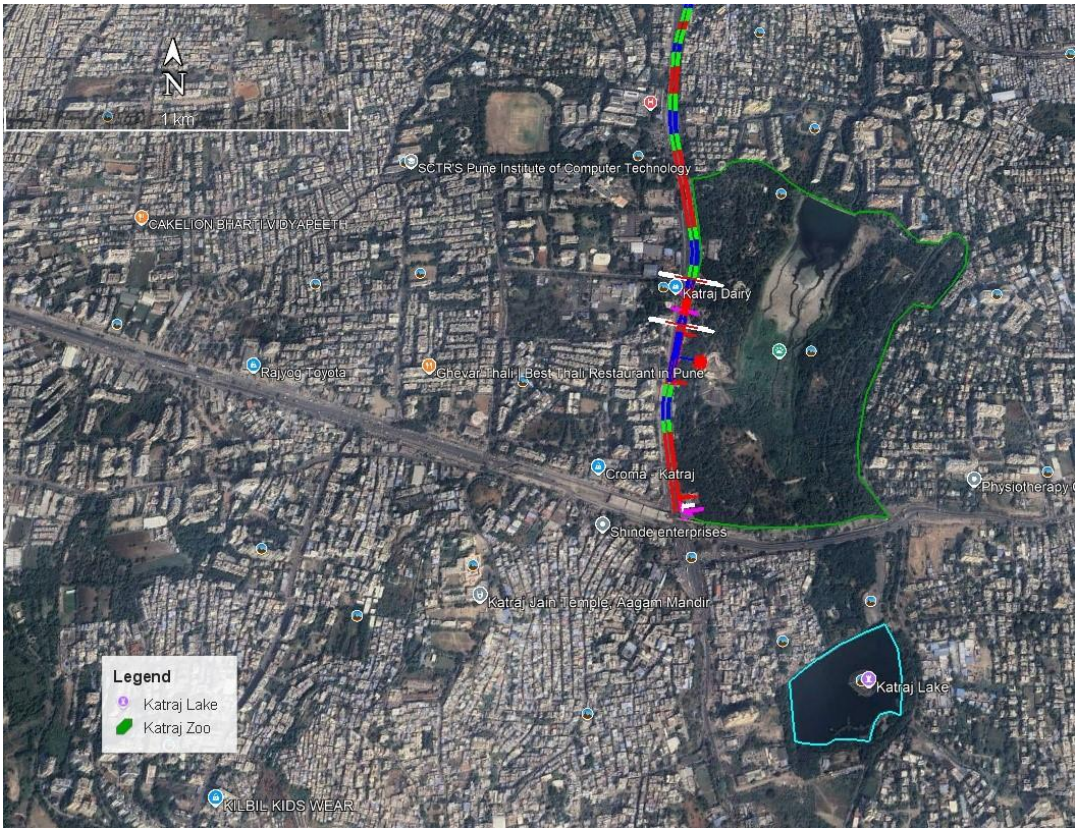
### 7. Protected Areas (Zoo)

269. The proposed Swargate–Katraj underground metro alignment traverses a highly urbanized area of Pune city. As presented in **Table 4-37**, the Rajiv Gandhi Zoological Park and Wildlife Rescue Centre (commonly known as Katraj Zoo) and the Katraj Lake are located adjacent to the southern end of the alignment near the proposed Katraj station. The zoo, managed by the Pune Municipal Corporation and regulated under the Central Zoo Authority (CZA), serves as an ex-situ conservation facility and houses a wildlife rescue and rehabilitation centre. Katraj Lake, situated within the same area, is an important urban waterbody that supports aquatic biodiversity and avifaunal populations. Although neither site is notified under the Wildlife (Protection) Act, 1972, both are considered environmentally sensitive receptors due to their ecological, conservation, and social significance.

*Table 4-37: List of Nearest Protected and Environmentally Sensitive Areas*

| Sr. No. | Protected / Sensitive Receptor | District | Approx. Distance from Alignment | Why Sensitive | Protection / Status |
|---|---|---|---|---|---|
| 1 | Rajiv Gandhi Zoological Park & Wildlife Rescue & Rehabilitation Centre (Katraj Zoo) | Pune | Adjacent (within 0–200 m of Katraj station area) | Ex-situ conservation facility with captive and rescued fauna; sensitive to noise, vibration, dust, and air emissions | Managed by Pune Municipal Corporation; operates under Central Zoo Authority (CZA) norms |
| 2 | Katraj Lake (Lower Katraj Lake within zoo precinct) | Pune | Adjacent (<100 m) | Freshwater body supporting aquatic life and avifauna; sensitive to runoff, sedimentation, and contamination – mitigated through simple strategies | Urban waterbody of local ecological importance; under Pune Municipal Corporation jurisdiction |

270. As the metro alignment in this section is fully underground, no construction or operational activities are anticipated to have any direct impact on the Rajiv Gandhi Zoological Park or Katraj Lake. These features have been recognized as sensitive receptors in the ESIA; however, due to the underground nature of the project, the integrity and functioning of these areas will remain unaffected.




## H. SOCIO ECONOMIC ENVIRONMENT

271. The growth of any economy is dependent on various factors which include availability of natural resources, presence of feasible climatic conditions, skilled man-power, infrastructural support and a steady orientation and research towards growth and development. A vast range of developmental projects have been carried out in the country. Their sole purpose has been improving the living conditions of the citizens.

272. All developmental activities are primarily centred on human development. However, when a country needs to grow in terms of its industrial and technological standing, infrastructural development is necessary. Infrastructure ranges from providing resources to employing sets of skilled manpower for obtaining the desired results. All these elements when balanced at an international level bring about global development. At a local level when such activities are being scoped, socio-economic surveys play an important role. They not only emphasize the individual standing of a community but also delineate the possible socio-economic outcomes of any project. They include all the elements, from the conditions of the people living in that area to their working status. When developmental activities are about to occur in any area the socio-economic standing of the locality comes to the forefront.

273. In order to study the socio-economic aspects of the communities living in and around proposed project, the required data has been collected, primarily in the form of socio-economic surveys conducted in the Project Study Area. Apart from this, secondary data was gathered from publications of the Census Department, Government of India (2011 Census) and other authenticated sources, as presented in the following sections.

.

274. The possible direct and indirect positive impacts of the project are listed below.

(i) The immediate benefits of Swargate to Katraj (Phase-1 Extension) project will come in the form of employment opportunities for those who are engaged as wage labourers, petty contractors, and suppliers of raw materials.

(ii) The mass transport under Swargate to Katraj (Phase-1 Extension) will encourage the people to shift from their private vehicles to public transport thereby resulting into lesser vehicles on the road contributing to reduction in traffic congestion, pollution, and accidents.

(iii) Due to Swargate to Katraj (Phase-1 Extension) metro rail network, there will be improved linkage between the sub-urban areas to Pune city thereby providing wider work and business opportunities. People can travel from Pune city to industrial zones like Hadapsar MIDC, Saswad etc. to work.

(iv) This will also help people to get faster access to essential services like school, health centre, public distribution system etc.

275. The possible adverse impacts of the Swargate to Katraj (Phase-1 Extension) project are:

(i) Loss of Private land: Despite efforts to minimize the resettlement impact some Private land will be acquired for Phase-I project under the direct purchase policy.

(ii) Loss of Common Property Resource (CPR): A very small number of CPR will be impacted due to metro station construction

(iii) Loss of livelihood: Temporary loss of livelihood is anticipated for the non-titled holder due to relocation to outside the of impact.

### 1. Demographic Features of Pune Municipal Corporation (PMC)

276. Development of the Pune Municipal Corporation dates back to the establishment of industries such as Bajaj Auto and Telco, in the middle of the 20th century. Pune Municipal Corporation (PMC) governs a diverse and rapidly growing population of over 3.1 million. With a high literacy rate of 89%, the city is an educational and IT hub, attracting migrants from across India. Pune's demographics reflect a mix of urban and semi-urban areas, with a blend of upscale localities and slums, shaped by industrialization and urbanization.

277. Demography of Pune District is controlled by socio-economic and environmental conditions. According to the 2011 census, Pune District comprising of 14 tehsils had a population of 9429408 and Pune city had a population ofthe Sex ratio of 948 per 1000 male in urban area. Average literacy rate was 79.89% from which, male literacy was 52.77% and female literacy was 47.22%. Working population of Pune (15–59 yrs. age category) was 38.50%. Demographics of Pune City is presented in **Table 4-38**.

*Table 4-38: Demographics of Pune District39*

| Indicators | Values |
|---|---|
| Population (2011 Census) | 3124458 |
| Male | 1603675 |
| Female | 1520783 |
| Total Number of Households | 742602 |
| Working population (15-59) | 1203153 |
| Total Literacy | 2496324 |
| Male Literacy | 52.77% |
| Female Literacy | 47.22% |

278. The Pune district covers a total area of about 15643 sq.km. of which Pune city accounts for 331.26 sq. km. (2.11%). Pune city is governed by Pune Municipal Corporation (PMC) which comes under Pune Region. As per the 2011 census, population of Pune city is 3124458 of which male and female are 1603675 and 1520783 respectively.

#### (a) Population

279. The current average estimate population (Average Arithmetical Increase Method, Incremental Increase Method, Geometrical Method, Average Population) of Pune city in 2024 is 4264399. The last census was conducted in 2011 and the schedule census for Pune city in 2021 was postponed due to COVID-19 epidemic. The current estimates of Pune city are based on past growth rate.

| Year | Population |
|---|---|
| 2025 | 4264399 |
| 2011 | 3124458 |
| 2001 | 2538473 |
| 1991 | 1727113 |

[39] *Source: www.censusindia.co.in/subdistrict/pune*

280. **Caste-wise population.** Schedule Caste (SC) constitutes 419396 while Schedule Tribe (ST) were 34025 of total population of Pune, as given below:

| Caste | Total | Male | Female |
|---|---|---|---|
| Scheduled Caste (SC) | 419396 | 211200 | 208196 |
| Scheduled Tribe (ST) | 34025 | 17828 | 16197 |

**(b) Education**

281. PMC is a major education hub in India. There are two types of schools in the city; PMC (Government) run schools and private schools run by trusts. These schools are governed by either of the following boards: Maharashtra State Board of Secondary and Higher Secondary Education, Central Board for Secondary Education (CBSE), Indian Certificate of Secondary Education (CBSC) and The International Baccalaureate (IB).

282. Total literates in PMC are 2496324 of which 52.77% are males while 47.22%are females.

**(c) Employment**

283. In Pune Municipal Corporation (PMC), total population is 3124458, out of these individuals were engaged in work activities. 1129388 of workers describe their work as Main Work (Employment or Earning more than 6 Months) while 73765 were involved in marginal activity providing livelihood for less than 6 months, 5408 were cultivators (owner or co-owner) while 5563 were agricultural labourers and 35001 working in household industries. The details are given below.

| Type of Workers | Total | Male | Female |
|---|---|---|---|
| Main Workers | 1129388 | 840185 | 289203 |
| Cultivators | 5408 | 4020 | 1388 |
| Agriculture Labourer | 5563 | 3874 | 1689 |
| Household Industries | 35001 | 19732 | 15269 |
| Other Workers | 1083416 | 812559 | 270857 |
| Marginal Workers | 73765 | 40669 | 33096 |
| Non-Working | 1921305 | 722821 | 1198484 |

**2. Utilities and households**

284. Large number of sub-surface, surface- and overhead- utility services viz. sewers, water mains, storm water drains, gas pipe lines, telephone/ communication cables, Overhead power transmission lines, power cables, traffic signals, etc. exists all along the proposed alignment. These utility services are essential and have to be maintained in working order during different stages of construction, by temporary/permanent diversions 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. Accordingly, overhead utilities were identified during physical survey of at the DPR stage itself. Moreover, liaison with concerned utility owners was made for identification and mapping of various underground utilities. No trenching / GPR survey etc. was conducted for underground utilities.

285. The Swargate to Katraj (Phase-1 Extension) will be mostly running through the urban area at an underground level. The alignment will need to negotiate underground water pipelines, sewage pipelines, underground telecommunication cables, elevated power lines, sewage pipelines, etc. which are all perpendicular as well as parallel to the alignment. The alignments will also cross storm water drains in some locations, which are not considered part of Utilities.

286. Swargate to Katraj (Phase-1 Extension) alignments pass number of educational and medical institutions located within 100 meters from the alignment centre. None of the sensitive receptors will be directly impacted by the project alignments, since the piers and viaducts are all planned on the median of the road or on the service road.

## 3. Physical Cultural Resources

287. Physical Cultural Resource/s (PCR/s) is/are defined as movable or immovable objects, sites, structures, groups of structures, and natural features and landscapes that have archaeological, paleontological, historical, architectural, religious, aesthetic, or other cultural significance. Physical cultural resources may be located in urban or rural settings and may be above or below ground or under water. Their cultural interest may be at the local, provincial, national, or international level.[40]

288. Examples of PCR are: (i) human-made objects such as buildings of architectural or historical interest, religious buildings, and historic roads, bridges, and walls; (ii) natural sites and landscapes such as paleontological sites, natural landscapes of outstanding aesthetic quality, and wellsprings and wells of spiritual significance; (iii) combined human-made and natural features such as cave paintings, sites used for religious or social functions, and places of pilgrimage. Other examples of PCR include sites used for religious or social functions such as weddings, funerals or other traditional community activities, etc.

289. No known protected archaeological monuments/sites nor heritage assets are located on or along the proposed alignment.

290. List of the resources of religious and cultural nature, and community resources are located within 100-150m from the Swargate to Katraj alignments are presented in **Annexure-12** (List of Sensitive Receptors)

## 4. Socio-Economic Profile of the PAPs

291. The socio-economic condition of a place is very much dependent on various factors which include availabilityof natural resources, presence of feasible climatic conditions, skilled man-power, infrastructural support and a steady orientation and research towards growth and development.

292. In order to study the socio-economic aspects of the communities living in and aroundproposed Pune metro extension line of Phase-I, the required data has been collected, primarily in the form of socio- economic surveys conducted in the Project Study Area.

293. Along with the census data collection, data on demographic and socio-economic profile of the PAPs were collected for their social mapping and understanding of the standard of living. The following section describes the socio-economic profile of 34 affected Families including the tenants in the structures.

### (a) Number of Project Affected Persons (PAPs)

294. There are 265 individual PAPs in total 71 HHs being affected by the project, which includes 140 (52.83%) male and 125 (47.17%) female. The average family size is 3.90 and the sex ratio among the PAPs is 893. The details of PAPs being affected in the project are presented in the **Table 4-39**:.

*Table 4-39: Number PAPs HHs Members*

| Sl. No. | Categories of APs | No. of Persons | % |
|---|---|---|---|
| 1 | Male | 140 | 52.83 |
| 2 | Female | 125 | 47.17 |
| **Total** | | **265** | **100** |

### *(b)* Social Categories of the PAPs

295. The social stratification of all the affected HHs in the project area indicates dominance of General Caste population with 34 (47.89%) HHs followed by 22 (30.99%) OBC and Scheduled Caste population with 12 (16.90%) HHs. There are 3 other entities not applicable for social categories. There is no Scheduled Tribe (ST) family affected under the project. The details of social grouping in the project area are presented in the **Table-4-40**

[40] *Source: Campbell, Ian (2009) - Physical cultural resources safeguard policy: guidebook (English). Washington, D.C.: World Bank Group. [http://documents.worldbank.org/curated/en/520411468149683036/Physical-cultural-resources-safeguard-policy-guidebook]*

*Table-4-40: Social Categories of PAPs from affected HHs*

| Sl. No. | Description of the Caste | No. of Families | % |
|---|---|---|---|
| 1 | Scheduled Caste | 12 | 16.90 |
| 2 | Other Backward Caste | 22 | 30.99 |
| 3 | General Caste | 34 | 47.89 |
| 4 | Other Entities (Society,Hospital,College) | 03 | 4.23 |
| **Total** | | **68** | **100** |

### *(c)* Religious Categories of the PAPs

296. Majority of affected persons belong to Hindu religion, (90.14%), Muslim (4.23%) and Buddhist (1.41%). The religious categories of PAPs are given below in **Table-4-41**

*Table-4-41: Religious Categories of PAPs from the affected HHs*

| Sl. No. | Description of the Religion | No. of Families | % |
|---|---|---|---|
| 1 | Hindu | 64 | 90.14 |
| 2 | Muslim | 3 | 4.23 |
| 3 | Buddhist | 1 | 1.41 |
| 4 | Others | 3 | 4.23 |
| **Total** | | **71** | **100** |

### *(d)* Vulnerable PAPs in the Project

297. According to project census survey there are 35 HHs enumerated as vulnerable HHs. In this project vulnerable group includes 12 SC HHs and 10 women headed HHs and followed by other vulnerable household details are presented in the **Table-4-42**

*Table-4-42: Vulnerable Categories of affected HHs*

| Sl. No. | Vulnerability Type | No. of Families | % |
|---|---|---|---|
| 1 | Scheduled Caste Families | 12 | 34.29 |
| 2 | Women Headed Families | 10 | 28.57 |
| 3 | Elderly headed Household | 01 | 2.86 |
| 4 | Differently able Household | 02 | 5.71 |
| 6 | NTH not falling under above category | 10 | 28.57 |
| **Total** | | **35** | **100** |

### *(e)* Annual Income Level of the PAPs

298. There are only 27 HHs (39.71%) having an average annual income below Rs. 242,000. The survey reveals that 32 (47.06%) families are earning above Rs. 242,000 and below 300,000; and 6 (8.82%) families were reported to be earning more than Rs. 300,000 per year. And there are 3 families (4.41) earning more than 500000. Rest of the three PAP (entities) are not given in the table due to its nature. The average income level of HHs in the project area is summarized in the **Table-4-43**

*Table-4-43: Income Level of PAPs*

| Sl. No. | Annual Income Categories in (Rs.) | No. of Households | % |
|---|---|---|---|
| 1 | Below 242000 | 27 | 39.71 |
| 2 | Above 242,000 and Below 300,000 | 32 | 47.06 |
| 3 | Above 300000 | 6 | 8.82 |
| 4 | Above 500000 | 3 | 4.41 |
| **Total** | | **68** | **100** |

### *(f)* Educational Status of PAPs

299. The educational status of PAPs reveals that there are 5.66 % who are illiterate. Among the PAPs, 30.36% are matric and 18.62% are graduate This data excludes the children below 6 years. The gender segregated details of educational status of PAPs are presented in the **Table-4-44**.

*Table-4-44: Educational Status of PAPs*

| Sl. No | Educational Status of APs | Male | Female | Total | % |
|---|---|---|---|---|---|
| 1 | Illiterate | 3 | 11 | 14 | 5.66 |
| 2 | Literate | 2 | 7 | 9 | 3.65 |
| 3 | Up to middle | 31 | 40 | 71 | 28.74 |

| | | | | | |
|---|---|---|---|---|---|
| 4 | Below matric | 21 | 10 | 31 | 12.55 |
| 5 | Matric | 49 | 26 | 75 | 30.36 |
| 6 | Graduate | 22 | 24 | 46 | 18.62 |
| 7 | Post Graduate | 1 | 0 | 1 | 0.41 |
| **Total** | | **129** | **118** | **247** | **100** |

### *(g)* Occupational Status of PAPs

300. The occupational pattern of PAPs excluding children below 6 years, student, housewife and unemployed, reveals that 86.89% PAPs is engaged in business activities. Among other categories, 7.38 % engaged in service, and 5.73% are labour. Affected persons' livelihoods are not primarily land based. The details of occupational status of PAPs are summarized in the **Table-4-45**

*Table-4-45: Occupational Status of PAPs*

| Sl. No | Occupational Status of PAPs | Male | Female | Total | % |
|---|---|---|---|---|---|
| 1 | Service | 5 | 4 | 9 | 7.38 |
| 2 | Business | 77 | 29 | 106 | 86.89 |
| 3 | Labour | 7 | 0 | 7 | 5.73 |
| **Total** | | **89** | **33** | **122** | **100** |

301. **Status of School Going Children** as per the sample socio-economic survey of 54 Families, 55 children are currently going to school and colleges of various standards. As presented in **Table-4-46**

*Table-4-46: School Going Status of Children*[41]

| Sl. No. | Education | No of Children | % |
|---|---|---|---|
| 1 | Primary School (up to Class V) | 12 | 21.81 |
| 2 | Middle School (Class VI - VIII) | 5 | 9.09 |
| 3 | Secondary School (Class IX - X) | 6 | 10.90 |
| 4 | Higher Secondary (Class XI - XII) | 10 | 18.18 |
| 5 | College | 22 | 40.00 |
| 6 | University | 0 | 0.00 |
| **Total** | | **55** | **100** |

302. **Source of Income by PAP.** Out of 71 surveyed Families, 71(100%) are earning their livelihoods from commercial activities, as **Table-4-47**

*Table-4-47: Major Sources of Income by Surveyed Families*

| Sl. No. | Source of Income | Number | % |
|---|---|---|---|
| 1 | Commercial | 71 | 100 |
| 2 | Service (Pvt./Govt.) | 0 | 0.00 |
| **TOTAL** | | **71** | **100** |

303. **Decision Making.** Women were asked about their role in decision-making on financial and social matters of the household. It was revealed that 100% of Families, women have always had a role in the financial and social decision-making process.

*Table 4-48: Participation of Women in Decision Making*[42]

| S.N. | Response | Financial Decision Making (HH) | % | Social Decision Making (HH) | % |
|---|---|---|---|---|---|
| 1 | Yes | 56 | 100 | 56 | 100 |
| 2 | No | 0 | 0.00 | 0 | 0.00 |
| **Total** | | **56** | **100** | **56** | **100** |

[41] *Source: Sample Socio-economic Survey, 2024*
[42] *Source: Sample Socio-economic Survey, 2025*

# Chapter 5. ANTICIPATED IMPACTS AND MITIGATION MEASURES

## A. METHODOLOGY

304. The methodology of assessing environmental impacts due to the project involved clear identification of the environmental components that will be impacted, the type of impacts, the assessment area where the impacts will be felt and defining the criteria for assessing the significance of each type of impact. After defining these aspects, a screening of project impacts during design and pre-construction (D) stage, construction (C) stage and operation (O) stage of the project was carried out to identify the minor, moderate and major impacts. This would guide development of mitigation measures and ensure that residual impacts are minimized to the maximum extent possible.

305. The Social Impact Assessment (SIA) methodology included a screening / reconnaissance survey during the inception phase using the corridor alignment map, followed by a census and baseline socio-economic survey of potentially affected households based on plot data provided by Maha Metro. This helped document the population, assets, and livelihoods at risk, with a cut-off date of 18th June 2024 for non-title holders. A census-based socio-economic survey established a baseline for assessing impacts on income, assets, cultural networks, and common property resources. Additionally, public consultations and focus group discussions were held to incorporate community feedback into the Social Impact Management Plan (SIMP).

## B. IDENTIFICATION OF ENVIRONMENTAL COMPONENTS

306. The identification of environmental components impacted by the project, involves identifying Valued Environmental Components (VEC) of the physical, biological, and human environments, that are at risk of being impacted by the project. The VECs for this project which are based on the collected environmental baseline data include:

(i) Physical environment – air quality and greenhouse gas emissions, land and soil, surface water quality and quantity, and groundwater quality and quantity;
(ii) Biological environment – terrestrial and aquatic vegetation, mammals, avifauna, and ecologically important areas;
(iii) Social environment – private land and buildings, public infrastructure including utility structures, noise and vibration levels, cultural / heritage buildings, and occupational health and safety for the construction workers and local community living within the vicinity of the project area.

307. **Type of impact on the VECs.** The type of impact can be described as:

(i) **Positive**: Improvement in the quality of the VECs because of the project;
(ii) **Negative**: Degradation or reduction in the quality of the VECs because of the project;
(iii) **Neutral**: No noticeable change in VECs.

308. **Area of impact assessment.** The area covered for assessing direct project impacts includes:

(i) Core Study Area of 500 m radial distance around each of the proposed alignments was studied for **Direct Impacts**;
(ii) In addition, Buffer Study area of 2 km around each of the proposed alignment was studied for **Indirect impacts**.
(iii) Sensitive receptors in an area of 100 meter on either side of the proposed alignments;

309. **Significance of impacts.** The assessment of the significance of the impacts on the VECs requires understanding the sensitivity of each VEC within the project context; the duration of impact; the extent of impact, the intensity of impact and the likelihood of impact. The following sections elaborate these.

310. **Sensitivity of VEC.** The sensitivity of a VEC can be determined by the existing conditions of the VEC within the project area and existence of important VEC's within the project areas. Sensitivity of each VEC is described as high, medium or low as described below.

(i) **Low.** No environmentally important areas (such as protected areas, natural or critical habitat areas, heritage sites, places of worship etc.) are located within the direct and indirect impact zone. The quality of existing conditions of VECs is good or fair;
(ii) **Medium.** There are one or more environmentally important areas within the indirect

impact zone of the project area. The quality of existing conditions of VECs is good or fair;

(iii) **High.** There are one or more environmentally important areas within the direct impact zone of the project area. The quality of existing conditions of the VECs is poor or degraded (such as poor air quality, high noise levels, poor water quality), which makes the VEC highly susceptible to further deterioration.

311. Based on baseline conditions in the project area and sensitivity criteria, the level of sensitivity of each VEC is provided in **Table 5-1**.

*Table 5-1: Sensitivity of VECs in the project area*

| Sr. No. | Valued Environmental Components (VECs) | Sensitivity Level | Remarks |
|---|---|---|---|
| **1.0** | **Physical Environment** | | |
| 1.1 | Air Quality | High | During the baseline survey value of PM2.5 and PM10 ranges between 21.74 to 37.85 µg/m$^3$ and 47.14 to 87.41 µg/m$^3$ respectively, whereas $SO_2$ and NOx values vary between 14.85 to 25.74 µg/m$^3$ and 15.54 to 34.85 µg/m$^3$ respectively. CO values vary between 0.08 to 1.85 mg/m$^3$. |
| 1.2 | GHG Emission | Medium | Vehicular emission in the construction phase is expected to be the main source of GHG pollution. |
| 1.3 | Surface Water quality | Medium | Water quality of the surface waters in the project area is sub-par due to high to moderate levels of organic and inorganic matter. |
| 1.4 | Groundwater quality | Medium | Water quality of the groundwater in the project area is moderate |
| 1.5 | Groundwater quantity | Safe Zone | Pune is not facing major groundwater shortages |
| 1.6 | Land degradation and pollution | Medium | The project alignment is following the median of the existing roads which pass mainly through residential and commercial areas |
| **2.0** | **Biological Environment** | | |
| 2.1 | Trees, terrestrial and aquatic vegetation | High | A total of 175 trees are likely to be affected in the construction of the project alignment. |
| 2.2 | Terrestrial fauna (mammals, birds, insects) | Low | No nesting / roosting sites were observed in vicinity of the proposed alignments (especially on trees likely to be affected) during the survey |
| 2.3 | Ecologically important areas | Low | There are no Protected / Eco-sensitive areas located within 10 km radial distance from alignment. However, Rajiv Gandhi Zoological Park and wildlife rescue centre is adjacent to the alignment at Katraj. |
| **3.0** | **Social Environment** | | |
| 3.1 | Private land and buildings | Medium | Approximately 54 structures (Comprising 52 HH/Families) will be affected, and approx. 4630.99 m$^2$ of land needs to be acquired |
| 3.2 | Public property / infrastructure / utility structures | Medium | The alignment will cross 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, footbridges etc. |
| 3.3 | Noise | High | The ambient noise levels in general meet the CPCB and WHO limits, except at a few locations. However, some residential buildings and sensitive receptors are close to the proposed alignments. |
| 3.4 | Vibration | Medium | There are several structures located near the proposed alignments. Regular traffic such as buses and trucks on the existing roads add to vibration levels. However, vibration analyses show that all levels are within National and International Limits |
| 3.5 | Occupational Health & Safety | Medium | All construction activities will be carried out in accordance with established occupational health and safety standards. Appropriate measures will be implemented to minimize risks to workers, including the use of personal protective equipment (PPE), regular |

| Sr. No. | Valued Environmental Components (VECs) | Sensitivity Level | Remarks |
|---|---|---|---|
| | | | safety training, and site supervision to ensure a safe working environment. |
| 3.6 | Public health and safety | Medium | Public health and safety measures include traffic management plans, dust and noise control, proper waste disposal, and clear signage to minimize risks to the community during project activities. |
| 3.7 | Physical Cultural Resources (PCR) | Low | There are a few religious places/sensitive receptors located close to the alignment (within 150m on either side) which are identified and presented in **Annexure-12**. |

312. **Duration of the impact**: Duration means the time dimension of the impact on the VECs. The terms permanent, temporary and short-lived are used to describe the duration of impact:

(i) **Short-lived:** The impact disappears promptly;
(ii) **Temporary:** The impact is felt during one project activity or, at most, during the construction period of the project;
(iii) **Permanent:** The impacts are felt throughout the life of the infrastructure.

313. **Extent of impact:** The extent of impact entails the spatial scale of impact on one or more of the VECs. The terms PMRC (Pune Metro Rail Corporation), local and on-site are used to describe the area of impact:

(i) **On-site:** The impact is felt within the direct impact zone;
(ii) **Local:** The impact is felt within the indirect impact zone;
(iii) **NMA:** The impact is felt beyond the indirect impact zone.

314. **Intensity of impact**: The intensity or seriousness of an impact entails understanding the repercussion or risks posed by the impact. This is a subjective criterion which is defined as high, medium or low as below:

(i) **High:** The severity of impact is high if grave repercussions are expected as a result of the impact due to any of the following or similar situations: the impact will be felt by a large number of people or receptors; the receptors are highly sensitive; the impacts will cause serious health issues; there is already a history of complaints from the project area and people have raised significant concerns during public consultation; some of the VEC in the project area already severely degraded and maybe further worsened by the project; there will be a significant change in one or more VEC because of the project;
(ii) **Medium:** The severity of impact is medium due to any of the following or similar situations: the impact will be felt by a small number of people; some receptors are affected but they are not sensitive; the impact will not cause serious health issues; some concerns were raised during public consultations, but they were not significant; there will be minor changes in one or more VEC because of the project;
(iii) **Low:** The severity of impact is low due to any of the following or similar situations: the impact will not be felt by anyone; no or limited receptors are affected; no concerns were raised during public consultations; there will be no noticeable changes in one or more VEC because of the project.

315. Based on the sensitivity of the VEC and the rating of duration, extent, intensity of impact as described above and bearing in mind the likelihood of occurrence of the impact, the overall significance of each impact was classified as major, moderate or minor as demonstrated in **Table 5-2**.

*Table 5-2: Criteria for Rating the Significance of Adverse Impacts*

| Significance | VEC Sensitivity | Duration | Extent | Intensity |
|---|---|---|---|---|
| Minor | Medium or Low | Short-lived or Temporary | Limited, Local or Regional | Low |
| | Low | Permanent | Limited | Low |
| Moderate | High or Medium | Temporary | Limited, Local or Regional | Medium |
| | Medium | Permanent | Limited | Medium |
| Major | High | Permanent or Temporary | Limited, Local or Regional | High |

| | | | | |
|---|---|---|---|---|
| | High or Medium | Permanent | Local or Regional | Medium |

## C. SCREENING OF IMPACTS

316. Based on the rating criteria provided in **Table 5-2** environmental impacts anticipated during the project design and pre-construction (D) stage, construction (C) stage and operation (O) stage were screened for their level of significance as demonstrated in **Table 5-3** below. If for example, the sensitivity of a VEC is considered high, as per **Table 5-1**, and a large number of people will be permanently affected on a regional scale, the impact will be considered highly significant. On the other hand, if a VEC is medium sensitive and only a few receptors will be temporarily affected on a localized scale, the significance of the impact will be minor. The screening was carried out for impacts that are expected without mitigation. Hence, it guided the identification of impacts that need mitigation and clearly point out significant / major negative impacts that need to be prioritized for mitigation.

317. The significance of each environmental impact or project activity is indicated in the cells in the second to last column of **Table 5-3**, while the last column shows the significance of anticipated residual impacts after mitigation. Red indicates a major negative impact, orange indicates a moderate negative impact; yellow indicates a minor negative impact and green indicates a positive impact. The following section discusses the details of impacts on each of the VECs in line with the identification of major, moderate, and minor impacts in the screening matrix. Major impacts have been given priority for identification of mitigation measures to ensure that residual impacts are minimized to the extent possible.

*Table 5-3: Screening of Environmental Impacts*

| Sl | Parameter | Adverse Impacts | | | | | | | | | | | | Significance before mitigation | Residual impacts after mitigation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Duration | | | Extent | | | Intensity / Risk | | | Likelihood | | | | |
| | | S | T | P | O | L | R | L | M | H | U | L | D | | |
| **A.** | **Impacts due to Location and Design (Pre-Construction)** | | | | | | | | | | | | | | |
| 1 | Degradation of surface water quality due to sewage discharge | | | * | * | | | * | | | | * | | Moderate | Minimal -ve |
| 2 | Use of surface water for stations | | | * | | * | | * | | | * | | | Moderate | Minimal -ve |
| 3 | Degradation of groundwater quality due to location of stations and inclusion of sewage treatment | | | * | | * | | | * | | * | | | Minor | Neutral |
| 4 | Location of construction yards | | * | | * | | | | * | | | | * | Minor | Minimal -ve |
| 5 | Location of muck disposal sites | | | * | * | | | * | | | | | * | Moderate | Minimal -ve |
| 6 | Location of project alignment in areas with vegetation and trees. | * | | | * | | | * | | | * | | | Minor | Minimal -ve |
| 7 | Impact of tunnel | | | * | | * | | | | * | | * | | Major | Moderate –ve |
| 8 | Transfer of 2.0277 ha government land and acquisition of 0.6001 ha private land. And impacted 52 structures | | | * | | * | | | * | | | | * | Moderate | Minimal -ve |
| 9 | Aesthetic impact: Limited reduction with proposed sleek structures | | | * | | * | | | | * | | * | | Moderate | Minimal -ve |
| 10 | Metro noise adds to baseline noise which is already high. Significant reduction with proposed design features | | | * | * | | | | | * | | * | | Major | Moderate –ve |
| 11 | Metro vibration adds to baseline vibration level. Limited reduction with proposed design features | | | * | * | | | * | | | | * | | Major | Minimal -ve |
| 12 | Design of Health and Safety features in stations and trains for construction workers and operating staff | | | * | * | | | | * | | | | * | Moderate | Moderate –ve |
| 13 | Safety risks due to flooding and earthquakes | | | * | * | | | * | | | * | | | Minor | Minimal –ve |
| 14 | Transmission of communicable diseases including HIV/AIDS, Covid-19, etc. | | | * | * | | | | | * | * | | | Moderate | Minimal –ve |
| 15 | Possible impact on religious or cultural buildings / structures within 100 meters of the alignments | | | * | | * | | | * | | * | | | Minor | Neutral |
| 16 | Increased energy demand from grid, causing additional GHG emissions | | | * | | | * | * | | | | | * | Moderate | Minimal –ve |
| 17 | Muck generation and disposal | | | | | | | | | | | | | Major | Moderate –ve |
| 18 | Vibration due to tunnelling | | | | | | | | | | | | | Moderate | Minimal –ve |
| **B.** | **Impacts due to Project Construction** | | | | | | | | | | | | | | |
| 1 | Sourcing of construction material; Emissions from machinery and vehicles; site operations; operations in construction yard; dumping at muck and waste disposal sites | | * | | * | | | | * | | | | * | Major | Minimal -ve |
| 2 | Degradation of surface- and ground-water quality due to run-off and waste water from construction sites, | | * | | * | | | * | | | | * | | Moderate | Minimal –ve |

| SI | Parameter | Adverse Impacts | | | | | | | | | | | | Significance before mitigation | Residual impacts after mitigation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Duration | | | Extent | | | Intensity / Risk | | | Likelihood | | | | |
| | | S | T | P | O | L | R | L | M | H | U | L | D | | |
| | construction yards, waste disposal sites, Labour camps, drainage changes due to C&D waste disposal sites, siltation of water bodies | | | | | | | | | | | | | | |
| 3 | Use of surface water for construction purposes | | | * | | * | | | * | | * | | | Moderate | Neutral |
| 4 | Reduction of ground water quantity due to dewatering activities | * | | | * | | | * | | | * | | | Moderate | Neutral |
| 5 | Soil erosion due to site clearing and levelling | | * | | * | | | * | | | * | | | Minor | Minimal –ve |
| 6 | Soil pollution due to various activities at construction yards, C&D and hazardous waste disposal sites | | * | | | * | | | * | | | | * | Moderate | Minimal –ve |
| 7 | Removal of 9 trees, damage to maintained trees and bushes | | | * | * | | | | * | | | | * | Moderate | Moderate –ve |
| 8 | Impact on avifauna due to height of viaduct, construction noise and vibration and lighting | | | * | * | | | * | | | | | * | Moderate | Neutral |
| 9 | Diversions of utility services and possible outages | | * | | | * | | * | | | | * | | Moderate | Neutral |
| 10 | Traffic diversions | | * | | * | | | | | * | | | * | Moderate | Minimal –ve |
| 11 | Temporary use of land for construction, Labour camps and traffic detours | | * | | * | | | | * | | | | * | Moderate | Neutral |
| 12 | Noise and Vibration due to operation of construction equipment and vehicular movement | | * | | * | | | | * | | | | * | Major | Minimal –ve |
| 13 | Impacts due to possible poor conditions in Labour camp, working at height and with heavy machinery, risk of transmission of communicable diseases including Covid-19 | | * | | * | | | * | | | * | | | Moderate | Moderate –ve |
| 14 | Public exposure to traffic, noise, vibrations, dust and communicable diseases including Covid-19 | | * | | * | | | | * | | | * | | Moderate | Minimal –ve |
| 15 | Chance finds of objects of physical or cultural value | | * | | * | | | * | | | * | | | Minor | Neutral |
| 16 | Impact on Protected Areas (Zoo and Katraj Lake) | | | | | | | | | | | | | Moderate | Minimal –ve |
| **C.** | **Impacts due to Project Operation** | | | | | | | | | | | | | | |
| 1 | Degradation of water quality due to sewerage discharge | | | * | | * | | | * | | * | | | Minor | Minimal –ve |
| 2 | Increased water demand from public water supply | | | * | | * | | | * | | * | | | Moderate | Minimal –ve |
| 3 | Land degradation due to insufficient waste management | | | * | * | | | * | | | * | | | Moderate | Neutral |
| 4 | Noise due to metro operations | | | * | * | | | | * | | | | * | | |
| 5 | Vibration due to metro operations | | | * | * | | | * | | | | | * | Major | Minimal –ve |
| 6 | Accidents, electromagnetic interference, exposure to electromagnetic radiation and communicable diseases | | * | | | * | | | * | | | * | | Moderate | Minimal –ve |
| **D.** | **Positive Impacts during Operation phase** | | | | | | | | | | | | | | |
| 1 | Reduced air pollution due to modal shift towards public | | | * | | | * | | | * | | | * | - | Major +ve |

| Sl | Parameter | Adverse Impacts | | | | | | | | | | | | Significance before mitigation | Residual impacts after mitigation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Duration | | | Extent | | | Intensity / Risk | | | Likelihood | | | | |
| | | S | T | P | O | L | R | L | M | H | U | L | D | | |
| | transport | | | | | | | | | | | | | | |
| 2 | More efficient and environmentally friendly movement of people | | | * | | * | | | | * | | | * | - | Major +ve |
| 3 | Groundwater recharge due to rainwater harvesting | | | * | | | * | | | * | | | * | - | Major +ve |
| 4 | Growth of compensated trees | | | * | | * | | | | * | | | * | - | Moderate +ve |
| 5 | Economic opportunities | | | * | | * | | | | * | | * | | - | Moderate +ve |

***Note:***

*Impact: +ve = positive; -ve = negative*

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

*Extent: O = On-site; L = Local; R: Regional (Pune Municipal Area)*

*Intensity: L = Low; M = Medium; H = High*

Likelihood: U: Unlikely; L: Likely; D: Definite

: positive impact; : minor negative impact; : moderate negative impact; : major negative impact;

## D. IMPACTS PRIOR TO MITIGATION

318. **Table 5-3** shows that during the pre-construction phase the most significant impacts (before mitigation) to be expected are:

(i) Degradation of surface water quality due to sewage discharge (Moderate)
(ii) Use of surface water for stations (Moderate)
(iii) Location of muck disposal sites (Moderate)
(iv) Impact of tunnel (Major)
(v) Aesthetic impact due to location and design (Moderate);
(vi) Noise impact due to choices in design (Major);
(vii) Vibration impact due to choices in design (Major);
(viii) Design of Health and Safety features in stations and trains for construction workers and operating staff (Moderate)
(ix) Impact on Health and Safety due to communicable diseases such as Covid-19 (Moderate)
(x) Increased energy demand from grid, causing additional GHG emissions (Moderate)

319. During construction phase the following impacts are of major significance:

(i) Impact on air quality due to emissions from machinery, vehicles and site operations, and due to sourcing of construction material (Major);
(ii) Impact due to increased noise and vibration from construction equipment (Major)
(iii) Degradation of surface- and ground-water quality due to run-off and waste water (Moderate);
(iv) Impact due to use of surface water for construction and dewatering of groundwater, if any (Moderate);
(v) Soil pollution due to various activities at construction yards, C&D and hazardous waste disposal sites (Moderate);
(vi) Impact due to removal of trees during construction phase (Moderate);
(vii) Impact due to diversions of Utility services and traffic diversions (Moderate);
(viii) Impact on land due to temporary use of land for construction, Labour camps and due to dumping at excavate and waste disposal sites (Moderate);
(ix) Impacts due to possible violation of Occupational Health & Safety norms at construction sites, labour camps, etc. (Moderate);
(x) Impact due to public exposure to traffic, noise, vibrations, dust and communicable diseases (Moderate).
(xi) Possible nuisance to residents due to perceptible vibrations and noise during night works.
(xii) Vibration can cause sleep disturbance and nuisance for residents, especially during night operations.
(xiii) Continuous vibration may affect foundations of old, dilapidated, or heritage structures in the influence zone.
(xiv) If muck management is not properly planned, it may lead to additional land requirement issues for its temporary storage and final disposal..
(xv) Muck Handling, loading, and transportation of muck creates fugitive dust emissions.
(xvi) Continuous movement of dump trucks for muck transport causes traffic jams, accidents, and road wear & tear.
(xvii) If muck not covered, the material gets windblown, worsening dust nuisance.
(xviii) If muck contains mixed construction debris, it may produce leachate or contamination when exposed to rain.

320. During the operational phase the only major impact that can be expected is an increase in noise and vibration due to operation of the metro.

321. Additionally, various positive impacts are also anticipated due to construction / operation of the metro like:

(i) Reduced air pollution due to modal shift towards public transport;
(ii) More efficient and environmentally friendly movement of people;
(iii) Groundwater recharge due to rainwater harvesting;
(iv) Plantation of compensatory afforestation's;
(v) Creation of Economic opportunities.

## E. ANTICIPATED IMPACTS AND MITIGATION MEASURES

322. In the following Sections, the identified impacts on each of the VECs are described including the measures that will be taken to mitigate these impacts. If the expected impacts cannot be mitigated completely the residual impact is described including its significance.

### 1. Air Quality

323. A major benefit of metro is reduction in ambient air pollution and greenhouse gases with consequent costs of health and accidents due to shift of passengers from usage of current road-based modes. Based on number of daily vehicle kilometre reduction, daily reduction in fuel (diesel and petrol) consumption has been estimated.

324. **Impacts.** Air pollution will be caused at construction sites during excavation, demolition, operation of construction equipment, blasting in rock; on routes of transportation of construction material, precast elements, excavated material and waste; at construction yards during aggregate crushing / screening, construction material and precast elements; at disposal sites during disposal of waste and excavated material. Emissions from DG sets, emissions from fuel and other hazardous chemicals are other sources of pollution. Open burning of solid waste and solid fuel in labour camps could cause air pollution. The pollution is in terms of fugitive dust and particulate and chemical emissions from trucks. Air pollution from road-based vehicles, especially particulate matter, is found to cause diseases of brain, heart, lungs and kidneys. Also Dust emissions during tunnel excavation can deteriorate air quality, causing respiratory problems and discomfort to workers. Prolonged exposure may also reduce visibility and create unsafe working conditions.

325. 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 excavate and waste disposal site. The estimate of air pollution impacts is based on vehicle km of truck movement to transport precast elements and material from construction yard and earth from site to disposal location for typical leads.

326. **Mitigation.** Contractor's transport vehicles and other equipment will conform to emission standards. The Contractor will carry out periodical checks and undertake remedial measures including replacement, if required, so as to operate within permissible norms.

327. 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 tyres etc.

328. Dust suppression through water spraying, use of extraction and ventilation systems, and regular cleaning will be ensured. Workers will be provided with PPE such as masks, respirators, and goggles to safeguard their health.

329. DG sets compliant with emission standards will be used.

330. The following dust protection methods will be used:
- (i) Dust screens during excavation and demolition near sensitive receptors
- (ii) Dust filters atop cement silos
- (iii) Wet suppression for aggregate crushing and screening.
- (iv) Good quality project roads with added petroleum emulsions and adhesives, speed control, traffic control.
- (v) Material of specifications as per contract will be procured by Contractor from Government-approved quarries

331. 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 inhabited (homes or workplaces or sensitive receptors such as schools, hospitals) areas.

332. The Contractor will ensure that all trucks carrying loose C&D waste will be covered and loaded with sufficient free - board to avoid spills through the tailboard or sideboards. Transportation of C&D

waste (muck) will be scheduled by time and route to minimize air pollution in habitat areas. Disposal of Hazardous waste will be done by licensed vendors at sites pre-approved independent of the project. Contractor will ensure that the vendor transports the waste with due care to avoid escape of fumes or spillage en route.

333. Temporary storage will be maintained by the Contractor at all times until the excavate is re-utilized for backfilling and C&D waste is evacuated from site. 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.

334. 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, high-pressure 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 as well as excavate/waste disposal sites will be located away from inhabited or ecologically sensitive areas.

335. Labour residing in camps will be provided with LPG fuel for cooking. Burning of waste or other unwanted materials will not be allowed on site or at labour camps.

336. Prediction of impacts on air environment in Operation phases of the project has been carried out by employing a mathematical model. Impact during construction phase will be due tunnel work and transportation of excavated material. Thus, impact of the same will be limited and temporarily in nature, hence it was not considered for air quality modelling. In the present case, AERMOD (10.2.1) dispersion model based on steady state Gaussian plume dispersion, designed for multiple point sources for short term has been used for predicting the ground level concentrations. The computations deal with major pollutants like Sulphur dioxide and Suspended Particulate Matter and Oxides of Nitrogen.

337. The air quality modelling study for the proposed facility was conducted using the AERMOD dispersion model to evaluate the ambient air quality and predict the incremental impacts from project operations. The baseline ambient air quality data was collected from six monitoring locations, strategically chosen based on wind patterns, proximity to sensitive receptors, and potential downwind and crosswind impacts.

338. Key parameters, including PM10, SO2 and NOx, were analysed, and all observed values were within the permissible limits set by the Central Pollution Control Board (CPCB). The operation of diesel generator (DG) sets, modelled under worst-case scenarios, indicated negligible incremental concentrations for all monitored pollutants. The cumulative concentration levels, including baseline and incremental impacts, remained well below regulatory thresholds at all receptor locations.

339. The study concludes that the project operations are unlikely to cause significant adverse impacts on ambient air quality. Nevertheless, the proposed mitigation measures, such as the installation of efficient air pollution control equipment and regular maintenance of DG sets, are recommended to ensure sustained compliance with environmental standards.

340. The air pollution modelling carried out represents the worst case and normal operating scenarios for metro corridors. Analysis of data is completed and a summary of the conclusions drawn from the predicted incremental Ground Level Concentrations (GLCs) is given here. Baseline PM10 levels ranged from 47.14 to 87.41 µg/m³, and PM2.5 from 21.74 to 37.85 µg/m³, within CPCB limits. Air dispersion modelling using AERMOD assessed emissions from 250 kVA DG sets, operating under worst-case 24-hour scenarios. Predicted incremental concentrations were minimal—0.05 to 0.4 µg/m³ for PM10, 0.6 to 1.0 µg/m³ for $SO_2$, and 1.0 to 6.0 µg/m³ for $NO_x$—indicating negligible deterioration in air quality during operation. Detailed report on Air quality modelling is attached as **Annexure-5** of this report.

341. **Residual Impact.** Through modal shift from fossil-fuel driven transport to metro the air quality will be positively impacted. The magnitude of the beneficial impact of metro will increase with increasing ridership. For a more efficient movement of people the alignment will be designed with a smaller number of curves and a curve radius better than minimum value. Stations will be designed with optimal platform and concourse space as per standard planning and design codes. Integration of metro with other modes

especially walk, public transport and intermediate public transport (hired modes) is found to increase ridership and lessen congestion inside and outside the stations. Residual impact is non-significant.

342. **Impact Significance**

- Design and pre-construction stage – major positive
- Construction stage – major negative
- Operation stage – major positive
- Residual Impact after Mitigation – major positive

**2. Noise**

343. Baseline noise is within permissible limits, at all monitored locations except one location.

344. **Impact due to Construction Phase.**

345. Noise during the construction of the Swargate to Katraj underground metro will be generated from the operation of construction equipment, tunneling activities, and vehicular movement associated with material transport. For underground works, major sources of noise will include:

- Tunnel Boring Machine (TBM) operation, including cutter head rotation, conveyor systems, and associated auxiliary equipment.
- Excavators, loaders, dump trucks, and conveyors for muck handling and material transportation.
- Cut-and-cover station construction equipment, including cranes, concrete pumps, vibratory compactors, and pile driving for foundation works.
- Surface construction equipment such as concrete batching plants and generators at temporary construction sites.

346. Actual noise levels from TBM operations, excavation, and auxiliary construction equipment at 50 m from the source are expected to range from 75–95 dB(A), depending on the activity. Vibratory pile driving, if required for station foundations, may reach 100–101 dB(A) near the source.

347. During construction, there will also be an increase in vehicular movement due to the transportation of excavated material (muck) and construction materials. The additional traffic is expected to be up to 5–6 trucks per hour along designated haul routes, potentially increasing ambient noise in nearby areas.

## Exposure of Construction Personnel

348. Operating personnel exposed to noise levels above 85 dB(A) for prolonged periods may experience hearing impacts. According to WBG-EHS guidelines, maximum allowable continuous exposure periods are provided in Table 5.6. For example, exposure to 88 dB(A) should be limited to 4 hours/day, while noise above 103 dB(A) is not permitted.

349. Noise will be generated from equipment during construction and wheel-rail interactions during operation phase. The major sources of noise during construction phase are operation of various types of 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[43] ranged from 76 dB(A) to 84 dB(A); vibratory pile driver at 101 dB(A).

350. The average / typical noise levels generated by various types of construction equipment are given in ***Table 5-4***, while actual noise generated by various construction equipment is summarised in ***Table 5-5***.

*Table 5-4 Average Noise Levels Generated by Various Construction Equipment[44]*

| Equipment | Typical Noise Level (dBA) at 50 ft from source |
|---|---|
| Air Compressor | 81 |
| Backhoe | 80 |

[43] *Construction Noise Handbook August 2006, FHWA, USA*
[44] *Source: FTA Transit Noise and Vibration Guidance Handbook, May 2006*

| Equipment | Typical Noise Level (dBA) at 50 ft from source |
|---|---|
| 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 |

*Table 5-5 Actual Noise Levels Generated by Various Construction Equipment*[45]

| Equipment | Actual Lmax Noise Level (dB(A)) at 50 ft |
|---|---|
| Tunnel Boring Machine (TBM) | 95 |
| Auger Drill Rig | 84 |
| Compressor | 78 |
| Dump Truck / Haul Truck | 76 |
| Excavator | 81 |
| Front End Loader | 79 |
| Vibratory Pile Driver | 101 |
| Press Pile | 70 |
| Batching Plant | 90 |
| Booster Pump | 80 |
| Concrete Pump (covered) | 82 |
| Concrete Vibrator | 76 |
| Crane (mobile/derrick) | 83–88 |
| Generator | 81 |
| Dozer | 85 |
| Roller | 74 |
| Paver | 89 |
| Pneumatic Tool | 85 |
| Jack Hammer | 88 |
| Loader | 85 |
| Rock Drill | 98 |

351. During construction phase, there will be significant increase in vehicular movement for transportation of construction material. Additionally, there will be noise from the usual traffic with possible traffic congestion due to traffic diversions. During construction phase, the increase in vehicular movement is expected to be up to a maximum of 5 to 6 trucks/hour.

352. 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 85 dB(A) affects the hearing acuity of the workers/operators and hence, should be avoided. To prevent these effects, WBG-EHS recommended that the exposure period of affected persons is limited (**Table 5-6**).

[45] *Source: Construction Noise Handbook, US FHWA, Aug 2006*

*Table 5-6 Maximum Exposure Periods Specified by WBG-EHS guidelines*

| Maximum equivalent continuous Noise level dB(A) | Unprotected exposure period per day for 8 hrs/day and 5 days/week[46] |
|---|---|
| 85 | 8 |
| 88 | 4 |
| 91 | 2 |
| 94 | 1 |
| 97 | ½ |
| 100 | ¼ |
| 103 | No exposure permitted at or above this level |

353. **Mitigation Measures**

To minimize noise impacts during underground construction, the following measures **will be implemented**:

1. **Low-noise construction practices**:
   - Wherever feasible, **low-noise equipment** will be deployed. Vehicles and construction machinery will be in good maintenance, fitted with noise mufflers, and designed to minimize noise.
2. **Tunnel excavation measures**:
   - TBM operations will be **enclosed within temporary acoustic barriers** at portal areas and surface sites.
   - Surface-based excavation activities (cut-and-cover stations, shafts) will use **transportable noise screens** to shield nearby sensitive receptors.
3. **Piling and foundation works**:
   - **Auger piling** will be preferred over mechanical driven piling, reducing noise to **70–75 dB(A)** at 50 m.
   - **2 m high GI sheet barricades** will be installed around piling operations, reducing noise by 10–15 dB(A).
   - Piling will be restricted to **daytime hours** only.
4. **Concrete pumping and handling**:
   - RCC pumps will be **covered from all sides**; bends and excessive head pressures will be avoided to reduce operational noise.
5. **Traffic management**:
   - Construction traffic will be confined to **designated haul routes** and, if required, restricted to **off-peak hours** to reduce noise in sensitive areas.
6. **Community engagement**:
   - Local residents, shops, and institutions will be informed in advance about the **nature, timing, and duration** of construction activities, including probable noise levels and mitigation measures.
7. **Noise monitoring**:
   - Continuous **noise monitoring** will be conducted at strategic locations around portals, stations, and surface sites. Field observations and measurements will be recorded to ensure compliance with prescribed standards.

354. Exposure of workers to high noise levels will be minimized by measures such as the following:
   (i) Personal protective equipment such as passive or active ear-muffs
   (ii) Use of electric instead of diesel-powered equipment
   (iii) Use of hydraulic tools instead of pneumatic tools
   (iv) Acoustic enclosures for noise generating construction equipment like DG sets
   (v) Scheduling work to avoid simultaneous activities that generates high noise levels
   (vi) Job rotation where feasible
   (vii) Sound-proof control rooms
   (viii) Automation of equipment and machineries, wherever possible.

*[46] Although hearing protection is preferred for any period of noise exposure in excess of 85 dB(A), an equivalent level of protection can be obtained, but less easily managed, by limiting the duration of noise exposure. For every 3 dB(A) increase in sound levels, the 'allowed' exposure period or duration should be reduced by 50 percent*

355. **Impact during Operation Phase:** During the operation phase the main source of noise will be from running of metro trains, particularly the noise radiated from train operations and track structures. Airborne noise is radiated from at-grade and elevated structures, while ground-borne noise and vibration are of primary concern in underground operations. Underground metros are not known to generate audible sound at the ground level. since the metro has underground alignment, noise pollution will not be the major issue.

356. In the context of rapid rail transit, noise levels exhibit distinct variations: when trains operate in underground tunnels at a speed of 50 mph (i.e. around 80 kmph), the noise level inside the tunnel can reach up to 85 dB(A); however, due to soil and structural damping, the noise level transmitted to the surface (ground level) typically registers at around 55–60 dB(A). At underground stations, the noise level is estimated at approximately 65 dB(A). The primary source of noise arises from train movement within the tunnel, with dominant contributors being the interaction between train wheels and tracks, and aerodynamic noise in confined tunnel spaces. However, since an average (schedule) speed of 32–34 kmph (around 20–21 mph) will be adopted, significantly lower surface-level noise emissions are anticipated during the operation phase of Swargate to Katraj (Phase-1 Extension)..

357. To estimate the operational noise level, the internationally recognized noise modelling software 'SoundPLAN' version 9.0 has been utilized. The Environmental noise propagation methodology adopted, and the equations used within the SoundPLAN model are based on the ISO 9613 'Acoustics – Attenuation of Sound during Propagation Outdoors' (ISO, 1996) and Railway noise using FTA/FRA-HSGT:2005.

358. Using SoundPlan 9.0, the calculation options that were selected for this project provided a balance between accuracy of noise assessment and time to complete the computation. The required inputs for modeling of Noise were collected from Maharashtra Metro Rail Corporation Limited (MMRCL) and presented in **Table 5-7** below. As mentioned earlier, in addition to the FTA/FRA-HSGT (2005) standards that were applied, the following options were adopted:

- The metro train service timing for all routes is 6:00 AM till midnight, 18 hours per day.
- The scheduled speed on all the routes is 34 kmph
- The maximum acceleration and deceleration shall be 1.0 m/s2 and 1.1 m/s$^2$
- Assessment: Day, Night, Ldn
- Emission time slices: 6-22, 22-6
- Reflection order: 3

*Table 5-7 Features of rolling stock and track*

| Parameter | Detail |
|---|---|
| Unit | 3 car basic unit DMC+TMC+DMC |
| DMC dimension | 21.64x2.9x3.9 (LxBxH) |
| TMC dimension | 21.34x2.9x3.9 (LxBxH) |
| Maximum coach length | 22.6m |
| Axle Load | ≤ 16T or 157kN |
| Number of axles | 4 |
| Normal braking system | Regenerative |
| Braking type | Disc brakes |
| Wheel diameter | 860mm (assumption) |
| Track Gauge | 1435mm |
| Track base | Ballast-less track with elastic and absorbent fittings |
| Rail joints | Minimum spacing (assumption) |

359. **Noise Emission Sources:** Noise generated from train operations and track structures remains the predominant source of noise in rail transit systems. In underground operations, ground-borne noise and vibration are of primary concern, while airborne noise radiation is significantly attenuated by the surrounding soil and tunnel structure. Unlike elevated or at-grade sections where airborne noise dominates, underground systems primarily transmit noise through structural pathways. The principal sources of underground transit noise include:

- Wheel / Rail Noise: Due to wheel /rail roughness
- Propulsion Equipment: Traction motors, cooling fans for Traction Motor, reduction gears etc.
- Auxiliary Equipment: Compressors, motor generators, brakes, ventilation systems, other car mounted equipment

360. Predicted noise levels for the project area were modelled in accordance with the Federal Transit Administration (FTA) guidelines. Future noise levels were projected based on existing ambient measurements and anticipated metro operational characteristics, including train frequency, rolling stock, and underground infrastructure.

- **Ground Elevation and Digital Ground Model**: The ground elevation data was taken from Google Earth to generate Digital Ground Model for surface-level receptor locations such as station entrances, ventilation shafts, and surrounding buildings.
- **Subsurface Alignment and Tunnel Structure**: The metro alignment is entirely underground, housed in reinforced concrete twin tunnels constructed using Tunnel Boring Machine (TBM) and cut-and-cover methods for stations and cross-passages. All stations are underground, and no viaduct or elevated structure is present along the corridor.
- **Rail Elevation**: Rail elevation data from the engineering vertical alignment profiles was used to establish the absolute and relative depth of the tunnel section with respect to ground level at various locations. For this project, the tracks are located at an approximate maximum depth of 35 m BGL, and this information was incorporated into the model to represent the underground alignment accurately in relation to surface-level receptors.
- **Building Location and Heights:** Building footprints were obtained from OpenStreetMap and Google Maps, while building heights were estimated using field observations and floor-count extrapolation. These were used to assess noise exposure at different vertical receptor heights near station access points or ventilation structures.
- **Surface Structures Considered**: While the main alignment is underground, surface-level components such as ventilation shafts, station entrances, emergency exits, and ancillary buildings were included in the model where relevant, as they represent the primary points of potential noise emission.

361. **Noise Modelling Studies:** Noise modelling studies for Swaragte to Katraj (Phase-1 Extension) project for operation phase have been carried out in accordance with the FTA guidelines. Predicted future noise levels in the project area were based on existing measured sound levels and future daily transit operations. Findings of the Noise modelling analysis carried out are summarised below and in **Table 5-8**. The detailed Noise modelling Study Report is attached as **Annexure-14** of this ESIA.

*Table 5-8: Predicted Noise levels due to Metro Operation*

| Name of Receptor | Land use Category as per CPCB | Baseline Noise Levels, dB(A) | | CPCB Noise Standards (dBA) | Projected Noise Levels, dB(A) | | Increase over Baseline Noise Levels, dB(A) | |
|---|---|---|---|---|---|---|---|---|
| | | Day | Night | | Day | Night | Day | Night |
| Swargate Metro Station | Proposed Station / Commercial | 64.2 | 53.7 | Day: 65 Night: 55 | 64.8 | 54.1 | 0.6 | 0.4 |
| Parvati Post Office | Commercial | 46.8 | 42.1 | Day: 65 Night: 55 | 48.1 | 43.2 | 1.3 | 1.1 |
| Market Yard Gultekdi Metro Station | Proposed Station / Commercial | 64.7 | 54.2 | Day: 65 Night: 55 | **65.1** | 54.5 | 0.4 | 0.3 |
| Padmavati Metro Station | Proposed Station/ Commercial | 63.5 | 54.3 | Day: 65 Night: 55 | 64.6 | **55.1** | 1.1 | 0.8 |
| YCI College of CNC Technology | Educational / Silent | 52.7 | 45.2 | Day: 50 Night: 40 | **53.5** | **45.9** | 0.8 | 0.7 |
| Katraj Metro Station | Proposed Station / Commercial | 64.1 | 53.5 | Day: 65 Night: 55 | 64.6 | 53.9 | 0.5 | 0.4 |

362. Total noise levels during metro operation are within CPCB permissible limits at most sensitive receptors. Where slight exceedances over standards occur, targeted noise attenuation measures will be implemented. Due to the underground nature of the project, traditional noise barriers are generally not feasible; instead, noise control will rely on vibration isolation, acoustic treatments within tunnels and stations, and noise attenuation at ventilation shafts and access points. At locations where baseline noise already exceeds standards, the focus will be on ensuring no significant increase through

engineering controls, regular monitoring, and stakeholder engagement. Overall, noise impacts are minimal and manageable with appropriate mitigation measures.

363. **Embedded Measures.** The use of ballast-less track with resilient fastenings and vibration-absorbing pads will significantly reduce ground-borne vibrations and secondary noise transmission in underground sections. In addition, the tunnel structure itself provides natural acoustic shielding, thereby minimizing the propagation of noise to the surface environment. To further mitigate vibration and noise impacts, floating slab track systems and resilient track bed designs may be adopted at sensitive locations such as educational institutions, hospitals, and heritage structures. Continuous monitoring during operation will ensure that vibration and noise levels remain within permissible limits.

364. In order to verify the predicted noise levels, the ESMP provides for noise monitoring during the first three years of operation.

365. **Residual impact.** The residual impacts due to metro operation will be negligible.

366. **Impact Significance:**

- Design and pre-construction stage – major negative
- Construction stage – major negative
- Operation stage – major negative
- Residual Impact after Mitigation – negligible

### 3. Vibration

367. Construction and operation of metro will cause vibration from equipment during construction and wheel-rail interaction during operation. As part of this ESIA, a general vibration and annoyance assessment for operational phase has been carried out. The vibration assessment required as a prolonged annoyance has been carried out based on the methodology proposed by the Federal Transit Administration of USA in the Transit Noise and Vibration Guidance Handbook, 2006. The vibration induced during the operational phase is based on the US Federal Transit Administrations methodology to create a ground-borne vibration prediction model to assess metro operation related vibration into buildings. The assessment also followed the “Metro Rail Transit System. Guidelines for Noise and Vibrations” elaborated by CT-38 Track Design Directorate, Research Designs and Standards Organisation (RDSO), Ministry of Railways of India.

368. The prediction of vibration due to Tunnel Boring Machine (TBM) and also other construction activities has been modeled with the standard finite element method. All the parameters concerned with the TBM have been taken into account while considering the vibration prediction. The speed of the tunneling work with TBM is considered to be 10m per day. The minimum soil cover of the proposed tunnel is considered as 15 m from the ground surface and the soil is taken as soft silty –sand with clay and kankar.

369. The vibration propagation caused due to the TBM will depend largely upon the source frequency and the local ground properties. The propagation equation of the vibration form is given below:

$$PPV = \frac{K}{d} e^{-\alpha d}$$

| | |
|---|---|
| $PPV$ | Peak particle velocity |
| $d$ | Distance in metres from the source |
| $K$ & $\alpha$ | Site / machine specific operators |

370. The equations are based on the peak particle velocity (PPV) at the dominant vibration frequency for a given machine. If the machine vibration is measured at a number of locations at varying distance from the source then the site-specific operators can be determined as shown below.

$$\alpha = -\frac{\ln(V_2 d_2 / V_1 d_1)}{(d_2 - d_1)}$$

$$K = \frac{V_1 d_1}{e^{-\alpha d_1}}$$

371. Where V1and V2 are measured for PPV at distance d1 and d2 respectively. Below **Figure 5-1** shows the typical vibration propagation curve for TBM vibration at the dominant frequencies.

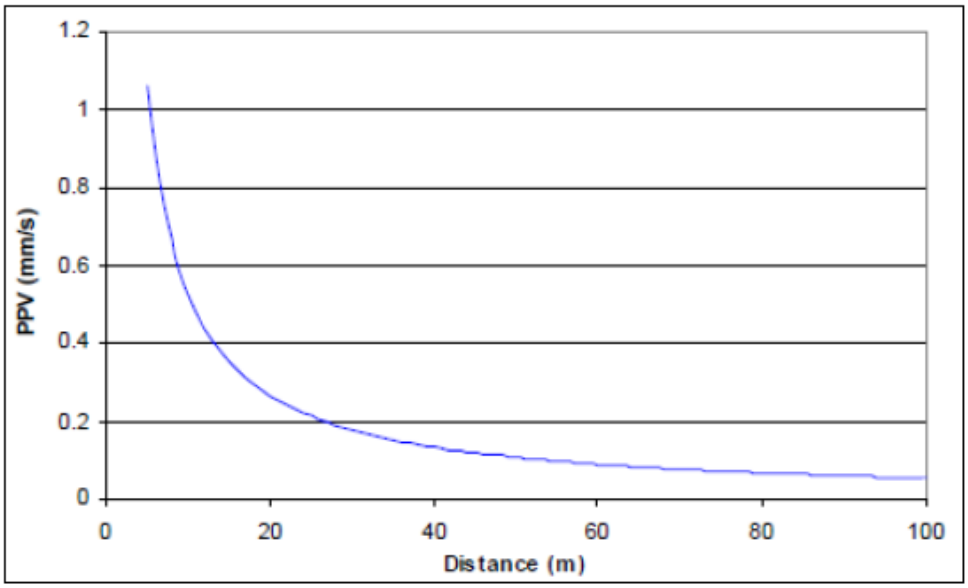



*Figure 5-1: Typical Vibration Propagation Curve for Tunnel Boring Machine (TBM)*

372. Vibration modelling was carried out using GIS software and empirical formula mentioned in this report. Vibration modelling was conducted at the proposed stations along the expansion of Swargate to Katraj alignment. The maps of the vibration modelling show the lines with different color representing vibration levels during operation of train.

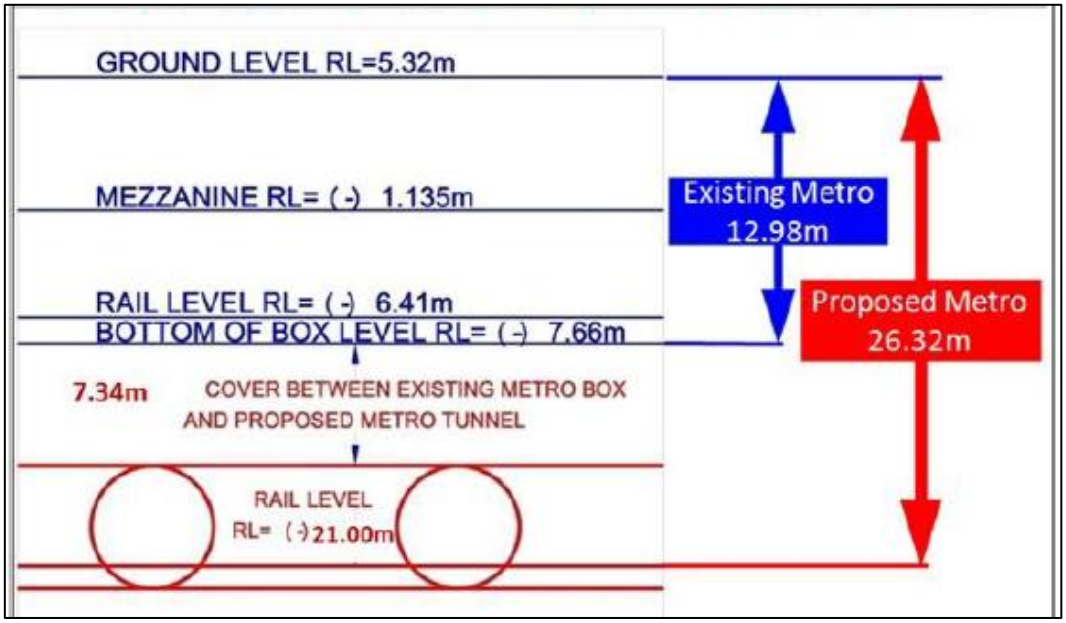



*Figure 5-2: Section showing the cross-section of underground track levels*

373. **Impact During Construction Phase:** Based on the general vibration assessment, it is concluded that during construction, pile drivers (impact or sonic), clam shovel drop, and vibratory roller are the most significant equipment of impact. Depending on the building structure type, pile driving can affect buildings up to 40m distance. Annoyance from piling could be felt at a distance of up to 100m. However, in this case, the assessment confirms that vibration levels are within acceptable limits, and no adverse impacts due to vibration are expected.

374. Pile driving for viaduct piers and buildings generate vibrations. Apart from distance from the alignment, soil, 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. Figure 5-3 provides typical PPV values at 25 ft. for several types of construction machinery as per the FTA, 2018.

375. Vibration from pile driving can be calculated with the following equation (FTA, 2018):

$PPV_{Impact\ Pile\ Driver} = PPV_{Ref}\ (25/D)^{1.5}$

Where, $PPV_{Ref}$ = 0.644 in/sec (for a typical pile driver at 25 ft.)
D = distance (from pile driver to the receiver in ft.)

376. Based on this equation a typical engineered concrete or masonry building is potentially at risk if it is located within 22 meter of the pile driving works.

| Equipment | | PPV at 25 ft, in/sec | Approximate Lv* at 25 ft |
|---|---|---|---|
| Pile Driver (impact) | upper range | 1.518 | 112 |
| | typical | 0.644 | 104 |
| Pile Driver (sonic) | upper range | 0.734 | 105 |
| | typical | 0.17 | 93 |
| Clam shovel drop (slurry wall) | | 0.202 | 94 |
| Hydromill (slurry wall) | in soil | 0.008 | 66 |
| | in rock | 0.017 | 75 |
| Vibratory Roller | | 0.21 | 94 |
| Hoe Ram | | 0.089 | 87 |
| Large bulldozer | | 0.089 | 87 |
| Caisson drilling | | 0.089 | 87 |
| Loaded trucks | | 0.076 | 86 |
| Jackhammer | | 0.035 | 79 |
| Small bulldozer | | 0.003 | 58 |

* RMS velocity in decibels, VdB re 1 micro-in/sec

*Figure 5-3: Vibration source levels for construction equipment (FTA)* [47]

377. The vibration modelling study, undertaken for both construction and operation phases of the Pune Metro extension, predicts that vibrations from Tunnel Boring Machine (TBM) activities during construction phase will range between 3.4 and 4.0 mm/s, well below the DGMS limit of 5 mm/s. These levels indicate that tunnelling will not cause structural damage or noticeable disturbance to nearby buildings, ensuring no significant impact on above-ground structures during construction. Potential impacts that may however be caused during construction ohase on the above-ground structures with their corresponding mitigation measures are given below in **Table 5-9**.

*Table 5-9: Vibration Impacts on above-ground structures during Construction and their Mitigation Measures*

| Potential Impact | Mitigation Measures |
|---|---|
| Ground settlement due to tunneling and excavation | Use advanced tunneling methods (TBM with pressurized face support), ground improvement techniques (grouting, soil stabilization), and controlled excavation practices |
| Vibration effects on nearby buildings | Adopt vibration control measures such as controlled blasting, use of low-vibration equipment, resilient mounting systems, and monitoring vibration levels at sensitive receptors |
| Foundation stress in weak or shallow structures | Conduct pre-construction structural surveys, provide temporary support/strengthening measures, and monitor structural health during tunneling |

[47] *Source: FTA Transit Noise and Vibration Impact Manual, September 2018.*

| | |
|---|---|
| Minor cracks, plaster damage, or tilting in fragile/old buildings | Carry out pre-condition surveys, install real-time monitoring instruments, and undertake immediate repair or strengthening works where required |
| Damage to underground utilities (pipelines, sewer lines, cables) | Identify utilities through surveys, provide adequate protection/shielding, reroute if necessary, and ensure prompt restoration in case of damage |

378. **Impact During Operational Phase:** In operation phase, a maximum distance of 29 m will be affected if 80 kmph design speed and masonry building structures are considered. This distance will be reduced to 10 m if 32 kmph scheduled speed is considered. As a feature of design, track fittings during operation will reduce vibration. Vibration during operation of the metro could cause annoyance and disturbance to daily living of residents and workers along the alignment. Vibration could damage fragile and old buildings over a period of time.

379. During operation vibration is found to be higher with higher speeds and lower with heavier transit structure.

380. Vibration modelling for the proposed Swargate to Katraj project has been carried out, and the detailed report of the same is attached as **Annexure-11** of this ESIA Report. The modelling results for the operational phase show that vibrations from metro train movement through the underground tunnels will also remain well below the permissible limits. The predicted vibration levels at the ground surface above the alignment range from 75 to 100 VdB, significantly lower than the DGMS limit of 134 VdB. These levels are considered safe for all types of above-ground structures, including residential, commercial, and heritage buildings. The vibrations are expected to be barely perceptible to occupants and will not lead to any structural deterioration or discomfort. Overall, the study concludes that metro operations will result in negligible vibration impacts on the surrounding built environment.

381. **Mitigation.** The design will include vibration reducing features such as, but not limited to ballast less track structure supported on two layers of rubber pads, resilient mounting and dampers and welded rails. Construction activities will be scheduled such that demolition, earthmoving and ground-impacting operations do not occur in the same time period. At locations where the alignment is close to sensitive structures, the contractor shall prepare a monitoring scheme prior to carrying out construction at such locations. Also, vibration mitigation measures will be implemented. Vibratory Rollers will be avoided near sensitive structures.

382. Prior to the commencement of construction, the contractor will undertake a pre-construction building condition survey of structures located near the alignment to document their baseline condition. Based on this survey, the contractor will develop a Vibration Management and Monitoring Plan (VMMP) in consultation with MahaMetro. The VMMP will outline the monitoring methodology, frequency, locations, thresholds, and mitigation measures for both construction and operation phases. It will include:

(i) Continuous vibration monitoring using sensors at sensitive receptor locations and inside tunnels.
(ii) Pre- and post-construction inspections of above-ground structures to identify any damage.
(iii) Preventive measures such as controlled construction techniques, damping treatments, and localized reinforcement of vulnerable buildings.
(iv) Procedures for reporting and responding to complaints or exceedances.

383. Damping treatments, localized stiffening or mass addition at the receptors to reduce post-construction vibration. Wave-Impeding Blocks (WIB), subgrade stiffening and wave barriers are effective measures of interrupting the propagation of waves through the soil. Visual inspections of pre-identified buildings at risk of damage caused by vibrations during construction will be done so as to serve as baseline to monitor progression of building damage if any. The visual inspections will be done in attendance of the owner of the building and will be recorded. Cast-in-situ piling will be deployed so as to reduce vibration.

384. In the case of vibrations from road traffic and pile driving, very deep barriers (in excess of 10 m) will be constructed to reduce vibration. In-ground barriers are trenches that are either left open or filled with a material (such as polymer slurry 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 demonstrated[48]. Measures will be decided upon forecast of vibration during the Visual inspections of pre-identified buildings at risk of damage caused by vibrations during construction, as mentioned above.

385. Detailed vibration modelling is needed if sensitive receptors are located within the reported distances from the track in order to determine if the negative impacts can be fully mitigated through the following mitigation measures:

(i) Ballasted tie-welded track with elastic steel fastenings and plastic or rubber absorbing pad will reduce noise and vibration levels. Surface irregularities on the wheel and rail will be minimized by good maintenance of wheel and rail condition.

(ii) 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 will be installed to reduce transmission of vibration from the track and superstructure. Using floating slab and high resilience fasteners to reduce the vibration at the point of emission.

386. **Residual impact.** The residual impact is considered minimal negative.

387. **Impact Significance**

- Design and pre-construction stage – major negative
- Construction stage – major negative
- Operation stage – moderate negative
- Residual Impact after Mitigation – minimal negative

### 4. Hydrology / Drainage

388. **Impact.** The construction of underground metro systems can have temporary impacts on local hydrology and groundwater regimes. Activities such as tunneling, station box excavation, and dewatering may lead to localized lowering of the groundwater table, which can affect nearby wells or vegetation dependent on shallow aquifers. Construction works may also intersect natural drainage channels or subsurface flow paths, potentially altering groundwater movement.

389. Surface impacts are generally minimal compared to elevated structures; however, improper handling of construction wastewater, slurry from tunneling, and accidental spillage of fuels or lubricants can contaminate nearby surface water bodies. In addition, disposal of excavated muck, if not managed properly, can obstruct natural drainage and increase siltation in watercourses.

390. **Mitigation.** Anticipated impacts of underground metro construction on hydrology will be mitigated through controlled dewatering supported by recharge or reinjection systems to maintain groundwater balance. Waterproofing and grouting techniques will be applied to minimize inflow of groundwater into tunnels. Construction wastewater and TBM slurry will be collected, treated, and reused wherever feasible, thereby preventing contamination of surface water bodies. Proper muck management plans will be implemented to ensure excavated material is stored and disposed without obstructing drainage channels. In addition, storm-water drains around station sites will be designed with sediment traps and oil interceptors to prevent pollutants from entering local water bodies, ensuring that hydrological impacts remain negligible.

391. As described earlier (Chapter IV – Section F) the alignment crosses water ways, like the Mula-Mutha Right Bank Canal near Swargate and a *stream / nallah* (Ambhil Odha) at Sangam hall near Padmavati. Tunnelling under water bodies, will be carried out with due precautions, ensuring structural and environmental safety. The following measures will be implemented during construction near or beneath such watercourses so as to avoid any impact on the respective water courses:

(i) Construction activities will be planned and executed to ensure no disturbance to the bed, bank, or embankment of the water body / stream / Nallah;

(ii) Tunnelling beneath water bodies will be carried out using pressurized-face TBMs or other suitable technologies to prevent water ingress or collapse;

(iii) Cut-and-cover construction for station boxes or shafts near water bodies will include

[48] *Source: 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.*

cofferdams, dewatering systems, and impervious barriers as required;

(iv) All work will follow strict timelines and pre-approved construction methodologies reviewed for hydrogeological and structural stability;

(v) Work sites will be restored immediately after completion, and any temporary diversions or support systems will be dismantled carefully;

(vi) No excavation material, spoils, or construction waste will be disposed of into canals, streams, or other water bodies;

(vii) All fuel, oil, and chemicals will be stored on impermeable surfaces with containment systems (e.g., bunds, drip trays) and located away from water bodies;

(viii) Workers and equipment operators will receive training on spill prevention and emergency response, with awareness materials in local languages;

(ix) If excavation or dewatering leads to potential sediment discharge, silt fences, sedimentation tanks, or brush barriers will be installed to prevent siltation of water bodies;

(x) All wastewater generated from construction sites will be collected and disposed of at designated, approved locations in accordance with applicable norms;

(xi) Vehicle parking, maintenance, and refuelling will not be permitted near water bodies to avoid contamination from oil, fuel, or lubricants;

(xii) Any construction camps or site offices will include sanitation facilities connected to treatment systems; no untreated sewage will be discharged into surface water;

(xiii) Construction activities near water bodies will be avoided during the monsoon season, and all materials, equipment, and debris will be cleared from flood-prone areas beforehand;

(xiv) Quarterly monitoring of wastewater and surface water quality will be carried out to ensure compliance with regulatory standards;

(xv) It will be mandatory for the Contractor to comply with all mitigation measures outlined in the Environmental and Social Management Plan (ESMP) provided in the contract documents.

392. **Embedded measures.** The following Flood Control Measures are embedded in the Project Design of Stations:

(i) All entrances extending to street level shall be protected against flooding. This protection shall include provision of minimum but appropriate number of steps and/or ramps to landing, considering minimum required height and/ or flood gates. The design of such protection shall be achieved according to the proper study of flood history record and topographical survey data.

(ii) Where required for flood protection the stair well on pavement entrances shall be surrounded by a solid balustrade 900 mm high. At sites not affected by flooding alternative entrance envelopes can be proposed.

(iii) Flood protection, as required for all standard station entrances shall be provided. Any incidental water, shall be similarly catered for.

393. **Impact Significance**

- Design and pre-construction stage – neutral
- Construction stage – minor negative
- Operation stage – minor negative
- Residual Impact after Mitigation – neutral

### 5. Surface water and Groundwater Quality

394. **Impact.** The wastewater discharged from the project during construction and operation can pollute surface water bodies and ground water if not handled and treated properly. However, as a feature of design, all stations will be connected to the municipal sewerage and therefore such water will be treated by municipal authorities as per norms before discharge into surface water bodies. The stations will therefore 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. In case of poor maintenance of the sewage system leakages might start to occur, thus impacting the quality of ground water. If the drainage capacity of the existing sewerage system is inadequate to handle the additional sewage the risk of localized flooding emerges.

395. Waste construction materials and hazardous waste 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. 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. Percolation / leaching of toxic substances at C&D waste disposal sites and hazardous waste disposal sites can pollute water.

396. **Mitigation**. As per design the stations will be connected to the municipal sewerage system. Prior to commencement of the works contractor will verify with the municipal authorities if the existing sewerage capacity is adequate to handle the extra sewage or if additional works on the existing sewerage system are necessary. This in order to prevent uncontrolled discharge of sewage into the environment.

397. In order to detect any leaks in the sewer system as soon as possible during the operational phase, regular visual inspections of the terrain surrounding the stations will be carried out. If subsidence of the ground is observed the sewer must be excavated for inspection and repairs when necessary.

398. Sedimentation ponds of adequate size and capacity will be built for the treatment of discharges from the batching plants and the crushing plants to allow the sediments to settle. Final discharges from the sedimentation ponds will comply with the National standards for wastewater. The settled sediments will be periodically removed and will be disposed of at the designated spoil disposal sites.

399. At the campsites wastewater treatment facilities will be constructed (e.g., septic tank and soak pit and site drainage) to avoid spillage of wastewater into surface water or groundwater.

400. Equipment/vehicle repair/maintenance and re-fuelling areas will be confined to areas in construction sites designed to contain spilled lubricants and fuels. Such areas will be equipped with a concrete perimeter and drainage system leading to an oil/grease-water separator that will be regularly skimmed of oil to prevent spilled oil/grease being discharged to the ground surface.

401. Management and storage of fuel, waste oil, and hazardous substances will be planned in accordance with the World Bank Group's Environmental, Health and Safety General Guidelines on Hazardous Materials Management. This includes the use of appropriate secondary containment structures capable of containing the larger of 110 % of the largest tank or 25% of the combined tank volumes in areas with above-ground tanks with a total storage volume equal or greater than 1,000 litres. Fuel storage tanks need to be placed under roofs and on concrete slabs with berms or dikes to contain spills in a secured covered area.

402. Spill clean-up equipment (e.g., absorbent pads, etc.) specifically designed for petroleum products and other hazardous substances will be maintained on-site. Should any accidental spills occur, immediate clean-up will be undertaken, and all clean-up materials will be stored in a secure area for further disposal. Disposal of such will be undertaken by a waste management company contracted by the Contractors. The waste management company must have the required licenses to transport and dispose of any hazardous waste before any such waste is removed from the site. The Contractors will keep copies of the company's licenses and provide waste transfer manifests at their camp site for routine inspection by the engineer.

403. **Residual impact.** Although waste water let into the sewers will be treated by municipal authorities to general effluent standards before discharge into surface water or groundwater, minimal negative impact on receiving bodies might occur in case of insufficient treatment. 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.

404. **Impact Significance:**

- Design and pre-construction stage – moderate negative
- Construction stage – moderate negative
- Operation stage – minor negative
- Residual Impact after Mitigation – minimal negative

### 6. Surface water and Groundwater Quantity

405. **Impact.** Water consumption during construction shall be about 22.5 KLD for Swargate to Katraj (Phase-1 Extension). Dewatering necessary for pile foundation construction will lead to a decrease in ground water quantity. Water demand at stations during operation is estimated at 6.7 KLD and will be met through municipal water supply, thus impacting the availability of this commodity.

406. **Mitigation**. Stations from Swargate to Katraj (Phase-1 Extension) will be connected to the municipal water supply system; there will be no direct use of surface water. However, city is partly depending on surface water for its water needs, the water use of the stations will impact the quantity of surface water indirectly to a certain extent.

407. Water for dust suppression (sprinkling) and tire washing will be sourced from surface runoff when possible. Used water from tyre washing will be collected, subjected to precipitation and re-used. Groundwater will not be used. Water for curing of concrete will be sourced from municipal supply, surface runoff or water from dewatering. Water for concrete batching plant and labour camps will be sourced from treated municipal water.

408. Waste water from construction yards, sites and labour camps that cannot be used for dust suppression or tyre washing will be discharged into public sewers after precipitation; it will be treated by municipal agencies to Environment Protection Rules (EPR) 1986 Schedule VI standards of discharge of general effluents into surface water. Additionally, DRDO based STP shall be installed at each station.

409. **Residual impact.** Rainwater harvesting will be implemented to recharge groundwater. Since no groundwater will be extracted and used in the project, the residual impact on groundwater quantity is high positive. Since the city is majorly dependent on surface water for its water needs, the use of municipal water at the stations will impact the quantity of surface water indirectly to a certain extent. This commodity cannot be completely mitigated through rainwater harvesting. A minimal negative residual impact on surface water quantity will therefore remain.

410. **Impact Significance:**

- Design and pre-construction stage – minor negative
- Construction stage – moderate negative
- Operation stage – minor negative
- Residual Impact after Mitigation – minimal negative (surface water)
  major positive (groundwater)

### 7. Land degradation

411. **Impact.** Construction yards with aggregate crushing and screening, pre-casting, material and fuel storage and ready-mix concrete plants and sites for disposal of C&D waste and disposal of surplus excavated soil can cause topography-related drainage changes, pollution of air, water and soil. Metro construction is a material intensive activity. Huge quantity of different construction materials will be required for construction of underground metro and stations, leading to depletion in construction material at source.

412. Quarry operations are independently regulated activities and outside the purview of the project proponent. It is, nonetheless, appropriate to consider 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 will be sourced only from legalized and approved quarries that are in full compliance with environmental and other applicable regulations and have an outstanding environmental track record. Opening of a new quarry specifically for proposed project is not foreseen under this ESIA.

413. Construction activities cause degradation of land in terms of loss of topsoil and pollution. Fertile topsoil which is removed during demolition, site levelling and excavation, if not securely preserved, could be washed off due to surface runoff or be lost as fugitive dust. Soil contaminants include heavy metals and Persistent Organic Pollutants (POPs) (due to processes pre-dating the metro construction activities); Polycyclic Aromatic Hydrocarbons (PAHs) (from exhaust of construction vehicles, equipment, DG sets) and mineral oils (from leakages and spillages).

414. Soil pollution and changes in local water drainage patterns could result from dumping of surplus

excavated soil and C&D waste. Hazardous waste will be taken away by licensed vendors who will be responsible for due disposal at pre-approved sites.

415. **Mitigation.** Construction yards will be located at least 500 m away from habitations and at least 1 km away from environmentally or ecologically sensitive area, if any. Selection of the sites for construction yards, batching plant, casting yard and waste disposal sites will follow the criteria for site selection, as laid down in **Annexure-10A** of this ESIA-ESMP report and Maha Metro's SHE Manual (**Annexure-7)**, with the final location and layout of the sites. Locations will be approved by Maha Metro and funding agencies before construction commences, in consultation with Municipal Authorities. Hazardous waste will be taken away by licensed vendors who will be responsible for due disposal at sites pre-approved independent of the project. The contractor will provide a plan with construction yard layout including batching plant, sewage and drainage system, provisions of precipitation tanks, access road, first aid facilities etc., to be approved by Maha Metro and the funding agencies before establishment.

416. C&D waste is part of solid waste that results from land clearing, excavation, construction, demolition, remodelling and repair of structures, roads and utilities. C&D waste has the potential to save natural resources (stone, river sand, soil etc.) and energy, 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 he transports and disposes it at sites approved by MPCB / Maha Metro for the project. Disposal of waste should follow good practice and some level of screening should be conducted. Normal construction waste can go to existing facilities conform to national systems, however when large scale spoil disposal will take place in specific designated locations this will need to be carefully managed.

417. Prior to demolition of any building or structure contractor will assess if Asbestos Containing Material (ACM) is potentially present in the building or structure to be demolished. The initial investigation on the potential presence of ACM will be executed by a competent and duly qualified person. If the presence of ACM is likely or confirmed, contractor will prepare an Asbestos Removal and Disposal Plan prior to the demolition works, to be approved by the PIU.

418. Material will be stabilized by watering or other accepted dust suppression techniques. The excavated soil and C&D waste (muck) will 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 disposal plan will be prepared by Contractor, which will be approved by Maha Metro.

419. The contractor will ensure that hazardous wastes from construction activity and equipment are labelled, recorded, stored in impermeable containment and for periods not exceeding mandated periods and, in a manner, suitable for handling storage and transport. The contractor will maintain a record of sale, transfer, storage of such waste and make these records available for inspection. The contractor will get Authorized Recyclers to transport and dispose Hazardous Waste, under intimation to the Project Authority.

420. Sites for disposal of surplus excavated soil and C&D waste will be decided by Maha Metro before start of construction in consultation with MPCB and Pune Municipal Corporation. The sites will be located away from residential areas, water bodies and ecologically sensitive locations as to avoid pollution and disruption of natural drainage. Disposal of hazardous waste will be done by licensed vendors at pre-approved sites independent of the project.

421. Non-hazardous solid waste generated in stations will be collected on a regular basis and transported to local municipal bins for onward disposal to disposal site by municipality. Regular inspection and maintenance of the waste collection system will be required in order to let it function effectively.

422. **Residual impact**. Metro construction will inevitably lead to depletion in construction material at source, the residual impact is considered to be minimal negative.

423. Since it will take some time for soil to settle after the construction works a minimal negative residual impact for soil erosion might exist. Although contractor has to take every effort to prevent

contamination of construction yards and muck disposal sites, a certain degree of pollution cannot be ruled out. Construction yards and muck disposal sites could also cause a change in drainage patterns around the sites. Therefore, a minimal negative residual impact exists, especially if the contractor's liability for any pollution that has arisen is insufficiently covered.

424. **Impact Significance**

- Design and pre-construction stage – minor negative
- Construction stage – moderate negative
- Operation stage – neutral
- Residual Impact after Mitigation – minimal negative

**8. Flora**

425. **Impact.** The alignment has been chosen in such a way that loss of trees and other vegetation is minimized as much as possible. However, a total of 175trees are likely to be affected due to proposed alignments. With removal of these trees, the process for $CO_2$ sequestration will get affected as follows:

(i) Total number of Trees affected: 175
(ii) Decrease in $CO_2$ absorption due to loss of 175 trees (@ 20 kg per tree per year): 3.5 tons/year
(iii) Decrease in Oxygen production due to tree loss of 175 trees (@ 110 kg per tree per year): 19.25 tons/year

426. The only significant long-term ecological impact of the project will be due to the loss of the 175 trees as mentioned above. Mitigation and enhancement measures proposed under the project to address this risk and ensure no net loss of biodiversity include implementation of a robust compensatory afforestation program including habitat improvement activities. The compensatory afforestation program includes planting of about 1750 trees to replace the 175 trees that will need removal / transplantation, as per the mandatory compensatory plantation as per the PMC Tree Authority guidelines rate of 1:10 ratio. There will be no net loss of biodiversity because of the project.

427. Fugitive dust from construction yards, construction sites; particulate pollutants and dust from trucks hauling construction material, segments and waste soil and C&D waste disposal sites will be deposited on leaves thus impacting vegetation growth. Construction activities also have the potential to cause physical damage to trees and vegetation nearby the construction sites.

428. **Mitigation**. The loss of trees will be compensated through planting of 10 saplings for each tree felled. Location for compensatory plantation will be decided by Maha Metro in consultation with owner of the land as well as the State Forest Department such that displacement does not become necessary. Depending on the chosen location, the Maharashtra Forest Department or the Pune Municipal Corporation will be responsible for the conservation and management of the trees. It is found that about 175 trees are likely to be lost in the project under line and stations, hence 1750 trees are likely to be planted. Native plant species and miscellaneous indigenous tree species are recommended for plantation. The saplings will be monitored for their survival for three years. Re-plantation shall be taken up every year with new saplings where saplings fail to survive.

429. Efforts will be made to minimize the cutting of trees by transplantation of the young trees when possible. Transplantation will be done in coordination with Maharashtra Forest Department. After completion of construction of the metro, Maha Metro will plant saplings in the road median: this re-planting is not in scope of works of the construction contractor.

430. Tree cutting and felling will be done only if the tree is in the way of construction and only after receiving clearance from Maha Metro and competent Authorities. No damage will be caused to trees during construction activities other than the trees marked for felling. Vegetative cover will be maintained as much as reasonably possible. Wherever excavations are made in the ground near the roots of trees that need to be maintained, appropriate measures will be taken to prevent exposed soil from drying out and causing damage to the tree and its roots.

431. To avoid negative impact on herbaceous vegetation along the waterways encountered along the alignments, vehicle & construction machinery movement will be restricted to designated roads. Similarly, dumping of muck, excessive site clearance, levelling etc. in the river/nallah basin will be avoided. No Excavated material will be stored near river/nallah basins. Vegetation clearing by chemicals / herbicides will not be permitted and workers will be briefed about do's and don'ts. Sedimentation of storm water will be minimized by avoiding stockpiling of excavated material. Portable sanitation,

treatment and disposal facility will be provided at construction site.

432. **Residual impact.** Although contractor has to take every effort not to damage trees and vegetation that needs to be maintained, the risk of damage to the vegetation cannot be ruled out completely. Since restoration of the vegetative cover will take some time a minimal negative residual impact will exist. Compensatory plantation will be done in a ratio of 10 saplings against each tree felled. Compensatory saplings will take time to mature, therefore the short-term residual impact of tree cutting will be minimal negative. Once the saplings have matured the residual impact will be positive.

433. **Impact Significance**

- Design and pre-construction stage – moderate negative
- Construction stage – moderate negative
- Operation stage – neutral
- Residual Impact after Mitigation – minimal negative (short term) to positive long term

**9. Fauna**

434. The alignment does not pass through any ecologically sensitive area. However, the Rajiv Gandhi Zoological Park and Wildlife Rescue Centre, a notified protected area under the jurisdiction of Pune Municipal Corporation, is located adjacent to the proposed underground alignment near Katraj. The zoo serves as a key habitat for captive wild species and functions as a wildlife conservation and education facility.s.

435. **Impact.** The underground project does not impede movement of terrestrial fauna.

436. The Rajiv Gandhi Zoological Park, identified as a protected and environmentally sensitive area, is located near the proposed underground metro alignment. As the alignment passes underground, no direct habitat loss or fragmentation occurs. However, indirect impacts may arise due to construction noise, vibration, lighting, and air emissions during tunnelling and station construction in the vicinity of the zoo. Potential risks include behavioural disturbance or stress to captive fauna sensitive to vibration and noise..

437. Preliminary vibration modelling and literature-based reference data indicate that vibration levels generated by modern Tunnel Boring Machines (TBMs) operating at depths greater than 15 m are typically below the threshold that would cause perceptible disturbance to animals or structural damage to enclosures. During train operation, vibration levels are expected to remain within permissible limits (< 0.15 mm/s PPV at the surface). Airborne noise during construction will be localized and intermittent, with levels reducing significantly beyond 50 m from the activity source.

438. **Mitigation.** With measures to minimize dust, noise and vibration during construction in place no additional measures with regard to fauna will be necessary. Lighting at stations entry-exit portals will be kept to the minimum and of such frequencies and brightness which do not affect bird behaviour.

439. Mitigation during Construction phase:

- Use of modern TBMs with face-pressure control and real-time monitoring to minimize ground-borne vibration and settlement.
- Implementation of temporary / permanant acoustic enclosures for construction machinery operating near the zoo boundary.
- Scheduling of high-noise or vibration-generating activities (e.g., TBM launching, piling) during daytime hours only.
- Continuous vibration and noise monitoring at the zoo boundary and within selected animal enclosures during tunnelling.
- Coordination with zoo management to share monitoring results and adjust work schedules if threshold levels are approached.
- Proper dust suppression and controlled lighting (non-glaring, downward-directed fixtures)

440. Mitigation during Operation Phase:

- Use of low-vibration rail fastening systems and continuous welded rails to minimize operational vibration.

- Periodic maintenance and track grinding to keep vibration and noise within acceptable limits.

441. With the above mitigation and monitoring measures, impacts on fauna at the Rajiv Gandhi Zoological Park are expected to be minor negative during construction as well as operation phases.

442. **Residual impact.** No threatened or endemic species occur in the area, and the zoo's controlled environment further reduces ecological risk. The residual impact is therefore minor and localized..

443. **Impact Significance**

- Design and pre-construction stage – neutral
- Construction stage – minor negative
- Operation stage – neutral
- Residual Impact after Mitigation – minor negative

### 10. Assessment on Muck Generation

444. **Major Source.** Muck generation during the construction of an underground metro include tunnel excavation using Tunnel Boring Machines (TBMs), station box excavation through the cut-and-cover method, as well as the development of shafts, cross-passages, and other ancillary structures. The muck generated typically comprises excavated soil, rock fragments, and mixed debris such as concrete, shotcrete, reinforcement materials, and minor construction waste. While the material is generally inert in nature, its composition may also include fine silt, clay, or slurry depending on the underlying geological conditions.

445. **Impact.**

- The potential environmental impacts of muck generation and handling during underground metro construction are multifaceted.
- Fugitive dust emissions arising from muck loading, unloading, and transportation can lead to elevated levels of PM10 and PM2.5, contributing to air pollution.
- The frequent movement of disposal trucks may also cause traffic congestion, increase the risk of accidents, and result in higher fuel consumption and vehicular emissions.
- Improper management of muck storage sites can lead to water pollution through runoff, causing siltation and choking of stormwater drains. Additionally, large areas are required for disposal, creating land pressure and the possibility of illegal or unscientific dumping.
- Open heaps of muck not only degrade the aesthetics of the surrounding environment but also pose safety risks to nearby communities, particularly when trucks are left uncovered or dumps are poorly managed.

446. **Disposal**

- Dedicated identified sites should be allocated by municipal/civic authorities.
- Storage sites must be Located away from surface water bodies, drains, and settlements
- Provided with proper bunds, covering (tarpaulin/green net), and drainage.
- Transportation should be through covered trucks, with routes planned to avoid sensitive areas (schools, hospitals, residential colonies).

447. **Re-use**

- Use in station box backfilling, approach ramps, and construction yards.
- Suitable coarse muck can be used for road sub-base, embankments, and approach roads.
- Fine muck (soil) can be used for land leveling in approved areas.
- Coarser muck (rock fragments) can be used for brick/block making, aggregates, and filling material.
- In some cases, material can be used for quarry reclamation or low-lying area filling (with approval from authorities).

448. **Mitigation and Management Measures**

- Segregate muck into reusable and non-reusable fractions.
- Cover muck heaps with tarpaulin; sprinkle water to suppress dust.
- Ensure safe loading, covering, and transportation.
- Develop tie-ups with local agencies for reuse in infrastructure projects.
- Maintain records of muck quantity, storage, disposal, and re-use.

### 11. Social Economic

449. Socio-economic impacts can be anticipated majorly at three different levels - during Pre-Construction, Construction and Operational stages. The intensity of social impacts will depend on and relate closely to the stages of the project cycle. The below **Table 5-10** gives a summary of the same, as per the separate SIA study carried out for the project.

*Table 5-10: Impacts at different stages of project cycle*

| Sl No | Stages | Possible Impacts |
|---|---|---|
| 1 | Design Stage | • Interruption in the delivery of services<br>• Land Speculation |
| 2 | Construction Stage | • Displacement and relocation of NTH<br>• Influx of migrant construction workforce<br>• Temporary Land requirement<br>• Health impacts on those who lives close to the construction site<br>• Traffic diversions and risk to existing structures<br>• Dust generation<br>• Noise pollution<br>• Safety of local communities living and working near the construction site.<br>• Accessibility due to movement restrictions.<br>• Occupational health and safety |
| 3 | Operational Stage | • Reduction in employment opportunities compared to the construction phase<br>• Impact on Elderly and Differently Abled people in terms of accessibility and use of services |

### a. Community Health and Safety

450. **Impacts.** Minor health risks due to initial site preparation activities and interactions with the community are envisaged. During the construction phase, there is a high risk of communicable diseases (e.g., HIV/AIDS and STIs) from an influx of about 500 workers. Increased road safety concerns may arise due to construction vehicles (20–30 trucks daily). Additionally, community safety risks such as accidents near work zones and restricted access to local areas are anticipated. During the operational phase, there will be minimal health risks, and improved health outcomes are expected due to reduced air pollution and better transportation access.

451. **Mitigation.** To mitigate the risk of communicable diseases, baseline health surveys will be conducted in the pre-construction phase to assess prevailing health conditions, followed by health awareness campaigns targeting at least 80% of the affected population. Road and community safety concerns will be managed through strict traffic control measures, enforced speed limits, proper barricading, signage, and designated pedestrian crossings. No significant mitigation is required during the operational phase, as health impacts are expected to be positive.

452. **Residual Impact:**

- **Construction:** Moderate with mitigation.
- **Operation:** Positive, with better access to healthcare facilities and reduced accident rates.

### b. Traffic and Accessibility

453. **Impacts.** During the pre-construction phase, a slight increase in traffic is expected from equipment and material transport, estimated at about 5–10 vehicles per day. In the construction phase, moderate congestion may occur due to an influx of 20–30 construction vehicles per day, barricading, and excavation works for stations and shafts. These activities may temporarily restrict pedestrian access, affect shopfronts, and limit mobility for local residents, commuters, and business owners, particularly in congested market areas, near educational institutions, and hospitals. Accessibility challenges will be more significant for vulnerable groups such as elderly persons, differently-abled individuals, and emergency vehicle users.

454. In addition, the construction and operation of the project may lead to disruptions in community accessibility across the road. Communities could face physical separation, affecting daily movement for work, education, healthcare, and social interaction. Access to essential public services like schools and markets may be hindered, and longer detours could increase travel time and transportation costs. The absence of safe crossings could raise safety risks for pedestrians and cyclists. Roadside vendors may experience reduced foot traffic, impacting livelihoods, while the social fabric of neighbourhoods may weaken due to restricted mobility. Temporary blocking of access routes during construction could cause inconvenience and confusion.

455. During the operational phase, the metro will provide fast, reliable, and inclusive transport services, resulting in improved corridor accessibility and a reduction in road traffic congestion by an estimated 30%.

456. **Mitigation**.

- Traffic management: Designated unloading areas, casting yards, and batching plants will be used to minimize disruption on public roads. Traffic diversions will be planned and implemented in consultation with local authorities. Adequate road signage, speed breakers, and barriers will be installed, and traffic marshals deployed at critical junctions to guide vehicles and pedestrians safely.
- Pedestrian and local access: Phased barricading, temporary pedestrian pathways, and access corridors for shop owners and residents will be provided to maintain essential connectivity.
- Safe crossings: To address potential loss of cross-road access, pedestrian underpasses, footbridges, and well-marked crosswalks will be incorporated into the design. Dedicated pedestrian and bicycle lanes, traffic calming measures, and signalized crossings will enhance safety.
- Inclusive access: Barrier-free provisions for persons with disabilities, elderly, and patients will be ensured. Emergency access routes will remain functional throughout construction.
- Roadside vendors: Vendors affected by reduced foot traffic will be relocated to suitable vending zones and supported through livelihood restoration measures.
- Community engagement: Active engagement with local communities will be undertaken to understand mobility patterns and maintain social connectivity. Residents and businesses will be informed in advance about traffic diversions, temporary closures, and duration of works.

457. **Residual Impact:** With the implementation of mitigation measures, accessibility and traffic impacts during construction will be localized and temporary, limited primarily to minor delays and inconvenience. In the long term, the operational metro will improve accessibility significantly, ensure safer pedestrian movement, and reduce road congestion by around 30%.

458. **Impact Significance:**

- Design and pre-construction stage – minor negative (station entry/exit siting, designated yards, and cross-road planning)
- Construction stage – moderate to major negative (temporary restrictions, physical separation, and diversions for traffic and pedestrians)
- Operation stage – major positive (enhanced accessibility, improved safety, and reduced congestion due to modal shift)
- Residual Impact after Mitigation – minor negative during construction; major positive during operation

### c. Employment

459. **Impacts.** The project is expected to generate employment for around 500 skilled/unskilled labourers during construction phase and a large skilled work force is required to operate and maintain the system during operation phase.

460. **Mitigation.** Prioritize employment generation for local population, targeting at least 50% local employment. Skill-building programs for affected community members, including women to be implemented. During operational phase conduct annual performance evaluations and training sessions for Maha Metro Staff.

461. **Residual Impact.**

- **Construction:** Positive.

**Operation:** Strongly positive

### d. Private Structure Affected

462. **Impact:** Due to the proposed project, 71 structures, owned by 69 families swill be affected. Among these, 03 structures are owned by 03 legal titleholders, 53 structures are owned by 51 families having commercial license from Municipality and 14 structures by 14 squatters and one by one leaseholder. This petrol pump is on lease by PMC and only front board part of the pump is being affected, no impact on the main structure or on the employees of the same. There are only 24 mobile vendors found during the survey, out of which 22 are having license, and 2 were found without license in the survey. The detail of loss of structures presented in the **Table 5-11**

*Table 5-11 Ownership Status of Affected Private Structures*

| Sl. No. | Ownership Status | No. of Structure | No. of HHs |
|---|---|---|---|
| 1 | Legal Titleholder (Boundary wall of a residential building or apartment, Security Guard room's wall, Movie Hall boundary wall) | 3 | 3 |
| 2 | Commercial Licence from Municipality<br>• 22 Stationary Vendors<br>• 9 Kiosks<br>• 22 Mobile Vendor | 53 | 51 (2 HHs own 2 structures each) |
| 3 | Commercial (Unlicensed)-<br>• 12 Stationary vendors<br>• 2 Mobile Vendor- | 14 | 14 |
| 4 | Other Commercial - On Lease from PMC (only front board part of the Petrol pump shed) | 1 | 1 |
| **Total** | | **71** | **69** |

463. As per census survey, out of 71 affected families 69 families are losing their commercial structures. Out of 69 families 34 Stationary Vendors, 1 Petrol Pump-Leaseholder, 24 are mobile vendors, 9 are kiosk. There is no family losing their residential structure in the proposed alignment. The details of structures and number of displaced Families are given in the **Table 5-12.**

*Table 5-12 Types and Usage of Affected Private Structures*

| Sl. No. | Type of Structure | No. of Structure | No. of HHs |
|---|---|---|---|
| 1 | Stationary Vendors (Licensed and Unlicensed) | 34 | 34 |
| 2 | Petrol Pump-Leaseholder | 1 | 1 |
| 3 | Kiosk (Licensed) | 9 | 9 |
| 4 | Mobile Vendors (Licensed and Unlicensed) | 24 | 22 |
| | **Total** | **68** | **66** |

464. The structures being affected in the project are of various types by construction such as temporary, semi-permanent and permanent nature. This categorization is based on inventory of structures as part of social impact assessment which will be further verified and evaluated during implementation by concerned government department. Out of 71 main structures, 67 are temporary in nature, 2 structures are of semi-permanent nature and 2 structures are of permanent in nature. The type of constructions of the affected structures are given in the **Table 5-13.**

*Table 5-13 Type of Construction of the Private Structure*

| Sl. No. | Type of Structures | Temporary (Kutcha) | Semi-Permanent (Semi-Pucca) | Permanent (Pucca) | Total |
|---|---|---|---|---|---|
| 1 | Residential (TH) | 0 | 1 | 0 | 1 |
| 2 | Commercial (TH) | 0 | 1 | 2 | 03 |
| 3 | Commercial (NTH) | 67 | 0 | 0 | 67 |
| **Total** | | **67** | **2** | **2** | **71** |

465. The land acquisition for the project will affect 5 HHs who will be losing land and the area of acquisition will be a total of 2500.32 square meters. Out of which one is residential and losing boundary wall with land, two are losing commercial land with structures and two are losing barren land. The details are presented in **Table 5-14.**

*Table 5-14 Land Use Details of Affected Land*

| Sl. No. | Land Use Type | Affected Families | Area (in Sq mtrs) |
|---|---|---|---|
| 1 | Residential (Boundary wall of a residential building/Apartment) | 01 | 451.54 |
| 2 | Commercial (Movie Hall boundary wall, Security Guard room wall) | 02 | 973.77 |
| 3 | Barren land | 02 | 1075.01 |
| **Total** | | **05** | **2500.32** |

466. **Mitigation (Relocation Strategy)** All the structures affected under the project as per provisions made in the entitlement matrix will be eligible for the following:

(i) Compensation for structure will be paid at the replacement cost as per RFCTLARR Act 2013,
(ii) One-time Resettlement allowance per affected families
(iii) Shifting assistance to all displaced structures,
(iv) Right to salvage materials from structure and other assets with no deductions from replacement value

467. In addition to the above-mentioned entitlements, to help the PAPs losing commercial structures and relocating themselves, following relocation strategy will be adopted in the project:

(i) Maha Metro shall conduct consultations with PAPs and will establish linkages to suitable government rehabilitation schemes.
(ii) At least 60 day's advance notice before demolition of structure.
(iii) Their dismantled structures materials will not be confiscated, and they will not pay any fine or suffer any sanction.
(iv) Maha Metro during the RAP implementation will assist PAPs during verification of assets and will provide necessary counselling on payment of compensation and assistance.
(v) Ensuring a smooth transition (during the part or full relocation of the PAPs), helping the PAPs to take salvaged materials and shift.
(vi) In close consultation with the PAPs, Maha Metro will fix the shifting dates agreed with the PAPs in writing and the arrangements desired by the AFs with respect to their entitlements.
(vii) During the economic relocation of families losing commercial structures and Maha Metro will ensure that after relocation the livelihood of economically affected families has been restored to the pre-project level through provisions of livelihood restoration measures as per the Entitlements Matrix (including alternate livelihood training, linkage to government schemes, access to credit and services).

### e. Public Property / Infrastructure / Utility Services

468. **Impact:** Swargate to Katraj (Phase-1 Extension) are planned to run underground. However, during construction 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, footbridges 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. The Organizations / Departments responsible for concerned utility services are reported in **Table 5-15**.

*Table 5-15 Organizations Responsible for Utilities and Services*

| SN | Organization/ Department | Utility/Services |
|---|---|---|
| 1 | Maharashtra Public Works Department | Roads and bridges other than National Highways |
| 2 | Pune Municipal Corporation | City roads and bridges, including hydrants and fountains etc., Roads, surface water drains, nallahs, sewer lines, streetlights, etc. |
| 3 | | Water and sewage treatment plants, pumping stations sewerage and drainage lines; water mains and their service |

| SN | Organization/ Department | Utility/Services |
|---|---|---|
| | | lines |
| 4 | National Highway Authority of India (NHAI) | Roads and bridges on National Highways |
| 5 | Indian Railways | Railway crossings, subways, signals, bridges, stations etc. |
| 6 | BSNL (OFC and Telephone Cables) | Tele cables, junction boxes, telephone posts, O.H lines |
| 7 | Airtel, Vodafone, Idea, Jio, etc. | Telecommunications cables, junction boxes, telephone posts, etc. |
| 8 | Power Grid Corporation of India Ltd. | HT towers, cables |
| 9 | Irrigation Dept. | Canals, if any |
| 10 | Maharashtra State Electricity Corporation Limited (MSEB) | HT/other overhead Power lines |

469. In case any gas pipelines and High Tension (HT) power lines have to be crossed, a proper HAZOP study (& Risk Analysis) will be conducted as mentioned in the ESMP by contractor and Maha Metro during pre-construction period for any kind of handling of this issue in concurrence with gas supply agency and the Power Grid Corporation of India.

470. During construction period, complete/partial traffic diversions on road will be required, as most of the construction activities are along the road. As the alignment runs along centre of existing roads, traffic originating from and destined to locations along this section of road will need to be diverted through internal roads. Further, traffic will move on a lesser width of road due to barricading of metro work zone along the road median. This will cause congestion leading to air pollution, fuel consumption, safety risks and passenger time loss due to decreased average speed of movement.

471. In case of shifting of utilities and temporary traffic diversions, it might be necessary to temporarily use land outside of the construction zone.

472. **Mitigation.** 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, utility protection measures, etc. In case public utilities are required to be shifted to private land in exceptional circumstances, then adequate compensation will be made by Maha Metro to the property owner on the same principles as temporary land acquisition. Following completion of construction of metro, such utilities shall be rehabilitated on public land.

473. Prior to the start of excavation, the contractor will perform a ground survey to confirm location of pipelines and other utilities after which detailed design consultant will revise, where necessary, spans and pile arrangement to ensure that pier foundations do not interfere with major underground utilities.

474. Where the alignment cannot be fine-tuned to avoid conflict with utilities, permanent diversions will be done before commencement of work on the pertinent section; temporary diversions can be done before or during construction. Plans for diversion or relocation of any utilities along with hazard studies if required will be prepared by the Contractor in consultation with and approval of respective utility agencies before finalization of time schedule of metro construction works. Preferably they will have to be diverted by the agencies themselves.

475. In order to retain satisfactory levels of traffic flow during the construction period, traffic management and engineering measures will be taken. They can be road widening, traffic segregation, one-way movements, traffic diversions, acquisition of service lanes, etc. Barricading of road space for construction is required along the central median of the road on viaduct and edge of road right of way at stations. To minimise traffic delays, segmental construction will be employed. Maintenance of diverted roads in good working condition to avoid slow down and congestion will be a prerequisite during construction period.

476. The following traffic management guidelines will form basis of 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 will develop detailed 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-specific plans.

(i) High visibility reflective jackets to construction workers;
(ii) Signage to warn the road user clearly and sufficiently in advance;
(iii) Safe and clearly marked lanes and buffer and work zones for guiding road users and workers;
(iv) The primary traffic control devices used in work zones will include signs, delineators, barricades, cones, pylons, pavement markings and flashing lights;
(v) Advance traffic updates/ information for users of affected roads;
(vi) Traffic diversion due to temporary road closures;
(vii) At congested sections, temporary traffic coordinators will be engaged to facilitate the traffic management;
(viii) Focus will be on ensuring safe access to properties, passage to pedestrians, parking;
(ix) Construction traffic moving from construction yards to construction sites and from construction sites to soil/waste disposal areas may be confined to certain routes (based on infrastructure capacity) or restricted to certain off -peak hours so to reduce noise pollution at night or to avoid commuting and school hours during the day; and
(x) If necessary, bus service and other public and private transport services in the area should be improved to meet residents' transportation needs.

477. **Residual impact**. After construction all utilities will be fully functional and temporary traffic diversions will no longer be necessary. Therefore, no residual impact will exist after completion of construction.

478. **Impact Significance:**

- Design and pre-construction stage – moderate negative
- Construction stage – moderate negative
- Operation stage – neutral
- Residual Impact after Mitigation – none

**f. Physical Cultural Resources (PCR)**

479. No known protected archaeological monuments / sites or heritage assets are located on the project.

480. **Impact.** Only cultural heritage resources (PCRs) are considered in this section. All other sensitive receptors, such as educational and medical buildings, have been assessed under the appropriate section on sensitive structures. A review of the area within 150 m of the alignment shows that no PCRs are present within this screening distance. Therefore, no direct impacts on cultural heritage are anticipated during construction or operation. Since the project involves use of Tunnel boring machines (TBM) for construction of underground metro and stations, there are possibilities that artefacts are encountered during construction.

481. **Mitigation.** The project will implement, where required, chance finds procedure contained in ESS8 of WBG ESF and EIB's Standard 10 (Cultural Heritage) and which includes a requirement to notify relevant authorities of found objects or sites; to fence-off the area of finds or sites to avoid further disturbance; to conduct an assessment of found objects or sites by cultural heritage experts; to identify and implement actions consistent with the requirements of this ESS and national law; and to train project personnel and project workers on chance find procedures.

482. Before start of civil work, the contractor and Maha Metro will coordinate with State Archaeological department / ASI to reconfirm that there is no presence of buried artefacts along the metro alignments. No piling or excavation will be allowed unless cleared by the Archaeological Department.

483. Standard chance-find procedures will be implemented in line with ESS8 of the WBG ESF and EIB Standard 10 (Cultural Heritage), including:

- Immediate notification of relevant authorities in case any artefacts or sites are discovered.
- Temporary fencing and avoidance of disturbance to the find.
- Expert assessment and implementation of recommended actions in accordance with ESS requirements and national law.
- Training of project personnel on chance-find procedures.

484. 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 Maha Metro.

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

486. **Residual impact.** Since no PCRs are located within the direct zone of impact, residual impact on cultural heritage is expected to be none.

487. **Impact Significance:**

- Design and pre-construction stage – neutral
- Construction stage – neutral
- Operation stage – neutral
- Residual Impact after Mitigation – none

**g.** ***Intensity of Impact in the Project***

488. In addition to the various types of impact on land and non-land assets as discussed above the intensity of impacts, the data has been analysed and provided in the **Table 5-16** and **Table 5-17** below. Further during the implementation, the viability of partially affected structures will be assessed by qualified engineers from the concerned department in consultation with the PAPs and the compensation will be paid for the entire structures as required. In table 11 the intensity of the impact on land shows that out of 4 families only one family is up to 10% and 2 families are losing up to 25% of land and 1 family is losing up to 50% of land. In table 12 the intensity of impact on structure shows that all the 52 families are losing 54 structures more than 75% up to 100%.

*Table 5-16 Intensity of Impact on Land*

| Sl. No. | Scale of Impact | No. of Family & No of plots | % |
|---|---|---|---|
| 1 | Up to 10% | 1family losing 1 plot | 25.00 |
| 2 | Above 10% and up to 25% | 2 families losing 2 plots | 50.00 |
| 3 | Above 25% and up to 50% | 1 family losing 1 plot | 25.00 |
| 4 | Above 50% to 100% | 0 | 0.00 |
| **Total** | | **4** | **100** |

*Table 5-17 Intensity of Impact on Structure*

| Sl. No. | Scale of Impact | No. of Structure | % |
|---|---|---|---|
| 1 | Below 25% | 00 | 0.00 |
| 2 | Above 25% to 50% | 00 | 0.00 |
| 3 | Above 50% to 75% | 00 | 0.00 |
| 4 | Above 75% to 100% | 54 | 0.00 |
| **Total** | | **54** | **100** |

489. **Mitigation**. Affected persons and will be paid cash compensation at market rates for land and structures, compensation for loss of livelihood and rehabilitation benefits as per the Resettlement Action Plan (Sept 2024).

490. **Residual impact:** Involuntary Resettlement is small in magnitude, project affected people will be duly compensated and a R&R plan will be implemented. The residual impact will therefore be minimal negative.

491. **Impact Significance:**

- Design and pre-construction stage – moderate negative
- Construction stage – moderate negative
- Operation stage – neutral / positive

- Residual Impact after Mitigation – minimal negative

h. ***Resettlement Impact on PAPs***

492. As per the Land Acquisition Plan (LAP) prepared for proposed Project and R&R survey conducted, 4630.99 square meters of land needs to be acquired permanently for the proposed alignment. The analysis of land acquisition requirement for the project shows that out of total land required for the project is 1430.82 square meters (22.22%) is private land which includes both above (914.32) and below ground land (516.50), and 3200.17 square meters (77.78%) is government land. Out of total 5 land plots, 4 owned by 4 families (Private) and 1 plot owned by government. There is no religious land. The government land required by the project will be transferred to Maha Metro and the private, religious and community land will be acquired by Maha Metro. The land acquisition requirement for the project is presented in the **Table 5-18**.

*Table 5-18 Details of Land Acquisition Requirement49*

| Sl. No. | Type of Ownership | Unit | No of Plots | Area (in Sqm.) | % |
|---|---|---|---|---|---|
| 1 | Private Revenue (Open Land + Below Ground Land) | 4 | 4 | 1430.82 | 22.22 |
| 2 | Government | 1 | 1 | 3200.17 | 77.78 |
| **Total** | | **5** | **5** | **4630.99** | **100** |

*Note: The unit in the table refers to the number of impacted entities including private (Families), government, religious and community etc.*

493. In addition to the above-mentioned permanent land acquisition, 24747.00 square meters of land will be temporarily utilized for the Project, out of which 2184.86 square meters is privately owned and rest of the 22562.14 square meters of land is owned by Government. The privately-owned land proposed to be taken under lease are currently vacant and not under any residential agricultural and commercial purpose. The temporary land will be obtained from private owners through administration of a lease agreement and appropriate compensation/rent will be paid on mutual agreement. The cost of lease/rent for the private land is included under the budget of this resettlement plan.

494. Based on the above requirement, the project impact assessed through project census survey includes loss of land, loss of non-land assets, loss of trees and loss of livelihoods. It is confirmed that the land to be rented (both privately owned and government owned) is not under any agricultural use and does not involve the presence of squatters or tenants. As such, no impacts from temporary land acquisition are expected.

495. A project census survey was carried out to identify the persons who would be affected and/or displaced by the project and to make an inventory of their assets that would be lost due to the project, which would be the basis of calculation of compensation. The census survey of proposed Swargate-Katraj corridor was carried out in between 11th September – 18th September, 2024. It was found that a total of 71 Families would be affected by this project. Among the affected Families, 3 Families are losing both land with structures, 65 Families are losing only structures (commercial) and only 2 Families are losing only land and one is partially losing one lease structure (Front board of Petrol Pump). There are no employee or seasonal workers/ helpers found in the commercial structures, either the commercial units are run by the owner or tenant themselves or their family members help them in running the business. In case any employee is identified during implementation he or she will be compensated by the titleholder who will be compensated two and half times of the market rate as per the EM. The details are being provided in the **Table 5-19**

*Table 5-19 Land Acquisition and Resettlement Impacts50*

| Sl. No. | Category of Loss | Impact on land and Structures | No. of Household | % |
|---|---|---|---|---|
| 1 | Land with Structure owned by Titleholders (TH) | 3 Land with Structures (Residential and Commercial) | 3 | 4.23 |
| 2 | Only Structure affected (NTH) | Loss of trading location and semi-permanent structures (kiosks) commercial | 65 | 91.55 |

[49] *Note: The below ground land doesn't require to be compensated it is just part of the whole land requirement calculation and it is not calculated in the R & R budget; Source: Land Acquisition Report and Census Survey 2024*

[50] *Source: Census Survey, 2024*

| | | | | |
|---|---|---|---|---|
| | Stationary vendors- 34, Kiosk-9 Mobile Vendors-24 | (53 licensed and 14 unlicensed) – 26 Food outlets (Kiosk), 4 Paan shop, 6 juice stalls, 5 Fruit stalls, 2 newspaper outlets, 1 printings, 2 accessories stalls, 1 mobile accessories, 16 flower outlets, 1 crockery shop, 3 intense sticks stalls) | | |
| 3 | Only Land owned by Titleholder (TH) | 2 Land (Barren land) | 2 | 2.81 |
| 4 | Lease by Government (PMC to Individual owner) | 1 structure (only front board part of the shed) | 1 | 1.41 |
| **Total** | | | **71** | **100** |

496. The start date of project census survey i.e. 11th September 2024 is the cut-off date for non-titleholders who will be eligible for compensation and assistance under the project. For titleholders, the date of notification of intended acquisition (Section 11) as per the provisions of RFCTLARR Act 2013, and/or the date of 1st notification by Land Purchase Policy of Maharashtra will be treated as the cut-off date. The findings and magnitude of impacts are discussed in the following sections.

497. **Mitigation.** In view of the layout design of proposed extension section of Phase-I project prepared by the DPR Consultant, the census survey was undertaken in September 2024. Based on the proposed layout and census survey, the nature of social impacts identified in the project mainly comprise of following impacts.

- Permanent loss of land
- Permanent loss of land with structures
- Loss of commercial structures (Shops/Kiosk/Mobile vendors)

498. Major part of the alignment runs along the central verge of the roads. This section will be mostly underground thus; the impact will be less on permanent acquisition of land. Therefore, it disturbs the people to the minimum. However, there may be some impacts on the people living in the vicinity of the alignment and passing through the roads of the alignment since there would be barricading to provide space for working.

499. The RAP is prepared to address the social issues in the project area or along the project corridor such as impact on private / common / business/ cultural properties and on the people residing or doing business/ work in the area. Project affected area includes the area in which property/assets would be affected or from where land would be acquired for the project. The RAP captures all social impacts resulted from the Project including involuntary resettlement impacts and the management plan will be prepared in the form of RAP.

500. During FGDs / Public and individual consultation it was found that the affected families are aware of the project and loss of their land. They demanded adequate compensation for affected assets will mitigate the negative impact. Hence, providing fair cash compensation to the affected households will be the suitable measure for mitigation of impacts. Thereby, the cash compensation will be provided through Direct Purchase Method under Maharashtra Government's GR No: Misc. 03/2015/C.N.34/A-2 (May 12, 2015, and September 30, 2015)

501. Maha Metro will provide adequate and appropriate cash compensation at full replacement cost for lost land and structures including eligible relocation assistance to the titleholders. Compensation will be paid to the non-titleholders for the loss of assets other than land, such as dwellings and also for other improvements to the land, at full replacement cost.

502. Despite being a linear project and efforts made to minimize the resettlement impacts, the proposed project will affect only commercial structures as a result of which economic displacement will arise and therefore need for relocation is envisaged in the project. Efforts are made through various provisions in this resettlement plan to mitigate negative social impacts on displaced persons and communities by supporting relocation of affected Families and by restoration of income to national minimum standard.

**i. *Loss of Livelihoods in the Project***

503. **Impact.** The affected livelihoods are not primarily land-based and the livelihood losses are mostly due to loss of commercial structures such as beauty kits store, tea stall, pan shop, small eateries, ice-cream shop, other provisional stores. As per the census survey, out of total 71 HHs affected, 65 HHs are losing livelihoods, which includes only owners of commercial structures. There are no residential, commercial structure employees affected under the project. The commercial units identified are small and operated by the owners themselves and family members. The details of impact on livelihoods in the project are presented in the **Table 5-20**.

*Table 5-20 Impact on Livelihoods*

| Sl. No. | Category of Impact | No. of HH/Entity | % |
|---|---|---|---|
| 1 | Owners of Commercial Structures (34 Stationary vendors, 9 kiosks, 24 Mobile Vendors) | 67 structures by 65 HHs | 100 |
| **Total** | | 67 structures by 65 HHs | 100 |

504. **Mitigation.** The project impacts reveal that due to loss of land and commercial structures and business, 67 Families will experience loss of their livelihood out of which, 67 owners of commercial structures will be losing their livelihood due to the project. Income loses due to loss of commercial structures and other livelihood loss will be supported by providing skill up-gradation/ training to the eligible PAPs.

505. The proposed Pune metro rail phase 1 extension project will have some impact on the livelihoods of PAPs. Hence, it is the responsibility of Maha Metro as the owner of the project to provide adequate provisions for restoration of livelihood of the affected families. The focus of restoration of livelihood will be to ensure that the PAPs are able to at least “regain their previous living standards”. Restoration of pre-project levels of income is an important part of rehabilitating individuals, families, and socio-economic and cultural systems in project affected areas. The basic objective of income restoration activities is that no project-affected person would be worse off than before the project.

506. Due to the proposed project, 54 structures, owned by 53 families will be affected. Among these, 02 structures are owned by 02 legal titleholders, 44 structures are owned by 43 families having license from municipality and 07 structures by 07 squatters and 01 by another titleholder. There are only 19 mobile vendors found during the survey, out of which 18 are having license, and 1 was found without license in the survey.

**j. *Loss of Community Property Resources***

507. **Impact.** In terms of community property resources (CPR), 21 structures used by local community are identified to be affected under the project. The types of affected CPRs are presented in the **Table 5-21**. and the list of CPR affected in the project is p resented in Annexure 2. CPRs will be compensated either by cash compensation at replacement cost to the community (registered trust, society or village committee as appropriate) or reconstruction of the community structure at a new location in consultation with the affected community. Based on the census survey, it is confirmed that none of the CPR loss will result in livelihood loss of any person.

*Table 5-21 Loss of Community Property Resources*

| Sl. No. | Type of Structure | No. of Structure | Ownership |
|---|---|---|---|
| 1 | Govt office | 1 | Pune Municipal Corporation |
| 2 | Police Station (Parking land ) | 1 | State Government |
| 3 | Rickshaw stand | 1 | Auto Drivers Union |
| | Bus Stop (Yatri shed, bus stops) | 16 | Pune Mahanagar Parivahan Mahamandal Limited (PMPML) |
| 4 | Other Religious (Water tank) | 1 | Shankar Maharaj temple |
| 5 | Other Religious (Small temple) | 1 | Shri Ruicha temple |
| **Total** | | **21** | |

508. **Mitigation.** There are 4 community property resources to be affected under the project. The affected CPRs will be compensated either by cash compensation at replacement cost to the community (registered trust, society or village committee as appropriate) or reconstruction of the community structure at a new location in consultation with the affected community. Based on the census survey, it is confirmed that none of the CPR loss will result in livelihood loss of any person. For CPR with religious significance, traditional ceremonies will be observed during relocation.

**k. *Project Entitlement and Budget Provision***

509. The entitlement matrix proposed for this project has adequate provisions for restoration of livelihood of the affected communities. The focus of restoration of livelihoods is to ensure that the PAPs are able to at least regain their pre-project living standards. To restore and enhance the economic conditions of the PAPs, various assistances are incorporated in the Entitlement Matrix. Maha Metro will play a proactive role to mobilize eligible PAPs to get some vocational skills training. The special training program should be conducted with the help of departments concerned of Govt. of Maharashtra which is actively working for specific livelihood schemes in the locality. Additional consultation with PAPs and other stakeholders will be conducted and a training needs assessment will be carried out by Maha Metro to refine the required livelihood restoration measures.

510. **Compensation for Land:** The calculation of compensation for land is based on the findings of inventory of loss of land, assessment of latest market rate for the year 2024-25, as published by Department of Registration and Stamp, Government of Maharashtra. The multiplication factor and solatium are also considered as per the requirement of RFCTLARR Act.

511. **Compensation for Structures for Titleholders (TH):** The cost of main structure is calculated as per the minimum guidance value (i.e. market value updated on a yearly basis) issued by Department of Registration and Stamp, Government of Maharashtra. The cost of boundary wall is estimated as per the market assessment survey. The multiplication factor and solatium for the structures belong to titleholders is also considered as per the requirement of RFCTLARR Act.

512. **Compensation for Structures Non-titleholders (NTH):** The impacts on various types of structures belong to non-titleholders' compensation calculated is based on the market assessment, which will be finalized by the Government approved valuer to be appointed by Maha Metro during implementation.

513. **Estimation of R&R Assistances:** R&R assistances like shifting allowance, resettlement allowance, livelihood allowance, vulnerability allowance etc. calculated as per the approved entitlement matrix provided under this RAP.

514. The resettlement cost estimate for this project includes eligible compensation, resettlement assistance and support cost for RAP implementation. The support cost, which includes staffing requirement, monitoring and reporting during project implementation and other administrative expenses are part of the overall project cost. The total R&R budget for the estimated project RAP implementation is Rs. 338.48 million.

515. The cost related to resettlement will be borne by the Maha Metro. The Maha Metro will ensure allocation of funds and availability of resources for smooth implementation of the project R&R activities. In the case of assistance and other rehabilitation measures, Maha-Metro will directly pay the money or any other assistance as stated in the RAP to PAPs.

**l. *Project Impact on Indigenous People***

516. As per the Census of India 2011, Schedule Tribe (ST) Families in Pune is 3.37% of the total population of the city. Since the project alignment is falling mostly in urban area, the presence of ST population is less. In this project no ST is identified among the PAPs hence no impact on the ST Families.

**m. *Project Impact on Women***

517. **Impact.** The Metro rail project will bring great benefits to women and girls. Direct benefits include a decrease in travel time and an increase in reliable and convenient transport service. Indirect benefits include improved access to products and services, including social services such as health, education, as well as other government services. During construction, operation and maintenance of this metro project women will also benefit from the increased employment opportunities. However, construction of metro rail may also lead to potential negative impacts such as the spread of STIs (sexually transmitted infections) and road safety issues. Potential negative impacts will be addressed through community awareness sessions. In addition, the contractor will also carry out HIV/AIDS awareness program among worker camps and nearby community as mandated in their contract. As per the findings of consultation with women group, the perceived benefits from the projects includes:

(i) Improved access to social facilities like health, education
(ii) Increase in income generating activities
(iii) Frequent, safe and affordable transport
(iv) Management of emergency situation
(v) Improved community relations
(vi) Increased frequency of health workers, extension worker's visits
(vii) Improved access to market
(viii) Increased Leisure time
(ix) Reduced time spent on transportation of goods and services

518. During the consultation process the women apart from loss of assets, could not easily articulate the negative impacts. However, along with the loss of assets the following negative impacts were also recorded:

(i) Loss of assets as a result of the metro rail construction
(ii) Preference to men as wage labour over women during construction
(iii) Discrimination in wage payment
(iv) More dependence of mechanized techniques in metro rail construction likely to have very little opportunity for women as labourers

519. There are 10 women headed Families (WHH) affected in the project. The negative impacts of the project on female-headed Families will be taken up on a case-to-case basis and assistance to these Families will be treated on a priority basis. During disbursement of compensation and provision of assistance, priority will be given to female-headed Families. Additionally, women headed Families are considered as vulnerable and provision for additional assistance has been made in the entitlement of the RAP. Provision for equal wage and health safety facilities during the construction will be ensured by the Maha Metro.

**n. *Aesthetics***

520. **Impact.** As the metro alignment between Swargate and Katraj is fully underground, there will be no visual intrusion from viaducts or elevated structures. However, the construction and presence of surface-level components such as station entry/exit structures, emergency escape shafts, ancillary buildings, and ventilation shafts may temporarily or permanently affect local aesthetics.

521. **Mitigation.** Where feasible, aesthetic integration of surface-level structures will be incorporated into the urban fabric through context-sensitive architectural design, use of appropriate materials and colours, landscaping, and minimizing footprint. Design considerations will aim to ensure visual harmony with the surrounding built environment and preserve pedestrian openness.

522. Residual impact. Given the underground nature of the alignment and limited surface footprint, the overall visual impact is low. In highly urbanized or commercial areas, the residual impact is expected to be minor to negligible. However, in select residential or sensitive zones, localized impacts may persist depending on the placement and design of surface structures.

523. **Impact Significance:**

- Design and pre-construction stage – minor negative
- Construction stage – moderate negative
- Operation stage – neutral to minor positive
- Residual Impact after Mitigation – minor to moderate negative

**o. *Occupational Health and Safety***

524. **Impact.** Safety and health of metro personnel can be impacted in terms of failure of equipment or operating personnel or security in stations and on trains. Proper design of health and safety features in stations and trains can reduce this impact.

525. It is estimated that about 500 persons will work during peak construction activity on site and casting yards. Estimated total population in the labour camps will be 500. The water requirement at camps will be 203 KLD, wastewater generation will be around 183 KLD & municipal solid waste

generation 0.75 ton per day. This is tentative and will vary depending on the construction schedule during construction. Unclean water can cause health problems to residents of worker camps. Problems could arise due to cultural differences between workers from outside and local residents. Construction workers are more prone to infectious diseases and lack of sanitation facilities (water supply and human waste disposal) and insect vectors. COVID-19 poses a greater hazard with a higher risk for workers in the labour camps due to proximity of living spaces of individuals and families. Sleeping and eating spaces and public conveniences will require area much higher than are as per current norms. Further, practices of personal hygiene such as hand sanitizing and face protection need to be incorporated in the psyche of the camp residents as well as local people who operate small shops at the camp. Testing, first aid, transportation and hospital facilities of a much higher order of safety will be required.

526. The following elements impact worker safety – working in Tunnels, excavations, electrical and mechanical; gases, machinery; equipment; blasting; formwork; piling; PPE; medical facilities; firefighting; housekeeping; segment launching; batching plant; transport; security; explosives; general safety.

527. Harmful electromagnetic radiation is emitted by electrical traction and rolling stock: exposure of personnel needs to be minimized; electronic equipment needs to be immunized. Maha Metro personnel could be impacted by the effects of electromagnetic interference, electromagnetic radiation, musculoskeletal disorders (MSDs), stress and other communicable diseases.

528. Electromagnetic Interference (EMI) in metro railway can disturb electronic circuits in 3 ways:

(i) EMI in railway infrastructure like signalling caused by rolling stock: Considering the criticality of signalling, such disturbances can cause accidents and safety of staff as well as passengers.

(ii) EMI in environment caused by rolling stock: The railway can impact environment up to at least 10m from the track (Railway EMI impact on train operation and environment, A Morant etal, IEEE, Dec 2012)

(iii) EMI in rolling stock caused by environment.

529. During underground metro construction, workers engaged in tunnel excavation face safety risks such as potential tunnel collapse, rockfall, exposure to dust and gases, limited ventilation, fire hazards, and accidents from the use of heavy machinery. Confined spaces also increase risks of fatigue and emergency evacuation challenges.

530. During tunnel construction, workers face additional risks including:

- Confined space hazards and limited ventilation, increasing exposure to dust, gases, and airborne contaminants.
- Risk of tunnel collapse, rockfall, and falling debris.
- Exposure to high noise and vibration levels from TBM and other machinery.
- Fire hazards and emergency evacuation challenges.
- Ergonomic hazards, fatigue, and mental stress due to confined working conditions.

531. **Mitigation.** Maha Metro has a SHE Manual in place outlining the minimum Health and Safety standards that will be required by Maha Metro during construction of the Swargate to Katraj (Phase-1 Extension). Additional measures will also be put in place to complement the SHE manual or ensure that the SHE manual is aligned with international standards in terms of requirements for managing the mentioned aspects. SHE manual (including worker management and accommodation) will be updated to align with EIB standards 8 and 9 and with IFC Workers' Accommodation: Processes and Standards (ifc.org) – please refer to paras 158-161 for better understanding. Furthermore, the manual has been developed to give guidance and assistance to the respective Contractors in the development and production of their Site Health and Safety Plans, to satisfy the required H&S standards established by the Contract Conditions and the Employer's Requirements. The SHE Manual forms integral part of the bidding documents for the works to be undertaken. Construction works will be executed as laid down in the manual as applicable to Swargate to Katraj (Phase-1 Extension) project. The applicable sections are i) Control Document; ii) Health and Safety Manual; and iii) Environmental Management Arrangements. Control comprises: Legal requirements; standards; Contractor`s organisation and interfaces with Maha Metro; procedures to identify hazards and estimate risk, hazard mitigation measures; emergency response plan; resources; arrangements for training, inspection, communication, compliance, reporting, documentation and audit, review; complaint redressal. The Health and Safety Manual covers**:** Contractor organisation; accidents; hazards and risks; emergency preparedness plan;

signage; industrial health and welfare; works - heights, excavations, electrical and mechanical; gases; machinery; equipment; blasting; formwork; piling; PPE; medical facilities; firefighting; traffic management; housekeeping; launching; batching plant; transport; security; explosives; general safety; flooding etc.

532. These risks will be addressed through provision of proper ventilation systems, continuous monitoring of air quality, installation of robust tunnel supports, use of protective equipment (helmets, respirators, safety harnesses), and implementation of emergency response plans including fire control systems and evacuation drills. Regular safety training and strict adherence to occupational health and safety protocols will ensure worker protection.

533. SHE Manual, comprising the above-mentioned sections, as mandated by Maha Metro for underground construction are placed in **Annexure-7** to this ESIA-ESMP report. Compliance with Maha Metro SHE Manual is mandatory requirement to meet the standards, for the contractors. While complying with this SHE Manual, site-specific and construction work-specific procedures will be prepared by the Contractor and approved by Maha Metro. Hazards and requisite safety measures related to working at height are of primary focus on this project.

534. Prior to construction, necessary (temporary) living facilities for project workers will be provided by the contractor. Locations of such camps, their layout and level of facilities so as to minimize health risks will be put up for approval of Maha Metro, PMC and Public Health Officer. The workers' camps will be developed by contractors as and where required. The accommodation, sanitation & other facilities required at camps shall be governed by Country labour laws as well as international standards like IFC/EBRD, Workers' Accommodation: Processes and Standards (ifc.org). As 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 labourers free of charge. Labour camps will be in full compliance of BOCW Act. Uncontaminated water will be provided for drinking, cooking and washing, health care.

535. Waste water from cooking, bathing and washing including sewage from toilets will be discharged into municipal drains. Such waste water will be treated by municipal agencies to Environment Protection Rules (EPR) 1986 Schedule VI standards of discharge of general effluents into surface water. In view of the distributed nature of the linear construction and quantities of waste water, it is not proposed to install sewage treatment plants by Maha Metro for construction and operation phases.

536. Garbage bins will be provided in the camp and regularly emptied into municipal bins. Municipal solid waste will be collected and taken away and disposed by municipality.

537. The Contractor will implement Covid-19 guidelines and Operating Procedures as part of the Contract. Residents of worker camps will be sensitized about need to implement precautions and trained in social distancing, sanitizing, avoiding groups; arrangements for thermal scanners and provision of sanitisers, face masks, gloves etc will be made by contractor. Site record of nearby hospitals will be maintained and fully equipped ambulances will be available to transport sick camp residents to hospitals. Daily disinfection of camps will be carried out.

538. The construction works will be undertaken in accordance with all applicable legislation and Indian statutory requirements and guidelines- ISO 45001-2018: Occupational Health and Safety Management System and ISO 14001-2015: Environmental Management Systems.

539. As part of medical facilities for workers, the Manual mentions support to the HIV/AIDS control agency. Measures to minimize Covid transmission will form part of the ESHS Requirements in the contract documents so as to guarantee that the Contractor will implement Covid-19 guidelines and Operating Procedures as part of the Contract.

540. In order to safeguard Maha Metro personnel during operation of the metro system, the design includes installing Automatic Train Protection and Automatic Train Supervision sub-systems, a backup power arrangement in form of DG sets and a Closed-Circuit TV for security and crowd control. Specifications and layout of equipment will be decided so as to minimise exposure of personnel to harmful electromagnetic radiation.

541. To reduce conducted or radiated emissions detailed specification and layouts of equipment e.g. power cables, rectifiers, transformer, E&M equipment etc. will be framed as per appropriate international

standards. Electromagnetic Compatibility and maximum electromagnetic emission levels of whole railway system to the outside world measured at the railway boundary fence will comply with EN50121-2.

542. Musculoskeletal disorders (MSDs) and stress were identified by the industry as their major work-related ill health issues (Position Paper on Work related stress in the rail industry, Office of Rail Regulation UK, June 2014). No such published data is available in India. MSD risk can be eliminated or minimized through product design, mechanization, appropriate handling aids, risk assessments, training and better use of specialists such as ergonomists and physiotherapists.

543. Stress can be managed at three levels of intervention:

(i) Primary level intervention: The main priority for Maha Metro will be to assess and reduce the risk of harmful levels of workplace stress from occurring. This may require action at an organisational level, for example by changes to job design, task allocation, training, and supervision.

(ii) Secondary level intervention: Good practice at the secondary level typically involves building individuals' ability to cope with stress, for example by emotional resilience training, relaxation, or mindfulness; employee assistance programmes (EAPs); 'buddying' schemes; or healthy lifestyle promotion.

(iii) Tertiary level intervention: This focuses on recovery and rehabilitation, for example trauma focussed cognitive behavioural therapy; counselling; EAPs and staged returns to support early return to work.

544. Tunnel construction worker safety will be managed through:

- Detailed Tunnel Worker Safety Assessment and Mitigation Plan, which provides a comprehensive evaluation of risks and measures is attached as Annexure-15 of this ESIA report, and will also be included in the Contract documents, to be followed mandatorily by the Contractor/s.
- Proper ventilation and air quality monitoring inside tunnels to control dust, gases, and oxygen levels.
- Installation of robust temporary supports, rock bolts, and shotcrete to prevent collapse.
- Use of personal protective equipment (PPE) including helmets, respirators, ear protection, harnesses, and safety boots.
- Noise and vibration monitoring to ensure levels remain below safe thresholds.
- Emergency response planning, including tunnel evacuation drills, fire detection and control systems, and rapid medical access.
- Training of all tunnel workers on occupational hazards, safety procedures, and use of protective equipment.
- Continuous supervision and inspections by the contractor and Maha Metro Safety Officer.

545. General occupational safety outside tunnels will continue as per the SHE Manual, including risks related to heights, excavation, electrical/mechanical hazards, machinery, piling, transport, batching plant, COVID-19 precautions, and sanitation in labor camps.

546. **Residual impact:** Even with comprehensive mitigation measures and adherence to SHE standards, tunnel construction carries inherent safety risks. With proper implementation of the mitigation measures summarized above and detailed in **Annexure-15**, the residual impact for tunnel workers is expected to be minimal negative, while general construction residual risks remain moderate negative.

547. **Impact Significance**

- Design and pre-construction stage – moderate negative
- Construction stage – minimal negative (tunnel-specific)
- Operation stage – neutral
- Residual Impact after Mitigation – moderate negative (general); minimal negative (tunnel-specific)

548. **Mitigation Measure-**Mitigation measures for workers inside the tunnel during underground metro construction focus on minimizing risks related to confined space, air quality, noise, structural stability, and fire hazards.

549. Adequate mechanical ventilation should be provided to maintain safe oxygen levels and prevent the accumulation of dust, carbon monoxide, and other gases. Continuous air quality monitoring and water spraying systems should be implemented to suppress dust, while regular maintenance of equipment will help control noise and vibration.

550. Proper illumination of at least 150 lux must be ensured with emergency backup lighting to prevent accidents. Fire protection systems including flameproof fittings, extinguishers, smoke detectors, and alarm systems should be installed at regular intervals. Drainage and dewatering systems must be maintained to prevent water ingress or flooding.

551. Workers should be provided with comprehensive safety training, including confined space entry procedures, use of personal protective equipment (PPE), and emergency response drills. PPE such as helmets with lamps, reflective jackets, dust masks or respirators, safety boots, ear protection, gloves, and harnesses must be worn at all times inside the tunnel.

552. A work permit system should be followed for hazardous operations, and shift rotations should be planned to prevent fatigue. Regular health checkups, supervision by safety officers, and periodic emergency drills should be conducted.

Emergency exits, safe assembly areas, and first aid facilities must be clearly marked and maintained. Through strict adherence to these engineering, administrative, and personal safety measures, risks to tunnel workers can be effectively minimized and a safe working environment can be maintained.

**12. Waste Management**

553. **Impact.** Estimated total population in the labour camps will be 500. The water requirement at camps will be 203 KLD, wastewater generation will be around 183 KLD & municipal solid waste generation 0.75 ton per day. No hazardous waste generated during construction and operational phase except fuel, lubricant etc. Domestic solid waste will be generated in stations during operational phase of the project. Solid waste generated during construction includes construction and demolition (C&D) waste such as concrete debris, metal scraps, wooden formwork, packaging material, and excavated soil. In addition, municipal solid waste (MSW) from labour camps—including food waste, paper, and plastics—contributes to the overall volume. It is estimated that labour colonies will generate approximately 0.75 tonnes of MSW per day, considering a peak workforce of 500 workers.
If not managed, this waste can lead to:

- Obstruction of storm water drains,
- Contamination of land and water bodies,
- Foul odours, and
- Proliferation of disease vectors

554. Hazardous waste such as used oils, spent lubricants, diesel residues, chemical containers, batteries, and solvents are expected to be generated during equipment maintenance and operations, particularly from DG sets and construction machinery. Improper disposal can lead to soil and groundwater contamination, fire hazards, and occupational health issues.

555. **Mitigation.** Labour camps will be constructed in semi urban set-up or outskirts of the city. At the campsites wastewater treatment facilities will be constructed (e.g., septic tank and soak pit and site drainage) to avoid spillage of wastewater into surface water or groundwater. Alternatively, a connection to the public sewer system may be realised. Sewage discharged into public sewers will be treated by municipal agencies to Environment Protection Rules (EPR) 1986 Schedule VI standards of discharge of general effluents into surface water. Alternately, the contractor shall install small STP/Bio-digester for treatment of sewage from workers' camps. This treated water shall be used for gardening & sprinkling on roads. Hazardous materials (e.g. fuel, lubricants etc.), will be stored and disposed off through authorised MPCB approved vendor. Waste disposal sites and disposal management plan, temporary storage location for hazardous & other solid waste shall be monitored on regular basis. Non-hazardous solid waste generated in stations will be collected on a regular basis and transported to local municipal bins for onward disposal to disposal site by municipality. Regular inspection and maintenance of the waste collection system will be required in order to let it function effectively.

556. Mitigation for Solid waste management may include:

- Source segregation of waste into biodegradable, recyclable, and non-recyclable components.
- Composting of organic waste and handover of inert and recyclable waste to PMC-authorized waste contractors.

- Reuse of suitable C&D material within the project (e.g., as backfill or sub-base material).
- Disposal of excess waste to designated landfill sites approved by the Maharashtra Pollution Control Board (MPCB).

557. Mitigation measures to manage hazardous wastes include the following:

- Storage of hazardous waste in labelled, leak-proof, and covered containers on impermeable surfaces.
- Regular collection by authorized handlers and disposal through registered recyclers or Treatment, Storage, and Disposal Facilities (TSDF).
- Maintenance of hazardous waste logs and registers in compliance with the Hazardous Waste Management Rules, 2016 (amended 2019).
- Onsite availability of spill containment kits and emergency response training for staff handling such materials.

558. **Residual Impact:**

- **Construction:** Moderate with mitigation.
- **Operation:** Minimal with mitigation

559. Maha Metro, through its Project Implementation Unit (PIU) and appointed General Consultant (GC), will oversee the implementation of the Waste Management Plan. The contractor will be contractually obligated to ensure full compliance with the WMP and other ESMP requirements. Periodic site inspections, waste handling audits, and compliance checks will be carried out to ensure that environmental safeguards are not compromised. Reports on waste generation, handling, and disposal will be submitted monthly for review by Maha Metro and the European Investment Bank (EIB).

### 13. Energy consumption

560. **Impact**. Metro is an electrical energy intensive transport system, needing power for traction, train control, depots and station facilities. Such demand will increase with increase in passenger demand over time. Demand details are given under section on operation.

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

(i) Control annual heat gain through favourable orientation and design of facades
(ii) Site planning according to contours
(iii) Site plan designed to preserve existing vegetation/ existing water bodies / other topographical features like boulders etc.
(iv) Manage storm water on site through rainwater harvesting
(v) Mitigate heat island effect by ensuring that building surface visible to sky is shaded by trees. Ensure zero SWD (Solid Waste Disposal) post-construction by means of ground water recharge and recharge of groundwater aquifers by rainwater. The building will be designed to incorporate low ODP (Ozone Depleting Potential) materials, indoor air quality and comfort, low-VOC (Volatile Organic Compounds) paints and adhesives, reduced landscape water demand, sustainable building materials and renewable energy utilization etc.

562. **Impact Significance:**

- Design and pre-construction stage – neutral
- Construction stage – moderate negative
- Operation stage – neutral / positive
- Residual Impact after Mitigation – minimal negative

## F. POSITIVE IMPACTS OF SWARGATE TO KATRAJ (PMRP PHASE 1 EXTENSION) ALIGNMENT

563. Construction of metro project in a city like PMC will yield many tangible benefits such as better accessibility; reduction in atmospheric air pollution; less travel time; more comfort and improved quality of life. Some of the benefits expected from the project include:

(i) **Employment Opportunities** – The project is expected to generate employment for unskilled labourers during construction phase and a large skilled work force is required to

operate and maintain the system during operation phase;

(ii) **Safety** – Metro trains are largely safer, efficient and faster compared to other modes and means of transportation. Also, operation of metro trains reduces traffic congestion and chaos on at-grade roads making the roads safer and reduces the incidence of accidents;

(iii) **Reduction in Traffic Congestion and resulting Air and Noise pollution** – Proposed extension of metro network provides quick access to commuters, attracting public to use metro, thus significantly reducing traffic congestion on city roads. The reduction in traffic congestion reduces the fuel consumption and helps to conserve fuel and reduce air pollution and noise pollution on the roads;

(iv) **Increase in Green Cover** – Compensatory plantation at the rate of 10 trees for each tree being cut due to the project, will increase the green cover by the time these trees mature;

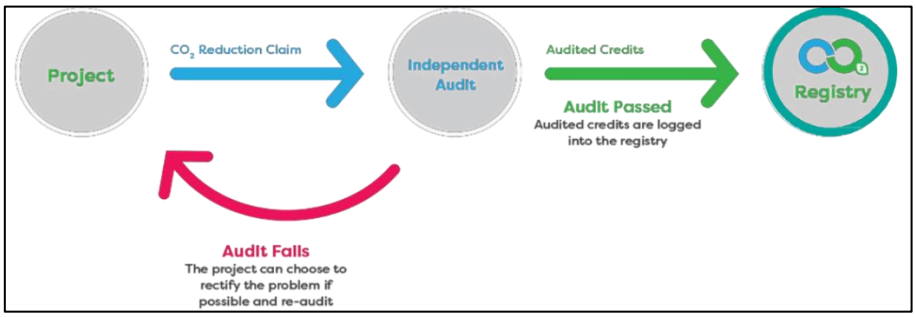
(v) **Benefits to Economy** – The project will facilitate movement of people from one end of PMC to the other. This safe and easy movement yields benefit to growth of economic activity due to better accessibility, savings in fuel consumption, reduction on investment on road infrastructure, reduction in vehicle operating costs, savings in travel time, improvement in safety and quality of life and reduction in loss of productivity due to health disorders resulting from pollution;

## G. CARBON CREDIT STUDY

### 1. What is Carbon Credit?

564. Carbon credits are reductions of emissions of greenhouse gases caused by a project or a product by anybody which directly or indirectly reduces or eliminates greenhouse gases. Currently, this reduction is measured in terms of Carbon dioxide or $CO_2$ reduced. The process for registering Carbon Credits against a project is shown in **Figure 5-4** below.

*Figure 5-4 Process of Registering Carbon Credits*




### 2. How it Works?

565. Carbon credits are bought voluntarily by companies and individuals to offset the environmental cost of their actions – which are typically measured by a verified third party and go towards funding projects in alternative energy, developing renewable resources, and other areas.

566. When companies or individuals go about their daily lives and conduct business they use energy. When this energy is derived from fossil fuels such as oil, coal and gas, it releases carbon and other greenhouse gases (GHGs) into the atmosphere. This is one of the key contributors to climate change.

567. Carbon markets provide the infrastructure for carbon trading or 'offsetting' -- the process by which businesses and individuals can be accountable for their unavoidable emissions by funding certified GHG emission reduction projects elsewhere in the world, as represented in **Figure 5-5**. Types of Carbon Credit Markets are shown in **Figure 5-6**

*Figure 5-5 How Carbon Markets work*

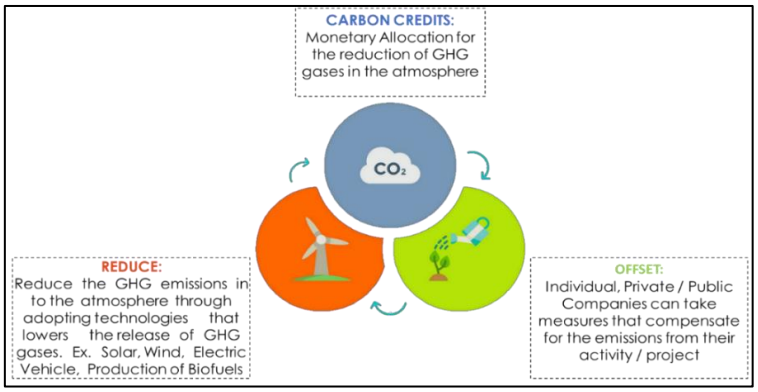
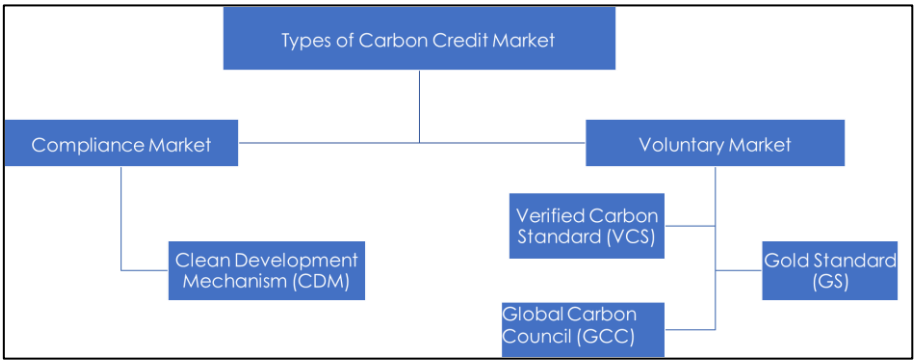



*Figure 5-6 Types of Carbon Credit Markets*




568. Estimating "$CO_2$ emission savings" of a Mass Rapid Transit System (MRTS) project shall give an opportunity to earn carbon credits under Clean Development Mechanism (CDM) of Kyoto protocol for 'Non-Annex I' countries like India. A summary of requirements and salient features of the CDM is summarised in **Table 5-22** below.

*Table 5-22 Salient features of the CDM for Carbon Credits*

| Mechanism | CDM |
|---|---|
| What is it? | United Nations' Carbon Crediting mechanism, which is globally accepted. However, the only major buyer right now is EU. |
| Eligibility | A prior intimation form needs to be sent to UN within 6 months of commissioning |
| Timeline for registration | Approx. 1 year, subject to DNA (MoEF&CC) Meeting & Host Country Approval (HCA) Letter |
| Strength | Taking the project under CDM ensures that it is also recognized by UNFCCC and remains eligible in all the current and future mechanism (Paris Agreement) proposed by UNFCCC |
| Major Use | CDM projects are eligible to be used under compliance mechanism mainly in EU ETS. |
| Critique | Focus only on Emission reductions, thus Sustainable Development not captured in the current scenario. |
| Long Term Vision | CDM, or any other mechanism that might come up under Paris Agreement that has to decide upon latest by Dec 2021. We strongly believe it's a justified gamble to keep the projects eligible under CDM to benefit in the long run since they will the country's legal compliance structure. |

### 3. Carbon Emission Estimation Swargate to Katraj (Phase-1 Extension)

569. As per the DPR (Dec. 2022) carbon emission of Swargate to Katraj (Phase-1 Extension) is presented in **Table 5-23**.

*Table 5-23 Carbon emission estimation*

| | |
|---|---|
| Treatment cost of CO2 Rs/Ton[51] | 500 |
| Carbon ($CO_2$) Emission - Ton /litre[52] | 0.0023 |

[51] *Source: Appraisal Guidelines for Metro Rail Projects Proposals, 2017, MOH&UA, GOI*
[52] *Source: GHG Analysis Road Improvement, Guidance Note, World Bank Group, February 2016)*

# Chapter 6. ANALYSIS OF ALTERNATIVES

## A. PROJECT PURPOSE

570. Over the years, the city's urban transportation infrastructure has been severely strained by widespread urbanization in IT/ITES and industrialization combined with a significant increase in the number of vehicles on the road. As of March 31, 2018, the vehicle count in PMC was 36.2 lakhs under the Regional Traffic Office MH-12, while PCMC had 15.68 lakhs registered vehicles, including 11.69 lakh two-wheelers and 2.54 lakh four-wheelers. In total, PMC and PCMC have approximately 51.88 lakh registered vehicles. Over the past 20 years, there has been a 700% increase in the number of vehicles in the Pune Urban Agglomeration, according to the Regional Transport Office.[53]

571. In addition to the existing public transport options in Pune, the Government of Maharashtra has granted in-principle approval for the Swargate to Katraj (Phase-1 Extension) of the Pune Metro Rail Project. This corridor has been identified as a critical link to address traffic congestion, improve accessibility, and provide a sustainable transport solution for the growing southern suburbs. The Maharashtra Metro Rail Corporation Limited (Maha-Metro) proposes to implement the extension as an efficient, safe, and high-capacity mass transit system that complements the existing metro network. The analysis of alternatives for the proposed alignment and design has therefore been undertaken to ensure that the project delivers maximum socio-economic and environmental benefits while minimising potential adverse impacts.

## B. PUBLIC TRANSPORT PLAN IN CMP

572. The Comprehensive Mobility Plan (CMP) considers bus rationalization, bus augmentation and Rapid Transit System for Pune city. The CMP seeks to make public transport facilities available to all residents within a reasonable distance from their homes, work places and other destination points. Apart from physical integration fare integration, information integration is also proposed. Intelligent Transport System is considered for Pune city including AFCs, Validators, Electronic Ticket Machines, Security Access Modules etc. High and medium capacity public transport systems have also been conceived in CMP.

### 1. Options of Mass Transport Systems

573. Mass transport systems in cities / urban agglomerations can be broadly classified into the following 5 categories, the E&S impacts of which are summarised in **Table 6-1**.

*Table 6-1: Mass Transport Systems with their respective Environmental & Social impacts*

| Mass Transport System | Environmental Impacts | Social Impacts |
|---|---|---|
| **Normal Bus System** | - Significant air and noise pollution due to diesel engines.<br>- High carbon emissions per passenger. | - Affordable but prone to delays and overcrowding.<br>- Lacks reliability and comfort. |
| **Bus Rapid Transit System (BRTS)** | - Moderate air and noise pollution reduction due to better traffic flow.<br>- Encourages reduced private vehicle use. | - Improved travel times and reliability.<br>- Limited capacity for high-density cities.<br>- May cause displacement due to lane segregation. |
| **Light Rail Transit System (LRT)** | - Minimal air pollution as it's electric-powered.<br>- Moderate land use compared to Metro. | - Provides efficient connectivity but limited capacity.<br>- May require resettlement during construction. |
| **Metro Rail System** | - Zero air pollution during operation (electric-powered).<br>- Sustainable in high-density urban areas. | - Highest passenger capacity (40,000–80,000 PHPDT).<br>- Reliable, fast, and future-proof for growing cities.<br>- Reduces congestion and travel time. |
| **Regional Rail** | - Low air pollution per passenger but moderate noise pollution. | - Useful for suburban connectivity but less efficient within urban cores.<br>- May require significant land acquisition for track expansion. |

574. Why Metro Rail System is the Best Alternative:

[53] *Source: The Indian Express, 2017*

- **Environmental Advantages**: Zero emissions during operation and high energy efficiency make it the most environmentally friendly option for urban transit.
- **High Capacity**: Metro rail can accommodate the highest passenger volumes, making it suitable for rapidly growing cities.
- **Reliability**: Fully segregated tracks ensure punctuality and safety, unlike systems that share roads with other vehicles.
- **Long-term Solution**: Though capital-intensive, metro systems offer sustainable and scalable transport for future urban growth.

575. The Swargate to Katraj extension is designed as an entirely underground alignment to ensure seamless continuity with the existing underground metro line terminating at Swargate. The corridor passes through a densely built-up urban area with high traffic volumes and limited right-of-way, making underground construction the most feasible solution to minimise surface-level disruption. This configuration also reduces land acquisition requirements, avoids displacement of properties, preserves the urban landscape, and maintains operational efficiency by adhering to optimal gradient requirements for metro operations.

### 2. Selection of alignment and stations in CMP

576. The PMRP is constantly trying to reduce the impact of the project by minimizing the Corridor of Impact through fine tuning their design without compromising with the safety precautions. Therefore, adequate attention has been given during the feasibility and detailed design phases of the project preparation to minimize the adverse impact on land acquisition and involuntary resettlement. However, technical and engineering constraints were one of the major concerns during exploration of various alternatives, especially in relations to road safety and decreasing congestion in key sections.

577. The engineering data and typical cross-sections formed the basis of determining the land requirement at stations locations. Based on this information such as presence of buildings, trees, utility services along the project corridor, the center line of the alignment is designed so as to cause minimum disturbance / impact on people. The existing land of the road will be utilized for the construction of line viaduct and stations.

578. Attempts have been made in modifying the engineering design and alignment of Phase-I extension metro line at various locations to minimize the land acquisition, resettlement, and adverse impacts on the people in the project area.

579. The Comprehensive Mobility Plan for Pune City (PMC) was developed in 2008 (CMP 2008, pmc.gov.in). This plan outlines a 25-year strategy with a vision for transportation in Pune, aiming to create an effective and well-organized transport system that meets the city's needs and addresses its concerns. The goals of the Comprehensive Mobility Plan (CMP) are to outline targeted actions through short, medium, and long-term improvement proposals to achieve the area's transportation vision. The primary aim of the CMP is to offer a long-term strategy for creating an ideal mobility pattern for the city's residents. To achieve this, the following are the main objectives:

(i) To develop a transportation vision for Pune.
(ii) To identify specific strategies and measures to address traffic growth of all modes of transportation in an effort to meet set goals.

580. The "Comprehensive Mobility Plan (CMP) needs to be prepared that focus on mobility of people rather than vehicles and accordingly give priority to pedestrians, Non-Motorized Transport (NMT), all modes of public transport and IPT." A vision is established for Pune city upon which the detailed mobility plan is structured: "Moving people safely and economically by emphasizing public transport and non-motorized transport.

The six most important pillars for ensuring Sustainable Mobility in urban areas are:

(i) Integrating Land use and Transport in Planning Process
(ii) Recognizing the use of non-motorized means of movement by introducing NMT favourable strategies
(iii) Bringing a control on movement of personal vehicles
(iv) Managing parking in the city
(v) Encouraging Public Transport System and other Sustainable modes
(vi) Directing city growth in a uniform manner with the help of better links and access roads
(vii) Sustainable Mobility however can only be ensured if the solutions are environmentally,

socially and economically sustainable. To ensure that Mobility solutions for Pune that are sustainable and in conformity with sustainable mobility, following Goals have been formulated in the CMP:

**Goal 1:** Develop public transit system in conformity with the land use that is accessible, efficient and effective.

**Goal 2:** Ensure safety and mobility of pedestrians and cyclists by designing streets and areas that make a more desirable, liveable city for residents and visitors and support the public transport system.

**Goal3:** Develop traffic and transport solutions that are economically and financially viable and environmentally sustainable for efficient and effective movement of people and goods

**Goal 4:** Develop a Parking System that reduces the demand for parking and need for private mode of transport and also facilitate organized parking for various types of vehicles.

581. The transport network of city is dependent on its land use. Land use and the transport network strategy development must go hand in hand. Connectivity helps in the realization of the land use planned. The land-use transport strategy developed focuses on accessibility, connectivity, and mixed land use developments to minimize private vehicle trips, encourage transit-oriented development. In the long term, the transport strategy should be based on the urban growth envisaged for the city. Transport network strategy, therefore, enables the city to take an urban form that best suits the geographical constraints of its location and also one that best supports the key social and economic activities of its residents.

582. As per the Comprehensive Mobility Plan for Pune Municipal Corporation and Pimpri - Chinchwad Municipal Corporation, the overall Per Capita Trip Rate (PCTR) observed in PMC and PCMC area was 1.33 and 1.17 respectively, while the vehicular PCTR (excluding walk) in PMC and PCMC area was 0.88 and 0.76.

583. The year 2018 is considered as the base year for the travel demand model. In 2018, the base case transport network includes buses, intermediate public transport (IPT), shared liners, out-station bus routes, existing suburban rail routes, and currently operational BRT routes.

584. For the years 2027, 2037, 2047, and 2057, the network with the project will encompass buses, IPT, shared liners, out-station bus routes, both existing and proposed suburban rail routes, as well as currently operational and proposed BRT routes. It will also feature metro lines under construction and proposed mass transit corridors according to the Comprehensive Mobility Plan (CMP), including proposed extension corridors such as Swargate-Katraj alignment.

### 3. Alternative Options for Lower Ridership Volumes

- **Personal Rapid Transit/ Cable Car**

585. Based on worldwide experience, Light Metro and LRT are feasible solutions for mass transit at volumes of around 5000 PHPDT or more.

586. Alternatives to Light Metro or LRT could be considered for the extension, for example monorail or various forms of Personal Rapid Transit (PRT

- **A Passenger Per Hour in Peak Direction (PPHPD) too high for the people mover option**

587. Typically, PRT vehicles are small in order to provide a personalised service, usually carrying between two and six passengers. As vehicles are small, infrastructure can be lighter in design.

588. Although larger vehicles have not so far been used for the limited examples of PRT in current operation, it might be possible to offer larger vehicles, but this would increase the size and cost of infrastructure and reduce the benefits of offering a personalised service.

589. If we assume vehicles carrying as many as 20 passengers (much larger than any application so far in the world), then 400 departures would be required in the peak hour in 2057, which does not appear feasible.

- **Monorail**

590. Monorail, a transport mode that has higher capacity than PRT but has been mainly developed for other than mass transit so far

591. Monorail can accommodate larger volumes of riders than PRT, similar to Light Metro and LRT, and at similar commercial speeds.

592. Most Monorail systems in the world have been short-distance lines, often aimed at tourists, but there are growing applications to mass transit systems (e.g. the Mumbai Monorail can accommodate over 550 passengers per train

- **Monorail, a system that has cheaper infrastructure than conventional rail-based project**

593. To be suitable for extension line, up to 11860 PHPDT would need to be accommodated by 2057 or beyond- even assuming trains of similar capacity to Mumbai monorail, this could require at least 15 departures per hour by 2047. Construction requires similar infrastructure to elevated Light Metro and LRT, although structures typically require less material compared to an equivalent Light Metro or LRT, without-turn infrastructure costs per km approximately 25% lower.

- **Monorail, a system that lacks flexibility compared to more conventional modes**

594. One major challenge is that monorail systems are less flexible than conventional Metro and LRT systems, for example switching between tracks requires additional infrastructure than with steel rails, and ride quality is lower than on steel rails. Evacuation can be more difficult/dangerous than even elevated conventional rail systems, unless adequate additional escape routes are built into the infrastructure.

- **Lack of diversity in monorail systems suppliers implying potential higher costs and risks**

595. Monorail vehicles are available from only a few suppliers, have less of a successful record of operation, and are more specialist than Light Metro or LRT vehicles. Consequently, monorail vehicles are likely to be more expensive than equivalent Light Metro or LRT vehicles, and the whole operating system would be provided by the vehicle supplier as it is bespeaking which would increase risk and potential cost.

596. Different monorail systems are not compatible with each other so that for example, a Hitachi monorail system will not run with rolling stock from another supplier. If the chosen supplier decided to end its monorail business line, then the system itself would be threatened (no possibility to renew rolling stock notably).

597. Timelines for completing systems of similar length to that proposed for extension appear to be similar for monorail and conventional rail-based systems (e.g. Mumbai Monorail five years to opening of first section; five years for São Paulo monorail line 15

## 4. Mode Selection

598. Pune is a growing city with high potential of economic activity and population growth. Commuting for day to day business and personal reasons results in to high passenger traffic and congestion on roads. Therefore, Phase-I of Pune Metro is already approved by Government and is currently under construction phase. Following this development, there is a demand for Swargate to Katraj (Phase-1 Extension).

599. The objective of Mass Transportation systems should be to provide high mobility, freedom and comfort at optimum cost, keeping safety and security of passengers on high priority. Mode change over a trip should be minimized to avoid passenger discomfort. The system and technological option should be selected keeping long term demand in view.

600. Phase-I of Pune Metro is designed and implemented as a medium metro. Based on worldwide experience, a medium metro is a system half-way between light and heavy metro. Its capacity is around

30,000 PPHPD (6 standees/sq.m.) or more.

601. While projections of demand for the Swargate to Katraj (Phase-1 Extension) show maximum PHPDT to be around 8010 in 2057 in section Swargate station to Station 1 (Near Market Yard, Gultekdi) and beyond, PHPDT for corridor-1 with extension in Nigdi-Swargate section, is projected around 18070 in 2037 and 28170 in 2057. PHPDT criteria indicates that Light Metro, LRT, BRT, Street-car, Urban Tram, monorail are feasible solutions for mass transit at volumes of around 10,000 to 15,000 PHPDT or more should satisfy projected traffic demand reasonably.

602. Feasible alternatives (e.g. Monorail) offer limited advantages and are unlikely to be delivered any faster than Light Metro or LRT. Ensuring compatibility across the whole network should offer economies of scale (both in capital expenditure – such as sharing depots – and in operating expenditure – sharing maintenance, staff, rolling stock, etc).

603. Considering the above factors and systems options, it is concluded Swargate to Katraj (Phase-1 Extension) provides a suitable Mass Rapid Transit System (MRTS) option to public in the area of extension and beyond. It will connect public in and around the area of Swargate to Katraj to the core area of city and can act as catalyst for further growth in this area.

## C. SCREENING CRITERIA FOR IDENTIFIED ALTERNATIVES

### 1. Goals & Objectives

604. Metro Rail Policy guidelines of MoHUA, 2017 suggests several screening criteria for Alternatives Analysis of projects. Following screening criteria have been identified for both the qualitative and quantitative evaluation:

(i) **Mobility Effects** - Primary purpose of this task is to assess the current travel demand for base year, with available future year networks and land use data as documented in CMP.

(ii) **Conceptual Engineering Effect -** Engineering effects have been analysed for civil aspects of alternatives. To refine the range of alternatives to relate the differences between options, all feasible alternatives have been compared including those as identified in CMP.

(iii) **System Effects -** The indigenous availability of rolling stock, carrying capacity, type of operation, safety, comfort, land availability for depot, are some of the core transport system related characteristics to be considered.

(iv) **Environmental Effects -** The purpose of preliminary environmental analysis is to identify environmentally sensitive areas early on, so that these areas can be avoided if possible, during design. A screening-level analysis has been conducted to determine the potential environmental impacts of each alternative identified.

(v) **Social Effects -** The analysis has been conducted to determine the potential social impacts of alternatives.

(vi) **Cost Effectiveness & Affordability -** The capital cost and annual costs associated e.g. operation & maintenance costs etc. for each alternative have been evaluated. Preliminary costs have been estimated based upon conceptual engineering for alternatives selected for evaluation.

(vii) **Financial and Economic Effects –** Financial plans, economic benefits and costs associated with the project have been identified and quantified for identification of optimum solution along with economic viability.

(viii) **Other Factors - Approval & Implementation -** The mass transport system to be introduced will require technology and set of components well established and proven so that statutory approvals and implementation of system do not result in time delays and cost implications. Established systems already in place in India will require less time for processing of approvals and would be easy to implement.

605. A scoring criterion for each of screening parameters has been developed for the initial qualitative evaluation. The following weightage has been considered as provided in **Table 6-2**:

*Table 6-2: Weightage of Screening Criteria For Qualitative Evaluation*

| SN | Criterion | Weightage |
|---|---|---|
| **1** | Mobility Effects | **20** |
| **2** | Conceptual Civil Engineering Effect | **15** |
| **3** | System Effects | **10** |

| | | |
|---|---|---|
| **4** | Environmental Effects | **15** |
| **5** | Social Effects | **5** |
| **6** | Cost Effectiveness & Affordability | **15** |
| **7** | Financial and Economic Effects | **15** |
| **8** | Approvals & Implementation | **5** |
| | **Total** | **100** |

606. The alternatives are ranked based on their relative performance under each criterion. Four scoring classifications considered for each parameter are:

(i) Excellent (100%)
(ii) High (75%)
(iii) Medium (50%)
(iv) Low (25%)

**2. Qualitative Evaluation of Alternatives**

**(a) Basis of Scoring the Screening Parameters for Quantitative Evaluation:**

(i) **Mobility Effects** – Mobility effects namely travel demand and existing transport characteristics in the city influence in determining the mass transport system required. Fulfilment of projected demand in long term scenario, ease of passenger transfer, utilization factor, possibility of intermodal integration between systems and catchment area connectivity are the identified parameters. Guided systems score high in mobility effects as they offer higher carrying capacity and frequency of regulated services, better utilization in terms of more passenger-km and thus reducing congestion on roads.

(ii) **Conceptual Civil Engineering Effects** – The parameters covered are available right of way, alignment design & constructability, geotechnical characteristics, station planning & intermodal integration and requirement for utility shifting. Road based systems score high as it requires less right of way and have easy constructability than grade separated rail-based systems and BRT. Rail based systems and elevated BRT with dedicated guideway systems have impact on shifting of existing surface / underground utilities. However, Metro Rail, LRT and BRT can offer better station planning and intermodal integration opportunities.

(iii) **System Effects** – The influential parameters are interoperability with existing Metro Phase-I, passenger's safety & comfort, type of operation and indigenous availability of the system. Rail based systems and Elevated BRT are more automated in operations while normal bus system is manually operated in mixed traffic conditions. Metro rail would be the most suitable mode considering continuity / interoperability with the Phase 1 metro system. Rail based systems offer better quality of travel and offer safe travel conditions than road-based systems. Except for LRT, other modes namely Metro, BRT and Normal bus have indigenous availability in the country.

(iv) **Environmental Effects** – The parameters considered are air & noise pollution, trees affected and management of hazardous waste. Rail based systems have been assigned better scores more than bus-based systems considering their ability to reduce pollution levels on the city roads. Grade separated Metro Rail and LRT being electrified systems play an important role in minimizing the air and noise pollution levels in the city.

(v) **Social Effects** – Normal Bus based system score high as very few structures /families are affected.

(vi) **Cost Effectiveness & Affordability** – Bus based systems are more affordable than rail-based systems due to lower capital and O&M costs per passenger-km and accordingly are assigned higher scores than metro and light rail systems. Rail based systems incur high capital cost whereas normal bus systems require comparatively less investment costs as buses share the existing roadway system with other modes. However, Metro, LRT and elevated BRT consume more construction and O&M costs as they are planned for a much higher operational period and an exclusive guideway system.

(vii) **Financial and Economic Effects** – Economic benefits and Life cycle cost of rail-based systems is much higher than road-based systems considering reduction in pollution levels, number of accidents and overall social benefits. The cost incurred in road-based systems considers fuel, operation and maintenance costs. Rail based systems on the

other hand result in saving considerable travel time, provide convenient and safe travel conditions thereby resulting in optimizing overall travel cost. The rail-based systems also allow Transit Oriented Development along dedicated corridors which generate additional revenue for the implementing agency/development authority.

(viii) **Approvals and Implementation** –Road based systems and Metro score higher than LRT as these systems have set standard procedures for approvals and implementation. LRT would consume more time as it has not been introduced yet in India.

## D. "DO NOTHING" SCENARIO

607. As part of the alternatives' assessment, a "Do Nothing" scenario analysis has been carried out to evaluate the potential implications of proceeding with or foregoing the proposed Swargate to Katraj (Phase-1 Extension) alignment of the Pune Metro Rail Project. This comparative assessment is crucial to understand the environmental and social significance of the proposed project. The "Do Nothing" scenario assumes continued reliance on existing transport infrastructure, which is already under strain due to rapid urbanization, increased vehicle ownership, and inadequate public transport options. In contrast, the "With Project" scenario envisions the implementation of a sustainable, efficient, and inclusive metro system that addresses urban mobility challenges while minimizing adverse impacts through well-defined safeguard measures. The following **Table 6-3** presents a side-by-side comparison of key environmental and social aspects under both scenarios.

*Table 6-3 Comparative analysis of "Do Nothing" Scenario vs. With Project Scenario*

| Aspect | "Do Nothing" Scenario | With Project Scenario |
|---|---|---|
| Air Quality | Continued deterioration due to rising number of private vehicles, resulting in higher emissions and dust levels in densely populated corridors. | Temporary air quality deterioration during construction due to dust and machinery emissions. Long-term improvement through modal shift to clean metro transport. |
| Noise & Vibration | High baseline noise from road traffic persists, especially near sensitive receptors like hospitals and schools. | Temporary increase during construction. Controlled through equipment maintenance, restricted working hours, and noise barriers near sensitive areas. |
| Water Resources | Urban runoff continues to pollute surface water. Groundwater use and recharge are unregulated. | Risk of contamination during construction (dewatering, run-off). Mitigated via proper drainage planning, sediment traps, and regulated water usage. |
| Ecology (Flora & Fauna) | Gradual decline in green cover due to urban sprawl; no additional compensatory efforts. | Tree cutting unavoidable at station locations; compensated through replanting and biodiversity conservation measures under ESMP. |
| Traffic Congestion | Traffic volumes expected to rise further, leading to increased travel time, fuel use, and commuter stress. | Short-term construction-related congestion. Long-term reduction in road congestion due to high-capacity metro service reducing dependence on private vehicles. |
| Land Acquisition & Livelihoods | No new land disturbance. However, unregulated growth may lead to informal occupation and urban sprawl. | Limited land acquisition with minimal displacement. Compensation, resettlement (if any), and livelihood restoration are planned as per national and EIB standards. |
| Occupational Health & Safety | Not applicable, as no new infrastructure activity occurs. | Construction phase entails risks like dust exposure, accidents, noise—mitigated through PPE, training, and safety audits as part of the OHS plan. |
| Community Impact | Inadequate public transport continues to inconvenience residents, especially low-income groups. | Temporary disruptions (access, noise, dust) during construction. Long-term benefit through reliable, safe, and inclusive metro access. |
| Climate Change Impact | Unabated GHG emissions from growing vehicle population. No net positive impact on sustainability. | Significant reduction in carbon footprint through modal shift and energy-efficient systems (e.g., regenerative braking, electrified rail). |
| Social Inclusion & Equity | Limited, inequitable access to mobility; women, children, elderly, and persons with disabilities continue to face mobility barriers. | Universal access design, affordable fares, improved connectivity—promoting inclusive urban mobility and supporting social equity goals. |

# Chapter 7. PUBLIC CONSULTATIONS AND INFORMATION DISCLOSURE

## A. CONSULTATIONS

608. EIB require projects to carry out meaningful public consultation on an ongoing basis. Public consultation for the Swargate to Katraj (Phase-1 Extension): (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.

609. Public consultation and participation are a continuous two-way process which involves promoting 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.

610. Public consultation/information is an integral part of the Swargate to Katraj (Phase-1 Extension) project cycle. Public consultations with the people of different sections of the society along the project alignments, shopkeepers, and influential persons of the area were made. Potential vulnerable people like, squatters, encroachers, schedule caste, and other backward section of society of society have been consulted as a part of SIA study to make them aware and identify adverse impacts of the project.

611. Considering the importance of people's participation in the project planning, public consultation and FGDs were also carried out both at community and government level. The objectives of the consultation were to disseminate information about the project to the potentially affected population in order to incorporate their views and suggestion for preparing the SIMP and the design and to assess the economic situation of the settlement. The consultation focuses on identification of issues raised by the PAHs and its integration in the Social Impact Management Plan.

612. As per EIB Environmental & Social Standards (ESS) 2022,
*"In order to ensure the effective participation of the identified stakeholders, the promoter shall make available to the public the following information in the most accessible way and as soon as it can reasonably be provided:*

a. *The purpose, nature and scale of the project, including the duration of proposed project activities;*
b. *The description of the likely project impacts and risks for local communities, as well as the proposed mitigation and/or compensatory/remedial measures as defined in Standard 1;*
c. *As and where applicable, the description of potential impacts and risks that might disproportionately affect vulnerable, marginalised, and/or discriminated-against groups and an overview of the different measures proposed to avoid and minimise these;*
d. *The proposed stakeholder engagement process and opportunities for public participation, including locations and dates of any envisaged public consultation meetings, and the process by which meetings are notified and reported, as described in the SEP and its revisions/updates where applicable;*
e. *The available project-level grievance or feedback mechanism, the EIB Group's Complaints Mechanism20 and how stakeholders can access them; and*
f. *Any opportunities for benefit-sharing and added value for affected communities, where applicable."*

613. Accordingly, Maha-Metro (PMRP) with the help of MITCON (the environmental consultant engaged for preparation of the ESIA) organised Public Consultations two locations along the PMRP South extension (Swargate to Katraj) alignment on 9th April 2025. Notice for the same was given in the identified areas one week in advance (i.e. on 1st April, 2025) in the form of posters put up at bus stations and other locations along the alignment, frequented by general public. Total of 35 persons attended the Public Consultations and were informed about all relevant details of the project. Details of the Public consultation along with attendance sheets, and other relevant details is attached as **Annexure-13**.

## B. IDENTIFICATION OF STAKEHOLDERS

614. Consultations with various stakeholders were carried out during preliminary survey and during SIA study of the project. The primary stakeholders of the Project are:

(i) Project Affected Persons (DPs/PAPs),
(ii) Project beneficiaries, and
(iii) Implementing agency.

615. Following key stakeholders at Central, State, District and local levels will be consulted as part of the consultation process.

(i) Ministry of Environment, Forests and Climate Change (MoEF&CC),
(ii) Central Pollution Control Board (CPCB),
(iii) Maharashtra Pollution Control Board (MPCB),
(iv) State Environmental Impact Assessment Authority (SEIAA)
(v) State Traffic Police Department
(vi) Pune Municipal Corporation (PMC)
(vii) State Archaeology Department
(viii) Central Ground Water Authority (CGWA)
(ix) Maharashtra Forest Department (MFD)
(x) Indian Meteorological Department (IMD)
(xi) Various Non-Government Organizations (NGOs)
(xii) Women groups / Self Help Groups (SHGs)
(xiii) Shopkeepers associations
(xiv) Auto-rickshaw Associations

616. The first step in the process of stakeholder engagement is stakeholder identification; that is, determining the various categories of project stakeholders, and their needs. Stakeholders are considered any person, groups of people, or entities that;

- Might be directly or indirectly, positively or negatively affected by the project in any phase of the project's construction and implementation.
- Might have an environmental or social interest taking place as a consequence of the project, or might impact project-related decisions and implementation in a way or another.

617. Most importantly, identifying stakeholder representatives is key to carrying out effective stakeholder engagement activities. These representatives do not only inform the project with their valuable information, but they also serve as a communication channel to disseminate information to large numbers of groups and receive feedback from them.

618. The following **Table 7-1** presents the potential primary and secondary stakeholders of the Project. Primary stakeholders are the ones who are affected directly by the project whether in a positive or a negative manner. Secondary stakeholders are those who are indirectly influenced by the project either positively or negatively. This list of stakeholders is likely to expand/change in composition as the project moves and since the SEP is a "living document" it will be updated regularly throughout the project life as appropriate.

*Table 7-1: Detailed list of Stakeholders involved in the project*

| Affected Parties | Other affected Parties |
|---|---|
| PAHs including title holders (TH), non- title holders (NTH) (squatters, mobile vendors), tenants, employees. | Community leaders and other Urban local body representatives |
| Villagers/Communities impacted by loss of Common Property Resources (CPRs) and loss of access to CPRs properties. | Village heads, Anganwadi workers, Teachers |
| School and Colleges along the corridors | Civil Society operational in the area |
| Vulnerable Groups within the PAHs Below Poverty Line (BPL) Scheduled Caste (SC), Persons with Disability (PwD), Women headed households (WHHs) | Laborers working with PMRP at construction sites |
| | Employees of Maha Metro/PMRP and Construction Contractors/ Vendors/ Suppliers to the Project |
| | District Administration |
| | Various Departments, GoM |
| | General Consultant (GC), DPR consultant, Environmental Impact Assessment (EIA) & SIA Consultant |
| | Media Houses |

## C. SCOPE OF WORK

619. All the baseline survey and consultation meetings were organized by giving prior intimation to the displaced persons and participants. During the consultation process, efforts were made by the survey team to

(i) Ascertain the views of the DPs/PAPs with reference to Swargate to Katraj (Phase-1 Extension) alignment and minimization of impacts.
(ii) Understand the views of the community on land acquisition & compensation,
(iii) Identify the major socio-economic characteristics to enable effective solution on loss of economic activity, if any during planning and implementation.
(iv) Obtain option from the discussion on issue related to impacts on community property resources.
(v) Examine DPs/PAPs opinion on problems and prospects of transport safety related issues.
(vi) Identify people's expectations.
(vii) Establish an understanding for identification of overall benefits of the project.

## D. METHODOLOGY

620. Public consultations and discussions with the displaced persons (DPs/PAPs) like Title Holders (TH), Non-title Holders (NTH), and wider communities like commuters, public transporters, local leaders, and other stakeholders have been carried out as part the Social Impact Assessment (SIA) studies carried out for the project. Methodology used for the consultations, is given in **Table 7-2.**

*Table 7-2: Methodology for Public Consultations*

| Stakeholders | Method of PC |
|---|---|
| Displaced Person (DP) / Project Affected Person (PAP) | Baseline census survey involving head of the household as respondents. |
| Local community | Through Focus Group Discussion (FGD) at affected station locations. |
| Public Transporters | Through Focus Group Discussion (FGD) at affected station locations. |
| Implementing Agency | Individual interview, discussion, joint visits |
| Line Department Agencies | Individual meetings and discussions. |

621. Consultations with stakeholders were carried out during various phases of project preparation. The stakeholders in the project are both primary and secondary. The primary stakeholders are PAPs, project beneficiaries, Executing Agency, Implementing Agency especially the officials in Maha metro and GC. The secondary stakeholders include officials from line departments, community leaders etc.

622. This section presents the consultation activities that have been conducted for the project to date. Previous consultation activities were limited to the consultations that took place for the PMRP phase-1 extension project and government authority and affiliated departments for the current project.

623. **Methods of Public Consultation:** Consultations and discussions were held along the project corridor with the affected families and other stakeholders. All affected Families were consulted while interacting with them during the project census survey. Consultation meetings were organized to get wider public input from both the primary and secondary stakeholders.

624. Consultations and discussions were held along the project corridor with the affected families and other stakeholders (details given in **Table 7-3**). All affected Families were consulted while interacting with them during the project census survey. Consultation meetings were organized to get wider public input from both the primary and secondary stakeholders. In addition to the individual consultation with all affected Families during census survey, some of the major issues that were discussed and feedback received from the project affected persons during the course of the consultations are summarised in Annexure-13 of this ESIA report. The project has received acceptability among the local people as it is expected to provide smooth flow of traffic and reduce travel time, reduce fuel consumption and subsequently reduce air emissions. The project would bring positive socio-economic changes in the area.

625. Public consultation as part of the ESIA studies were undertaken along the Swargate to Katraj alignment. The PAPs and other stakeholders identified (auto drivers, students, shop & kiosk owners/ leases, etc.) have shown their satisfaction with the existing Pune metro rail project Phase 1. When they

were informed about the proposed extension of the existing network, they have given a positive response. The PAPs and stakeholders said that it is necessary to extend the metro line further because there are many hurdles to travel from outskirts of the city into main Pune city centre solely by road transport. Sometimes they find it difficult to travel by road due to traffic congestion and hence they would welcome the metro rail system, so that they can safely reach their destination on time.
Public Consultation for the project was conducted strictly in accordance with statutory requirements and established good practices. Adequate advance notice was provided to the public through advertisements to ensure maximum participation. During the consultation, project details were presented, and the views, suggestions, and concerns of participants were carefully recorded. The process was transparent and inclusive, offering stakeholders and affected people the opportunity to express their opinions and seek clarifications. For reference, the detailed Public Consultation Report has been enclosed as **Annexure-13**.

*Table 7-3: Details of FGDs and Public Consultations*

| Date | Location | Participants |
|---|---|---|
| September 16, 2024 | Padmavati | 6 Male, 2 Females (Total: 8) |
| September 16, 2024 | Market Yard | 9 Male, 1 Female (Total: 10) |
| April 9, 2025 | Katraj | 16 Male, 6 Female (Total: 22) |
| April 9, 2025 | Bibvewadi | 13 Male (Total: 13) |

## E. DISCUSSION WITH LOCAL PEOPLES

626. Summary, of the discussion held in public consultation that were part of ESIA study is given **Table 7-4**:.

*Table 7-4: Summary & Findings of Public Consultations held as part of ESIA study*

| Sr. No. | Name of Person | Contact Details | Summary of Discussion | Reference Photograph |
|---|---|---|---|---|
| 1 | Mr. Balasaheb Maval | Auto Driver 9960223351 | Metro is good source for public transport. Traffic will increase during construction and auto parking station will be removed. Requested to provide<br>Auto parking stop during construction as well as during operational phase |  |
| 2 | Mr. Ajit Bhosale | owner (Mob. No. 9762416667) | Metro is good source for public transport. It will be beneficial for all. |  |

| Sr. No. | Name of Person | Contact Details | Summary of Discussion | Reference Photograph |
|---|---|---|---|---|
| 3 | Mr. Raj Dabade | Auto Driver (Mob No. 9022557438) | Metro will be beneficial for all. Request to give place for auto stand during construction and operational phase |  |
| 4 | Mr. Vishal Rokde | Bus Passenger Student Mob. 8862054548 | Metro is very good and rapid public transport for all students |  |
| 5 | Mr. Appa Shankar Gouli | Sugarcane juice Centre Owner 9529605030 | Metro will be beneficial for all. Requested to provide appropriate place |  |
| 6 | 1. Mr. Suresh Potale<br>2. Rundlik More<br>3.Kamlesh Kumar<br>4. Avinash More<br>5.Madhukar More<br>6.Aman Suryawarsh<br>7. Akshay Chowdhari<br>8. R. K. Jadhav<br>9. Anil Atkale<br>10. Uma Pawar | Road side Shop Owner at Market yard 8484841362 | Proper signalling and signages to be placed at various places and interval |  |

| Sr. No. | Name of Person | Contact Details | Summary of Discussion | Reference Photograph |
|---|---|---|---|---|
| 7 | Mr. Ranjeet Gupta | Road Side Cap and glasses seller 7758992509 | Metro will be beneficial for all. Requested to provide place for stall |  |
| 8 | Mr. Rajesh Bavaria | Road side Tatto maker | Metro will be beneficial for all. Requested to provide place for stall |   |
| 9 | Mr Mukesh Shah | Road Side Cap and glasses seller | Metro will be beneficial for all. Requested to provide place for stall |  |
| 10 | Mr. Vijay Rajput | Employ of City Pride 9922908771 | Beneficial to workers. Construction work to be completed within time frame along with safety measures |  |

| Sr. No. | Name of Person | Contact Details | Summary of Discussion | Reference Photograph |
|---|---|---|---|---|
| 11 | 1.Tajesh Londe<br>2.Randao Londe<br>3.Pralhlad Sardesai<br>4.Madhukar Sathe<br>5.Kirshandri<br>6.Kachan Suryawanshi<br>7.Hanumant Ladkat<br>8.Bandas Revade | Road side owners of flower stall | Metro will be beneficial for all. Requested to provide place for stall |  |
| 12 | Mr. Pradeep | TVS Showroom Owner Mob. 9890833999 | Metro is very good and rapid public transport for all. Requested to provide walk in passage in front of showroom during construction phase and requested to complete work in phases. |  |
| 13 | Sajid Shaik | Petrol pump manager 9822374250 | Proper signages to be display at various intervals throughout the alignment during construction phase |  |
| 14 | Mr. Hemant Balasaheb | Tata Garage Worker 7507167711 | Construction material to be stored at proper place and work to be completed within time. |  |

## F. STAKEHOLDER ENGAGEMENT

### 1. Stakeholder Engagement Methods & Strategies

627. Different stakeholders have different needs for information and levels of interest in engaging with the project. Different stakeholder groups will also require different engagement approaches depending on their socio-cultural characteristics. Furthermore, stakeholders and their level of interest or connection to the project often change over time through the development phases of the project.

*Table 7-5: Stakeholders Engagement Methods*

| Sl No | Engagement Technique | Description and use | Target Audience |
|---|---|---|---|
| 1 | Community/public meetings | To convey general information on the Project, detailed discussions on sub-project activities, project social impacts, risks and mitigation measures and public grievances, update on implementation progress. Meeting will also enable stakeholders to express their views, demands, constraints etc. | Project- affected communities including NTHs and other interested parties. |
| 2 | Focus Group Discussions | To facilitate discussion on specific issues such as gender-based violence, disability inclusion, etc | Vulnerable People, Women Groups |
| 3 | One on one interviews<br><br>Survey/ Independent evaluations | To solicit views and opinions on project impacts and solutions<br><br>To get gather beneficiary opinions and Views about project interventions. Gather baseline data. for monitoring impacts. | PAPs including Vulnerable individuals, NGOs, Trusts Associations, women groups, PAPs<br><br>Project beneficiaries |
| 4 | Websites | Detailed Project Report (DPR), EIA, SIA, Resettlement Action Plan (RAP), Resettlement Policy Framework (RPF) and SEP will be published on official websites of PMRP. | All stakeholders |
| 5 | Printed media advertisement | This will be used to disseminate and disclose project documents intended for general readers and audience. | General Public |
| 6 | Distribution of printed public materials: project information, leaflets, brochures, facts sheets | This will be used to convey general information on the project and to provide regular updates on its progress to local, regional and national stakeholders. | General public |
| 7 | Correspondence by phone/ email/ written letters | Receive suggestions and reply to queries of stakeholders. | Government officials,NGOs, (Community Based Organizations) CBOs,Trusts, Community / Associations, Development Partners etc. |

628. Stakeholder engagement is an on-going process, the strategies used during following stages of the Project; concept and planning/design (During SIA) are mentioned in column 3 (Stakeholder Engagement Strategy) of below table. Strategies that will be adopted during construction & operation stage are presented **Table 7-6**:

*Table 7-6: Stakeholders Engagement Strategy*

| Sl No | Stages | Stakeholders in the Project |
|---|---|---|
| 1 | Engagement at the project concept stage | • Interviews with stakeholder representative key informants, and government officials.<br>• Stakeholder planning forum |
| 2 | Engagement during SIA studies | • Interviews with stakeholder representatives and key informants.<br>• Participatory techniques used to consult with focus groups on impact - specific topics<br>• Participatory techniques used to consult with stakeholders most disadvantaged by the project<br>• Stratified sample interviews.<br>• One-on-one interviews through census & socio-economic survey<br>• Public & Formal Meetings |

| | | |
|---|---|---|
| | | • Focused Group Discussions (FGDs)<br>• Open houses, in field office and project headquarter (HQ)<br>• Posting of announcements in public spaces or government buildings/ municipality offices, construction sites.<br>• Dissemination of information regarding compensation including Resettlement & Rehabilitation (R&R) assistance and rehabilitation process through public consultations and census & socio-economic survey. |
| 3 | Engagement during construction and operations | • Participatory monitoring<br>• One-on-one interviews<br>• Public & Formal Meetings<br>• Grievance redress mechanisms.<br>• Quarterly/Annually targeted interviews and consultation, e.g., with specific stakeholder groups.<br>• Project Monitoring Dashboard.<br>• Open houses, in field office and project HQ.<br>• Posting of announcements in public spaces or government buildings/ municipality offices, construction sites. |
| 4 | Engagement on new stakeholder issues and concerns that may arise in future | • Grievance mechanisms<br>• Annual/quarterly household questionnaires with project affected people<br>• Annual stakeholder meetings/Dissemination Workshop. |

## 2. Stakeholder Engagement Plan (SEP)

629. The SEP simply outlines the roles of all the relevant stakeholders from the communication perspective while making the communication process more effective and transparent.

630. The EIB's Environmental and Social Standards (Standard 10) require the executing agency to prepare a SEP to increase access to information about the project, and also to improve communication and information sharing with project-affected peoples and other concerned stakeholders (including women and vulnerable groups) throughout the project tenure. It is a tool to manage communications between different stakeholders. Specific objectives of the SEP include:

a. To establish the essence of the project as a 'community demand-driven participatory approach' and have participation and engagement from all the stakeholders at various level.
b. To facilitate decision-making and create an atmosphere of understanding among critical stakeholders that actively involves the local community and project beneficiaries.
c. To ensure that stakeholders are aware of the project's purpose, impacts, benefits, GRM and implementation arrangements.
d. To promote inclusive, gender-sensitive and culturally appropriate communication during the implementation period of the project.

631. The overall objective of this SEP is to define a programme for stakeholder engagement, including public information disclosure and consultation, throughout the entire project cycle. The SEP outlines the ways in which the project team will communicate with stakeholders and includes, a mechanism by which people can raise concerns, provide feedback, or make complaints about the metro project and any activities related to it. The SEP should have the following purpose:

- Identify different categories of stakeholders in the context of this project and the likely risks and impacts posed to them;
- Understand the requirements for engagement for each category of stakeholder under the project, including their information and engagement needs;
- Create opportunities for stakeholders to effectively participate in project activities and derive direct and indirect benefits from the project investments;
- Provide a roadmap for stakeholder engagement, including the strategies and approaches to be adopted and their timing through the project cycle;
- Provide guidance on the likely information disclosure and consultation strategies that the project could use based on a) their importance, b) the profile and needs of the targeted stakeholders- giving the stakeholders an opportunity to proactively participate and influence project planning/ design;

- Establish formal grievance/resolution mechanisms for the stakeholders, define roles and responsibilities for implementation of the SEP, including the resource requirements and recommend the reporting and monitoring measures to ensure effective implementation of the SEP.

### 3. Specific Provisions under Maha Metro for Stakeholder Engagement

632. Stakeholder's participation in the planning and delivery of projects is considered important for achieving high quality outcomes that meet community expectations. In addition to adhering to requirements set out in legislation and government policies, consultation and continuous engagement activities are being undertaken by PMRP as mentioned below.

a. **Metro *Samvaad*:** A very novel initiative started by Maha-Metro whereby the stakeholder and citizens can have a direct interaction with MMRCL. The Samvad is organized near a proposed Metro station where the concerned stakeholders and citizens are informed on the ongoing work through films and presentations. This is then followed by a very interactive Question and Answer session. Metro Samvad was halted due to 3rd wave of COVID-19 but has resumed.
b. **Press Release:** Project updates are given to stakeholder and public at large through regular press releases.
c. **Radio:** Maha-Metro also provides regular updates of its project through FM Radio.
d. **TV Channels:** Maha-Metro provides regular bytes through prominent Hindi and Marathi TV Channels as well as the local channels.
e. **Face Book:** Maha-Metro has its own social media account on Facebook. This is a very interactive page with 100% response rate. Updates of projects are regularly posted on its page. MMRCL takes care to reply to the queries without delay and the suggestions received from citizens and stakeholders are also forwarded to the concerned project departments.
f. **Website:** Maha-Metro regularly provides updates and information of the project on its website: https://www.punemetrorail.org.The website provides information on the Organization, its people, Goal and Mission, the project work progress, tenders, photographs, news events, videos of works and events are also updated regularly by MMRCL.

Information disclosure and stakeholder engagement are the cornerstones of managing the social impacts of project. The type of information disclosed and the specific method of communication to be undertaken by PMRP for the Project are summarized in **Table 7-7**.

*Table 7-7: Information Dissemination and Mode of Disclosure*

| Sl No | Objective | Target Stakeholders | Information to be disclosed | Mode of Disclosure | Timeline/ Frequency | Responsibility | Resources (Human and Financial) |
|---|---|---|---|---|---|---|---|
| 01 | To ensure timely information of the project to the PAPs<br><br>(During Pre-construction, operational period and completion period) | PAPs including NTH | • Project Non-Technical Summary, ESIA, RAP, SEP, ESMP,<br>• Schedule of preparation and construction<br>• Outline of construction and operation environmental and social impacts and proposed mitigation measures<br>• Compensation Implementation and income restoration Plan<br>• Regular updates of key information, especially the information related to any design change that is likely to materially change its environmental or social risks and impacts, notably unanticipated land acquisition<br>• Seek feedback on changes<br>• Access awareness to Grievance mechanism process | • Participation in consultative meetings and workshops; Household surveys, consultations, FGDs<br>• Written information in local language (Marathi)<br>• Project details on Pune Metro website<br>• GRM helpline number through display at project site locations and offices | Prior to and during construction and operation<br><br>Twice in the project preparation stage:<br>• Preliminary screening has been carried out.<br>• Household level census & socio-economic survey with all PAHs including vendors and consultations has been carried out during DPR and detailed SIA stage | Project Management Unit (PMU)<br>Environmental and Social Safeguard Specialist<br>Contractors, Site Engineers | Human and Financial<br>(As mentioned in the budget) |
| 02 | To enhance accessibility of Vulnerable and disadvantaged people to project activities | Project Affected Disadvantaged<br><br>and vulnerable HHs Including PwD people | • Design intervention for vulnerable, PwD particularly provision of access ramps to stations, platforms<br>• Land acquisition and compensation process<br>• Provisions of eligible entitlements including Livelihood Restoration activities | • Participation in consultative meetings and workshops; Household surveys, consultations, FGDs<br>• Written information in local language (Marathi)<br>• Project details on Pune Metro website<br>GRM helpline number through display at project site locations and offices | Prior to and during construction and operation<br><br>Twice in the project preparation stage:<br>• Preliminary screening has been carried out.<br>Household level census & socio-economic survey with all PAHs including vendors and consultations has been carried out during DPR and detailed SIA stage | Project Management Unit (PMU)<br>Environmental and Social Safeguard Specialist<br>Contractors, Site Engineers | Human |
| 03 | To carry out the project with timely coordination and | Maha metro and Pune Metro | • Facilitate mapping of stakeholders and review the same on a timely basis | • Organise and chair the consultative meetings and | Continuous throughout the entire project implementation period | • Primarily responsible for coordinating, implementing the | Human and Financial |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | communication with site offices | | • Organise periodic review of the feedback and communication from other stakeholders<br>• Coordinate with and support | workshops at the state and district level;<br>• Issue press releases,<br>• website disclosures seeking feedback; Update and interact through social media channels;<br>• Communication through email or contact numbers provided in the information boards<br>• Print advertisement<br>• Meetings with associated department and NGOs/Farms<br>• Photo & video documentation | Monthly review and planning meeting<br><br>Face to Face meeting with all the relevant stakeholders<br><br>Yearly state level consultation and workshop | project | |
| 04 | To extend support required from the department whenever required | Dept of Urban planning, Revenue Department, Transport Department, Civil Society | • Coordinate with PMRP<br>• Leverage existing resources of the department for community benefits | • Participation in coordination meeting<br>• Participation in dissemination workshop | As per the requirement | Responsible for nay relevant works and provide support accordingly | Human |
| 05 | To response to PMRP's requirement during the project implementation | Pollution Control Board | • Inputs in terms of reports and recommendations<br>• Appraising PMRP on major concerns regarding Air quality and environmental impacts | • Participation in dissemination workshop<br>• Updates sharing on air quality | Continuous engagement until 2030 | Testing of air quality & Maintenance of the quality | Human |
| 06 | To follow the process and to update PMRP on progress and report | Contractors /Suppliers | • Ensure the workers and the staff are aware about their safety and entitlements<br>• Inform about the project or construction work and related GRC details (specific contractors and suppliers engaged for construction activity) | • Display boards<br>• Meeting with the community, workers and the staff at construction site | Continuous until completion of construction | • Share the progress of work mechanism of engaging the local community and women<br>• Information sharing on critical issues like HIV/AIDS and other communicable diseases in construction<br>• Communicate on GRM | Human |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 07 | To disseminate information on the project for mass awareness and to enhance project visibility | Media | PMRP will coordinate and inform media about the project highlights regular press releases, media briefings for major project milestones, prompt responses to media inquiries | • Press releases, media briefings, official statements<br>• Participation in workshops and community events organised by Maha Metro and PMRP | Continuous until completion | • Report on project initiatives and impact on people<br>• Report on project progress, case studies and good practices | Human and Financial |
| 08 | To establish the project mandates as inclusive and to provide them with the benefits | DAG (Household belong to disadvantage d groups) | • Provide leadership to community-based groups<br>• Support for the project activities through participation and engagement in various project activities<br>• Understanding of how to access GRM services | • Participation in all the meetings, consultation and focused group discussions (FGDs)<br>• Sharing of their experiences in meetings & community-based workshops, training<br>• One to one communication with the service providers | Continuous until completion | • Sharing of local knowledge and challenges<br>• Understanding of project/sub projects benefits, potential impacts<br>• Suggest for sustainability of the initiatives | Human |
| 09 | To establish the project mandates as inclusive and to provide them with the benefits | Women including Female Headed Households | • Being in leadership roles and actively engage in various community groups<br>• Support in mobilizing other women<br>• Enhancement of knowledge on accessing various services including the project related benefits | • Participation in all the meetings, consultation and focused group discussions (FGDs)<br>• Sharing of their experiences in meetings & community-based workshops, training<br>• One to one communication with the service providers and NGO facilitators | Continuous until completion | • Women actively participate and take leadership roles in the community-based groups<br>• Awareness and understanding of opportunities to enhance livelihoods and quality of lives particularly for women | Human |
| 10 | Other interested Party (External) | | • If anything raised by other interested parties regarding the project | Public meetings, open houses,<br>trainings/ workshops<br>Disclosure of written information: brochures, poster, flyers, website, information boards at construction sites | As per requirement | | Human |

## G. PLAN FOR FUTURE PUBLIC CONSULTATIONS

633. The effectiveness of the Public Consultation process is directly related to the degree of continuing involvement of those affected by the Project. Several additional rounds of consultations with DPs/PAPs will form part of further stages of project preparation and implementation. The Implementing Agency – Maha Metro – will be entrusted with the task of conducting these consultations during implementation of the Resettlement Plan (RP), which will involve disclosure on compensation, assistance options, entitlement packages and restoration measures suggested for the project. The consultation will continue throughout the project implementation phase. The following set of activities are planned to be undertaken:

- In case of any change in engineering alignment planning, the DPs/PAPs and other stakeholders will be consulted in selection of alignment for minimization of resettlement impacts, development of mitigation measures, etc.
- Maha Metro will conduct information dissemination sessions (Metro *Samvaad*) in the project area and solicit the help of the local community / community leaders and encourage the participation of the DPs/PAPs in Plan implementation.
- During the implementation of RP, Maha Metro will organize public meetings (Metro *Samvaad*), and will appraise the communities about the progress in the implementation of project works, creating further awareness regarding proposed extension of project.
- Consultation and Focus Group Discussions (FGDs) will be conducted with the vulnerable groups, if any, like women-headed households, persons with disability and SC communities, to ensure that the vulnerable groups understand the process and their needs are specifically taken into consideration.
- To ensure facilities for women in the project construction & operation phases, they will be specifically involved in the consultation process.

## H. INFORMATION DISCLOSURE

634. To keep more transparency in planning and for further active participation for DPs/PAPs and other stakeholders, in project extension, the project information will be disseminated through disclosure of all project related documents. Information disclosure will follow the procedure and requirements of EIB E&S policy for High Risk projects.

635. All environmental documents such as the final ESIA, any updated ESIA, corrective action plans prepared during project implementation and the environmental monitoring reports are subject to public disclosure, and therefore, will be made available to the public. The implementing agency, Maha Metro will translate the Executive Summary of the ESIA in Marathi and disclose it along with the Full ESIA report, on their website. The same will be disclosed on EIB website also. For DPs/PAPs who are illiterate, appropriate, and implementable methods will be followed to aware them. The Maha Metro will disclose the information through public consultations and other appropriate method and will pay specific attention to ensure those who are lacking for the information will receive information on a timely basis. The hard copies of ESIA will be made available at Maha Metro office as well as at other locations, easily accessible to all stakeholders. Maha Metro will also ensure that meaningful public consultations, particularly with Project Affected Persons (PAPs) are undertaken throughout the design, construction and operation.

# Chapter 8. GRIEVANCE REDRESSAL MECHANISM

## A. INTRODUCTION

636. The Grievance Redress Mechanism (GRM) is an integral and important arrangement for receiving, evaluating, and addressing/resolving the concern and grievances of the Displaced Persons' (DPs) / Project Affected Persons (PAPs) queries and complaints pertaining to social and environmental aspects of the project in a transparent and swift manner. The PMRP will formulate a project specific GRM intended to address the 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. During the project preparation, the information regarding the availability of GRM will be disclosed to public through public consultation process. A Grievance Redress Committee (GRC) will be constituted by PMRP to address the grievances. Records of grievances received, during implementation of the project, corrective actions taken, and their outcomes will be properly maintained and form part of the periodic progress reports submitted to the funding agencies.

637. 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 past experiences of the Maha Metro Pune of dealing with DP/PAPs grievances in Phase I of the metro project, a common GRM has already been put in place in order to address social, environmental or any other grievances of Project Affected Persons (PAPs). 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 the GRC will not bar them from doing so.

## B. CONSTITUTION OF GRIEVANCE REDRESS COMMITTEE (GRC)

638. A three tier GRM has been established with formation of Grievance Redress Committee (GRC) at three levels i.e. Junior Management Level, Senior Management Level and Higher Management Level.

639. Junior Management Level (Field Level) GRC Committee comprises of the:
- (i) Manager (Civil), Maha Metro (Chair Person)
- (ii) Asst. Manager/Manager (Social), Maha Metro
- (iii) Asst. Manager/Manager (Land), Maha Metro
- (iv) Asst. Manager/Manager (Environment), Maha Metro
- (v) Asst. Manager/Manager (Finance), Maha Metro
- (vi) Asst. Social/Environmental Expert of GC
- (vii) Asst. Manager/Manager (Legal), Maha Metro

640. The Senior Management Level GRC Committee comprises of the:
- (i) Director (Works), Maha Metro (Chair Person)
- (ii) Senior Deputy General Manager (Social & Land), Maha Metro
- (iii) Senior Deputy General Manager (Environment), Maha Metro
- (iv) Deputy General Manager (Finance), Maha Metro
- (v) Senior Environment/Social Expert of GC

641. The Higher Management Level GRC Committee comprises of the:
- (i) Managing Director (MD), Maha Metro (Chair Person)
- (ii) Director (Works), Maha Metro
- (iii) Director (Finance), Maha Metro

642. To receive and facilitate resolution of the DPs/PAPs concern & complaints in a transparent process. As per EIB's requirement, Maha Metro, Pune shall constitute two-tier constitution of Grievance Redress Committee (GRC) with representative from implementing agency, community, NGOs etc. for

Swargate to Katraj (Phase-1 Extension). The Grievance will be received by following ways,

(i) Letter to respective GRC or by email.
(ii) Telephonic grievance.
(iii) Grievance communicated to field staff or PMRP / GC / Contractor will have to be in writing and recorded by the field staff in a register which will be given to respective GRC.

643. The phone numbers and communication address shall be displayed at prominent locations near construction sites during Construction phase, and at all stations during Operation phase of the project.

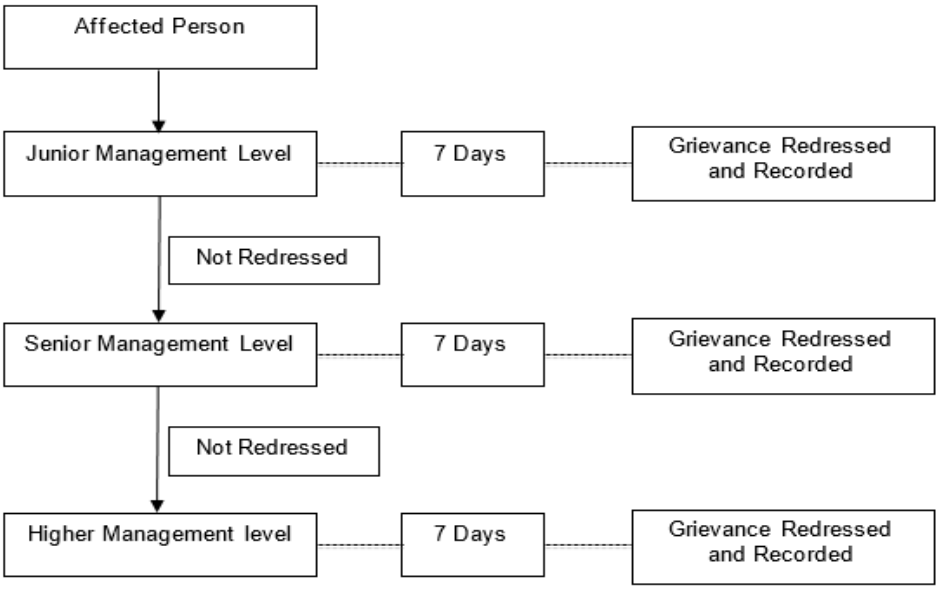
644. Although the project has one common GRM, the composition of the GRC's for social and environmental issues differ to ensure dedicated and timely resolution of specific social or environmental grievances. Often the resettlement / social grievances will be resolved at a higher level GRC, whereas environment safeguard issues can be resolved at the working level GRC. Thus, GRC for the project will be at constituted at two levels – Site Level and Headquarters (HQ) level. The GRC working mechanism shall be as follows:

(i) Grievances of DPs/PAPs will be first brought to the attention at field level staff (Site Engineer).
(ii) Site Engineer will forward the received grievance to Deputy Chief Project Manager (Dy.CPM) and Chief Project Manager (CPM) for consideration and redressal. The CPM (Tier 1) to the extent possible will address the complaint.
(iii) For grievances addressed at site level (Tier 1), the copy of the compliance will be sent to the head office for record.
(iv) If the Grievance is not redressed at Tier-1, then the Grievance will forward to Tier-2 level i.e. at PMRP head office.
(v) The Tier-2 GRC will include competent authority from land department of PMRP, designated officers from Revenue Department, Government of Maharashtra (GoM) along with representatives from NGOs / Community and a Social Expert.
(vi) The PMRP will maintain grievance registers both at site offices and at head office.
(vii) Both the GRCs at Tier-1 and Tier-2 will address only social and resettlement issues both for title holders and non-title holders. Grievances related to compensation and ownership rights will be dealt in court as per The Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013 only after the DPs dissatisfied with the verdict of GRM.
(viii) With a view to Affirmative Action to enhance women inclusivity, one-woman representative of local community from each 5 km section of the alignment will be members of the GRC and GRC-E. The representative(s) from the location(s) to which the grievance(s) pertain(s) will be invited to deliberations of the Committee.
(ix) When any grievance is brought to the Tier-1 GRC (Site level), it shall be resolved within 30 days from the date of complaint, whereas the time taken to redress the grievance at Tier-2 (HQ level) will be 2 weeks (14 days).
(x) PMRP will maintain a log of grievances documented at site and HQ levels respectively.

645. People who are, or may in the future be, adversely affected by the project may also submit complaint to EIB's Complaint Mechanism. The Complaints Mechanism provides an independent forum and process whereby people adversely affected by EIB's assisted projects can voice, and seek a resolution of their problems, as well as report alleged violations of EIB's operational policies and procedures.

646. The decision of GRC will be documented and communicated to the concerned person in a transparent manner. However, the complainant is free to access the country's legal system at any time and stage. The GRC records will be made available to the external monitor for its review. A flow chart of the GRM in place for the PMRP project is indicated in **Figure 8-1**

*Figure 8-1 Grievance Redressal Mechanism for Swargate to Katraj Project*



# Chapter 9. ENVIRONMENTAL & SOCIAL MANAGEMENT PLAN (ESMP)

## A. INTRODUCTION

647. The Environmental & Social Management Plan (ESMP) consists of a set of mitigation, monitoring and institutional measures to be taken for Swargate to Katraj (Phase-1 Extension) project to avoid, minimize and mitigate adverse environmental and social impacts and enhance positive impacts. The plan also includes the actions needed for the implementation of these measures. The major components of the ESMP are:

(i) Mitigation of potentially adverse impacts;
(ii) Environmental monitoring;
(iii) Applicable Management Plans like stakeholder engagement, grievance management, worker GM, chance find procedure, waste management etc.
(iv) Emergency response procedures;
(v) Institutional arrangements and reporting mechanism;
(vi) Implementation Schedule;
(vii) Training and capacity building, and
(viii) Cost estimates.

648. The purpose of environmental and social monitoring is to ensure that the ESMP is fully and competently implemented across all phases of the project's development, and to provide a basis for appropriate and timely corrective action when it is found not to be. The environmental monitoring process should be understood not only as a means of supervision and enforcement, but also as a vehicle for organizational learning and progress towards mainstream international best practice in construction site and facility management. Effective monitoring can also be a vital tool in forestalling conflict with the communities most likely to suffer the consequences of negative environmental impacts, as problems can be identified and corrected in a timely manner, before they grow to nuisance or dangerous levels. Environmental monitoring must continue until issuance of a Project Completion Report (PCR).

## B. OBJECTIVES OF ENVIRONMENTAL MANAGEMENT PLAN

649. The main objectives of this ESMP are:

(i) To ensure compliance with MDBs' applicable policies, and regulatory requirements of GoM and GoI;
(ii) 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
(iii) To stipulate monitoring and institutional requirements for ensuring safeguard compliance.

## C. INSTITUTIONAL ARRANGEMENT

### 1. Executing Agency

650. Maharashtra Metro Rail Corporation Limited (Maha Metro) was incorporated by Government of India – Ministry of Corporate Affairs on 18th February 2015 as a Special Purpose Vehicle (SPV) for smooth implementation and operations of the Metro Rail Project. It has now been converted into a Joint Venture of Government of India (GoI) and Government of Maharashtra (GoM) with equal equity holding. The GoM and GoI will be the executing agency of the proposed five stations of metro project.

651. Maha Metro shall be responsible for implementation of the proposed five stations of metro rail project. The Managing Director (MD), Maha Metro will be the in charge of the overall project activities. Maha Metro shall be accountable to GoM (i.e. the executing agency).

652. Project Implementation Unit (PIU), Maha Metro headed by the Project Director (PD) is responsible for the overall execution of the project and implementation of the ESMP. The PIU will be assisted by General Consultant (GC). The safeguard role of GC is to assist Maha Metro in review of documentation and monitoring the implementation of ESMP and Environmental Monitoring Plan (EMoP) during construction and operation phases, by means of scheduled inspections, meetings and reports submitted to Maha Metro.

## 2. Implementation of ESMP

### (a) Maha Metro:

653. ESMP will be committed by Maha Metro as part of its agreement with Multilateral Development Banks (MDBs). The responsibility to implement the ESMP including Grievance Redressal rests with Maha Metro. Environmental and other Clearances related to locations and design of the project will be secured before start of construction. Permissions / certifications required during operation of the project and Environment monitoring during operation, shall also be the responsibility of Maha Metro.

### (b) Contractor:

654. Permits required during construction and those directly related to construction shall be the responsibility of the Contractor. The ESMP will be implemented by the Contractors of different packages based on the contract agreement. Contractor needs to prepare a Construction Environmental and Social Management Plan (CESMP) which needs to be approved by Maha Metro before the start of any construction activity on the site. The Contractor Social, Health and Environment SH&E team will be headed by a Senior Manager assisted by qualified and trained safety professionals and environment engineers along with onsite junior field personnel and community liaison personnel. This team will be assisted by:

(i) electrical and mechanical engineers qualified in safety evaluation;
(ii) environment engineer;
(iii) traffic engineer;
(iv) professionals in occupational health and labour welfare.
(v) Environment monitoring during construction
(vi) Regular monthly reports on implementation will be submitted by contractor to (GC).

655. The contractors' environmental team should include an environmental expert with proven experience in preparing Site-Specific CESMP for major construction contracts in line with internationally recognized standards. Such a role might be an itinerant short-term role separate from that of the full-time Environmental Officers and Health and Safety Officers. A bill of quantities (BoQ) item to be included in the bidding document will provide for the services of such an environmental expert to assist the contractor prepare the Site-Specific ESMP to meet international financing institutions' requirements. The Site-Specific ESMP will provide;

(i) Clear description of the project influence area especially broader affected areas subject to induced or secondary impacts
(ii) Clear identification of sensitive receptors along the alignment on a plan of appropriate scale
(iii) Risk assessment undertaken to determine how vulnerable the sensitive receptors are to project impacts (air, noise, vibration, water quality, erosion, sedimentation, traffic safety, etc.). This would include seasonal related impacts (heavy rain, flood, etc.).
(iv) Site-specific mitigation measures at specified locations based on the results of a risk assessment. This should include a narrative description of the site-specific mitigation methodology. The specific mitigation measures should be shown on site plans/designs showing what and where specific mitigation measures/structures will be applied on the site.
(v) Environmental audit inspection procedures which describe how and when site audits are undertaken to check implementation and effectiveness of mitigation measures (including audit checklists based on Site-Specific ESMP, to be used for regular inspections) and how corrective action is initiated and resolved (internal communication mechanisms to ensure compliance with the Site-Specific ESMP). For example, inspection reports are discussed and provided to management, reported in progress meetings for action, etc.

656. The Employer Requirements for Health, Safety and Environment have been prepared for Project. They will be issued to the Contractors as part of the contract documentation for construction. The requirements comprise the following 3 documents:

### (c) Maha Metro and GC:

657. Supervision and review of implementation will be the responsibility of GC. With assistance from GC, Maha Metro will also be responsible for reviewing and approving any specific documents / plans

that have to be provided by contractors (traffic management plan, site waste management plan, excavated soil and C&D waste / muck disposal plan, etc.). In view of the common principles of ESMP and common project implementation philosophy of MDB projects. Implementation of ESMP will be continuously monitored by the Safety, Health and Environment (SH&E) team of environment experts from GC and Maha Metro.

658. Maha metro's SH&E team will be headed by a Senior Manager assisted by qualified and trained mid-level safety professionals, environment engineers, traffic engineer, labour welfare officer. The Manager SH&E for the project in Maha Metro will report directly to Director (Works) and Managing Director, Maha Metro.

659. Terms of Reference for GC in implementation of the ESMP and EMoP is provided in **Annexure-9** of this ESIA-ESMP Report, which include following contribution:

(i) Specialists from fields of safety, environment, traffic engineering, occupational and community health, ecology, noise and vibration.
(ii) Onsite junior field personnel.
(iii) The visits and review meetings will comprise:
  (a) Weekly site visits independently by Maha Metro and jointly with contractor;
  (b) Weekly review meetings by Maha Metro and contractor.
  (c) Periodic quarterly reports will be submitted on implementation of ESMP and its internal monitoring by Maha Metro to MDBs.
  (d) Orientation and training of Maha Metro team in implementation of ESMP and environmental monitoring will be undertaken at the beginning of the project.

**(d) MDBs:**

660. The monitoring of ESMP implementation will be conducted on a regular basis by the contractor and the GC, however, the monitoring reports will be disclosed semi-annually as per EIB's requirements once shared by Maha Metro. Implementation of the ESMP will be monitored half yearly by MDBs through their experts.

661. The General Consultant will document the project's compliance monitoring system in an environmental supervision procedures manual so that all parties have a clear understanding of their roles including regular monitoring tasks to be undertaken, checklists to be used and procedures to be followed. This will include roles and responsibilities of various parties, lines of communication, checklists to be used, and procedures to be followed including how and when noncompliance is communicated to the contractor and corrective actions initiated, tracked, and resolved. The manual will also describe regular recording and reporting requirements of these activities including information to be provided in contractor(s)' monthly monitoring reports.

662. The General Consultant will have the right to suspend work or payments if the Contractor(s) are in violation of any of his obligations under the ESMP and Site-Specific ESMP.

**(e) External Monitor:**

663. An external agency will be engaged by Maha Metro, if required, in consultation with MDBs to evaluate the environmental performance of afore-mentioned parties. The agency will report to GC & Maha Metro who in turn will report it to the MDBs. Separate External Monitor will be engaged for entire project. The terms of reference for engaging the External Monitoring Agencies are attached as **Annexure-8** and includes:

(i) To conduct third party monitoring of environmental compliance under the project;
(ii) To ensure that the Project will be implemented in conformity with the policies of GoI, GoM, as well as the MDBs' policies;
(iii) To identify any safeguard related implementation issues and necessary corrective actions and reflect these in a time-bound corrective action plan for Maha Metro to implement;
(iv) Involving users and stakeholders in the monitoring process; and
(v) Strengthening the capacity of the Maha Metro to manage and replicate third-party monitoring with metro users and other stakeholders.

664. The reporting line of all relevant parties is: **Contractor → PIU → Maha Metro and GC → MDBs.** The environmental monitoring involves regular checking of the environmental management issues to ascertain the implementation of mitigation measures according to the progress of the project

work. It provides the necessary feedback for the impact of the project on environment which ultimately leads to human health. The reporting procedure will be maintained as per prescribed below:

(i) The contractor will report to Construction Supervision Consultant (GC) and GC will report to Maha Metro. Maha Metro may disseminate the information to all interested parties.
(ii) Non- compliance of the monitoring will be seen by the Maha Metro.
(iii) Photographic monitoring record will be maintained by the contractor. All material source points, disposal locations, plant locations, camp locations, etc. should be photographed.
(iv) A full record of construction activities will be kept as a part of normal contract monitoring system under the various stages of construction.

665. The external monitor will conduct independent monitoring and inspections to inform Maha Metro of any remediation actions to ensure the safeguard compliances. Monitoring and Reporting Frequency for implementation of the ESMP is shown in **Table 9-1**:.

*Table 9-1: Monitoring and Reporting for ESMP and ESMoP*

| **Particulars** | **Frequency of reporting** | **Reporting by / Reporting to** | **Review by / Monitoring by** |
|---|---|---|---|
| Implementation of ESMP:<br>• Start of the construction & during construction. (Monthly Environmental Monitoring Report)[54] | Monthly till completion of construction | Contractor to GC | Maha-Metro |
| Submission of ESMP & EMoP Progress report to MDBs | Half Yearly | GC to MDBs | Maha-Metro |
| Submission of External E&S progress report by third party (If required) | • Semi-annually for the four years of construction phase<br>• Yearly during first 2 years of Operation & Maintenance. | GC to MDBs | Maha-Metro |

## D. ESMP FOR SWARGATE TO KATRAJ (PHASE-1 EXTENSION):

666. Environmental & Social Management Plan (ESMP) Matrix including mitigation measures proposed for Swargate to Katraj (Phase-1 Extension) is presented in **Table 9-2**:. The RAP is prepared to address the social issues in the project area or along the project corridor such as impact on private / common / business/ cultural properties and on the people residing or doing business/ work in the area. Project affected area includes the area in which property/assets would be affected or from where land would be acquired for the project. The RAP captures all social impacts resulted from the Project including involuntary resettlement impacts and the management plan will be prepared in the form of RAP. The ESMP and other safeguard requirements (including any conditions stipulated in the government clearances and permits) will be included in bidding documents and civil works contracts. The bidders will be required to submit, as part of their bids, the expected costs of implementing the ESMP to ensure that sufficient resources are allocated for ESMP implementation.

667. Following requirements of EIB E&S Standards (2022), Maha Metro Pune will apply pollution prevention and control technologies and practices consistent with international good practice as reflected in internationally recognized standards such as the World Bank Group's Environment, Health and Safety Guidelines. When Government regulations differ from these levels and measures, Maha Metro Pune will achieve whichever is more stringent. If less stringent levels or measures are appropriate in view of specific project circumstances, Maha Metro Pune will provide full and detailed justification for any proposed alternatives that are consistent with the requirements presented in EIB.

[54] *The monthly reports will include a summary of the status of environmental mitigation implementation including site inspection activities, issues identified, and associated corrective actions undertaken for resolution during the reporting month.*

*Table 9-2: Environmental and Social Management Plan (ESMP) Matrix*

| Sr. No | Activity | Aspect / Parameter affected | Impact | Mitigation Measures | Performance Indicator | Responsibility | |
|---|---|---|---|---|---|---|---|
| | | | | | | Implementation | Supervision |
| **Planning and Design Phase** | | | | | | | |
| 1 | Change in Land use | Land | Land use will be slightly changed | • PMC developed the Comprehensive Mobility Plan (CMP) for PMRP in 2013 to identify the present and future mobility patterns of PMC<br>• Proper clearances / permissions / consents will be sought from competent authorities before construction. | All clearances and approval copies | Maha Metro | Maha Metro (as SPA notified by GoM) |
| 2 | Contractor Management | EHS | • EHS accidents<br>• Reputational Risk | • Integration of EHS contractor management into broader project management, procurement, human resources, legal, and financial management.<br>• Prime contractor will be responsible for EHS practices of the subcontractor including HR policy which complies with applicable labour legislations, including decisions on material supplies and equipment given environmentally friendly priorities, and prepare subcontract agreements accordingly.<br>• Contractor management incorporates “adaptive management” to monitor and adapt over time; integration with sustainable procurement approach or concepts.<br>• 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.<br>• Training and Health & Safety plans<br>• Contractor must prepare a CESMP that must be approved by the promoter before any construction | EHS/Incident-Accident records | Contractor / GC | Maha Metro |

| Sr. No | Activity | Aspect / Parameter affected | Impact | Mitigation Measures | Performance Indicator | Responsibility | |
|---|---|---|---|---|---|---|---|
| | | | | | | Implementation | Supervision |
| | | | | starts. | | | |
| 3 | Contractor Preparatory Works (Upon issuance of Notice to Proceed) | EHS | Non-compliance with contract conditions and regulatory requirements. | • The Contractor shall complete the following activities no later than 30 days upon issuance of Notice to proceed,<br>(a) appoint contractor's Safety, Health and Environmental Officer (SHEO);<br>(b) SHEO will engage GC-Environment Specialist to discuss EMP, seek clarification and recommend corresponding revisions if necessary;<br>(c) SHEO will agree with GC the monthly monitoring template and deadlines for submission;<br>(d) SHEO will submit for GC's approval all necessary sub-plans as listed in this ESIA. The plans will include a work plan to secure all permits and approvals needed to be secured during construction stage which will include but are not limited to: i) operation of crushers, ii) transport and storage of hazardous materials (e.g. fuel, lubricants, explosives), iii) waste disposal sites and disposal management plan, iv) temporary storage location, iv) water use, and v) emission compliance of all vehicles. Arrangements to link with government health programs on hygiene, sanitation, and prevention of communicable diseases including Covid-19 will also be included in the action plan;<br>(e) SHEO will submit for GC's approval of the construction camp layout and management plan before its establishment; | EHS records and requisite permits and approvals | Contractor / GC | Maha Metro |
| 4 | Labour Management | Labour | Labour rights | • Compliance with GoI's labour legislation, ratified with International Labour Organization (ILO) conventions.<br>• Prohibition of child labour, 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.<br>• Elimination of discrimination with respect to | Labour records / Contractor Migratory labour records / contract agreements | Contractor | GC / Maha Metro |

| Sr. No | Activity | Aspect / Parameter affected | Impact | Mitigation Measures | Performance Indicator | Responsibility | |
|---|---|---|---|---|---|---|---|
| | | | | | | Implementation | Supervision |
| | | | | 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.<br>• 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.<br>• Grievance Redress Mechanism (GRM) for workers should be established as early as possible to function no later than construction commencement.<br>• There will be provision for group accidental and medical insurance for the workers.<br>• Contractor will prepare a detailed Labour Management Plan including mitigation on labour camp management | | | |
| | | Health and Safety | Accidents / illness | • Make mandatory the use of safety gears (helmets, safety belts, masks, gloves, Ear plugs/ muffs and boot) by workers depending on nature of work.<br>• Necessary planning and safety approach will be made for rescue during emergency.<br>• Use of dust controls (exhaust ventilation) for dust control<br>• Workers will be provided with first aid and health facilities at the site.<br>• There should have facility to deal with medical aspects of HIV/AIDS treatment with specialized services<br>• Maha Metro Covid-19 protocols forming part of the SHE Requirements contained in the contract document shall be followed; labour shall be trained and informed of precautions such as social distancing, sanitizing, avoiding groups; arrangements for thermal scanners; provision of sanitisers, face masks, gloves etc.; site record of | EHS records and requisite permits and approvals | Contractor | GC / Maha Metro |

| Sr. No | Activity | Aspect / Parameter affected | Impact | Mitigation Measures | Performance Indicator | Responsibility | |
|---|---|---|---|---|---|---|---|
| | | | | | | Implementation | Supervision |
| | | | | Covid-19 hospitals; daily disinfection of site, equipment and vehicles. | | | |
| 5 | Obtaining Clearance, Permission and Consents | Regulatory Compliance | Tree felling information, Consents to establish labour camps, pre-casting and material yards, depots, establish and operate hot mix plant, crushers, batching plant, DG sets, etc. C&D waste (muck) disposal. | • Consultation and coordination with relevant authorities to prepare the documents to obtain clearance, permission and consents[55]<br>• Conditions set in permission and consents to be incorporated into the site-specific EMPs, with dedicated officers to maintain the regulatory compliance tracker. | Government approvals and Tree felling records | Maha Metro / Contractor | Tree Authority (PMC), Maharashtra Forest Dept. / MPCB |
| 6 | Site Clearance and Demolition | Tree felling | About 175 trees will be affected Additionally, in some areas, pruning will be required. | • Maha Metro and the 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, if possible. Plan to avoid cutting trees, including adjustments in project design to minimize effect on such trees.<br>• 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.<br>• 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.<br>• Adequate coordination with applicable government regulatory authorities. As alignment passes through built-up land use, green belt development along the alignment is not feasible. Compensatory plantation of 10 saplings for every tree felled will be done in sites to be identified in consultation with PMC and Maharashtra Forest Dept. Maha Metro to allocate sufficient tree replantation budget.<br>• Prior to demolition of any building or structure contractor has to assess if Asbestos Containing | • Government approvals and Tree felling records<br>• Government licenses and approvals<br>• ACM handling and Management Plan<br>• Stakeholder Analysis records of meetings<br>• Waste Management Plan and Waste registers maintained at site.<br>• Workers' Training Records | Maha Metro / Contractor | Tree Authority (PMC), Maharashtra Forest Dept. / PMRDA |

| Sr. No | Activity | Aspect / Parameter affected | Impact | Mitigation Measures | Performance Indicator | Responsibility | |
|---|---|---|---|---|---|---|---|
| | | | | | | Implementation | Supervision |
| | | | | Material (ACM) is potentially present in the building or structure to be demolished. The initial investigation on the potential presence of ACM has to be executed by a competent and duly qualified person. If the presence of ACM is likely or confirmed, contractor has to prepare an Asbestos Removal and Disposal Plan prior to the demolition works, to be approved by the PIU.<br>• Stakeholder communication to avoid or minimize public concerns or protests.<br>• 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 Maha Metro and the Contractor.<br>• Families impacted due to fully affected (displaced/demolished) structures and partially affected structures will be compensated in accordance with the approved Resettlement Plan.<br>• To avoid negative impact on herbaceous vegetation, vehicle & Construction machinery movement should have restricted to designated roads. Similarly, it is suggested to avoid dumping of muck, excessive site clearance, levelling etc. in the river/nallah basin.<br>• Proper management of waste material will be ensured. No excavated material should not be stored near river/nallah basin<br>• Vegetation clearing by chemicals / herbicides will not be permitted<br>• Workers should be briefed about do's and don'ts like "No hunting / poaching", "No burning of vegetation for firewood, or any other purpose", "No collection of eggs or any other forest resources", not causing any disturbances to any habitat, etc.<br>• Sedimentation of storm water will be minimized by avoiding stockpiling of excavated material. Portable sanitation, treatment and disposal facility shall be provided at construction site. | | | |
| | | Noise | Noise will be generated due to tunnel work | • The procedure of tunnel work will be conducted as per prescribed guidelines. | Noise Monitoring records | Contractor | GC / Maha Metro |

| Sr. No | Activity | Aspect / Parameter affected | Impact | Mitigation Measures | Performance Indicator | Responsibility | |
|---|---|---|---|---|---|---|---|
| | | | | | | Implementation | Supervision |
| | | Physical Cultural Resources; sensitive buildings and structures | Historic and Cultural Value Loss | • Contractor to conduct pre-construction structural integrity inspections if there are known or a significant likelihood of archaeological and / or culturally valuable sites or finds in the project's direct area of influence.<br>• Contractor will develop a photo-report that can be used as evidence for the condition of buildings inspected during this process. Any report should include photographs and consultation with those entrusted to protect the buildings' condition.<br>• Prepare a monitoring scheme prior to construction based on the above inspections, with a focus on pre-identified receptors comprising educational, medical and physical cultural buildings located within recommended screening distance of 62m (for Category 2) on either side of alignment, or finds in the project's direct area of impact.<br>• Compliance with applicable legislation (permits and procedures) and good international practice.<br>• Adaptive management in site-specific ESMP during final design, including site locations (stations and construction staging areas).<br>• Chance finds procedure to be prepared by Contractor and reviewed by GC/Maha Metro before submitting to all lenders. | Site Inspection report by contractor | Contractor | GC / Maha Metro / PMC |
| 7 | Severance of utilities | Social<br>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. | • Assets and utilities will be maintained without affecting and damages by shifting temporary/ permanently where it is necessary.<br>• Based on utility maps and network information, Maha Metro and Contractor in collaboration with utility owners oversees an investigation of existing utility Maha Metro 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 | • Daily site inspection reports/records<br>• Hazard risk assessment study for utilities,<br>• Utility Shifting Plan | Maha Metro / Contractor | Maha Metro / PMC, MSEB, MNGL, Telecom companies, etc. |

| Sr. No | Activity | Aspect / Parameter affected | Impact | Mitigation Measures | Performance Indicator | Responsibility | |
|---|---|---|---|---|---|---|---|
| | | | | | | Implementation | Supervision |
| | | | | diversions and protection measures to minimize the risk to existing utilities from ground movement and surface settlement.<br>• For gas pipelines and HT electricity lines, Contractor will conduct the hazardous operation study to ensure the smooth and safe shifting.<br>• Utility shifting plan will be developed by Maha Metro and Contractor in coordination with concerned authorities and shifting of utilities will be done as per agreed utility 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). In case public utilities are required to be shifted to private land in exceptional circumstances, then adequate compensation shall be made by Maha Metro to the property owner on the same principles as temporary land acquisition as per the provisions of Resettlement Action Plan (RAP). Following completion of construction of metro, such utilities shall be rehabilitated on public land. | | | |
| 8 | Noise and Vibration Impacts Related Design | Environmental Nuisance and possible structural damages due to vibration. | Noise and vibration from construction and train operation | • The detailed noise and vibration analysis (mathematical modelling) at pre-identified receptors comprising educational, medical and physical cultural buildings and other fragile buildings located within recommended screening distance of 62m (RRT, Cat.2) for vibration and 100m (RRT, intervening buildings) for noise on either side of alignment 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.<br>• Visual inspections of buildings / structures shall be done by the contractor so as to serve as baseline to monitor progression of building damage if any due to vibration.<br>• Ballast less track structure is supported on two | Noise and Vibration Monitoring reports during the construction phase. | Contractor | GC / Maha Metro |

| Sr. No | Activity | Aspect / Parameter affected | Impact | Mitigation Measures | Performance Indicator | Responsibility | |
|---|---|---|---|---|---|---|---|
| | | | | | | Implementation | Supervision |
| | | | | layers of rubber pads to reduce noise and vibrations, wherever required. 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.<br>• Noise mitigation measures such as acoustic treatment and vibration isolation will be implemented at surface-level structures like station entrances, ventilation shafts, and ancillary facilities near sensitive receptors, where required. | | | |
| 9 | Coordinate with the Traffic Department on Traffic Management Plan | Land, Occupational safety, Community safety | Nuisance from traffic congestion | • 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.<br>• At congested sections, the temporary traffic coordinators will be engaged by Maha Metro to facilitate the traffic management.<br>• 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.<br>• 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.<br>• The logistics should be considered to manage transport materials from storage areas outside of | • Traffic Management Plan<br>• Road Safety Awareness campaign records<br>• Incident / accident register at site | Contractor | GC / Maha Metro / Traffic Police Dept. |

| Sr. No | Activity | Aspect / Parameter affected | Impact | Mitigation Measures | Performance Indicator | Responsibility | |
|---|---|---|---|---|---|---|---|
| | | | | | | Implementation | Supervision |
| | | | | 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).<br>• 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.<br>• Maha Metro 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. | | | |
| 10 | Construction method, construction material and sites selection | Environment | Pollution and nuisance | • Contractor is committed to use environmentally friendly construction methods and materials, including cement, asphalt, and other construction materials etc.<br>• Construction material shall be sourced from legalized and approved quarries.<br>• Energy saving technologies will be embedded into the Project design wherever possible. For instance, solar panels, etc.<br>• 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 | • Site inspection<br>• Site specific ESMP<br>• MPCB yearly compliance monitoring reports | Contractor | GC / Maha Metro |

| Sr. No | Activity | Aspect / Parameter affected | Impact | Mitigation Measures | Performance Indicator | Responsibility | |
|---|---|---|---|---|---|---|---|
| | | | | | | Implementation | Supervision |
| | | | | construction.<br>• Procedures for minimizing waste segregation, reuse, temporary storage, recycling, donation, and disposal.<br>• 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 access for site visits to discuss EHS management).<br>• 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.<br>• Focus will be placed on reuse of the extracted soil for enhancement of green space, waste recycle, and storm water runoff.<br>• Sites for disposal of excavated soil and C&D waste (muck) will be decided by Maha Metro before start of construction in consultation with MPCB, PMC, 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. Hazardous waste will be taken away by licensed vendors who will be responsible for due disposal at permitted sites. | | | |
| 11 | Climate Designs | Health and Safety | Natural disasters generated health and safety accidents Maintenance Cost | • Disaster management plan will pay special attention to road drainage during any natural disaster.<br>• Other climate adaptation designs will be embedded in the final design, such as (a) Increase in capacity of storm water drainage will be made so as to deal with extreme flooding in addition to demand of future land use growth along this | • Disaster Management Plan<br>• Emergency Response and Communication Plan | Contractor | GC / Maha Metro |

| Sr. No | Activity | Aspect / Parameter affected | Impact | Mitigation Measures | Performance Indicator | Responsibility | |
|---|---|---|---|---|---|---|---|
| | | | | | | Implementation | Supervision |
| | | | | alignment.<br>• Increased number of pits for RWH from metro alignment to cater to flood waters and heavy rains.<br>• Climate change mitigation measures shall be implemented, 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. | | | |
| 12 | Documents Review and Information Disclosure | Environment | Unanticipated impacts management | • With the assistance of GC, Maha Metro will review the above said data collections, surveys and pre-construction plans prepared by Contractor.<br>• Maha Metro will submit to all lenders to review the documents and disclose in a timely and meaningful manner prior to construction. | • Site EHS register<br>• Physical inspection | Maha Metro | GoM |
| 13 | Establishment of Grievance Redress Mechanism | EHS | Complaints not resolved in time | • Separate Grievance Redress Mechanism for workers and project affected people should be established as early as possible to function no later than ground work commencement. | • GRC committee formulation | Maha Metro | GoM |
| 14 | Community Liaison | Social | Complaints | • To ensure that the GRM functions effectively for affected people on construction nuisance at ground level with well documented grievance log. Contractor to develop a community communication plan as 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). | • Community / External Communication Plan | Contractor | GC / Maha Metro |
| 15 | Land Acquisition and Resettlement | Social | Permanent Acquisition of 6193.23 sqm. of land.<br><br>Private land – 2500.32 sqm.<br>Government land-3692.91 sqm.<br><br>In addition to Permanent Land Acquisition, total Temporary Land Acquisition of 40692.01 | • Land Acquisition is being carried out as per the provisions of GoM, GoI and EIB policies. The affected people will be compensated and assisted as per the provisions of Resettlement Action Plan (RAP).<br>• Land and structures to be acquired through Direct Purchase method by paying additional 25% of Market value as per Maharashtra State Govt. GR. In case of Direct Purchase Method fails, the land will be acquired under Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act | • Documents / evidence of land sell deed and other records from the PAPs<br>• Documents / evidence of agreement other records from the PAPs | State Revenue Dept., Govt. of Maharashtra / Maha Metro | GoM |

| Sr. No | Activity | Aspect / Parameter affected | Impact | Mitigation Measures | Performance Indicator | Responsibility | |
|---|---|---|---|---|---|---|---|
| | | | | | | Implementation | Supervision |
| | | | sqm. (Private - 2748.90 sqm. and Government-37943.11 sqm.) | (RFCTLARR), 2013.<br>• The temporary land will be obtained from private owners through administration of a lease agreement and appropriate compensation/rent will be paid on mutual agreement. | | | |
| | | Social | Physical displacement of residential structures (non-title holders) | • Compensation at replacement value with other relocation assistance<br>• Option for alternate housing under EWS Scheme of PMC.<br>• Providian of all entitlements as per detailed entitlements in the RAP. | • Documents of<br>• compensation received with supportive documents for alternative housing i.e. photographs and reports | Maha Metro | GoM |
| | | Social | Loss of Livelihood, Economic displacement and loss of economic structures | • Provision of all entitlements as per detailed entitlements in the RAP. Measures include the following as applicable for the different categories of PAPs (title holders / non-title holders; licensed / unlicensed):<br>• Compensation for structure (valuation of structures without depreciation).<br>• Relocation Assistance.<br>• Skill training for one of the members of the affected family.<br>• Support to access government income generating and development programs.<br>• Transportation Allowance.<br>• Subsistence Allowance.<br>• One-time allowance and assistance during shifting / relocation by Maha Metro. | • Verification of<br>• structures, Report of the skill training and supportive documents i.e. photographs and reports for other compensation and assistance received<br>• Supportive documents of completed transactions and assistance | Maha Metro | GoM |
| | | Social | Impact on vulnerable PAPs | • Assistance to all the vulnerable households. | • Supportive documents of completed assistance | Maha Metro | GoM |
| | | Social | Displacement or loss of access to CPRs | • Reconstruction or relocation in consultation with the community<br>• Civic infrastructure and community services with basic amenities would be provided in consultation with the affected community and the local administration<br>• Compensation for structure if opted by the owner/ community | • Supportive documents of completed relocation of reconstructed structures | Maha Metro | GoM |

| Sr. No | Activity | Aspect / Parameter affected | Impact | Mitigation Measures | Performance Indicator | Responsibility | |
|---|---|---|---|---|---|---|---|
| | | | | | | Implementation | Supervision |
| | | | | • | | | |
| 16 | Vulnerable sections especially Elderly and Persons with all kinds of Disability | Social | -Impacts on Vulnerable sections of society | • It shall be ensured that Train contains fully accessible carriages.<br>• Stations for all levels should be fully accessible with wide entrances and shall be accessible by wheelchair.<br>• For persons with hearing impairments, an electronic sign board shall be displayed on each platform at noticeable locations for persons with visual impairments audio system announcing the station names and door location shall be available<br>• The gap between the car doors and the platform shall be less than 12 mm Identification signage shall be provided on coach.<br>• Space for a wheel chair should be available at the side of the door. The space shall be indicated inside and outside the car by using the international symbol of access; Wheel stoppers and ring-strap or other appropriate safety grip shall be provided for wheelchair users.<br>• An appropriate number of designated seats for passengers with disabilities and elderly people shall be provided near the doors.<br>• Approach route shall not have level differences. If the station is not on the same level as the walkway or pathway, it shall have ramp. Walkway surfaces shall be non-slippery.<br>• Approach walkway should have tactile pavements for persons with visual impairments. At least one of the counters shall have an induction loop unit to aid people with hearing impairments.<br>• The counters shall have pictographic maps indicating all the services offered at the counter and at least one of the counter staff should be sign language literate.<br>• There shall be at least one unisex accessible toilet.<br>• At least one of the ticket gates shall be for disable person (low level counter) to allow a wheelchair user through and have a continuous line of guiding paver for people with visual impairments.<br>• The Platforms shall have seating areas for people with ambulatory disabilities.<br>• All platforms shall inter- connect by means of an | - | Contractor | GC/ Maha Metro |

| Sr. No | Activity | Aspect / Parameter affected | Impact | Mitigation Measures | Performance Indicator | Responsibility | |
|---|---|---|---|---|---|---|---|
| | | | | | | Implementation | Supervision |
| | | | | accessible routes or lifts and way finding references shall be available at decision points.<br>• Colour shall be used to identify routes and aid in locating doors, walls and hazards. Structural elements such as columns shall be colour contrasted or brightly marked to assist visually impaired. | | | |
| **Construction Phase** | | | | | | | |
| 17 | Construction Monitoring | EHS | Breach of legislation, ESIA, ESMP, Contracts Accidents | • 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 / Maha Metro on monthly basis.<br>• GC / Maha Metro to review the data compared to baseline data and urge Contractor to take immediate actions over any project generated pollution / contamination.<br>• If any unanticipated EHS impacts arise during construction, implementation or operation of the Project that were not considered in the ESIA / ESMP, Contractor and GC to promptly inform Maha Metro of the occurrence of such risks or impacts, with detailed description of the event and proposed corrective action plan. Maha Metro will report to all lenders accordingly.<br>• Maha Metro to engage qualified and experienced third-party monitor, if required, to verify information produced through the Project monitoring process, and facilitate the carrying out of any verification activities by such third-party monitor.<br>• Maha Metro to submit the semi-annual monitoring reports (GC's and third party's) using the agreed the template to all lenders.<br>• Maha Metro to report all lenders any actual or potential breach of compliance with the measures and requirements set forth in the ESMP promptly after becoming aware of the breach. | • Environment Monitoring reports/records for all parameters<br>• MPCB compliance reports | Contractor / GC | Maha Metro |
| 18 | Community Liaison | Social | Complaints | • GRM for affected people should function effectively with well documented grievance log. | • GRM records/Register | Contractor | GC / Maha Metro |

| Sr. No | Activity | Aspect / Parameter affected | Impact | Mitigation Measures | Performance Indicator | Responsibility | |
|---|---|---|---|---|---|---|---|
| | | | | | | Implementation | Supervision |
| | | | | • 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), Maha Metro will undertake consultations.<br>• Adaptive management that monitors, adjusts, or adds measures to reflect actual community risks.<br>• 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). | • Action Plans | | |
| 19 | Construction Vehicle Management | Environment<br>Social | Community disruption<br>Accidents<br>Reputational risk | • Contractor's transport vehicles and other equipment shall conform to emission standards.<br>• 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 wheel 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. Used water shall be collected and re-used after settling in a settling basin or tank.<br>• Definition of allowable routes, speeds, and times (day or week).<br>• Driver requirements and controls, including pre-work 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.<br>• Driver contracts with clearly specified requirements and remedies for noncompliance.<br>• 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, | • Accident/Incident register<br>• Site EHS records<br>• Physical Verification<br>• Worker Training records | Contractor | GC / Maha Metro |

| Sr. No | Activity | Aspect / Parameter affected | Impact | Mitigation Measures | Performance Indicator | Responsibility | |
|---|---|---|---|---|---|---|---|
| | | | | | | Implementation | Supervision |
| | | | | batteries, and tires etc.<br>• Equipment/vehicle repair/maintenance and re-fuelling areas will be confined to areas in construction sites designed to contain spilled lubricants and fuels. Such areas will be equipped with a concrete perimeter and drainage system leading to an oil/grease-water separator that will be regularly skimmed of oil to prevent spilled oil/grease being discharged to the ground surface. | | | |
| 20 | Levelling of Site | Land | Surface levelling will alter the soil texture and compactness, which will affect the infiltration and soil ecology. Also, levelling will involve alteration of natural drainage | • Interim drainage system will be installed prior to construction.<br>• Where feasible, infiltration losses will be countered by installing Rainwater Harvesting pits away from construction site. | • Field Verification / Site Inspection | Contractor | GC / Maha Metro |
| 21 | Auger piling | Noise | During piling operations, noise will be generated which may go up to 70-75 dB (A) at a distance of 5m | • At all piling 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.<br>• Efforts should be made to keep the noise levels under control by appropriate noise attenuation and adopting employee safety measures.<br>• Use of low-noise equipment and ensuring good maintenance, and trying to avoid using high-noise equipment simultaneously at the same section.<br>• Information dissemination to local residents and shop owners about the nature and duration of intended activities including the construction method, probable effects, safety measures and precautions prior to commencement and kept updated as to changes in the management and mitigation plan.<br>• Enclose especially noisy activities if above the noise limits and employ transportable noise screens | • Noise Quality Monitoring reports | Contractor | GC / Maha Metro |

| Sr. No | Activity | Aspect / Parameter affected | Impact | Mitigation Measures | Performance Indicator | Responsibility | |
|---|---|---|---|---|---|---|---|
| | | | | | | Implementation | Supervision |
| | | | | between noise sources and identified noise sensitive areas for the duration of noisy construction activities.<br>• Monitoring required during construction, including field observations and measurements. | | | |
| | | Vibration | Tunnelling work may generate vibrations | • Contractor to ensure that vibration levels will not exceed 5.0 mm/s.<br>• 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.<br>• Monitoring during construction including field observations and measurements. | • Building condition Survey<br>• Vibration Monitoring reports | Contractor | GC / Maha Metro |
| | | Surface water | Degradation of water quality due to tunnel construction in water courses | • It is prohibited to dispose excavated spoils and wastes into river/streams water;<br>• All chemicals, fuel and oil shall be stored at least 500 m away from water and shall be stored at concreted platform with catchment pits for spills collection;<br>• Contractor will make sure that spill kits are on site at any time in case of an accident or incident;<br>• The contractor shall arrange awareness programme to all equipment operators, drivers, on immediate response for spill contamination and eventual clean-up. Further, emergency procedures and reports preferably written in easy-to-understand local dialects shall be distributed to the workers as well as local people;<br>• If required, silt fencing and/or brush barrier shall be installed for collecting sediments before letting them into the water body. Silt/sediment shall be collected and stockpiled for possible reuse as surfacing of slopes for re-vegetation;<br>• All wastes arising from the construction sites shall be collected and disposed in a designated location. The wastes shall be collected, stored and transported at approved disposal sites;<br>• No vehicles or equipment shall be washed, parked or refuelled within 100 m distance to the nearest surface water, to avoid contamination of streams water from fuel and lubricants; | • Spill control and prevention plan<br>• Surface water quality monitoring reports<br>• Water Quality management Plan | Contractor | GC / Maha Metro |

| Sr. No | Activity | Aspect / Parameter affected | Impact | Mitigation Measures | Performance Indicator | Responsibility | |
|---|---|---|---|---|---|---|---|
| | | | | | | Implementation | Supervision |
| | | | | • Vehicle parking and maintenance areas will have waterproof floors from which drainage is collected and treated to legal standards;<br>• No untreated sanitary wastewater from camps shall be discharged into the streams water;<br>• Bridge and cross drainage work at river/streams will not be undertaken during the peak monsoon season. All supporting structures, construction materials, waste materials and debris will be removed from the riverbed prior to the peak monsoon season;<br>• The contractor will take appropriate measures to avoid and contain any spillage and pollution of the water; | | | |
| | | Physical Cultural Resources | Historic and Cultural Value Loss<br>Conflicts with community | • On-site training shall be provided to site workers if any historical or cultural artefact is noticed during work.<br>• The work shall be immediately stopped and information will be delivered to the higher authority.<br>• All workers will undergo a briefing with the Archaeology Department to ensure safeguarding of heritage resource and / or cultural / religious practices.<br>• 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 Maha Metro.<br>• The project will implement, where required, chance finds procedure contained in ESS8 of WBG ESF. It includes requirement to notify relevant authorities; to fence-off the area of finds or sites to avoid further disturbance; to assess found objects or sites by cultural heritage experts; to identify and implement actions consistent with the requirements of this ESS and national law; and to train project personnel and project workers on chance find procedures. | • Physical Verification<br>• EHS records | Contractor | GC / Maha Metro |
| | | Health & Safety | Noise and vibration generated during work will affect the health and safety of the workers | • Standard 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).<br>• To reduce the harmful effects, personnel working at | • EHS records<br>• Noise Monitoring reports | Contractor | GC / Maha Metro |

| Sr. No | Activity | Aspect / Parameter affected | Impact | Mitigation Measures | Performance Indicator | Responsibility | |
|---|---|---|---|---|---|---|---|
| | | | | | | Implementation | Supervision |
| | | | | high noise levels would be provided with noise protective gears such as ear mufflers, sound barriers, job rotations per occupational exposure limits etc.<br>• Procedure to receive, evaluate, and compensate (if applicable) damages due to construction and establishment of financial resources to cover this expense. | | | |
| 22 | Tunnelling | Air | Dust and emissions during muck handling and shaft excavation | • Fugitive dust will be controlled through regular water sprinkling at mucking points, access roads, and around shaft perimeters. Water used will be sourced from treated effluent, surface runoff, or construction site drainage; use of potable water will be avoided.<br>• Muck shall be transported in covered trucks or via enclosed conveyors to prevent dust emissions.<br>• Ventilation systems will be installed in shafts and tunnels to maintain air quality for workers and surrounding areas.<br>• DG sets and excavation machinery will use low-sulphur diesel and be properly maintained to reduce emissions.<br>• Vehicle washing facilities will be provided at site exits. Used water will be collected and reused after settlement. | • Air quality monitoring reports | Contractor | GC / Maha Metro |
| | | Noise & Vibration | Noise and vibration due to TBM operations and shaft excavation near sensitive receptors | • Efforts will be made to keep noise levels under permissible limits by using low-noise equipment, enclosing noisy activities wherever possible, and avoiding simultaneous operation of high-noise machinery at the same shaft location.<br>• TBM operations near sensitive areas will be scheduled to avoid night-time activity wherever feasible.<br>• Information will be disseminated to nearby residents and shop owners about construction timelines, expected impacts, and mitigation measures.<br>• Temporary noise barriers or enclosures will be installed around surface-level equipment as needed.<br>• A vibration monitoring plan will be implemented at sensitive receptors.<br>• Pre-construction structural condition surveys will be conducted for buildings within the recommended screening distance (62 m for Category 2 receptors). | Noise & vibration monitoring reports<br>Site inspection | Contractor | GC / Maha Metro |

| Sr. No | Activity | Aspect / Parameter affected | Impact | Mitigation Measures | Performance Indicator | Responsibility | |
|---|---|---|---|---|---|---|---|
| | | | | | | Implementation | Supervision |
| | | | | • Contractor will prepare and implement a vibration mitigation and compliance monitoring plan, with regular reporting. | | | |
| | | Groundwater | Ingress of groundwater into tunnels; potential drawdown effects due to dewatering | • Dewatering, if required, will be done using controlled pumping methods to avoid overdrawal and ground settlement.<br>• Groundwater collected during tunnelling will be settled, tested, and reused for construction activities where feasible.<br>• Groundwater discharge, if necessary, will be routed to municipal sewer systems after compliance with CPCB and EPR 1986 standards.<br>• Groundwater level and quality will be regularly monitored around shaft locations.<br>• Drainage systems will be developed around shafts based on local contours to avoid accumulation and runoff. | Groundwater quality and level monitoring reports | Contractor | GC / Maha Metro |
| | | Surface Water | Pollution risk from spoil storage, concrete wash-off, oil spills near open shafts near water bodies | • Construction near water bodies (if any) will follow established watercourse protection protocols, including no disposal of construction waste or excavated material into water bodies.<br>• Proper drainage channels with sedimentation features will be constructed to divert stormwater away from shafts.<br>• Chemicals, oils, and fuels will be stored on concreted, bunded platforms with spill containment measures.<br>• No equipment will be washed, refuelled, or parked near drains, nallahs, or canal areas.<br>• All temporary structures will be removed from water-sensitive zones before the monsoon season.<br>• Any discharge from the site will meet EPR 1986 standards. | Site inspection<br>MPCB compliance | Contractor | GC / Maha Metro |
| | | Soil | Soil erosion and disposal issues due to excavation and tunnelling spoil | • Proper drainage systems using site contours will be established around shafts to control erosion and sediment runoff.<br>• Excavated spoil will be reused within the project to the extent possible for backfilling or levelling.<br>• Topsoil will be separately preserved and stored for reuse during site restoration or landscaping works. | • Site inspection<br>• EHS audit reports | Contractor | GC / Maha Metro |

| Sr. No | Activity | Aspect / Parameter affected | Impact | Mitigation Measures | Performance Indicator | Responsibility | |
|---|---|---|---|---|---|---|---|
| | | | | | | Implementation | Supervision |
| | | | | • Bringing soil from outside the site will be avoided unless necessary.<br>• All excess spoil will be transported to designated and approved disposal sites. | | | |
| | | PCR | Potential chance finds during shaft excavation or cross-passage construction | • If any artefacts or features of archaeological interest are discovered during tunnelling or shaft excavation, work will be stopped immediately and the relevant authorities (State Archaeology Department) will be informed.<br>• All personnel will be trained and briefed on cultural heritage protection and chance find procedures before starting work.<br>• A record of training including participant names, dates, and location will be maintained and included in monthly reports.<br>• The project will implement a chance finds procedure as per ESS8 of the World Bank Group's ESF, including fencing of discovery site and expert assessment of finds.<br>• Any actions taken will be consistent with Indian law and international best practices. | • Site inspection<br>• Monthly reports | Contractor | GC / Maha Metro |
| | | Health & Safety | Risk of confined space hazards, tunnel collapse, gas leaks, fire | • Number and length of shifts will be pre-defined and strictly followed to avoid fatigue-related incidents.<br>• TBM operations and tunnelling works will follow confined space entry protocols, with availability of rescue equipment and trained personnel.<br>• Hoardings and fencing will be provided at all surface-level access points, particularly near public roads or footpaths.<br>• Tunnel air quality will be continuously monitored for gases like CO, $CO_2$, methane, and oxygen deficiency; emergency ventilation will be available.<br>• Fire extinguishers and communication systems will be provided at intervals inside the tunnel.<br>• Emergency response plans will be displayed and drills conducted periodically.<br>• Contaminated soil or water (if any) will be managed through temporary on-site storage and treatment, and disposed of per applicable norms. | • Site inspection<br>• EHS audit reports | Contractor | GC / Maha Metro |
| | | Aesthetics | Visual impacts due to shaft construction and mucking operations | • All open shaft areas will be barricaded using GI sheets along the full perimeter to minimize visual disturbance. | • Site inspection<br>• EHS audit reports | Contractor | GC / Maha Metro |

| Sr. No | Activity | Aspect / Parameter affected | Impact | Mitigation Measures | Performance Indicator | Responsibility | |
|---|---|---|---|---|---|---|---|
| | | | | | | Implementation | Supervision |
| | | | | • Movement of excavated material will be restricted to non-peak hours to reduce nuisance.<br>• Dust and waste will be managed to prevent spill over into adjacent public areas.<br>• Restoration of the site—including roads, pavements, footpaths, and greenery—will be undertaken immediately after the completion of tunnelling works.<br>• Any permanent structures such as ventilation shafts will be aesthetically designed to blend into the urban surroundings. | | | |
| 23 | Excavation | Air | Excavation will result into fugitive dust generation | • 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 Maha Metro). Surface runoff, wastewater from construction sites, construction yards and treated water will be used.<br>• Imposition of speed controls for vehicles on unpaved site roads. 10-30 kmph is the recommended limit.<br>• Every vehicle should be washed to remove any dusty materials from its body and wheels before leaving the construction sites. Used water shall be collected and re-used after settling in a settling basin or tank. Water for sprinkling and tire washing will be sourced from treated effluent from ETPs located nearby, seawater or surface runoff; use of municipal treated water shall be minimized.<br>• Excavation machinery will be topped up by low-Sulphur fuel. | • Air quality Monitoring reports | Contractor | GC / Maha Metro |
| | | Noise and Vibration | Nuisance | • Efforts should be made to keep the noise levels under control by appropriate noise attenuation and adopting employee safety measures.<br>• Use of low-noise equipment and ensuring good maintenance, and trying to avoid using high-noise equipment simultaneously at the same section.<br>• 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 | • Noise and Vibration Monitoring reports<br>• Site inspection | Contractor | GC / Maha Metro |

| Sr. No | Activity | Aspect / Parameter affected | Impact | Mitigation Measures | Performance Indicator | Responsibility | |
|---|---|---|---|---|---|---|---|
| | | | | | | Implementation | Supervision |
| | | | | mitigation plan.<br>• 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.<br>• Monitoring required during construction, including field observations and measurements.<br>• Vibratory rollers near sensitive receptors shall be avoided.<br>• The contractor should prepare a mitigation plan and implement the same during the final design and construction phase of the project. This scheme shall include:<br>• Monitoring requirements for vibrations at sensitive receptors during the construction period; Pre-construction structural integrity inspections of sensitive structures, if required.<br>• Information dissemination about the construction method, probable effects, quality control measures and precautions to be used.<br>• vibration monitoring plan during final design and the implementation of a compliance monitoring program during construction<br>• Contractor to ensure that vibration levels at receptors comprising educational, medical and physical cultural buildings and other fragile buildings located within recommended screening distance of 62m (for cat. 2) on either side of each alignment will not exceed 5.0 mm/s. | | | |
| | | Surface water | Dumping of construction waste like concrete, bricks, waste material etc. cause surface water pollution. | • Proper drainage systems using contour information will be constructed around active and & large construction sites. After settling, it shall be discharged into public sewers; it will be treated by municipal agencies to Environment Protection Rules (EPR) 1986 Schedule VI standards of discharge of general effluents into surface water.<br>• To avoid water pollution and soil erosion due to flooding, earthwork will be limited during monsoon season. | • MPCB compliance monitoring and correspondences. | Contractor | GC / Maha Metro |
| | | Groundwater | Dewatering (if done) will adversely affect the groundwater regime | • Proper drainage systems using contour information will be constructed around active and & large construction sites. After settling, it shall be | • Ground water quality Monitoring reports<br>• Site inspection | Contractor | GC / Maha Metro |

| Sr. No | Activity | Aspect / Parameter affected | Impact | Mitigation Measures | Performance Indicator | Responsibility | |
|---|---|---|---|---|---|---|---|
| | | | | | | Implementation | Supervision |
| | | | | discharged into public sewers; it will be treated by municipal agencies to Environment Protection Rules (EPR) 1986 Schedule VI standards of discharge of general effluents into surface water.<br>• To avoid water pollution and soil erosion due to flooding, earthwork will be limited during monsoon season. | | | |
| | | Soil | Excavation will adversely affect the soil | • 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.<br>• The topsoil should be preserved (by storing it at appropriate places) so that same can be restored after completion of work. | • Site inspection<br>• EHS audit reports | Contractor | GC / Maha Metro |
| | | Physical Cultural Resources | Historic and cultural value loss<br>Conflicts with community | • If any artefacts of archaeological importance are noticed, work should be stopped and information to be given to the higher authorities.<br>• All workers will undergo a briefing with the Archaeology Department to ensure safeguarding of heritage resource and cultural/religious practices.<br>• 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 Maha Metro.<br>• The project will implement, where required, chance finds procedure contained in ESS8 of WBG ESF. It includes requirement to notify relevant authorities; to fence-off the area of finds or sites to avoid further disturbance; to assess found objects or sites by cultural heritage experts; to identify and implement actions consistent with the requirements of this ESS and national law; and to train project personnel and project workers on chance find procedures | • Site inspection<br>• EHS audit reports | Contractor | GC / Maha Metro |
| | | Health and Safety | Accidents | • To specify the number and length of shifts for each worker.<br>• 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. | • Site inspection<br>• EHS audit reports | Contractor | GC / Maha Metro |

| Sr. No | Activity | Aspect / Parameter affected | Impact | Mitigation Measures | Performance Indicator | Responsibility | |
|---|---|---|---|---|---|---|---|
| | | | | | | Implementation | Supervision |
| | | | | • 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 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. | | | |
| | | Aesthetics | Temporary loss of aesthetics value due to excavation and related activities. | • The excavation sites will be barricaded on all sides using GI sheets. Hauling will be carried out in non-peak hours.<br>• Aesthetic value of the site will be restored after completion of the works. | • Site inspection<br>• EHS audit reports | Contractor | GC / Maha Metro |
| 24 | Hauling of excavated material | Air | During transportation of excavated material, fugitive dust will be generated from two sources, (1) from re-suspension of dust from road surface, (2) from the movement of air, against the excavated material being hauled | • The traffic management plan will be stringently implemented with regular monitoring and inspections.<br>• Trucks / dumpers carrying the excavated material will be covered using tarpaulin/similar covering materials.<br>• Sprinkling of water should be carried out.<br>• Truck tyres 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. Used water shall be collected and re-used after settling in a settling basin or tank.<br>• Water for sprinkling and tire washing will be sourced from treated effluent from ETPs located nearby, seawater or surface runoff; use of municipal treated water shall be minimized. Groundwater will not be used in construction or operation of the project.<br>• Haul roads will be kept in good state of maintenance. | • Traffic Management Plan<br>• Site inspection<br>• EHS audit reports | Contractor | GC / Maha Metro / Traffic Police Dept. |
| | | 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 | • The routing, timing and logistics of the haul truck movement should be planned to have minimal impacts on noise level.<br>• The route selection will avoid any sensitive receptors.<br>• Efforts should be made to keep the noise levels under control by appropriate noise attenuation and | • Site inspection<br>• EHS audit reports | Contractor | GC / Maha Metro |

| Sr. No | Activity | Aspect / Parameter affected | Impact | Mitigation Measures | Performance Indicator | Responsibility | |
|---|---|---|---|---|---|---|---|
| | | | | | | Implementation | Supervision |
| | | | impacts of noise will be most intense in the residential / urban areas. | adopting employee safety measures.<br>• 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.<br>• 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.<br>• Monitoring required during construction, including field observations and measurements. | | | |
| | | Social | Incessant movement of trucks could create social issues. | • The local community has to be taken into confidence before the construction commences. Their advice must be taken and incorporated in decision making.<br>• GRM for affected people should function effectively with grievance log well documented. | • GRM records | Contractor | GC / Maha Metro |
| | | Health & Safety | The movement of trucks will increase the traffic risk of the commuters. | • The routing, timing and logistics of the haul truck movement should be planned to have minimal impact on occupational and community health and safety. | • Site inspection<br>• EHS audit reports | Contractor | GC / Maha Metro |
| 25 | Dumping of excavated materials | Air | The dumping operation of excavated material will generate fugitive dust in the nearby areas | • Site of dumping will be selected in consultation with authorities.<br>• The disposal plan will be stringently implemented with site monitoring and inspections.<br>• It will be located outside of urban habitation.<br>• Sprinkling of water should be carried out. Water shall be sourced from surface runoff, wastewater from construction sites, and construction yards. Use of municipal treated water shall be minimized. | • Site inspection<br>• EHS audit reports | Contractor | Maha Metro / PMC / MPCB |
| | | Soil | Dumping may increase the height of the land and affect the natural drainage pattern of the area | • The dumping will be done in pre-designated low-lying areas identified by PMC, MPCB, and Maha Metro for this specific purpose.<br>• The disposal plan will be stringently implemented with regular monitoring and inspections.<br>• Field inspections, monitoring, and documentation of dumping excavated materials. | • Site inspection<br>• EHS audit reports | Contractor | GC / Maha Metro |

| Sr. No | Activity | Aspect / Parameter affected | Impact | Mitigation Measures | Performance Indicator | Responsibility | |
|---|---|---|---|---|---|---|---|
| | | | | | | Implementation | Supervision |
| 26 | 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. | • Permission from Pune 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.<br>• Adaptive management with field inspections and monitoring during plan implementation and adjustments, as needed, to reflect actual traffic congestion or related issues<br>• 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. | • Applicable permit/license copies<br>• Site inspection<br>• EHS audit reports | Contractor | GC / Maha Metro / Traffic Police Dept. |
| | | Noise | Barricading & detouring may result into traffic congestion in the urban areas. This will result into (a) noise from vehicular movement and (b) honking noise due to congestion. | • Permission from Pune 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.<br>• Detour route selection to avoid sensitive receptors to noise.<br>• Adaptive management with field inspections and monitoring during plan implementation and adjustments, as needed, to reflect actual traffic congestion or related issues. | • Applicable permit/license copies<br>• Site inspection<br>• EHS audit reports | Contractor | GC / Maha Metro |
| | | Social | Traffic diversion (esp. for public transport) will create inconvenience | • Implement the traffic management plan consistent with the Indian Guidelines on Traffic Management in work zones (IRC: SP:55-2014). 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.<br>• 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.<br>• Adaptive management with field inspections and | • Traffic Management Plan<br>• Applicable permit/license copies<br>• Site inspection<br>• EHS audit reports | Contractor | GC / Maha Metro |

| Sr. No | Activity | Aspect / Parameter affected | Impact | Mitigation Measures | Performance Indicator | Responsibility | |
|---|---|---|---|---|---|---|---|
| | | | | | | Implementation | Supervision |
| | | | | monitoring during plan implementation and adjustments, as needed, to reflect actual traffic congestion or related issues. | | | |
| | | Resource consumption | Detouring will increase the road length to be travelled by a car, thus, increasing the overall fuel consumption. | • The detour will be planned to be optimum in terms of road length. The faster completion of works will also tend to reduce enhanced fuel consumption. | | Contractor | GC / Maha Metro |
| 27 | Restricted pedestrian movement | Social | Restricted pedestrian movement will cause social uproar, esp. in people living near metro stations | • Safe passage for pedestrians with proper sunshade / fall protection and signage will be planned. Public consensus will be built. Representatives of non-governmental organisations and volunteers from local communities at respective sections of the project shall be invited to participate in meetings with Maha Metro, GC, and Traffic Police where joint decision on diversion measures will be arrived at.<br>• GRM for affected people should function effectively with grievance log well documented. | • Applicable permit/license copies<br>• Site inspection<br>• EHS audit reports<br>• GRM register | Contractor | GC / Maha Metro |
| | | Health & Safety | Movement though constricted space may cause potential health & safety issues amongst pedestrians | • Movement through construction area shall be prohibited.<br>• Safe passage for pedestrians with proper fall protection and signage will be planned. This applies to movement along existing roads on which the metro is constructed. It is clarified that their movement through construction areas shall be prohibited. | | Contractor | GC / Maha Metro |
| 28 | C&D waste (muck) generation & disposal (incl. spent drill fluid and polymer slurry) | Surface water | Muck generated including spent polymer slurry from auger drilling operations will drain with surface runoff and pollute nearby water bodies | • Muck disposal plan will be stringently implemented with regular monitoring and inspections.<br>• The construction sites will be provided with garland drains with intercepting pits to trap silt & muck.<br>• Muck will be stored in lined tanks / ponds. Such tank/ ponds could be covered during monsoon to control runoff.<br>• 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<br>• Transportation of muck will be scheduled by time and route to minimize air pollution in habitat areas. | • Muck Disposal Plan<br>• Applicable permit/license copies<br>• Site inspection<br>• EHS audit reports | Contractor | GC / Maha Metro |

| Sr. No | Activity | Aspect / Parameter affected | Impact | Mitigation Measures | Performance Indicator | Responsibility | |
|---|---|---|---|---|---|---|---|
| | | | | | | Implementation | Supervision |
| | | Groundwater | Muck, spent polymer slurry & drill fluids may settle down from pond / tanks and will affect groundwater | • The tanks / ponds holding muck will be lined to prevent infiltration into groundwater. It will be passed through settling chambers and discharged into public sewers; it will be treated by municipal agencies to Environment Protection Rules (EPR) 1986 Schedule VI standards of discharge of general effluents into surface water. Upon discharge of general wastewater into municipal sewers by Maha Metro, the municipal agencies are required by law to treat it appropriately before disposal. Maha Metro shall duly consult with the agencies before start of construction.<br>• Groundwater quality monitoring before, during and after the use of muck tanks/ponds. | • Muck Disposal Plan<br>• Applicable permit/license copies<br>• Site inspection<br>• EHS audit reports | Contractor | GC / Maha Metro |
| | | Aesthetics | Muck generation will create an aesthetic issue | • The construction site will be covered from all sides to reduce visual impacts. | • Muck Disposal Plan<br>• Applicable permit/license copies<br>• Site inspection<br>• EHS audit reports | Contractor | GC / Maha Metro |
| 29 | Stacking & warehousing of raw material | Surface water | Washed out raw material could pose serious threat to surface water bodies | • Small dykes 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. | • Site inspection<br>• EHS audit reports | Contractor | GC / Maha Metro |
| | | Soil | Spillage of materials / mix products on the ground could pollute soil | • Proper care will be taken. Such spills will be cleared by scraping and disposing the products as road sub-grade material. | • Site inspection<br>• EHS audit reports | Contractor | GC / Maha Metro |
| | | Health & Safety | Fine products like cement/ silt/ sand could cause harm to respiratory system. | • Cement and sand will be stacked under tarpaulin and secured by GI sheet barricading (working & wind break). Shorter work shift and daily medical check-ups of workers will be implemented.<br>• Dust filters atop cement silos, wet suppression for aggregate crushing and screening will be employed | • Site inspection<br>• EHS audit reports | Contractor | GC / Maha Metro |
| | | Aesthetics | Stacking of raw material will cause aesthetic issues for residential areas located nearby | • The height of walls between the residential area and RM yard / construction area will be raised using GI sheets. | • Site inspection<br>• EHS audit reports | Contractor | GC / Maha Metro |
| 30 | 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 | • Timing of using RCC pumps will be planned and specified by the Engineer.<br>• RCC pumps will be covered from all sides.<br>• Bends and excessive head will be avoided. | • Site inspection<br>• EHS audit reports | Contractor | GC / Maha Metro |

| Sr. No | Activity | Aspect / Parameter affected | Impact | Mitigation Measures | Performance Indicator | Responsibility | |
|---|---|---|---|---|---|---|---|
| | | | | | | Implementation | Supervision |
| | | | areas. | | | | |
| | | Soil | Spillage from concrete pouring may contaminate soil | • The spoils from pouring concrete will be collected and reused as sub-grade material in road constriction. | • Site inspection<br>• EHS audit reports | Contractor | GC / Maha Metro |
| | | Aesthetics | Spoils from concrete pouring will create unpleasant looking visuals | • After each pouring cycle, the spoils will be manually collected and reused as sub-grade material in road constriction. | • Site inspection<br>• EHS audit reports | Contractor | GC / Maha Metro |
| 31 | 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 varies between 82-93 dB (A). | • If the consistency of concrete could be altered, the need for use of vibrator (esp. in low temperature & low thickness casting) could be reduced. Damping could be used to reduce high frequency noise, and thereby reducing the noise levels. Workers should be provided with suitable PPEs. | • Site inspection<br>• EHS audit reports | Contractor | GC / Maha Metro |
| | | Soil | During setting, spillage from cast could take place. | • The spoils from pouring concrete will be collected and reused as sub-grade material in road construction. | • Site inspection<br>• EHS audit reports | Contractor | GC / Maha Metro |
| 32 | Curing of concrete (use of water) | Surface water | Curing water will drain to the low-lying areas and pollute water courses | • Garland drainage is proposed to be constructed around the construction yard. This will intercept the runoff generated from site.<br>• After settling it shall be discharged into public sewers; it will be treated by municipal agencies to Environment Protection Rules (EPR) 1986 Schedule VI standards of discharge of general effluents into surface water.<br>• Curing needs will be met from municipal supply, water resulting from dewatering during piling and surface runoff water.<br>• Rainwater harvesting (as a compensatory measure) will be practiced. | • Site inspection<br>• EHS audit reports | Contractor | GC / Maha Metro |
| | | Groundwater | Curing water will drain to the low-lying areas and pollute water courses | • Excess curing water shall be channelled properly in to the nearest public drain. | • Site inspection<br>• EHS audit reports | Contractor | GC / Maha Metro |
| | | Aesthetics | Curing will create water impounding and may lead to vector propagation | • Garlanding drain will be constructed around the construction area. The curing water impounded will be reused for curing. | • Site inspection<br>• EHS audit reports | Contractor | GC / Maha Metro |

| Sr. No | Activity | Aspect / Parameter affected | Impact | Mitigation Measures | Performance Indicator | Responsibility | |
|---|---|---|---|---|---|---|---|
| | | | | | | Implementation | Supervision |
| 33 | Use of Crane & Launchers | Noise | Operation of launchers and crane will generate noise which in times may go up to 85-90 dB (A). Legris & Poulin has found that the average daily noise exposure was approx. 84 to 99 dB (A) for heavy equipment, and 74 to 97 dB (A) for the crane operators. | • The sensitive receptors (workers & external parties, if applicable) have to be isolated from heavy construction noise generated. This is possible by erecting reinforced 2 m tall GI sheet barrier around the area where heavy construction works is undertaken.<br>• Workers working inside or near construction equipment should be provided with proper PPEs like ear plugs / muffs complying with IS 4869.<br>• 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.<br>• 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. | • Applicable permit/license copies<br>• Site inspection<br>• EHS audit reports | Contractor | GC / Maha Metro |
| | | Health & Safety | Cranes and launchers are a major safety concern. | • As per Maha Metro's SHE Manual, 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 must take place before commencement of work. | • On site SHE manual<br>• Applicable permit/license copies<br>• Site inspection<br>• EHS audit reports | Contractor | GC / Maha Metro |
| 34 | Construction of labour camp(s) and associated environmental issues | Surface water | Sewage from labour camps may be discharged into open slopes thus contaminating surface water | • Labour camps will be constructed in semi urban set-up or outskirts of the city. At the campsites wastewater treatment facilities will be constructed (e.g., septic tank and soak pit and site drainage) to avoid spillage of wastewater into surface water or groundwater. Alternatively, a connection to the public sewer system may be realised. Sewage discharged into public sewers will be treated by municipal agencies to Environment Protection Rules (EPR) 1986 Schedule VI standards of discharge of general effluents into surface water.<br>• Alternately, the contractor shall install small STP/Bio-digester for treatment of sewage from workers' camps. This treated water shall be used for gardening & sprinkling on roads. | • Applicable permit/license copies<br>• Site inspection<br>• EHS audit reports | Contractor | GC / Maha Metro |

| Sr. No | Activity | Aspect / Parameter affected | Impact | Mitigation Measures | Performance Indicator | Responsibility | |
|---|---|---|---|---|---|---|---|
| | | | | | | Implementation | Supervision |
| | | Groundwater | Surface water on flat terrain could percolate and contaminate groundwater. | • Contractor to collect the groundwater baseline data prior to construction.<br>• Disposal in compliance with applicable regulatory requirements.<br>• Groundwater quality monitoring.<br>• Water abstracted must be measured / recorded periodically.<br>• After Construction, Contractor will conduct groundwater analysis and be obliged to reinstate the used sites no worse than the conditions of pre-construction. | • Applicable permit/license copies<br>• Site inspection<br>• EHS audit reports | Contractor | GC / Maha Metro |
| | | Soil | Solid waste generated from the labour camps will cause soil pollution | • Contractor to collect the soil baseline data prior to construction.<br>• Municipal solid waste will be collected and taken away and disposed by municipality.<br>• Solid waste will have to be disposed in compliance with Municipal Solid Waste (Management & Handling) Rules, 2000, as amended to date.<br>• After Construction, Contractor will conduct soil analysis and be obliged to reinstate the used sites no worse than the conditions of pre-construction. | • Waste Management plan<br>• Applicable permit/license copies<br>• Site inspection<br>• EHS audit reports | Contractor | GC / Maha Metro |
| | | Social | Influx of non-local labours will create a social issue | • Mixing of skilled non-local labours with local unskilled people will reduce social frictions.<br>• To avoid labour influx risk, sensitizing of local community and the non-local workers separately as well as jointly will be done regularly. | • Applicable permit/license copies<br>• Site inspection<br>• EHS audit reports | Contractor | GC / Maha Metro |
| | | Health & safety | Living in congested condition, make-shift temporary arrangement; the labours are prone to diseases. | • Regular counselling, medical check-ups and treatment at separate clinics, coordination with local health authorities will be conducted.<br>• As per the 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 labourers, free of charge. Labour camps will be in full compliance of BOCW Act.<br>• Covid-19 protocols for construction forming part of the Environmental Social Health and Safety Requirements shall be fine-tuned to be adopted for labour camps; camp residents shall be trained and informed of precautions such as social distancing, | • Applicable permit/license copies<br>• Site inspection<br>• EHS audit reports | Contractor | GC / Maha Metro |

| Sr. No | Activity | Aspect / Parameter affected | Impact | Mitigation Measures | Performance Indicator | Responsibility | |
|---|---|---|---|---|---|---|---|
| | | | | | | Implementation | Supervision |
| | | | | sanitizing, avoiding groups; arrangements for thermal scanners; provision of sanitisers, face masks, gloves; record of Covid-19 hospitals; protected ambulances at camp; daily disinfection of site, equipment and camp. | | | |
| | | Resources | Labours will consume resources like wood for cooking | • Liquid Petroleum Gas (LPG) cylinders will be made available free of cost to the labourers by the Contractor.<br>• Labour camps are provided with canteen systems. They shall be provided with treated water suitable for drinking, bathing and other needs. | • Applicable permit/license copies<br>• Site inspection<br>• EHS audit reports | Contractor | GC / Maha Metro |
| 35 | Loading / unloading of construction material | Air | Loading & unloading of construction material will generate fugitive dust | • The traffic management plan will be stringently implemented with regular monitoring and inspections.<br>• The trucks/dumpers carrying the material will be covered using tarpaulin/similar covering materials.<br>• Fugitive dust could be controlled using water sprinkling. Contractors should carry out water sprinkling.<br>• Truck tyres 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. Used water shall be collected and re-used after settling in a settling basin or tank.<br>• Water for sprinkling and tyre washing will be sourced from treated effluent from ETPs located nearby, or surface runoff. | • Air Quality Monitoring reports<br>• Site inspection records<br>• EHS register | Contractor | GC / Maha Metro |
| | | Noise | Loading & unloading of construction material will generate noise | • The RM storage yard will be separately built and enclosed from all sides. This will reduce noise generation at site.<br>• Concrete preparation will only take place in casting yards (away from habitation).<br>• 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. | • Noise Monitoring reports<br>• Community Awareness campaign records | Contractor | GC / Maha Metro |

| Sr. No | Activity | Aspect / Parameter affected | Impact | Mitigation Measures | Performance Indicator | Responsibility | |
|---|---|---|---|---|---|---|---|
| | | | | | | Implementation | Supervision |
| | | | | • 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. | • Cement and sand will be stacked under tarpaulin and secured by GI sheet barricading (working & wind break). Shorter work shifts and regular health check-ups 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. | • Air quality Monitoring reports | Contractor | GC / Maha Metro |
| 36 | Use of batching plant | Air | Loading & unloading of construction material into batching plant will generate fugitive dust | • High GI sheet screens and water sprinkling will be employed.<br>• Batching plant / casting yard shall be barricaded and made as a compulsory PPE zone. This will effectively reduce the fugitive dust generation. | • Air Quality monitoring reports | Contractor | GC / Maha Metro |
| | | Noise | Operation of batching plant will generate noise | • GI sheet barricading around batching area and worker PPE like ear muffs will be used.<br>• Batching plant / casting yard shall be barricaded and made as a compulsory PPE zone. This will reduce the impacts of noise generation. | • Noise Monitoring report<br>• Physical verification of Worker PPE | Contractor | GC / Maha Metro |
| | | Soil and Groundwater | Runoff of waste can contaminate soil and groundwater | • Contractor to collect baseline soil and groundwater quality data prior to operate the plants.<br>• Municipal water will be used. In view of fragile groundwater status, extraction will be avoided.<br>• The construction sites will be provided with drains with intercepting pits in which the cement and sand will settle. After settling it shall be discharged into public sewers; it will be treated by municipal agencies to Environment Protection Rules (EPR) 1986 Schedule VI standards of discharge of general effluents into surface water.<br>• Soil and Groundwater quality monitoring.<br>• 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. | • Ground Water quality Monitoring reports | Contractor | GC / Maha Metro |
| | | Hazardous waste | Health impacts and soil and groundwater pollution from hazardous water at | • The use and storage of hazardous materials at the casting yard and batching plant should adhere to SPCB requirements. | • License (Consent to Establish / Consent to Operate) from MPCB | Contractor | GC / Maha Metro |

| Sr. No | Activity | Aspect / Parameter affected | Impact | Mitigation Measures | Performance Indicator | Responsibility | |
|---|---|---|---|---|---|---|---|
| | | | | | | Implementation | Supervision |
| | | | batching/casting yards | • The transport, handling and storage of hazardous waste will be done in accordance with the provisions of Hazardous and Other Wastes (Management and Transboundary Movement) Amendment Rules 2019. Hazardous wastes from construction activity and equipment are labelled, recorded, stored in impermeable containment and for periods not exceeding mandated periods and, in a manner, suitable for handling storage and transport.<br>• The contractor shall maintain a record of sale, transfer, storage of hazardous waste and make these records available for inspection.<br>• The contractor shall get Authorized Recyclers to transport and dispose Hazardous Waste.<br>• Proper collection and storage facilities will be provided especially for hazardous waste. | • Hazardous Waste Management Plan<br>• Waste management register | | |
| | | Resources | If the batching plant will get its power from DG sets, substantial diesel will be consumed.<br>(A 30 $m^3$/hr. batching plant will require approx. 60 KW/hr. (or, approx. 75 KVA, assuming PF = 0.8) energy. In most cases the Contractor has used DG sets (from 100 – 250 kVA) for batching plant & ancillary facilities. Thus, the diesel req. will range from 30 - 45L/hr, at 100% load) | • As a primary source, power from the grid shall be used with prior permission from power supply company obtained by the Contractor.<br>• 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).<br>• 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.<br>• Diesel storage if done beyond threshold limit (1000 L) permission should be obtained from Chief Controller of Explosives. Diesel should be stored on pukka platforms and spillages should be avoided.<br>• Refer to Activity 42 “Use of DG sets” and Activity 44 “Storage of Diesel” for further measures. | | Contractor | GC / Maha Metro |
| 37 | Casting of segments and I-beams | Groundwater | Casting will require use of water | • 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 settling it shall be discharged into public sewers; it will be treated by municipal agencies to Environment Protection Rules (EPR) 1986 Schedule VI standards of discharge of general effluents into | • R-CGWA permits<br>• Ground water quality monitoring records | Contractor | GC / Maha Metro |

| Sr. No | Activity | Aspect / Parameter affected | Impact | Mitigation Measures | Performance Indicator | Responsibility | |
|---|---|---|---|---|---|---|---|
| | | | | | | Implementation | Supervision |
| | | | | surface water.<br>• Groundwater quality monitoring. | | | |
| | | Resources | Casting (incl. operation of gantry and hydraulic pre-stressing units) will consume lot of energy | • Pre-stressing and casting are basic requirements. However, whenever possible of the power should be drawn from approved lines, not from DG sets. | • Physical Verification | Contractor | GC / Maha Metro |
| 38 | Curing of segments & I-beams | Groundwater | Curing will require a significant amount of water | • Garland drainage is proposed to be constructed around the construction yard. This will intercept the runoff generated from site. Stagnation of water (and resultant vector propagation) should be avoided.<br>• Groundwater quality monitoring.<br>• After precipitation, it shall be discharged into public sewers; it will be treated by municipal agencies to EPR 1986 standards of discharge of general effluents into surface water.<br>• Groundwater will not be used. Water will be sourced from municipal supply, surface runoff or water from dewatering. | • Site inspection<br>• Ground Water quality Monitoring reports | Contractor | GC / Maha Metro |
| 39 | Use of DG sets | Air | Emission of NOx, SOx, CO, $PM_{10}$, $PM_{2.5}$ from DG sets will create air pollution problems | • Primary power source will be power distribution company; DG sets will be used only for power back-ups for stations.<br>• The required permissions from local Environmental Authorities / MPCB 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.<br>• Stack height of DG sets will be as per CPCB requirement [stack ht. = 0.2*(rating in kVA)0.5]<br>• Stack monitoring of the criteria pollutants will be conducted monthly, if the DG set id operated regularly.<br>• Compliance monitoring will be done to the regularly and check the monitoring instruments.<br>• Fuels used for DG will be High Speed Diesel with low-sulphur content. | • Ambient Air quality and DG set stack monitoring reports | Contractor | GC / Maha Metro |

| Sr. No | Activity | Aspect / Parameter affected | Impact | Mitigation Measures | Performance Indicator | Responsibility | |
|---|---|---|---|---|---|---|---|
| | | | | | | Implementation | Supervision |
| | | Noise & Vibration | Noise & vibration will be generated from the use of DG sets | • DG sets compliant with CPCB norms will be used.<br>• Monitoring required during construction, including field observations and measurements.<br>• DG sets will be enclosed type, with noise levels approx. 75 dB (A) at a distance of 1m in compliance with GSR 371(E) dt. 17-05-2002.<br>• Noise will be controlled using acoustic enclosure.<br>• The DG sets will be mounted on damping skids, which will reduce the vibration generated from DG sets. | • Noise and Vibration Monitoring reports | Contractor | GC / Maha Metro |
| | | Resources | DG sets will consume Diesel (and in effect reduce the levels of a non-renewable resource) | • DG sets will be used as a power back up, and not the primary sources of power. This should be made mandatory for all Contractors.<br>• Refer to Activity 42 “Storage of Diesel” for further measures. | • Site inspection<br>• Monthly- Diesel consumption records | Contractor | GC / Maha Metro |
| | | Aesthetics | Operation of DG sets will cause an aesthetic issue | • Enclosures will be used to keep them off from public views.<br>• PM content of DG sets smoke will be as pert the CPCB norms, thus the DG will emit dark smokes only during start-up & shut-down (b) Noise will be controlled using acoustic enclosure. | • DG stack monitoring reports | Contractor | GC / Maha Metro |
| 46 | All Construction Activities | Environment | Construction and Demolition (C&D) waste results from land clearing, excavation, construction, demolition, remodelling and repair of structures, roads and utilities | • Records of movement and loading/unloading of C&D waste and records of waste loaded by vendors.<br>• 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.<br>• The contractor will segregate and temporarily store the C&D waste till the vendor takes it away for recycling and disposal at authorized facilities.<br>• Provision given in Annexure-10B shall be followed by Contractor at all times during construction stage<br>• Contractor will adhere with the C&D Waste Management Rules.<br>• Management and storage of fuel, waste oil, and hazardous substances will be planned in accordance with the World Bank Group’s Environmental, Health and Safety General Guidelines on Hazardous Materials Management. This includes the use of appropriate secondary containment structures capable of containing the | • Waste management register<br>• Site inspection records | Contractor | GC / Maha Metro |

| Sr. No | Activity | Aspect / Parameter affected | Impact | Mitigation Measures | Performance Indicator | Responsibility | |
|---|---|---|---|---|---|---|---|
| | | | | | | Implementation | Supervision |
| | | | | larger of 110 % of the largest tank or 25% of the combined tank volumes in areas with above-ground tanks with a total storage volume equal or greater than 1,000 litres. Fuel storage tanks need to be placed under roofs and on concrete slabs with berms or dikes to contain spills in a secured covered area.<br>• Spill clean-up equipment (e.g., absorbent pads, etc.) specifically designed for petroleum products and other hazardous substances will be maintained on-site. Should any accidental spills occur, immediate clean-up will be undertaken, and all clean-up materials will be stored in a secure area for further disposal. Disposal of such will be undertaken by a waste management company contracted by the Contractors. The waste management company must have the required licenses to transport and dispose of any hazardous waste before any such waste is removed from the site. The Contractors will keep copies of the company's licenses and provide waste transfer manifests at their camp site for routine inspection by the engineer. | | | |
| | | Occupational Health and Safety | Accidents<br>All parties' reputation | • 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 labour.<br>• Contractor shall report significant environmental incidents to Maha Metro Pune / GC within 8 hrs. of the event and shall take necessary measures to rectify it as soon as possible.<br>• Contractor will provide regular training and 'tool box talks' to ensure workers safety.<br>• 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)<br>• Provision of PPE for workers especially working at heights or near water bodies in accordance with GIP | • EHS reports<br>• Accident/Incident records<br>• Worker safety training records<br>• Tool Box talk records<br>• Site Health and safety Plan<br>• Labour Audit records. | Contractor | GC / Maha Metro |

| Sr. No | Activity | Aspect / Parameter affected | Impact | Mitigation Measures | Performance Indicator | Responsibility | |
|---|---|---|---|---|---|---|---|
| | | | | | | Implementation | Supervision |
| | | | | health and safety regulations and requirements. This will include the provision of (as needed): life jackets, safety boots, helmets, gloves, protective clothing, respirators, goggles, earplugs, harnesses etc.<br>• Training will be regularly provided to workers on Occupational Health and Safety and work hazards including extreme climatic conditions, drowning, physical injury etc. Regular meetings with workers will be held and recorded.<br>• Occupational health and safety matters will be given a high degree of publicity to all work personnel and posters will be displayed prominently at construction sites.<br>• All workers will be given basic training in sanitation, general health and safety matters, and work hazards. An awareness program for HIV/AIDS and other communicable diseases will be implemented for workers and the local communities.<br>• Provide personal protection equipment to workers as needed, e.g. safety boots, helmets, gloves, protective clothing, goggles, ear protection.<br>• Core labour standards will be implemented. Civil works contracts will stipulate priorities to: (i) employ local people for works; (ii) ensure equal opportunities for women and men; (iii) pay equal wages for work of equal value and pay women's wages directly to them; and (iv) not employ child or forced labour. Specific targets for employment have been included in the project gender action plan. | | | |
| 47 | Storage of Diesel | Health & safety | Diesel spillage (from underground or above ground storage facility) will affect groundwater quality adversely | • Before it percolates into the groundwater, contaminated runoff water can be run through adsorbents such as polymer slurry to remove the diesel. The diesel will be quickly collected into steel trays and disposed to authorized recyclers.<br>• All bulk diesel tanks shall be properly supported in an elevated position to facilitate gravity discharge.<br>• Spillage will be controlled using methods mentioned in the environmental contingency plan, to be included in the emergency response plan.<br>• Groundwater quality monitoring before installation of the tanks and after demobilization. | • Daily Site inspection reports with photos<br>• Spill prevention and control plan<br>• Ground Water quality Monitoring reports | Contractor | GC / Maha Metro |

| Sr. No | Activity | Aspect / Parameter affected | Impact | Mitigation Measures | Performance Indicator | Responsibility | |
|---|---|---|---|---|---|---|---|
| | | | | | | Implementation | Supervision |
| | | | Storage of Diesel will attract the provisions of Hazardous Chemicals (Management & Handling) Rules and Petroleum Rules; as amended to date. It could cause serious damage to health & safety of workers / property if ignited | • Proper onsite emergency plan will be prepared and will be approved through Maha Metro.<br>• 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).<br>• A registry of all activities that involve the handling of potentially hazardous substances will be developed, including protocols for the storage, handling and spill response.<br>• All chemicals, toxic, hazardous, and harmful materials will be transported in spill-proof tanks with filling hoses and nozzles in working order.<br>• All chemicals, toxic, hazardous, and harmful materials will be stored in secure areas with impermeable surfaces and protective dikes such that spillage or leakage will be contained from affecting soil, surface water or groundwater systems. The area should be a 110% volume of storage capacity. Their usage will be strictly monitored and recorded.<br>• Good housekeeping procedures will be established to avoid the risk of spills.<br>• Spills will be dealt with immediately, and personnel will be trained and tasked with this responsibility.<br>• Workers will be properly trained before handling hazardous wastes and have the required protective equipment. | • Onsite Emergency Plan<br>• Hazardous/Non-hazardous Material register<br>• Hazard/non-hazardous material storage handling and management plan.<br>• Daily site inspection reports. | Contractor | GC / Maha Metro |
| 48 | Clean-up Operations, Restoration and Rehabilitation | Environment | Aesthetics | • 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. | • Site Inspection records | Contractor | GC / Maha Metro |
| 49 | Labour Camps providing safe habitation to workers | Social | Social | • Providing hygienic conditions in Labour camps and adequate housekeeping in Labour camps<br>• Contractor shall make sufficient arrangements to provide safe habitation to workers<br>• Secluded sanitary facilities shall be provided for female laborers working onsite | | Contractor, Maha Metro | Maha Metro /GC |

| Sr. No | Activity | Aspect / Parameter affected | Impact | Mitigation Measures | Performance Indicator | Responsibility | |
|---|---|---|---|---|---|---|---|
| | | | | | | Implementation | Supervision |
| 50 | Sanitation, Sewerage and waste disposal | Social | Social | • Authorized agencies shall be deployed for disposal of sewage and other solid waste generated at worker camps and construction sites | • Site Inspection records | Contractor, Maha Metro | Maha Metro /GC |
| 51 | Traffic management | Social | Social | • Avoid and minimize inconvenience to public due to congestion and traffic jams during construction | | Contractor, Maha Metro | Maha Metro /GC |
| **Operation Phase** | | | | | | | |
| 52 | 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. | • 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, if required. 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.<br>• Since the rakes will be air conditioned and enclosed from all side, the impacts of noise on the travellers will be nominal.<br>• Noise barriers will be installed at sensitive receptor locations based on final design noise prediction analysis, if required.<br>• Wherever baseline noise already exceeds the standards, only 3dB of noise increase is allowed. If baseline noise is below the CPCB and IFC-EHS standards, the operation noise has to meet these standards that is, operation noise level has to be less than level prescribed in these standards.<br>• The mitigations suggested based on the detailed noise and vibration analysis carried out prior to commencement of construction, should be strictly followed.<br>• Detailed vibration modelling is needed if sensitive receptors are located within the reported distances from the track in order to determine if the negative impacts can be fully mitigated through the following mitigation measures:<br>• Ballasted tie-welded track with elastic steel fastenings and plastic or rubber absorbing pad will reduce noise and vibration levels. Surface irregularities on the wheel and rail will be minimized | • Noise and Vibration monitoring report<br>• Building condition Survey reports | Maha-Metro through Third-Party Agency for Noise & Vibration Monitoring | Maha Metro |

| Sr. No | Activity | Aspect / Parameter affected | Impact | Mitigation Measures | Performance Indicator | Responsibility | |
|---|---|---|---|---|---|---|---|
| | | | | | | Implementation | Supervision |
| | | | | by good maintenance of wheel and rail condition.<br>• 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 will be installed to reduce transmission of vibration from the track and superstructure.<br>• Using floating slab and high resilience fasteners to reduce the vibration at the point of emission.<br>• Vibration monitoring and building condition surveys is required to determine if there are negative impacts and annoyance post mitigation implementation. | | | |
| | | Health and Safety | Accidents<br>Reputational risks | • 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.<br>• The Metro system as a complete vehicle (trains, signalling & 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 etc. EMC requirements of international standards for whole railway system to the outside world shall comply with EN50121-2.<br>• Automatic Train Protection and Automatic Train Supervision sub-systems will be installed to provide a high level of safety.<br>• CCTV system will be installed for local and centralized monitor of operation.<br>• 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.<br>• Emergency team, ambulance, contact number and hospital should be available. Emergency response plan should be implemented during operation periods. | • Site EHS register<br>• Incident/Accident records<br>• Site inspection / Physical Verification | O & M -Maha Metro | Maha Metro |

| Sr. No | Activity | Aspect / Parameter affected | Impact | Mitigation Measures | Performance Indicator | Responsibility | |
|---|---|---|---|---|---|---|---|
| | | | | | | Implementation | Supervision |
| | | | Operating Personnel Health risks | • Operating staff such as drivers and Control Centre staff shall be administered regular medical check-ups for musculo-skeletal disorders, fatigue, eye strain.<br>• Well-designed workstations, lighting in Control Centre.<br>• Emotional resilience training, counselling for recovery and rehabilitation. | • Medical records at site | O & M -Maha Metro | Maha Metro |
| | | Health of metro staff and commuters | Severely contagious diseases such as Covid-19 can impact health of staff thereby affecting operations; can cause economic loss to the country and loss of reputation to the project. | • National Covid-19 SOP shall be implemented; staff shall be trained; staff and commuters shall be informed of precautions such as social distancing, sanitizing; arrangements for stationary and hand-held thermal scanners; provision of sanitizer pedestals, vending machines of face masks and gloves etc. shall be provided in stations; site record of Covid-19 hospitals; daily disinfection of operating rooms, circulation spaces, equipment and vehicles; protected ambulances at stations. | • Covid-19 SOP | O & M -Maha Metro | Maha Metro |
| | | Aesthetics | Metro rail will increase the aesthetics of Pune | • A proper housekeeping routine will be followed to enhance the aesthetics of metro rail station. | | O & M -Maha Metro | Maha Metro |
| 53 | Track repair | Environment | Spill accidents | • Maha Metro to ensure no illegal disposal of solid waste or wastewater. | • Site EHS records/inspection | O & M -Maha Metro | |
| 54 | Use of DG sets | Air | Emission from DG sets will create air pollution problems | • DG sets compliant with CPCB norms will be used. Monitoring of air quality shall be done as per CPCB norms. Compliance monitoring will be undertaken as specified in the EMoP.<br>• Fuel used for DG sets will have a low-sulphur content | • Dg stack monitoring report | O & M -Maha Metro | Maha Metro |
| | | Noise & Vibration | Noise & vibration will be generated from the use of DG sets | • DG sets compliant with CPCB norms will be used.<br>• Noise enclosures will be used and will comply with GSR 371(E) dt. 17-05-2002.<br>• Wherever baseline noise already exceeds the standards, only 3dB of noise increase is allowed. If baseline noise is below the CPCB and IFC-EHS standards, the operation noise has to meet these standards that is, noise level has to be less than level prescribed in these standards.<br>• The DG sets will be mounted on damping skids, which will reduce the vibration generated from the use of the DG sets. | • Noise and monitoring reports | O & M -Maha Metro | Maha Metro |

| Sr. No | Activity | Aspect / Parameter affected | Impact | Mitigation Measures | Performance Indicator | Responsibility | |
|---|---|---|---|---|---|---|---|
| | | | | | | Implementation | Supervision |
| | | Groundwater | Diesel spillage (from underground or above ground storage facility) will affect groundwater quality adversely. | • Storage of diesel shall be done in designated areas paved with concrete floors and with an arrangement of oil interceptors to prevent oil entering the groundwater.<br>• Precautions shall be taken to avoid any spillage of diesel.<br>• Oil that is mixed in water will be removed in the ETP operated by municipal authorities or by other approved methods to EPR 1986 standards before disposal into surface- or ground-water | • Site inspection reports with photographs<br>• Hazardous material storage, handling and Management Plan | O & M -Maha Metro | Maha Metro |
| | | 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 | • Diesel should be stored in designated sites prior to final disposal.<br>• If the diesel storage crosses the threshold limits permissions from Chief Controller of Explosives (CCoE), proper fire protection norms shall be undertaken as per National Building Code, 2005.<br>• Proper onsite emergency plan will be prepared by GC and will be approved through Maha Metro. | | O & M -Maha Metro | Maha Metro |
| | | Resources | DG sets will consume Diesel (and in effect reduce the levels of a non-renewable resource) | • DG sets compliant with CPCB norms will be used only as backup. | • DG set stack monitoring reports | O & M -Maha Metro | |
| | | Aesthetics | Operation of DG sets will cause an aesthetic issue | • Enclosures for DG Sets will be used. | • Site inspection records | O & M -Maha Metro | Maha Metro |
| 55 | 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 | • Maha Metro 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. | • Metro feeder operating records | O & M -Maha Metro | Maha Metro |
| | | Health & safety | Better & frequent transport system will reduce risk of traffic accidents | • The new feeder routes should:<br>• follow proper timetable;<br>• should have frequent services during the morning & evening peak;<br>• should have a limited carrying capacity.<br>• The feeder buses should arrive and depart from designated bus bays or similar structures. Proper | • Site inspect records | O & M -Maha Metro | Maha Metro |

| Sr. No | Activity | Aspect / Parameter affected | Impact | Mitigation Measures | Performance Indicator | Responsibility | |
|---|---|---|---|---|---|---|---|
| | | | | | | Implementation | Supervision |
| | | | | arrangements for road crossing should be established.<br>• The appointed personnel should assist passengers to reach their destinations. An easily accessible grievance Redressal system should be established by Maha Metro. | | | |
| | | Aesthetics | Better designed coaches will enhance ride pleasure and aesthetics | • The buses should be properly maintained from time to time in order to enhance the aesthetic value. | • Inspection records. | O & M -Maha Metro | Maha Metro |
| 56 | Generation of employment | Social | The proposed project will result into generation of employment | • 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. | • Interview with workers under indirect employment. HR records for direct employment. | O & M -Maha Metro | Maha Metro |
| 57 | Ancillary development along metro routes | Land | Ancillary developments will take place along with metro | • 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. | • TOD plan | O & M -Maha Metro | |
| | | Social | Ancillary development along the metro alignment will have positive effect on the social environment | • There should be positive participation of the common people in the ancillary development process. An open, transparent & people-centric outlook has to be adopted. | • Any record of meetings / consultations. | O & M -Maha Metro | Maha Metro |
| 58 | Children & Women | Social | | • Priority seating for pregnant women and elderly citizens will be provided in the coaches.<br>• Emergency intercom and video surveillance shall be part of metro operating system<br>• Separate toilets for men and women at stations shall be provided;<br>• Patrolling of platforms after sunset hours by security personnel shall be ensured<br>• Lady security personnel to be deployed for frisking women passengers;<br>• Proactively encourage and promote women's employment in the metro services sector<br>• Secluded sanitary facilities shall be provided for women workers working onsite | | Maha Metro /GC | Maha Metro |
| 59 | Elderly and Persons with Disability | Social | | • It will be ensured that station operations shall be easy to understand and operate for persons with learning disabilities, intellectual disabilities, and elderly persons | | Maha Metro /GC | Maha Metro/PMRP |

| Sr. No | Activity | Aspect / Parameter affected | Impact | Mitigation Measures | Performance Indicator | Responsibility | |
|---|---|---|---|---|---|---|---|
| | | | | | | Implementation | Supervision |
| | | | | • Braille buttons and audio announcement system shall be ensured for persons with vision impairments<br>• Information or help desks shall be close to the station entrance, and highly visible upon entering the station<br>• Staff managing the counters shall know sign language and lighting shall be positioned to illuminate the receptionist/person managing the counter | | | |

*Note: This ESMP Matrix will form part of the contract document together with Maha Metro's SHE Manual for all contractors. This ESMP has been aligned with the SHE Manual wherever possible.*

## E. ESMP BUDGET

668. Mitigation measures proposed in the ESMP will be implemented by the Contractor. The budgetary provisions for the implementation of the environmental management plan of Swargate to Katraj (Phase-1 Extension) are presented in **Table 9-3**

*Table 9-3 Summary of ESMP Budget for Swargate to Katraj (Phase-1 Extension)*

| Sr. No. | Item | Estimated Total Cost (₹) |
|---|---|---|
| 1. | Compensatory Plantation of 1750 trees in lieu of 175 affected trees (as per the PMC Tree Authority guidelines rate in 1:10 ratio) | 1,75,00,000 |
| 2. | Rainwater Harvesting | 50,00,000 |
| 3. | Environmental Monitoring | 2,20,45,000 |
| 4. | Training and Capacity building | 15,00,000 |
| 5. | R&R and RP | 32,90,00,000 |
| 6. | Public Consultation | 10,00,000 |
| **Total ESMP Cost for Swargate to Katraj (Phase-1 Extension)** | | **37,60,45,000** |

Thus, cost of ESMP for Swargate to Katraj works out to be around ₹ 376.05 million

## F. DEVELOPMENT AND IMPLEMENTATION OF SUB-PLANS

669. As part of the Construction phase EMP, the contractors need to develop various sub-plans as discussed in the ESMP (item 4 to 13 during pre-construction stage) and in the ESHS system requirements as described in Maha Metro's Health and Safety Manual (**Annexure-7**). These plans are aimed at good environmental management practices and serve as guide documents. While the relevant impacts have been adequately assessed in this ESIA, further topic or location specific information from the contractor will be needed to complete these plans which is not available for inclusion in the main ESMP at the time of approval. These sub-plans will form part of Construction phase ESMP, and be consistent with the contractor's SHE Plan to be included in the bid documents. Some of the key plans to be developed by the contractor and the party responsible for its approval, is summarised in **Table 9-4**:**.**

*Table 9-4: Contractors' Sub-plans and Approval Requirements*

| Sr. No. | Plan | Description | Approvals / NoC | | |
|---|---|---|---|---|---|
| | | | PIU | GC | MDBs |
| 1. | Work plan for securing all permits and approvals | The plan will list all necessary permits, approvals and/ or consent including the responsible authorities and the timeframe of obtaining them. | Yes | Yes | No |
| 2. | Construction and Labour Camp Management Plan | The plan will provide a layout map of the construction sites and campsite and clearly show the access road, entry and exit and different facilities inside the camp. Facilities inside the camp may include contractor's office, residential quarters, toilets, health center, construction plants, storage areas etc. The plan will include information on waste management, supply of water for drinking and bathing, waste water and drainage management, traffic movement routes etc. | Yes | Yes | No |
| 3. | Site and Labour Camp Restoration Plan | Describes the clean-up and restoration operations to be implemented by the Contractor prior to demobilization including clearance of all temporary structures, disposal of all garbage, night soils and petroleum, oil and lubricants wastes and filling and sealing of all disposal pits or trenches. | Yes | Yes | Yes |
| 4. | Muck Disposal and Re-use Plan | The plan shall describe sources of muck generation (piling work for viaducts etc.), type and quantity of muck generated from various sources, use of muck generated, method collection and transportation, transportation routes, disposal site location and design, approvals required for disposal sites, and treatment methods. Recommendations provided in the ESIA must be considered.<br>Identifies muck generation from TBM tunneling, station box excavation, and ancillary works. Specifies type/quantity, collection, reuse potential (backfilling, road works, land | Yes | Yes | Yes |

| | | | | | |
|---|---|---|---|---|---|
| | | reclamation), transport routes, storage, and approved disposal sites. | | | |
| 5. | Waste Management Plan | The plan shall describe waste streams and amounts, describe recycling/reuse methods for each material, identify the waste destinations and transport modes, including what materials are being segregated on site for reuse or recycling, specify responsibilities for managing and disposal of waste. Describe special measures for material use and handling. Describe communication and training to support and encourage participation from everyone on site. Recommendations provided in the ESIA must be considered. | Yes | Yes | No |
| 6. | Traffic Management Plan | The plan shall be designed to ensure that traffic congestion and traffic safety impacts due to construction activities and movement of construction vehicles, haulage trucks, and equipment is minimized. The plan shall be prepared in consultation with traffic officials. The plan shall identify traffic diversion and management issues, haul road network plan, traffic schedules, traffic arrangements showing all detours/lane diversions, modifications to signaling at intersections, necessary barricades, warning/advisory signs, road signs, lighting, and other provisions to ensure that adequate and safe access is provided to motorists and other road users in the affected areas. Pre-construction access road surveys will also form part of the TMP. The plan shall also include locations for pedestrian crossings and conditions for the management of these crossings, including the use of flagmen. | Yes | Yes | No |
| 7. | Occupational and Community Health and Safety Plan | Consistent with international standards (e.g., World Bank Group Environmental, Health, and Safety Guidelines, 2007) and Labour Code of India. The Plan shall address health and safety hazards associated with construction activities (e.g., excavations, piling, etc.), use of heavy equipment, transport of materials and other hazards associated with various construction activities and shall provide links to existing government health programs. The plan will also include a Covid-19 response and management plan. The document to be read together with the Camp Management Plan. Recommendations provided in the ESIA must be considered. | Yes | Yes | Yes |
| 8. | Labour and Working Conditions Management Plan (**Annexure-10 A** Outline for Labour Management Plan) | This will include: policy / legal framework information (including labour and OHS requirements of National legislation, ADB SPS 2009, EIB standards), workforce induction and information on rights, child and forced labor, equal opportunity, migrant workers, promotion of local employment opportunities, labor union, worker accommodation requirements, provision for retrenchment plans, workforce grievance mechanism, security personnel (Voluntary Principles on Security and Human Rights), etc. Contractor needs to ensure that the core labor requirements are cascaded down across the entire contracting chains, including sub-contractors and suppliers of core materials. The plan shall also comply with IFC Guidance Note "Workers' accommodation: processes and standards". | Yes | Yes | Yes |
| 9. | Code of Conduct | The Contractor shall prepare a Code of Conduct that outlines camp rules articulating acceptable behaviors of the workforce with local communities. Associated induction training will be provided to ensure rules are well understood and enforced. | Yes | Yes | Yes |
| 10. | Emergency Response Plan | This plan shall prescribe measures to prevent, mitigate, respond to and recover from emergency events that could occur due to project activities such as accidents, spills of hazardous substances, fire, extreme weather events, and others; measures to prevent, mitigate, respond to and recover from emergency events that could occur due to project activities such as accidents, release of toxic gas, spills of hazardous substances, fire, floods, earthquakes, etc. | Yes | Yes | No |
| 11. | Construction Vibration and Noise Management Plan | Detailed procedures will be established for vibration surveys, monitoring, and control. These will include condition surveys for all sensitive receptors identified in the ESIA, defined measurement locations and methods, and methodology statements for vibration-inducing activities. Trial construction | Yes | Yes | Yes |

| | | | | | |
|---|---|---|---|---|---|
| | | sections will be carried out to determine expected vibration levels at specified distances from the source, providing sufficient detail for the contractor to finalize construction methods that avoid excessive vibration. The procedures will also include descriptions of the instrumentation and equipment to be used, instruction manuals, calibration and certification records, and resumes of technical personnel demonstrating relevant experience. Protocols for data collection, analysis, measurement frequency, threshold warnings, and Action Plans will be defined, including positive measures by the contractor to switch to alternative low-vibration construction techniques if needed. In parallel, noise monitoring and control procedures will be rigorously implemented. These will involve baseline ambient noise assessments and selection of monitoring locations near sensitive receptors such as hospitals, schools, and residential areas. Measurements will follow international standards using calibrated sound level meters and dosimeters, with equipment specifications and certifications provided. Noise modeling will guide prediction of exceedances, and methodology statements for high-noise activities like piling, concrete breaking, and machinery use will support controlled execution. Protocols will be defined for data collection, analysis, and monitoring frequency for both day and night periods. Thresholds will align with applicable regulations, with alert systems in place for exceedances. Noise Action Plans will include mitigation such as quieter equipment, acoustic barriers, and optimized scheduling to reduce impact. The aim is to ensure construction proceeds with minimal disruption to surrounding communities through effective monitoring and timely response.<br>Covers monitoring/control of vibration and noise from TBM tunneling, blasting (if any), piling, and excavation near sensitive receptors. | | | |
| 12. | Construction Water Management Plan | Plan to describe the water sources, required permits and ways to minimize water wastage | Yes | Yes | No |
| 13. | Utility shifting and restoration plan | Plan to describe temporary or permanent diversions of utility services in order to secure that utility services remain operational during the entire construction period and after completion of project. | Yes | Yes | No |
| 14 | Stakeholder Engagement Plan | The Plan will outline the framework for identifying, informing, and engaging with project-affected communities and relevant stakeholders throughout the project lifecycle. It will include consultation schedules, methods of engagement, documentation protocols, and feedback incorporation mechanisms. The plan shall also provide for continued stakeholder engagement during implementation and operation phases. | Yes | Yes | No |
| 15 | Grievance Redress Mechanism for Workers and project affected families | The project will establish two separate grievance redress mechanisms: (i) one for workers, as part of the Labour Management Plan, to confidentially raise and resolve workplace-related complaints; and (ii) another for stakeholders and project-affected communities, as part of the Stakeholder Engagement Plan, to address concerns related to construction, environmental and social impacts. Each mechanism will outline clear processes for submission, response, resolution, escalation, and documentation. | Yes | Yes | No |
| 16 | Resettlement Action Plan (RAP) | The RAP outlines the process for identifying project-affected persons (PAPs), assessing involuntary resettlement and livelihood impacts, and ensuring timely compensation and assistance in line with applicable national laws (such as the RFCTLARR Act, 2013), the Maharashtra Direct Purchase Policy, and EIB's environmental and social standards. It includes a socio-economic survey and census of affected households, detailed entitlements, relocation and income restoration strategies, a grievance redress mechanism, implementation responsibilities, timelines, budget, and monitoring framework. All compensation and assistance will be provided before any displacement occurs. | Yes | Yes | Yes |

| | | | | | |
|---|---|---|---|---|---|
| 17 | Tunnel Drilling and TBM Operation Plan | Specific plan for safe TBM/tunneling operations: alignment monitoring, ground settlement control, ventilation, dust/gas monitoring, spoil handling, equipment maintenance, and safety protocols. | Yes | Yes | Yes |
| 18 | Underground Station Construction and Excavation Plan | Covers excavation of station boxes, cut-and-cover sections, structural supports, groundwater ingress management, and safety monitoring. | Yes | Yes | Yes |

## G. ENVIRONMENTAL MONITORING PLAN (EMOP)

670. Environmental Monitoring Plan (EMoP) is a companion document of the ESMP. The EMoP contains 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:

(i) Ensure that impacts do not exceed the established legal and project specific standards
(ii) Check the implementation of mitigation measures in the manner described in the ESIA report
(iii) Monitor implementation of the ESMP
(iv) Provide an early warning of potential environmental damage
(v) Check whether the proposed mitigation measures have been achieved the intended results, and or / other environmental impacts occurred

671. 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 9-5**.

*Table 9-5: ESMoP Swargate to Katraj (Phase-1 Extension)*

| Environmental Features | Aspect to be Monitored | Standard to be complied with | Time and Frequency of Monitoring | Location | Estimated Total Cost (₹) | Responsibility |
|---|---|---|---|---|---|---|
| **Pre-Construction stage** | | | | | | |
| Air | Emission of dust and particulate matter as PM2.5 and PM10, NOx and SOx, CO | GoI and WHO / IFC (most stringent) | Once, 24 hours continuously | Each station, batching plant and casting yard, Muck disposal site. | 3,15,000 | Contractor; monitored by MahaMetro / third-party auditor |
| 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 | GoI and WHO / IFC (most stringent) | Once, 1 sample each location | Groundwater at batching plant and casting yard, Muck disposal site, construction camps and 10 excavation sites. Surface water wherever waterbody located within 100m from sites. | 1,80,000 | Contractor; monitored by MahaMetro / third-party auditor |
| Soil | pH, Sulphate (SO3), Chloride, ORP, water Soluble salts, Organic Matter (Mineral Oil (GC)), Heavy metals, Poly-Aromatic Hydrocarbons (PAH), Moisture Content | GoI and WHO / IFC (most stringent) | Once, 1 sample each location | At batching plant and casting yard, Muck disposal site, construction camps. | 40,000 | Contractor; monitored by MahaMetro / third-party auditor |
| Noise & vibration | Noise levels in dB(A); Vibration PPV mm/s; Building condition survey | GoI and WHO/IFC most stringent / Federal Transit Administration (FTA) Guideline Standards or any other internally recognized standards | a) Once; b) Hourly basis for 24 hours (noise & vibration); c) Building Condition Survey: height measurements, crack survey, detailed photographic records etc. | a) At key structure locations; b) At receptors comprising educational, medical and physical cultural buildings and other fragile buildings located within recommended screening distance of 62m (for cat. 2) on either side of alignment. | 3,20,000 | Contractor (pre-construction survey); monitored by MahaMetro / third-party auditor |
| | | | | **Sub-Total (A)** | **8,55,000** | |
| **Construction stage** | | | | | | |
| Air | Emission of dust and particulate matter as PM2.5 and PM10, NOx and SOx, CO | GoI and WHO / IFC (most stringent) | 24 hours continuously every month; Continuous visual monitoring for dust | For each station until civil works completed, batching plant and casting yard, Muck disposal site, throughout construction phase (at each work-front site) | 1,15,20,000 | Contractor; monitored by MahaMetro / third-party auditor |

| | | | | | | |
|---|---|---|---|---|---|---|
| Water (Surface and Ground) | DO, Turbidity, Conductivity, pH, Heavy metals, TN, TP, E. Coli, TSS, Oil and Grease, VOCs (groundwater only) and TDS | GoI and WHO / IFC (most stringent) | Quarterly, 1 sample each location | Groundwater at batching plant and casting yard, Muck disposal site, construction camps throughout construction phase; Surface water at wherever waterbody located within 100m from sites | 21,60,000 | Contractor; monitored by MahaMetro / third-party auditor |
| Soil | PH, Sulphate (SO3), Chloride, ORP, water Soluble salts, Organic Matter (Oil), Heavy metals, PAH, Moisture Content | GoI and WHO / IFC (most stringent) | Quarterly, 1 sample each location | At batching plant and casting yard, Muck disposal site, construction camps throughout construction phase | 10,80,000 | Contractor; monitored by MahaMetro / third-party auditor |
| a) Noise, b) Vibration | a) Noise levels in dB(A); b) Vibration PPV mm/s | GoI and WHO / IFC (most stringent) / Federal Transit Administration (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 during piling (vibration); c) Pre-construction survey and post-construction re-check of structures | a) For each station (at work front site) until completion of civil works; b) At sensitive receptor locations; c) Tunnel monitoring throughout construction; d) Above-ground structures monitored from time to time and re-checked at end of construction | 10,80,000 | Contractor; monitored by MahaMetro / third-party auditor |
| 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 | 25,00,000 | Contractor; monitored by MahaMetro / third-party auditor |
| | | | | **Sub-Total (B)** | **1,83,40,000** | |
| **Operation Stage** | | | | | | |
| Air | Emission from DG sets (SPM, NOx and SOx), Odor | GoI and WHO / IFC (most stringent) | At least 2 times in a year for the first year, annually for next 3 years | DG sets of all stations | 14,00,000 | Operator / Contractor; monitored by MahaMetro / third-party auditor |
| Groundwater | DO, Turbidity, Conductivity, pH, Heavy metals, TP, TN, E.Coli, TSS, Oil and Grease, VOCs and TDS | GoI and WHO / IFC (most stringent) | At least 2 times in a year for the first year; once annually for next 3 years | Groundwater at / near construction sites and other construction plants / yards, etc. | 1,40,000 | Operator / Contractor; monitored by MahaMetro / third-party auditor |
| Noise | Noise levels in dB(A) | GoI and WHO / IFC (most stringent) | At least 2 times in a year for the first | Alignment, Stations, above-ground structures near to station entry-exit portals and Shaft openings | 2,80,000 | Operator / Contractor; monitored by MahaMetro / third-party auditor |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | year, annually for next 3 years | | | |
| Vibration | PPV mm/s | Federal Transit Administration (FTA) Guideline Standards or any other internally recognized standards | At least 2 times in a year for the first year, once annually for next 3 years | At receptors comprising educational, medical and physical cultural buildings (if any) and other fragile buildings located within recommended screening distance of 62m (for cat. 2) on either side of alignment | 2,80,000 | Operator / Contractor; monitored by MahaMetro / third-party auditor |
| Health and Safety | As specified in project ESMP and Maha Metro's SHE Manual | IFC General and Sector EHS Guidelines or any other internationally recognized guidelines | Monthly for 4 years | Station locations | 7,50,000 | SHE Officer / Contractor; monitored by MahaMetro / third-party auditor |
| | | | | **Sub-Total (C)** | **28,50,000** | - |
| | | | | **Grand Total (A + B + C)** | **2,20,45,000** | **-** |

Thus, the total EMoP Cost for Swargate to Katraj (PMRP Phase 1 extension) project works out to be around **₹ 22.05 million.**

## H. GENERAL CONDITIONS FOR E&S WELFARE

672. In addition to implementation of ESMP as outlined in **Table 9-2**: the Contractor is expected to comply with the general conditions outlined under various clauses of SHE Conditions (Volume 8). The general conditions and reference SHE clauses are listed here in **Table 9-6**:

*Table 9-6: General Conditions for Environment and Social Welfare*

| Sr. No. | General Condition | Responsibility |
|---|---|---|
| 1 | The Contractor as per Rule 69 of the MBOCW shall formulate a Safety & Health policy and get it approved by Chief Inspector and display it at conspicuous places at work sites in Hindi and Marathi i.e. languages understood by the majority of construction workers. | Corporate SHE Head / Project Manager |
| 2 | Contractor shall set the goals for environmental performance for certain periods of project duration and shall develop the plans to improve the performance and monitor it. | Corporate SHE Head / Project Manager / SHE Head |
| 3 | Contractor shall prepare the method statement for major activities which will be undertaken at sites. It should be ensured that environmental risk assessment should be done for every activity and suitable plan is developed to mitigate the impact. | Project Manager / SHE Head / Quality Head |
| 4 | Contractor shall ensure that designer (appointed by the Contractor) shall include / prepare designs in a way that minimize the risk to health and safety of those who are going to construct, maintain, clean, repair, dismantle or demolish the structures as well as anyone else like adjoining road users / general public, who might be affected by the work. | Project Manager / Designer / SHE Head |
| 5 | The Contractor shall appoint the required SHE personnel as prescribed in General Instruction of Maha Metro Pune based upon the statutory requirement and establish the safety organization based upon the Contract value. The minimum educational qualification and the work experience are given in General Instruction of Maha Metro Pune. | Corporate SHE Head / Project Manager / SHE Head |
| 6 | The Contractor shall ensure the formation, and monitor the functioning, of Contractor SHE committees. All employees should be able to participate in the making and monitoring of arrangements for safety, industrial health and environment at their place of work. | Corporate SHE Head / Project Manager / SHE Head |
| 7 | The Contractor shall ensure that all personnel working at the site receive an induction SHE training explaining 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. The training shall cover the contents as given in the General Instruction of Maha Metro Pune. | Corporate SHE Head/ Project Manager/SHE Head |
| 8 | The Contractor shall organize SHE training to engage managers, supervisors and other personnel in behavioural change and improve safety performance. The environmental training module shall be approved by Maha Metro Pune. | Corporate SHE Head / Project Manager / SHE Head |
| 9 | The Contractor shall evolve and administer a system of conducting environmental inspections twice in a month. Contractor key personnel including the project manager shall attend the site environmental inspections and necessary compliance shall be arranged for GC/ Maha Metro Pune observations. | Project Manager / SHE Head |
| 10 | Monthly environmental report shall be submitted by the contractor to GC / Maha Metro Pune on or before 10$^{th}$ of day of every month. The report shall track the progress in brief, compliance status of observations given by GC / Maha Metro Pune during site visits, general compliance with ESMP / EMP, monitoring records and other notable environmental issues related to site. The report shall include the demonstrative site photographs to highlight the issue. | Project Manager / SHE Head |
| 11 | Contractor shall develop the work permit system such that it considers the environmental aspects of major activities carried on site. | Project Manager / SHE Head |
| 12 | The Contractor shall take every effort to communicate the Environment management measures through posters campaigns / billboards / banners / glow signs being displayed around the work site as part of the effort to raise environmental/social awareness amongst the work force.<br>Posters should be in Hindi, English, and other suitable language as deemed appropriate. Posters / billboards / banners/ glow signs should be changed at | Project Manager / SHE Head |

| Sr. No. | General Condition | Responsibility |
|---|---|---|
| | least once in a month to maintain the impact.<br>The Contractor shall also observe important days as listed in General Instruction of Maha Metro Pune and printing and displaying safety signage and posters as listed in General Instruction of Maha Metro Pune. | |
| 13 | Contractor shall report significant environmental incidents to Maha Metro Pune / GC within 8 hrs. of the event and shall take necessary measures to rectify it as soon as possible. The environmental incident shall include but not be limited to excessive road soiling, excessive oil spills, excessive dust generation etc. | Project Manager / SHE Head |

## I. TRAINING AND CAPACITY BUILDING PROGRAMS

673. While Maha Metro has sufficient capacity to manage and monitor environmental aspects of metro projects, it is proposed to organize targeted training programs for officials from Maha Metro, the General Consultant (GC), and contractors' environment, health, and safety (EHS) teams. These sessions will focus on meeting the monitoring and reporting requirements of EIB. If an external monitor is appointed, they will also contribute to capacity-building efforts. The training content will be finalized in consultation with Maha Metro and EIB, and funds for these activities have been allocated in the Environmental and Social Management Plan (ESMP).

674. To strengthen environmental oversight, an Environmental Safeguards Specialist has been added to the Project Implementation Unit (PIU) to oversee compliance across all EIB-funded corridors. Maha Metro's core Environment Safeguards team will take overall responsibility for environmental management across corridors, supported during construction by dedicated environmental engineers assigned to each corridor. These engineers will work closely with safety, environmental, traffic, and labour welfare professionals from the General Consultant (GC). During the operational phase, the core team will continue monitoring the implementation of the ESMP through metro operations contractors. External environmental monitoring agencies will be engaged to ensure compliance with the Environmental Monitoring Plan (EMoP) during operations.

675. Comprehensive training and capacity-building programs were implemented for all site workers to ensure high standards of safety, efficiency, and technical competency. These initiatives focused on a range of key areas, including occupational health and safety, proper handling of construction equipment, environmental awareness, emergency response preparedness, and adherence to standard operating procedures. Special emphasis was placed on familiarizing workers with the specific challenges of working in urban, high-density environments, where coordination and precision are critical. The training sessions were conducted regularly and tailored to different worker roles, ensuring that both skilled and unskilled labourers received the knowledge necessary to perform their tasks effectively. By investing in continuous learning and skill enhancement, the project aimed to minimize accidents, maintain worksite discipline, and uphold the quality and timelines of metro construction activities.

676. The tentative schedule of the training programs for Environmental Engineers is as **Table 9-7**.

*Table 9-7: Tentative Schedule of the Training Programs for Environmental Engineers*

| Sr. No. | Particulars | Frequency | Agency |
|---|---|---|---|
| 1 | Awareness about principles, guidelines & compliance requirements of funding institutions | Quarterly | Third Party / GC |
| 2 | Monitoring & reporting of Environmental compliances during Construction and Operation Phases | Quarterly | Third Party through Contractor / GC |
| 3 | Safety, Health & Environment | As per the SHE Manual of Maha Metro | Contractor / GC |

# Chapter 10. CONCLUSION AND RECOMMANDATION

677. Alignment is not located in any protected area or near a site of historical / cultural significance. Some impact is anticipated due to cutting of about 175 public trees along existing roads.

678. Significant adverse impacts of `medium to high` risk and `likely to definite` likelihood are:
- (i) social impacts due to involuntary resettlement,
- (ii) loss of trees,
- (iii) utility diversion,
- (iv) air, noise, vibration, C&D waste (muck) disposal, labour safety, water demand,
- (v) likely climate vulnerability.

679. Measures to mitigate adverse impacts have been recommended.

680. After mitigation some residual impacts are expected, predominantly due to noise, vibration, visual intrusion and health and safety risks.

681. Benefits include reduced air pollution and road accidents, 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 alignments.

682. Existing Phase I Grievance Redress Mechanism (GRM) will help 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.

683. 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.

684. 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 applicable policies and standards.

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

686. Where unanticipated environmental impacts become apparent during project implementation, the borrower/client will update the environmental assessment and EMP or prepare a new environmental assessment and EMP to assess the potential impacts, evaluate the alternatives, and outline mitigation measures and resources to address those impacts

# Final ESIA-ESMP Report

# Annexures

## Swargate to Katraj

## (South Extension of Phase 1)




**MAHARASHTRA METRO RAIL CORPORATION LIMITED**

Pune Metro Rail Project, A2, A3 Block Civil Court Interchange Metro Station, Nyaymurti Ranade Path, Shivajinagar, Pune-411005, Maharashtra, Website: https://www.punemetrorail.org

## IND: Pune Metro Rail Project

## (October, 2025)

Prepared by **MITCON Consultancy & Engineering Services Limited** for **Maharashtra Metro Rail Corporation Limited, Pune Metro Rail Project (PMRP) Phase 1 Extension** under the Funding of **European Investment Bank (EIB)**

# LIST OF ANNEXURES


| | | |
|---|---|---|
| Annexure-1 | | NABET Certificate |
| Annexure-2 | | Ambient Air Quality and Noise Quality Analyses (Laboratory Reports) |
| Annexure-3 | | Water Quality Analyses (Laboratory Reports) |
| Annexure-4 | | Soil Quality Analyses (Laboratory Reports) |
| Annexure-5 | | Air Quality Modelling / Ground Level Concentrations (GLCs) Report |
| Annexure-6 | | List of Trees likely to be Affected |
| Annexure-7 | | Bidding documents for the design and construction of Swargate to Katraj project including Maha Metro's Safety, Health & Environment (SHE) Manual |
| Annexure-8 | | Terms of Reference (ToR) for External Monitoring Agency |
| Annexure-9 | | Guidelines/Tasks for GC in implementation of ESMP and EMoP |
| Annexure-10 | A | Guidelines for Site Selection and Management Plan |
| Annexure-10 | B | Muck Handling Plan |
| Annexure-11 | | Vibration Modelling Report |
| Annexure-12 | | List of Sensitive Receptors |
| Annexure-13 | | Public Consultation Report |
| Annexure-14 | | Noise Modelling Report |
| Annexure-15 | | Tunnel Worker Safety Assessment & Mitigation Plan |

# **Annexure-1:**

NABET Certificate - MITCON

भारतीय गुणवत्ता परिषद्
QUALITY COUNCIL® OF INDIA
QCI Creating an Ecosystem for Quality

NABET®

# National Accreditation Board for Education and Training

# Certificate of Accreditation

## MITCON Consultancy and Engineering Services Ltd., Pune

Agriculture College Campus, Next to DIC Office, Shivajinagar, Pune – 411005

*The organization is accredited as **Category-A** under the QCI-NABET **Scheme for Accreditation of EIA Consultant Organization, Version 3**: for preparing EIA/EMP reports in the following Sectors-*

| S. No | Sector Description | Sector (as per) | | Cat. |
|---|---|---|---|---|
| | | NABET | MoEFCC | |
| 1. | River Valley projects | 1 (c) | 3 | A |
| 2. | Thermal power plants | 1 (d) | 4 | A |
| 3. | Metallurgical industries (ferrous & non-ferrous) | 3 (a) | 8 | A |
| 4. | Petro-chemical complexes | 5 (c) | 18 | A |
| 5. | Synthetic organic chemicals industry | 5 (f) | 21 | A |
| 6. | Distilleries | 5 (g) | 22 | A |
| 7. | Sugar Industry | 5 (j) | 25 | B |
| 8. | Industrial estates/ parks/ complexes/areas, export processing Zones (EPZs), Special Economic Zones (SEZs), Biotech Parks, Leather Complexes | 7 (c) | 31 | A |
| 9. | Ports, harbours, break waters and dredging | 7 (e) | 33 | A |
| 10. | Highways, | 7 (f) | 34 | A |
| 11. | Common Effluent Treatment Plants (CETPs) | 7 (h) | 36 | B |
| 12. | Common Municipal Solid Waste Management Facility (CMSWMF) | 7 (i) | 37 | B |
| 13. | Building and construction projects | 8 (a) | 38 | B |
| 14. | Townships and Area development projects | 8 (b) | 39 | B |

***Note: Names of approved EIA Coordinators and Functional Area Experts are mentioned in RAAC minutes dated July 19, 2024 posted on QCI-NABET website.***

*The Accreditation shall remain in force subject to continued compliance to the terms and conditions mentioned in QCI-NABET's letter of accreditation bearing no QCI/NABET/ENV/ACO/24/3330 dated Aug 09, 2024. The accreditation needs to be renewed before the expiry date by MITCON Consultancy and Engineering Services Ltd., Pune following due process of assessment.*

**Issue Date**
**August 09, 2024**

**Valid up to**
**Feb 05, 2027**

**Mr. Ajay Kumar Jha**
**(Sr. Director, NABET)**

**Certificate No.**
**NABET/EIA/24-27/RA 0343**

**Prof (Dr) Varinder S Kanwar**
**(CEO NABET)**

*For the updated List of Accredited EIA Consultant Organizations with approved Sectors please refer to QCI-NABET website.*

# Annexure-2:

Ambient Air Quality and Noise Quality Analyses (Laboratory Reports)

**MITCON Consultancy & Engineering Services Ltd.**
Environment Management and Engineering Division
(Environmental Laboratory)
Agriculture College Campus, Next to DIC office, Shivaji Nagar, Pune. 411 005,
Ph. No. 66289405/400, email: emelab@mitconindia.com

- **ISO 45001:2018 Certified Laboratory.**
- **Recognized by MoEF & CC**

Solutions for Sustainable Tomorrow

Format No. EME/LAB/Format 7.8/TR

# Test Report

**Report Number:** MITCON/2024-25/August/7219

**Issue Date:** 14/08/2024

| Client's Name & Address | | |
|---|---|---|
| **M/s. Maharashtra Metro Rail Corporation Limited** | **Reference No.** | **MITCON/2024-25/August/7219/1** |
| | **Date of Monitoring** | **12/08/2024** |
| | **Date of Analysis** | **13/08/2024** |
| | **Product Group** | **Atmospheric Pollution** |
| **Project Name** – Extension of Phase-I from Swargate to Katraj | **Product Name** | **Ambient Air** |
| | **Method of Sampling** | **IS 5182 Part 1 : 2006** |
| | **Test Location** | AAQ1 Swargate Metro Station |
| | **Latitude/Longitude** | 18°29'55.80"N 73°51'28.55"E |
| | **Monitoring Done By** | MITCON |

## RESULT

| Parameter No. | Description | Unit | Results | NAAQ Standards | Standard method |
|---|---|---|---|---|---|
| 01 | Sulphur Dioxide ($SO_2$) | µg/M³ | 24.95 | ≤ 80 | IS:5182(Part 2)-2001 (Reaffirmed 2017) |
| 02 | Oxides of Nitrogen ($NO_2$) | µg/M³ | 31.57 | ≤ 80 | IS:5182(Part 6)-2006 (Reaffirmed 2017) |
| 03 | Particulate Matter $PM_{10\ micron}$ | µg/M³ | 87.41 | ≤ 100 | IS:5182(Part 23)-2006 (Reaffirmed 2017) |
| 04 | Particulate Matter $PM_{2.5\ micron}$ | µg/M³ | 36.75 | ≤ 60 | IS 5182 (Part 24) : 2019 (Reaffirmed 2019) |
| 05 | Carbon Monoxide (CO) | mg/M³ | 1.74 | ≤ 04 (1Hr) | Instrumental Manual |

**REMARKS/OBSERVATIONS:**

- All above results are within National Ambient Air Quality standards.

**For MITCON Consultancy & Engineering Services Ltd,**

**Checked By**
**(Mrs. Kadambari Deshmukh)**

**Authorized Signatory**
**Dr. Sandeep Jadhav**
**Quality Manager/HOD**

- *This Report is valid for tested sample only.*
- *This Report shall not be reproduced except in full & with written permission of MITCON.*
- *This Report should not be used for advertisement / judicial purpose.*
- *Customer complaint register is available in the laboratory.*

**MITCON Consultancy & Engineering Services Ltd.**
Environment Management and Engineering Division
(Environmental Laboratory)
Agriculture College Campus, Next to DIC office, Shivaji Nagar, Pune. 411 005,
Ph. No. 66289405/400, email: emelab@mitconindia.com

- **ISO 45001:2018 Certified Laboratory.**
- **Recognized by MoEF & CC**

MITCON®
Solutions for Sustainable Tomorrow

Format No. EME/LAB/Format 7.8/TR

# Test Report

**Report Number: MITCON/2024-25/August/7219**

**Issue Date:** 14/08/2024

| **Client's Name & Address** | **Reference No.** | **MITCON/2024-25/August/7219/2** |
|---|---|---|
| **M/s. Maharashtra Metro Rail Corporation Limited** | **Date of Monitoring** | **12/08/2024** |
| | **Date of Analysis** | **13/08/2024** |
| | **Product Group** | **Atmospheric Pollution** |
| **Project Name** – Extension of Phase-I from Swargate to Katraj | **Product Name** | **Ambient Air** |
| | **Method of Sampling** | **IS 5182 Part 1 : 2006** |
| | **Test Location** | AAQ2 Parvati Post Office |
| | **Latitude/Longitude** | 18°29'30.35"N 73°51'27.13"E |
| | **Monitoring Done By** | MITCON |

## RESULT

| Parameter No. | Description | Unit | Results | NAAQ Standards | Standard method |
|---|---|---|---|---|---|
| 01 | Sulphur Dioxide ($SO_2$) | µg/M³ | 14.85 | ≤ 80 | IS:5182(Part 2)-2001 (Reaffirmed 2017) |
| 02 | Oxides of Nitrogen ($NO_2$) | µg/M³ | 19.74 | ≤ 80 | IS:5182(Part 6)-2006 (Reaffirmed 2017) |
| 03 | Particulate Matter $PM_{10\ micron}$ | µg/M³ | 56.74 | ≤ 100 | IS:5182(Part 23)-2006 (Reaffirmed 2017) |
| 04 | Particulate Matter $PM_{2.5\ micron}$ | µg/M³ | 27.54 | ≤ 60 | IS 5182 (Part 24) : 2019 (Reaffirmed 2019) |
| 05 | Carbon Monoxide (CO) | mg/M³ | 0.18 | ≤ 04 (1Hr) | Instrumental Manual |

**REMARKS/OBSERVATIONS:**

- All above results are within National Ambient Air Quality standards.

**For MITCON Consultancy & Engineering Services Ltd,**

**Checked By**
**(Mrs. Kadambari Deshmukh)**

**Authorized Signatory**
**Dr. Sandeep Jadhav**
**Quality Manager/HOD**

- *This Report is valid for tested sample only.*
- *This Report shall not be reproduced except in full & with written permission of MITCON.*
- *This Report should not be used for advertisement / judicial purpose.*
- *Customer complaint register is available in the laboratory.*

**MITCON Consultancy & Engineering Services Ltd.**
Environment Management and Engineering Division
(Environmental Laboratory)
Agriculture College Campus, Next to DIC office, Shivaji Nagar, Pune. 411 005,
Ph. No. 66289405/400, email: emelab@mitconindia.com

- **ISO 45001:2018 Certified Laboratory.**
- **Recognized by MoEF & CC**

MITCON®
Solutions for Sustainable Tomorrow

Format No. EME/LAB/Format 7.8/TR

# Test Report

**Report Number:** MITCON/2024-25/August/7219

**Issue Date:** 14/08/2024

| Client's Name & Address | Reference No. | MITCON/2024-25/August/7219/3 |
|---|---|---|
| **M/s. Maharashtra Metro Rail Corporation Limited** | **Date of Monitoring** | **12/08/2024** |
| | **Date of Analysis** | **13/08/2024** |
| | **Product Group** | **Atmospheric Pollution** |
| **Project Name** – Extension of Phase-I from Swargate to Katraj | **Product Name** | **Ambient Air** |
| | **Method of Sampling** | **IS 5182 Part 1 : 2006** |
| | **Test Location** | Market Yard Giltekdi Metro Station |
| | **Latitude/Longitude** | 18°29'12.40"N 73°51'27.66"E |
| | **Monitoring Done By** | MITCON |

## RESULT

| Parameter No. | Description | Unit | Results | NAAQ Standards | Standard method |
|---|---|---|---|---|---|
| 01 | Sulphur Dioxide ($SO_2$) | µg/M³ | 20.25 | ≤ 80 | IS:5182(Part 2)-2001 (Reaffirmed 2017) |
| 02 | Oxides of Nitrogen ($NO_2$) | µg/M³ | 28.45 | ≤ 80 | IS:5182(Part 6)-2006 (Reaffirmed 2017) |
| 03 | Particulate Matter $PM_{10\ micron}$ | µg/M³ | 73.85 | ≤ 100 | IS:5182(Part 23)-2006 (Reaffirmed 2017) |
| 04 | Particulate Matter $PM_{2.5\ micron}$ | µg/M³ | 34.58 | ≤ 60 | IS 5182 (Part 24) : 2019 (Reaffirmed 2019) |
| 05 | Carbon Monoxide (CO) | mg/M³ | 1.25 | ≤ 04 (1Hr) | Instrumental Manual |

**REMARKS/OBSERVATIONS:**

- All above results are within National Ambient Air Quality standards.

**For MITCON Consultancy & Engineering Services Ltd,**

**Checked By**
**(Mrs. Kadambari Deshmukh)**

**Authorized Signatory**
**Dr. Sandeep Jadhav**
**Quality Manager/HOD**

- *This Report is valid for tested sample only.*
- *This Report shall not be reproduced except in full & with written permission of MITCON.*
- *This Report should not be used for advertisement / judicial purpose.*
- *Customer complaint register is available in the laboratory.*

**MITCON Consultancy & Engineering Services Ltd.**
Environment Management and Engineering Division
(Environmental Laboratory)
Agriculture College Campus, Next to DIC office, Shivaji Nagar, Pune. 411 005,
Ph. No. 66289405/400, email: emelab@mitconindia.com

- **ISO 45001:2018 Certified Laboratory.**
- **Recognized by MoEF & CC**

Solutions for Sustainable Tomorrow

Format No. EME/LAB/Format 7.8/TR

# Test Report

**Report Number: MITCON/2024-25/August/7219**

**Issue Date:** 14/08/2024

| **Client's Name & Address** | **Reference No.** | **MITCON/2024-25/August/7219/4** |
|---|---|---|
| **M/s. Maharashtra Metro Rail Corporation Limited** | **Date of Monitoring** | **12/08/2024** |
| | **Date of Analysis** | **13/08/2024** |
| | **Product Group** | **Atmospheric Pollution** |
| **Project Name** – Extension of Phase-I from Swargate to Katraj | **Product Name** | **Ambient Air** |
| | **Method of Sampling** | **IS 5182 Part 1 : 2006** |
| | **Test Location** | AAQ4 Padmavati Metro Station |
| | **Latitude/Longitude** | 18°28'21.87"N 73°51'24.42"E |
| | **Monitoring Done By** | MITCON |

## RESULT

| Parameter No. | Description | Unit | Results | NAAQ Standards | Standard method |
|---|---|---|---|---|---|
| 01 | Sulphur Dioxide ($SO_2$) | µg/M³ | 22.74 | ≤ 80 | IS:5182(Part 2)-2001 (Reaffirmed 2017) |
| 02 | Oxides of Nitrogen ($NO_2$) | µg/M³ | 30.14 | ≤ 80 | IS:5182(Part 6)-2006 (Reaffirmed 2017) |
| 03 | Particulate Matter $PM_{10\ micron}$ | µg/M³ | 78.45 | ≤ 100 | IS:5182(Part 23)-2006 (Reaffirmed 2017) |
| 04 | Particulate Matter $PM_{2.5\ micron}$ | µg/M³ | 33.85 | ≤ 60 | IS 5182 (Part 24) : 2019 (Reaffirmed 2019) |
| 05 | Carbon Monoxide (CO) | mg/M³ | 1.05 | ≤ 04 (1Hr) | Instrumental Manual |

**REMARKS/OBSERVATIONS:**

- All above results are within National Ambient Air Quality standards.

**For MITCON Consultancy & Engineering Services Ltd,**

**Checked By**
**(Mrs. Kadambari Deshmukh)**

**Authorized Signatory**
**Dr. Sandeep Jadhav**
**Quality Manager/HOD**

- *This Report is valid for tested sample only.*
- *This Report shall not be reproduced except in full & with written permission of MITCON.*
- *This Report should not be used for advertisement / judicial purpose.*
- *Customer complaint register is available in the laboratory.*

**MITCON Consultancy & Engineering Services Ltd.**
Environment Management and Engineering Division
(Environmental Laboratory)
Agriculture College Campus, Next to DIC office, Shivaji Nagar, Pune. 411 005,
Ph. No. 66289405/400, email: emelab@mitconindia.com

- **ISO 45001:2018 Certified Laboratory.**
- **Recognized by MoEF & CC**

MITCON®
Solutions for Sustainable Tomorrow

Format No. EME/LAB/Format 7.8/TR

# Test Report

**Report Number: MITCON/2024-25/August/7219** **Issue Date:** 14/08/2024

| **Client's Name & Address** | **Reference No.** | **MITCON/2024-25/August/7219/5** |
|---|---|---|
| **M/s. Maharashtra Metro Rail Corporation Limited** | **Date of Monitoring** | **12/08/2024** |
| | **Date of Analysis** | **13/08/2024** |
| | **Product Group** | **Atmospheric Pollution** |
| **Project Name** – Extension of Phase-I from Swargate to Katraj | **Product Name** | **Ambient Air** |
| | **Method of Sampling** | **IS 5182 Part 1 : 2006** |
| | **Test Location** | AAQ5 YCI College of CNC Technology |
| | **Latitude/Longitude** | 18°27'51.47"N 73°51'30.11"E |
| | **Monitoring Done By** | MITCON |

**RESULT**

| Parameter No. | Description | Unit | Results | NAAQ Standards | Standard method |
|---|---|---|---|---|---|
| 01 | Sulphur Dioxide ($SO_2$) | µg/M³ | ≤ 10 | ≤ 80 | IS:5182(Part 2)-2001 (Reaffirmed 2017) |
| 02 | Oxides of Nitrogen ($NO_2$) | µg/M³ | 15.74 | ≤ 80 | IS:5182(Part 6)-2006 (Reaffirmed 2017) |
| 03 | Particulate Matter $PM_{10\ micron}$ | µg/M³ | 47.14 | ≤ 100 | IS:5182(Part 23)-2006 (Reaffirmed 2017) |
| 04 | Particulate Matter $PM_{2.5\ micron}$ | µg/M³ | 21.74 | ≤ 60 | IS 5182 (Part 24) : 2019 (Reaffirmed 2019) |
| 05 | Carbon Monoxide (CO) | mg/M³ | 0.08 | ≤ 04 (1Hr) | Instrumental Manual |

**REMARKS/OBSERVATIONS:**

- All above results are within National Ambient Air Quality standards.

**For MITCON Consultancy & Engineering Services Ltd,**

**Checked By**
**(Mrs. Kadambari Deshmukh)**

**Authorized Signatory**
**Dr. Sandeep Jadhav**
**Quality Manager/HOD**

- *This Report is valid for tested sample only.*
- *This Report shall not be reproduced except in full & with written permission of MITCON.*
- *This Report should not be used for advertisement / judicial purpose.*
- *Customer complaint register is available in the laboratory.*

**MITCON Consultancy & Engineering Services Ltd.**
Environment Management and Engineering Division
(Environmental Laboratory)
Agriculture College Campus, Next to DIC office, Shivaji Nagar, Pune. 411 005,
Ph. No. 66289405/400, email: emelab@mitconindia.com

- **ISO 45001:2018 Certified Laboratory.**
- **Recognized by MoEF & CC**

MITCON®
Solutions for Sustainable Tomorrow

Format No. EME/LAB/Format 7.8/TR

# Test Report

**Report Number: MITCON/2024-25/August/7219** **Issue Date:** 14/08/2024

| Client's Name & Address | | |
|---|---|---|
| **M/s. Maharashtra Metro Rail Corporation Limited** | **Reference No.** | **MITCON/2024-25/August/7219/6** |
| | **Date of Monitoring** | **12/08/2024** |
| | **Date of Analysis** | **13/08/2024** |
| | **Product Group** | **Atmospheric Pollution** |
| **Project Name** – Extension of Phase-I from Swargate to Katraj | **Product Name** | **Ambient Air** |
| | **Method of Sampling** | **IS 5182 Part 1 : 2006** |
| | **Test Location** | AAQ6 Katraj Metro Station |
| | **Latitude/Longitude** | 18°27'9.33"N 73°51'28.83"E |
| | **Monitoring Done By** | MITCON |

## RESULT

| Parameter No. | Description | Unit | Results | NAAQ Standards | Standard method |
|---|---|---|---|---|---|
| 01 | Sulphur Dioxide ($SO_2$) | µg/M³ | 25.74 | ≤ 80 | IS:5182(Part 2)-2001 (Reaffirmed 2017) |
| 02 | Oxides of Nitrogen ($NO_2$) | µg/M³ | 34.85 | ≤ 80 | IS:5182(Part 6)-2006 (Reaffirmed 2017) |
| 03 | Particulate Matter $PM_{10\ micron}$ | µg/M³ | 82.74 | ≤ 100 | IS:5182(Part 23)-2006 (Reaffirmed 2017) |
| 04 | Particulate Matter $PM_{2.5\ micron}$ | µg/M³ | 37.85 | ≤ 60 | IS 5182 (Part 24) : 2019 (Reaffirmed 2019) |
| 05 | Carbon Monoxide (CO) | mg/M³ | 1.85 | ≤ 04 (1Hr) | Instrumental Manual |

**REMARKS/OBSERVATIONS:**

- All above results are within National Ambient Air Quality standards.

**For MITCON Consultancy & Engineering Services Ltd,**

**Checked By**
**(Mrs. Kadambari Deshmukh)**

**Authorized Signatory**
**Dr. Sandeep Jadhav**
**Quality Manager/HOD**

- *This Report is valid for tested sample only.*
- *This Report shall not be reproduced except in full & with written permission of MITCON.*
- *This Report should not be used for advertisement / judicial purpose.*
- *Customer complaint register is available in the laboratory.*

**MITCON Consultancy & Engineering Services Ltd.**
Environment Management and Engineering Division
(Environmental Laboratory)
Agriculture College Campus, Next to DIC office, Shivaji Nagar, Pune. 411 005,
Ph. No. 66289405/400, email: emelab@mitconindia.com

- **ISO 45001:2018 Certified Laboratory.**
- **Recognized by MoEF & CC**

MITCON®
Solutions for Sustainable Tomorrow

Format No. EME/LAB/Format 7.8/TR

# Test Report

**Report Number: MITCON/2024-25/August/7219** **Issue Date:** 14/08/2024

| **Client's Name & Address** | **Reference No.** | **MITCON/2024-25/August/7219/7** |
|---|---|---|
| **M/s. Maharashtra Metro Rail Corporation Limited** | **Date of Monitoring** | **12/08/2024** |
| | **Product Group** | **Atmospheric Pollution** |
| | **Product Name** | **Ambient noise** |
| **Project Name** – Extension of Phase-I from Swargate to Katraj | **Method of Sampling** | IS 9989:1981 (RA 2008) |
| | **Monitoring Done By** | MITCON |

## READINGS

| Sr. No. | Test Location | Latitude/ Longitude | Unit | Readings | |
|---|---|---|---|---|---|
| | | | | 15:00 Hrs. (Day Time) | 22:45 (Night Time) |
| 01 | NQ1 Swargate Metro Station | 18°30'2.68"N 73°51'27.96"E | dB(A) | 64.2 | 53.7 |
| 02 | NQ2 Parvati Post Office | 18°29'32.32"N 73°51'27.36"E | dB(A) | 46.8 | 42.1 |
| 03 | NQ3 Market Yard Giltekdi Metro Station | 18°29'12.87"N 73°51'26.61"E | dB(A) | 64.7 | 54.2 |
| 04 | NQ4 Padmavati Metro Station | 18°28'20.11"N 73°51'24.83"E | dB(A) | 63.5 | 54.3 |
| 05 | NQ5 YCI College of CNC Technology | 18°27'50.45"N 73°51'29.95"E | dB(A) | 52.7 | 45.2 |
| 06 | NQ6 Katraj Metro Station | 18°27'10.43"N 73°51'30.59"E | dB(A) | 64.1 | 53.5 |

**REMARKS / OBSERVATIONS:**

- **Limits:** Maharashtra Pollution Control Board has prescribed 65 dB (A) as an upper limit of Noise Level during daytime & 55 dB (A) as an upper limit during night time in commercial area.
- **Note : 1 Day time shall mean from 6:00 a.m. and 10:00 p.m.**
- **Note : 2 Night time shall mean from 10:00 p.m. and 6:00 a.m.**

**For MITCON Consultancy & Engineering Services Ltd,**

**Checked By**
**(Mrs. Kadambari Deshmukh)**

**Authorized Signatory**
**Dr. Sandeep Jadhav**
**Quality Manager/HOD**

- *This Report is valid for tested sample only.*
- *This Report shall not be reproduced except in full & with written permission of MITCON.*
- *This Report should not be used for advertisement / judicial purpose.*
- *Customer complaint register is available in the laboratory.*

# Annexure-3:

Water Quality Analyses
(Laboratory Reports)

**MITCON Consultancy & Engineering Services Ltd.**
Environment Management and Engineering Division
(Environment Laboratory)
Agriculture College Campus, Next to DIC office, Shivaji Nagar, Pune. 411 005,
Ph. No. 66289405/400, email: emelab@mitconindia.com
- **ISO 45001:2018 Certified Laboratory.**
- **Recognized by MoEF & CC**

MITCON®
Solutions for Sustainable Tomorrow

Format No. EME/LAB/Format 7.8/TR

# Test Report

**Report Number : MITCON/2024-25/August/7219** **Issue Date: 14/08/2024**

## ANALYSIS RESULTS

| Client's Name & Address | Sample Details | |
|---|---|---|
| **M/s. Maharashtra Metro Rail Corporation Limited**<br><br>**Project Name** – Extension of Phase-I from Swargate to Katraj | **Sample Code** | **MITCON/2024-25/August/7219/8** |
| | **Name of Sample** | Surface water (SW1) |
| | **Sample Details** | Ambil odha downstream |
| | **Container Details** | 2 lit Plastic Can + 100 ml Sterile bottle |
| | **Sample Collected By** | MITCON |
| | **Method of sampling** | IS 3025 (Part I) |
| | **Sample Collected On** | 7/8/2024 |
| | **Date of Sample Receipt** | 7/8/2024 |
| | **Analysis Start Date** | 8/8/2024 |
| | **End Date of Analysis** | 14/8/2024 |

| Sr. No | Parameters | Results | Unit | Test Methods |
|---|---|---|---|---|
| 1 | pH at 25 °C | 7.19 | - | APHA 4500 H+, A, 4-95, 23rd Ed.2017. |
| 2 | Temperature | 24.4 | °C | APHA 2550 B,2-69 to 2-70 ,23rd Ed.2017. |
| 3 | Electrical Conductivity at 25 °C | 318.6 | µS/cm | APHA 2510 B,2-56 to 2-58 ,23rd Ed.2017. |
| 4 | Turbidity | 1.5 | NTU | IS: 3025 Part-10 (Rev.1,RA:2012) |
| 5 | Total Dissolved Solids | 185.0 | mg/l | APHA 2540 C, 2-69 to 2-70, 23rd Ed.2017. |
| 6 | Total Solids | 201.0 | mg/l | APHA 2540 C, 2-68 to 2-69, 23rd Ed.2017. |
| 7 | Acidity as $CaCO_3$ | <5 | mg/l | IS 3025 (part 22),1986,(Rev 1R.A.2014) |
| 8 | Total Alkalinity as $CaCO_3$ | 75.14 | mg/l | APHA 2320 B, 2-37 to 2-3923rd Ed.2017.. |
| 9 | Total Hardness as $CaCO_3$ | 92.16 | mg/l | APHA 2340 C ,2-48 to 2-50,23rd Ed.2017. |
| 10 | Calcium as Ca | 28.14 | mg/l | APHA 3500 Ca B, 3.-69 to 3-70,23rd Ed.2017. |
| 11 | Magnesium as Mg | 12.16 | mg/l | APHA 3500 Mg B, 3.-86 ,23rd Ed.2017. |
| 12 | Chloride as $Cl^-$ | 13.02 | mg/l | APHA 4500 Cl B,4-75 to 4-76,23rd Ed.2017. |
| 13 | Sulphates as $SO_4$ | 12.24 | mg/l | APHA 4500 SO4-E,4-199 to 4-200 23rd Ed.2017. |
| 14 | Nitrate as NO3 | 2.95 | mg/l | APHA 4500 NO3 - B 4-127 23rd Ed.2017. |
| 15 | Ammonical Nitrogen as $NH_4$-N | <0.1 | mg/l | APHA 4500 $NH_3$ F, 4-119 to 4-120 23rd Ed.2017. |
| 16 | Total Kjeldahl Nitrogen as NH3-N | 3.15 | mg/l | APHA 4500 N org B and 4500 N-$NH_3$ C |
| 17 | salinity | 0.023 | ppt | By Calculation |
| 18 | Fluoride as F | <0.1 | mg/l | APHA 4500 F-D 4-90 to 4-91 ,23rd Ed.2017. |
| 19 | Total Phosphorous | 3.15 | mg/l | APHA 4500 P-C4-162, 23rd Ed.2017. |
| 20 | Silica as $SiO_3$ | <0.5 | mg/l | APHA 4500 SIO2, C 4-175 to 4-177 ,23rd Ed.2017. |
| 21 | Sodium as Na | 2.45 | mg/l | APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS) |
| 22 | Potassium as K | <1 | mg/l | APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS) |

- *This Report is valid for tested sample only.*
- *This Report shall not be reproduced except in full & with written permission of MITCON.*
- *This Report should not be used for advertisement / judicial purpose.*
- *Customer complaint register is available in the laboratory.*

**MITCON Consultancy & Engineering Services Ltd.**
Environment Management and Engineering Division
(Environment Laboratory)
Agriculture College Campus, Next to DIC office, Shivaji Nagar, Pune. 411 005,
Ph. No. 66289405/400, email: emelab@mitconindia.com
- **ISO 45001:2018 Certified Laboratory.**
- **Recognized by MoEF & CC**

Format No. EME/LAB/Format 7.8/TR

## Test Report

**Report Number : MITCON/2024-25/August/7219** **Issue Date: 14/08/2024**

| | | | | |
|---|---|---|---|---|
| 23 | Hexavalent Chromium (as Cr6+) | <0.02 | mg/l | APHA 3500 Cr-B 3-71 23rd Ed.2017. |
| 24 | Iron (as Fe) | <0.05 | mg/l | APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS) |
| 25 | Copper (as Cu) | <0.04 | mg/l | APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS) |
| 26 | Nickel | <0.01 | mg/l | APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS) |
| 27 | Zinc as Zn | <0.05 | mg/l | APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS) |
| 28 | Manganese | <0.1 | mg/l | APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS) |
| 29 | Chromium | <0.03 | mg/l | APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS) |
| 30 | Lead | <0.01 | mg/l | APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS) |
| 31 | cadmium | <0.003 | mg/l | APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS) |
| 32 | Phenol | <0.001 | mg/l | IS 3025 (Part 43)(Rev 1:R.A: 2014 |
| 33 | Biochemical Oxygen Demand | 11 | mg/l | IS: 3025 Part-44-1993 (Rev.1, RA 2014) |
| 34 | Chemical Oxygen Demand | 33 | mg/l | APHA 5220 C,5-20 to 5-21 23rd Ed 2017 |
| 35 | Dissolved Oxygen | 3.9 | mg/l | IS: 3025 (Part-38)-1989 |
| 36 | Boron | <0.04 | mg/l | APHA 4500 B-c 4-27 23rd Ed 2017 |
| 01 | Total Coliforms | Present | Per100 ml | IS: 1622 (R.A 1 2014) |
| 02 | E-coli | Present | Per100 ml | IS: 1622 (R.A 1 2014) |

**For MITCON Consultancy & Engineering Services Ltd.**

**Checked By**
(Mrs. Kadambari Deshmukh)

**Authorized Signatory**
Dr. Sandeep Jadhav
(Senior Vice President)

- *This Report is valid for tested sample only.*
- *This Report shall not be reproduced except in full & with written permission of MITCON.*
- *This Report should not be used for advertisement / judicial purpose.*
- *Customer complaint register is available in the laboratory.*

**MITCON Consultancy & Engineering Services Ltd.**
Environment Management and Engineering Division
(Environment Laboratory)
Agriculture College Campus, Next to DIC office, Shivaji Nagar, Pune. 411 005,
Ph. No. 66289405/400, email: emelab@mitconindia.com
- **ISO 45001:2018 Certified Laboratory.**
- **Recognized by MoEF & CC**

MITCON®
Solutions for Sustainable Tomorrow

Format No. EME/LAB/Format 7.8/TR

# Test Report

**Report Number : MITCON/2024-25/August/7219** **Issue Date: 14/08/2024**

| Client's Name & Address | Sample Details | |
|---|---|---|
| **M/s. Maharashtra Metro Rail Corporation Limited**<br><br>**Project Name** – Extension of Phase-I from Swargate to Katraj | **Sample Code** | **MITCON/2024-25/August/7219/9** |
| | **Name of Sample** | Surface water (SW2) |
| | **Sample Details** | Ambil odha downstream |
| | **Container Details** | 2 lit Plastic Can + 100 ml Sterile bottle |
| | **Sample Collected By** | MITCON |
| | **Method of sampling** | IS 3025 (Part I) |
| | **Sample Collected On** | 7/8/2024 |
| | **Date of Sample Receipt** | 7/8/2024 |
| | **Analysis Start Date** | 8/8/2024 |
| | **End Date of Analysis** | 14/8/2024 |

## ANALYSIS RESULTS

| Sr. No | Parameters | Results | Unit | Test Methods |
|---|---|---|---|---|
| 1 | pH at 25 °C | 7.18 | - | APHA 4500 H+, A, 4-95, 23rd Ed.2017. |
| 2 | Temperature | 24.2 | °C | APHA 2550 B,2-69 to 2-70 ,23rd Ed.2017. |
| 3 | Electrical Conductivity at 25 °C | 313.7 | µS/cm | APHA 2510 B,2-56 to 2-58 ,23rd Ed.2017. |
| 4 | Turbidity | 1.5 | NTU | IS: 3025 Part-10 (Rev.1,RA:2012) |
| 5 | Total Dissolved Solids | 224.0 | mg/l | APHA 2540 C, 2-69 to 2-70, 23rd Ed.2017. |
| 6 | Total Solids | 235.0 | mg/l | APHA 2540 C, 2-68 to 2-69, 23rd Ed.2017. |
| 7 | Acidity as $CaCO_3$ | <5 | mg/l | IS 3025 (part 22),1986,(Rev 1R.A.2014) |
| 8 | Total Alkalinity as $CaCO_3$ | 91.18 | mg/l | APHA 2320 B, 2-37 to 2-3923rd Ed.2017.. |
| 9 | Total Hardness as $CaCO_3$ | 116.445 | mg/l | APHA 2340 C ,2-48 to 2-50,23rd Ed.2017. |
| 10 | Calcium as Ca | 32.16 | mg/l | APHA 3500 Ca B, 3.-69 to 3-70,23rd Ed.2017. |
| 11 | Magnesium as Mg | 13.89 | mg/l | APHA 3500 Mg B, 3.-86 ,23rd Ed.2017. |
| 12 | Chloride as $Cl^-$ | 16.25 | mg/l | APHA 4500 Cl B,4-75 to 4-76,23rd Ed.2017. |
| 13 | Sulphates as $SO_4$ | 14.45 | mg/l | APHA 4500 SO4-E,4-199 to 4-200 23rd Ed.2017. |
| 14 | Nitrate as NO3 | 1.14 | mg/l | APHA 4500 NO3 - B 4-127 23rd Ed.2017. |
| 15 | Ammonical Nitrogen as $NH_4$-N | <0.1 | mg/l | APHA 4500 $NH_3$ F, 4-119 to 4-120 23rd Ed.2017. |
| 16 | Total Kjeldahl Nitrogen as NH3-N | 2.85 | mg/l | APHA 4500 N org B and 4500 N-$NH_3$ C |
| 17 | salinity | 0.023 | ppt | By Calculation |
| 18 | Fluoride as F | <0.1 | mg/l | APHA 4500 F-D 4-90 to 4-91 ,23rd Ed.2017. |
| 19 | Total Phosphorous | 3.15 | mg/l | APHA 4500 P-C4-162, 23rd Ed.2017. |
| 20 | Silica as $SiO_3$ | <0.5 | mg/l | APHA 4500 SIO2, C 4-175 to 4-177 ,23rd Ed.2017. |
| 21 | Sodium as Na | 2.45 | mg/l | APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS) |
| 22 | Potassium as K | <1 | mg/l | APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS) |

- *This Report is valid for tested sample only.*
- *This Report shall not be reproduced except in full & with written permission of MITCON.*
- *This Report should not be used for advertisement / judicial purpose.*
- *Customer complaint register is available in the laboratory.*

**MITCON Consultancy & Engineering Services Ltd.**
Environment Management and Engineering Division
(Environment Laboratory)
Agriculture College Campus, Next to DIC office, Shivaji Nagar, Pune. 411 005,
Ph. No. 66289405/400, email: emelab@mitconindia.com
- **ISO 45001:2018 Certified Laboratory.**
- **Recognized by MoEF & CC**

Format No. EME/LAB/Format 7.8/TR

## Test Report

**Report Number : MITCON/2024-25/August/7219** **Issue Date: 14/08/2024**

| | | | | |
|---|---|---|---|---|
| 23 | Hexavalent Chromium (as Cr6+) | <0.02 | mg/l | APHA 3500 Cr-B 3-71 23rd Ed.2017. |
| 24 | Iron (as Fe) | <0.05 | mg/l | APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS) |
| 25 | Copper (as Cu) | <0.04 | mg/l | APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS) |
| 26 | Nickel | <0.01 | mg/l | APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS) |
| 27 | Zinc as Zn | <0.05 | mg/l | APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS) |
| 28 | Manganese | <0.1 | mg/l | APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS) |
| 29 | Chromium | <0.03 | mg/l | APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS) |
| 30 | Lead | <0.01 | mg/l | APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS) |
| 31 | cadmium | <0.003 | mg/l | APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS) |
| 32 | Phenol | <0.001 | mg/l | IS 3025 (Part 43)(Rev 1:R.A: 2014 |
| 33 | Biochemical Oxygen Demand | 13 | mg/l | IS: 3025 Part-44-1993 (Rev.1, RA 2014) |
| 34 | Chemical Oxygen Demand | 40 | mg/l | APHA 5220 C,5-20 to 5-21 23rd Ed 2017 |
| 35 | Dissolved Oxygen | 3.2 | mg/l | IS: 3025 (Part-38)-1989 |
| 36 | Boron | <0.04 | mg/l | APHA 4500 B-c 4-27 23rd Ed 2017 |
| 01 | Total Coliforms | Present | Per100 ml | IS: 1622 (R.A 1 2014) |
| 02 | E-coli | Present | Per100 ml | IS: 1622 (R.A 1 2014) |

**For MITCON Consultancy & Engineering Services Ltd.**

**Checked By**
(Mrs. Kadambari Deshmukh)

**Authorized Signatory**
Dr. Sandeep Jadhav
(Senior Vice President)

- *This Report is valid for tested sample only.*
- *This Report shall not be reproduced except in full & with written permission of MITCON.*
- *This Report should not be used for advertisement / judicial purpose.*
- *Customer complaint register is available in the laboratory.*

**MITCON Consultancy & Engineering Services Ltd.**
Environment Management and Engineering Division
(Environment Laboratory)
Agriculture College Campus, Next to DIC office, Shivaji Nagar, Pune. 411 005,
Ph. No. 66289405/400, email: emelab@mitconindia.com
- **ISO 45001:2018 Certified Laboratory.**
- **Recognized by MoEF & CC**

MITCON®
Solutions for Sustainable Tomorrow

Format No. EME/LAB/Format 7.8/TR

# Test Report

**Report Number : MITCON/2024-25/August/7219**

**Issue Date: 14/08/2024**

| Client's Name & Address | Sample Details | |
|---|---|---|
| **M/s. Maharashtra Metro Rail Corporation Limited**<br><br>**Project Name** – Extension of Phase-I from Swargate to Katraj | **Sample Code** | **MITCON/2024-25/August/7219/10** |
| | **Name of Sample** | Surface water (SW3) |
| | **Sample Details** | Ambil odha U/S near padmavati metro station |
| | **Container Details** | 2 lit Plastic Can + 100 ml Sterile bottle |
| | **Sample Collected By** | MITCON |
| | **Method of sampling** | IS 3025 (Part I) |
| | **Sample Collected On** | 7/8/2024 |
| | **Date of Sample Receipt** | 7/8/2024 |
| | **Analysis Start Date** | 8/8/2024 |
| | **End Date of Analysis** | 14/8/2024 |

## ANALYSIS RESULTS

| Sr. No | Parameters | Results | Unit | Test Methods |
|---|---|---|---|---|
| 1 | pH at 25 °C | 7.32 | - | APHA 4500 H+, A, 4-95, 23rd Ed.2017. |
| 2 | Temperature | 24.4 | °C | APHA 2550 B,2-69 to 2-70 ,23rd Ed.2017. |
| 3 | Electrical Conductivity at 25 °C | 345.5 | µS/cm | APHA 2510 B,2-56 to 2-58 ,23rd Ed.2017. |
| 4 | Turbidity | 1.2 | NTU | IS: 3025 Part-10 (Rev.1,RA:2012) |
| 5 | Total Dissolved Solids | 185.0 | mg/l | APHA 2540 C, 2-69 to 2-70, 23rd Ed.2017. |
| 6 | Total Solids | 193.0 | mg/l | APHA 2540 C, 2-68 to 2-69, 23rd Ed.2017. |
| 7 | Acidity as $CaCO_3$ | <5 | mg/l | IS 3025 (part 22),1986,(Rev 1R.A.2014) |
| 8 | Total Alkalinity as $CaCO_3$ | 74.12 | mg/l | APHA 2320 B, 2-37 to 2-3923rd Ed.2017.. |
| 9 | Total Hardness as $CaCO_3$ | 95.78 | mg/l | APHA 2340 C ,2-48 to 2-50,23rd Ed.2017. |
| 10 | Calcium as Ca | 38.17 | mg/l | APHA 3500 Ca B, 3.-69 to 3-70,23rd Ed.2017. |
| 11 | Magnesium as Mg | 14.10 | mg/l | APHA 3500 Mg B, 3.-86 ,23rd Ed.2017. |
| 12 | Chloride as $Cl^-$ | 14.56 | mg/l | APHA 4500 Cl B,4-75 to 4-76,23rd Ed.2017. |
| 13 | Sulphates as $SO_4$ | 26.12 | mg/l | APHA 4500 SO4-E,4-199 to 4-200 23rd Ed.2017. |
| 14 | Nitrate as NO3 | 2.02 | mg/l | APHA 4500 NO3 - B 4-127 23rd Ed.2017. |
| 15 | Ammonical Nitrogen as $NH_4$-N | <0.1 | mg/l | APHA 4500 $NH_3$ F, 4-119 to 4-120 23rd Ed.2017. |
| 16 | Total Kjeldahl Nitrogen as NH3-N | <1 | mg/l | APHA 4500 N org B and 4500 N-$NH_3$ C |
| 17 | salinity | 0.026 | ppt | By Calculation |
| 18 | Fluoride as F | <0.1 | mg/l | APHA 4500 F-D 4-90 to 4-91 ,23rd Ed.2017. |
| 19 | Total Phosphorous | <1 | mg/l | APHA 4500 P-C4-162, 23rd Ed.2017. |
| 20 | Silica as $SiO_3$ | <0.5 | mg/l | APHA 4500 SIO2, C 4-175 to 4-177 ,23rd Ed.2017. |
| 21 | Sodium as Na | 4.01 | mg/l | APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS) |
| 22 | Potassium as K | <1 | mg/l | APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS) |

- *This Report is valid for tested sample only.*
- *This Report shall not be reproduced except in full & with written permission of MITCON.*
- *This Report should not be used for advertisement / judicial purpose.*
- *Customer complaint register is available in the laboratory.*

**MITCON Consultancy & Engineering Services Ltd.**
Environment Management and Engineering Division
(Environment Laboratory)
Agriculture College Campus, Next to DIC office, Shivaji Nagar, Pune. 411 005,
Ph. No. 66289405/400, email: emelab@mitconindia.com
- **ISO 45001:2018 Certified Laboratory.**
- **Recognized by MoEF & CC**

Format No. EME/LAB/Format 7.8/TR

## Test Report

**Report Number : MITCON/2024-25/August/7219** **Issue Date: 14/08/2024**

| | | | | |
|---|---|---|---|---|
| 23 | Hexavalent Chromium (as Cr6+) | <0.02 | mg/l | APHA 3500 Cr-B 3-71 23rd Ed.2017. |
| 24 | Iron (as Fe) | <0.05 | mg/l | APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS) |
| 25 | Copper (as Cu) | <0.04 | mg/l | APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS) |
| 26 | Nickel | <0.01 | mg/l | APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS) |
| 27 | Zinc as Zn | <0.05 | mg/l | APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS) |
| 28 | Manganese | <0.1 | mg/l | APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS) |
| 29 | Chromium | <0.03 | mg/l | APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS) |
| 30 | Lead | <0.01 | mg/l | APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS) |
| 31 | cadmium | <0.003 | mg/l | APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS) |
| 32 | Phenol | <0.001 | mg/l | IS 3025 (Part 43)(Rev 1:R.A: 2014 |
| 33 | Biochemical Oxygen Demand | 10 | mg/l | IS: 3025 Part-44-1993 (Rev.1, RA 2014) |
| 34 | Chemical Oxygen Demand | 32 | mg/l | APHA 5220 C,5-20 to 5-21 23rd Ed 2017 |
| 35 | Dissolved Oxygen | 4.0 | mg/l | IS: 3025 (Part-38)-1989 |
| 36 | Boron | <0.04 | mg/l | APHA 4500 B-c 4-27 23rd Ed 2017 |
| 01 | Total Coliforms | Present | Per100 ml | IS: 1622 (R.A 1 2014) |
| 02 | E-coli | Present | Per100 ml | IS: 1622 (R.A 1 2014) |

**For MITCON Consultancy & Engineering Services Ltd.**

**Checked By**
(Mrs. Kadambari Deshmukh)

**Authorized Signatory**
Dr. Sandeep Jadhav
(Senior Vice President)

- *This Report is valid for tested sample only.*
- *This Report shall not be reproduced except in full & with written permission of MITCON.*
- *This Report should not be used for advertisement / judicial purpose.*
- *Customer complaint register is available in the laboratory.*

**MITCON Consultancy & Engineering Services Ltd.**
Environment Management and Engineering Division
(Environment Laboratory)
Agriculture College Campus, Next to DIC office, Shivaji Nagar, Pune. 411 005,
Ph. No. 66289405/400, email: emelab@mitconindia.com
- **ISO 45001:2018 Certified Laboratory.**
- **Recognized by MoEF & CC**

MITCON®
Solutions for Sustainable Tomorrow

Format No. EME/LAB/Format 7.8/TR

# Test Report

**Report Number : MITCON/2024-25/August/7219** **Issue Date: 14/08/2024**

| Client's Name & Address | Sample Details | |
|---|---|---|
| **M/s. Maharashtra Metro Rail Corporation Limited**<br><br>**Project Name** – Extension of Phase-I from Swargate to Katraj | **Sample Code** | **MITCON/2024-25/August/7219/11** |
| | **Name of Sample** | SW 4 |
| | **Sample Details** | Katraj Lake (NW side) |
| | **Container Details** | 2 lit Plastic Can + 100 ml Sterile bottle |
| | **Sample Collected By** | MITCON |
| | **Method of sampling** | IS 3025 (Part I) |
| | **Sample Collected On** | 7/8/2024 |
| | **Date of Sample Receipt** | 7/8/2024 |
| | **Analysis Start Date** | 8/8/2024 |
| | **End Date of Analysis** | 14/8/2024 |

## ANALYSIS RESULTS

| Sr. No | Parameters | Results | Unit | Test Methods |
|---|---|---|---|---|
| 1 | pH at 25 °C | 7.25 | - | APHA 4500 H+, A, 4-95, 23rd Ed.2017. |
| 2 | Temperature | 24.3 | °C | APHA 2550 B,2-69 to 2-70 ,23rd Ed.2017. |
| 3 | Electrical Conductivity at 25 °C | 313.7 | µS/cm | APHA 2510 B,2-56 to 2-58 ,23rd Ed.2017. |
| 4 | Turbidity | 1.1 | NTU | IS: 3025 Part-10 (Rev.1,RA:2012) |
| 5 | Total Dissolved Solids | 207.0 | mg/l | APHA 2540 C, 2-69 to 2-70, 23rd Ed.2017. |
| 6 | Total Solids | 213.0 | mg/l | APHA 2540 C, 2-68 to 2-69, 23rd Ed.2017. |
| 7 | Acidity as $CaCO_3$ | <5 | mg/l | IS 3025 (part 22),1986,(Rev 1R.A.2014) |
| 8 | Total Alkalinity as $CaCO_3$ | 95.83 | mg/l | APHA 2320 B, 2-37 to 2-3923rd Ed.2017.. |
| 9 | Total Hardness as $CaCO_3$ | 103.28 | mg/l | APHA 2340 C ,2-48 to 2-50,23rd Ed.2017. |
| 10 | Calcium as Ca | 28.95 | mg/l | APHA 3500 Ca B, 3.-69 to 3-70,23rd Ed.2017. |
| 11 | Magnesium as Mg | 18.90 | mg/l | APHA 3500 Mg B, 3.-86 ,23rd Ed.2017. |
| 12 | Chloride as $Cl^-$ | 23.25 | mg/l | APHA 4500 Cl B,4-75 to 4-76,23rd Ed.2017. |
| 13 | Sulphates as $SO_4$ | 18.67 | mg/l | APHA 4500 SO4-E,4-199 to 4-200 23rd Ed.2017. |
| 14 | Nitrate as NO3 | 2.75 | mg/l | APHA 4500 NO3 - B 4-127 23rd Ed.2017. |
| 15 | Ammonical Nitrogen as $NH_4$-N | <0.1 | mg/l | APHA 4500 $NH_3$ F, 4-119 to 4-120 23rd Ed.2017. |
| 16 | Total Kjeldahl Nitrogen as NH3-N | <1 | mg/l | APHA 4500 N org B and 4500 N-$NH_3$ C |
| 17 | salinity | 0.041 | ppt | By Calculation |
| 18 | Fluoride as F | <0.1 | mg/l | APHA 4500 F-D 4-90 to 4-91 ,23rd Ed.2017. |
| 19 | Total Phosphorous | <1 | mg/l | APHA 4500 P-C4-162, 23rd Ed.2017. |
| 20 | Silica as $SiO_3$ | <0.5 | mg/l | APHA 4500 SIO2, C 4-175 to 4-177 ,23rd Ed.2017. |
| 21 | Sodium as Na | 3.02 | mg/l | APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS) |
| 22 | Potassium as K | <1 | mg/l | APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS) |

- *This Report is valid for tested sample only.*
- *This Report shall not be reproduced except in full & with written permission of MITCON.*
- *This Report should not be used for advertisement / judicial purpose.*
- *Customer complaint register is available in the laboratory.*

**MITCON Consultancy & Engineering Services Ltd.**
Environment Management and Engineering Division
(Environment Laboratory)
Agriculture College Campus, Next to DIC office, Shivaji Nagar, Pune. 411 005,
Ph. No. 66289405/400, email: emelab@mitconindia.com
- **ISO 45001:2018 Certified Laboratory.**
- **Recognized by MoEF & CC**

Format No. EME/LAB/Format 7.8/TR

## Test Report

**Report Number : MITCON/2024-25/August/7219** **Issue Date: 14/08/2024**

| | | | | |
|---|---|---|---|---|
| 23 | Hexavalent Chromium (as Cr6+) | <0.02 | mg/l | APHA 3500 Cr-B 3-71 23rd Ed.2017. |
| 24 | Iron (as Fe) | <0.05 | mg/l | APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS) |
| 25 | Copper (as Cu) | <0.04 | mg/l | APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS) |
| 26 | Nickel | <0.01 | mg/l | APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS) |
| 27 | Zinc as Zn | <0.05 | mg/l | APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS) |
| 28 | Manganese | <0.1 | mg/l | APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS) |
| 29 | Chromium | <0.03 | mg/l | APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS) |
| 30 | Lead | <0.01 | mg/l | APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS) |
| 31 | cadmium | <0.003 | mg/l | APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS) |
| 32 | Phenol | <0.001 | mg/l | IS 3025 (Part 43)(Rev 1:R.A: 2014 |
| 33 | Biochemical Oxygen Demand | 04 | mg/l | IS: 3025 Part-44-1993 (Rev.1, RA 2014) |
| 34 | Chemical Oxygen Demand | 14 | mg/l | APHA 5220 C,5-20 to 5-21 23rd Ed 2017 |
| 35 | Dissolved Oxygen | 5.1 | mg/l | IS: 3025 (Part-38)-1989 |
| 36 | Boron | <0.04 | mg/l | APHA 4500 B-c 4-27 23rd Ed 2017 |
| 01 | Total Coliforms | Present | Per100 ml | IS: 1622 (R.A 1 2014) |
| 02 | E-coli | Present | Per100 ml | IS: 1622 (R.A 1 2014) |

**For MITCON Consultancy & Engineering Services Ltd.**

**Checked By**
(Mrs. Kadambari Deshmukh)

**Authorized Signatory**
Dr. Sandeep Jadhav
(Senior Vice President)

- *This Report is valid for tested sample only.*
- *This Report shall not be reproduced except in full & with written permission of MITCON.*
- *This Report should not be used for advertisement / judicial purpose.*
- *Customer complaint register is available in the laboratory.*

**MITCON Consultancy & Engineering Services Ltd.**
Environment Management and Engineering Division
(Environment Laboratory)
Agriculture College Campus, Next to DIC office, Shivaji Nagar, Pune. 411 005,
Ph. No. 66289405/400, email: emelab@mitconindia.com
- **ISO 45001:2018 Certified Laboratory.**
- **Recognized by MoEF & CC**

MITCON®
Solutions for Sustainable Tomorrow

Format No. EME/LAB/Format 7.8/TR

# Test Report

**Report Number : MITCON/2024-25/August/7219** **Issue Date: 14/08/2024**

| Client's Name & Address | Sample Details | |
|---|---|---|
| **M/s. Maharashtra Metro Rail Corporation Limited**<br><br>**Project Name** – Extension of Phase-I from Swargate to Katraj | **Sample Code** | **MITCON/2024-25/August/7219/12** |
| | **Name of Sample** | GW1 |
| | **Sample Details** | Swargate metro station |
| | **Container Details** | 2 lit Plastic Can + 100 ml Sterile bottle |
| | **Sample Collected By** | MITCON |
| | **Method of sampling** | IS 3025 (Part I) |
| | **Sample Collected On** | 7/8/2024 |
| | **Date of Sample Receipt** | 7/8/2024 |
| | **Analysis Start Date** | 8/8/2024 |
| | **End Date of Analysis** | 14/8/2024 |

## ANALYSIS RESULTS

| Sr. No | Parameters | Results | Unit | IS:10500:2012 Required Standards | Test Methods |
|---|---|---|---|---|---|
| **CHEMICAL POTABILITY** | | | | | |
| 1. | pH at 25 °C | 7.25 | - | 6.50 to 8.50 | APHA 4500 H+, A, 4-95, 23rd Ed.2017. |
| 2 | Temperature | 24.6 | °C | N.S. | APHA 2550 B,2-69 to 2-70 ,23rd Ed.2017. |
| 3 | Electrical Conductivity at 25 °C | 400.8 | µS/cm | N.S. | APHA 2510 B,2-56 to 2-58 ,23rd Ed.2017. |
| 4 | Turbidity | <1 | NTU | ≤ 1 | IS: 3025 Part-10 (Rev.1,RA:2012) |
| 5 | Total Dissolved Solids | 267.0 | mg/l | ≤ 500 | APHA 2540 C, 2-69 to 2-70, 23rd Ed.2017. |
| 6 | Total Solids | 269.0 | mg/l | N.S. | APHA 2540 C, 2-68 to 2-69, 23rd Ed.2017. |
| 7 | Total suspended Solids | <5 | mg/l | N.S | APHA 2540 D ,2-70 to 2-71 23rd Ed 2017 |
| 8 | Acidity as $CaCO_3$ | <5 | mg/l | N.S. | IS 3025 (part 22),1986,(Rev 1R.A.2014) |
| 9 | Total Alkalinity as $CaCO_3$ | 104.68 | mg/l | ≤ 200 | APHA 2320 B, 2-37 to 2-3923rd Ed.2017.. |
| 10 | Total Hardness as $CaCO_3$ | 128.54 | mg/l | ≤ 200 | APHA 2340 C ,2-48 to 2-50,23rd Ed.2017. |
| 11 | Calcium as Ca | 37.16 | mg/l | ≤ 75 | APHA 3500 Ca B, 3.-69 to 3-70,23rd Ed.2017. |
| 12 | Magnesium as Mg | 25.14 | mg/l | ≤ 30 | APHA 3500 Mg B, 3.-86 ,23rd Ed.2017. |
| 13 | Chloride as $Cl^-$ | 40.10 | mg/l | ≤ 250 | APHA 4500 Cl B,4-75 to 4-76,23rd Ed.2017. |
| 14 | Sulphates as $SO_4$ | 16.89 | mg/l | ≤ 200 | APHA 4500 SO4-E,4-199 to 4-200 23rd Ed.2017. |
| 15 | Nitrate as NO3 | <1.0 | mg/l | ≤ 45 | APHA 4500 NO3 - B 4-127 23rd Ed.2017. |
| 16 | Ammonical Nitrogen as $NH_4$-N | <0.1 | mg/l | N.S. | APHA 4500 $NH_3$ F, 4-119 to 4-120 23rd Ed.2017. |
| 17 | Total Kjeldahl Nitrogen as NH3-N | <1 | mg/l | N.S. | APHA 4500 N org B and 4500 N-$NH_3$ C |
| 18 | salinity | 0.072 | ppt | N.S. | By Calculation |
| 19 | Fluoride as F | <0.1 | mg/l | ≤ 1.0 | APHA 4500 F-D 4-90 to 4-91 ,23rd Ed.2017. |

- *This Report is valid for tested sample only.*
- *This Report shall not be reproduced except in full & with written permission of MITCON.*
- *This Report should not be used for advertisement / judicial purpose.*
- *Customer complaint register is available in the laboratory.*

**MITCON Consultancy & Engineering Services Ltd.**
Environment Management and Engineering Division
(Environment Laboratory)
Agriculture College Campus, Next to DIC office, Shivaji Nagar, Pune. 411 005,
Ph. No. 66289405/400, email: emelab@mitconindia.com
- **ISO 45001:2018 Certified Laboratory.**
- **Recognized by MoEF & CC**

Format No. EME/LAB/Format 7.8/TR

## Test Report

**Report Number : MITCON/2024-25/August/7219** **Issue Date: 14/08/2024**

| | | | | | |
|---|---|---|---|---|---|
| 20 | Total Phosphorous | <1 | mg/l | N.S. | APHA 4500 P-C4-162, 23rd Ed.2017. |
| 21 | Silica as $SiO_3$ | 2.85 | mg/l | N.S. | APHA 4500 SIO2, C 4-175 to 4-177 ,23rd Ed.2017. |
| 22 | Sodium as Na | 5.45 | mg/l | N.S. | APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS) |
| 23 | Potassium as K | <1 | mg/l | N.S. | APHA 3111B, 3-20 to 3-21 ,23rd Ed.2017. (AAS) |
| 24 | Hexavalent Chromium (as Cr6+) | <0.02 | mg/l | N.S. | APHA 3500 Cr-B 3-71 23rd Ed.2017. |
| 25 | Iron (as Fe) | <0.05 | mg/l | ≤ 0.3 | APHA 3111 B, 3-18 to 3-21 , 23rd Ed.2017. |
| 26 | Copper (as Cu) | <0.04 | mg/l | ≤ 0.05 | APHA 3111 B, 3-18 to 3-21 , 23rd Ed.2017. (AAS) |
| 27 | Nickel | <0.01 | mg/l | ≤ 0.01 | APHA 3111 B, 3-18 TO 3-21, 23rd Ed.2017.(AAS) |
| 28 | Zinc as Zn | <0.05 | mg/l | ≤ 5 | APHA 3111 B, 3-18 TO 3-21, 23rd Ed.2017.(AAS) |
| 29 | Manganese | <0.1 | mg/l | ≤ 0.1 | APHA 3111 B, 3-18 TO 3-21, 23rd Ed.2017.(AAS) |
| 30 | Chromium | <0.03 | mg/l | ≤ 0.05 | APHA 3111 B, 3-18 TO 3-21, 23rd Ed.2017.(AAS) |
| 31 | Lead | <0.01 | mg/l | ≤ 0.01 | APHA 3111 B, 3-18 TO 3-21, 23rd Ed.2017.(AAS) |
| 32 | cadmium | <0.003 | mg/l | ≤ 0.003 | APHA 3111 B, 3-18 TO 3-2123rd Ed.2017.(AAS) |
| 33 | Phenol | <0.001 | mg/l | ≤ 0.001 | IS 3025 (Part 43)(Rev 1:R.A: 2014 |
| **BACTERIOLOGICAL POTABILITY** | | | | | |
| 01 | Total Coliforms | Absent | Per100 ml | Absent | IS: 1622 (R.A 1 2014) |
| 02 | E-coli | Absent | Per100 ml | Absent | IS: 1622 (R.A 1 2014) |

**For MITCON Consultancy & Engineering Services Ltd.**

**Checked By**
(Mrs. Kadambari Deshmukh)

**Authorized Signatory**
Dr. Sandeep Jadhav
(Senior Vice President)

- *This Report is valid for tested sample only.*
- *This Report shall not be reproduced except in full & with written permission of MITCON.*
- *This Report should not be used for advertisement / judicial purpose.*
- *Customer complaint register is available in the laboratory.*

**MITCON Consultancy & Engineering Services Ltd.**
Environment Management and Engineering Division
(Environment Laboratory)
Agriculture College Campus, Next to DIC office, Shivaji Nagar, Pune. 411 005,
Ph. No. 66289405/400, email: emelab@mitconindia.com
- **ISO 45001:2018 Certified Laboratory.**
- **Recognized by MoEF & CC**

MITCON®
Solutions for Sustainable Tomorrow

Format No. EME/LAB/Format 7.8/TR

# Test Report

**Report Number : MITCON/2024-25/August/7219** **Issue Date: 14/08/2024**

| Client's Name & Address | Sample Details | |
|---|---|---|
| **M/s. Maharashtra Metro Rail Corporation Limited**<br><br>**Project Name** – Extension of Phase-I from Swargate to Katraj | **Sample Code** | **MITCON/2024-25/August/7219/13** |
| | **Name of Sample** | GW2 |
| | **Sample Details** | Market yard gultekdi metro station |
| | **Container Details** | 2 lit Plastic Can + 100 ml Sterile bottle |
| | **Sample Collected By** | MITCON |
| | **Method of sampling** | IS 3025 (Part I) |
| | **Sample Collected On** | 7/8/2024 |
| | **Date of Sample Receipt** | 7/8/2024 |
| | **Analysis Start Date** | 8/8/2024 |
| | **End Date of Analysis** | 14/8/2024 |

## ANALYSIS RESULTS

| Sr. No | Parameters | Results | Unit | IS:10500:2012 Required Standards | Test Methods |
|---|---|---|---|---|---|
| **CHEMICAL POTABILITY** | | | | | |
| 1. | pH at 25 °C | 7.19 | - | 6.50 to 8.50 | APHA 4500 H+, A, 4-95, 23rd Ed.2017. |
| 2 | Temperature | 24.7 | °C | N.S. | APHA 2550 B,2-69 to 2-70 ,23rd Ed.2017. |
| 3 | Electrical Conductivity at 25 °C | 389.6 | µS/cm | N.S. | APHA 2510 B,2-56 to 2-58 ,23rd Ed.2017. |
| 4 | Turbidity | <1 | NTU | ≤ 1 | IS: 3025 Part-10 (Rev.1,RA:2012) |
| 5 | Total Dissolved Solids | 174.0 | mg/l | ≤ 500 | APHA 2540 C, 2-69 to 2-70, 23rd Ed.2017. |
| 6 | Total Solids | 177.0 | mg/l | N.S. | APHA 2540 C, 2-68 to 2-69, 23rd Ed.2017. |
| 7 | Total suspended Solids | <5 | mg/l | N.S | APHA 2540 D ,2-70 to 2-71 23rd Ed 2017 |
| 8 | Acidity as $CaCO_3$ | <5 | mg/l | N.S. | IS 3025 (part 22),1986,(Rev 1R.A.2014) |
| 9 | Total Alkalinity as $CaCO_3$ | 98.25 | mg/l | ≤ 200 | APHA 2320 B, 2-37 to 2-3923rd Ed.2017.. |
| 10 | Total Hardness as $CaCO_3$ | 137.15 | mg/l | ≤ 200 | APHA 2340 C ,2-48 to 2-50,23rd Ed.2017. |
| 11 | Calcium as Ca | 39.16 | mg/l | ≤ 75 | APHA 3500 Ca B, 3.-69 to 3-70,23rd Ed.2017. |
| 12 | Magnesium as Mg | 29.15 | mg/l | ≤ 30 | APHA 3500 Mg B, 3.-86 ,23rd Ed.2017. |
| 13 | Chloride as $Cl^-$ | 42.16 | mg/l | ≤ 250 | APHA 4500 Cl B,4-75 to 4-76,23rd Ed.2017. |
| 14 | Sulphates as $SO_4$ | 18.98 | mg/l | ≤ 200 | APHA 4500 SO4-E,4-199 to 4-200 23rd Ed.2017. |
| 15 | Nitrate as NO3 | <1.0 | mg/l | ≤ 45 | APHA 4500 NO3 - B 4-127 23rd Ed.2017. |
| 16 | Ammonical Nitrogen as $NH_4$-N | <0.1 | mg/l | N.S. | APHA 4500 $NH_3$ F, 4-119 to 4-120 23rd Ed.2017. |
| 17 | Total Kjeldahl Nitrogen as NH3-N | <1 | mg/l | N.S. | APHA 4500 N org B and 4500 N-$NH_3$ C |
| 18 | salinity | 0.076 | ppt | N.S. | By Calculation |
| 19 | Fluoride as F | <0.1 | mg/l | ≤ 1.0 | APHA 4500 F-D 4-90 to 4-91 ,23rd Ed.2017. |
| 20 | Total Phosphorous | <1 | mg/l | N.S. | APHA 4500 P-C4-162, 23rd Ed.2017. |

- *This Report is valid for tested sample only.*
- *This Report shall not be reproduced except in full & with written permission of MITCON.*
- *This Report should not be used for advertisement / judicial purpose.*
- *Customer complaint register is available in the laboratory.*

**MITCON Consultancy & Engineering Services Ltd.**
Environment Management and Engineering Division
(Environment Laboratory)
Agriculture College Campus, Next to DIC office, Shivaji Nagar, Pune. 411 005,
Ph. No. 66289405/400, email: emelab@mitconindia.com
- **ISO 45001:2018 Certified Laboratory.**
- **Recognized by MoEF & CC**

MITCON®
Solutions for Sustainable Tomorrow

Format No. EME/LAB/Format 7.8/TR

## Test Report

**Report Number : MITCON/2024-25/August/7219** **Issue Date: 14/08/2024**

| | | | | | |
|---|---|---|---|---|---|
| 21 | Silica as $SiO_3$ | 3.89 | mg/l | N.S. | APHA 4500 SIO2, C 4-175 to 4-177 ,23rd Ed.2017. |
| 22 | Sodium as Na | 6.12 | mg/l | N.S. | APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS) |
| 23 | Potassium as K | <1 | mg/l | N.S. | APHA 3111B, 3-20 to 3-21 ,23rd Ed.2017. (AAS) |
| 24 | Hexavalent Chromium (as Cr6+) | <0.02 | mg/l | N.S. | APHA 3500 Cr-B 3-71 23rd Ed.2017. |
| 25 | Iron (as Fe) | <0.05 | mg/l | ≤ 0.3 | APHA 3111 B, 3-18 to 3-21 , 23rd Ed.2017. |
| 26 | Copper (as Cu) | <0.04 | mg/l | ≤ 0.05 | APHA 3111 B, 3-18 to 3-21 , 23rd Ed.2017. (AAS) |
| 27 | Nickel | <0.01 | mg/l | ≤ 0.01 | APHA 3111 B, 3-18 TO 3-21, 23rd Ed.2017.(AAS) |
| 28 | Zinc as Zn | <0.05 | mg/l | ≤ 5 | APHA 3111 B, 3-18 TO 3-21, 23rd Ed.2017.(AAS) |
| 29 | Manganese | <0.1 | mg/l | ≤ 0.1 | APHA 3111 B, 3-18 TO 3-21, 23rd Ed.2017.(AAS) |
| 30 | Chromium | <0.03 | mg/l | ≤ 0.05 | APHA 3111 B, 3-18 TO 3-21, 23rd Ed.2017.(AAS) |
| 31 | Lead | <0.01 | mg/l | ≤ 0.01 | APHA 3111 B, 3-18 TO 3-21, 23rd Ed.2017.(AAS) |
| 32 | cadmium | <0.003 | mg/l | ≤ 0.003 | APHA 3111 B, 3-18 TO 3-2123rd Ed.2017.(AAS) |
| 33 | Phenol | <0.001 | mg/l | ≤ 0.001 | IS 3025 (Part 43)(Rev 1:R.A: 2014 |
| **BACTERIOLOGICAL POTABILITY** | | | | | |
| 01 | Total Coliforms | Absent | Per100 ml | Absent | IS: 1622 (R.A 1 2014) |
| 02 | E-coli | Absent | Per100 ml | Absent | IS: 1622 (R.A 1 2014) |

**For MITCON Consultancy & Engineering Services Ltd.**

**Checked By**
(Mrs. Kadambari Deshmukh)

**Authorized Signatory**
Dr. Sandeep Jadhav
(Senior Vice President)

- *This Report is valid for tested sample only.*
- *This Report shall not be reproduced except in full & with written permission of MITCON.*
- *This Report should not be used for advertisement / judicial purpose.*
- *Customer complaint register is available in the laboratory.*

**MITCON Consultancy & Engineering Services Ltd.**
Environment Management and Engineering Division
(Environment Laboratory)
Agriculture College Campus, Next to DIC office, Shivaji Nagar, Pune. 411 005,
Ph. No. 66289405/400, email: emelab@mitconindia.com
- **ISO 45001:2018 Certified Laboratory.**
- **Recognized by MoEF & CC**

MITCON®
Solutions for Sustainable Tomorrow

Format No. EME/LAB/Format 7.8/TR

# Test Report

**Report Number : MITCON/2024-25/August/7219** **Issue Date: 14/08/2024**

| Client's Name & Address | Sample Details | |
|---|---|---|
| **M/s. Maharashtra Metro Rail Corporation Limited**<br><br>**Project Name** – Extension of Phase-I from Swargate to Katraj | **Sample Code** | **MITCON/2024-25/August/7219/14** |
| | **Name of Sample** | GW3 |
| | **Sample Details** | Padmavati Metro station |
| | **Container Details** | 2 lit Plastic Can + 100 ml Sterile bottle |
| | **Sample Collected By** | MITCON |
| | **Method of sampling** | IS 3025 (Part I) |
| | **Sample Collected On** | 7/8/2024 |
| | **Date of Sample Receipt** | 7/8/2024 |
| | **Analysis Start Date** | 8/8/2024 |
| | **End Date of Analysis** | 14/8/2024 |

## ANALYSIS RESULTS

| Sr. No | Parameters | Results | Unit | IS:10500:2012 Required Standards | Test Methods |
|---|---|---|---|---|---|
| **CHEMICAL POTABILITY** | | | | | |
| 1. | pH at 25 °C | 7.39 | - | 6.50 to 8.50 | APHA 4500 H+, A, 4-95, 23rd Ed.2017. |
| 2 | Temperature | 24.6 | °C | N.S. | APHA 2550 B,2-69 to 2-70 ,23rd Ed.2017. |
| 3 | Electrical Conductivity at 25 °C | 389.6 | µS/cm | N.S. | APHA 2510 B,2-56 to 2-58 ,23rd Ed.2017. |
| 4 | Turbidity | <1 | NTU | ≤ 1 | IS: 3025 Part-10 (Rev.1,RA:2012) |
| 5 | Total Dissolved Solids | 174.0 | mg/l | ≤ 500 | APHA 2540 C, 2-69 to 2-70, 23rd Ed.2017. |
| 6 | Total Solids | 177.0 | mg/l | N.S. | APHA 2540 C, 2-68 to 2-69, 23rd Ed.2017. |
| 7 | Total suspended Solids | <5 | mg/l | N.S | APHA 2540 D ,2-70 to 2-71 23rd Ed 2017 |
| 8 | Acidity as $CaCO_3$ | <5 | mg/l | N.S. | IS 3025 (part 22),1986,(Rev 1R.A.2014) |
| 9 | Total Alkalinity as $CaCO_3$ | 85.16 | mg/l | ≤ 200 | APHA 2320 B, 2-37 to 2-3923rd Ed.2017.. |
| 10 | Total Hardness as $CaCO_3$ | 97.16 | mg/l | ≤ 200 | APHA 2340 C ,2-48 to 2-50,23rd Ed.2017. |
| 11 | Calcium as Ca | 28.85 | mg/l | ≤ 75 | APHA 3500 Ca B, 3.-69 to 3-70,23rd Ed.2017. |
| 12 | Magnesium as Mg | 20.12 | mg/l | ≤ 30 | APHA 3500 Mg B, 3.-86 ,23rd Ed.2017. |
| 13 | Chloride as $Cl^-$ | 38.70 | mg/l | ≤ 250 | APHA 4500 Cl B,4-75 to 4-76,23rd Ed.2017. |
| 14 | Sulphates as $SO_4$ | 14.13 | mg/l | ≤ 200 | APHA 4500 SO4-E,4-199 to 4-200 23rd Ed.2017. |
| 15 | Nitrate as NO3 | <1.0 | mg/l | ≤ 45 | APHA 4500 NO3 - B 4-127 23rd Ed.2017. |
| 16 | Ammonical Nitrogen as $NH_4$-N | <0.1 | mg/l | N.S. | APHA 4500 $NH_3$ F, 4-119 to 4-120 23rd Ed.2017. |
| 17 | Total Kjeldahl Nitrogen as NH3-N | <1 | mg/l | N.S. | APHA 4500 N org B and 4500 N-$NH_3$ C |
| 18 | salinity | 0.069 | ppt | N.S. | By Calculation |
| 19 | Fluoride as F | <0.1 | mg/l | ≤ 1.0 | APHA 4500 F-D 4-90 to 4-91 ,23rd Ed.2017. |
| 20 | Total Phosphorous | <1 | mg/l | N.S. | APHA 4500 P-C4-162, 23rd Ed.2017. |

- *This Report is valid for tested sample only.*
- *This Report shall not be reproduced except in full & with written permission of MITCON.*
- *This Report should not be used for advertisement / judicial purpose.*
- *Customer complaint register is available in the laboratory.*

**MITCON Consultancy & Engineering Services Ltd.**
Environment Management and Engineering Division
(Environment Laboratory)
Agriculture College Campus, Next to DIC office, Shivaji Nagar, Pune. 411 005,
Ph. No. 66289405/400, email: emelab@mitconindia.com
- **ISO 45001:2018 Certified Laboratory.**
- **Recognized by MoEF & CC**

Format No. EME/LAB/Format 7.8/TR

## Test Report

**Report Number : MITCON/2024-25/August/7219** **Issue Date: 14/08/2024**

| | | | | | |
|---|---|---|---|---|---|
| 21 | Silica as $SiO_3$ | 5.02 | mg/l | N.S. | APHA 4500 SIO2, C 4-175 to 4-177 ,23rd Ed.2017. |
| 22 | Sodium as Na | 4.95 | mg/l | N.S. | APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS) |
| 23 | Potassium as K | <1 | mg/l | N.S. | APHA 3111B, 3-20 to 3-21 ,23rd Ed.2017. (AAS) |
| 24 | Hexavalent Chromium (as Cr6+) | <0.02 | mg/l | N.S. | APHA 3500 Cr-B 3-71 23rd Ed.2017. |
| 25 | Iron (as Fe) | <0.05 | mg/l | ≤ 0.3 | APHA 3111 B, 3-18 to 3-21 , 23rd Ed.2017. |
| 26 | Copper (as Cu) | <0.04 | mg/l | ≤ 0.05 | APHA 3111 B, 3-18 to 3-21 , 23rd Ed.2017. (AAS) |
| 27 | Nickel | <0.01 | mg/l | ≤ 0.01 | APHA 3111 B, 3-18 TO 3-21, 23rd Ed.2017.(AAS) |
| 28 | Zinc as Zn | <0.05 | mg/l | ≤ 5 | APHA 3111 B, 3-18 TO 3-21, 23rd Ed.2017.(AAS) |
| 29 | Manganese | <0.1 | mg/l | ≤ 0.1 | APHA 3111 B, 3-18 TO 3-21, 23rd Ed.2017.(AAS) |
| 30 | Chromium | <0.03 | mg/l | ≤ 0.05 | APHA 3111 B, 3-18 TO 3-21, 23rd Ed.2017.(AAS) |
| 31 | Lead | <0.01 | mg/l | ≤ 0.01 | APHA 3111 B, 3-18 TO 3-21, 23rd Ed.2017.(AAS) |
| 32 | cadmium | <0.003 | mg/l | ≤ 0.003 | APHA 3111 B, 3-18 TO 3-2123rd Ed.2017.(AAS) |
| 33 | Phenol | <0.001 | mg/l | ≤ 0.001 | IS 3025 (Part 43)(Rev 1:R.A: 2014 |
| **BACTERIOLOGICAL POTABILITY** | | | | | |
| 01 | Total Coliforms | Absent | Per100 ml | Absent | IS: 1622 (R.A 1 2014) |
| 02 | E-coli | Absent | Per100 ml | Absent | IS: 1622 (R.A 1 2014) |

**For MITCON Consultancy & Engineering Services Ltd.**

**Checked By**
(Mrs. Kadambari Deshmukh)

**Authorized Signatory**
Dr. Sandeep Jadhav
(Senior Vice President)

- *This Report is valid for tested sample only.*
- *This Report shall not be reproduced except in full & with written permission of MITCON.*
- *This Report should not be used for advertisement / judicial purpose.*
- *Customer complaint register is available in the laboratory.*

**MITCON Consultancy & Engineering Services Ltd.**
Environment Management and Engineering Division
(Environment Laboratory)
Agriculture College Campus, Next to DIC office, Shivaji Nagar, Pune. 411 005,
Ph. No. 66289405/400, email: emelab@mitconindia.com
- **ISO 45001:2018 Certified Laboratory.**
- **Recognized by MoEF & CC**

MITCON®
Solutions for Sustainable Tomorrow

Format No. EME/LAB/Format 7.8/TR

# Test Report

**Report Number : MITCON/2024-25/August/7219** **Issue Date: 14/08/2024**

| Client's Name & Address | Sample Details | |
|---|---|---|
| **M/s. Maharashtra Metro Rail Corporation Limited**<br><br>**Project Name** – Extension of Phase-I from Swargate to Katraj | **Sample Code** | **MITCON/2024-25/August/7219/15** |
| | **Name of Sample** | GW4 |
| | **Sample Details** | Katraj metro station |
| | **Container Details** | 2 lit Plastic Can + 100 ml Sterile bottle |
| | **Sample Collected By** | MITCON |
| | **Method of sampling** | IS 3025 (Part I) |
| | **Sample Collected On** | 7/8/2024 |
| | **Date of Sample Receipt** | 7/8/2024 |
| | **Analysis Start Date** | 8/8/2024 |
| | **End Date of Analysis** | 14/8/2024 |

## ANALYSIS RESULTS

| Sr. No | Parameters | Results | Unit | IS:10500:2012 Required Standards | Test Methods |
|---|---|---|---|---|---|
| **CHEMICAL POTABILITY** | | | | | |
| 1. | pH at 25 °C | 7.27 | - | 6.50 to 8.50 | APHA 4500 H+, A, 4-95, 23rd Ed.2017. |
| 2 | Temperature | 24.3 | °C | N.S. | APHA 2550 B,2-69 to 2-70 ,23rd Ed.2017. |
| 3 | Electrical Conductivity at 25 °C | 271.5 | µS/cm | N.S. | APHA 2510 B,2-56 to 2-58 ,23rd Ed.2017. |
| 4 | Turbidity | <1 | NTU | ≤ 1 | IS: 3025 Part-10 (Rev.1,RA:2012) |
| 5 | Total Dissolved Solids | 142.0 | mg/l | ≤ 500 | APHA 2540 C, 2-69 to 2-70, 23rd Ed.2017. |
| 6 | Total Solids | 144.0 | mg/l | N.S. | APHA 2540 C, 2-68 to 2-69, 23rd Ed.2017. |
| 7 | Total suspended Solids | <5 | mg/l | N.S | APHA 2540 D ,2-70 to 2-71 23rd Ed 2017 |
| 8 | Acidity as $CaCO_3$ | <5 | mg/l | N.S. | IS 3025 (part 22),1986,(Rev 1R.A.2014) |
| 9 | Total Alkalinity as $CaCO_3$ | 71.25 | mg/l | ≤ 200 | APHA 2320 B, 2-37 to 2-3923rd Ed.2017.. |
| 10 | Total Hardness as $CaCO_3$ | 82.52 | mg/l | ≤ 200 | APHA 2340 C ,2-48 to 2-50,23rd Ed.2017. |
| 11 | Calcium as Ca | 32.16 | mg/l | ≤ 75 | APHA 3500 Ca B, 3.-69 to 3-70,23rd Ed.2017. |
| 12 | Magnesium as Mg | 17.45 | mg/l | ≤ 30 | APHA 3500 Mg B, 3.-86 ,23rd Ed.2017. |
| 13 | Chloride as $Cl^-$ | 39.15 | mg/l | ≤ 250 | APHA 4500 Cl B,4-75 to 4-76,23rd Ed.2017. |
| 14 | Sulphates as $SO_4$ | 13.37 | mg/l | ≤ 200 | APHA 4500 SO4-E,4-199 to 4-200 23rd Ed.2017. |
| 15 | Nitrate as NO3 | <1.0 | mg/l | ≤ 45 | APHA 4500 NO3 - B 4-127 23rd Ed.2017. |
| 16 | Ammonical Nitrogen as $NH_4$-N | <0.1 | mg/l | N.S. | APHA 4500 $NH_3$ F, 4-119 to 4-120 23rd Ed.2017. |
| 17 | Total Kjeldahl Nitrogen as NH3-N | <1 | mg/l | N.S. | APHA 4500 N org B and 4500 N-$NH_3$ C |
| 18 | salinity | 0.071 | ppt | N.S. | By Calculation |
| 19 | Fluoride as F | <0.1 | mg/l | ≤ 1.0 | APHA 4500 F-D 4-90 to 4-91 ,23rd Ed.2017. |
| 20 | Total Phosphorous | <1 | mg/l | N.S. | APHA 4500 P-C4-162, 23rd Ed.2017. |

- *This Report is valid for tested sample only.*
- *This Report shall not be reproduced except in full & with written permission of MITCON.*
- *This Report should not be used for advertisement / judicial purpose.*
- *Customer complaint register is available in the laboratory.*

**MITCON Consultancy & Engineering Services Ltd.**
Environment Management and Engineering Division
(Environment Laboratory)
Agriculture College Campus, Next to DIC office, Shivaji Nagar, Pune. 411 005,
Ph. No. 66289405/400, email: emelab@mitconindia.com
- **ISO 45001:2018 Certified Laboratory.**
- **Recognized by MoEF & CC**

MITCON® Solutions for Sustainable Tomorrow

Format No. EME/LAB/Format 7.8/TR

## Test Report

**Report Number : MITCON/2024-25/August/7219** **Issue Date: 14/08/2024**

| | | | | | |
|---|---|---|---|---|---|
| 21 | Silica as $SiO_3$ | 4.38 | mg/l | N.S. | APHA 4500 SIO2, C 4-175 to 4-177 ,23rd Ed.2017. |
| 22 | Sodium as Na | 2.73 | mg/l | N.S. | APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS) |
| 23 | Potassium as K | <1 | mg/l | N.S. | APHA 3111B, 3-20 to 3-21 ,23rd Ed.2017. (AAS) |
| 24 | Hexavalent Chromium (as Cr6+) | <0.02 | mg/l | N.S. | APHA 3500 Cr-B 3-71 23rd Ed.2017. |
| 25 | Iron (as Fe) | <0.05 | mg/l | ≤ 0.3 | APHA 3111 B, 3-18 to 3-21 , 23rd Ed.2017. |
| 26 | Copper (as Cu) | <0.04 | mg/l | ≤ 0.05 | APHA 3111 B, 3-18 to 3-21 , 23rd Ed.2017. (AAS) |
| 27 | Nickel | <0.01 | mg/l | ≤ 0.01 | APHA 3111 B, 3-18 TO 3-21, 23rd Ed.2017.(AAS) |
| 28 | Zinc as Zn | <0.05 | mg/l | ≤ 5 | APHA 3111 B, 3-18 TO 3-21, 23rd Ed.2017.(AAS) |
| 29 | Manganese | <0.1 | mg/l | ≤ 0.1 | APHA 3111 B, 3-18 TO 3-21, 23rd Ed.2017.(AAS) |
| 30 | Chromium | <0.03 | mg/l | ≤ 0.05 | APHA 3111 B, 3-18 TO 3-21, 23rd Ed.2017.(AAS) |
| 31 | Lead | <0.01 | mg/l | ≤ 0.01 | APHA 3111 B, 3-18 TO 3-21, 23rd Ed.2017.(AAS) |
| 32 | cadmium | <0.003 | mg/l | ≤ 0.003 | APHA 3111 B, 3-18 TO 3-2123rd Ed.2017.(AAS) |
| 33 | Phenol | <0.001 | mg/l | ≤ 0.001 | IS 3025 (Part 43)(Rev 1:R.A: 2014 |
| **BACTERIOLOGICAL POTABILITY** | | | | | |
| 01 | Total Coliforms | Absent | Per100 ml | Absent | IS: 1622 (R.A 1 2014) |
| 02 | E-coli | Absent | Per100 ml | Absent | IS: 1622 (R.A 1 2014) |

**For MITCON Consultancy & Engineering Services Ltd.**

**Checked By**
(Mrs. Kadambari Deshmukh)

**Authorized Signatory**
Dr. Sandeep Jadhav
(Senior Vice President)

- *This Report is valid for tested sample only.*
- *This Report shall not be reproduced except in full & with written permission of MITCON.*
- *This Report should not be used for advertisement / judicial purpose.*
- *Customer complaint register is available in the laboratory.*

# Annexure-4:

Soil Quality Analyses
(Laboratory Reports)

**MITCON Consultancy & Engineering Services Ltd.**
Environment Management and Engineering Division
(Environment Laboratory)
Agriculture College Campus, Next to DIC office, Shivaji Nagar, Pune. 411 005,
Ph. No. 66289405/400, email: emelab@mitconindia.com
- **ISO 45001:2018 Certified Laboratory.**
- **Recognized by MoEF & CC**

MITCON®
Solutions for Sustainable Tomorrow

Format No. EME/LAB/Format 7.8/TR

# Test Report

**Report Number : MITCON/2024-25/August/7219** **Issue Date: 14/08/2024**

| Client's Name & Address | Sample Details | |
|---|---|---|
| **M/s. Maharashtra Metro Rail Corporation Limited**<br><br>**Project Name** – Extension of Phase-I from Swargate to Katraj | **Sample Code** | **MITCON/2024-25/August/7219/16** |
| | **Name of Sample** | Soil |
| | **Sample Details** | Swargate metro station |
| | **Container Details** | 1 kg plastic bag |
| | **Sample Collected By** | MITCON |
| | **Sample Collected On** | 7/8/2024 |
| | **Date of Sample Receipt** | 7/8/2024 |
| | **Analysis Start Date** | 8/8/2024 |
| | **End Date of Analysis** | 14/8/2024 |

**ANALYSIS RESULTS**

| Sr. No. | Parameters | Results | Unit | Test Method |
|---|---|---|---|---|
| 01 | Texture | Sandy | - | IS 2720 (Part 4) |
| 02 | Percentage Of Different Components | | | |
| | sand<br>Silt<br>Clay | 40.0<br>25.0<br>35.0 | %<br>%<br>% | IS 2720 (Part 4) |
| 03 | Soil Moisture | 17.15 | % | IS 2720 Part II1973 |
| 04 | Bulk Density | 1.13 | gm/cm$^2$ | IS 2720 (part XXIX) |
| 05 | Water Holding Capacity | 31.15 | % | IS 14767:2000 |
| 06 | pH | 8.19 | -- | IS 2720 (Part 26) 1987,Rev..2,Reaff 2011 |
| 07 | Conductivity | 315.15 | µs/cm | IS 14767,2000,Reaff 2016 |
| 08 | Organic Carbon | 0.16 | % | IS 2720 (Part 22) |
| 09 | Calcium (as Ca) | 85.16 | mg/kg | P.K Behra soil analysis manual |
| 10 | Magnesium (as Mg) | 38.14 | mg/kg | P.K Behra soil analysis manual |
| 11 | Available Nitrogen | 114.53 | kg/ha | IS 14684 |
| 12 | Phosphorous (as P) | 7.12 | kg/ha | IS 10158 |
| 13 | Potassium (as K) | 135.78 | kg/ha | USEPA 3050 B |
| 14 | Iron (as Fe) | 0.14 | mg/kg | USEPA 3050 B |
| 15 | Zinc (as Zn) | 0.32 | mg/kg | USEPA 3050 B |
| 16 | Copper (as Cu) | 0.48 | mg/kg | USEPA 3050 B |
| 17 | Sodium | 31.6 | mg/kg | USEPA 3050 B |
| 18 | Manganese (as Mn) | 0.23 | mg/kg | USEPA 3050 B |
| 19 | Total Chromium (as Cr) | <0.05 | mg/kg | USEPA 3050 B |
| 20 | Nickel (as Ni) | <0.02 | mg/kg | USEPA 3050 B |
| 21 | Cadmium (as Cd) | <0.05 | mg/kg | USEPA 3050 B |
| 22 | Lead (as Pb) | <0.1 | mg/kg | USEPA 3050 B |
| 23 | Sodium Absorption Ratio | 1.49 | - | EME/LAB/SOP/SAR |

**For MITCON Consultancy & Engineering Services Ltd.**

**Checked By**
(Mrs. Kadambari Deshmukh)

**Authorized Signatory**
Dr. Sandeep Jadhav
(Senior Vice President)

- *This Report is valid for tested sample only.*
- *This Report shall not be reproduced except in full & with written permission of MITCON.*
- *This Report should not be used for advertisement / judicial purpose.*
- *Customer complaint register is available in the laboratory.*

**MITCON Consultancy & Engineering Services Ltd.**
Environment Management and Engineering Division
(Environment Laboratory)
Agriculture College Campus, Next to DIC office, Shivaji Nagar, Pune. 411 005,
Ph. No. 66289405/400, email: emelab@mitconindia.com
- **ISO 45001:2018 Certified Laboratory.**
- **Recognized by MoEF & CC**

MITCON®
Solutions for Sustainable Tomorrow

Format No. EME/LAB/Format 7.8/TR

# Test Report

**Report Number : MITCON/2024-25/August/7219** **Issue Date: 14/08/2024**

| Client's Name & Address | Sample Details | |
|---|---|---|
| **M/s. Maharashtra Metro Rail Corporation Limited**<br><br>**Project Name** – Extension of Phase-I from Swargate to Katraj | **Sample Code** | **MITCON/2024-25/August/7219/17** |
| | **Name of Sample** | Soil |
| | **Sample Details** | Market yard gultekdi metro station |
| | **Container Details** | 1 kg plastic bag |
| | **Sample Collected By** | MITCON |
| | **Sample Collected On** | 7/8/2024 |
| | **Date of Sample Receipt** | 7/8/2024 |
| | **Analysis Start Date** | 8/8/2024 |
| | **End Date of Analysis** | 14/8/2024 |

**ANALYSIS RESULTS**

| Sr. No. | Parameters | Results | Unit | Test Method |
|---|---|---|---|---|
| 01 | Texture | Sandy loam | - | IS 2720 (Part 4) |
| 02 | Percentage Of Different Components | | | |
| | sand<br>Silt<br>Clay | 25.0<br>20.0<br>55.0 | %<br>%<br>% | IS 2720 (Part 4) |
| 03 | Soil Moisture | 13.15 | % | IS 2720 Part II1973 |
| 04 | Bulk Density | 1.08 | gm/cm$^2$ | IS 2720 (part XXIX) |
| 05 | Water Holding Capacity | 43.6 | % | IS 14767:2000 |
| 06 | pH | 8.02 | -- | IS 2720 (Part 26) 1987,Rev..2,Reaff 2011 |
| 07 | Conductivity | 745.64 | µs/cm | IS 14767,2000,Reaff 2016 |
| 08 | Organic Carbon | 0.18 | % | IS 2720 (Part 22) |
| 09 | Calcium (as Ca) | 75.16 | mg/kg | P.K Behra soil analysis manual |
| 10 | Magnesium (as Mg) | 55.37 | mg/kg | P.K Behra soil analysis manual |
| 11 | Available Nitrogen | 114.37 | kg/ha | IS 14684 |
| 12 | Phosphorous (as P) | 8.92 | kg/ha | IS 10158 |
| 13 | Potassium (as K) | 116.37 | kg/ha | USEPA 3050 B |
| 14 | Iron (as Fe) | 0.27 | mg/kg | USEPA 3050 B |
| 15 | Zinc (as Zn) | 0.32 | mg/kg | USEPA 3050 B |
| 16 | Copper (as Cu) | 0.52 | mg/kg | USEPA 3050 B |
| 17 | Sodium | 29.6 | mg/kg | USEPA 3050 B |
| 18 | Manganese (as Mn) | 0.24 | mg/kg | USEPA 3050 B |
| 19 | Total Chromium (as Cr) | <0.05 | mg/kg | USEPA 3050 B |
| 20 | Nickel (as Ni) | <0.02 | mg/kg | USEPA 3050 B |
| 21 | Cadmium (as Cd) | <0.05 | mg/kg | USEPA 3050 B |
| 22 | Lead (as Pb) | <0.1 | mg/kg | USEPA 3050 B |
| 23 | Sodium Absorption Ratio | 1.32 | - | EME/LAB/SOP/SAR |

**For MITCON Consultancy & Engineering Services Ltd.**

**Checked By**
(Mrs. Kadambari Deshmukh)

**Authorized Signatory**
Dr. Sandeep Jadhav
(Senior Vice President)

- *This Report is valid for tested sample only.*
- *This Report shall not be reproduced except in full & with written permission of MITCON.*
- *This Report should not be used for advertisement / judicial purpose.*
- *Customer complaint register is available in the laboratory.*

**MITCON Consultancy & Engineering Services Ltd.**
Environment Management and Engineering Division
(Environment Laboratory)
Agriculture College Campus, Next to DIC office, Shivaji Nagar, Pune. 411 005,
Ph. No. 66289405/400, email: emelab@mitconindia.com
- **ISO 45001:2018 Certified Laboratory.**
- **Recognized by MoEF & CC**

MITCON®
Solutions for Sustainable Tomorrow

Format No. EME/LAB/Format 7.8/TR

# Test Report

**Report Number : MITCON/2024-25/August/7219** **Issue Date: 14/08/2024**

| Client's Name & Address | Sample Details | |
|---|---|---|
| **M/s. Maharashtra Metro Rail Corporation Limited**<br><br>**Project Name** – Extension of Phase-I from Swargate to Katraj | **Sample Code** | **MITCON/2024-25/August/7219/18** |
| | **Name of Sample** | Soil |
| | **Sample Details** | Padmavati Metro station |
| | **Container Details** | 1 kg plastic bag |
| | **Sample Collected By** | MITCON |
| | **Sample Collected On** | 7/8/2024 |
| | **Date of Sample Receipt** | 7/8/2024 |
| | **Analysis Start Date** | 8/8/2024 |
| | **End Date of Analysis** | 14/8/2024 |

**ANALYSIS RESULTS**

| Sr. No. | Parameters | Results | Unit | Test Method |
|---|---|---|---|---|
| 01 | Texture | Silty loam | - | IS 2720 (Part 4) |
| 02 | Percentage Of Different Components | | | |
| | sand<br>Silt<br>Clay | 19.0<br>35.0<br>46.0 | %<br>%<br>% | IS 2720 (Part 4) |
| 03 | Soil Moisture | 18.12 | % | IS 2720 Part II1973 |
| 04 | Bulk Density | 1.10 | gm/cm$^2$ | IS 2720 (part XXIX) |
| 05 | Water Holding Capacity | 61.45 | % | IS 14767:2000 |
| 06 | pH | 8.02 | -- | IS 2720 (Part 26) 1987,Rev..2,Reaff 2011 |
| 07 | Conductivity | 769.4 | µs/cm | IS 14767,2000,Reaff 2016 |
| 08 | Organic Carbon | 0.16 | % | IS 2720 (Part 22) |
| 09 | Calcium (as Ca) | 78.54 | mg/kg | P.K Behra soil analysis manual |
| 10 | Magnesium (as Mg) | 38.33 | mg/kg | P.K Behra soil analysis manual |
| 11 | Available Nitrogen | 105.14 | kg/ha | IS 14684 |
| 12 | Phosphorous (as P) | 5.23 | kg/ha | IS 10158 |
| 13 | Potassium (as K) | 118.73 | kg/ha | USEPA 3050 B |
| 14 | Iron (as Fe) | 0.25 | mg/kg | USEPA 3050 B |
| 15 | Zinc (as Zn) | 0.20 | mg/kg | USEPA 3050 B |
| 16 | Copper (as Cu) | 0.16 | mg/kg | USEPA 3050 B |
| 17 | Sodium | 32.7 | mg/kg | USEPA 3050 B |
| 18 | Manganese (as Mn) | 0.12 | mg/kg | USEPA 3050 B |
| 19 | Total Chromium (as Cr) | <0.05 | mg/kg | USEPA 3050 B |
| 20 | Nickel (as Ni) | <0.02 | mg/kg | USEPA 3050 B |
| 21 | Cadmium (as Cd) | <0.05 | mg/kg | USEPA 3050 B |
| 22 | Lead (as Pb) | <0.1 | mg/kg | USEPA 3050 B |
| 23 | Sodium Absorption Ratio | 1.57 | - | EME/LAB/SOP/SAR |

**For MITCON Consultancy & Engineering Services Ltd.**

**Checked By**
(Mrs. Kadambari Deshmukh)

**Authorized Signatory**
Dr. Sandeep Jadhav
(Senior Vice President)

- *This Report is valid for tested sample only.*
- *This Report shall not be reproduced except in full & with written permission of MITCON.*
- *This Report should not be used for advertisement / judicial purpose.*
- *Customer complaint register is available in the laboratory.*

**MITCON Consultancy & Engineering Services Ltd.**
Environment Management and Engineering Division
(Environment Laboratory)
Agriculture College Campus, Next to DIC office, Shivaji Nagar, Pune. 411 005,
Ph. No. 66289405/400, email: emelab@mitconindia.com
- **ISO 45001:2018 Certified Laboratory.**
- **Recognized by MoEF & CC**

MITCON®
Solutions for Sustainable Tomorrow

Format No. EME/LAB/Format 7.8/TR

# Test Report

**Report Number : MITCON/2024-25/August/7219** **Issue Date: 14/08/2024**

| Client's Name & Address | Sample Details | |
|---|---|---|
| **M/s. Maharashtra Metro Rail Corporation Limited**<br><br>**Project Name** – Extension of Phase-I from Swargate to Katraj | **Sample Code** | **MITCON/2024-25/August/7219/19** |
| | **Name of Sample** | Soil |
| | **Sample Details** | YCI College of CNC Technology |
| | **Container Details** | 1 kg plastic bag |
| | **Sample Collected By** | MITCON |
| | **Sample Collected On** | 7/8/2024 |
| | **Date of Sample Receipt** | 7/8/2024 |
| | **Analysis Start Date** | 8/8/2024 |
| | **End Date of Analysis** | 14/8/2024 |

**ANALYSIS RESULTS**

| Sr. No. | Parameters | Results | Unit | Test Method |
|---|---|---|---|---|
| 01 | Texture | Sandy loam | - | IS 2720 (Part 4) |
| 02 | Percentage Of Different Components | | | |
| | sand<br>Silt<br>Clay | 44.0<br>22.0<br>34.0 | %<br>%<br>% | IS 2720 (Part 4) |
| 03 | Soil Moisture | 14.23 | % | IS 2720 Part II1973 |
| 04 | Bulk Density | 1.07 | gm/cm$^2$ | IS 2720 (part XXIX) |
| 05 | Water Holding Capacity | 55.65 | % | IS 14767:2000 |
| 06 | pH | 8.02 | -- | IS 2720 (Part 26) 1987,Rev..2,Reaff 2011 |
| 07 | Conductivity | 714.52 | µs/cm | IS 14767,2000,Reaff 2016 |
| 08 | Organic Carbon | 0.18 | % | IS 2720 (Part 22) |
| 09 | Calcium (as Ca) | 91.27 | mg/kg | P.K Behra soil analysis manual |
| 10 | Magnesium (as Mg) | 41.20 | mg/kg | P.K Behra soil analysis manual |
| 11 | Available Nitrogen | 90.16 | kg/ha | IS 14684 |
| 12 | Phosphorous (as P) | 5.43 | kg/ha | IS 10158 |
| 13 | Potassium (as K) | 102.18 | kg/ha | USEPA 3050 B |
| 14 | Iron (as Fe) | 0.31 | mg/kg | USEPA 3050 B |
| 15 | Zinc (as Zn) | 0.47 | mg/kg | USEPA 3050 B |
| 16 | Copper (as Cu) | 0.12 | mg/kg | USEPA 3050 B |
| 17 | Sodium | 33.7 | mg/kg | USEPA 3050 B |
| 18 | Manganese (as Mn) | 0.19 | mg/kg | USEPA 3050 B |
| 19 | Total Chromium (as Cr) | <0.05 | mg/kg | USEPA 3050 B |
| 20 | Nickel (as Ni) | <0.02 | mg/kg | USEPA 3050 B |
| 21 | Cadmium (as Cd) | <0.05 | mg/kg | USEPA 3050 B |
| 22 | Lead (as Pb) | <0.1 | mg/kg | USEPA 3050 B |
| 23 | Sodium Absorption Ratio | 1.53 | - | EME/LAB/SOP/SAR |

**For MITCON Consultancy & Engineering Services Ltd.**

**Checked By**
(Mrs. Kadambari Deshmukh)

**Authorized Signatory**
Dr. Sandeep Jadhav
(Senior Vice President)

- *This Report is valid for tested sample only.*
- *This Report shall not be reproduced except in full & with written permission of MITCON.*
- *This Report should not be used for advertisement / judicial purpose.*
- *Customer complaint register is available in the laboratory.*

**MITCON Consultancy & Engineering Services Ltd.**
Environment Management and Engineering Division
(Environment Laboratory)
Agriculture College Campus, Next to DIC office, Shivaji Nagar, Pune. 411 005,
Ph. No. 66289405/400, email: emelab@mitconindia.com
- **ISO 45001:2018 Certified Laboratory.**
- **Recognized by MoEF & CC**

MITCON
Solutions for Sustainable Tomorrow

Format No. EME/LAB/Format 7.8/TR

# Test Report

**Report Number : MITCON/2024-25/August/7219** **Issue Date: 14/08/2024**

| Client's Name & Address | Sample Details | |
|---|---|---|
| **M/s. Maharashtra Metro Rail Corporation Limited**<br><br>**Project Name** – Extension of Phase-I from Swargate to Katraj | **Sample Code** | **MITCON/2024-25/August/7219/20** |
| | **Name of Sample** | Soil |
| | **Sample Details** | Katraj Metro station |
| | **Container Details** | 1 kg plastic bag |
| | **Sample Collected By** | MITCON |
| | **Sample Collected On** | 7/8/2024 |
| | **Date of Sample Receipt** | 7/8/2024 |
| | **Analysis Start Date** | 8/8/2024 |
| | **End Date of Analysis** | 14/8/2024 |

**ANALYSIS RESULTS**

| Sr. No. | Parameters | Results | Unit | Test Method |
|---|---|---|---|---|
| 01 | Texture | Silty loam | - | IS 2720 (Part 4) |
| 02 | Percentage Of Different Components | | | |
| | sand<br>Silt<br>Clay | 25.0<br>23.0<br>52.0 | %<br>%<br>% | IS 2720 (Part 4) |
| 03 | Soil Moisture | 13.25 | % | IS 2720 Part II1973 |
| 04 | Bulk Density | 1.10 | gm/cm$^2$ | IS 2720 (part XXIX) |
| 05 | Water Holding Capacity | 60.23 | % | IS 14767:2000 |
| 06 | pH | 8.02 | -- | IS 2720 (Part 26) 1987,Rev..2,Reaff 2011 |
| 07 | Conductivity | 714.52 | µs/cm | IS 14767,2000,Reaff 2016 |
| 08 | Organic Carbon | 0.18 | % | IS 2720 (Part 22) |
| 09 | Calcium (as Ca) | 91.27 | mg/kg | P.K Behra soil analysis manual |
| 10 | Magnesium (as Mg) | 41.20 | mg/kg | P.K Behra soil analysis manual |
| 11 | Available Nitrogen | 90.16 | kg/ha | IS 14684 |
| 12 | Phosphorous (as P) | 5.43 | kg/ha | IS 10158 |
| 13 | Potassium (as K) | 102.18 | kg/ha | USEPA 3050 B |
| 14 | Iron (as Fe) | 0.31 | mg/kg | USEPA 3050 B |
| 15 | Zinc (as Zn) | 0.47 | mg/kg | USEPA 3050 B |
| 16 | Copper (as Cu) | 0.12 | mg/kg | USEPA 3050 B |
| 17 | Sodium | 33.7 | mg/kg | USEPA 3050 B |
| 18 | Manganese (as Mn) | 0.19 | mg/kg | USEPA 3050 B |
| 19 | Total Chromium (as Cr) | <0.05 | mg/kg | USEPA 3050 B |
| 20 | Nickel (as Ni) | <0.02 | mg/kg | USEPA 3050 B |
| 21 | Cadmium (as Cd) | <0.05 | mg/kg | USEPA 3050 B |
| 22 | Lead (as Pb) | <0.1 | mg/kg | USEPA 3050 B |
| 23 | Sodium Absorption Ratio | 1.53 | - | EME/LAB/SOP/SAR |

**For MITCON Consultancy & Engineering Services Ltd.**

**Checked By**
(Mrs. Kadambari Deshmukh)

**Authorized Signatory**
Dr. Sandeep Jadhav
(Senior Vice President)

- *This Report is valid for tested sample only.*
- *This Report shall not be reproduced except in full & with written permission of MITCON.*
- *This Report should not be used for advertisement / judicial purpose.*
- *Customer complaint register is available in the laboratory.*

# Annexure-5:

Air Quality Modelling / Ground Level Concentrations (GLCs) Report

# Annexure-5 : Air Quality Modelling_GLC Report

## Project Description

Maha Metro is a Special Purpose Vehicle (SPV) created for the smooth implementation and operations of the Pune Metro Rail Project and is an equal equity joint venture of Government of India (GoI) & Government of Maharashtra (GoM). PMRP shall be solely responsible for the successful and timely completion of the project & its operations subsequently.

Systra has carried out the investigation and studies for Pune Metro Rail Project (PCMC TO NIGDI & Swargate to Katraj) (North - Southward Extension of Corridor-1 of Phase 1) and prepared a Detailed Project Report (DPR) in August 2021 & December 2021 respectively based on which the project is proposed to be implemented

## Description of PMRP Swargate to Katraj (Phase-1 Extension)

Proposed extension Corridor comprise of 3 Underground stations from Swargte to Katraj with a total length of 5.464 km as given in Table 1

*Table 1 Description of PMRP Phase I Extension*

| Corridor | Stations | | | |
|---|---|---|---|---|
| | Underground | At Grade | Total | Underground |
| Swargate to Katraj (Phase-1 Extension) | 5 | **0** | 5 | 0 |
| **Total** | **5** | **0** | **5** | **0** |

**Route Alignment: Swargate to Katraj**

- Proposed alignment of Phase-1 extension from Swargate and goes up to Katraj near Rajeev Gandhi Zoological Park. Total length of the corridor is 5.464 km which is completely underground.
- This corridor is an extension of existing corridor 1 under Phase 1 i.e. PCMC to Swargate in the south.
- 5 Stations have been proposed in extension corridor, all of which are underground stations. Summary of the section is given below

The proposed alignment is an extension of Pune Metro Phase 1

Total 3 stations (underground) are proposed in this corridor are summarized as under **in Table 2,** while Line 1 map presented as **Figure 1**

*Table 2 PMRP Phase 1 Extension from Swargate to Katraj with chainage & distance*

| Name of Stations | Chainage (m) | Intermediate Distance (km) | Type |
|---|---|---|---|
| Station 1 (Market Yard, Gultekdi) | 17982 | 0.78 | Underground |
| Station 2 (Bibwewadi) | 19568 | 2.1 | Underground |
| Station 3 (Padamavati) | | | Underground |
| Station 4 (BalajiNagar) | | | Underground |
| Station 5 (Katraj) | 21860 | 2.23 | Underground |

*Figure 1 Alignment Map of PRMRP Phase 1 Extension Corridor (Swargate to Katraj) showing station locations*




Total length of corridor is 5.464 km, which is fully underground**.** Station – Near Padmavati has been proposed on the south side of road, whereas Station – Near Market Yard and Katraj Station has been proposed on the median of the road (when travelling from Swargate to Katraj).

**Baseline Monitoring with respect to Air Environment**

**1. Ambient Air Environment**

Air quality is an important parameter of the baseline environment and its study is an indispensable tool for planning further development in the adjoining areas of the project. The extant air quality was studied to assess the current status of the same and to check the air quality status of the region vis-à-vis the air quality standards prescribed by the Central Pollution Control Board.

**(a) Methodology (Criteria for choice of Parameters for Air monitoring)**

The Air Quality Index monitored in India comprises Particulate matter, carbon monoxide,

sulphur dioxide, nitrogen dioxide, ammonia, lead and ozone. The US EPA list of criteria pollutants comprises all of the above except ammonia. As per WHO, concentrations of nitrogen dioxide are often strongly correlated with those of other toxic pollutants, and because it is easier to measure, it is often used as a surrogate for the pollutant mixture as a whole. Wide adverse effects of particulate matter (PM) are observed in both short-term and long-term exposures. It is possible to derive a quantitative relationship between the concentration of the pollutant as monitored in ambient air and specific health outcomes (usually mortality).

The biggest source of lead in air is petrol and mining: neither of them are present in Pune and so lead was not measured. Ammonia was not measured because it is highly reactive making it difficult for monitoring instruments to capture it; uncertainty surrounding sources; the gas can have a very short life span. Ozone is a secondary pollutant resulting from action of nitrogen oxides and VOCs; nitrogen oxides are measured as dioxide and therefore ozone was not measured.

The sampling and analysis of ambient air quality parameters was carried out as per the procedures detailed in relevant Parts of IS-5182 (Indian Standards for Ambient Air Quality Parameters).

The following air pollution parameters were monitored and measured by sampling:

(i) Particulate Matter less than 10µm ($PM_{10}$)
(ii) Particulate Matter less than 2.5µm (PM2.5)
(iii) Sulphur dioxide ($SO_2$)
(iv) Oxides of nitrogen ($NO_X$)
(v) Carbon monoxide (CO)

### (b) Sampling Period, Frequency and Parameters

Ambient air quality monitoring was conducted at a total of 6 locations in the project study area. Location maps showing Air sampling locations for Swargate to Katraj Corridor is presented as **Figure 2.** The monitoring locations have been selected primarily based on the predominant wind direction. The other factors considered while selection of the monitoring stations include accessibility, location of receptors and availability of power. Justification for selection of the locations for ambient Air quality monitoring in the Project Study area is summarised in **Table 3**

*Table 3 Justification for selection of AAQ locations*

| Corridor | AAQ locations at PMRP-P1 Stations | AAQ locations at Sensitive Receptors | Crosswind Locations | Downwind Locations | Upwind Locations |
|---|---|---|---|---|---|
| 2A | 6 | 1 | 2 | 4 | 0 |

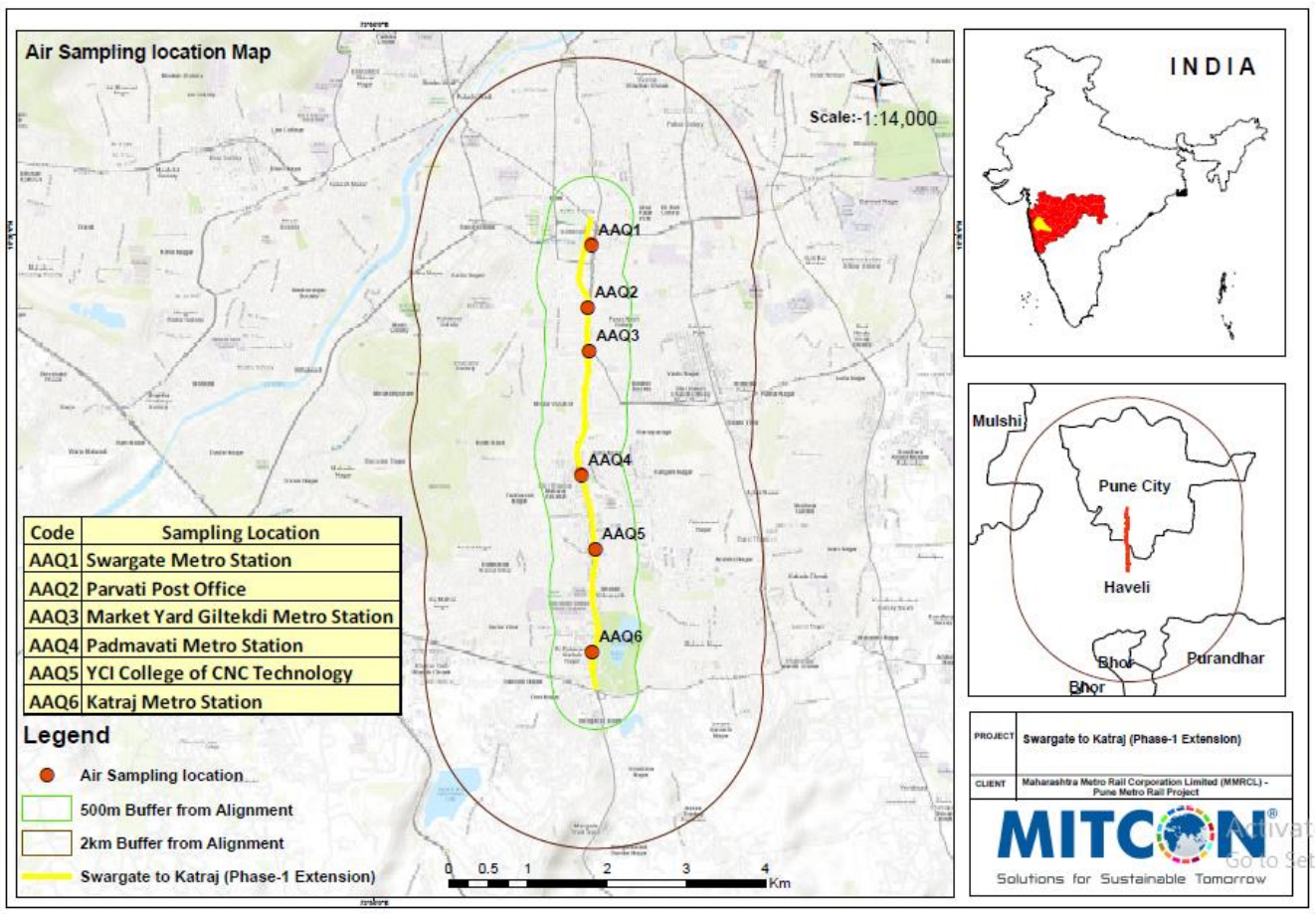
*Table 4 Ambient Air Quality Stations monitored in Project Study Area*

| Sampling Code | Sampling Location | Type of Sample | Latitude | Longitude | Wind type[#] |
|---|---|---|---|---|---|
| AAQ.1 | Swargate Metro Station | Commercial | 18°29'55.80" N | 73°51'28.55" E | C W |
| AAQ.2 | Parvati Post Office | Commercial | 18°29'30.35" N | 73°51'27.13" E | DW |
| AAQ.3 | Market Yard Giltekdi Metro Station | Commercial | 18°29'12.40" N | 73°51'27.66" E | D W |

| Sampling Code | Sampling Location | Type of Sample | Latitude | Longitude | Wind type[#] |
|---|---|---|---|---|---|
| AAQ.4 | Padmavati Metro Station | Commercial | 18°28'21.87" N | 73°51'24.42" E | D W |
| AAQ.5 | YCI College of CNC Technology | Silent | 18°27'51.47" N | 73°51'30.11" E | DW |
| AAQ.6 | Katraj Metro Station | Commercial | 18°27'9.33"N | 73°51'28.83" E | C W |

[#] *DW – Down-wind; CW – Cross-wind; UW – Up-wind.*

*Figure 2 Air Monitoring Locations for Swaragte to Katraj Corridor*




### (c) Ambient Air Quality Results

The air pollutants emitted by point and non-point sources are transported, dispersed or concentrated by meteorological and topographical conditions. Error! Reference source not found. shows a summary of the analytical results of Air Quality monitoring samples gathered in the Project Study Area.

*Table 5 Summary of Results of Ambient Air Quality monitoring*

| Sampling Location | $PM_{2.5}$ (60 µg/m³) | $PM_{10}$ (100 µg/m³) | $SO_2$ (80 µg/m³) | $NO_X$ (80 µg/m³) | CO (2 mg/m³) |
|---|---|---|---|---|---|
| **AAQ1** | 36.75 | 87.41 | 24.95 | 31.57 | 1.74 |
| **AAQ2** | 27.54 | 56.74 | 14.85 | 19.74 | 0.18 |
| **AAQ3** | 34.58 | 73.85 | 20.25 | 28.45 | 1.25 |
| **AAQ4** | 33.85 | 78.45 | 22.74 | 30.14 | 1.05 |

| | | | | | |
|---|---|---|---|---|---|
| **AAQ5** | 21.74 | 47.14 | <10 | 15.54 | 0.08 |
| **AAQ6** | 37.85 | 82.74 | 25.74 | 34.85 | 1.85 |

**Anticipated Impacts during Operation Phase**

During Operation Phase, the significant impact on air pollution will be due to operation of D.G. Set. However, D.G. Sets will be operated only in case of emergency power failure. Each station will be provided with 1 no. of D.G. Set of capacity 250 kVA as an emergency power back up.

**Air modelling**

It is to provide a means of calculating ambient ground-level concentrations of an emitted substance given information about the emissions and the nature of the atmosphere. The amount released can be determined from knowledge of the process or actual measurements. It is a steady-state plume model. In the stable boundary layer (SBL), it assumes the concentration distribution to be Gaussian in both the vertical and horizontal. In the convective boundary layer (CBL), the horizontal distribution is also assumed to be Gaussian, but the vertical distribution is described with a bi-Gaussian probability density function.

AERMOD constructs vertical profiles of required meteorological variables based on measurements and extrapolations of those measurements using similarity (scaling) relationships. Vertical profiles of wind speed, wind direction, turbulence, temperature, and temperature gradient are estimated using all available meteorological observations. AERMOD requires only a single surface measurement of wind speed, wind direction and ambient temperature. Like ISC3, AERMOD also needs observed cloud cover.

**Input to the Model**

The input parameters required for carrying out Air Modelling are presented Table 6

*Table 6 The input parameters required for carrying out Air Modelling*

| Sr. No. | Particulates | DG Set 250 kVA |
|---|---|---|
| 1. | Fuel Firing rate (lit/hr) | 56.9 |
| 2. | Fuel Type | HSD |
| 3. | Temperature ($^{O}$C) | 550 |
| 4. | Volumetric Flow rate (Nm3/hr) | 226.65 |
| 5. | Height (m) | 20 |
| 6. | Stack dia.(m) | 0.18 |
| 7. | Exit velocity (m/s) | 12 |
| 8. | Emission Rate of PM10 (g/s) carried for impact Assessment | 0.02 |
| 9. | Emission Rate of SO2 (g/s) carried for impact Assessment | 0.07 |
| 10. | Emission Rate of NOx (g/s) carried for impact Assessment | 0.44 |

* **Note –** The operation of all the DG sets has been considered simultaneously for 24 hours as worst-case scenario. Since Ash Content in HSD is 0.01%, $PM_{2.5}$ is not emitted hence not considered for modelling.

**Study Area**

10 km radius study area has been considered from the centre of each alignment and the contours are plotted accordingly.

**Meteorological Data**

Meteorology data from IMD for Pune Station (nearest IMD Station) for the period of July and August, for wind speed, wind direction and temperature has been used for computations. Hourly atmospheric stability has been calculated. As the site-specific mixing heights are not available, the mixing height data as published by CPCB document PROBES/88/2002-2003 is followed for project area has been considered for modelling. A baseline monitoring of 24 hours was conducted in July and August during non-rainy days to determine the present conditions of the site. The same results have been used a background concentration.

**Results & Discussion**

The short-term ground level concentrations predicted for SPM within study area is presented Below

The isopleths of incremental concentration for $PM_{10}$, $SO_2$ & $NO_X$ have been shown **Figure 3 to Figure 5** Cumulative concentration at the receptors due to operation of DG sets for PM10, SO2 & NOX have been shown in **Table 7** to **Table 9** below –

*Figure 3 Isopleth of Incremental concentration of PM10*

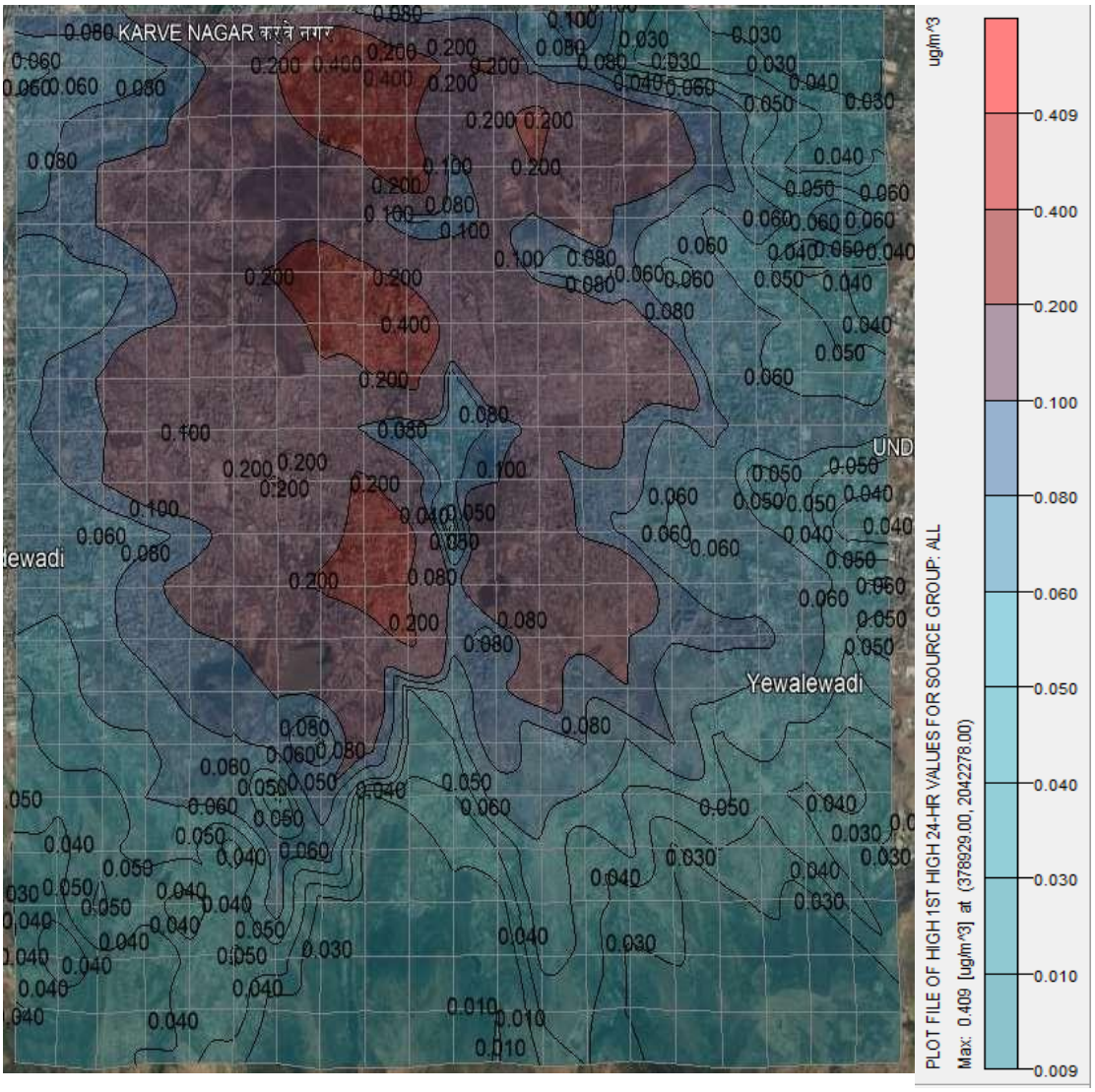


*Table 7 Cumulative concentration of PM10*

| Sampling Location | Sampling Location | $PM_{10}$ (100 µg/m$^3$) | Incremental Concentration (µg/m3) | Total Concentration (µg/m3) |
|---|---|---|---|---|
| **AAQ1** | Swargate Metro Station | 87.41 | - | 87.41 |
| **AAQ2** | Parvati Post Office | 56.74 | 0.2 | 56.94 |
| **AAQ3** | Market Yard Giltekdi Metro Station | 73.85 | 0.4 | 74.25 |
| **AAQ4** | Padmavati Metro Station | 78.45 | 0.2 | 78.65 |
| **AAQ5** | YCI College of CNC Technology | 47.14 | 0.2 | 47.34 |
| **AAQ6** | Katraj Metro Station | 82.74 | 0.05 | 82.79 |

*Figure 4 Isopleth of Incremental concentration of SO2*

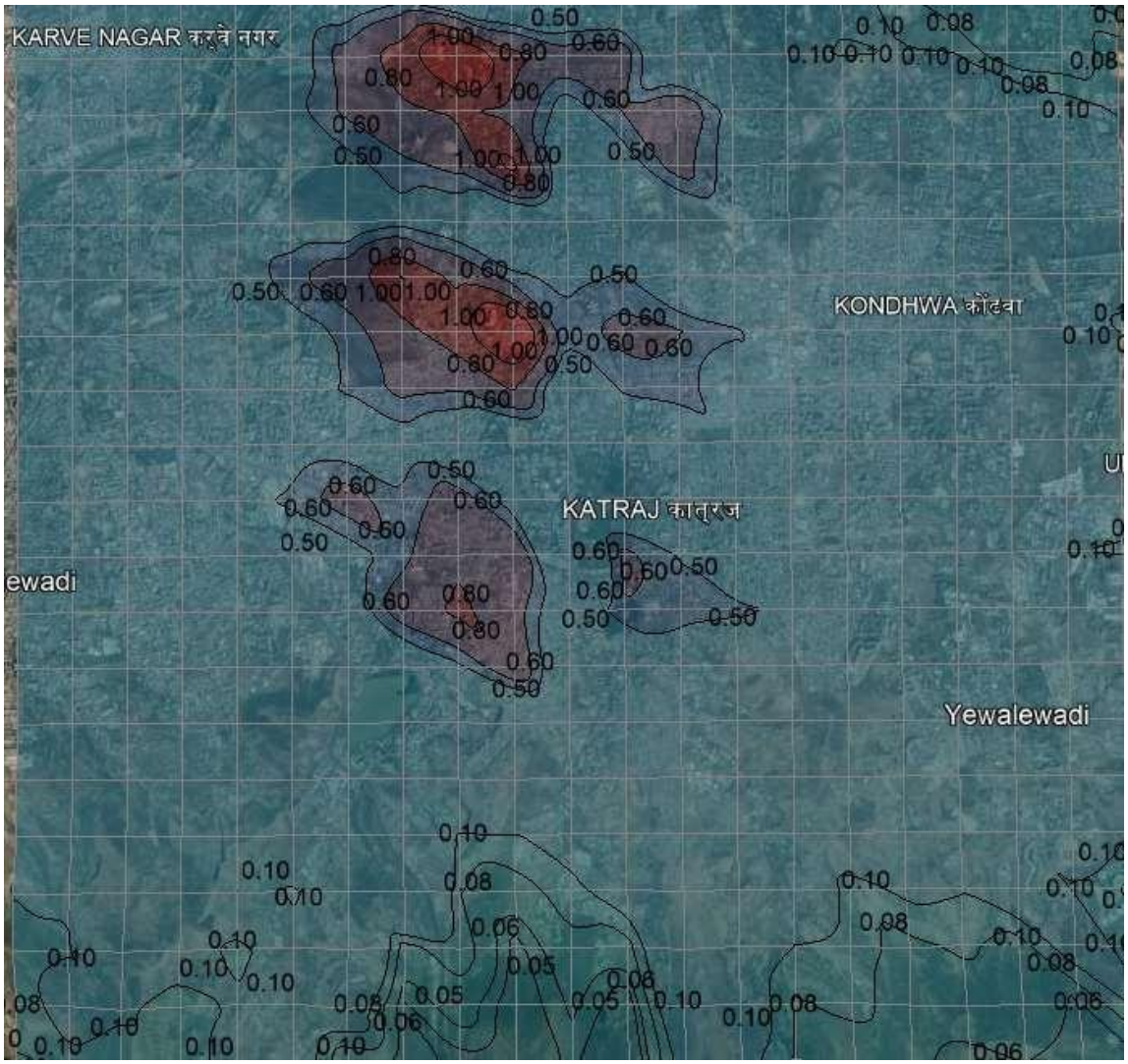


*Table 8 Cumulative concentration of SO2*

| Sampling Location | Sampling Location | Baseline Concentration (µg/m3) | Incremental Concentration (µg/m3) | Total Concentration (µg/m3) |
|---|---|---|---|---|
| **AAQ1** | Swargate Metro Station | 24.95 | - | 24.95 |
| **AAQ2** | Parvati Post Office | 14.85 | 0.80 | 15.65 |
| **AAQ3** | Market Yard Giltekdi Metro Station | 20.25 | 1.00 | 21.25 |
| **AAQ4** | Padmavati Metro Station | 22.74 | 0.60 | 23.34 |
| **AAQ5** | YCI College of CNC Technology | <10 | 0.60 | 10.60 |
| **AAQ6** | Katraj Metro Station | 25.74 | 0.60 | 26.34 |

*Figure 5 Isopleth of Incremental concentration of NOx*

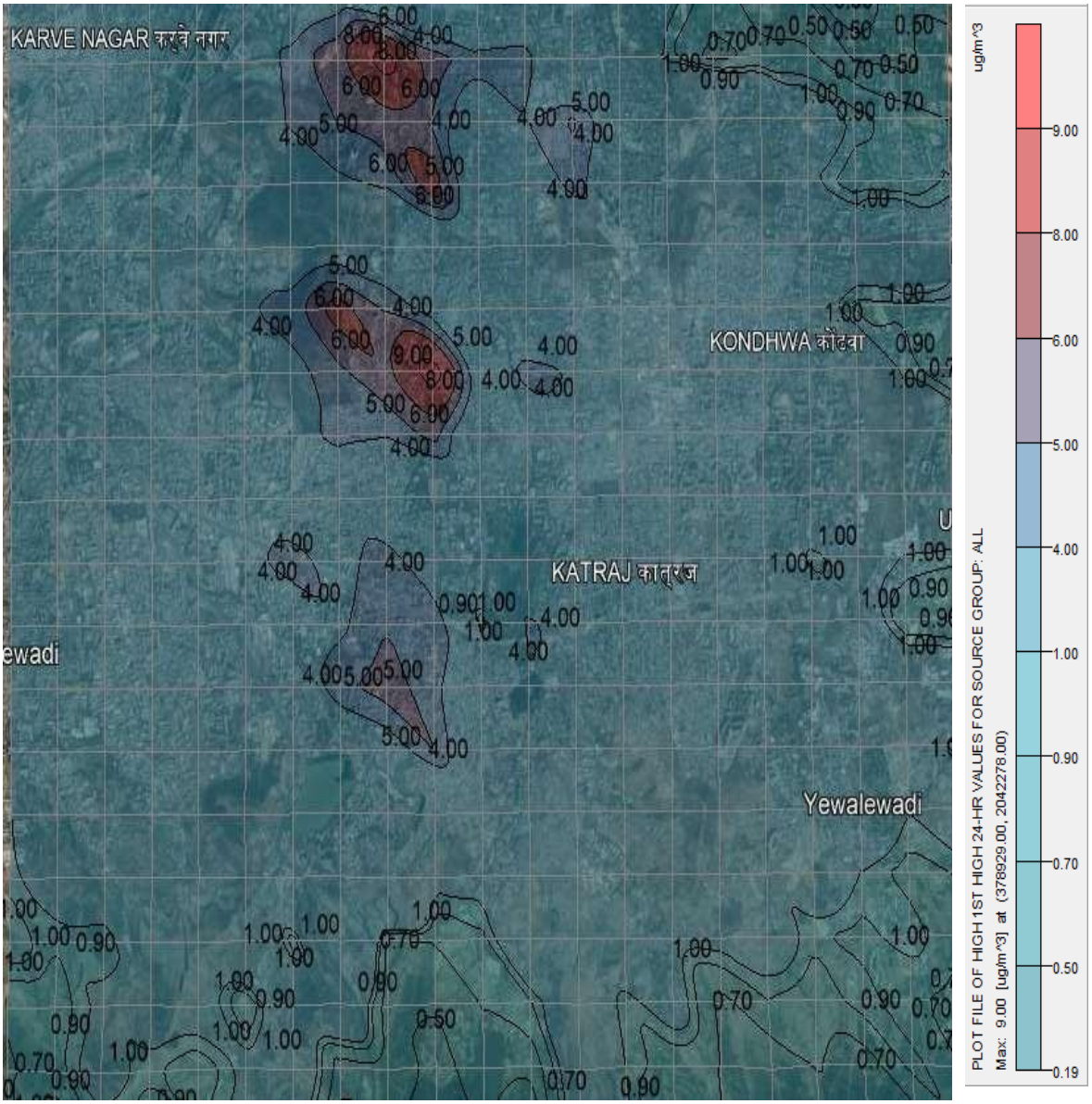


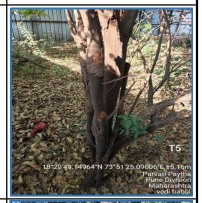
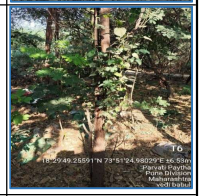
*Table 9 Cumulative concentration of NOx*

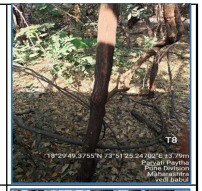
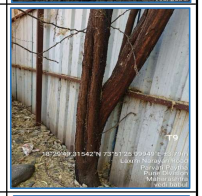
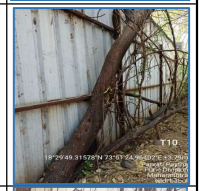
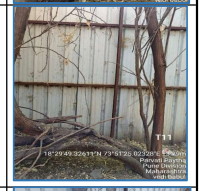
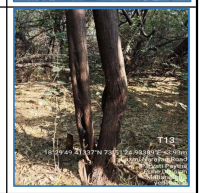
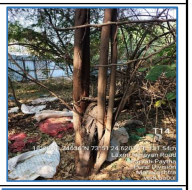
| Sampling Location | Sampling Location | Baseline Concentration (µg/m3) | Incremental Concentration (µg/m3) | Total Concentration (µg/m3) |
|---|---|---|---|---|
| **AAQ1** | Swargate Metro Station | 31.57 | - | 31.57 |
| **AAQ2** | Parvati Post Office | 19.74 | 4.00 | 23.74 |
| **AAQ3** | Market Yard Giltekdi Metro Station | 28.45 | 6.00 | 34.45 |
| **AAQ4** | Padmavati Metro Station | 30.14 | 5.00 | 35.14 |
| **AAQ5** | YCI College of CNC Technology | 15.54 | 4.00 | 19.54 |
| **AAQ6** | Katraj Metro Station | 34.85 | 1.00 | 35.85 |

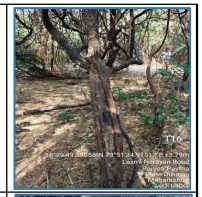
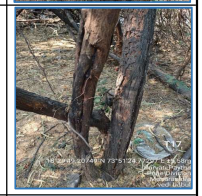
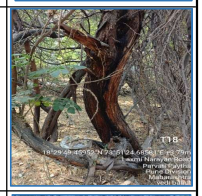
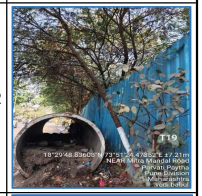
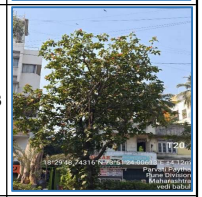
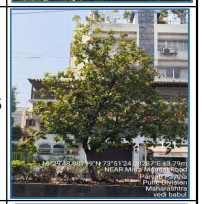
# Annexure-6:

List of Trees likely to be Affected

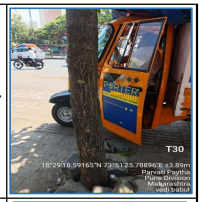
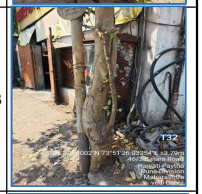
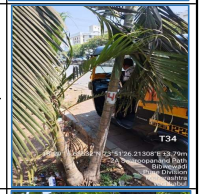
## Annexure-6: List of Trees likely to be Affected

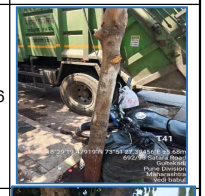
| Section | Side | Sr.No. | Botanical Name | Family | Name of Tree | GBH (M) | Height (m) | Canopy (m) | Age in years (approx) | GPS Location | Tree Photo |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | *Neltuma juliflora* (Sw.) Raf. | Fabaceae | Vedi Babul | 80 | 6 | 5 | 23 | 18.496904, 73.856788 |  |
| | | 2 | *Neltuma juliflora* (Sw.) Raf. | Fabaceae | Vedi Babul | 21 | 4 | 2 | 8 | 18.496891, 73.856814 |  |
| | | 3 | *Neltuma juliflora* (Sw.) Raf. | Fabaceae | Vedi Babul | 28 | 4 | 2 | 9 | 18.496883, 73.856848 |  |
| | | 4 | *Neltuma juliflora* (Sw.) Raf. | Fabaceae | Vedi Babul | 29 | 6 | 3 | 9 | 18.496894, 73.856885 |  |
| | | 5 | *Neltuma juliflora* (Sw.) Raf. | Fabaceae | Vedi Babul | 23 | 4 | 2 | 8 | 18.496930, 73.856910 |  |
| | | 6 | *Neltuma juliflora* (Sw.) Raf. | Fabaceae | Vedi Babul | 30 | 5 | 3 | 9 | 18.496936, 73.856877 |  |
| | | 7 | *Neltuma juliflora* (Sw.) Raf. | Fabaceae | Vedi Babul | 38 | 6 | 4 | 9 | 18.496940, 73.856844 |  |

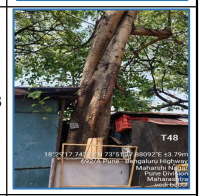
| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Swargate** | **Median Trees** | **8** | *Neltuma juliflora* (Sw.) Raf. | Fabaceae | Vedi Babul | 30 | 5 | 2 | 8 | 18.496974, 73.856808 |  |
| | | **9** | *Neltuma juliflora* (Sw.) Raf. | Fabaceae | Vedi Babul | 42 | 6 | 3 | 10 | 18.496966, 73.856915 |  |
| | | **10** | *Neltuma juliflora* (Sw.) Raf. | Fabaceae | Vedi Babul | 65 | 4 | 4 | 14 | 18.496997, 73.856938 |  |
| | | **11** | *Neltuma juliflora* (Sw.) Raf. | Fabaceae | Vedi Babul | 70 | 4 | 2 | 17 | 18.497034, 73.856974 |  |
| | | **12** | *Neltuma juliflora* (Sw.) Raf. | Fabaceae | Vedi Babul | 21 | 3 | 1 | 8 | 18.497022, 73.856944 |  |
| | | **13** | *Neltuma juliflora* (Sw.) Raf. | Fabaceae | Vedi Babul | 42 | 7 | 4 | 10 | 18.497026, 73.856889 |  |
| | | **14** | *Neltuma juliflora* (Sw.) Raf. | Fabaceae | Vedi Babul | 49 | 6 | 3 | 12 | 18.497056, 73.856909 |  |
| | | **15** | *Neltuma juliflora* (Sw.) Raf. | Fabaceae | Vedi Babul | 46 | 6 | 3 | 11 | 18.496904, 73.856981 |  |

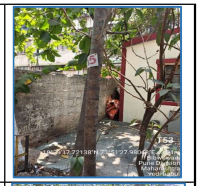
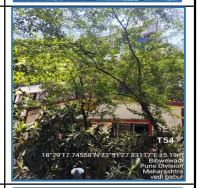
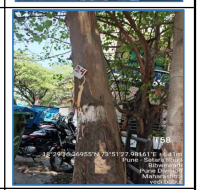
| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **16** | *Neltuma juliflora* (Sw.) Raf. | Fabaceae | Vedi Babul | 48 | 5 | 3 | 13 | 18.497080, 73.856930 |  |
| **17** | *Neltuma juliflora* (Sw.) Raf. | Fabaceae | Vedi Babul | 46 | 6 | 3 | 11 | 18.497075, 73.856915 |  |
| **18** | *Neltuma juliflora* (Sw.) Raf. | Fabaceae | Vedi Babul | 83 | 6 | 3 | 26 | 18.497056, 73.856864 |  |
| **19** | *Acacia nilotica* (L.) Delile | Leguminosae | Babul | 30 | 5 | 2 | 9 | 18.4969134, 73.8566852 |  |
| **20** | *Cordia sebestena* Forssk. | Boraginaceae | Scarlett | 45 | 5 | 3 | 10 | 18.4967824, 73.8566573 |  |
| **21** | *Cordia sebestena* Forssk. | Boraginaceae | Scarlett | 35 | 4 | 3 | 10 | 18.4967659, 73.8567395 |  |
| **22** | *Khaya senegalensis* A.Juss. | Meliaceae | Khaya | 316 | 13 | 8 | 109 | 18.4968374, 73.8568971 |  |

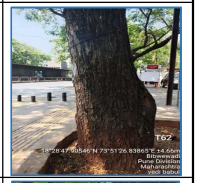
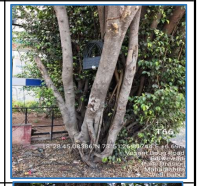
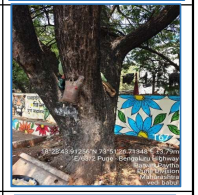
| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **23** | *Cordia sebestena* Forssk. | Boraginaceae | Scarlett | 35 | 4 | 3 | 8 | 18.4967462, 73.85689 |  |
| | | **24** | *Ficus racemosa* L. | Moraceae | Umbar | 83 | 8 | 4 | 22 | 18.4966638, 73.8568645 |  |
| | | **25** | *Ficus religiosa* L. | Moraceae | Pimpal | 204 | 12 | 6 | 73 | 18.4966657, 73.8568877 |  |
| | | **26** | *Ficus racemosa* L. | Moraceae | Umbar | 61 | 10 | 3 | 17 | 18.4966689, 73.8569162 |  |
| | | **27** | *Ficus benghalensis L.* | Moraceae | Vad | 170 | 6 | 5 | 95 | 18.4966603, 73.8569088 |  |
| | | **28** | *Terminalia catappa L.* | Combretaceae | Indian almond | 82 | 7 | 3 | 21 | 18.4873805, 73.8573175 |  |
| | | **29** | *Terminalia catappa L.* | Combretaceae | Indian almond | 45 | 4 | 2 | 9 | 18.4884244, 73.8571918 |  |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **30** | *Terminalia catappa L.* | Combretaceae | Indian almond | 47 | 6 | 3 | 11 | 18.4884473, 73.8571887 |  |
| | | **31** | *Polyalthia longifolia (Sonn.) Hook.f. & Thomson* | Annonaceae | Ashok | 70 | 10 | 3 | 16 | 18.4881821, 73.8572099 |  |
| | | **32** | *Ficus racemosa* L. | Moraceae | Umbar | 55 | 6 | 3 | 16 | 18.4883297, 73.8571938 |  |
| | | **33** | *Mangifera indica* L. | Anacardiaceae | Amba | 22 | 4 | 2 | 8 | 18.4879885, 73.8572826 |  |
| | **RHS** | **34** | *Dypsis lutescens (H.Wendl.)* | Arecaceae | Areca Palm | 25 | 3 | 1 | 9 | 18.4878931, 73.8573004 |  |
| | | **35** | *Terminalia catappa L.* | Combretaceae | Indian almond | 84 | 10 | 5 | 26 | 18.4878082, 73.8572903 |  |
| | | **36** | *Ficus racemosa* L. | Moraceae | Umbar | 103 | 8 | 4 | 46 | 18.4877061, 73.8572568 |  |

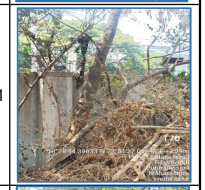
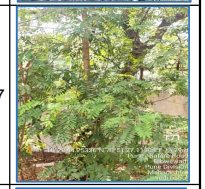
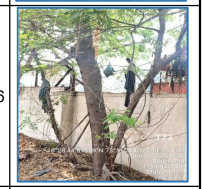
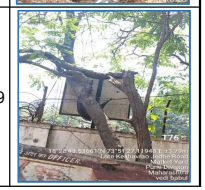
| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Market Yard Metro Station** | | **37** | *Ficus racemosa* L. | Moraceae | Umbar | 143 | 9 | 5 | 91 | 18.4875824, 73.8572712 |  |
| | | **38** | *Ficus benghalensis L.* | Moraceae | Vad | 230 | 8 | 5 | 114 | 18.4874444, 73.8573215 |  |
| | | **39** | *Terminalia catappa L.* | Combretaceae | Indian almond | 65 | 10 | 4 | 11 | 18.4874123, 73.857282 |  |
| | | **40** | *Ficus religiosa* L. | Moraceae | Pimpal | 240 | 10 | 5 | 123 | 18.4874034, 73.8573255 |  |
| | | **41** | *Terminalia catappa L.* | Combretaceae | Indian almond | 34 | 5 | 2 | 10 | 18.4887405, 73.8575596 |  |
| | | **42** | *Syzygium cumini* (L.) Skeels | Myrtaceae | Jamun | 65 | 6 | 4 | 17 | 18.4886966, 73.8575549 |  |
| | | **43** | *Ficus benjamina* L. | Moraceae | Nandruk | 32 | 5 | 3 | 8 | 18.4886648, 73.8575582 |  |
| | | **44** | *Samanea saman (Jacq.) Merr.* | Fabaceae | Rain Tree | 115 | 12 | 6 | 67 | 18.4886203, 73.8576065 |  |

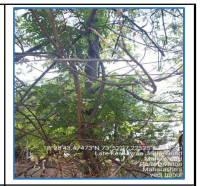
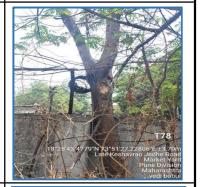
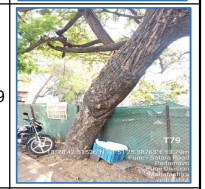
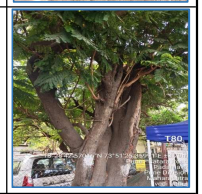
| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **45** | *Samanea saman (Jacq.) Merr.* | Fabaceae | Rain Tree | 184 | 12 | 6 | 113 | 18.4884893, 73.8576373 |  |
| | | **46** | *Samanea saman (Jacq.) Merr.* | Fabaceae | Rain Tree | 300 | 11 | 6 | 108 | 18.4883774, 73.8576373 |  |
| | | **47** | *Samanea saman (Jacq.) Merr.* | Fabaceae | Rain Tree | 163 | 12 | 6 | 84 | 18.4882505, 73.8576099 |  |
| | | **48** | *Ficus religiosa* L. | Moraceae | Pimpal | 190 | 13 | 6 | 85 | 18.4882925, 73.8576578 |  |
| | | **49** | *Polyalthia longifolia (Sonn.) Hook.f. & Thomson* | Annonaceae | Ashok | 60 | 10 | 2 | 11 | 18.4884327, 73.8576984 |  |
| | | **50** | *Polyalthia longifolia (Sonn.) Hook.f. & Thomson* | Annonaceae | Ashok | 66 | 9 | 2 | 13 | 18.4883882, 73.8577178 |  |
| | **LHS** | **51** | *Delonix regia (Hook.) Raf.* | Leguminosae | Gulmohar | 125 | 10 | 5 | 53 | 18.4883287, 73.8577262 |  |
| | | **52** | *Terminalia catappa L.* | Combretaceae | Indian almond | 40 | 6 | 3 | 11 | 18.4882928, 73.8577356 |  |

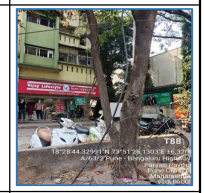
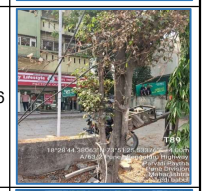
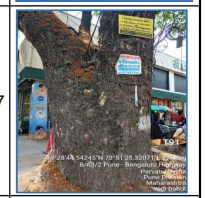
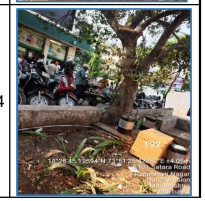
| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **53** | *Areca catechu* L. | Arecaceae | Supari | 28 | 8 | 2 | 9 | 18.4882991, 73.8577037 |  |
| | | **54** | *Pithecellobium dulce (Roxb.) Benth.* | Fabaceae | Vilayati Chinch | 20 | 3 | 1 | 7 | 18.4883049, 73.8576799 |  |
| | | **55** | *Samanea saman (Jacq.) Merr.* | Fabaceae | Rain Tree | 254 | 10 | 6 | 88 | 18.4881541, 73.8576498 |  |
| | | **56** | *Ficus religiosa* L. | Moraceae | Pimpal | 180 | 12 | 5 | 91 | 18.4879745, 73.8576819 |  |
| | | **57** | *Eucalyptus globulus* Labill. | Myrtaceae | Nilgiri | 104 | 12 | 4 | 39 | 18.4879684, 73.8577238 |  |
| | | **58** | *Eucalyptus globulus* Labill. | Myrtaceae | Nilgiri | 110 | 10 | 3 | 39 | 18.4879777, 73.8577466 |  |
| | | **59** | *Alstonia scholaris (L.) R. Br.* | Apocynaceae | Satvin | 171 | 12 | 5 | 48 | 18.4879789, 73.8577845 |  |
| | | **60** | *Samanea saman (Jacq.) Merr.* | Fabaceae | Rain Tree | 212 | 12 | 7 | 73 | 18.4804132, 73.8573829 |  |

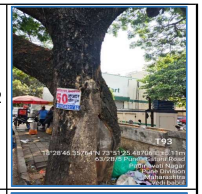
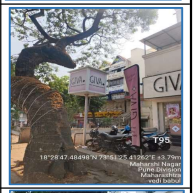
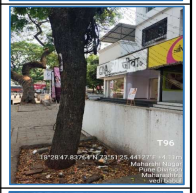
| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **61** | *Samanea saman (Jacq.) Merr.* | Fabaceae | Rain Tree | 280 | 11 | 6 | 85 | 18.4801646, 73.8573949 |  |
| **62** | *Samanea saman (Jacq.) Merr.* | Fabaceae | Rain Tree | 210 | 13 | 8 | 79 | 18.4800635, 73.8574221 |  |
| **63** | *Samanea saman (Jacq.) Merr.* | Fabaceae | Rain Tree | 285 | 12 | 6 | 88 | 18.4799700, 73.8574415 |  |
| **64** | *Samanea saman (Jacq.) Merr.* | Fabaceae | Rain Tree | 180 | 10 | 5 | 56 | 18.4798485, 73.8574757 |  |
| **65** | *Samanea saman (Jacq.) Merr.* | Fabaceae | Rain Tree | 340 | 12 | 7 | 93 | 18.4797073, 73.8574322 |  |
| **66** | *Ficus benjamina* L. | Moraceae | Nandruk | 50 | 9 | 4 | 10 | 18.4792252, 73.8574379 |  |
| **67** | *Samanea saman (Jacq.) Merr.* | Fabaceae | Rain Tree | 120 | 10 | 6 | 36 | 18.4789365, 73.8573966 |  |
| **68** | *Samanea saman (Jacq.) Merr.* | Fabaceae | Rain Tree | 180 | 10 | 6 | 51 | 18.4788481, 73.8574312 |  |

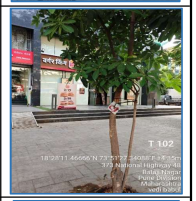
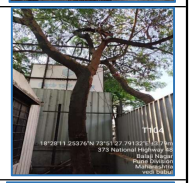
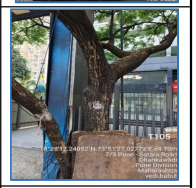
LHS

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **69** | *Leucaena leucocephala* (Lam.) de Wit | Mimosaceae | Subabul | 80 | 9 | 4 | 19 | 18.4790395, 73.8574452 |  |
| **70** | *Leucaena leucocephala* (Lam.) de Wit | Mimosaceae | Subabul | 50 | 7 | 3 | 14 | 18.4789976, 73.8574781 |  |
| **71** | *Cassia siamea Lam.* | Fabaceae | Kashid | 35 | 7 | 4 | 9 | 18.4789581, 73.8574677 |  |
| **72** | *Cassia siamea Lam.* | Fabaceae | Kashid | 55 | 8 | 3 | 16 | 18.4788894, 73.8574529 |  |
| **73** | *Cassia siamea Lam.* | Fabaceae | Kashid | 60 | 10 | 3 | 14 | 18.4788557, 73.8574456 |  |
| **74** | *Cassia siamea Lam.* | Fabaceae | Kashid | 66 | 10 | 3 | 15 | 18.4788297, 73.8574412 |  |
| **75** | *Cassia siamea Lam.* | Fabaceae | Kashid | 60 | 11 | 4 | 13 | 18.4787998, 73.8574409 |  |
| **76** | *Cassia siamea Lam.* | Fabaceae | Kashid | 70 | 10 | 4 | 21 | 18.4787797, 73.8574419 |  |

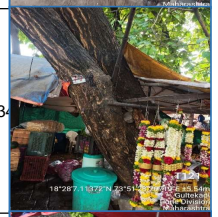
| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **77** | *Cassia siamea Lam.* | Fabaceae | Kashid | 60 | 9 | 3 | 14 | 18.4787613, 73.8575411 |  |
| **Bibavewadi Metro Station** | | **78** | *Samanea saman (Jacq.) Merr.* | Fabaceae | Rain Tree | 180 | 11 | 8 | 61 | 18.4784045, 73.8570188 |  |
| | | **79** | *Samanea saman (Jacq.) Merr.* | Fabaceae | Rain Tree | 120 | 10 | 4 | 29 | 18.4785171, 73.8569839 |  |
| | | **80** | *Peltophorum pterocarpum* (DC.) Baker | Fabaceae | Sonmohar | 60 | 7 | 2 | 13 | 18.4786621, 73.857007 |  |
| | | **81** | *Samanea saman (Jacq.) Merr.* | Fabaceae | Rain Tree | 115 | 12 | 6 | 24 | 18.4787638, 73.8570191 |  |
| | | **82** | *Samanea saman (Jacq.) Merr.* | Fabaceae | Rain Tree | 121 | 12 | 5 | 29 | 18.4788144, 73.8570302 |  |
| | | **83** | *Terminalia catappa L.* | Combretaceae | Indian almond | 109 | 11 | 4 | 22 | 18.4788360, 73.8570201 |  |
| | | **84** | *Sterculia foetida L.* | Malvaceae | Jangali Badam | 39 | 6 | 2 | 11 | 18.4788863, 73.8570349 |  |

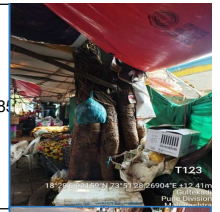
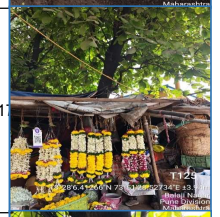
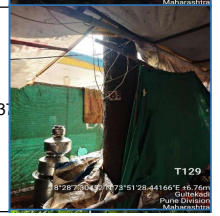
| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | RHS | **85** | *Sterculia foetida L.* | Malvaceae | Jangali Badam | 210 | 13 | 6 | 54 | 18.4789279, 73.8570201 |  |
| | | **86** | *Sterculia foetida L.* | Malvaceae | Jangali Badam | 62 | 14 | 4 | 13 | 18.4789467, 73.8570208 |  |
| | | **87** | *Roystonea regia* (Kunth) O.F.Cook | Arecaceae | Royal Palm | 120 | 10 | 4 | 28 | 18.4789721, 73.8570198 |  |
| | | **88** | *Ficus benjamina* L. | Moraceae | Nandruk | 60 | 6 | 3 | 12 | 18.4790103, 73.857011 |  |
| | | **89** | *Ficus benjamina* L. | Moraceae | Nandruk | 49 | 5 | 2 | 13 | 18.4790589, 73.8569926 |  |
| | | **90** | *Polyalthia longifolia (Sonn.) Hook.f. & Thomson* | Annonaceae | Ashok | 60 | 9 | 3 | 14 | 18.4790891, 73.8569896 |  |
| | | **91** | *Samanea saman (Jacq.) Merr.* | Fabaceae | Rain Tree | 320 | 12 | 6 | 129 | 18.4791648, 73.8570127 |  |
| | | **92** | *Ficus racemosa* L. | Moraceae | Umbar | 140 | 13 | 6 | 55 | 18.4792780, 73.8570134 |  |

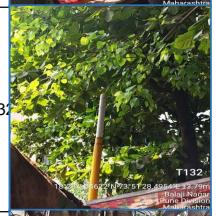
| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **93** | *Samanea saman (Jacq.) Merr.* | Fabaceae | Rain Tree | 260 | 12 | 6 | 73 | 18.4795362, 73.8570352 |  |
| | | **94** | *Samanea saman (Jacq.) Merr.* | Fabaceae | Rain Tree | 30 | 5 | 2 | 8 | 18.4796399, 73.8570097 |  |
| | | **95** | *Samanea saman (Jacq.) Merr.* | Fabaceae | Rain Tree | 320 | 11 | 6 | 111 | 18.4798285, 73.8570556 |  |
| | | **96** | *Cassia siamea Lam.* | Fabaceae | Kashid | 108 | 11 | 6 | 26 | 18.4799169, 73.8570211 |  |
| | | **97** | *Samanea saman (Jacq.) Merr.* | Fabaceae | Rain Tree | 320 | 13 | 7 | 113 | 18.4800472, 73.8570178 |  |
| | | **98** | *Samanea saman (Jacq.) Merr.* | Fabaceae | Rain Tree | 330 | 14 | 7 | 120 | 18.4802298, 73.8570268 |  |
| | | **99** | *Samanea saman (Jacq.) Merr.* | Fabaceae | Rain Tree | 180 | 12 | 6 | 67 | 18.4802997, 73.857004 |  |
| | | **100** | *Samanea saman (Jacq.) Merr.* | Fabaceae | Rain Tree | 310 | 13 | 7 | 95 | 18.4804221, 73.8570154 |  |

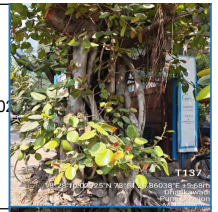
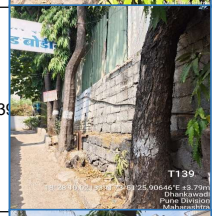
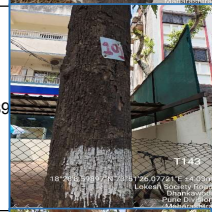
| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **101** | *Terminalia mantaly* H.Perrier | Combretaceae | China almond tree | 66 | 9 | 5 | 14 | 18.4699916, 73.8576655 |  |
| | | **102** | *Alstonia scholaris (L.) R. Br.* | Apocynaceae | Satvin | 19 | 4 | 2 | 7 | 18.4699480, 73.8576725 |  |
| | | **103** | *Alstonia scholaris (L.) R. Br.* | Apocynaceae | Satvin | 19 | 3 | 2 | 8 | 18.4699006, 73.8576789 |  |
| | | **104** | *Leucaena leucocephala* (Lam.) de Wit | Mimosaceae | Subabul | 160 | 10 | 4 | 37 | 18.4698081, 73.8576903 |  |
| | | **105** | *Samanea saman (Jacq.) Merr.* | Fabaceae | Rain Tree | 90 | 8 | 6 | 26 | 18.4700348, 73.8576226 |  |
| | | **106** | *Samanea saman (Jacq.) Merr.* | Fabaceae | Rain Tree | 75 | 10 | 5 | 23 | 18.4699559, 73.8576125 |  |
| | | **107** | *Samanea saman (Jacq.) Merr.* | Fabaceae | Rain Tree | 87 | 10 | 5 | 24 | 18.4699575, 73.8575914 |  |
| | | **108** | *Samanea saman (Jacq.) Merr.* | Fabaceae | Rain Tree | 105 | 10 | 5 | 31 | 18.4699092, 73.8576142 |  |

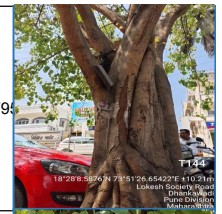
| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **109** | *Samanea saman (Jacq.) Merr.* | Fabaceae | Rain Tree | 120 | 10 | 6 | 29 | 18.4698688, 73.8576306 |  |
| **110** | *Samanea saman (Jacq.) Merr.* | Fabaceae | Rain Tree | 131 | 10 | 6 | 43 | 18.4698364, 73.8576353 |  |
| **111** | *Samanea saman (Jacq.) Merr.* | Fabaceae | Rain Tree | 80 | 9 | 4 | 19 | 18.4696780, 73.8576752 |  |
| **112** | *Samanea saman (Jacq.) Merr.* | Fabaceae | Rain Tree | 140 | 11 | 6 | 59 | 18.4695556, 73.8577084 |  |
| **113** | *Samanea saman (Jacq.) Merr.* | Fabaceae | Rain Tree | 140 | 10 | 6 | 51 | 18.4694621, 73.857754 |  |
| **114** | *Ficus racemosa* L. | Moraceae | Umbar | 90 | 8 | 4 | 30 | 18.4692328, 73.857818 |  |
| **115** | *Ficus racemosa* L. | Moraceae | Umbar | 120 | 8 | 4 | 34 | 18.4690347, 73.857872 |  |

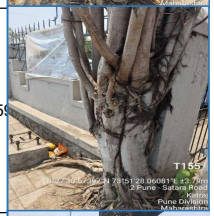
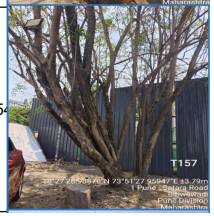
| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | LHS | **116** | *Samanea saman (Jacq.) Merr.* | Fabaceae | Rain Tree | 260 | 12 | 6 | 59 | 18.4689405, 73.857830 |  |
| | | **117** | *Samanea saman (Jacq.) Merr.* | Fabaceae | Rain Tree | 180 | 10 | 6 | 53 | 18.4688814, 73.857842 |  |
| | | **118** | *Syzygium cumini* (L.) Skeels | Myrtaceae | Jamun | 30 | 7 | 2 | 9 | 18.4688435, 73.857869 |  |
| | | **119** | *Terminalia catappa L.* | Combretaceae | Indian almond | 91 | 10 | 6 | 26 | 18.4688102, 73.857874 |  |
| | | **120** | *Samanea saman (Jacq.) Merr.* | Fabaceae | Rain Tree | 150 | 10 | 6 | 43 | 18.4687189, 73.857877 |  |
| | | **121** | *Samanea saman (Jacq.) Merr.* | Fabaceae | Rain Tree | 320 | 12 | 7 | 118 | 18.4686168, 73.857883 |  |
| | | **122** | *Samanea saman (Jacq.) Merr.* | Fabaceae | Rain Tree | 180 | 12 | 7 | 61 | 18.4685446, 73.857890 |  |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Padmavati Metro Station** | | **123** | *Ficus religiosa* L. | Moraceae | Pimpal | 250 | 13 | 6 | 73 | 18.4685284, 73.857948 |  |
| | | **124** | *Samanea saman (Jacq.) Merr.* | Fabaceae | Rain Tree | 140 | 10 | 6 | 56 | 18.4684708, 73.857908 |  |
| | | **125** | *Terminalia catappa L.* | Combretaceae | Indian almond | 120 | 12 | 4 | 34 | 18.4684740, 73.857931 |  |
| | | **126** | *Terminalia catappa L.* | Combretaceae | Indian almond | 97 | 10 | 4 | 24 | 18.4687542, 73.857900 |  |
| | | **127** | *Terminalia catappa L.* | Combretaceae | Indian almond | 70 | 9 | 4 | 18 | 18.4687208, 73.857906 |  |
| | | **128** | *Terminalia catappa L.* | Combretaceae | Indian almond | 80 | 10 | 5 | 16 | 18.4686686, 73.857915 |  |
| | | **129** | *Terminalia catappa L.* | Combretaceae | Indian almond | 90 | 10 | 4 | 21 | 18.4686308, 73.857933 |  |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **130** | *Terminalia catappa L.* | Combretaceae | Indian almond | 85 | 9 | 3 | 20 | 18.4686019, 73.857936 |  |
| | | **131** | *Terminalia catappa L.* | Combretaceae | Indian almond | 78 | 9 | 2 | 16 | 18.4685647, 73.857948 |  |
| | | **132** | *Terminalia catappa L.* | Combretaceae | Indian almond | 70 | 8 | 3 | 15 | 18.4685198, 73.857963 |  |
| | | **133** | *Ficus benghalensis L.* | Moraceae | Vad | 70 | 7 | 5 | 23 | 18.4699423, 73.857120 |  |
| | | **134** | *Ficus benghalensis L.* | Moraceae | Vad | 200 | 8 | 5 | 109 | 18.4698974, 73.857124 |  |
| | | **135** | *Ficus benghalensis L.* | Moraceae | Vad | 65 | 2 | 0 | 12 | 18.4697893, 73.857134 |  |
| | | **136** | *Ficus benghalensis L.* | Moraceae | Vad | 90 | 7 | 3 | 22 | 18.4695489, 73.857156 |  |

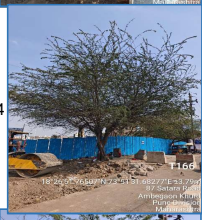
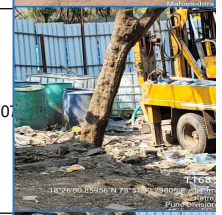
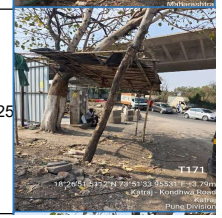
| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| RHS | **137** | *Ficus benghalensis L.* | Moraceae | Vad | 260 | 8 | 3 | 75 | 18.4694951, 73.8571602 |  |
| | **138** | *Polyalthia longifolia (Sonn.) Hook.f. & Thomson* | Annonaceae | Ashok | 60 | 9 | 3 | 13 | 18.4694548, 73.857187 |  |
| | **139** | *Azadirachta indica* A.Juss. | Meliaceae | Neem | 80 | 8 | 4 | 26 | 18.4694529, 73.8571539 |  |
| | **140** | *Polyalthia longifolia (Sonn.) Hook.f. & Thomson* | Annonaceae | Ashok | 69 | 9 | 3 | 14 | 18.4690964, 73.857301 |  |
| | **141** | *Polyalthia longifolia (Sonn.) Hook.f. & Thomson* | Annonaceae | Ashok | 70 | 8 | 3 | 15 | 18.4691129, 73.857286 |  |
| | **142** | *Polyalthia longifolia (Sonn.) Hook.f. & Thomson* | Annonaceae | Ashok | 80 | 10 | 3 | 15 | 18.4691313, 73.857285 |  |
| | **143** | *Polyalthia longifolia (Sonn.) Hook.f. & Thomson* | Annonaceae | Ashok | 90 | 10 | 3 | 23 | 18.4691422, 73.857289 |  |

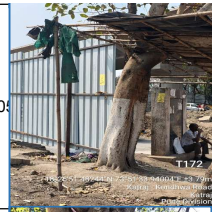
| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **144** | *Ficus religiosa* L. | Moraceae | Pimpal | 150 | 6 | 3 | 62 | 18.4690592, 73.857379 |  |
| **145** | *Ficus religiosa* L. | Moraceae | Pimpal | 180 | 9 | 4 | 89 | 18.4689431, 73.857411 |  |
| **146** | *Ficus racemosa* L. | Moraceae | Umbar | 46 | 7 | 3 | 10 | 18.4688311, 73.857403 |  |
| **147** | *Grevillea robusta A.Cunn. ex R.Br.* | Proteaceae | Silver Oak | 76 | 9 | 3 | 21 | 18.4686295, 73.857374 |  |
| **148** | *Grevillea robusta A.Cunn. ex R.Br.* | Proteaceae | Silver Oak | 85 | 10 | 3 | 29 | 18.4685796, 73.857377 |  |
| **149** | *Polyalthia longifolia (Sonn.) Hook.f. & Thomson* | Annonaceae | Ashok | 90 | 9 | 3 | 27 | 18.4685119, 73.857369 |  |
| **150** | *Barringtonia acutangula* Gaertn. | Lecythidaceae | Samudraphal | 40 | 6 | 2 | 11 | 18.4685208, 73.857389 |  |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **151** | *Ficus racemosa* L. | Moraceae | Umbar | 40 | 7 | 3 | 13 | 18.4683707, 73.8574389 |  |
| | | **152** | *Ficus religiosa* L. | Moraceae | Pimpal | 45 | 6 | 3 | 10 | 18.4683907, 73.8574593 |  |
| | | **153** | *Cassia siamea Lam.* | Fabaceae | Kashid | 88 | 7 | 3 | 23 | 18.4587697, 73.857781 |  |
| | | **154** | *Ficus religiosa* L. | Moraceae | Pimpal | 40 | 2 | 0 | 12 | 18.4585480, 73.857791 |  |
| | | **155** | *Ficus religiosa* L. | Moraceae | Pimpal | 120 | 6 | 3 | 26 | 18.4585353, 73.857795 |  |
| | | **156** | *Spathodea campanulata* P.Beauv. | Bignoniaceae | Pichkari | 75 | 5 | 3 | 14 | 18.4583515, 73.857815 |  |
| | | **157** | *Gliricidia sepium (Jacq.) Kunth* | Fabaceae | Giripushp | 60 | 8 | 5 | 17 | 18.4580853, 73.857815 |  |

RHS

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Balaji Nagar Metro Station** | RHS | **158** | *Tabebuia pentaphylla* Hemsl. | Bignoniaceae | Pink Trumpet Tree | 60 | 7 | 3 | 22 | 18.4580694, 73.857602 |  |
| | | **159** | *Psidium guajava L.* | Myrtaceae | Peru | 25 | 4 | 2 | 9 | 18.4581149, 73.857861 |  |
| | | **160** | *Ficus racemosa* L. | Moraceae | Umbar | 65 | 7 | 3 | 19 | 18.4578783, 73.858041 |  |
| | | **161** | *Moringa oleifera* Lam. | Moringaceae | Shevaga | 45 | 6 | 2 | 12 | 18.4578719, 73.858067 |  |
| | | **162** | *Ficus racemosa* L. | Moraceae | Umbar | 60 | 7 | 3 | 18 | 18.4576321, 73.858103 |  |
| | LHS | **163** | *Samanea saman (Jacq.) Merr.* | Fabaceae | Rain Tree | 200 | 12 | 6 | 66 | 18.4576372, 73.858514 |  |
| | LHS | **164** | *Samanea saman (Jacq.) Merr.* | Fabaceae | Rain Tree | 160 | 12 | 5 | 42 | 18.4575326, 73.858567 |  |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **165** | *Samanea saman (Jacq.) Merr.* | Fabaceae | Rain Tree | 195 | 12 | 6 | 87 | 18.4574225, 73.858570 |  |
| **Katraj Metro Station** | LHS | **166** | *Neltuma juliflora* (Sw.) Raf. | Fabaceae | Vedi Babul | 113 | 8 | 4 | 26 | 18.4476737, 73.8589204 |  |
| | | **167** | *Neltuma juliflora* (Sw.) Raf. | Fabaceae | Vedi Babul | 90 | 8 | 6 | 22 | 18.4475230, 73.858968 |  |
| | | **168** | *Delonix regia (Hook.) Raf.* | Leguminosae | Gulmohar | 60 | 8 | 3 | 24 | 18.4476076, 73.858970 |  |
| | | **169** | *Delonix regia (Hook.) Raf.* | Leguminosae | Gulmohar | 55 | 6 | 3 | 17 | 18.4476270, 73.858990 |  |
| | | **170** | *Cassia siamea Lam.* | Fabaceae | Kashid | 65 | 8 | 3 | 18 | 18.4476635, 73.859374 |  |
| | | **171** | *Eucalyptus globulus* Labill. | Myrtaceae | Nilgiri | 40 | 6 | 3 | 13 | 18.4477081, 73.859425 |  |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **172** | *Ficus religiosa* L. | Moraceae | Pimpal | 95 | 8 | 4 | 34 | 18.4477306, 73.859390 |  |
| | | **173** | *Ficus racemosa* L. | Moraceae | Umbar | 60 | 2 | 1 | 21 | 18.4464642, 73.859201 |  |
| | | **174** | *Ficus racemosa* L. | Moraceae | Umbar | 30 | 4 | 2 | 10 | 18.4465542, 73.859212 |  |
| | RHS | **175** | *Ficus religiosa* L. | Moraceae | Pimpal | 90 | 7 | 4 | 25 | 18.4477246, 73.858380 |  |

# Annexure-7:

Bidding documents for the design and construction of Swargate to Katraj project including Maha Metro's Safety, Health & Environment (SHE) Manual

# LIST OF CONTENTS


**PART I: SHE MANAGEMNT ..... 4**

1.0 GENERAL ..... 4
2.0 'SHE' TARGETS AND GOALS ..... 6
3.0 COMPLIANCE ..... 7
4.0 CONTRACTOR ENVIRONMENT HEALTH AND SAFETY POLICY AND PLAN ..... 2
5.0 DESIGNER'S ROLE ..... 6
6.0 CONTRACTOR SHE ORGANISATION ..... 7
7.0 CONTRACTOR SHE COMMITTEE ..... 9
8.0 ID CARD AND FIRST DAY AT WORK, SHE ORIENTATION TRAINING ..... 12
9.0 SHE TRAININGS ..... 13
10.0 SHE INSPECTIONS ..... 14
11.0 SHE AUDITS ..... 16
12.0 SHE COMMUNICATIONS ..... 23
13.0 SHE SUBMITTALS TO THE EMPLOYER ..... 23
14.0 ACCIDENT REPORTING AND INVESTIGATION ..... 24
15.0 EMERGENCY PREPAREDNESS PLAN ..... 28
16.0 EXPERTS / AGENCIES FOR SHE SERVICES ..... 28

**PART II: SAFETY ..... 29**

17.0 HOUSEKEEPING ..... 29
18.0 WORKING AT HEIGHT ..... 31
19.0 OVERHEAD PROTECTION ..... 1
20.0 SLIPPING, TRIPPING, CUTTING, DROWNING AND FALLING HAZARDS ..... 1
21.0 LIFTING APPLIANCES AND GEAR ..... 2
22.0 LAUNCHING OPERATION ..... 5
23.0 CONSTRUCTION MACHINERY ..... 6
24.0 MACHINE AND GENERAL AREA GUARDING ..... 11
25.0 MANUAL LIFTING AND CARRYING OF EXCESSIVE WEIGHT ..... 11
26.0 SITE ELECTRICITY ..... 11
27.0 LIGHTING ..... 14
28.0 HAND TOOLS AND POWER TOOLS ..... 15
29.0 WELDING, GOUGING AND CUTTING ..... 17
30.0 DANGEROUS AND HARMFUL ENVIRONMENT ..... 18
31.0 FIRE PREVENTION, PROTECTION AND FIGHTING SYSTEM ..... 19
32.0 CORROSIVE SUBSTANCES ..... 20
33.0 DEMOLITION ..... 20
34.0 EXCAVATION ..... 21
35.0 WORK PERMIT SYSTEM ..... 23
36.0 TRAFFIC MANAGEMENT ..... 24
37.0 WORK ADJACENT TO LIVE RAILWAYS ..... 27
38.0 BATCHING PLANT AND CASTING YARD LAYOUT ..... 27
39.0 PERSONAL PROTECTIVE EQUIPMENTS (PPEs) ..... 27
40.0 VISITORS TO SITE ..... 29

**PART III: OCCUPATIONAL HEALTH AND WELFARE ..... 31**

41.0 PHYSICAL FITNESS OF WORKMEN ..... 31
42.0 MEDICAL FACILITIES ..... 31

43.0 NOISE & VIBRATIONS ..... 34
44.0 VENTILATION AND ILLUMINATION ..... 35
45.0 RADIATION ..... 35
46.0 WELFARE MEASURES FOR WORKERS ..... 36
**PART- IV ENVIRONMENTAL MANAGEMENT ..... 39**
47.0 ENVIRONMENTAL MANAGEMENT ..... 39
48.0 TOPSOIL CONSERVATION ..... 39
49.0 FELLING OF TREES & TREE PRESERVATION ..... 39
50.0 FLY ASH ..... 39
51.0 CONTAMINANT OF AIR POLLUTION ..... 40
52.0 CONTAINMENT OF WATER POLLUTION AND CONSERVATION OF WATER ..... 44
53.0 CONTAINMENT OF NOISE AND VIBRATION ..... 45
54.0 WASTE MANAGEMENT ..... 48
55.0 ENVIRONMENTAL MONITORING ..... 52
56.0 ENVIRONMENTAL SANITATION ..... 56
57.0 AVOIDANCE OF NUISANCE ..... 58
58.0 ARCHAEOLOGICAL AND HISTORICAL PRESERVATION ..... 59
59.0 LANDSCAPE AND GREENERY ..... 59
60.0 ENERGY MANAGEMENT ..... 59
61.0 ENVIRONMENTAL SITE INSPECTION ..... 59
62.0 IGBC GREEN MRTS RATING REQUIREMENTS ..... 60
**PART - V: PENALTY AND AWARDS ..... 61**
63.0 PENALTIES TO BE CHARGED/RECOVERED FROM THE CONTRACTOR ..... 61
64.0 STOPPAGE OF WORK ..... 75
65.0 OCCUPATIONAL HEALTH AND SAFETY AWARDS ..... 75
66.0 ENVIRONMENTAL AWARDS ..... 75
**PART - VI: APPENDIX, FORMS AND GENERAL INSTRUCTION ..... 76**
Appendix No.1: MoU between Maha-Metro and the Contractor for safe execution of contract work ..... 76
Appendix no.: 2: OHS and Welfare requirements as per BOCW Act 1996 and Rules 1998 ..... 78
Appendix no. : 3 Site Safety,Health and Environmental Plan ..... 81
Appendix No.4: Workplace Policy on HIV Prevention & Control for Workmen ..... 83
General Instruction: Maha-Metro/SHE/GI/001: Minimum Manpower Requirements of SHE Org. ..... 84
General Instruction: Maha-Metro/SHE/GI/002: Minimum Qualification and exp. for SHE Professionals ..... 86
General Instruction: Maha-Metro/SHE/GI/003: Min. Requirements of SHE Monitoring and A.V. Equip. ..... 88
General Instruction: Maha-Metro/SHE/GI/004:SHE Induction Training ..... 90
General Instruction: Maha-Metro/SHE/GI/005: ID Card Format ..... 91
General Instruction: Maha-Metro/SHE/GI/006: SHE Training details for Managers and Supervisors ..... 92
General Instruction: Maha-Metro/SHE/GI/007: SHE Training Matrix ..... 94
General Instruction: Maha-Metro/SHE/GI/008: Days to Be Observed for Creating SHE Awareness ..... 95
General Instruction: Maha-Metro/SHE/GI/009: Minimum Requirements of SHE Communications ..... 96
General Instruction: Maha-Metro/SHE/GI/010: Experts / Agencies for SHE Services ..... 98
General Instruction: Maha-Metro/SHE/GI/011: Minimum Lighting Requirements ..... 101
General Instruction: Maha-Metro/SHE/GI/012: Warning Traffic Sign ..... 102
General Instruction: Maha-Metro/SHE/GI/013 :IGBC Document submission ..... 103
General Instruction: Maha-Metro/SHE/GI/014: Environmental Inspection Checklist ..... 107
Form No. SF/001: Formation of Site SHE Committee ..... 111
Form No. SF/002: Minutes of SHE Committee Meeting ..... 112

# PART I: SHE MANAGEMNT

## 1.0 GENERAL

### 1.1 Scope

1.1.1 This document defines the principal requirements of the Employer on Safety, Health, and Environment (SHE) associated with the Contractor / sub-contractor and any other agency to be practiced at construction worksites at all time.

### 1.2 Definition / languages

1.2.1 The Environmental Quality Management Manual (EQM) forms an essential part of the overall Environmental Protection System employed by Maha-Metro for the construction of Pune Metro Rail Project.

1.2.2 Definition & Abbreviations

**a)** **"Environment"** means the total surroundings of an organism including water, air and land and other living creatures.

**b)** **"Environmental Pollutant"** means any solid, liquid or gaseous substance present in such concentration as may be or tend to be injurious to environment.

**c)** **"Environmental Pollution"** means the presence in the environment of any environmental pollutant.

**d)** **"Nuisance"** is annoyance, which results from any construction activity that affects the material comfort and quality of life of the inhabitants of the area surrounding the construction site.

**e)** **"Monitoring"** is the use of direct or indirect reading field instrumentation to provide information regarding the levels of pollutants released during construction.

**f)** **"Construction Site"** is the contract limits for construction. It shall be all the area within the limits of the work as shown on the Plans. Construction Site shall also include staging, and debris disposal areas and transportation routes to and from these areas.

**g)** **"Noise"** is any unwanted sound disturbance of the environment around the area of construction operations.

**h)** **"Decibel"** is a measure on a logarithmic scale of the magnitude of a particular quantity (such as sound pressure, sound power) with respect to a standardized reference quantity.

**i)** **"A - weighted Noise levels"** in Decibels (referenced to 20 micro-Pascal) as measured with A-weighting network of standard sound level meter, abbreviated dB (A).

**j)** **"Energy Equivalent Level ($L_{eq}$)"** is the level of a steady noise which has the same energy as the fluctuating noise level integrated over the period of measurement. **$L_{max}$** is the maximum Noise Level during the period of measurement. **$L_{10}$** and **$L_{90}$**are the percentile exceeding levels of sound which is exceeded 10% and 90% of the time of measurement.

**k)** **"Waste"** is unwanted surplus substance arising from the application of all construction operations and any substance or article, which is required to be disposed.

**l)** **"Suspended Particulate Matter"** is abbreviated as SPM and measured in µg/$m^3$.

**m)** **"Environmental Quality Management Manual"** is abbreviated as **EQM**.

**n)** **"Air Monitoring and Control Plan"** is abbreviated as **AMCP**.

**o)** **"Noise Monitoring and Control Plan"** is abbreviated as **NMCP**.

p) **"Ministry of Environment and Forests, Government of India"** is abbreviated as **MOEF**.

q) **"Central Pollution Control Board"** is abbreviated as **CPCB**.

r) Notwithstanding the definition of "Site" of Clause 1.1.6.7 of the GCC and in the context of the present specification the ESHS specifications, the word "Worksite(s)" means: The land where work will be carried out, or

i. the land necessary for the implantation of Worksite facilities (work camp, workshops, offices, storage areas, concrete production plants) and including special access roads, or

ii. quarries for aggregates, rock material and riprap, or

iii. borrow areas for sand and other selected material, or

iv. stockpiling areas for backfill material or other demolition rubble, or

v. any other location, specifically designated in the Contract as a Worksite

The term « Worksite(s) » encompasses any individual Worksite or all Worksites.

1.2.3 In this document:

i. The use of **"shall'** indicates a mandatory requirement.

ii. The use of **"should"** indicates a guideline that is strongly recommended.

iii. The use of **"may"** indicates a guideline that is to be considered.

iv. **"SHE"** means Safety, Health, and Environment.

v. **"Employer"** means Maharashtra Metro Rail Corporation Limited or Maha-Metro

vi. **"Chief Safety Officer"** means an officer nominated by Maha-Metro who is overall responsible for monitoring all SHE functions prescribed in this document.

vii. **"BOCWA"** means Building and Other Construction Workers (Regulation of Employment and Conditions of Service) Act, 1996

viii. **"BOCWR"** means Building and Other Construction Workers (Regulation of Employment and Conditions of Service) Central Rules, 1998

ix. **"DG"** means Director General of Ministry of Labour, Govt. of India.

x. **"BOCWWCA"** means Building and Other Construction Workers' Welfare Cess Act, 1996

xi. **"BOCWWCR"** means Building and Other Construction Workers Welfare Cess Rules 1998

xii. "MBOCWR" means Maharashtra Building and Other Construction Workers (Regulation of Employment and Conditions of Service) Rules, 2003

xiii. **"Notifications"** (Central and state) – collection of cesses.

xiv. "**CIIBC**" means Chief Inspector of Inspection of Building and Other Constructions of Government of Maharashtra

xv. "HIRA" means Hazard Identification and Risk Assessment

## 1.3 Application of this document

1.3.1 This document applies to all aspects of the Contractor's scope of work, including allaspects conducted by sub-contractors and all other agencies. There shall be no activity associated to the Contract, which is exempted from the purview of this document.

Pursuant to Clause 4.4 of the GCC, the Contractor is fully liable for all actions, non-compliance and negligence by subcontractors, their representatives, employees, and workers, to the same degree as it would be held liable for its own actions, non-compliance or negligence or that of its own representatives, employees or workers.

1.3.2 The present SHS specifications apply to the Contractor and unless explicitly agreed with the engineer, all subcontractors used for the execution of the works. Pursuant to Clause 4.4 of the GCC, the Contractor is fully liable for all actions, non-compliance and negligence by subcontractors, their representatives, employees and workers, to the same degree as it would be held liable for its own actions, non-compliance or negligence or that of its own representatives, employees or workers.

1.3.3 "The SHE specifications refer to:

a) Protection of the natural environment (water, air, soil, vegetation, biological diversity) in areas adjacent to the Worksite, access roads, quarries, borrow areas, stockpiling of backfill material, labour camps or storage areas,

b) Health and safety conditions to be maintained for the Contractor's personnel and any other person present on the Worksites, or along access routes,

c) Working practices and the protection of people and populations living near the Worksite, but exposed to the general disturbance caused by works

**1.4 Purpose of this document**

1.4.1 The objective of these guidelines is to ensure that adequate precautions are taken to avoid accidents, occupational illness, and harmful effects on the environment during construction.

1.4.2 This document:

i. Describes the SHE interfaces between Employer and the Contractor

ii. Details the processes by which the Contractor shall manage SHE issues while carrying out the work under the Contract.

iii. Describes by reference, the practices and procedures as given in the Maha-Metro Project Safety, Health & Environment Manual for best SHE performance.

1.4.3 These requirements shall be read together with **Maha-Metro's Project SHE Manual** as amended/revised time to time and all ammendments/revisions during the execution of the work shall also be applicable, **ISO 45001-2018** Occupational Health and Safety Management System and **ISO 14001: 2015** Environmental Management Systems. Definition of key terms used in these requirements related to **ISO 45001-2018** and **ISO 14001:2015** standards are found in Maha-Metro's Project SHE Manual.

**2.0 'SHE' TARGETS AND GOALS**

2.1 The SHE targets, goals and aim for the Works are to achieve:

(i) Zero total recordable injuries.

(ii) Zero reportable environmental incidents

(iii) All personnel inducted in accordance with the approved contractor's SHE plan.

(iv) Total compliance of conducting inspections and audits as per approved SHE plan

(v) 100% incident recording and reporting

(vi) 100% adherence of usage of appropriate PPEs at work

(vii) Executing construction work with least disturbance to the environment, adjoining road users and traffic.

## 3.0 COMPLIANCE

### 3.1 Memorandum of Understanding (MOU)

3.1.1 A Memorandum of Understanding placed at Appendix No. 1 shall be executed before the award of Contract by the Contractor with regard to various provisions on Safety, Health, and Environment to be practiced during the construction work.

### 3.2 Maha-Metro's SHE Policy and Management Systems

3.2.1 The construction works shall be undertaken in accordance with Maha-Metro's SHE Policy and Management Systems as amended from time to time provided in Project, SHE Manual.

### 3.3 Indian statutory requirements

3.3.1 Primary statutory regulations

3.3.1.1 Contractor shall develop thorough understanding about Building and Other Construction Workers (Regulation of Employment and Conditions of Service) Act 1996, Central Rules 1998, The Building & Other Construction Workers Welfare Cess Act 1996 and Central Welfare Rules 1998, Maharashtra Building and Other Construction Workers (Regulation of Employment and Conditions of Service) Rules, 2003, Building and Other Construction Workers Welfare Cess act 1996 and Central Rules 1998, Notification [Central & State] – Collection of Cess, not only to satisfy the Inspectors' perspective but the use of legislation as the strong tool for effective SHE management at construction worksites. Contractor is strongly advised to practice the principle of voluntary compliance.

3.3.1.2 In order to facilitate the Contractor for better understanding on the various provisions of the above Act and Rules, a tabulated information highlighting the Sections/Rules referring to the corresponding registration of Contractors, maintenance of registers and records, hours of work and wages, cess & welfare, medical facilities, and safety requirements are given in Appendix No. 2. It is an indicative one and not a limiting list.

3.3.2 In addition, the construction works shall be undertaken in accordance with all applicable legislation and Indian statutory requirements listed below but not limiting to:

| | |
|---|---|
| (i) | Indian Electricity Act 2003 and Rules 1956 and its amendments |
| (ii) | National Building Code, 2005 and its amendments |
| (iii) | Factories Act, 1948, Maharashtra Government Factories Rules, 1963 and its amendments |
| (iv) | Motor Vehicles Act as amended in 1994 and The Central Motor Vehicles Rules, 1989 |
| (v) | The Motor Transport Workers Act 1961 &Maharashtra Rules 1965 and its amendments |
| (vi) | Indian Road Congress Code IRC: SP: 55-2001 'Guidelines on Safety in Road Construction Zones' |
| (vii) | The Petroleum Act, 1934 and Rules 1976 and its amendments |
| (viii) | Gas Cylinder Rules, 2003 and its amendments |
| (ix) | Indian Explosives Act, 1884, along with the Explosives Substance Act 1908 and the Explosives Rules 1983 |
| (x) | The (Indian) Boilers Act, 1923 and its amendments |
| (xi) | The Public Liability Insurance Act 1991 and Rules 1991 and its amendments |
| (xii) | Minimum Wages Act, 1948 and The Minimum Wages (Maharashtra Rules) 1961 and its amendments |
| (xiii) | The Contract Labour (Regulation & Abolition) Act 1970 & The Contract Labour (P&R) (Maharashtra) Rules, 1972 and its amendments |
| (xiv) | The Child Labour (Prohibition & regulation) Act 1986 and Maharashtra Rules 1994 and its amendments |
| (xv) | Environment Protection Act, 1986 and Rules 1986 and its amendments |
| (xvi) | Air (Prevention and control of Pollution) Act, 1981 and its amendments |

(xvii) Water (Prevention and Control of Pollution) Act, 1974 and its amendments

(xviii) The Noise Pollution (Regulation & Control) Rules, 2000 and its amendments

(xix) The Maharashtra (Urban Areas) Preservation of Trees Act, 1975 and its amendments

(xx) Notification on Control of Noise from Diesel Generator (DG) sets, 2002 and its amendments

(xxi) Recycled Plastic Usage Rules, 1998 and its amendments

(xxii) Notification, Central Ground Water Board, Act January 1997 and its amendments

(xxiii) The Manufacturing, Storage, and Import of Hazardous Chemical Rules, 1989 and its amendments

(xxiv) Chemical Accidents (Emergency Planning, Preparedness and Response) Rules, 1996 and its amendments

(xxv) The Hazardous Waste (Management, Handling& Trans-boundary Movement) Rules, 2007 and its amendments

(xxvi) Relevant Rules / Guidelines regarding Preservation of Trees

(xxvii) Batteries (Management and Handling) Rules and its amendments

(xxviii) Fly ash utilization notification, Sept 1999 as amended in August 2003 and its amendments

(xxix) Guidelines of Pune Urban Development Authority

(xxx) Guidelines of Maharashtra Pollution Control Board

Further, Contractor shall apply and take various clearances from the concerned agencies as presented in Table below: These clearances are indicative and contractor is required to take any other clearance as required for its construction activities.

**Table: Key Clearance Required**

| Permission/ Clearance/Permit | Relevant Acts/Rules | Concerned Agency |
|---|---|---|
| Consent to Establish and Consent to Operate batching plants,casting yards, grouting plant, Hot Mix plant, if any | • The Water (Prevention and Control of Pollution) Act, 1974, amended 1988 and<br>• The Air (Prevention and Control of Pollution) Act 1981, amended 1987 | Maharashtra Pollution Control Board (MPCB) |
| Authorization for generation, handling, storage and transportation hazardous waste | Hazardous and other Wastes (Management & Transboundary Movement) Rules, 2016 and its amendments | Maharashtra Pollution Control Board (MPCB) |
| Permission for extraction of ground water | Environment (Protection) Act, 1986/Central Ground Water Authority guidelines | Central Ground Water Authority |
| Pollution Under Control Certificate | Central Motor and Vehicle Act 1988 Vehicular Exhaust Norms, CPCB 2007 | Department of Transport, Maharashtra |
| C&D Waste Management Plan | Construction & Demolition Waste Management Rules, 2016 | Local Authority (Municipal Corporation) |

3.3.3 Workman Compensation Act, 1923 along with allied Rules

The Contractor shall ensure that all his employees / workmen are covered under 'Workmen Compensation Act' and shall pay compensation to his workmen as and when the eventuality for the same arises.

3.3.4 Notwithstanding the above Act/Rules, there is nothing in those to exempt the Contractor from the purview of any other Act or Rule in Republic of India for the safety of men and materials.

3.3.5 If the requirements stated in this document are less stringent than or in conflict with the country's applicable legislation, the latter shall apply.

### 3.4 International Standards, Guidelines & ISO Certifications

3.4.1 The Contractor complies with norms, standards and discharge limit values recommended by the specialised international organisations affiliated to the United Nations, as described in relevant clause below.

3.4.2 The specialised international organisations affiliated to the United Nations referred in relevant clause include:

- World Bank, including the IFC and its Environmental, Health and Safety guidelines available from http://www.ifc.org/ehsguidelines

For matters not addressed in the IFC above document, the norms, standards, and discharge limit values of the following institutions shall apply:

- World HealthOrganization (WHO)
- Internaitonal Labour Organization (ILO) (in particular in pursuance to Clauses 6.20, 6.21, 6.23 and 6.24 of the GCC)
- International Maritime Organization (IMO)

3.4.3 The works should be undertaken in accordance with the applicable international guidelines, standards and specifications on SHE and every contract shall aim to achieve ISO certifications listed below during the currency of the contract:

**ISO 45001-2018** : Occupational Health and Safety Management System.
**ISO 14001-2015** : Environmental Management Systems.

3.4.4 The process of certification shall start immediately after the award of the work and to be completed within 4 months' timeline. Towards this, the Contractor shall undertake the required steps including appointment of ISO consultant for obtaining the certification on Occupational Health and Safety Management System and Environment Management System. The certification shall be maintained throughout the currency of the contract.

3.1 In case of failure on the part of the Contractor, the Employer at the cost of the Contractor shall do the same.

### 3.5 Method Statement and Risk Assessment

3.5.1 Method Statement should be submitted by the Contractor. The Method Statement should include activity list, job step, equipment list, HIRA (Hazard Identification and Risk Assessment) etc.

3.5.2 Method statements shall be submitted to the Engineer **Twenty-One (21)** days prior to commencement of task.

3.5.3 Method statements shall incorporate control measures within the process methodology as identified within the risk assessment.

3.5.4 Risk Assessment should be work-site and Situation specific; a Generic format shall not be acceptable.

### 3.5.5 Risk Register & Hazard Log

(i) A proper record of monitoring and control of Risk Assessment and appropriate control measures shall be maintained at site, which shall be produced when asked for.

(ii) All applicable Method Statement and Standard Operating Procedure confirming to the work and site requirement is an essential control measure. The contractor shall ensure submission of Method Statement along with applicable requisite procedures as part of SHE Plan well in advance as mentioned herein before commencement of work. The Hazard Log with Risk Assessment shall identify future method statement and operational procedures pertaining to specific equipment, operations, and local environmental constraints. OHS&E Plans for execution of work, shall not be accepted without the completed Hazard Log and Risk Register.

## 4.0 CONTRACTOR ENVIRONMENT HEALTH AND SAFETY POLICY AND PLAN

4.1 The contractor as per rule 39 of the BOCW central rule shall formulate a Safety & Health policy in line with Maha-Metro's policies and display it at conspicuous places at work sites in Hindi and a local language understood by the majority of construction workers. The policy shall contain the following as minimum coverage:

i. The intention and commitments of the establishment regarding health, safety and environment protection of the workers
ii. Organisational arrangement made to carry out the policy specifying the responsibilities at different levels of hierarchy
iii. Responsibilities of the contractors, sub-contractor, transporter or other agencies involved in the construction work
iv. Techniques and methods for assessment of risk to safety and health and remedial measures
v. Arrangement for training of works, supervisors or other persons engaged in the construction work
vi. Other arrangement for making the policy more effective

4.2 Contractor shall revise the policy whenever any modification having implication on the safety and health of the workers is made or any new construction work, substances, or technique are introduced which have implication on health, safety of workers

4.3 Within Eight weeks from date of contract agreement, the Contractor shall submit a detailed and comprehensive Contract specific site Safety & Health Plan. The Safety & Health Plan shall include detailed policies, procedures and regulations which, when implemented, will ensure compliance of the contract provisions as well as statutory regulations. The Safety & Health Plan shall include the following but not be restricted to:

I. A statement of the Contractor's policy, organization and arrangements for Safety & Health

II. The name(s) and experience of person(s) within the Contractor's proposed management who shall be responsible for coordinating and monitoring the Contractor's Safety & Health performance;

III. The number of Safety & Health staff who shall be employed on the Works, their responsibilities, authority and line of communication with the proposed Contractor's agent;

IV. A statement of the Contractor's policy and procedures for identifying and estimating hazards, and the measures for addressing the same;

V. A list of Safety & Health hazards anticipated for this Contract and sufficient information to demonstrate the Contractor's proposals for achieving effective and efficient health and safety procedures;

VI. A description of the Safety & Health training courses and emergency drills which shall be provided by the Contractor, with an outline of the syllabus to be followed;

VII. Details of the safety equipment which shall be provided by the Contractor, including personal protective equipment;

VIII. A statement of the Contractor's policy and procedures for ensuring that Contractor's Equipment used on the Project Site are maintained in a safe condition and are operated in a safe manner;

IX. A statement of the Contractor's policy and procedures for ensuring that sub- contractors comply with the Contractor's safety plan;

X. A statement of the Contractor's disciplinary procedures with respect to Safety & Health related matters;

XI. A statement of the Contractor's procedure for reporting and investigating accidents, dangerous occurrences or occupational illnesses;

XII. Detailed Standard Operating Procedures (SOP)/Safe Work Procedures (SWP) for every activity likely to be undertaken as well as for use and maintenance of Plant, Machines & Equipment shall be made as part of Safety & Health Plan;

XIII. Contract shall formulate format like work permit etc. and made checklist for activity involving risk as well as for using plant & machines/equipment's.

4.4 The Contractor shall formulate an Environment Policy in line with Maha-Metro Environment and other policies and display it at conspicuous places at work sites in Hindi and a local language understood by the majority of construction workers.

4.5 Within Eight weeks of the notification of acceptance of the tender, contractor shall submit a detailed and comprehensive contract specific site Environmental Plan. The Environment Plan shall include detailed policies, procedures and regulations which, then implemented, will ensure compliance of the contract provisions.

4.6 The site Environment Plan shall include the following but not be restricted to:

(i) Within the period defined above, the contractor shall submit a draft contract specific Site Environment Plan for the approval of the Maha-Metro/Engineer and a final version prior to the commencement of the works.

(ii) The site Environment Plan shall provide details of the means (as elaborated in Point No. 3 below) by which the contractor (and all sub-contractors working for the contractor) will implement the recommended mitigation measures and achieve the environmental performance standards defined both in Indian environmental legislation and in this document.

(iii) The contract specific Site Environmental Plan will contain details of manpower required for environment related works, description of all procedures developed to meet the requirement defined in various sections of this document, to control environment pollution and organizational hierarchy for the effective implementation of the plan. Elements of the plan must address the management of pollution, the monitoring programme and the reporting requirements.

(iv) Outline of the Site Environmental Plan is given below:

| S. No. | SITE ENVIRONMENTAL PLAN OUTLINE |
|---|---|
| **1** | **GENERAL** |
| (i) | The Environmental Policy of the Contractor is clearly defined in the Site Environmental Plan, which, inter-alia, commits the Contractor to follow national and state environmental legislation and regulations. |
| (ii) | The person responsible for day-to-day environmental matters is identified and vested with authority to execute the Site Environmental Plan. The Contractor has environmental lines of communication. |
| (iii) | Procedure is available for Contractor's system of enforcing good environmental practices of its Sub-contractor. By procedure it is implied that the Sub Contractor has been given clear written directions to comply with all requirements mentioned in this document and as applicable. |
| (iv) | The Site Environmental Plan contains procedures for screening material used in the contract, for their environmental friendliness. This implies that the procedure will comply with MC2 and MC 3 credits of IGBC Green Mass Rapid System (MRTS). |
| **2** | **ENVIRONMENT FRIENDLY CONSTRUCTION PRACTICES** |
| (i) | The Site Environmental Plan shall contain specific procedures for achieving environmental performance requirements as given in the Employer's requirements on Environment. |
| (ii) | Procedures for carrying out Aspect/Impact analysis of contractor's proposed works and their effect on environment. This will be cross reference with ISO 14001:2015 (EMS) procedures. |
| (iii) | Procedures for setting up Objectives and Targets commensurate with Employer's requirement on Environment and how these shall be met. |

| | |
|---|---|
| (iv) | Procedures for formulating Environmental Management Plans and Operational Control Procedures to meet contractual requirements. |
| (v) | Procedures for offering environmental training and methods for promoting environmental awareness amongst his employees. |
| (vi) | The Site Environmental Plan must contain details on Air Monitoring and Control Plan which details Mitigation measures / Corrective Action / Preventive Action and Monitoring Schedule. |
| (vii) | The Site Environmental Plan must contain details on Noise Monitoring and Control Plan which details Mitigation measures / Corrective Action / Preventive Action and Monitoring Schedule. |
| (viii) | The Site Environmental Plan must contain procedures on prevention and control of water pollution from sanitary surface runoff and process wastewater. |
| (ix) | The Site Environmental Plan must contain details on procedures for Storage, handling and disposal of waste including, Municipal, C&D, Plastic, Bio-Medical, Chemical and Hazardous wastes. |
| (x) | The Site Environmental Plan must contain procedures for reuse/recycle of waste, selling to authorized recyclers and records thereof. |
| (xi) | The Site Environmental Plan must contain procedures for preservation of landscape disturbed due to construction, housekeeping/Environmental Sanitation and traffic management as required under the contract. |
| (xii) | The Site Environmental Plan must contain procedures for dealing with unforeseen environmental situations under Environmental Emergency. |
| **3** | **MONITORING, AUDITS AND RECORDS** |
| (i) | The Site Environmental Plan shall contain the environmental monitoring requirements as per the contract requirements. |
| (ii) | The Contractor keeps records of environmental monitoring and the Site Environmental Plan must contain provision for reporting results of environmental monitoring in a manner as specified in this document. |
| (iii) | The Site Environmental Plan must contain procedures for carrying out inspections |
| (iv) | The Site Environmental Plan must contain provisions for submitting monthly Environmental Management reports. |
| (v) | The Site Environmental Plan must contain procedures for recording environmental complaints and response process. |

4.7 The Contractor shall, from time to time and as necessary as required by the Employer to produce supplements to the Safety & Health and Environment Plans such that it is at all times a detailed, comprehensive and contemporaneous statement by the Contractor of his site safety industrial health, responsibilities, policies and procedures relating to work on Site. Any and all submissions of supplements to the Safety & Health and Environment Plans shall be made to the Employer in accordance with the agreed procedures.

4.8 If at any time the Safety & Health and Environment plans is, in the Employer's opinion, insufficient or requires revision or modification to ensure the security of the Works and the safety, health and welfare of all workmen upon and visitors to the Site, the Employer may instruct the Contractor to revise the Safety & Health and Environment plans and the Contractor shall within 7 days submit the revised plan to the Employer for review.

4.9 Any omissions, inconsistencies and errors in the Safety & Health and Environment Plans or the Employer's acceptance or rejection of the Safety & Health and Environment Plans 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 recognized safety and environmental practices throughout the execution of the Work.

4.10 The Contractor shall adhere to the Safety & Health and Environment Plans 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 Safety & Health and Environment Plans and comply with its provisions.

4.11 The details of contents to be covered in the site Health & Safety Plan are given in Appendix No. 3.

## 5.0 DESIGNER'S ROLE

### 5.1 Designer's role in Safety, Health, and Environment

Designer's primary role includes to minimise the risk to Environment, 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 might be affected by the work.

### 5.2 General Philosophy

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, build ability 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.

### 5.3 Hierarchy of Risk Control

5.1 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 (e.g., 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 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).

### 5.4 Duty to provide health and safety risks in the drawing itself

5.1 In case of situations where the designers have carried out the design work and concluded that there are risks, which are not reasonably practicable to avoid, detailed information shall be given about the health and safety risks, which remain. This information needs to be included with the design 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.

5.2 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.

### 5.5 Employer's approval

5.1 Every structure like scaffold, false work, launching girder, earth retaining structures etc. shall have its design calculations included in the method statements in addition to health and safety risks. Employers' designer or his approved proof check consultants as applicable as per the contract conditions shall approve all these designs.

5.6 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.

5.7 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.

## 6.0 CONTRACTOR SHE ORGANISATION

### 6.1 Education and Experience

6.1.1 The Contractor shall appoint the required Environment, Health and Safety personnel as prescribed in General Instruction Maha-Metro/SHE/GI/001 (enclosed at the end) based upon the statutory requirement and establish the SHE organisation based upon the Contract value. The minimum educational qualification and the work experience are given in General Instruction Maha-Metro/SHE/GI/002.

6.1.2 The Contractor appoints a person responsible for relations with external stakeholders for the site: local communities, administrative authorities, and representatives of economic activities located within one-hour travel from the Worksite. This person will be based on the Worksite on a permanent basis. Administrations and local authorities will be informed of the existence of this person as of the start of works and will be provided with telephone contact details so as to be able to contact this person if a problem arises during the execution of works or concerning the behaviour of the Contractor's employees outside the Worksite.

6.1.3 In order to effectively interact on labour welfare matters with the Employer and the statutory authorities enforcing the labour welfare legislations every Contractor shall employ a duly qualified and experienced full time Labour Welfare Officer.

### 6.2 Conduct and competency

6.2.1 The conduct and functioning of the Contractor SHE personnel shall be monitored by the Employer. Any default or deficiency shall attract penalty as per details given under penalty Clause of this document.

6.2.2 The Contractor shall ensure that all personnel are competent to perform the job assigned to them. In the event that the Contractor is unable to demonstrate the competency of any person whose activities can directly impact on the Works' SHE performance, the Employer shall remove that person from the site without any procedural formalities.

**6.2.3 Security Guards**

Necessary security and checks as required shall be established by the contractor to prevent entry of any unauthorised and unprotected person to the construction site.

### 6.3 Approval from Employer

6.3.1 The name, address, educational qualification, work experience and health condition of each personnel deployed for SHE jobs shall be submitted to the Maha-Metro Environment, Health & Safety department in the format prescribed for the purpose for comments and approval well before the start of the work. Only on approval by the Employer these personnel are authorised to work. In case any of the SHE personnel leaves the Contractor the same shall be intimated to the Employer. The Contractor shall recruit new personnel and fill up the vacancy.

### 6.4 Responsibility of SHE personnel

6.4.1 For all works carried out by the Contractor and his sub-contractors, the responsibility of ensuring the required SHE manpower lies with the main Contractor only. The minimum required manpower indicated by the Employer includes the sub-contractors' work also. It shall be the responsibility of the main Contractor to provide required SHE manpower for all the works executed by all Contractors. Necessary conditions shall be included in all sub-contract documents executed by the main Contractor.

### 6.5 Employment status of SHE personnel

6.5.1 No Contractor shall engage SHE manpower from any outsourcing agencies in which case the effectiveness would be lost. All SHE 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.

### 6.6 Reporting of SHE personnel

6.6.1 All SHE personnel are to report to the Chief SHE Manager who shall report directly to the Chief Project Manager. The Employer Environment, Health and Safety department shall monitor adherence to this procedure at all times. In case of non-adherence penalty shall be levied as indicated in the penalty clause.

### 6.7 Inadequate SHE personnel

6.7.1 Contractor shall appoint its Chief Safety Manager well before the start of activity for preparatory work like formulation, submission & approval of Safety, Health and Environment Plan, Method Statements, Environment, Health & Safety training facilities, identification & finalization of Agencies for External Safety & Health Audit, ISO certification, Safety & Health Training, Hospital Tie-up etc. The organisation shall grow as the work fronts are made available and adequate Safety & Health

manpower shall be ensured as per the contract agreement and site availability. No demobilization of Environment, safety & Health Manpower shall take place without the approval of Maha Metro concerned department and shall be remained filled till final handover of the project to Maha Metro.

6.7.2 In case if the Contractor fail to provide the minimum required manpower as illustrated in General Instruction Maha-Metro/SHE/GI/001 or fail to fill up vacancies created within 14 days, the same shall be provided by the Employer at Contractor's cost. Any administrative expenses involved, providing the same like paper advertisement or manpower consultant charges, etc shall also be at the cost of Contractor.

### 6.8 Prohibition of performance of other duties

6.8.1 As per Schedule VIII of BOCWR, no SHE personnel shall be required or permitted to do any work which is unconnected to, inconsistent with or detrimental to the performance of the SHE duties for respective category mentioned in General Information Maha-Metro/SHE/GI/001.

### 6.9 Facilities to be provided to SHE personnel

6.9.1 As per Schedule VIII of BOCWR, the Contractor shall provide all SHE personnel with such facilities, equipment and information that are necessary to enable him to dispatch his duties effectively.

6.9.2 The minimum Employer's requirements of such facilities / equipments to be provided for SHE personnel are given in the General Instruction Maha-Metro/SHE/GI/003.

## 7.0 CONTRACTOR SHE COMMITTEE

**7.1** All employees should be able to participate in the making and monitoring of arrangements for safety, industrial health and environment at their place of work. The establishment of site SHE committees in which employees and Contractor and sub-contractor management are represented can increase the involvement and commitment of employees. The Contractor shall ensure the formation and monitor the functioning of Contractor SHE committees.

### 7.2 Guidelines onTerms of Reference, Agenda, MoM of SHE Committee

**7.2.1** The Guidelines on Terms of Reference, Agenda, Minutes of Meeting of SHE Committee shall be as follows:

i. To establish company Safety & Health and Environment policies and practices
ii. To monitor the adequacy of the contractor's site Safety & Health and Environment plans and ensure its implementation
iii. To review compliance to Safety & Health and Environment legal requirements
iv. To review Safety & Health and Environment training
v. To review the contractor's monthly monitoring report consisting Air and Noise monitoring results
vi. To review the contractor's monthly waste management records
vii. Review the progress of ISO certification
viii. To review the contractor's monthly Safety & Health and Environment reports.
ix. To identify probable causes of accident and unsafe practices in building or other construction work and to suggest remedial measures.
x. To stimulate interest of Employer and building workers in safety by organizing safety week, safety competition, talks and film-shows on safety, preparing posters or taking similar other measures as and when required or as necessary.
xi. To go round the construction site with a view to check unsafe practices and detect unsafe conditions, condition of health and welfare amenities and to recommend remedial measures for their rectifications including medical first-aid, occupational health centers and welfare facilities like canteen, rest room, drinking water, toilet/urinals etc.

xii. Committee team members should perform a site inspection before every committee meetings and to monitor Safety & Health and Environment inspection reports.
xiii. To bring to the notice of the Employer the hazards associated with use, handling and maintenance of the equipment used during the course of building and other construction work
xiv. 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.
xv. 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.
xvi. To review the last, SHE committee meeting minutes and to take action against persons/sub-contractors for non-compliance if any.

**7.3** Within 14 days of award of Contract, the SHE Committee shall be constituted and notification regarding the same shall be communicated to the members and employees as per the format provided in Form No. SF 001.

**7.4** Site SHE Committee meeting shall be conducted at least once in a month with the minimum members listed below:

| | |
|---|---|
| Chairman | Project Manager |
| Secretary | Chief SHE Manager (In-charge) |
| Members | Labour Welfare Officer<br>Sr. Environment Manager<br>In charge of plant and machinery<br>In charge of site electrics<br>In charge of stores.<br>Senior Managers/ Engineers heading different sub functions.<br>Sub – contractor's representative<br>Labour Contractor's representative<br>Workers' representative<br>Co-contractor representative.<br>Other SHE staffs |
| Employer's Representatives | Maha-Metro Safety, Health and Environment in charge and other representatives |

**7.5** Construction SHE Committee meeting shall be conducted at least once in a week with the minimum members listed below:

| | |
|---|---|
| Chairman | Project Manager |
| Secretary | Chief SHE Manager (In-charge) |
| Members | Sr. Environment Manager<br>Labour Welfare Officer<br>In charge of plant and machinery<br>In-charge of site electricity<br>Senior Managers / Engineers heading different sub functions<br>Sub- Contractor's representative<br>Labour contractor's representative<br>Workers' representatives<br>Other SHE Staffs |

### 7.6 Co-contractors' participation

7.6.1 In case of depot, station and other contiguous areas where more than one main contractor are working together, the Employer shall instruct the other contractors to join for the monthly SHE committee meeting of the main civil contractor, so as to discuss and decide about the common provision of security, lighting, toilet, drinking water etc. and sharing the maintenance cost of the same etc.

7.6.2 The general principle for sharing the cost shall be either based on the Contract value of works executed at the contiguous area or the daily average number of workmen employed by each contractor in the contiguous area.

### 7.7 Minimum time between two monthly SHE Committee meetings

7.7.1 A minimum period of 21 days shall be maintained between any two SHE monthly committee meetings.

### 7.8 Agenda

7.8.1 The Secretary shall circulate the agenda of the meeting at least seven working days in advance of the scheduled date of the meeting to all members.

7.8.2 The agenda should broadly cover the following:

(i) Confirmation of minutes

(ii) Chairman's review/overview of site SHE performance / condition

(iii) Previous month SHE statistics

(iv) Incident and Accident Investigation / dangerous occurrence / near miss report

(v) Site SHE inspection

(vi) Sub-contractors' SHE issues

(vii) Safety presentation by Members

(viii) Report from Employer

(ix) Presentation on Environment aspects by Contractor's Environment representative which shall include the following:

(i) Legal compliance
(ii) Air and Noise monitoring results
(iii) Monthly waste management record
(iv) Progress of ISO certification
(v) Progress of Green Building Certification
(vi) Material consumption details (cement, aggregate, water, steel, sand etc)
(vii) Fly ash consumption details
(viii) Use of products made from recycled C&D waste products
(ix) Public Complaints on Environment especially related to Noise, dust and vibration
(x) Steps taken to improve Environment sanitation at site
(xi) Steps taken to address Employers instructions on Environment
(xii) Environmental issues related to site

### 7.9 Minutes of the meeting

7.9.1 The Minutes of the meeting shall be prepared as per the format provided at Form No. SF-002 and sent to all members within 2 working days preferably by mail followed by hardcopy. Safety Committee meeting minutes shall also be displayed in the notice board for wider publicity to all concerned.

### 7.10 Disciplinary Action

7.10.1 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 monitory penalty as per the relevant contract clauses, the Employer shall ensure that the same is implemented.

## 8.0 ID CARD AND FIRST DAY AT WORK, SHE ORIENTATION TRAINING

8.1 The Contractor shall ensure that all personnel working at the site receive an induction SHE training explaining 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. The training shall cover the contents as given in the General Instruction Maha-Metro/SHE/GI/004.

8.2 All personnel shall be issued a photo identity card of size 85mm x 55mm duly signed by the authorized representative of the Contractor before they are engaged for any work as per the format given in the General Instruction Maha-Metro/SHE/GI/005

8.2.1 Starting work sessions are organised for each employee and shall cover as a minimum:

a) Rules of precedure
b) Safety rules on Worksite
c) Protection of areas adjacent to Worksite
d) Risks relating to sexually transmitted diseases (Clause 6.7 of the GCC)
e) Basic health: combating malaria (if prevalent) and waterborne diseases, improving hygiene
f) Emergency response procedures or evacuation

8.2.2 Technical training:

a) Training in the skills needed for tasks requiring a work permit
b) Training in first aid and transporting the injured in order to achieve the targets defined in relevant clause on the number of first aid officers per shift.
c) Ability to drive on rough ground.

8.3 Contractor shall also issue personnel SHE handbook in a language known to the workers, which provides information on SHE and emergency procedures that all personnel working on contract are required to know and the need to follow. Contractor shall ensure that this is distributed, and its content introduced to all personnel working at the site.

8.4 All personnel shall be issued with a temporary ID Cards on completion of Contractor's' induction. The temporary ID shall be signed by the Human Resource Manager of contractor or their appointed representative, with the validity period of one week, and after expiry of which the temporary ID Card shall be replaced with a permanent ID Card with photograph.

8.5 No Individuals shall be permitted to enter work site without a valid ID Card.

8.6 The contractor shall ensure proper accounting and records of issued and cancelled ID Cards. These ID cards shall be maintained strictly for any checks and inspections. On the expiry of the validity, new ID Card shall be issued. The expired/cancelled ID Cards shall be properly destroyed, and records shall be maintained by the contractor.

## 9.0 SHE TRAININGS

9.1 The behaviour of people at all levels of the Contractor is critical for SHE performance. To achieve a more participative approach and sharing of Safety functions by site teams, the contractor shall ensure that all site staff engaged for project execution is Safety trained.

9.2 The Contractor shall organise quality SHE training to engage Managers, supervisors and other personnel in behavioural change and improve safety performance and effective compliance of labour welfare provisions. The attendance for the same shall be maintained and produced on demand of Maha Metro.

9.3 The Contractor shall analyse the training requirements for all the employees and initiate a training program to demonstrate that all persons employed, including subcontractors, are suitably qualified, competent and fit. This will include:

i. Detailed Job descriptions for all personnel, to include their specific Safety & Health and Environment responsibilities
i. Specification of qualifications, competency and training requirements for all personnel
ii. Assessment and recording of training needs for all personnel, including subcontractors' employees in the workforce, vendor representatives and site visitors
iii. A system for assessing new hirers e.g. previous training
iv. A means of confirming that the system is effective
v. A matrix and schedule of training requirements, covering general, task– specific and Safety & Health and Environment-related training, showing the training frequency and interval between refresher courses
vi. Timely, competent delivery of training courses

9.4 The Contractor shall arrange behavioural-based training programmes for all the executives to identify, recognise and eliminate unsafe act and unsafe conditions.

9.5 The minimum Employer's requirement of training needs for various categories of employees are given in General Instruction Maha-Metro/SHE/GI/006

9.6 The contents of SHE training to Managers/Supervisors as given in General Instruction Maha-Metro/SHE/GI/007 shall be conducted.

9.7 The refresher-training programme to all employees shall be conducted once in six months for a minimum duration of 24 (3X8 hrs) working hours.

9.8 Toolbox talk as given in the Employer's Project SHE Manual shall be conducted to all high-risk workmen every day.

9.9 On-the spot practical skill development training on height safety including scaffold safety, crane safety, welding safety, electrical safety, traffic safety for marshals shall also be conducted to all foremen/ workmen who were associated to the concerned jobs.

9.10 Every employee including workman shall take safety Oath daily without fail.

9.11 All vehicle drivers including heavy vehicle operators shall be trained on defensive driving at training institute recognized by MaharashtraState Road Transport Corporation / Government of Maharashtra, or any other driving institute registered under Motor Vehicles Act.

9.12 All the above listed training programmes except at Clause 9.11 shall be organised by the Contractor only after taking approval from the Maha Metro for the training faculty / organisation, content, and durations.

9.13 In case of failure on the part of the Contractor to provide all the above-mentioned training programs to all employees in time, the same shall be provided by the Employer through accredited agencies if required by formulating a common scheme to all contractors. Any administrative expenses and training fee towards the same shall be at the cost of the Contractor.

9.14 The Contractor detail in the training programme the actions and ESHS training for subcontractors and other members of the joint venture when applicable.

9.16 Records of all training conducted shall be maintained and made available for inspection and monitoring.

## 10.0 SHE INSPECTIONS

10.1 The Contractor shall evolve and administer a system of conducting SHE inspections and other risk management analysis on a periodical basis.

10.2 The purpose of SHE inspection is to identify any variation in construction activities and operations, machineries, plant and equipment and processes against the SHE Plan and its supplementary procedures and programs.

10.3 Following SHE inspections program shall be adopted:

i. Planned General Inspection
ii. Routine Inspection
iii. Specific Inspection
iv. Other Inspection

### 10.3.1 Planned General Inspection

10.3.1.1 Planned general inspection are performed at predetermined intervals and it usually involves the representation from both Contractor and the Employer.

10.3.1.2 Inspections that will be classified under this inspection program are:

i. Monthly contractor and sub-contractors site Safety, Haelth and Environment Committee Inspection.
ii. Weekly Safety, Haelth and Environment inspection by construction supervisors (Contractors and Sub-contractors)
iii. Daily safety inspection by contractor site Safety, Haelth and Environment team.

### 10.3.2 Routine Inspection

10.3.2.1 Routine inspections are often referring to the inspection of work site, equipment and temporary structures performed by site and equipment operators and temporary structure erectors.

Inspections that will be classified under this inspection program are:

i. Daily Inspection of plant and equipment by operator
ii. Weekly Inspection of scaffold by scaffolding supervisor
iii. Monthly Inspection of electrical hand tools by competent electrical supervisor
iv. Quarterly Inspection of temporary electrical systems by competent electrical supervisor
v. Wages, PF and ESI related records
vi. Half-yearly inspection of lifting machinery, lifting appliances, equipment and gears by Govt. approved competent person.

10.3.2.2 The list mentioned above is not exhaustive. Contractor may add additional categories. Contractors' Site SHE Manager will ensure that a system of routine inspections are carried out periodically to all plants, equipment, powered tools, and any other temporary structures that will pose a hazard to operators and workmen.

10.3.3 **Specific Inspection**

10.3.3.1 Specific inspections are performed on activities without a predetermined date. Competent supervisors usually perform inspections for ensuring an activity whether it is executed in accordance to a general set of rules; method statement submitted or developed procedures. The following are examples that will be commonly performed as required on the construction site:

i. Inspection performed before a heavy lifting operation.
ii. Inspection performed before and after the entry of person into a confined space.
iii. Inspection performed before and after a welding and gas cutting operation.
iv. Inspection of formwork before concreting by formwork erector.

10.3.3.2 The list mentioned above is not exhaustive. The contractor shall ensure that a competent supervisor inspects all high-risk processes and activities.

10.3.4 Other Inspection

Other inspections include the following:

i. Mandatory Inspections by Labour Department of Government.
ii. Maha-Metro Health & Safety management team

## 10.4 Environmental Inspection

10.4.1 The contractor shall evolve and administer a system of conducting Environment inspections on a periodic basis. The purpose of Environment inspection is to identify any variation in construction activities and operations, machineries, plant and equipment and processes against the Site Environment Plan and its supplementary procedures and programs. Following Environment inspections program shall be adopted.

i. Planned General Inspection
ii. Other Inspection

10.4.2 Planned General Inspection Planned general inspections are performed at predetermined intervals and it usually involves the representatives from both Contractor and the Employer. Inspections that will be classified under this inspection program are:

i. Monthly contractor and sub-contractors site SHE committee inspection
ii. Weekly/ daily siteinspection by Contractor's Environment team

10.4.3 Other Inspections: Other inspections include the following:

I. Maha-Metro Environment Management team
II. Inspections by Central Pollution Control Board, /Maharashtra Pollution Control Board, Ministry of Environment and Forest and Climate Change, National Green Tribunal etc.

10.4.4 The contractor shall prepare all required Environmental inspection checklists for all activities, operations and equipment. Checklists will be prepared based on the Indian standards, rules and regulations and Employer's requirements. The formats provided in the General Instruction Maha-Metro/SHE/GI/14 shall be referred.

10.4.5 All inspection records and reports will be properly kept and filed for audit purpose.

10.4.6 Whenever employer's representative conducts an inspection, contractor shall depute its representative to accompany him/her.

10.4.7 Conformity report shall be submitted by the contractor within 1 week of submission of inspection report to the employer.

10.4.8 In case of non-conformity of items, the Employer shall take necessary steps including stoppage of work and or imposing penalty for getting the item implemented.

10.4.9 Whenever employer's representative conducts an inspection, contractor shall depute its representative to accompany him/her.

## 11.0 SHE AUDITS

### 11.1General

11.1.1 The purpose and scope of SHE audit is to assess potential risk, liabilities, and the degree of compliance of construction Safety, Health & Environmental plan and its supplementary procedures and programs against applicable and current SHE legalisation regulations and requirements of the Employer.

11.1.2 Project Manager holds the ultimate responsibility in ensuring implementation of SHE audit program during the construction work.

### 11.2Monthly Audit Rating Score (MARS)

11.2.1 Monthly Audit Rating Score (MARS) will be performed once in a month. A team consisting of Project Manager and Employer representative based on the pre-designed score-rating format will conduct it. The details of the pre-designed monthly audit score rating formats are given in the Project SHE Manual.

11.2.2 This Monthly SHE Audit Rating Score (MARS) report will enable the Employer to evaluate the general compliance by the Contractor with the Conditions of Contract, the Employer's Project SHE Manual and the Contractor's site specific SHE Plan.

11.2.3 Monthly Audits will be conducted in accordance with Maha-Metro Guidelines. The Project Manager accompanied by the Employer's Representatives shall carry out the Audit. The Contractor's senior manager and SHE in-charge should also be invited to attend.

11.2.4 Timing

The Monthly Audit Rating Score (MARS) should be conducted at least 7 days prior to the scheduled date of Monthly SHE Committee meeting.

11.2.5 Evaluation

11.2.5.1 The numerical scoring has been weighed on a 1-10 scale. The audit team will use their observations noted in evaluating the points to be awarded against each of the elements of the audited section. Wherever some topics and sub-topics are not applicable the score rating need not be given. The overall audit ratings shall be achieved by:

$$Overall\ Audit\ Rating = \frac{Actual\ Score\ Achieved}{Max\ Possible\ Score} * 100$$

11.2.5.2 The criticality of the required actions for the respective sections of the Audit will be classified as:

| SN | Score | Description | Action |
|---|---|---|---|
| 1 | < 60% | Immediate | Require Contractor to rectify within 24 hours |
| 2 | < 75% | Improvement Necessary | Contractor rectification within 7 days and confirmed in writing to Employer |
| 3 | < 90% | Improvement Desirable | Contractor rectification within one month and confirmed in writing to Employer |

**11.2.6 Report**

A copy of each Audit Report will be sent to Employer and to all subcontractors, with whom it will then be discussed in detail at the Monthly health and safety Committee Meeting in order to ensure that any corrective actions are agreed upon.

**11.3 Monthly Electrical Safety Audit**

11.3.1 A team comprising of Contractor's senior SHE (Electrical) engineer and Employer's Representative shall conduct monthly electrical safety audit covering the following and submit the report to Employer:

I. Electrical accidents investigation findings and remedy
II. Adequacy of power generation and power requirements
III. Power distribution and transmission system in place
IV. Updated electrical single line diagram showing the current condition of power source and distribution including the IP44 DBs arrangement.
V. Electrical protection devices – selection, installation and maintenance.
VI. Earth or ground connection and earth pit maintenance details
VII. Education and training of electrical personnel undertaken
VIII. Routine electrical inspection details
IX. Electrical maintenance system and register.
X. Name plate details of major electrical equipment
XI. Classified zones in the site, if any.

**11.4 External Health and Safety Audit**

11.4.1 External Health & Safety audits are to be conducted by external agencies having excellent competency in Health and Safety with the prior approval of the Employer.

**11.4.2 Areas of competence of Audit team:**

11.4.2.1 Practical understanding of BOCW Act and Rules, statutory requirements on health/medical and welfare of workmen, construction hazards and its prevention and control, traffic management, electrical safety, rigging, safety of construction equipment and construction environment management.

11.4.2.2 Audit shall be conducted as per the guidelines of ISO, ILO, and national standards. Audit report shall also be presented as per the above formats.

11.4.3 External Health and Safety audits shall be conducted on a quarterly basis throughout the currency of the Contract.

11.4.4 **Targets of Health & Safety Audit:** The contents and coverage of the external audit shall include the following items

11.4.4.1 Safety and Health management

I. Safety & Health Organization
II. Safety & Health policy and plan
III. SHE Committee
IV. Safety & Health orientation
V. Safety & Health training
VI. Safety & Health inspection
VII. Safety & Health communication and motivation
VIII. Safety & Health submittals to the employer
IX. Safety & Health promotional and awareness program
X. Incident reporting and investigation
XI. Onsite/Offsite Emergency preparedness plan
XII. Hazard identification and Risk Assessment

11.4.4.2 Technical

I. Work Method Statements
II. Operational Control Procedures / Safe operating procedures
III. Working at Height
IV. Hand tools and Power tools
V. Electrical Safety
VI. Fire prevention and control
VII. Housekeeping
VIII. Overhead protection
IX. Slipping, Tripping, Cutting, Drowning and Falling hazard
X. Lifting appliances and Gear, Tools and Tackles
XI. Lifting and Launching operation
XII. Construction plant and machinery
XIII. Machine and area guarding
XIV. Material handling

XV. Hot Work
XVI. Demolition
XVII. Excavation and Tunneling
XVIII. Work Permit System
XIX. Traffic Management
XX. Chemical Handling
XXI. Dangerous and Harmful Environments
XXII. Maintenance matrix of Mechanical and Electrical Machines / Equipment's
XXIII. Working on or under water
XXIV. Working near or under High Tension line
XXV. Personal Protective Equipment's
XXVI. Visitors at Site
XXVII. Occupational Health and Welfare measures
XXVIII. All statutory Forms, returns under various statutes

### 11.4.5 Audit Documents

11.4.5.1 Contractor shall make the below listed documents available for the review by the Audit team.

i. Safety & Health policy
ii. Safety Inspections
iii. Safety & Health organization chart
iv. Annual Safety & Health objectives / programs
v. Accident / near miss statistics and analysis
vi. Safety & Health Training program / records for all personnel
vii. Operation and Maintenance manual of all equipments including Safe operating procedures for various activities, checklists etc.
viii. Records of test and examination of all lifting appliances and gears, plant and machines
ix. Medical records for all personnel
x. Risk identification, assessment and control details
xi. On-site emergency plans and records of Mock Drills
xii. Records of work permits
xiii. Record of monitoring of flammable and explosive substances at work place
xiv. Maintenance and testing of firefighting equipment's
xv. All statutory Registers, Forms, Returns under various statutes
xvi. First Aid, Medical facilities and other welfare measures
xvii. Material Safety Data Sheets
xviii. Housekeeping inspection records
xix. Minutes of SHE committee meetings
xx. Maintenance procedure of Plant & machines
xxi. Calibration & Testing records
xxii. Records of previous Audits

xxiii. Safety inspection records

### 11.4.6 Audit Preparation

i. Audit team members are required to gather information by observations through interviews and by checks of hardware and documentation.

ii. Audit team shall prepare checklist to cover all parts based on SHE legislations rules and regulations and Maha-Metro requirements.

iii. Audit team members shall verify the facts and findings leading to the identified gaps and weakness.

iv. Audit leader has overall responsibility for reaching a conclusion.

### 11.4.7 Reporting

11.4.7.1 Audit report shall be prepared and directly sent to the Employer within 7 days of conducting the audit with a copy to the contractor.

### 11.4.8 Report contents

i. **Executing summary:** Based on the finalized checklists as written the findings to the Employer by the audit team members, the audit leader will compile a concise and accurate summary of observations and findings.

ii. **Introduction:** This will contain basic information regarding the facilities or organization audited, the specific audit dates (inclusion of those for preparation and post-audit activities).

iii. **Principal positive findings:** This will contain the summary of positive aspects as observed by the auditors. It will also contain highlights of those issue, which may warrant dissemination as best practice regarding methodology used or achievement.

iv. **Audit Findings:** All audit findings as detailed in the audit checklists shall be grouped together as priority 1 and 2 as detailed below in a separate listing.

A. **Priority 1**: Actions to rectify gaps or weakness should generally be implemented within 2 – weeks, if risk potential is high or unacceptable.

B. **Priority 2:** Actions should be generally implemented or rectified with a maximum of 3 – 4 weeks, if not rectified would create a likelihood of minor injury or business loss.

### 11.4.9 Conformity Report & Action by Employer

11.4.9.1 The auditor shall inspect the site after 14 days of conducting initial audit for checking the adequacy of implementation of items maintained under priority 1 by the Contractor and shall submit a conformity / non-conformity report to the Employer with a copy to the contractor.

11.4.9.2 The auditor shall again inspect after 28 days of conducting initial audit for checking the adequacy of implementation of items mentioned under priority 2 by the Contractor and shall submit a conformity / non-conformity report to the Employer with a copy to the Contractor.

11.4.9.3 In case of non-conformity of items mentioned by auditor, the Employer shall take necessary steps including stoppage of work and or imposing any penalty for getting the item implemented.

11.4.9.4 Failure of Contractor to conduct External SHE Audit

11.4.9.5 If the Contractor fails to conduct the external, SHE audit in time, the Employer at the cost of Contractor shall get it done.

## 11.5 Environmental Audit

### 11.5.1 Contractor's Environmental Audit

11.5.1.1 The purpose and scope of environmental audit is to assess the degree of compliance of environmental plan and its supplementary procedures and programs against applicable and current environment legislations and requirements of the employer.

11.5.1.2 The employer may undertake regular audits at monthly/quarterly intervals of the contractor's onsite practices and procedures as a means of assessing the ongoing performance of the contractor.

11.5.1.3 Monthly/quarterly audits will be conducted in accordance with Maha-Metro SHE guidelines. The contractor's Project Manager, Chief SHE/Senior Environment Manager accompanied by Maha-Metro Environment department shall carry out the audit.

11.5.1.4 A checklist of environmental requirements will be prepared amended as necessary, throughout the construction phase to focus on areas of frequent non-compliance and to reflect the potential impacts associated with specific activities within the construction programme.

11.5.1.5 The criteria against which the review will be undertaken will be derived from (but not limited to):

a) The appropriate approaches, procedures and commitments given by the contractor in the 'Site Environmental Management Plan'
b) The clauses contained within the Employer's Requirement on Environment.
c) The allocation of responsibility for fulfilling environmental requirement and the effective lines of communication with regard to environmental issues;
d) Compliance with procedure established to enable and effective response to environmental incident, exceedance or non- compliance;
e) The extent and accuracy of record-keeping related to environmental performance indicators;
f) The effectiveness of ensuring high levels of awareness with regard to environmental requirements; and
g) The effectiveness of environmental management activities including the speed and effectiveness of responses to complaints.

11.5.1.6 The criteria against which the audits will be undertaken shall be derived from the clauses within the Employer's Requirements contract-specific Site Environmental Plan and previous site inspection results.

11.5.1.7 A copy of each Audit Report will be sent to Maha-Metro Environment Department and to all subcontractors, with whom it will then be discussed in detail at the Monthly SHE Committee Meeting in order to ensure that any corrective actions are agreed upon.

### 11.5.2 External Environmental Audit

11.5.2.1 External Environmental audits are to be conducted by external agencies that are competent in formulating of Environmental Management measures for construction sector shall be engaged with prior approval from the Environment Department of Maha-Metro.

11.5.2.2 The audit team shall undertake regular audits at quarterly intervals, of the contractor's onsite practices and procedures as a means of assessing the on going performance of the contractor.

11.5.2.3 A checklist of Environmental requirements will be prepared and amended as necessary, throughout the construction phase to focus on areas of frequent non-compliance and to reflect the potential impacts associated with specific activities within the construction programme.

**11.5.2.4 Areas of competence of Audit team/Auditors**

a) Environmental auditiors shall have a regular and qualified degree in Environment and have excellent understanding of environmental issues, knowledge of environmental requirements at construction sites, and shall have demonstrable experience of at least five years in environment management issues.

11.5.2.5 Audit shall be conducted as per the requirements laid out in the conditions of contract on environment, as the case may be.

11.5.2.6 External Environmental audits shall be conducted on a quarterly basis throughout the currency of the contract.

**11.5.2.7 Audit Documents:**

11.5.2.7.1 Contractor shall make the below listed documents available for the review by the Audit team

a) Environmental policy
b) Site Environment Plan
c) Environmental Rules and Regulation
d) Environmental organization chart
e) Annual Environmental objectives / programs
f) Environment Training program / records for all personnel
g) Environment monitoring and management reports
h) Environmental submittals to the employer
i) Environmental monitoring reports
j) Environmental sanitation records
k) Minutes of SHE committee meetings

**11.5.2.8 Reporting:**

11.5.2.8.1 Audit report shall be prepared and directly sent to the Employer within 7 days of conducting the audit with a copy to the contractor.

**11.5.2.9 Report contents:**

i) **Executing summary -** the audit leader will compile a concise and accurate summary of observations and findings.
ii) **Introduction -** this will contain basic information regarding the facilities or organization audited, the specific audit dates (inclusion of those for preparation and post-audit activities).
iii) **Principal positive findings -** This will contain the summary of positive aspects as Observed by the auditors. It will also contain highlights of those issue, which may warrant dissemination as best practice regarding methodology used or Achievement.
iv) **Audit Findings -** All audit findings as detailed in the audit checklists shall be grouped together as priority 1 and 2 as detailed below in a separate listing.

a. **Priority 1:** Actions to rectify gaps or weakness should generally be implemented within two-weeks time, if risk potential is high or unacceptable.

b. **Priority 2:** Actions should be generally implemented or rectified with a maximum of 3 – 4 weeks, if not rectified would create a likelihood of minor injury or business loss.

**11.5.2.10 Conformity Report & Action by Employer**

11.5.2.10.1 The auditor shall inspect the site after 14 days of conducting initial audit for checking the adequacy of implementation of items maintained under priority 1 by the contractor and shall submit a conformity/non-conformity report to the Employer with a copy to the contractor.

11.5.2.10.2 The auditor shall again inspect after 28 days of conducting initial audit for checking the adequacy of implementation of items mentioned under priority 2 by the contractor and shall submit a conformity/non-conformity report to the Employer with a copy to the contractor.

11.5.2.10.3 In case of non-conformity of items mentioned by auditor, the Employer shall take necessary steps including stoppage of work and or imposing any penalty for getting the item implemented.

11.5.2.10.4 Failure of contractor to conduct External Environmental Audit:- If the contractor fails to conduct the external Environment audit in time, the Employer at the cost of contractor shall get it done.

**12.0 SHE COMMUNICATIONS**

12.1 The Contractor shall take every effort to communicate the Safety, Occupational health and Environment management measures through posters campaigns / billboards / banners / glow signs being displayed around the work site as part of the effort to rise safety awareness amongst to the work force. Posters should be in Hindi, English and other suitable language deemed appropriate. Posters / billboards / banners/ glow signs should be changed at least once in a month to maintain the impact.

12.2 The Contractor shall also observe important days as listed in General Instruction Maha-Metro/SHE/GI/008 and printing and displaying safety signage and posters as listed in General Instruction Maha-Metro/SHE/GI/009

12.3 The list indicated are the minimum requirements of the Employer and the Contractor is encouraged to further the SHE communication activities by formulating suitable reward schemes for safety performers and any other activities, which deem fit for the purpose.

**13.0 SHE SUBMITTALS TO THE EMPLOYER**

13.1 The Contractor's SHE management should send the following reports to the Employer periodically:

i) Daily Reporting of total number of workmen (as given in Clause 13.2)
ii) Monthly Environment, Health and Safety Report (as given in Clause 13.3)
iii) SHE Committee Meeting Minutes (as given in relevant clause)
iv) SHE Inspection Reports
v) External Environment Audit report
vi) External Health & Safety Audit Report
vii) Monthly Audit Rating Score (MARS) and Electrical Safety Audit Report etc.

**13.2 Daily Reporting of total number of workmen**

13.2.1 The Contractor shall report to the Employer the total number of workmen engaged by all including any subcontractor within 2 hours of starting of any shift in any day. This reporting shall be the primary duty of the Chief SHE Manager of the Contractor and reporting shall be through tele-fax / email. The onus of checking the receipt of the same by the Employer lies with the Contractor. If the information is not received or received more than 2 hrs after starting of the shift, penalty shall be levied as per relevant clause.

### 13.3 Monthly SHE Report

13.3.1 The Contractor shall prepare a monthly SHE reports consisting of the following and submit 3 copies within 7$^{th}$of next month to the Employer as specified in the Project SHE Manual.

| | |
|---|---|
| **Monthly Health & Safety Report** consisting of the followings: | |
| I. | Monthly Accident Statistics |
| II. | Monthly accident / incident details category wise. |
| III. | SHE committee details |
| IV. | Details of Safety & Health training conducted in the month |
| V. | Safety & Health Inspection and Compliance status |
| VI. | Brief details of Safety & Health internal audit like Electrical audit, MARS etc. |
| VII. | Safety & Health Communication activities undertaken in the month including the number of posters displayed and balance availability in stock. |
| VIII. | Toolbox talks details |
| IX. | PPE details: Quantity purchased, issued to the workmen and stock available. |
| X. | Details on lighting poles, welding and cutting equipment's and inspection of Ladders, Hoists, Lifting appliances, tools & tackles etc. |
| XI. | Monthly site illumination monitoring results including emergency power back up |
| XII. | Housekeeping |
| XIII. | Barricade lighting and maintenance details |
| XIV. | No of critical excavations |
| XV. | Health & Welfare activities, Statutory Registers and returns |
| XVI. | Safety walk conducted by Contractors' Project Manager in the month |
| XVII. | Safety & Health Activities Planned for next month |
| XVIII. | Maintenance schedule of plant and machines |
| **Monthly Environmental Report** shall include (but not limited to) the followings: | |
| I. | Executive summary |
| II. | Brief mention of construction activities |
| III. | Monitoring report of Air, noise, water, soil and DG set stack quality |
| IV. | Waste Management Record i.e. quantity generated and disposed of all types of wastes for the month and cumulative quantities |
| V. | Details of C&D waste produce procured and consumed |
| VI. | Details of Water Consumption for the month and cumulative consumption |
| VII. | Details of fly ash consumption for the month and cumulative consumption |
| VIII. | Raw materials consumption for the month and cumulative consumption |
| IX. | Weekly Environment Inspection checklist |
| X. | Details of environmental training imparted |
| XI. | Point wise compliance of Maha-Metro comments made on previous Monthly Environmental Report |

## 14.0 ACCIDENT REPORTING AND INVESTIGATION

### 14.1 Reporting to Employer

14.1.1 All accidents, "near miss" and dangerous occurrences shall immediately be informed verbally to the Employer. This will enable the Employer to reach to the scene of accident / dangerous occurrences

to monitor/assist any rescue work and/or start conducting the investigation process so that the evidences are not lost.

14.1.2 Reports of all accidents (fatal / injury) and dangerous occurrences shall also be sent within 24 hours as per approved format.

14.1.3 No accident / dangerous occurrences are exempted from reporting to the Employer.

14.1.4 Any wilful delay in verbal and written reporting to the Employer shall be penalised as per relevant clause.

**14.1.5 Near Miss**

An incident or a situation with clear potential for an undesirable outcome to occur, even though no actual negative consequences happened. In other words, it is an event with potential to cause injury, property damage, environmental release, or an adverse community reaction. Generally, the following events are some examples of near miss when:

i) A person trips over an object and falls to the ground but did not get injured
ii) A person has to dive or jump out of the way to avoid a collision with a motorized vehicle, a moving object like a suspended part on a conveyor or from an uncontrolled suspended load;
iii) A person has to jump from a falling ladder;
iv) An object with significant mass falls from a distance of sufficient height that would cause injury to a person if they were struck;
v) A machine part becomes a projectile;
vi) A person works on a piece of equipment that he/EHS believes is de-energized and that equipment starts up putting that person in jeopardy;
vii) A low-speed collision occurs and an occupant of that vehicle is not wearing a seat belt and is not injured.
viii) Stored energy unexpectedly releases which could cause injury if a person were struck or contacted, e.g., a high-tension spring (like your garage door spring) breaks or a pocket of steam releases;
ix) Any steps of the vessel entry procedure are omitted in a vessel entry;
x) Any emergency equipment (fire extinguisher, Scott Air Pack, Oxygen sensor, eye wash, etc) fails to operate properly when called on in an emergency.

If Protective Equipment is called for and worn and it prevents an injury, then in this case it would not be a near miss. As an example, a mechanic is wearing a hard hat in a barricaded area where hard hats must be worn and a 100gram bolt falls from a height of 2 meters and strikes his hard hat and no injury occurs. That would not be a near miss. But if he were not wearing a hardhat and the bolt falls a meter away, then it would be a near miss.

14.1.6 Each non-conformity will be documented by a digital photograph with captions to provide a visual illustration, explicitly indicating the location, date of inspection and the non-conformity in question.

**14.2 Reporting to Government organisations**

14.2.1 In addition to the above verbal and written reporting to the Employer, as per Rule 210 of BOCWR, notice of any accident to a worker at the building or construction site that:

i) causes loss of life; or

ii) disables a worker from working for a period of 48 hours or more immediately following the accident;

iii) shall forthwith be sent by telegram, telephone, fax, or similar other means including special messenger within four hours in case of fatal accidents and 72 hours in case of other accidents, to:

a. the Regional Labour Commissioner, wherein the Contractor has registered the firm/work
b. the board with which the worker involved was registered as a beneficiary;
c. Director General and
d. the next of kin or other relative of the worker involved in the accident;

14.2.2 Further, notice of accident shall be sent in respect of an accident which:

i) causes loss of life; or

ii) disables the injured worker from work for more than 10 days to

a. the officer-in-charge of the nearest police station;
b. the District Magistrate or, if the District Magistrate by order so desires, to
c. the Sub-Divisional Magistrate

14.2.3 In case of an accident-causing minor injury, first-aid shall be administered and the injured worker shall be immediately transferred to a hospital or other place for medical treatment.

14.2.4 Where any accident-causing disablement that subsequently results in death, notice in writing of such death, shall be sent to the authorities mentioned in Clause 14.2.1 and 14.2.2 above within 72 hours of such death.

**14.2.5 Reporting of dangerous occurrences**

14.2.5.1 The following classes of dangerous occurrences shall be reported to the Inspector having jurisdiction, whether or not any disablement or death caused to the worker, namely:

a. collapse or failure of lifting appliances, or hoist, or conveyors, or similar equipment for handling of building or construction material or breakage or failure of rope, chain, or loose gears; or overturning of cranes used in construction work;

b. falling of objects from height;

c. collapse or subsidence of soil, tunnel, pipe lines, any wall, floor, gallery, roof or any other part of any structure, launching girder, platform, staging, scaffolding or means of access including formwork;

d. explosion of receiver or vessel used for storage of pressure greater than atmospheric pressure, of any gas or gases or any liquid or solid used as building material;

e. fire and explosion causing damage to any place on construction site where building workers are employed;

f. spillage or leakage of any hazardous substance and damage to their container;

g. collapse, capsizing, toppling or collision of transport equipment;

h. leakage or release of harmful toxic gases at the construction site;

14.2.6 In case of failure of launching girder, lifting appliance, loose gear, hoist or building and other construction work, machinery and transport equipment at a construction site, such appliances,

gear, hoist, machinery or equipment and the site of such occurrence shall, as far as practicable, be kept undisturbed until inspected by the Authorities;

14.2.7 Every notice given for fatal accidents or dangerous occurrences shall be followed by a written report to the concerned Authorities under Section 39 of BOCWA and the Director General in the specified Form XIV of BOCWR.

## 14.3 Accident investigation

### 14.3.1 General

14.3.1.1 Investigations should be conducted in an open and positive atmosphere that encourages the witnesses to talk freely. The primary objective is to ascertain the facts with a view to prevent future and possibly more serious occurrences.

14.3.1.2 Accidents and Dangerous Occurrences which result in death, serious injury or serious damage must be investigated by the Contractor immediately to find out the cause of the accident/occurrence so that measures can be formulated to prevent any recurrence.

14.3.1.3 Near misses and minor accidents should also be investigated by the Contractor as soon as possible as they are signals that there are inadequacies in the safety management system.

14.3.1.4 Procedure of incident investigation

14.3.1.4.1 It is important after any accident or dangerous occurrence that information relating to the incident is gathered in an organised way. The following steps shall be followed:

a. take photographs and make sketches
b. examine involved equipment, workplace or material and the environmental conditions
c. interview the injured, eye-witnesses and other involved parties
d. consult expert opinion where necessary
e. identify the specific Contractor or sub-contractor involved.
f.

14.3.1.5 Having gathered information, it is then necessary to make an analysis of incident

a. establish the chain of events leading to the accident or incident
b. find out at what stage the accident took place
c. consider all possible causes and the interaction of different factors that led up to the accident, and identify the most probable cause. The cause of an accident should never be classified as carelessness. The specific act or omission that caused the accident must be identified.

14.3.1.6 The next stage is to proceed with the follow-up action

a. report on the findings and conclusions
b. formulate preventive measures to avoid recurrence
c. publicise the findings and the remedial actions taken

## 14.4 Employers' independent incident investigation

14.4.1 In case of fatal / dangerous occurrence the Employer shall also conduct independent investigation. Contractor and his staff shall extend necessary co-operation and testify about the accident.

14.4.2 The Contractor shall take every effort to preserve the scene of accident till the Employer completes the investigation.

14.4.3 All persons summoned by the Employer in connection to witness 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.

## 15.0 EMERGENCY PREPAREDNESS PLAN

15.1 The Contractor shall prepare as required under Rule 36 of BOCWR, an Emergency Response Plan for all work sites as a part of the Contractor SHE Plan. The plan shall integrate the emergency response plans of the Contractor and all other subcontractors. The Emergency Response Plan shall detail the Contractor's procedures, including detailed communications arrangements, for dealing with all emergencies that could affect the Site. This include where applicable, injury, sickness, evacuation, fire, chemical spillage, severe weather and rescue.

15.2 The Contractor shall ensure that an Emergency Response Plan is prepared to deal with emergencies arising out of:

i) Fire and explosion
ii) Collapse of lifting appliances and transport equipment
iii) Collapse of building, sheds, or structure etc.
iv) Gas leakage or spillage of dangerous goods or chemicals
v) Bomb threatening, Criminal or Terrorist attack
vi) Drowning of workers
vii) Landslides getting workers buried floods, Earthquake, storms, and other natural calamities.

15.3 Arrangements shall be 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 shall be adequately publicized and conspicuously displayed in the workplace.

15.4 Contractors shall require to tie-up with the hospitals and fire stations located in the neighbourhood for attending to the casualties promptly and emergency vehicle kept on standby duty during the working hours for the purpose.

15.5 Contractor shall conduct an onsite emergency mock drill once in every month for all his workers and his subcontractor's workers.

15.6 It shall be the responsibility of the Contractor to keep the Local Law & Order Authorities informed and seek urgent help, as the case may be, so as to mitigate the consequences of an emergency. Prompt communication to Maha-Metro, telephonically initially and followed by a written report, shall be made by the Contractor.

15.7 Necessary interfacing and coordination with other working contractors shall be insured by the contractors through the Nodal Officer in charge of the site.

## 16.0 EXPERTS / AGENCIES FOR SHE SERVICES

I. Contractors may utilise the services of experts/agencies empanelled under Rule 250 of BOCWR for the purpose of training, internal audit and any other SHE services with prior approval of the Employer.

II. As an aide to contractors, a list of experts/agencies and the offered service are given in General Instruction Maha-Metro/SHE/GI/010 for ready reference. In addition to it if the Contractor would like to use any expert/agencies' services for any SHE activities the same can also be allowed provided that they are competent and meet to the general requirements of Employer. In every case prior approval of the Employer is mandatory.

# PART II: SAFETY

## 17.0 HOUSEKEEPING

17.1 Housekeeping is the act of keeping the working environment cleared of all unnecessary waste, thereby providing a first-line of defence against accidents and injuries.

17.2 Contractor shall understand and accept that improper housekeeping is the primary hazard in any construction site and ensure that a high degree of housekeeping is always maintained. Indeed "Cleanliness is indeed next to Godliness"

17.3 Housekeeping is the responsibility of all site personnel, and line management commitment shall be demonstrated by the continued efforts of supervising staff towards this activity.

17.4 General Housekeeping shall be carried out by the Contractor and ensured at all times at Work Site, Construction Depot, Batching Plant, Labour Camp, Stores, Offices, and toilets / urinals. Towards this the Contractor shall constitute a special group of housekeeping personnel as per General Instruction Maha-Metro/SHE/GI/001. This group shall ensure daily cleaning at work sites and surrounding areas and maintain a register as per the approved format by the Employer.

17.5 Adequate time shall be assigned to ensure that good housekeeping is maintained. Team of housekeeping squad shall carry out this.

17.6 The Contractor shall be responsible to provide segregated containers for disposal of debris at required places and regular cleaning of the same.

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

17.8 The structure dimension of the barricade, material and composition, its colour scheme, Maha-Metro logo and other details shall be in accordance with specifications laid down in tender document.

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

17.10 Lumber with protruding nails shall be bent or removed and properly stacked.

17.11 All surplus earth and debris are removed/disposed off from the working areas to officially designated dumpsites. Trucks carrying sand, earth and any pulverized materials etc. in order to avoid dust or odour impact shall be covered while moving. The tyres of the trucks leaving the site shall be cleaned with water, wherever the possibility of spillage on carriageways meant for regular road traffic exists.

17.12 No parking of trucks/trolleys, cranes and trailers etc. shall be allowed on roads, which may obstruct the traffic movement. All truck drivers should generally be accompanied by a Cleaner.

17.13 Roads shall be kept clear and materials like: pipes, steel, sand boulders, concrete, chips, and brick etc. shall not be allowed on the roads to obstruct free movement of road traffic.

17.14 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 relevant clause.

17.15 Proper and safe stacking of material are of paramount importance at yards, stores, and such locations where material would be unloaded for future use. The storage area shall be well laid out with easy access and material stored / stacked in an orderly and safe manner.

17.16 Flammable chemicals / compressed gas cylinders shall be safely stored.

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

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

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

17.20 The Contractor shall ensure that all his sub-contractors maintain the site reasonably clean through provisions related to house keeping.

17.21 Cover many general issues around safety management, but not establishing rules of procedure.

17.21.1 Rules of procedure are established by the Contractor for Worksites, addressing the following: safety rules, zero tolerance for substance abuse (refer relevant clause), environmental sensitivity of areas around the Worksites, the dangers of STDs and HIV/AIDS and respect for the beliefs and customs of the populations and community relations generally.

17.21.2 The rules are clearly displayed at the different Worksites and posted in the Contractor'svehicles and machinery driving cabs.

17.21.3 The rules confirm the Contractor's commitment to implementing the ESHS provisions provided for in the Contract.

17.21.4 New employees and existing members of personnel are made aware and acknowledge their understanding of the rules of procedure and the associated provisions. Rules of procedure document are initialed by all employees prior to the start of works.

17.21.5 Pursuant to Clauses 6.9 and 6.11 of the GCC, the rules of procedure include a list of acts considered as serious misconduct and which result in dismissal by the Contractor should an employee repeatedly commit the offence despite awareness of the rules of procedure, and this is without prejudice to any legal action by the public authority for non-compliance with applicable regulations:

I. Drunkenness during working hours, leading to risks for the safety of local inhabitants,
II. customers, users and personnel,
III. Punishable statements or attitudes, and sexual harassment in particular,
IV. Violent behavior,
V. Intentional damage to the assets and interests of others, or the environment,

VI. Repeated negligence or imprudence leading to damage or prejudice to the environment the population or properties, particularly breaching provisions intended to prevent the spreading of STD and AIDS,
VII. Drug use,
VIII. Possession and/or consumption of meat or any other part of an endangered animal or
IX. plant as defined in the Washington convention (CITES) and national regulations

17.21.6 Serious misconduct, such as organization of sex trade (pimping), committing pedophilia, physical aggression, drug trafficking, deliberate and severe pollution, trading and/or trafficking in all or part of protected species, will lead to immediate dismissal as of the first report of misconduct is detected, in application of the rules of procedure and labour laws.

17.21.7 The employer establishes a record for each case of serious misconduct, and a copy will be provided to the employee in question, indicating all action taken to terminate the misconduct by the employee in question and to bring the attention of other members of personnel to the type of incident detected. This record will be provided to the Engineer as an attachment to the monthly report

**17.22 Joint Interphase safety walks**

17.22.1 It is the responsibility of the civil contractor CSM to arrange weekly or as and when required joint interphase safety walks with all the concerned civil and system contractors CSM and site team to highlight various SHE related issues.

**17.23 OHE Charging & Train movements during construction phase**

17.23.1 One of the high risk activity during the construction stage is overhead OHE charging and train movement for signal and trains testing. All the concerned contractors Project manager and CSM have to give necessary safety clearance for the same in writing. There shall be no obstruction and/or infringements for the same.

**18.0 WORKING AT HEIGHT**

18.1 Definitions

18.1.1 “**access**” and “**egress**” include ascent and descent.

18.1.2 “**Fragile surface”** means a surface, which would fail if any reasonably foreseeable loading were to be applied to it.

18.1.3 “**line**” includes rope, chain, or webbing

18.1.4 “**Personal fall protection**” means:

I. a fall prevention, work restraint, work positioning, fall arrest or rescue system, other than a system in which the only safeguards are collective safeguards; or

II. rope access and positioning techniques;

18.1.5 "**Work at height"** means:

I. work in any place, including a place at or below ground level;

II. obtaining access to or egress from such place while at work, except by a staircase in a permanent workplace, where, if protective measures were not taken, a person could fall a distance liable to cause personal injury;

18.1.6 "**Work equipment**" means any machinery, appliance, apparatus, tool or installation for use at work (whether exclusively or not) and includes:

I. a guard-rail, toe-board, barrier, or similar collective means of protection
II. a working platform
III. a net, airbag, or other collective safe guard for arresting falls
IV. personal fall protection system
V. ladders

18.1.7 "**Working platform**" means:

I. any platform used as a place of work or as a means of access to or egress from a place of work;

II. includes any scaffold, suspended scaffold, cradle, mobile platforms, trestle, gangway, gantry and stairway which is so used.

18.2 **Organisation and planning**

The Contractor shall ensure that work at height is:

I. properly planned for any emergencies and rescue
II. appropriately supervised; and
III. carried out in a manner, which is reasonably practicable safe.

18.3 The Contractor shall ensure that work at height is carried out only when the weather conditions do not jeopardise the health or safety of persons involved in the work.

18.4 Competence

The Contractor shall ensure that no person engages in any activity, including organization, planning and supervision, in relation to work at height or work equipment for use in such work unless he is competent to do so or, if being trained, is being supervised by a competent person.

**18.5 Avoidance of risks from work at height**

The Contractor shall ensure that work is not carried out at height where it is reasonably practicable to carry out the work safely otherwise than at height.

18.6 Where work is carried out at height, the Contractor shall take suitable and sufficient measures as given below to prevent, so far as is reasonably practicable, any person falling a distance liable to cause personal injury.

i) his ensuring that the work is carried out:

A. from an existing place of work; or
B. (In the case of obtaining access or egress) using an existing means, complying to the requirements as given in relevant clause.

Where it is reasonably practicable to carry it out safely and under appropriate ergonomic conditions; and

ii) Where it is not reasonably practicable for the work to be carried out in accordance with sub-paragraph (a), his providing sufficient work equipment for preventing, so far as is reasonably practicable, a fall occurring.

18.7 Where the measures taken under Clause 18.6 do not eliminate the risk of a fall occurring, every Contractor shall:

i) So far as is reasonably practicable, provide sufficient work equipment to minimise:

a. The distance and consequences; or
b. Where it is not reasonably practicable to minimise the distance, the consequences, of a fall; and

ii) Without prejudice to the generality of Clause 18.4, provide such additional training and instruction or take other additional suitable and sufficient measures to prevent, so far as is reasonably practicable, any person falling a distance liable to cause personal injury.

18.8 **Selection of 'work equipment' for work at height**

i) The Contractor, in selecting work equipment for use in work at height, shall:

a. Give collective protection measures priority over personal protection measures; and

b. Take account of:

1. The working conditions and the risks to the safety of persons at the place where the work equipment is to be used;
2. In the case of work equipment for access and egress, the distance to be negotiated;
3. The distance and consequences of a potential fall;
4. The duration and frequency of use;
5. The need for easy and timely evacuation and rescue in an emergency; and
6. Any additional risk posed by the use, installation, or removal of that work equipment or by evacuation and rescue from it;

ii) The Contractor shall select work equipment for work at height which:

(a) has characteristics including dimensions which:

1) Are appropriate to the nature of the work to be performed and the foreseeable loadings; and
2) Allow passage without risk; and

(b) Is in other respects the most suitable work equipment, having regard in particular to the purposes specified in Clause18.5 and 18.6.

18.9 **Fragile surfaces**

18.9.1 The Contractor shall ensure that no person at work passes across or near, or working on, from or near, a fragile surface where it is reasonably practicable to carry out work safely and under appropriate ergonomic conditions without his doing so.

18.9.2 Where it is not reasonably practicable to carry out work safely and under appropriate ergonomic conditions without passing across or near, or working on, from or near, a fragile surface, every Contractor shall:

I. ensure, so far as is reasonably practicable, that suitable and sufficient platforms, coverings, guard rails or similar means of support or protection are provided and used so that any foreseeable loading is supported by such supports or borne by such protection;

II. where a risk of a person at work falling remains despite the measures taken under the preceding provisions of this regulation, take suitable and sufficient measures to minimise the distances and consequences of his fall.

18.9.3 Where any person at work may pass across or near, or work on, from or near, a fragile surface, every Contractor shall ensure that:

(i) prominent warning notices are so far as is reasonably practicable affixed at the approach to the place where the fragile surface is situated; or

(ii) where that is not reasonably practicable, such persons are made aware of it by other means.

**18.10 Falling objects**

18.10.1 The Contractor shall, wherever necessary to prevent injury to any person and damage to the property of third party, take suitable and sufficient steps to prevent, so far as is reasonably practicable, the fall of any material or object.

18.10.2 where it is not reasonably practicable to comply with the requirements of Clause18.9, every Contractor shall take suitable and sufficient steps to prevent any person being struck by any falling material or object which is liable to cause personal injury & damage to the property of third party.

18.10.3 The Contractor shall ensure that no material or object is thrown or tipped from height in circumstances where it is liable to cause injury to any person and the property of third party.

18.10.4 Every Contractor shall ensure that materials and objects are stored in such a way as to prevent risk to any person arising from the collapse, overturning or unintended movement of such materials or objects.

**18.11 Danger areas**

18.11.1 Without prejudice to the preceding requirements of these Regulations, every Contractor shall ensure that,

(i) Where a workplace contains an area in which, owing to the nature of the work, there is a risk of any person at work;

a. falling a distance; or
b. being struck by a falling object,

which is liable to cause personal injury, the workplace is so far as is reasonably practicable equipped with devices preventing unauthorised persons from entering such area; and

(ii) such area is clearly indicated.

**18.12 Inspection of work equipment**

18.12.1 The Contractor shall ensure that, where the safety of work equipment depends on how it is installed or assembled, it is not used after installation or assembly in any position unless it has been inspected in that position.

18.12.2 The Contractor shall ensure that work equipment exposed to conditions causing deterioration which is liable to result in dangerous situations is inspected

(i) at suitable intervals; and
(ii) each time that exceptional circumstances which are liable to jeopardise the safety of the work equipment have occurred,

to ensure that health and safety conditions are maintained and that any deterioration can be detected and remedied in good time.

18.12.3 Without prejudice to Clause 18.12.1, the Contractor shall ensure that a working platform

(i) used for construction work; and
(ii) from which a person could fall 2 metres or more,

is not used in any position unless it has been inspected in that position or, in the case of a mobile working platform, inspected on the site, within the previous 7 days.

18.12.4 The Contractor shall ensure that the reports of all inspections are properly maintained and shown to the Employer as and when required.

18.12.5 **In this clause "inspection",**

(i) means such visual or more rigorous inspection by a competent person as is appropriate for safety purposes; and
(ii) includes any testing appropriate for those purposes,

**18.13 Inspection of places of work at height**

The Contractor shall so far as be reasonably practicable ensure that the surface and every parapet, permanent rail or other such fall protection measure of every place of work at height are checked on each occasion before the place is used.

**18.14 Duties of persons at work**

18.14.1 Any workmen employed by the Contractor shall report to the supervisor about any defect relating to work at height which he knows is likely to endanger the safety of himself or another person.

18.14.2 Every workman shall use any work equipment or safety device provided to him for work at height by the Contractor, in accordance with:

(i) any training in the use of the work equipment or device concerned which have been received by him; and

(ii) the instructions respecting that use which have been provided to him by the Contractor as per the requirements of the Employer

18.15 Requirements for existing places of work and means of access or egress at height

Every existing place of work or means of access or egress at height shall:

(i) be stable and of sufficient strength and rigidity for the purpose for which it is intended to be or is being used;

(ii) where applicable, rest on a stable, sufficiently strong surface;

(iii) be of sufficient dimensions to permit the safe passage of persons and the safe use of any plant or materials required to be used and to provide a safe working area having regard to the work to be carried out there;

(iv) possess suitable and sufficient means for preventing a fall;

(v) possess a surface which has no gap

a. through which a person could fall;
b. through which any material or object could fall and injure a person; or
c. giving rise to other risk of injury to any person, unless measures have been taken to protect persons against such risk;

(vi) be so constructed and used, and maintained in such condition, as to prevent, so far as is reasonably practicable:

a. the risk of slipping or tripping; or
b. any person being caught between it and any adjacent structure;

(vii) where it has moving parts, be prevented by appropriate devices from moving inadvertently during work at height.

18.16 Requirements for guardrails, toe-boards, barriers and similar collective means of protection

(i) Unless the context otherwise requires, any reference in this section to means of protection is to a guardrail, toe-board, barrier or similar collective means of protection.

(ii) Means of protection shall

a. be of sufficient dimensions, of sufficient strength and rigidity for the purposes for which they are being used, and otherwise suitable;
b. be so placed, secured and used as to ensure, so far as is reasonably practicable, that they do not become accidentally displaced; and
c. be so placed as to prevent, so far as is practicable, the fall of any person, or of any material or object, from any place of work.

(iii) In relation to work at height involved in construction work

a. the top guard-rail or other similar means of protection shall be at least 950 millimetres above the edge from which any person is liable to fall;
b. toe-boards shall be suitable and sufficient to prevent the fall of any person, or any material or object, from any place of work; and
c. any intermediate guardrail or similar means of protection shall be positioned so that any gap between it and other means of protection does not exceed 470 millimetres.

(iv) Any structure or part of a structure which supports means of protection or to which means of protection are attached shall be of sufficient strength and suitable for the purpose of such support or attachment.

**18.17 Requirements for all Working Platforms**

(i) Every working platform requires a supporting structure for holding it

(ii) Any surface upon which any supporting structure rests shall be stable, of sufficient strength and of suitable composition safely to support the supporting structure, the working platform and any loading intended to be placed on the working platform.

(iii) Stability of supporting structure

Any supporting structure shall

a. be suitable and of sufficient strength and rigidity for the purpose for which it is being used;
b. in the case of a wheeled structure, be prevented by appropriate devices from moving inadvertently during work at height;
c. in other cases, be prevented from slipping by secure attachment to the bearing surface or to another structure, provision of an effective anti-slip device or by other means of equivalent effectiveness;
d. be stable while being erected, used, and dismantled; and
e. when altered or modified, be so altered, or modified as to ensure that it remains stable.
f. Have suitable base plates and properly footed thereby.

(iv) Stability of working platforms

A working platform shall

a. be suitable and of sufficient strength and rigidity for the purpose or purposes for which it is intended to be used or is being used;
b. be so erected and used as to ensure that its components do not become accidentally displaced so as to endanger any person;
c. when altered or modified, be so altered, or modified as to ensure that it remains stable; and
d. be dismantled in such a way as to prevent accidental displacement.

(v) Safety on working platforms

A working platform shall

a. be of sufficient dimensions to permit the safe passage of persons and the safe use of any plant or materials required to be used and to provide a safe working area having regard to the work being carried out there;

b. possess a suitable surface and, in particular, be so constructed that the surface of the working platform has no gap

1. through which a person could fall;
2. through which any material or object could fall and injure a person; or
3. giving rise to other risk of injury to any person, unless measures have been taken to protect persons against such risk; and

c. be so erected and used, and maintained in such condition, as to prevent, so far as is reasonably practicable

1. the risk of slipping or tripping; or
2. any person being caught between the working platform and any adjacent structure.

(vi) Loading

A working platform and any supporting structure shall not be loaded so as to give rise to a risk of collapse or to any deformation, which could affect its safe use.

(vii) Additional requirements for scaffolding

Strength and stability calculations for scaffolding shall be carried out unless

a. a note of the calculations, covering the structural arrangements contemplated, is available; or
b. it is assembled in conformity with a generally recognised standard configuration.

(viii) Depending on the complexity of the scaffolding selected, a competent person shall draw up an assembly, use and dismantling plan. This may be in the form of a standard plan, supplemented by items relating to specific details of the scaffolding in question.

(ix) A copy of the plan, including any instructions it may contain, shall be kept available for the use of persons concerned in the assembly, use, dismantling or alteration of scaffolding until it has been dismantled.

(x) The dimensions, form and layout of scaffolding decks shall be appropriate to the nature of the work to be performed and suitable for the loads to be carried and permit work and passage in safety.

(xi) While a scaffold is not available for use, including during its assembly, dismantling or alteration, it shall be marked with general warning signs in accordance with and be suitably delineated by physical means preventing access to the danger zone.

(xii) Scaffolding may be assembled, dismantled, or significantly altered only under the supervision of a competent person and by persons who have received appropriate and specific training in the operations envisaged which addresses specific risks which the operations may entail and precautions to be taken, and more particularly in:

a. understanding of the plan for the assembly, dismantling or alteration of the scaffolding concerned;
b. safety during the assembly, dismantling or alteration of the scaffolding concerned;
c. measures to prevent the risk of persons, materials or objects falling;
d. safety measures in the event of changing weather conditions which could adversely affect the safety of the scaffolding concerned;
e. permissible loadings;
f. any other risks which the assembly, dismantling or alteration of the scaffolding may entail.

**18.18 Requirements for collective safeguards for arresting falls**

(i) Collective safeguard is a safety net, airbag or other collective safeguard for arresting falls

(ii) A safeguard shall be used only if

a. a risk assessment has demonstrated that the work activity can so far as is reasonably practicable be performed safely while using it and without affecting its effectiveness;
b. the use of other, safer work equipment is not reasonably practicable; and
c. a sufficient number of available persons have received adequate training specific to the safeguard, including rescue procedures.

(iii) A safeguard shall be suitable and of sufficient strength to arrest safely the fall of any person who is liable to fall.

(iv) A safeguard shall:

a. in the case of a safeguard which is designed to be attached, be securely attached to all the required anchors, and the anchors and the means of attachment thereto shall be suitable and of sufficient strength and stability for the purpose of safely supporting the foreseeable loading in arresting any fall and during any subsequent rescue;
b. in the case of an airbag, landing mat or similar safeguard, be stable; and
c. in the case of a safeguard, which distorts in arresting a fall, afford sufficient clearance.

(v) Suitable and sufficient steps shall be taken to ensure, so far as practicable, that in the event of a fall by any person the safeguard does not itself cause injury to that person.

### 18.19 Requirements for personal fall protection systems

(i) A personal fall protection system shall be used only if

a. a risk assessment has demonstrated that

1. the work can so far as be reasonably practicable be performed safely while using that system; and
2. the use of other safer work equipment is not reasonably practicable; and

b. the user and a sufficient number of available persons have received adequate training specific to the operations envisaged, including rescue procedures.

(ii) A personal fall protection system shall

a. be suitable and of sufficient strength for the purposes for which it is being used having regard to the work being carried out and any foreseeable loading;
b. where necessary, fit the user;
c. be correctly fitted;
d. be designed to minimise injury to the user and, where necessary, be adjusted to prevent the user falling or slipping from it, should a fall occur; and
e. be so designed, installed, and used as to prevent unplanned or uncontrolled movement of the user.

(iii) A personal fall protection system designed for use with an anchor shall be securely attached to at least one anchor, and each anchor and the means of attachment thereto shall be suitable and of sufficient strength and stability for the purpose of supporting any foreseeable loading.

(iv) Suitable and sufficient steps shall be taken to prevent any person falling or slipping from a personal fall protection system.

(v) All fall protection system should be inspected weekly as a minimum.

### 18.20 Requirements for Ladders

(i) Every Contractor shall ensure that a ladder is used for work at height only if a risk assessment has demonstrated that the use of more suitable work equipment is not justified because of the low risk and

a. The short duration of use; or
b. Existing features on site, which he cannot alter.

(ii) Only metal ladders shall be allowed. Bamboo ladders are prohibited.

(iii) Any surface upon which a ladder rests shall be stable, firm, of sufficient strength and of suitable composition safely to support the ladder so that its rungs or steps remain horizontal, and any loading intended to be placed on it.

(iv) A ladder shall be so positioned as to ensure its stability during use

(v) A suspended ladder shall be attached in a secure manner and so that, with the exception of a flexible ladder, it cannot be displaced and swinging is prevented.

(vi) A portable ladder shall be prevented from slipping during use by:

a. securing the stiles at or near their upper or lower ends;
b. an effective anti-slip or other effective stability device; or
c. any other arrangement of equivalent effectiveness.

(vii) A ladder used for access shall be long enough to protrude sufficiently above the place of landing to which it provides access, unless other measures have been taken to ensure a firm handhold.

(viii) No interlocking or extension ladder shall be used unless its sections are prevented from moving relative to each other while in use.

(ix) A mobile ladder shall be prevented from moving before it is stepped on.

(x) Where a ladder or run of ladders raises a vertical distance of 9 metres or more above its base, there shall, where reasonably practicable, be provided at suitable intervals sufficient safe landing areas or rest platforms.

(xi) Every ladder shall be used in such a way that

a. a secure handhold and secure support are always available to the user; and

b. the user can maintain a safe handhold when carrying a load unless, in the case of a step ladder, the maintenance of a handhold is not practicable when a load is carried, and a risk assessment has demonstrated that the use of a stepladder is justified because of

1. the low risk; and
2. the short duration of use.

(xii) Ladders should be inspected weekly for any damage or corrosion.

## 18.21 Detailed requirements for Scaffolding

### 18.21.1 Scaffold General

This procedure provides general information about the competent person, erection, inspection, and use of both welded-frame and tube-and-coupler scaffolds.

(i) Scaffolds are intended to provide safe working positions at elevations. To eliminate fall exposures, scaffolds must have complete handrails, mid-rails, and decking. Do not use fall arrest equipment as a substitute for handrails, mid-rails, or a complete deck.
(ii) Before erecting scaffolds, consider all nearby or overhead hazardous energy sources such as electrical, mechanical, pneumatic, thermal, and chemical.
(iii) Welded-frame scaffolds are made of basic prefabricated end frames, cross-bracing, and frame-connecting devices to hold the parts firmly in place. Tube and-coupler and system scaffolds are made of various lengths of tubing clamped together by special patented couplers to support working platforms of various shapes.
(iv) All complete scaffolds will have a top handrail approx. 1.1 meter above the platform, mid rail approx. 0.6 meter above the platform and a toe plate 10 cm tall from the platform.
(v) Do not inter mix scaffold components manufactured by different manufacturers unless the component parts fit together without force or modification.
(vi) Bamboo components are not permitted on Maha-Metro Sites.

**Competent person**: one who is capable of identifying existing and predictable hazards in the surroundings or working conditions which are unsanitary, hazardous, or dangerous to employees, and who has authorization to take prompt, corrective measures to eliminate those.

**Qualified person**: one who, by possession of a recognized degree, certificate, or professional standing, or who by extensive knowledge, training, and experience, has successfully demonstrated his or her ability to solve or resolve problems related to the subject matter, the work, or the project.

### 18.21.2 Erecting Scaffolds

(i) Only employees who have been trained by and are under the supervision of a competent person will erect scaffolds. The Maha-Metro Project Safety Manager must approve scaffolds higher than 50 feet (15 meters) above the base plates.

(ii) Where fall hazards cannot be eliminated, use fall-arrest systems while erecting, modifying, and dismantling scaffolds. It is the responsibility of the competent person to determine the feasibility and type of fall-arrest system to be used.

(iii) Set scaffold legs on base plates placed on foundations or mudsills that are adequate for supporting the maximum intended loads. Scaffold boards and

(iv) masonry blocks are not appropriate scaffold foundations. The total load on a scaffold consists of the sum of the weight of the workers and materials on a scaffold plus the weight of the scaffold.

(v) Install adjusting screws only between the base plate and the vertical frame section. Never use adjusting screws together with casters. Do not extend adjusting screws beyond 12 inches (30 centimetres).

(vi) The position and number of braces used on a scaffold not only restricts the amount of side movement, but also determines the strength of the scaffold. Never use cross-braces as substitutes for handrails or mid rails.

(vii) When the height of a scaffold exceeds three times the smallest width of the base, secure it to the building or structure at every other lift and every 9 meters horizontally. The scaffold should be secured by both ties and braces to prevent movement Equip scaffold working platforms with handrails approximately one-meter high, mid rails, and toe boards, all secured rigidly. Working platforms should be completely decked with safety planks, manufactured scaffold decking, or laminated wooden planks.

(viii) To allow access to the working platform of a tubular welded frame scaffold, the ladder built into the end frames can be used if it has been specifically designed and constructed by the manufacturer for the purpose of access.

(ix) Employees engaged in erecting or dismantling tubular-welded frame scaffolds may use the end-frame horizontal members for access provided they are parallel, level, and are not more than 22 inches apart vertically. Hook-on attachable ladders shall be installed as soon as scaffold erection has progressed to a point that permits safe installation and use. Consideration should be given to breaking the ladder at approximately 6-meter intervals. Retractable or vertical lifelines should be used for fall protection while climbing more than 20-feet.

(x) When portable straight or extension ladders are used for access to tube-and coupler scaffolds, the 4-to-1 slope should be maintained to avoid a horizontal tube interfering with the use of the ladder.

(xi) Scaffold users should be able to step off the scaffold access ladder directly onto the working platform. Provide entry gates for scaffolds to eliminate the need for users to climb over handrails.

(xii) Tag or otherwise identify scaffolds that should not be occupied or that require particular safety precautions. The tag should indicate special requirements, the date of erection, and the signature of the competent person.

(xiii) Scaffolds and their components must be capable of supporting, without failure, at least four times the maximum intended load. Materials should be evenly distributed on platforms and not concentrated in one small area.

(xiv) During erection of scaffolds, the electrical clearances shall be maintained as per the tabulation mentioned herein in this document

### 18.21.3 Scaffold Inspection

(i) A competent person shall visually inspect all components of the scaffold for defects prior to each shift's use and following any occurrence that could affect the scaffold's structural integrity. Defective components will be immediately discarded.

(ii) Before erecting and while dismantling scaffolds, inspect all components. Scaffold components should be straight and free from bends, kinks, dents, and severe rusting. Immediately discard defective components. Inspections should include an evaluation of the following components:

a. Handrails, mid-rails, toe boards, cross-bracing and steel tubing for nicks and other damage, especially near the centre span, and for signs that welding arcs may have struck the equipment
b. weld zones on the scaffold frame for cracks
c. the end of tubing for splits or cracks
d. manufactured decks for loose bolts or rivet connections and bent, kinked, or dented frames
e. safety planks for rot, cracks, cuts, and other external damage
f. tie rods or bolts and angle iron cleats
g. cams, springs, threaded connection, toggle pins, or other quick-connecting devices
h. Casters for rough rolling surfaces, "sticky" swivels, and defective locking mechanisms.

(iii) Scaffold Inspection Tag, Boards, identifying that the scaffold is “Safe for Use” or “Scaffolds Under Construction” must be attached to all scaffolds.

### 18.21.4 Scaffold Training

(i) Employees involved in the erection, dismantling, moving, repairing, etc., of scaffolding shall receive training from a competent person. The purpose of the training is to recognize any hazards associated with the work in question. Training shall consist of:

a. The nature of scaffold hazards
b. The correct procedures for erecting, disassembling, moving, operating, repairing, inspecting, and maintaining the type of scaffold.
c. The design criteria, maximum intended load-carrying capacity, and intended use of the scaffold.

(ii) Employees who perform work while on a scaffold shall be trained by a qualified person so they will recognize hazards associated with the type of scaffold being used and understand the procedures to control those hazards. Training will cover the following topics as necessary:

a. The nature of any electrical hazards, fall hazards, and falling object hazards in the work area.
b. The correct procedures for dealing with electrical hazards and for erecting, maintaining, and disassembling the fall protection systems and falling object protection systems used.
c. The proper use of the scaffold and the proper handling of materials on the scaffold.
d. The maximum intended load and the load-carrying capacities of the scaffolds used.

### 18.21.5 Suspended Scaffolding

Swinging stages, toothpicks, boatswain chairs, float, and needle beams require special approval prior to use.

Attach and secure safety harness before stepping on these scaffolds and do not remove until clear of the scaffold. Tie off to independent lifeline or building structure. One lifeline per person.

### 18.22 Provision of safety nets

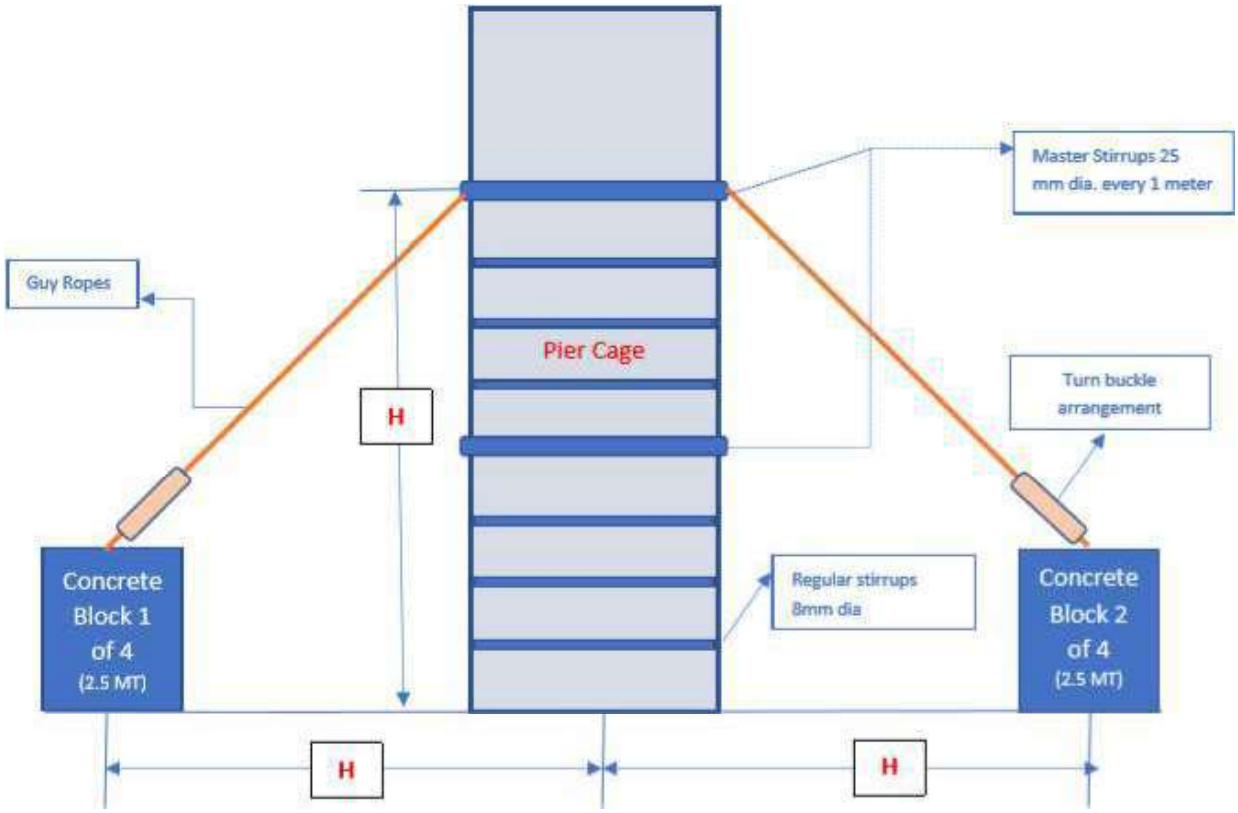
Garware make/Equivalent to safety nets have to be provided at all the locations where there is free fall of men/materials from the site to the live road or ground floor. Double/Triple layer safety nets has to be provided without fail

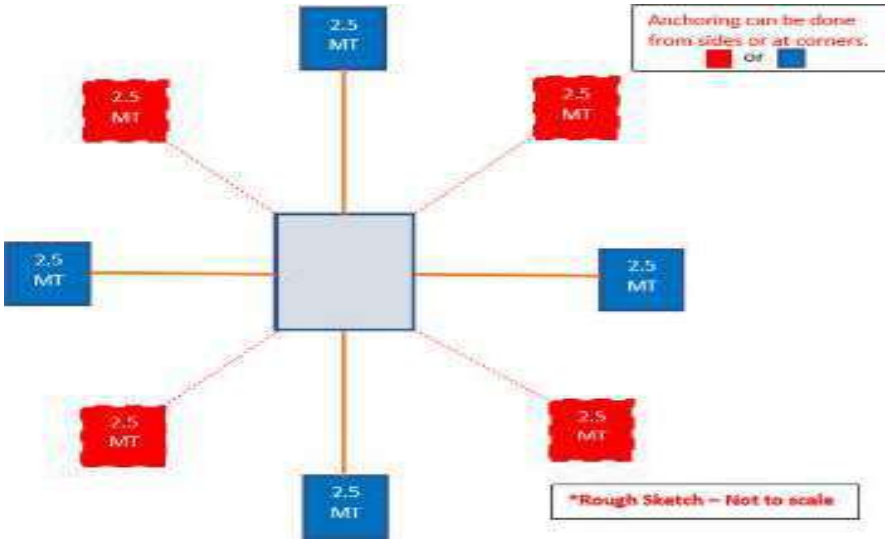
### 18.23 Pier Reinforcement Cage Protection

Tying of Pier reinforcement should be done as per sketch A. wherever due to space constraint, it isdesirable that two cranes should be used; one to hold the pier reinforcement and the other one toerect the shuttering.

1. 25mm dia. master stirrup to be installed every 1 m height, in addition to regular stirrups.
2. Master stirrup need to be used to anchor the pier cage with guy ropes at four sides. Concrete blocks (2.5 MT) shall be placed in such a way that the guy ropes make an angle of $45^0$ with the ground. (referattached sketch A)
3. For all pier reinforcement / shuttering works more than 6m height, advance RFI along with safetyinspection checklist must be raised for permission of GC personnel for de-staging of support and placement of shuttering

## Typical Sketch A - Pier cage - Concrete blocks placement & anchorage method






## 19.0 OVERHEAD PROTECTION

19.1 All contractors shall provide overhead protections as per Rule 41 of BOCWR.

19.2 Overhead protection should be erected along the periphery of every building which is under construction and the building height shall be 15m or above after construction.

19.3 Overhead protection shall be minimum 2m wide and the outer edge shall be 150mm higher than the inner edge and an angle not more than 20º to its horizontal sloping into the building.

19.4 Overhead protection shall not be erected more than a height of 5m from the base of the building.

19.5 Areas of inadvertent hazard of falling of material shall be guarded or barricaded or roped-off thereby by the Contractor.

## 20.0 SLIPPING, TRIPPING, CUTTING, DROWNING AND FALLING HAZARDS

As per Rule 42 of BOCWR:

20.1 All places should be free from dust, debris or similar materials.

20.2 Sharp projections or any protruding nails or similar objects shall be suitably guarded or shall even be avoided to make the place safe to work.

20.3 Contractor shall not allow workmen to work or use platforms, scaffolds/passageways or any walkways, which has water, or oil or similar substances spilt and has a slipping hazard, unless it is cleaned off or covered or sanded or saw dusted or make it safe with any suitable material.

20.4 When workers are exposed to areas where fall into water is possible, the Contractor shall provide suitable and adequate equipment for saving the workers from drowning and rescuing from such hazard. If the Employer considers, the Contractor shall provide well-equipped boat or launch, manned with trained personnel at the work place.

20.5 Open side or opening where worker, equipment, vehicle or lifting appliance may fall at a building or outside shall be guarded suitably except in places of free access by reasons of nature of work.

20.6 Suitable safety net shall be provided at places of material / man falling is possible in accordance with national standards.

20.7 The collapse of formwork in the construction industry has the potential for severe injury and death. The four stages of the use of formwork (erection, adjustment, concrete placement and dismantling) all need to be managed in a risk assessment framework. Implementing suitable control measures can eliminate or reduce the potential for events such as the collapse of formwork. Suitable control measures include:

I. keeping the documentation for the formwork at the workplace;
II. following the formwork documentation;
III. planning to ensure that all elements of the process are conducted in a safe manner – e.g., ensuring operators such as crane operators, concrete placers are suitably licensed and trained, appropriate personal protective equipment is used etc;
IV. erecting the formwork on foundations which will support the loads to be imposed on the formwork;
V. not erecting formwork near excavation;
VI. ensuring materials used in the erection of formwork are not defective;
VII. securing loose material which may be dislodged as a result of inclement weather;
VIII. inspecting the formwork assembly before and during the placement of concrete;
IX. not attaching equipment to the formwork assembly unless specifically designed for this purpose; and not using a stripping process which may cause damage to the permanent structure.

## 21.0 LIFTING APPLIANCES AND GEAR

21.1 Lifting appliances means a crane, hoist machinery, derrick, winch, gin pole, sheer legs, jack, hoist drum, slewing machinery, slewing bearing fasteners, lifting machinery sheaves, pulley blocks, hooks or other equipment used for lifting materials, objects or building workers and lifting gears means ropes, chain slings, shackles, hooks, lifting lugs, wire ropes, lifting eyebolts and eyenuts and other accessories of a lifting appliance.

21.2 No machine shall be selected to do any lifting on a specific job until its size and characteristics are considered against:

I. the weights, dimensions, and lift radius of the heaviest and largest loads

II. the maximum lift height, the maximum lift radius and the weight of the loads that must be handled at each lifting operation.

III. Proper mockup without load trials shall be carried out for heavy duty lifting operations by crane before resorting to the actual lifting of the load.

IV. the number and frequency of lifts to be made and maintained in Lifting Register.

V. how long the crane will be required on site to be ensured by lifting team.

VI. the type of lifting to be done (for example, is precision placement of loads important?)

VII. the type of carrier required (this depends on ground conditions and machine capacity in its operating quadrants) capacity is normally greatest over the rear, less over the side, and non-existent over the front

VIII. whether loads will have to be walked or carried

IX. whether loads will have to be suspended for lengthy periods

X. the site conditions, including the ground where the machine will be set up, access roads and ramps it must travel, space for erection and any obstacles that might impede access or operation.

XI. Method Statement with attached Risk Assessment, Lifting Plan, lifting method drawing/sketch and the list of Competent Lifting Team/Responsible Person shall be submitted to employer well in advance as mentioned herein before at Clause 3.5.2.

XII. Pre-lifting Toolbox-Talk must be conducted before lifting operation with listed Lifting team ensuring their roles and responsibilities in lifting operation.

21.3 The Contractor shall ensure that a valid certificate of fitness issued as per Clause 21.5 is available for all lifting appliances including synchronised mobile jacks, pre-stressing hydraulic jacks, jacks fitted with launching girders etc. and Employer's approval before inducting to the site. Only after obtaining the approval from the Employer any lifting appliances and gear shall be used.

21.4 The laminated photocopies of fitness certificate issued by competent person, the Employers' approval letter, the operators' photo, manufacturer's load chart and competency certificate shall always be either kept in the operator cabin or pasted on the visible surface of the lifting appliances.

21.5 All lifting appliances and loose gears shall be clearly marked for its safe working load and identification by stamping or other suitable means.

21.6 The Contractor shall also maintain a register containing a system of identification of all tools and tackles, its date of purchase, safe working load, competent person date of examination etc.

21.7 Test and periodical examination of lifting appliances and gears

21.7.1 All lifting appliances including all parts and gears thereof, whether fixed or movable shall be thoroughly tested and examined by a competent person once at least in every six months or after it has undergone any alterations or repairs liable to affect its strength or stability. Within the validity, if the lifting appliances are shifted to a new site, re-examination by the same competent person for ensuring its safety shall also be done.

21.7.2 Contractors can utilise the services of any competent person as defined in Factories Act, 1948 and approved by Chief Inspector of Factories with the permission of the Employer.

21.7.3 All alarms and signals like Automatic Safe Load Indicators (ASLI), boom angle indicators, boom extension indicators, over lift boom alarm, swing alarm, hydraulic safety valves, mechanical radius indicators, load moment indicators etc. shall be periodically examined and maintained always in working condition.

21.8 Automatic Safe Load Indicators

21.8.1 As stipulated in relevant Rule of GBOCWR 2003, no lifting appliances gear or any other material handling appliance is used, if:

(i) the Inspector having jurisdiction is not satisfied with reference to a certification of test or examination or to an authenticated record maintain as provided under these rules; and

(ii) in the view of such Inspector, the lifting appliance, lifting gear or any other material handling appliance is not safe for use in building or other construction work; and

(iii) no pulley block is used in building or other construction work unless the safe working load and its identification are clearly marked on such block.

21.8.2 All lifting appliances and gears, like cranes, hydras etc, if so constructed that the safe working load may be varied by raising or lowering of the jib or otherwise shall be attached with an automatic indicator of safe working loads approved by Bureau of Indian standards/ International

certifying bodies which gives a warning to the operator and arrests further movements of the lifting parts.

21.9 Qualification of operator of lifting appliances and of signaller etc.

21.9.1 The Contractor shall not employ any person to drive or operate a lifting machine like crane, hydra etc whether driven by mechanical power or otherwise or to give signals to work as a operator of a rigger or derricks unless he:

(i) is above twenty-one years of age and possesses a valid heavy transport vehicle driving licence as per Motor Vehicle Act and Rules.

(ii) is absolutely competent and reliable

(iii) possesses the knowledge of the inherent risks involved in the operation of lifting appliances by undergoing a formal training at any institution of national importance acceptable to Employer

(iv) is medically examined periodically as specified in Schedule VII of BOCW Rules.

21.10 General requirements of appliances

21.10.1 Out-of level

One of the most severe effects of being out-of fit level is that side loads develop in the boom. Because of side loads all mobile cranes lose capacity rapidly as the degree of out-of-level increases and therefore control of out-of-level is of utmost importance.

21.10.2 Boom

(i) The boom is one of the more critical elements of the crane and must be in perfect condition at all time. No boom section with a bent lattice member shall be allowed

(ii) All welds shall be crack and corrosion free

(iii) No member of the boom shall be bent

(iv) All telescopic boom shall be free from cracks, rust, flaking or cracked paint, bulges, greases or varnishes

21.10.3 The sweep area (work area) of the construction machinery shall be always free from obstructions.

21.10.4 All hydraulic piping and fittings shall be maintained leak proof.

21.10.5 The operator cab shall posses good and safe:

(i) structure, windows, and windshield wipers
(ii) Drivers chair and foot rest
(iii) Control handles
(iv) Cab instrumentation
(v) Telecommunication
(vi) Cab out fitting
(vii) wind indicator with an adjustable set point shall be in a position representative for the wind on the crane. The indicator shall give continuous information regarding constant speeds and gusts.

21.11 Mandatory rigging requirements

21.11.1 Rigging shall be done under experienced and qualified rigger only.

21.11.2 The primary requirement in rigging shall be to assess the weight of load before attempting any lift.

21.11.3 All hooks shall be fitted with Master Rings having certificate of fitness from the competent person, so that the hooks are subjected to balanced vertical loading only.

21.11.4 Only four legged slings shall be allowed which includes master link (ring), intermediate master link (ring) if necessary, chain / wire rope sling, sling hook or other terminal fitting.

21.11.5 Hand spliced slings up to 32mm diameter shall not be used at site for any lifting purpose.

21.11.6 No load shall be slewed over public areas without stopping the pedestrians and road traffic first.

21.11.7 Requirements of outriggers

(i) All outriggers shall be fully extended and at all tyres are clear of the ground

(ii) Heavy duty blocking having large bearing area shall be necessary to prevent sinking of floats

21.11.8 All loads shall have tag-lines attached in order to ensure that the load can be controlled at all times.

21.11.9 No close working to any live overhead power line is permitted without the operation of a strict Permit to Work.

21.11.10 Minimum lighting is to be ensured at all lifting operations.

21.11.11 Usage of First-Generation Hydra is STRICTLY PROHIBITED in Pune Metro project, if found violated, penalty shall be imposed without any warning letter.

21.11.12 Crane used for lifting operations shall not be older than 10 years, in case of tyre mounted and 15 years in case of crawler mounted.

21.12 Failure to do any of the above shall attract penalty from the Employer as per relevant clause

## 22.0 LAUNCHING OPERATION

22.1 As launching operation is one of the riskiest jobs, the Contractor shall take utmost precaution at all stages like; planning, establishing casing yard, casting segments, transporting segments, fabrication and erection of launching girders, launching of segments, pre-stressing, auto launching of girders and dismantling of launching girders.

22.2 The Contractor shall prepare a comprehensive Method Statement for the launching operation, adhering to the SHE conditions laid down in conditions of contract on SHE and Project SHE Manual. Particular reference shall be made to the provisions on working at height. As the entire process of launching has to be undertaken at an elevated level, the safety of workers and the girder is paramount important. The following general guidelines shall be adhered throughout the launching operation.

(i) Necessary 'working platforms' and fall protection anchorage arrangement shall be provided in the launching girder itself.

(ii) Provisions for mounting light fittings shall also be made available in the launching girder.

(iii) The casting yard shall be established ensuring the provision given in Clause 38.0

(iv) The workmen engaged in fabrication of reinforcement, concreting the segment shall be provided with necessary PPEs including compulsory hand protection gloves.

(v) Casting and curing of segment shall be undertaken under the direct supervision of the responsible engineer of the Contractor.

(vi) Trucks with valid registration, licence, safe worthiness certificate, Employer's approval certificate, and pollution under check certificate shall only be used for transport of segments.

(vii) All vehicle drivers including heavy vehicle operators shall be trained on defensive driving at training institute recognized by Maharashtra State Road Transport Corporation / Government of Maharashtra, or any other driving institute registered under Motor Vehicles Act.

(viii) Drivers shall also have undergone proper medical examination as per relevant clause mentioned under 'Medical Facilities.'

(ix) The segments shall be rigidly secured to the truck with necessary wooden wedges and necessary red indicators/safety tapes provided so that the vehicle is clearly seen by other road users both in day / night time. Further, necessary arrangements / modification should be made in the trailer and Engineer / Employer approval shall be obtained before the transportation starts.

(x) Every launching girder shall have a responsible engineer on duty all the time.

(xi) All the time from erection to dismantling the area between the two piers wherein launching is in progress shall always be barricaded.

(xii) Unloading of segments from trucks, lifting of segments, shifting of segments, gluing shall be done under the direct supervision of the approved engineer of the Contractor.

(xiii) Auto launching shall be done only after approval from the Employer. After every auto launching the stability of launching girder shall be ensured.

(xiv) The vertical deflection of launching girder shall be monitored at all critical stages like with/without loads and after every auto launching.

(xv) A register containing all important operational details from erection to dismantling of launching girders shall be maintained and made available to Employer whenever called for.

(xvi) Test certificate for all lifting gears including Macalloy bars shall be maintained at a location closer to the launching girder itself so that it can be referred during all inspections.

(xvii) Adequate lighting at all time shall be ensured in the entire area of operation.

(xviii) Access to drinking water & toilet shall be ensured to all workmen engaged for launching process.

(xix) Proper access ladders/stairways shall be maintained for safe ascending / descending of workmen / engineers.

22.3 Non-adherence to any of the clauses mentioned above shall be viewed seriously by the Employer and penalty levied as per relevant clause.

**23.0 CONSTRUCTION MACHINERY**

23.1 Construction machineries may include dumpers and dump trucks, lift trucks and telescopic handlers piling rigs, vibro hammers, rail welding equipments, mobile elevating work platforms, cranes, tipper lorries, lorry loaders, skip wagons, 360° excavators, 180° backhoe loaders, crawler

tractors, scrapers, graders, loading shovels, trenchers, side booms, pavers, planers, chippers, road rollers, locomotives, tankers and browsers, trailers, hydraulic and mechanical breakers etc.

23.2 Safe worthiness certificate

23.2.1 Every construction equipment shall be in sound mechanical working condition and certified by either competent person under Factories Act or manufacturers' warranty in case of brand new equipments or authorized persons / firms approved by Employer before induction to any site.

23.2.2 Every such certificate shall have the date of purchase, main overhauling undertaken in the past, any accident to the equipment, visual examination details, critical components safety check, list of safety devises and its working condition, manufacturer's maintenance checklist, past projects wherein the equipments were used etc as its minimum content.

23.3 Reverse Horns and reverse cameras

All Vehicles shall be fitted with audible reverse alarms and reverse cameras, maintained in good working condition. Reversing shall be done only when there is adequate rear-view visibility or under the directions of a banks man

23.4 General operating procedures

(i) Drivers entering site shall be instructed to follow the safe system of work adopted on site. These shall be verbal instructions or, preferably, written instructions showing the relevant site rules, the site layout, delivery areas, speed limits, etc.

(ii) No passengers shall be carried, unless specific seating has been provided in accordance with the manufacturers' recommendations.

(iii) Working on gradients beyond any equipments capability shall not be allowed.

(iv) Prevention of dumper and dump truck accidents should be managed by providing wheel stops at a sufficient distance from the edges of excavations, spoil heaps, pits, etc.

(v) The manufacturer's recommended bucket size must not be exceeded in excavators.

(vi) If excavators operating on a gradient which cannot be avoided, it must be ensured that the working cycle is slowed down, that the bucket is not extended too far in the downhill direction, and that travel is undertaken with extreme caution. A large excavator must never be permitted to travel in a confined area, or around people, without a banks man to guide the driver, who should have the excavator attachment close in to the machine, with the bucket just clear of the ground. On wheeled excavators, it is essential that the tyres are in good condition and correctly inflated. If stabilizing devices are fitted, they should be employed when the machine is excavating.

(vii) When the front shovel of the 180° backhoe loaders is being employed, the backhoe attachment shall be in its "travel" position, with the safety locking device in place.

(viii) When operating the backhoe in poor ground conditions, the stabilisers tend to sink into the surface of the ground, reducing stability. Therefore, frequent checks shall be made for the stability of the machine. The loading shovel should always be lowered to the ground to stabilise the machine when the backhoe is employed.

(ix) The netting operation of the skip wagons should be carried out prior to lifting the skip to reduce the risks of working on the rear platform.

(x) If a tractor dozer is employed on clearing scrub or felling trees, it shall be provided with adequate driver protection.

(xi) When two or more scrapers are working on the same job, a minimum distance of at least 25m shall be kept between them.

(xii) In case of hydraulic breakers, hydraulic rams and hoses shall be in good working condition

23.5 All wood working machines shall be fitted with suitable guards and devices such as top guard, riving knife, push stick, guards for drive belts and chains, and emergency stop switch easily accessible by the operator.

23.6 Requirements related to use of Bulldozers

23.6.1 General

(i) Be careful when working near the edge of banks, ditches, cuts, or fills, or near overhanging material. The vibration and weight of the machine may cause the edge to give way or overhanging material to fall.

(ii) Before starting work, ensure that an observer is present when plant is required to work in water where the depth may endanger the operator.

(iii) Avoid obstacles such as rocks or logs. If forced to cross them, use extreme caution, and change to the lowest gear.

(iv) Ease up to the balance point and ease down to minimise the jolt on contact with the other side.

(v) When receiving a wire rope on a drum or through Sheaves, operators should disengage the master clutch, idle the engine, and lock the brakes.

NOTE: All operators should stop engines before working with ropes wound on front-mounted drums.

23.6.2 Clearing Operations

(i) When clearing trees, watch out for dead branches in treetops.

(ii) Dozer operators should make sure that all persons are standing clear before pushing over trees, dozing rocks or rolling logs.

(iii) A long rope should be used to pull over large dead trees. (Make sure in advance that a falling tree will clear the machine and operator).

(iv) In excavation work, operators should be alert to dangers from overhanging dirt and rocks. In such cases, dozers should be equipped with the relevant overhead protection.

23.7 Requirements related to use of Excavators

(i) When excavating trenches, place the excavated material at a distance of one and a half times the depth of the trench from the edge of that trench. Where this is not practicable, place excavated materials at least one (1) metre from the edge of the trench.

(ii) Ensure the ground beneath the machine is not undercut.

(iii) Watch boom clearance when travelling. Uneven ground may cause the boom to weave and collide with obstructions.

(iv) Avoid jerky slewing or sudden braking. These can make the machine unstable and overload machine components.

(v) Ensure the operator has the appropriate restricted operator's licence if the excavator is to be used in the crane mode.

(vi) When an excavator is used in the crane mode, check that the lifting weight is well within the approved lifting capacity for the machine. This lifting capacity shall be clearly and permanently marked on each machine.

(vii) Only operate attachments while stationary, as operation during travelling may starve one of the track drive motors and result in an unintended turn.

(viii) Consider implementing a 'Permit to Work' system, particularly when working near power lines or underground power for example: - that the height of power lines is known; - that the underground location is known; and - visible measure, such as tiger tails, are put in place.

23.8 Requirements related to use of Trucks

23.8.1 General

(i) Drive defensively
(ii) Obey road signs
(iii) Never race with other vehicles
(iv) When following another vehicle, always allow enough distance to stop safely.
(v) One truck length for every 10 km per hour of truck speed should be the minimum distance between vehicles.
(vi) Reversing is the most hazardous truck operation. Reversing alarms, which are fitted on some trucks, are effective in warning persons of the danger. Reverse trucks only when they are under the direction of a signalman or when satisfied that the way is clear and will remain clear.
(vii) Be cautious of spillage from loaded units and any hazards the spillage might present to people on the ground and to the tyres of other plant.
(viii) Trucks sometimes fall over a tip head because the driver backs over the edge or the edge collapses under the weight of the truck.
(ix) Use a protective beam or timber baulk or back under the control of a signalman in order to avoid this happening.
(x) Principal Contractors should provide an earth mound to at least half the wheel diameter. This is a known control that is also used in the mining industry.
(xi) Where ground conditions are soft, or the tip head is likely to subside, dump loads back from the edge and have a dozer move the material over the edge.

23.8.2 Loading

(i) Never enter or leave the cab during loading.
(ii) Watch for and avoid other vehicles, personnel, and rock outcrops on entering or leaving the loading area.
(iii) Stay a safe distance from trucks ahead at the loading point, and follow the directions of the signalman or loader operator before moving into the loading position.
(iv) Move off when signalled that loading is complete.
(v) Load material, e.g., timber, so that it does not project beyond the truck body and present a hazard to other plant, people, or structures.
(vi) Where material is to be transported on a public road, maintain a distance of 1.2 metre or more beyond the front or rear of the vehicle, or 150 mm on either side, shall have a visible red flag or object fastened to the projecting end.
(vii) Unusually wide or long loads require a permit from the Police Department.
(viii) Secure loads at the lowest possible level on the tray with ropes or chains, and take special care when the truck is to travel over rough terrain.
(ix) Truck operators are responsible for giving load placement requirements to crane operators before loading operations begin.
(x) The load should be placed so that it will remain stable during loading, unloading and travelling.

23.8.3 Unloading

(i) Lower truck bodies before leaving the dump area.
(ii) Only raise truck bodies to unload materials on surfaces where the vehicle will remain stable and upright.
(iii) Never raise truck bodies to within a specified distance of overhead power line.
(iv) Take special care when tipping a load or spreading screenings on a road.
(v) With the tray up, trucks are less stable and are more likely to roll over, particularly on hilly sections or roads with surface irregularities or steep shoulders.
(vi) Check that the raised tray will not foul overhead power lines or telephone wires.
(vii) Never place part of your body under a raised truck body unless the truck body is securely propped.

23.8.4 Transporting personnel

(i) Trucks shall not be used to transport personnel unless they are specifically designed to do so.
(ii) Where a bus is employed for the transportation of personnel, the bus shall: -be enclosed; have seats which are attached to the vehicle; have a safe means of access and exit; and, have two means of exit in case of emergency.
(iii) Drivers transporting personnel should be alert, dependable and careful.
(iv) Relevant safety rules include: never allow passengers to ride with their arms outside the vehicle; only start the vehicle after everyone is seated; persons should only get on or off the vehicle when it is stationary; tools, plant or gear should be stored in a compartment separate from passengers, i.e., compartments that are designed for storage and transportation and are separate from where personnel are seated.
(v) All items stored in this compartment should be secured against movement; and ensure that exhaust fumes do not enter the passengers' compartment.

23.8.5 Towing

(i) When towing another vehicle, take the following precautions: ensure the towing cable is undamaged and has a safe working load adequate for the job.
(ii) Slings, straps, or chains which are used for towing should not be used for lifting any gear or materials and should be identified as such, e.g., slings and chains, etc. should be tagged "not for use in hoisting operations";
(iii) Before reversing, ensure everyone is clear. Get help from a signalman if the rear view is obstructed;
(iv) Attach the towing cable securely to the machines at the points recommended by the manufacturer.
(v) If these are not known, ensure fixing points are selected that will not damage the tow cable or the machine;
(vi) check what brakes are operational on the towed vehicle. There is unlikely to be any power assistance available for the brake system. Do not rely on parking brakes as a means of control;
(vii) When moving off, take up the slack carefully. Do not jerk the cable, and keep it taut to avoid damage;
(viii) keep towing speed down and as constant as possible;
(ix) Keep clear of the area between the towing vehicle and the towed vehicle; and attach a warning sign on the rear of the towed vehicle or machine which reads "Vehicle Under Tow".
(x) Working of heavy mobile equipments in marshy soil, must ensure to keep two nos. of 25 mm thick MS Plates at the base (track chain) of the respective machine to avoid collapse of the same with sand bags at the ground.

23.9 Penalty

If any of the above clauses are not adhered, penalty shall be imposed as per relevant clause depending upon the gravity of the unsafe act and or condition.

## 24.0 MACHINE AND GENERAL AREA GUARDING

24.1 The Contractor shall ensure at the construction site all motors, cogwheels, chains and friction gearing, flywheels, shafting, dangerous and moving parts of machinery are securely fenced or legged. The fencing of dangerous part of machinery is not removed while such machinery is in motion or in use.

## 25.0 MANUAL LIFTING AND CARRYING OF EXCESSIVE WEIGHT

25.1 The Contractor shall ensure at his construction site of a building or other construction work that no building worker lifts by hand or carries overhead or over his back or shoulders any material, article, tool, or appliances exceeding in weight as said below as per Rule 38 of BOCWR, unless aided by another building worker or device.

| Person | Maximum weight in kg |
|---|---|
| Adult man | 55 |
| Adult woman | 30 |

25.2 No building worker aided by other building worker shall lift or carry weight higher than or exceeding the sum of total of maximum limits set out for each building worker separately as mentioned in the table above.

## 26.0 SITE ELECTRICITY

26.1 Competency of Electrical personnel

26.1.1 The Contractor shall employ qualified and competent electrical personnel as specified in General Instruction Maha-Metro/SHE/GI/001.

26.2 Assessment of power

26.2.1 The Contractor shall assess the size and location of the electrical loads and the manner in which they vary with time during the currency of the Contract.

26.2.2 The Contractor shall elaborate as to how the total supply is to be obtained / generated. The details of the source of electricity, earthing requirement, substation / panel boards, distribution system shall be prepared and necessary approval from Employer obtained before proceeding of the execution of the job.

26.2.3 The main Contractor shall take consideration, the requirements of the sub / petty contractors' electric power supply and arrive at the capacity of main source of power supply from diesel generators.

26.2.4 As the sub / petty contractors' small capacity generators create more noise and safety hazard, no small capacity diesel generators shall be allowed for whatsoever the type of job to be executed under this contract.

26.2.5 If any unsafe noise making small capacity diesel generators are found used by sub / petty contractors the main contractor shall only be penalised.

26.3 Work on site

The Contractor shall also submit electrical single line diagram, schematic diagram and the details of the equipment for all temporary electrical installation and these diagrams together with the temporary electrical equipment shall be submitted to the Employer's for necessary approval. Failure to do so shall invite penalty as per relevant clause.

26.4 Strength and capability of electrical equipment

No electrical equipment shall be put into use where its strength and capability may be exceeded in such a way as may give rise to danger.

26.5 Adverse or hazardous environments

Electrical equipment, which may reasonably foreseeably be exposed to:

a) Mechanical damage;
b) the effects of the weather, natural hazards, temperature, or pressure;
c) the effects of wet, dirty, dusty, or corrosive conditions; or
d) any flammable or explosive substance, including dusts, vapours, or gases,

shall be of such construction or as necessary protected as to prevent, so far as is reasonably practicable, danger arising from such exposure.

26.6 Distribution system

26.6.1 The Contractor shall provide distribution system for control and distribution of electricity from a main AC supply of 50Hz for typical appliances:

a) Fixed plant – 400V 3 phase
b) Movable plant fed via trailing cable over 3.75 kW – 400V, 3 phase
c) Installation in site buildings – 230V single phase
d) Fixed flood lighting – 230V single phase
e) Portable and hand tools – 115V single phase
f) Site lighting - 115V single phase
g) Portable hand lamps – 115V single phase

26.7 Electrical protection circuits

26.7.1 Precautions shall be taken, either by earthing or by other suitable means, to prevent danger arising when any conductor (other than a circuit conductor) which may reasonably foreseeable become charged as a result of either the use of a system, or a fault in a system, becomes so charged. A conductor shall be regarded as earthed when conductors of sufficient strength and current-carrying capability to discharge electrical energy to earth connect it to the general mass of earth.

If a circuit conductor is connected to earth or to any other reference point, nothing which might reasonably be expected to give rise to danger by breaking the electrical continuity or introducing high impedance shall be placed in that conductor unless suitable precautions are taken to prevent that danger.

26.7.2 Appropriate electrical protection shall be provided for all circuits, against over load, short circuit, and earth fault current.

26.7.3 The Contractor shall provide sufficient ELCBs (maintain sensitivity 30 mA) / RCCBs for all the equipments (including Potable equipments), electrical switchboards, distribution panels etc. to prevent electrical shocks to the workers.

26.7.4 All protection devices shall be capable of interrupting the circuit without damage to any equipments and circuits in case of any fault may occur.

26.7.5 Rating of fuses and circuit breakers used for the protection of circuits should be coordinate with equipment power ratings.

26.7.6 Protection against lightning shall be ensured to all equipment kept in open at sites.

**26.8 Cables**

26.8.1 Cables shall be selected after full consideration of the condition to which they shall be exposed and the duties for which they are required. Supply cable up to 3.3 kV shall be in accordance with BS 6346.

26.8.2 For supplies to mobile or transportable equipment where operating of the equipment subjects the cable to flexing, the cable shall conform to any of these codes BS 6007 / BS 6500 / BS 7375.

26.8.3 Flexible cords with a conductor cross sectional area smaller than 1.5 mm2 shall not be used and insulated flexible cable shall conform to BS 6500 and BS 7375.

26.8.4 Where low voltage cables are to be used, reference shall be made to BS 7375. The following standards shall also be referred to particularly for underground cables BS 6346 and BS 6708

26.8.5 Cables buried directly in the ground shall be of a type incorporating armour or metal sheath or both. Such cables shall be marked by cable covers or a suitable marking tape and be buried at a sufficient depth to avoid their being damaged by any disturbance of the ground. Cable routes shall be marked on the plans kept in the site electrical register.

26.8.6 Cabling passing under the walk way and across way for transport and mobile equipment shall be laid in ducts at a minimum depth of 0.6 meters.

26.8.7 Cables that need to cross open areas, or where span of 3m or more are involved, a catenary wire on poles or other supports shall be provided for convenient means of suspension. Minimum height shall be 6m above ground.

26.8.8 Cables carrying a voltage to earth in excess of 65V other than supply for welding process shall have metal armour or sheath, which has been effectively earthed and monitored by the contractor. In case of flexible and trailing cables such earthed metal sheath and/or armour should be in addition to the earth core in the cable and shall not be used as the protective conductor.

26.8.9 Armoured cables having an over-sheath of polyvinyl chloride (PVC) or an oil resisting and flame retardant compound shall be used whenever there is a risk of mechanical damage occurring

26.9 Plugs, socket-outlets, and couplers

26.9.1 The Contractor shall ensure plugs, socket-outlets, and couplers available in the construction site as “splash proof” type. The minimum degree of Ingress Protection should be of IP44 in accordance with BS EN 60529.

26.9.2 Only plugs and fittings of the weatherproof type shall be used and they should be colour coded in accordance with the Internationally recognised standards for example as detailed as follows:

i) 110 volts: Yellow
ii) 240 volts: Blue
iii) 415 volts: Red

26.10 Connections

26.10.1 Every joint and connection in a system shall be mechanically and electrically suitable for use to prevent danger. Proper cable connectors as per national/international standards shall only be used to connect cables.

26.10.2 No loose connections or tapped joints shall be allowed anywhere 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.

26.11 Portable and hand-held equipments

The Contractor shall ensure the use of double insulated or all-insulated portable electrical hand equipment may be used without earthing (i.e., two core cables), but they shall still be used only on 110V because of the risk of damage to trailing leads.

26.12 Other equipments:

26.12.1 All equipment shall have the provision for major switch/cut-off switch in the equipment itself.

26.12.2 All non-current carrying metal parts of electrical equipment shall be earthed through insulated cable

26.12.3 Isolate exposed high-voltage (over 415 Volts) equipment, such as transformer banks, open switches, and similar equipment with exposed energized parts and prevent unauthorised access.

26.12.4 Approved perimeter markings shall be used to isolate restricted areas from designated work areas and entryways and shall be erected before work begins and maintained for entire duration of work. Approved perimeter marking shall be installed with either red barrier tape printed with the words "DANGER—HIGH VOLTAGE" or a barrier of yellow or orange synthetic rope, approximately 1 to 1.5 meter above the floor or work surface.

26.13 Work on or near live conductors

No person shall be engaged in any work activity on or so near any live conductor (other than one suitably covered with insulating material so as to prevent danger) that danger may arise unless:

a) it is unreasonable in all the circumstances for it to be dead; and
b) it is reasonable in all the circumstances for him to be at work on or near it while it is live; and
c) suitable precautions (including where necessary the provision of suitable protective equipment) are taken to prevent injury.

26.14 Inspection and Maintenance

26.14.1 All electrical equipment should be permanently numbered and a record kept of the date of issue, date of last inspection and recommended inspection period.

26.14.2 Fixed installations shall be inspected at least at three monthly intervals; routine maintenance being carried out in accordance with equipment manufactures recommendations.

## 27.0 LIGHTING

27.1 The Contractor shall provide sufficient site lighting, of the right type and at the right place for it to be properly effective. Lighting ought not to introduce the risk of electric shock. Therefore, 230V supplies should be used for those fittings, which are robustly installed, and well out of reach e.g., flood lighting or high-pressure discharge lamps.

27.2 Selection of Luminaries

The Contractor shall select the luminaries as per the area requirement indicated below:

| SN | Type of Lighting | Area of Requirement | Luminaries |
|---|---|---|---|
| 1 | Area Lighting | Workmen and vehicles to move about in safely. | Shovel type: non-symmetrical<br>Symmetrical or non-symmetrical tungsten halogen |
| 2 | Beam flood lighting | Concentrated light over an area from a relatively great distance. | Portable flood light (Conical beam)<br>Wide angle flood (fan shaped beam)<br>Medium or narrow angle flood (Conical beam) |

| | | | |
|---|---|---|---|
| 3 | Dispersive lighting | Lighting for indoor | Dispersive (Mercury florescent)<br>Cargo cluster<br>Florescent trough |
| 4 | Walkway lighting | Lighting for stairways, ladder ways, corridors, scaffold access routes, etc. | Well glass unit<br>Bulkhead unit (tungsten filament)<br>Bulk head unit (Florescent) |
| 5 | Local lighting | Lighting on sites and fittings are generally accessible to operatives | PAR (Parabolic Aluminised Reflector) lamp cluster<br>Festoons (with or without shades)<br>Adjustable florescent work lamp<br>Portable flood lamp (mounted on own cable drum) |

27.3 The Contractor shall ensure that luminaries should always be placed so that no person is required to work in their own shadow and so that the local light for one person is not a source of glare for the others. Strongly made clamps should be available for attaching luminaries to poles and other convenient supports.

27.4 Luminaries should be robust, resistant to corrosion and rain proof especially at the point of the cable entry.

27.5 The correct type of lamp for each luminary should always be used and when lamps need to be replaced if shall be in accordance with the supply voltage.

27.6 Lamp holders not fitted with a lamp should be capped off.

27.7 The Contractor shall take every effort to illuminate the work site as per the Employer's requirement illustrated in General Instruction Maha-Metro/SHE/GI/011.

**28.0 HAND TOOLS AND POWER TOOLS**

28.1 General

28.1.1 The Contractor is wholly responsible for the safe condition of tools and equipment used by his employees and that of his sub-contractors.

28.1.2 Use of short / damaged hand tools shall be avoided and the Contractor shall ensure all his hand tools used at his worksite are safe to work with or stored and shall also train his employees (including his sub-contractors) for proper use thereby.

28.1.3 All hand tools and power tools shall be duly inspected before use for safe operation.

28.1.4 All hand tools and power tools shall have sufficient grip and the design specification on par with national/international standards on anthropometrics.

28.2 Hand tools

28.2.1 Hand tools shall include saws, chisels, axes and hatches, hammers, hand planes, screw drivers, crow bars, nail pullers.

28.2.2 The Contractor shall ensure that,

a) For crosscutting of hardwood, saws with larger teeth points (no. of points per inch) shall be preferred to avoid the saw jumping out of the job.
b) Mushroom headed chisels shall not be used in the worksite where the fragments of the head may cause injury.
c) Unless hatchet has a striking face, it shall be used as a hammer.
d) Only knives of retractable blades shall be used in the worksite.
e) No screwdrivers shall be used for scraping, chiselling, or punching holes.

f) A pilot hole shall always be driven before driving a screw.
g) Wherever necessary, usage of proper PPEs shall be used by his employees.

28.3 Power tools

28.3.1 Power tools include drills, planes, routers, saws, jackhammers, grinders, sprayers, chipping hammers, air nozzles and drills.

28.3.2 The Contractor shall ensure that:

(i) Electric tools are properly grounded or / and double insulated.

(ii) GFCIs/ RCCBs shall be used with all portable electric tool 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 spaces or for prolonged periods, hearing protection shall be required. The same shall also apply to working with equipments, which gives out more noise as mentioned in Clause 43.0 of this document.

(v) Tool is held firmly and the material is properly secured before turning on the tool.

(vi) All drills shall have suitable attachments respective of the operations and powerful for ease of operation.

(vii) When any work / operation needs to be performed 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 in 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 the top of the ladder to drill holes in walls / ceilings, which can be hazardous, instead standing on the fourth or fifth rung shall be recommended.

(xii) Electric plane shall 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 180° of the wheels 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 and also correct chain tension shall be ensured to avoid “kickback”.

(xvi) Leather aprons and gloves shall be used as an additional personal protection auxiliary to withstand kickback.

(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.

(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.

(xix) Only trained employees shall use explosive actuated tools and the tool shall also be unloaded when not in use.

(xx) Usage of such explosive actuated tools shall be avoided in case of places where explosive/flammable vapours or gases may be present.

(xxi) Explosive actuated tools and their explosives shall be stored separately and be taken out and loaded only before the time of immediate use.

(xxii) Misfired cartridges of explosive actuated tools must be placed in a container of water and be removed safely from the project.

(xxiii) No worker shall point any power operated / hand tool to any other person especially during loading / unloading.

**29.0 WELDING, GOUGING AND CUTTING**

29.1 Gas cylinders in use shall be kept upright on a custom-built stand or trolley fitted with a bracket to accommodate the hoses and equipment or otherwise secured. The metal cap shall be kept in place to protect the valve when the cylinder is not connected for use.

29.2 Hose clamp or clip shall be used to connect hoses firmly in both sides of cylinders and torches.

29.3 All gas cylinders shall be fixed with pressure regulator and dial gauges

29.4 Non-return valve and Flashback arrester shall be fixed at both end of cylinder and torch.

29.5 Domestic LPG cylinders shall not be used for Gas welding and Cutting purpose.

29.6 DCP or CO2 type Fire Extinguisher not less than 5 kg shall be fixed at or near to welding process zone in an easily accessible location. Fire Extinguisher should confirm to IS 2190: 1992.

29.7 Use firewatchers if there is a possibility of ignition unobserved by the operator (e.g., on the other side of bulkheads).

29.8 Oxygen cylinders and flammable gas cylinders shall be stored separately, at least 6.6 meters (20 feet) apart or separated by a fire proof, 1.5 meters (5 feet) high partition. Flammable substances shall not be stored within 15 meters of cylinder storage areas.

29.9 Transformer used for electrical arc welding shall be fixed with Ammeter and Voltmeter and also fixed with separate main power switch.

29.10 Welding grounds and returns should be securely attached to the work by cable lugs, by clamps in the case of stranded conductors, or by bolts for strip conductors. The ground cable will not be attached to equipment or existing installations or apparatus.

29.11 Use a low voltage open circuit relay device if welding with alternating current in constricted or damp places.

29.12 Take precautions against the risk of increased fume hazards when welding with chrome containing fluxed consumables or high current metal inert gas (MIG) or tungsten inert gas (TIG) processes.

29.13 Avoid being in contact with water or wet floors when welding. Use duckboards or rubber protection.

29.14 All electrical installations shall meet the IS: 5571: 1997 and NFPA 70 for gas cylinder storage area and other hazardous areas.

29.15 The current for Electric arc welding shall not exceed 300 A on a hand welding operation.

29.16 Fire blankets are to be used at all the times while hot works are in progress in order to arrest the free fall of welding spatters

## 30.0 DANGEROUS AND HARMFUL ENVIRONMENT

30.1 A confined space is any space that:

i) Is large enough and so configured that a worker can bodily enter (any portion of the body) and perform assigned work,
ii) Has limited or restricted mean for entry and/or exit,
iii) Is not designed for continuous occupancy
iv) Contains or has the potential to contain a hazardous atmosphere,
v) Contains a material that has the potential for engulfing an entrant,
vi) Has an internal configuration such that an entrant could be trapped or asphyxiated by inwardly converging walls or by a floor which slopes downward and tapers to a smaller cross section, or
vii) Contains other recognized serious safety or health hazard.

30.2 Contractors must ensure all confined spaces are identified and managed using documented site confined space management methods.

30.3 As per BOCWR Rule 40:

(i) When internal combustion engines are to be used into a confined space or excavation or tunnel or any other workplace where neither natural or artificial ventilation system is inadequate to keep carbon monoxide below 50ppm, exposure of building workers shall be avoided unless suitable measures are taken and provided by the Contractor.

(ii) No worker shall be allowed into any confined space or tank or trench or excavation wherein there is given off any dust, fumes / vapours or other impurities which is likely to be injurious or offensive, explosive, or poisonous or noxious or gaseous material or other harmful articles unless steps are carried out by the Contractor and certified by the responsible person to be safe.

30.4 Dangerous Substances: -

30.4.1 A substance is considered dangerous if one or several of its properties render it dangerous. The Contractor identifies and manages dangerous substances planned for use on the Worksite in the manner described in the present Clause.

30.4.2 The transport to the Worksite and use of dangerous substances requires prior authorisation from the Engineer.

30.4.3 Details of risks and related prevention and protection measures are included in the health and safety plan.

30.4.4 The Contractor obtains all necessary authorisations and/or licenses for the storage and use of dangerous substances from local authorities. A copy of the authorisations is provided to the Engineer.

30.4.5 For each dangerous substance used, the Contractor will implement the recommendations described (i) in the Material Safety Data Sheets (MSDS), and (ii) by the Globally Harmonized System of Classification and Labelling of Chemicals established by the United Nations for hazardous chemicals.

30.4.6 Copies of MSDSs are kept on the Worksite and made available to personnel. The Contractor provides the Engineer with copies of all MSDSs.

30.4.7 Storage of dangerous substances

Storage areas are designed and equipped by the Contractor based, not only on the chemical and physical properties of the products, but also on the types of containers stored, the number of people requiring access, and the quantities of the substance used.

Pursuant to SHE Clause 53.11, the Contractor anticipates and plans for the storage and management of hazardous waste.

Storage areas for dangerous substances are subject to strict rules, which are regularly checked by the SHE manager appointed. The rules include the following as a minimum:

a) Access to the storage area is limited to trained and authorised individuals.

b) An inventory is maintained up-to-date.

c) MSDSs must be available for all stored dangerous substances, and the substances must be clearly labelled.

d) A strict and methodical storage system is implemented (storage plan posted, large or heavy packaging may not be stored at heights, equipment and tools may not be stored in the dangerous substance storage room).

e) Compliance with product expiry dates and implementation of a disposal procedure for substances which are not needed, or which have expired.

f) Entrances, exits and access to emergency equipment are always kept clear.

Storage areas are clearly identified with warning signs at the entrance. The Contractor displays the storage plan (location of the different products, maximum inventory), a summary of labelling system and information on chemical incompatibilities.

Chemicals which could react together (leading to explosions, fire, projections, or the emission of dangerous gases) are physically separated.

Products that react violently with water are stored so as to prevent contact with water, even in the event of flooding.

Inflammable products are always stored separately in a dedicated area with adequate ventilation.

Buildings used to store large quantities of dangerous substances are isolated from other buildings to avoid the spreading of fire. Such buildings are constructed using solid and non-combustible building materials and are equipped with evacuation systems and the appropriate firefighting equipment. Access to the buildings is clear, allowing for rapid evacuation in the event of an accident. The electrical systems are reduced to the essential minimum, and access points are equipped with adequate lighting (300 lux).

All storage areas are equipped with secondary retentions. Each storage area acts as a general secondary retention. Suitable absorbents (neutralising and non-combustible) are available in the storage area to clean up any spills and leaks.
The Contractor maintains the storage area at a suitable temperature for dangerous substances to prevent overpressure and bursting of containers.

## 31.0 FIRE PREVENTION, PROTECTION AND FIGHTING SYSTEM

31.1 The Contractor shall ensure that construction site is provided with fire extinguishing equipment sufficient to extinguish any probable fire at construction site. An adequate water supply is provided at ample pressure as per national standard.

31.2 Recharging of fire extinguishers and their proper maintenance should be ensured and as a minimum should meet Indian National Standards.

31.3 All drivers of vehicles, foreman, supervisors, and managers shall be trained on operating the fire extinguishers and fire fighting equipment.

31.4 The Contractor shall also consider the provision of adequate fire fighting arrangements within the underground and tunnelling operations including the provision of Fire Service compatible hose connections and emergency lighting.

31.5 As per the GBOCW Rules 2003, all lifting appliances' driver cabin should be provided with a suitable portable fire extinguisher.

31.6 Combustible scrap and other construction debris should be disposed off site on a regular basis. If scrap is to be burnt on site, the burning site should be specified and located at a distance no less than 12 metres from any construction work or any other combustible material.

31.7 Every fire, including those extinguished by Contractor personnel, shall be reported to the Employer representatives.

31.8 Emergency plans and Fire Evacuation plans shall be prepared and issued. Mock drills should be held on a regular basis to ensure the effectiveness of the arrangements and as a part of the programme, the Telephone Number of the local fire brigade should be prominently displayed near each telephone on site.

**32.0 CORROSIVE SUBSTANCES**

As per BOCWR Rule 44, corrosive substances including alkalis and acids shall be stored and used by a person dealing with such substances at a building / construction site in a manner that it does not endanger the building worker and suitable PPE shall be provided by the Contractor to the worker during such handling and work. In case of spillage of such substances on building worker, the Contractor shall take immediate remedial measures.

**33.0 DEMOLITION**

33.1 The Contractor shall ensure that:

(i) all demolition works be carried out in a controlled manner under the management of experienced and competent supervision.

(ii) the concerned department of the Government or local authority be informed, and permission obtained wherever required. Media shall also be informed regarding this concern.

(iii) all glass or similar materials or articles in exterior openings are removed before commencing any demolition work and all water, steam, electric, gas and other similar supply lines are put-off and such lines so located or capped with substantial coverings so as to protect it from damage and to afford safety to the building workers and public.

(iv) examine the walls of all structures adjacent to the structure to be demolished to determine thickness, method of support to such adjacent structures

(v) no demolishing work be performed if the adjacent structure seems to be unsafe unless and until remedial measures life sheet piling, shoring, bracing, or similar means be ensured for safety and stability for adjacent structure from collapsing.

(vi) debris / bricks and other materials or articles shall be removed by means of:

(a) chutes
(b) buckets or hoists
(c) through openings through floors or
(d) any other safe means

(vii) no person other than building workers or other persons essential to the operation of demolition work shall be permitted to enter a zone of demolition and the area be provided with substantial barricades.

**33.2 Damages to people and property.**

33.2.1 Pursuant to Clauses 4.14 and 17.1 of the GCC, the Contractor is responsible for damages to people and property caused by the execution of the works or the procedures used for execution.

33.2.2 The Engineer is informed of any damage caused to people, or the property of individuals, other than the Contractor's personnel, within 6 hours of the event, regardless of the value of the prejudice.

33.2.3 Housing existing before the start of the works, located within a minimum radius of 800 m around the perimeter of the quarries and within a minimum radius of 500 m around the other Worksites that will be subject to blasting, will be examined by a bailiff unless agreed upon otherwise with the Engineer.

33.2.4 The bailiff's sworn statement is prepared and provided to the Engineer with the SEPP.

33.2.5 Should any problems be detected due to the intensity of blasting, the Engineer is entitled to request that the Contractor carry out seismic measurements of the intensity of the vibrations induced by the blasting, at variable distances from the blasting points, under the supervision of the Engineer, and at the cost of the Contractor.

## 34.0 EXCAVATION

34.1 Excavation: The Contractor shall ensure:

(i) where 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 one 1.5 m above his footing, such worker is protected by adequate piling and bracing against such bank or side.

(ii) where banks of an excavation are undercut, adequate shoring is provided to support the material or article overhanging such bank.

(iii) excavated material is not stored at least 0.65 m from the edge of an open excavation or trench and banks of such excavation or trench are stripped of loose rocks and the 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.

(iv) metal ladders and staircases or ramps are provided, as the case may be, for safe access to and egress from excavation where, the depth of such excavation exceeds 1.5 m and such ladders, staircases or ramps comply with the IS 3696 Part 1&2 and other relevant national standards.

(v) trench and excavation are protected against falling of a person by suitable measures if the depth of such trench or excavation exceeds 1.5 m and such protection is an improved protection in accordance with the design and drawing of a professional engineer, where such depth exceeds 4m.

34.2 Tunnelling

34.2.1 The Contractor shall inform in writing to the Director General within 30 days, prior to the commencement of any tunnelling work.

34.2.2 The Contractor shall appoint a responsible person for safe operation for tunnelling work as per Rule 121 & 125 of BOCWR.

34.2.3 The contractor shall ensure:

(i) every compressed air system in a tunnel is provided with emergency power supply for maintaining continued supply of compressed air as per Rule 155 of BOCWR

(ii) watertight bulkhead doors are installed at the entrance of a tunnel to prevent flooding.

(iii) reliable and effective means of communication such as telephone or walkie-talkie are provided and maintained for arranging better effective communication at an excavation or tunnelling work as per Rule 136 of BOCWR.

(iv) all portable electrical hand tools and inspection lamp used in underground and confined space at an excavation or tunnelling work is operated at a voltage not exceeding 24V.

(v) only flame proof equipment of appropriate type as per IS: 5571:2000 and or other relevant national standard is used inside the tunnel

(vi) petrol or LPG of any other flammable substances are not used, stored inside the tunnel except with prior approval from Employer, and also no oxy-acetylene gas is used in a compressed air environment in excavation or tunnelling.

(vii) adequate number of water outlets provided for fire fighting purpose, an audible fire alarm and adequate number and types of fire extinguishers are provided and maintained.

(viii) temperature in any working chamber in an excavation or tunnelling work where workers employed does not exceed 29ºC as per Rule 165 of BOCWR.

(ix) all working areas in a free air tunnel are provided with ventilation system as approved by the Director General and the fresh air supplied in such tunnel is not less than 6 $m^3$/ min for each worker employed in tunnel as per Rule 153 of BOCWR.

34.3 Piling

34.3.1 General Precautions

There are certain hazards which are common to all types of piling, and the following precautions are necessary:

i) prior to piling, all underground services should be located and made safe. A check should be made to ensure there are no cellars, underground water courses or ground conditions which might cause hazards; there should be a firm level base for the crane, or crane mats provided;
ii) when working on piling operations one must wear a safety helmet, and ear and eye protection where necessary;
iii) All cranes, lifting appliances and lifting gear must have appropriate certificates of testing and thorough examination, and should be large enough for the job;
iv) particular attention should be paid to the risk of damage to lifting gear from sharp edges;
v) Cranes used for raising or lowering workers must be fitted with a dead man's handle and lowering should be done under power; you must be carried in properly constructed cages which cannot spin or tip;
vi) piling contractors should be asked to provide a written method statement setting out the precautions relevant to the type of piling they are to employ;
vii) Induction training and information for you as supervisor or operative should be specifically related to the method statement.

34.3.2 Bored Piles

Workers may need to enter a borehole for inspection or for clearing out in undercuts, and there are certain precautions which must be taken prior to entry:

(i) the borehole should be at least 75 cm in diameter;

(ii) the borehole should be treated as a confined space and the precautions which are advised elsewhere to ensure a satisfactory atmosphere must be closely followed;
(iii) waste material from the borehole should be kept clear of the borehole;
(iv) Descent into a borehole should be in properly designed skips, chains or cages fitted with an anti-spin device. The power source of the lifting appliance should be kept running throughout the time someone is underground;
(v) while a worker is working down a borehole, he/she must wear a safety harness;
(vi) all workers concerned must be trained and competent in rescue from deep boreholes, and emergency rescue drills should be carried out at regular intervals;
(vii) A banksman who can see workers in the borehole should be present at all times;
(viii) There must be adequate lighting at safe reduced voltage and a means of communication from the borehole.
(ix) Wherever possible, the need for workers to enter pile boreholes should be avoided by the use of television cameras and other techniques for remote inspection.

34.4 Warning signs and notices

The Contractor shall ensure that:

(i) suitable warning signs or notices, required for the safety of building workers carrying out the work of an excavation or tunnelling, shall be displayed or erected at conspicuous places in Hindi and in a language understood by majority of such building workers at such building such excavation or tunnelling work

(ii) such warning signs and notices with regard to compressed air working shall include

(a) the danger involved in such compressed air work
(b) fire and explosion hazard
(c) the emergency procedures for rescue from such danger or hazards.

**35.0 WORK PERMIT SYSTEM**

35.1 The Contractor shall develop a Work Permit system, which is a formal written system used to control certain types of work that are potentially hazardous. A work permit is a document, which specifies the work to be done, and the precautions to be taken. Work Permits form an essential part of safe systems of work for many construction activities. They allow work to start only after safe procedures have been defined and they provide a clear record that all foreseeable hazards have been considered. Permits to Work are usually required in high-risk areas as identified by the Risk Assessments.

35.2 A permit is needed when construction work can only be carried out if normal safeguards are dropped or when new hazards are introduced by the work. Examples of high-risk activities include but are not limited to:

(i) Entry into confined spaces
(ii) Work in close proximity to overhead power lines and telecommunication cables.
(iii) Hot work
(iv) To dig where underground services may be located
(v) Work with heavy moving machinery
(vi) Working on electrical equipment
(vii) Work with radioactive isotopes
(viii) Heavy lifting operations and lifting operations closer to live power line

35.3 The permit-to-work system should be fully documented, laying down:

(i) How the system works;
(ii) The jobs it is to be used for;
(iii) The responsibilities and training of those involved; and
(iv) How to check its operation;

35.4 A Work Permit authorisation form shall be completed with the maximum duration period not exceeding 12 hours.

35.5 A copy of each Permit-to-Work shall be displayed, during its validity, in a conspicuous location in close proximity to the actual works location to which it applies.

## 36.0 TRAFFIC MANAGEMENT

36.1 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.

36.2 All construction workers should be provided with high visibility jackets with reflective tapes as most of viaduct /tunnelling and station works or either above or under right-of-way. The conspicuity of workmen at all times shall be increased so as to protect from speeding vehicular traffic.

36.3 The guiding principles to be adopted for safety in construction zone are to:

(i) Warn the road user clearly and sufficiently in advance.
(ii) Provide safe and clearly marked lanes for guiding road users.
(iii) Provide safe and clearly marked buffer and work zones
(iv) Provide adequate measures that control driver behaviour through construction zones.

36.4 Legal permission

36.4.1 In all cases, the Contractor shall employ proper precautions. Wherever operations undertaken are likely to interfere with public traffic, specific traffic management plans shall be drawn up and implemented by the Contractor in consultation with the approval of local police authorities and/or the concerned metropolitan/civil authorities as the case may be.

36.4.2 Such traffic management plans shall include provision for traffic diversion and selection of alternative routes for transport of equipment. If necessary, the Contractor shall carry out road widening before commencement of works to accommodate the extra load.

36.5 The primary traffic control devices used in work zones shall include signs, delineators, barricades, cones, pylons, pavement markings and flashing lights.

36.6 The road construction and maintenance signs which fall into the same three major categories as do other traffic signs, that are Regulatory Signs, Warning Signs and Direction (or guidelines) Signs shall only be used. The IRC: 67 (Code of Practice for Road Signs) provide a list of traffic signs. The size, colours and placement of sign shall confirm to IRC: 67.

36.7 Regulatory signs

Regulatory signs impose legal restriction on all traffic. It is essential, therefore, that they are used only after consulting the local police and traffic authorities.

36.8 Warning signs

36.8.1 Warning signs in the traffic control zone shall be utilised to warn the drivers of specific hazards that may be encountered.

36.8.2 The Contractor shall place detour signage at strategic locations and install appropriate warning signs. In order to minimize disruption of access to residences and business, the Contractor shall maintain at least one entrance to a property where multiple entrances exist.

36.8.3 A warning sign as given in General Instruction Maha-Metro/SHE/GI/012 shall be 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 so as to alert the road users regarding the 'Metro Work in Progress'.

36.8.4 Materials hanging over / protruded from the chassis / body of any vehicle especially during material handling shall be indicated by red indicator (red light/flag) to indicate the caution to the road users.

36.9 Delineators

The delineators are the elements of a total system of traffic control and have two distinct purposes:

(i) To delineate and guide the driver to and along a safe path
(ii) As a taper to move traffic from one lane to another.

36.9.1 These channelizing devices such as cones, traffic cylinders, tapes and drums shall be placed in or adjacent to the roadway to control the flow of traffic. These should normally be retro-reflectors complying with IRC: 79 - Recommended Practice for Road Delineators.

36.9.2 Traffic cones and cylinders

Traffic cones of 500mm, 750mm and 1000mm high and 300mm to 500mm in diameter or in square shape at base and are often made of plastic or rubber and normally have retro-reflectorised red and white band shall be used wherever required.

36.9.3 Drums

Drums about 800mm to 1000mm high and 300mm in diameter can be used either as channelizing or warning devices. These are highly visible, give the appearance of being formidable objects and therefore command the respect of drivers.

36.9.4 Barricades

(i) Full height fence, barriers, barricades etc. shall be erected around the site in order to prevent the working area from the risk of accidents due to speedy vehicular movement. Same the way barricades protect the road users from the danger due to construction equipment and other temporary structures.

(ii) The structure dimension of the barricade, material and composition, its colour scheme, Maha-Metro logo and other details shall be in accordance with specifications laid down in tender document.

(iii) All barricades shall be erected as per the design requirements of the Employer, numbered, painted and maintained in good condition and also Barricade in-charge maintains a barricade register in site.

(iv) All barricades shall be conspicuously seen in the dark/night time by the road users so that no vehicle hits the barricade. Conspicuity shall be 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 minimum gap of 1000mm. In addition, minimum one red light or red light blinker should be placed at the top of each barricade.

36.9.5 The Contractor shall ensure that all his construction vehicles plying on public roads (like dump trucks, trailers, etc.) have proper license to ply on public roads from the State Transport Authority. Drivers holding proper valid license as per the requirements of Motor Vehicles Act shall drive these vehicles.

36.9.6 The Contractor shall not undertake loading and unloading at carriageways obstructing the free flow of vehicular traffic and encroachment of existing roads by the contractor applying the excuse of work execution.

36.9.7 Tow away vehicle

The Contractor shall make arrangements by keeping tow away van / manpower to tow away any breakdown vehicle in the traffic flow without losing any time at his cost.

36.9.8 Cleaning of roads

The Contractor shall ensure the cleanliness of roads and footpaths by deploying proper manpower for the same. The Contractor shall have to ensure proper brooming, cleaning washing of roads and footpaths on all the time throughout the entire stretch till the currency of the contract including disposal of sweepage.

36.9.9 The Contractor defines the characteristics of its fleet of vehicles and site machinery in the WESMP.

36.9.9.1 The Contractor defines the itineraries used on a map for each route between the different Worksites and obtains the validation of the Engineer. The Contractor requests that the Employer obtain the authorisations of the competent administrative authorities if public roads are used.

36.9.9.2 Within one month of the start of works, the Contractor informs the administrative authorities of areas crossed by the Contractor's vehicles, of the itinerary and characteristics (frequency of passing, size and weight of trucks, materials carried) of the Contractor's fleet of vehicles.

36.9.9.3 If public roads are used, and unless approved otherwise by the Engineer, the Contractor mandates a bailiff to make a sworn report regarding the state of the road prior to use by the Contractor's vehicles. The report is annexed to the W-ESMP.

36.9.9.4 The Contractor describes in the W-ESMP expected traffic created by its fleet of vehicles (frequency of trips between Worksites, working hours, convoys).

36.9.9.5 Unless specified otherwise in the Contract or instructed otherwise by the Engineer, heavy vehicles (i.e. with a GVWR of more than 3.5 tons) may not be used at night between 22:00 and 06:00.

**36.9.9.6 Speed limits**

36.9.9.6.1 The Contractor takes action to limit and check the speed of all vehicles and machinery used to execute the works.

36.9.9.6.2 The maximum speed of all machinery and vehicles of the Contractor comply with the lowest of the following: the speed limit defined according to the Employer's country regulations or the following limits.

a) 10 km/h within the Worksites.
b) 30 km/h in villages or hamlets, from 100m before the first house.
c) 50 km/h in towns.
d) 80 km/h on unpaved roads outside of towns, villages, hamlets and camps.

36.9.9.6.3 Pursuant to Clause 4.15 of the GCC, and in coordination with the competent Employer's country authorities, the Contractor provides and installs signs for the fleet of vehicles along public roads, when public signs are inadequate.

36.9.9.6.4 The Contractor provides each of its drivers with a map at the appropriate scale of the roads authorised for the execution of the works, clearly indicating the maximum speeds authorised, and ensures their understanding.

36.9.9.6.5 The Contractor implements a real-time GPS location solution for each of its vehicles and permanently remote monitor of the position and speed of each vehicle.

## 37.0 WORK ADJACENT TO LIVE RAILWAYS

37.1 Whenever work is to be conducted in close proximity to the live railways then the following measures shall need to be addressed:

(i) The rules provided for in the Railway's manual should be followed.
(ii) No persons are allowed to encroach onto the railway unless the owner has given specific authority.
(iii) Adequate protection in accordance with the railway owner's requirements shall be followed. (Provision of Block Inspectors, Flagmen and Lookouts)
(iv) All persons shall wear high visibility clothing at all times.
(v) Any induction training requirements of the railways shall be strictly observed

## 38.0 BATCHING PLANT AND CASTING YARD LAYOUT

38.1 The batching plant / casting yard shall be effectively planned for smooth flow of unloading and stacking the aggregates reinforcements and cement, batching plant, transport of concrete, casting the segment, stacking the segment and loading the segments to the trucks. As far as possible the conflicts should be avoided.

38.2 Required permission (CTE and CTO) from Maharashtra Pollution Control Board shall be obtained prior to establishing and commissioning of the batching plant and conditions of the CTE and CTO shall be complied.

38.3 The batching plant area shall be barricaded for wind breaking and shall be made as a compulsory PPE zone

38.4 If in case of material unloading area is not maintainable as PPE zone, the same shall be segregated properly and made as a non-PPE zone with appropriate barrications.

38.5 Electrical system shall also be suitably planned so that location of diesel generator, if any, location of DBs, routing of cables and positioning of area lighting poles/masts does not infringe on any other utility and pose danger.

38.6 Drainage shall be effectively provided and waste water shall be disposed after proper treatment

38.7 Time office, canteen, drinking water, toilet and rest place shall be suitably located for the easy access to workers. All the facilities shall be properly cleaned and maintained during the entire period of operation.

38.8 Manual handling of cement shall be avoided to a larger extent. Whenever it is absolutely necessary the workmen shall be given full body protection, hand protection and respiratory protection as a basic measure of ensuring better health.

38.9 The PPEs provided to cement handling workmen shall conform to international standards.

38.10 Access roads and internal circulation roads shall be well laid and maintained properly at all time.

38.11 Non-adherence to any of the above provision shall be penalised as per relevant penalty clause.

38.12 Approval of the batching plant to be taken from CPCB/MPCB/Local Municipal Corporation.

## 39.0 PERSONAL PROTECTIVE EQUIPMENTS (PPEs)

39.1 The Contractor shall provide required PPEs to workmen to protect against safety and / or health hazards. Primarily PPEs are required for the following protection

(i) Head Protection (Safety helmets)
(ii) Foot Protection (Safety footwear, Gumboot, etc)
(iii) Body Protection (High visibility clothing (waistcoat/jacket), Apron, etc)
(iv) Personal fall protection (Full body harness, Rope-grap fall arrester, etc)
(v) Eye Protection (Goggles, Welders glasses, etc)
(vi) Hand Protection (Gloves, Finger coats, etc)
(vii) Respiratory Protection. (Nose mask, SCBAs, etc.)
(viii) Hearing Protection (Ear plugs, Ear muffs, etc)

39.2 The PPEs and safety appliances provided by the Contractor shall be of the standard as prescribed by Bureau of Indian Standards (BIS). If materials conforming to BIS standards are not available, the Contractor as approved by the Employer shall procure PPE and safety appliances.

39.3 All construction workers should be provided with high visibility jackets with reflective tapes confirming to the requirement specified under BS EN 471: 1994 as most of viaduct /tunnelling and station works are executed either above or under right-of-way. The conspicuity of workmen at all times shall be increased so as to protect them from speeding vehicular traffic.

39.4 The Contractor shall provide safety helmet, safety shoe and high visibility clothing for all employees including workmen, traffic marshal and other employees who are engaged for any work under this contract as per the following requirement.

| All employees of the Contractor including workmen | Traffic marshals |
|---|---|
| Hard hat with company Logo | Hard hat with reflective tape |
| Safety boots | Safety boots |
| Hi-visibility waistcoat covering upper body and meeting the following requirements as per BS EN 471:1994:<br><br>Background in fluorescent orange-red in colour<br>Two vertical green strips of 5cm wide on front side, covering the torso at least 500 cm2<br>Two diagonal strips of 5 cm wide on back in an 'X' pattern covering at least 570cm2<br>Horizontal strips not less than 5cm wide running around the bottom of the vertical strip in front and 'X' pattern at back.<br>The bottom strip shall be at a distance of 5cm from the bottom of the vest.<br>Strips must be retro reflective and fluorescent<br>Waistcoat shall have a side adjustable fit and a side and front tear-away feature on vests made of nylon. | Hi-visibility jacket covering upper body and meeting the following requirements as per BS EN 471:1994:<br><br>Background in fluorescent orange-red in colour<br>Jackets with full-length sleeves with two bands of retro reflective material, which shall be placed at the same height on the garment as those of the torso. The upper band shall encircle the upper part of the sleeves between the elbow and the shoulder; the bottom of the lower band shall not be less than 5cm from the bottom of the sleeve.<br>Two vertical green strips of 5cm wide on front side, covering the torso at least 500 cm2<br>Two diagonal strips of 5 cm wide on back in an 'X' pattern covering at least 570cm2<br>Horizontal strips not less than 5cm wide running around the bottom of the vertical strip in front and 'X' pattern at back.<br>The bottom strip shall be at a distance of 5cm from the bottom of the vest.<br>Strips must be retro reflective and fluorescent. |

39.4.1 Colour coding for helmets

| Safety Helmet Colour Code (Every Helmet should have the LOGO* affixed /painted) | Person to use |
|---|---|
| White | Maha-Metro staffs |
| Grey | All Designers, Architect, Consultants, etc. |
| Violet | Main Contractors (Engineers / Supervisors) |

| | |
|---|---|
| Blue | All Sub-contractors (Engineers / Supervisors) |
| Red | Electricians (Both Contractor and Sub-contractor) |
| Green | Safety Professionals (Both Contractor and Sub-contractor) |
| Orange | Security Guards / Traffic marshals |
| Yellow | All workmen/Drivers/Operators |
| White (with "VISITOR" sticker) | Visitors |

**Note:** LOGO*

(i) Logo shall have its outer dimension 2" *2" and shall be conspicuous
(ii) Logo shall be either painted or affixed
(iii) No words shall come either on Top / Bottom of Logo

Logo of the corresponding main contracting company for their employees and sub-contracting company for their employees shall only be used.

39.5 In addition to the above any other PPE required for any specific jobs like, welding and cutting, working at height, tunnelling etc shall also be provided to all workmen and also ensure that all workmen use the PPEs properly while on the job.

39.6 The Contractor shall not pay any cash amount in lieu of PPE to the workers/sub-contractors and expect them to buy and use during work.

39.7 The Contractor shall at all time maintain a minimum of 10% spare PPEs and safety appliances and properly record and show to the Employer during the inspections. Failing to do so shall invite appropriate penalty as per the provisions of the contract.

39.8 It is always the duty of the Contractor to provide required PPEs for all visitors. Towards this required quantity of PPEs shall be kept always at the security post.

39.9 Warning to Safety offenders

i) A warnings cards shall be issued by nominated person of Maha-Metro to Contractor staff or worker in case of serious violation.

ii) Yellow card shall be issued on first safety offence/violation. A sticker to be pasted on his helmet and his identity card shall be stamped for two weeks during which he will be under observation. The warning cards shall be withdrawn by the same nominated person after satisfactory completion of two weeks of period.

iii) Red card shall be issued in case of repeat safety violation carried out in two weeks by the same person or if he repeats safety violation more than three times in a year. Such Red card holders shall be withdrawn from site and attend a repeat Safety Training for min. three days before re-induction. The person shall be demobilised in case of second Red Card issue.

## 40.0 VISITORS TO SITE

40.1 No visitor is allowed to enter the site without the permission of the Employer. All authorised visitors should report at the site office. Contractor shall provide visitor's helmet (White helmet with visitor sticker) and other PPEs like Safety Shoe, reflective jacket, respiratory protection etc. as per requirement of the site.

40.2 All Visitors shall be accompanied at all times by a responsible member of the site personnel.

40.3 The Contractor shall be fully responsible for all visitors' safety and health within the site.

**40.4 Complaint Response Process**

40.4.1 Inquiries, complaints, and requests for information can be expected from a wide range of individuals and organizations both private and government. The majority of complaints are likely to be received by Maha-Metro, although the site offices are also likely to be contacted.

40.4.2 The objective of complaint process is to ensure that public and agency complaints are addressed and resolved consistently and expeditiously.

40.4.3 The Contractor's Site Manager will be notified immediately on receipt of complaint that may relate to environmental impacts. The Site Manager will immediately inform the Engineer and through him the Maha-Metro.

40.4.4 Field investigation should determine whether the complaint has merit, and if so, action should be taken to address the impact.

40.4.5 The outcome of the investigation and the action taken shall be documented on a complaint performa prepared by the Contractor and approved by the Engineer in advance of the works.

40.4.6 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.

**40.5 Completion of the EQM Programme**

40.5.1 The construction of Project will be undertaken as a series of individual construction contracts with necessarily different construction program and completion dates.

40.5.2 The Engineer shall maintain an overview of the 'impact causing potential' of each site or contract and monitoring parameter with a view to maintaining the most cost-effective use of the environmental resources dedicated to the Project.

40.5.3 Termination of EQM should focus on the percentage contract completion status and on the basis of a history of environmental impact arising from the site over a representative period of monitoring.

40.5.4 Justifiable application for termination of EQM shall be put forward by the Contractor to the Engineer, as necessary throughout the construction period.

# PART III: OCCUPATIONAL HEALTH AND WELFARE

## 41.0 PHYSICAL FITNESS OF WORKMEN

41.1 The Contractor shall ensure that his employees / workmen subject themselves to such medical examination as required under the law or under the contract provision and keep a record of the same.

41.2 The Contractor shall not permit any employee / workmen to enter the work area under the influence of alcohol or any drugs.

## 42.0 MEDICAL FACILITIES

42.1 Medical Examination

42.1.1 The Contractor shall arrange a medical examination of all his employees including his sub-contractor employees employed as drivers, operators of lifting appliances and transport equipment before employing, after illness or injury, if it appears that the illness or injury might have affected his fitness and, thereafter, once in every two years up to the age of 40 and once in a year, thereafter.

(i) The Contractor shall maintain the confidential records of medical examination or the physician authorized by the Employer.
(ii) No building or other construction worker is charged for the medical examination and the cost of such examination is borne by Contractor employing such building worker.
(iii) The medical examination shall include:

a. Full medical and occupational history

b. Clinical examination with particular reference to:

(i) General Physique;

(ii) Vision: Total visual performance using standard orthorator like Titmus Vision Tester should be estimated and suitability for placement ascertained in accordance with the prescribed job standards.
(iii) Hearing: Persons with normal must be able to hear a forced whisper at twenty-four feet. Persons using hearing aids must be able to hear a warning shout under noisy working conditions.
(iv) Breathing: Peak flow rate using standard peak flow meter and the average peak flow rate determined out of these readings of the test performed. The results recorded at pre-placement medical examination could be used as a standard for the same individual at the same altitude for reference during subsequent examination.
(v) Upper Limbs: Adequate arm function and grip
(vi) Spine: Adequately flexible for the job concerned.
(vii) Lower Limbs: Adequate leg and foot concerned.
(viii) General: Mental alertness and stability with good eye, hand and foot coordination.

c. Any other tests which the examining doctor considers necessary

42.1.2 If the Contractor fails to get the medical examination conducted as mentioned above, the Employer will have the right to get the same conducted by through an agency with intimation to the Contractor and deduct the cost and overhead charges.

**42.2 Occupational Health Centre**

The Contractor shall ensure at a construction site an occupational health centre, mobile or static is provided and maintained in good order. Services and facilities as per the scale lay down in Schedule X of BOCWR. A construction medical officer appointed in an occupational health centre, possess the qualification as laid down in Schedule XI of BOCWR.

**42.3 Ambulance van and room**

The Contractor shall ensure at a construction site of a building or other construction work that an ambulance van and room are provided at such construction site or an arrangement is made with a nearby hospital for providing such ambulance van for transportation of serious cases of accident or sickness of workers to hospital promptly and such ambulance van and room are maintained in good repair and is equipped with standard facilities specified in Schedule IV and Schedule V of BOCWR.

**42.4 First-aid boxes**

The Contractor shall ensure at a construction site one First-aid box for 100 workers provided and maintained for providing First-aid to the building workers. Every First-aid box is distinctly marked "First-aid" and is equipped with the articles specified in Schedule III of BOCWR.

**42.5 HIV/ AIDS prevention and control**

42.5.1 The Contractor shall adopt the Employer's Policy on "HIV / AIDS Prevention and Control for Workmen Engaged by Contractors" and the copy of the policy is given in Appendix No. 4.

42.5.2 The Employer will engage a professional agency for implementing the guidelines laid down in the policy and communicate to the Contractor.

42.5.3 The Contractor shall extend necessary support to the appointed agency by deputing the workmen to attend the awareness creation programmes.

42.5.4 The Contractor shall also extend necessary organizational support to the appointed agency for the effective implementation of the Employers' workplace policy on HIV/AIDS for workmen of the Contractors.

42.5.5 As laid down in the policy the Contractor shall identify peer educators (1 for every 100 workers) and refer them for professional training to the Employers' appointed agency for the purpose.

42.5.6 The peer educators on completion of the training shall serve as the focal point for any information, education, and awareness campaign among the workmen throughout the contract period.

42.5.7 The peer educators will be paid a monthly honorarium as fixed by the Employer for rendering his services in addition to his regular duty.

42.5.8 The total number of peer educators (1 for 100 workers) shall always be maintained by the Contractor.

42.5.9 In case if these peer educators leave the Contractor by creating vacancy, then the Contractor at his own expense train the new replacement peer educator from the Employers' appointed agency for the purpose.

42.5.10 It is suggested to the Contractor that due care should be taken to select the peer educators from among the group of workmen so that they remain with the Contractor throughout the contract period.

**42.6 Prevention of mosquito breeding**

42.6.1 Measures shall be taken to prevent mosquito breeding at site. The measures to be taken shall include:

(i) Empty cans, oil drums, packing and other receptacles, which may retain water shall be deposited at a central collection point and shall be removed from the site regularly.

(ii) There should not be accumulation of still water at any site, in case of still water, it should be covered by earth and levelled.

(iii) Contractor's equipment and other items on the site, which may retain water, shall be stored, covered, or treated in such a manner that water could not be retained.

(iv) Water storage tanks shall be provided.

42.6.2 Posters inHindi and English, which draw attention to the dangers of permitting mosquito breeding, shall be displayed prominently on the site.

42.6.3 The Contractor at periodic interval shall arrange to prevent mosquito breeding by fumigation / spraying of insecticides. Most effective insecticides shall include SOLFAC WP 10 or Baytex, The Ideal Larvicide etc.

**42.7 Alcohol and drugs**

42.7.1 The Contractor shall ensure at all times that no employee is working under the influence of alcohol / drugs which are punishable under Government regulations.

42.7.2 Smoking at public worksites by any employee is also prohibited as per Government regulations.

42.7.3 Any person suspected by the Engineer to be under the influence of alcohol or controlled substances is immediately suspended from his position by the Contractor, pending the results of medical tests.

**42.8 Access to health care**

42.8.1 The Contractor guarantees access to health care as defined in Clause 29 for all personnel in case of accident or illness occurring during the execution of the works, i.e.:

a) Medical check ups: initial (recruitment), annual and upon returning to work after sick leave;
b) Screening, vaccinations and preventive healthcare;
c) General healthcare during the execution of the works;
d) Medical assistance in the event of an accident and assistance for emergency evacuations

.

42.8.2 Subcontractor personnel, other contractors, the Employer or the Engineer, present at the Worksite, must never be refused medical assistance, under the pretext that they are not directly employed by the Contractor. The Contractor may however define a unit rate cost per medical act for personnel, other than its own personnel, display this rate in the healthcare centre and forward the information to the Engineer.

42.8.3 In the event of accident or serious illness, medical personnel must be trained, available and equipped with the necessary material, medicines and consumables to provide first aid for the patient, stabilise their condition, until the patient is:

a) a) either treated or discharged, or
b) b) hospitalized at the camp or in a larger hospital, or
c) c) evacuated to a medical centre which is well equipped for intensive care, if necessary.

## 43.0 NOISE & VIBRATIONS

43.1 The Contractor shall consider noise as an environmental constraint in his design, planning and execution of the Works and provide demonstrable evidence of the same on Employer's request. The Contractor shall, at his own expense, take all appropriate measures to ensure that work carried out by the Contractor and by his sub-Contractors, whether on or off the Site, will not cause any unnecessary or excessive noise which may disturb the occupants of any nearby dwellings, schools, hospitals, or premises with similar sensitivity to noise.

43.1.1 Without prejudice to the generality of the foregoing, noise level reduction measures shall include the following:

a) The Contractor shall ensure that all powered mechanical equipment used in the Works shall be effectively sound reduced using the most modern techniques available including but not limited to silencers and mufflers.

b) The Contractor shall construct acoustic screens or enclosures around any parts of the Works from which excessive noise may be generated.

43.1.2 The Contractor shall ensure that noise generated by work carried out by the Contractor and his sub-Contractors during daytime and night time shall not exceed the maximum permissible noise limits, whether continuously or intermittently. The same may be varied from time to time by and at the sole discretion of the Employer, In the event of a breach of this requirement, the Contractor shall immediately re-deploy or adjust the relevant equipment or take other appropriate measures to reduce the noise levels and thereafter maintain them at levels which do not exceed the said limits. Such measures may include without limitation the temporary or permanent cessation of use of certain items of equipment.

### 43.2 Control Requirements

43.2.1 Construction material should be operated and transported in such a manner as not to create unnecessary noise as outlined below;

I. Perform Work within the procedures outlined herein and comply with applicable codes, regulations, and standards established by the Central and State Government and their agencies.

II. Keep noise to the lowest reasonably practicable level. Appropriate measures will be taken to ensure that construction works will not cause any unnecessary or excessive noise, which may disturb the occupants of any nearby dwellings, schools, hospitals, or premises with similar sensitivity to noise. Use equipment with effective noise-suppression devices and employ other noise control measures as to protect the public.

III. Schedule and conduct operations in a manner that will minimize, to the greatest extent feasible, the disturbance to the public in areas adjacent to the construction activities and to occupants of buildings in the vicinity of the construction activities.

IV. The Contractor shall submit to the Employer a Noise Monitoring and Control Plan (NMCP) under contract specific Site Environmental Plan. It shall include full and comprehensive details of all powered mechanical equipment, which he proposes to use during daytime and night time, and of his proposed working methods and noise level reduction measures. The NMCP shall include detailed noise calculations and vibration levels to demonstrate the anticipated noise generation and vibrations by the Contractor.

V. The NMCP prepared by the Contractor shall guide the implementation of construction activity. The NMCP will be reviewed on a regular basis and updated as necessary to assure that current construction activities are addressed. It may appear as a regular agenda item in project coordination meetings, if noise is an issue at any location in the contract.

### 43.3 Occupational Noise

I. Protection against the effects of occupational noise exposure should be provided when the sound levels exceeds the threshold values.

II. When employees are subjected to sound levels exceeding, feasible administrative or engineering controls should be utilized.

III. If such controls fail to reduce sound levels within the levels of the table, personal protective equipment shall be provided and used to reduce sound levels within the levels of the table.

IV. When the daily noise exposure is composed of two or more periods of noise exposure of different levels, their combined effect should be considered, rather than the individual effect of each. Exposure to different levels for various periods of time shall be computed according to the formula and sample computation.

### 43.4 Vibration Level

43.4.1 In locations where the alignment is close to historical / heritage structures, the contractor shall prepare a monitoring scheme prior to construction at such locations. This scheme for monitoring vibration level at such historical / heritage sites shall be submitted to Employer for his approval. This scheme shall include:

I. Monitoring requirements for vibrations at regular intervals throughout the construction period.

II. Pre-construction structural integrity inspections of historic and sensitive structures in project activity.

III. Information dissemination about the construction method, probable effects, quality control measures and precautions to be used.

IV. The vibration level limits at work sites adjacent to the alignment shall conform to the permitted values of peak p velocity

## 44.0 VENTILATION AND ILLUMINATION

44.1 Ventilation

44.1.1 The Contractor shall ensure at a construction site of a building or other construction work that all working areas in a free tunnel are provided with ventilation system as approved by the DG/CIIBC and the fresh air supply in such tunnel is not less than 6m3/min for each building worker employed underground in such tunnel and the free air flow movement inside such tunnel is not less than 9m/min.

44.1.2 The oxygen level shall not be less than 19.5% in the working environment.

44.2 Illumination

44.2.1 The Contractor shall take every effort to illuminate the work site as per the Employer's requirement illustrated in General Instruction Maha-Metro/SHE/GI/011.

44.2.2 The Contractor shall conduct a monthly illumination monitoring by lux meter for all the locations and the report shall be sent to the Employer within 7th of the next month and the same shall be reviewed during the monthly SHE committee meeting.

## 45.0 RADIATION

45.1 The use of radioactive substances and radiating apparatus shall comply with the Government regulatory requirements and all subsidiary legislation

45.2 Operations involving ionising radiation shall only be carried out after having been reviewed without objection by the Employers representative and shall be carried out in accordance with a method statement.

45.3 Each area containing irradiated apparatus shall have warning notices and barriers, as required by the Regulations, conspicuously posted at or near the area.

45.4 Radioactive substances will be stored, used, or disposed shall be strictly in accordance with the Government Enactments.

45.5 The Contractor shall ensure that all site personnel and members of the public are not exposed to radiation.

**46.6 Asbestos**

Asbestos fibres are naturally occurring and extremely aerodynamic. Because of this, almost everyone is exposed to asbestos. Asbestos fibres can become a health risk if inhaled at high concentrations over extended periods of time. Asbestos is only dangerous if it becomes airborne. As long as asbestos-containing materials are not damaged, the asbestos fibres do not become airborne, and do not pose a health hazard to building occupants.

As a preventive action, no asbestos containing material will be used during any of the site activity mitigate the hazard

**46.7 Lead-Based Paint**

Lead-based paint is a source of lead poisoning. Ingestion and inhalation of lead dust that is created as lead-based paint chips and peels, or from improper sanding or scraping of lead-based painted surfaces can lead to exposure.

Paints and other chemicals used for painting should be stored in a proper contained area. Empty Paint containers, waste paint brushes, clothes stained with paint shall be disposed as per prevailing regulations.

**46.0 WELFARE MEASURES FOR WORKERS**

**46.1 Latrine and Urinal Accommodation**

46.1.1 The Contractor shall provide one latrine seat for every 20 workers up to 100 workers and thereafter one for every additional 50 workers. In addition, one urinal accommodation shall be provided for every 100 workers.

46.1.2 When women are employed, separate latrine and urinals accommodation shall be provided on the same scale as mentioned above.

46.1.3 Latrine and urinals shall be provided as per Section 33 of BOCWA and maintained as per Rule 243 of BOCWR and shall also comply with the requirements of public health authorities

**46.1.4 Moving sites**

In case of works like track laying, the zone of work is constantly moving at elevated level or at underground level. In such cases mobile toilets with proper facility to drain the sullage shall be provided at reasonably accessible distance.

46.1.5 In case if the Contractor fail to provide required number of urinals and latrines or fail to maintain it as per the requirements of Public Health laws, the Employer shall have the right to provide/maintain through renowned external agencies at the cost of the Contractor.

**46.2 Canteen**

In every workplace wherein not less than 250 workers are ordinarily employed, the Contractor shall provide an adequate canteen conforming to Section 37 of BOCWA, Rule 244 of BOCWR

and as stipulated in Rule 247 of BOCWR the changes for food stuff shall be based on 'no profit no loss' basis. The price list of all items shall be conspicuously displayed in such canteen.

**46.3 Serving of tea and snacks at the workplace**

As per Rule 246 of BOCWR, at a building or other construction work where a workplace is situated at a distance of more than 200 m from the canteen provided under Rule 244(1) of BOCWR, the Contractor employing building works shall make suitable arrangement for serving tea and light refreshment to such building works at such place. Proper Housekeeping should be maintained at such locations where tea and snacks are served.

**46.4 Drinking water**

46.4.1 As per Section 32 of BOCWA the Contractor shall make in every worksite, effective arrangements to provide sufficient supply of wholesome drinking water with minimum quantity of 5 litres per workman per day. Quality of the drinking water shall conform to the requirements of national standards (**IS 10500**) on Public Health.

46.4.2 While locating these drinking water facilities due care shall be taken so that these are easily accessible within a distance of 200m from the place of work for all workers at all location of work sites.

46.4.3 All such points shall be legible marked "Drinking Water" in a language understood by a majority of the workmen employed in such place and such point shall be situated within six metres of any washing places, urinals, or latrines.

**46.5 Labour Accommodation**

The Contractor shall provide free of charges as near as possible, temporary living accommodation to all workers conforming to provisions of Section 34 of BOCWA. These accommodations shall have cooking place, bathing, washing and lavatory facilities

**46.6 Creches**

In every workplace where in more than 50 female workers are ordinarily employed, there shall be provided and maintained a suitable room for use of children under age of 6 yrs, conforming to the provisions of Section 35 of BOCWA.

**46.7 Heat Stress**

Contractors/Subcontractors shall establish the necessary programs to ensure that project employees work safely in heat stress conditions. The reduction of adverse health effects can be accomplished by engineering controls, work practices, training, acclimatization, monitoring, water and electrolyte balance and the recognition and treatment of heat stress emergencies.

**46.8 First aid**

The Contractor ensures that at least one first aid officer is present at all times during working hours, per shift for 10 to 50 workers present, and one extra first aid officer for each additional 100 workers allocated to the shift.
The Contractor equips the Worksite with a communication system exclusively for the purposes of communication with the first aid services. Information on how to communicate with the first aid services is clearly indicated near the communications equipment.

46.9 **Pandemic (National Disaster as Covid-19/Omicron etc.)**

1. All the workmen shall be sensitized on the hygiene and other work requirements like social distancing before being engaged for the work.
2. Body temperature need to be monitored by infrared thermometer before being engaged for the work

3. Work area need to be displayed with COVID-19 symptoms, Do's & Don'ts issued by local authorities.

**46.9.1 Safety Motivational & Awareness Campaign:**

1. Posters about COVID-19 for workplace must be displayed to help staffs and workers to stay informed, have accurate information, and know how to perform in working area to protect themselves and other.
2. Initiatives / Campaigns must be organised to protect the employees and labours against the risk of coronavirus infection. This is applied to both indoor (Labour Camps, Accommodation's) and outdoor accommodation.
3. All areas in the premises including Office, stores Labour camps shall be disinfected completely with the use of approved disinfectant mediums.
4. The workmen welfare facilities including Labour accommodations, Rest areas, Toilet facilities, drinking water facilities shall be inspected for adequate precautions especially from Hygiene and social distancing point of view, by the Contractor to ensure their adequacy.

**46.9.2 Reporting of Covid-19**

1. A Daily report regarding COVID-19 status must be sent to Maha-Metro for updating of Positive cases, suspected cases, and their control measures to face the challenge and threat posed by the growing pandemic of COVID-19.
2. On daily basis, COVID-19-Follow-up & reporting system must be carried out to the latest numbers on Covid tests, Covid cases status (Negative or Positive), hospitalizations, and patient outcomes from contractors ends.

46.9.3 The following reports must be submitted by the contractors on daily basis who will further scrutinize, compile and forward to Maha metro and to local authorities (as directed by Maha metro).

1. Details of workmen who is get affected by Covid-19 Virus.
2. Status of health of affected workemen and submit the health report by medical expert.
3. Details of Workmen engaged who are from outside Maharashtra
4. Emergency Preparedness & Response report

**46.9.4 General Precautionary measures**

1. Ensure Social Distancing by Restriction in gathering of 5 or more in workplaces and public places. Large meeting to be prohibited and large gathering of more than 10 people in workplaces is discouraged. Seating arrangement shall be at least 6 feet from each other.
2. Wearing face-cover/musk at public places & workplaces
3. Spitting in workplaces / public places shall be punishable with fine.
4. Ban on liquor, Gutka, and tobacco in workplaces
5. Temperature screening during entry and exit to be done.
6. Sanitizers and hand wash facility shall be made available at convenient places at worksites
7. Staggered lunch breaks to ensure social distancing
8. Persons above 65 years, persons with co-morbidities, parents of children below the age of 5 should be encouraged to work from home.
9. Daily Sanitize/disinfect the workplace
10. Vehicles with 30-40% passenger capacity
11. 2/4 (depending on the size) will be allowed to travel in lifts/hoists
12. Restrict / Ban non -essential visitors
13. List of authorized hospitals/clinics nearby areas to treat COVID 19 to be executed.

**46.9.5 Isolation Room/Quarantine Centre**

The Contractor shall provide an Isolation Room/ Quarantine Centre if some one found symptoms of virus or get affected positive.

# PART- IV ENVIRONMENTAL MANAGEMENT

## 47.0 ENVIRONMENTAL MANAGEMENT

Environmental Management is an essential part of the overall Environmental protection system employed by Maha Metro for the construction of Pune Metro Rail project and shall apply to all contract packages i.e. Civil, Track, E&M and System contracts subject to activities involved in respective pacakges.

## 48.0 TOPSOIL CONSERVATION

48.1 The contractor shall ensure that adequate measures are taken for the prevention of erosion of the topsoil during the construction phase.

48.2 The contractor should maintain the record of topsoil quantity excavated from construction from all locations where vegetation existed prior to construction. The record shall include photographic evidence of the topsoil quantity excavated.

48.3 Top soil should be stripped to a depth of 20 cm from the areas to be disturbed, it should be stockpiled to a maximum height of 40 cm in designated areas, covered or stabilized with temporary seeding for erosion prevention and should be reapplied to site during plantation of the proposed vegetation. Topsoil should be separated from subsoil, debris and stones larger than 50mm diameter. The stored topsoil may be used as finished grade for planting areas.

## 49.0 FELLING OF TREES & TREE PRESERVATION

49.1 The contractor shall identify the number and type of trees that are required to be felled as a result of construction of works and facilities related to Pune Metro Project and inform the Employer.

49.2 All trees and shrubbery, which are not specifically required to be cleared or removed for construction purposes, shall be preserved and shall be protected from any damage that may be caused by Contractor's construction operations and equipment. The contractor shall not fell, remove or dispose of any tree or forest produce in any land handed over to him for the construction of works and facilities related to Pune Metro except with the previous permission obtained from the Forest Department or other Competent Authority.

49.3 The contractor shall ensure that no tree, existing or otherwise, shall be harmed and damage to roots during trenching, placing backfill, driving or parking heavy equipment, dumping of trash, oil, paint, and other materials detrimental to plant health.

49.4 The contractor shall avoid cut and fill in the root zones.

49.5 Special care shall be exercised where trees or shrubs are exposed to injuries by construction equipment, blasting, excavating, dumping, chemical damage or other operation and the Contractor shall adequately protect such trees by use of protective barriers or other methods approved by the Employer. Trees shall not be used for anchorage.

49.6 Trees should be protected around 1m periphery by providing tree guard and no construction or storage of materials shall be carried out within its premise.

## 50.0 FLY ASH

50.1 The contractor shall use fly ash as a percentage substitution of cement, in concrete for certain structures and works as prescribed in the latest MoEF&CC fly ash notification dated September 1999 and its subsequent amendments.

50.2 As per the notification, only fly ash based products shall be used for construction such as cement or concrete, fly ash bricks or blocks or tiles or clay fly ash bricks, block or tiles or cement fly ash

bricks or bricks or blocks or similar products or a combination or aggregate of them. The contractor shall provide details of usage of such products to employer.

50.3 In all such uses of Fly Ash, the contractor shall maintain a detailed record of usage of Fly Ash. The contractor shall also collect related details and provide to the Employer.

## 51.0 CONTAMINANT OF AIR POLLUTION

### 51.1 At Construction Site

51.1.1 The Contractor shall erect barricades securely around all construction work sites during the entire phase of construction activity, to contain dust within the site area and also to reduce air turbulence caused by passing traffic.

51.1.2 Barricades are to be installed on either side of the road or at the centre of the road median.

51.1.3 Barricades are also required at work sites around the periphery of which are located residential or commercial property.

51.1.4 The barricades shall be safely secured to the ground to prevent from toppling. There shall be no gap between bottom of barrier and ground/road. The barrier shall be placed at all times till there is likelihood of dust escaping from the site or material being stored at the site.

51.1.5 In case of construction work located near residential or commercial properties, the contractor shall erect barricade of suitable approved material around the entire construction site of height not more than 10m or 1/3rd of building height whichever is less, having acoustic properties, apart from providing relief from dust. There should be no gap in the enclosure erected by the barrier except at entry and exit to or from site.

51.1.6 The barricading material if used as noise barrier shall conform to have following acoustic properties:

**Table 1.1 Properties of Noise Barrier**

| Barrier type | Absorptive |
|---|---|
| Life span | At least 3-4 years |
| NRC | More than 0.75 |
| Insertion Loss | 10 dBA |

51.1.7 The barrier material shall be light weight, weatherproof, fire resistant and easy to maintain. The supporting frames and mountings should also be light weight and easy to install.

51.1.8 Before the start of work, the Contractor shall provide wet automated wheel washing facility with two stage sedimentation tank at the exit of Batching Plant, Casting Yard, and Underground stations. It shall also be provided at off the road elevated stations. At other locations i.e. viaduct, on the road elevated stations etc. where there are space restrictions, the contractor shall adopt dry wheel cleaning mechanism with prior approval from employer. If work site contains multiple exits, then wheel washing facility shall be provided for all these exits where vehicle carrying construction materials or trucks or vehicles or plant/machinery transit from construction site on to live public roads. The wheel wash shall be located as close to the exit gate, as possible. However, care to be taken to ensure that the surface from wheel wash to exit gate is either bitumen or concrete paved. The contractor shall ensure the wheel washing facility remains functional till the end of contract.

51.1.9 At such facility, high-pressure water jets will be directed at the wheels of vehicles to remove all spoil and dirt. Water shall be pumped through an electrically operated pump set, to hydrants attached with rubber hoses, by activation of push button located at the hydrant, allowing for up to 10 minutes of wash time.

51.1.10 Wheel washing facility shall be provided with efficient drainage, incorporating silt traps to prevent any excessive build-up of water. These facilities should include water re-circulation mechanism to minimise water consumption.

51.1.11 At the wheel wash facility, water, dirt, gravel etc. shall be drained into precast trench drains with removable grated cover. This dirty water shall flow, through a piping, into solids separator and from there to oil separator before final discharge.

51.1.12 At each construction site including batching plant and casting yard, the Contractor shall provide storage facilities for dust generating materials which shall be closed containers/bins or wind protected shelters or mat covering or walled or any combination of the above to the satisfaction of the Employer. Suitable sprinkling system shall be installed and operationalized in this area. The quality of water for sprinkling shall be the same as used for concrete batching.

51.1.13 The contractor shall not store any construction material/debris/soil outside barricaded area.

51.1.14 Soil, sand, aggregate, debris of any kind and all dust prone material that is stored at site will be fully covered with tarpaulin or hessian cloth in all respects with proper anchorage so that it does not disperse in the air in any form.

51.1.15 The dust emissions from the construction site should be completely controlled and all precautions taken in that behalf.

51.1.16 The Contractor shall use nozzle based mist system at construction sites such as elevated station, underground station, launching shaft, depot, retrieval shaft, batching plant & casting yard as required to suppress dust.

51.1.17 Nozzle based mist system shall also be used during the delivery and handling of sand and aggregate and other similar materials, when dust is likely to be generated.

51.1.18 At sites where the sprinkling is to be carried out manually, sprinkling will be carried out at a frequency of at least thrice a day or as directed by engineer in charge. For dust suppression contractor shall use, STP treated water or RO reject or treated water from sedimentation tank. Use of fresh water to be refrained.

51.1.19 Stockpiles of sand and aggregate greater than 20m3, used for concrete manufacturing, shall be enclosed on three sides, with walls extending above the height of stockpile and two (2) meters beyond the front of the stockpile. The contractor shall provide sprinkler system in sand and aggregate storage area and the water for sprinkling shall be of the same quality as used for concrete batching.

51.1.20 Areas within the site such as casting yard and batching plant, where there is a regular movement of vehicles shall have an approved hard surface (PCC) that is kept clear of loose surface material.

51.1.21 Unless the Employer has given consent otherwise, the Contractor shall restrict all motorised vehicles on the site to a maximum speed of 10 kilo-meter per hour and vehicles shall move on designated path.

51.1.22 The contractor shall use wet-jet in grinding and stone cutting works with two stage sedimentation tank facility to recycle/re-use the water. The water from the final chamber of sedimentation tank shall be reused.

51.1.23 In the event recorded PM10 level is greater than the base line/Limit levels, the Employer may direct the Contractor to take effective remedial measures including, but not limited to, reviewing dust sources and modifying working procedures.

51.1.24 Where the recorded baseline levels exceed the ambient air quality standards, then at such locations the baseline level shall be considered as limit level. Contractor shall take all effective remedial measures to contain the levels to their limit level as a result of his activities.

51.1.25 If the measures to control air pollution are found to be ineffective, the employer may issue stop work order till the time remedial measures are found to be effective to the satisfaction of employer.

51.1.26 At the Batching plant the following additional conditions shall be complied with:

a) The contractor shall not install Star Batcher Concrete Batching Plant for manufacturing/producing concrete.

b) Inside the batching plant, ground surface must be paved with Cement Concrete. The plant shall have proper drainage system with outlet connected to two stage sedimentation tank. No dust shall be allowed to deposit on road inside Batching plant.

c) The contractor shall procure cement through bulker instead of conventional cement bags.

d) Continuous dust/wind breaking barricades of height at least 6 meters around the batching plant shall be constructed of suitable material which will act as boundary wall.

e) If the batching plant is located near the residential area, then the boundary wall shall be acoustically treated to act as noise barrier also. In such event the property of boundary wall cum noise barrier will conform to specification given in para 51.1.6 above.

f) The contractor shall provide sufficient number of openings in the cement godown/cement feeding area with industrial grade exhaust fans with ducting system. The ducts shall be connected to a container filled with water.

g) The contractor shall cover the conveyor belt used for carrying aggregate.

h) Nozzle based mist system shall be used during the delivery and handling of sand and aggregate and other similar materials, when dust is likely to be generated and to dampen all stored materials.

i) The contractor shall provide and ensure dust masks (proper PPEs) to all workers/labour/staff working at batching plant.

j) The Contractor shall undertake at all times the prevention of dust nuisance as a result of his activities.

k) The Contractor shall frequently clean and water the concrete batching plant and crushing plant sites and ancillary areas to minimise any dust emission.

51.1.27 Minimum stack height of DG set shall be as given in Central Pollution Control Board (CPCB) Emission Regulations Part IV: COINDS/26/1986- 87 and Emission Standards for Diesel Engines (Engine Rating more than 0.8 MW (800 KW) which were notified by the Environment (Protection) Third Amendment Rules 2002, vide G.S.R. 489 (E), dated 9thJuly, 2002 at serial no. 96, under the Environment (Protection) Act, 1986 and its amendments.

51.1.28 Consent for height of stacks of Diesel Engines with rating more than 800 KW shall be obtained by the Contractor from statutory Government agency. Where the calculated height of stack is obtrusive and does not blend with the neighbourhood, the contractor could provide either alternative source of power or provide a solution that is acceptable to the employer. This may include but not limited to providing appropriate cladding for the stack.

51.1.29 Contractor's transport vehicles and other equipments shall conform to emission standards fixed by Statutory Agencies of Government of India or the State Government from time to time. The contractor shall carry out periodical checks and undertake remedial measure including replacement, if required so as to ply within permissible norms.

51.1.30 Contractor shall provide green net for dust control at construction sites i.e stations, viaduct, depot, batching plant, casting yard, at the top of barricade boards near residential/commercial and sensitive areas. These should be of sufficient height and firmly secured so as to prevent escape of dust to residential/ commercial and industrial areas.

51.1.31 To avoid dust generation during drilling and grinding, it is preferred to use drilling machine, angle grinder and floor grinder connected to a vacuum cleaner. The dust collected in the vacuum cleaner should be disposed off without causing air pollution.

51.1.32 All Air Conditioner's shall confirm the ozone depleting substances (Regulation and Control) Rules, 2000.

51.1.32 The Contractor shall protect structures, utilities, pavements roads and other facilities from disfiguration and damage as a result of his activities. Where this is not possible, the contractor shall restore the structures, utilities, pavements, roads and other facilities to their original or better, failing which the rectification/restoration work shall be carried out at the risk and cost of the contractor.

**51.2 During Handling of excavated earth**

51.2.1 Storage of Excavated earth should be such that it's maximum height shall be 0.5 m below the barricading height.

51.2.2 Excavated earth shall be covered with tarpaulin sheets which are firmly secured to the ground, as long as it is stored at site.

51.2.3 If the excavated material is to be stored for long duration, dust containment measures like growing grass should be adopted.

**51.3 During Transport of Material/muck/soil/C&D Waste (Debris)**

51.3.1 The Contractor shall take precautions to minimise visible particulate matter from being deposited upon public roadways as a direct result of his operations. Toe dust along the barricade shall be cleaned regularly at least once a day.

51.3.2 The vehicle carrying construction materials and construction debris of any kind should be cleaned in all respect before it is permitted to ply on the road.

51.3.3 The contractor shall take precaution against spillage of concrete on road from transit mixer by providing collection bag at end point discharge chute

51.3.4 Any deposition of material/muck/soil on public streets due to construction should be promptly removed by manual sweeping, or by deploying electro – mechanical devices.

51.3.5 Trucks carrying construction material, excavated earth and debris shall be fully covered and protected so as to ensure that these materials do not get dispersed into the air or atmosphere, in any form whatsoever or fall off the vehicle. Such trucks carrying construction material shall not be permitted to leave the site until this requirement is met.

**51.4 At Dumping Sites**

51.4.1 The dumping sites should be temporarily barricaded by the contractor or as per provisions in the Employer's Requirements on Construction. The contractor shall provide wheel cleaning mechanism at the exit gate of dumping site.

51.4.2 The Contractor shall place excavated materials in the dumping / disposal areas approved by Employer.

51.4.3 The Contractor shall place material in a manner that will minimise dust generation. Material shall be stabilised each day by watering or other acceptable dust suppression techniques.

51.4.5 The heights from which materials are dropped shall be the minimum practical height to limit fugitive dust generation.

51.4.6 The Contractor shall stockpile material in the Employer designated locations with suitable slopes. Access to the site shall be regulated for entry of men, material and machine.

51.4.7 The contractor should cover the surface with grass to prevent dust generation during summer months and erosion in rainy period.

51.4.8 The Contractor shall provide water sprinkling at any time that it is required for dust control use.

51.4.9 Sufficient equipment, water, and personnel shall be available at dumping sites at all time to minimise dust formation and to prevent nuisance.

51.4.10 Dust control activities shall continue even during work stoppages.

## 52.0 CONTAINMENT OF WATER POLLUTION AND CONSERVATION OF WATER

52.1 The Contractor shall provide digital water meters at all the bore wells, inlets and outlets of RO plants, dewatering outlets, municipal water delivery points and other suitable locations to record the accurate figures of water extraction and consumption for various purposes and submit the details. The contractor shall obtain necessary permission for extracting ground water from relevant government agency.

52.2 At underground construction site and dumping sites, temporary drainage works shall be maintained, removed and reinstated as necessary and all other necessary precautions should be taken for avoidance of damage by flooding and silt.

52.3 Temporary open storage of excavated materials from cut and cover and tunnelling work used for backfill at site should be covered with tarpaulin which is firmly secured to ground.

52.4 Polymer slurry or other grouts used in diaphragm wall construction piling and other concrete works shall be collected in a separate slurry collection system. If reuse is not practicable then it shall only be disposed off at nearest landfill site after obtaining permission from agency owning the landfill and under the conditions imposed by the agency concerned, or to a different disposal location as advised by the Employer. Record of disposal of Polymer slurry at landfills or elsewhere shall be maintained by the contractor and reported in the contractor's Monthly Environment Report to be shown to employer when requested.

52.5 Beneath the hopper of Batching Plant, the slope of the surface shall be maintained in a such a way that the slurry from Batching Plant shall enter into sedimentation tank. The area should be cleaned regularly to avoid slush generation.

52.6 Any mud slurry from drilling, tunnelling, diaphragm wall construction or grouting etc. shall not be discharged into the drainage system unless treatment is carried out that will remove silt, mud particles etc. The Contractor shall provide treatment facilities as necessary to prevent the discharge of contaminated ground water.

52.7 The Contractor is not allowed to discharge water from the site without the approval of the Employer. The Contractor must comply with the requirements of the Central Ground Water Board for discharge of water arising from dewatering. Any water obtained from dewatering systems installed in the works must be either re-used for construction purposes or recharged to the ground or pumped into the nearest water body/park or supplied to concerned authority with prior permission of the Employer. In case, the dewatered water is required to be used for reuse in construction or recharge, the Contractor must submit his proposals for prior approval of Employer along with, his proposed locations of dewatering.

52.8 Roof top run-off from casting yard and batching plants as well as water from curing (if, any) should be conserved through properly designed rainwater harvesting structures via adequately designed sand/silt removal facilities such as sand traps, silt traps or sediment basins. Excess discharge should be discharged into storm drains.

52.9 Perimeter channels/drains shall be constructed in casting yard and batching plant. Silt removal facilities, channels and manholes should be maintained and the deposited silt and grit should be removed regularly, to ensure that these facilities are functioning properly at all times.

52.10 Oil separator/interceptors shall be provided to prevent the release of oil and grease into the drainage system. These shall be cleaned on a regular basis. Area which is storing admixtures/oils should be connected to a drainage system with a oil & grease trap. Spillage of material during transfer should be avoided by using appropriate /design mechanism for such transfer.

52.11 Measures should be taken to minimize the ingress of rainwater into trenches. If excavation of trenches in wet seasons is necessary, they should be dug and backfilled in short sections. Rainwater pumped out from trenches or foundation excavation should be discharged into storm drains via silt removal facilities.

52.12 Manholes (including newly constructed ones) should always be adequately covered and temporarily sealed so as to prevent silt, construction materials or debris from getting into the drainage system. Discharge of surface run-off into sewers must always be prevented in order not to unduly overload the sewerage system.

52.13 The drainage system should cover the entire area of Casting Yard/ Batching Plant. The drainage system shall be designed in such a way that it should have sufficient capacity to hold the runoff of the catchment area.

52.14 Waste water from Reverse Osmosis (RO) plant shall be used only for dust suppression, wheel washing and road washing. It shall not be drained into public sewers or storm water drainage system.

52.15 The Contractor may discharge wastewater arising from site offices, canteens or toilet facilities constructed by him into sewers after obtaining prior approval of agency controlling the system.

52.16 The Contractor shall provide adequate precautions to ensure that no spoil, wastewater, spills or debris of any kind is pushed, washed, falls or deposited on land adjacent to the site perimeter including public roads or existing stream courses water bodies (Natural /artificial), ground water and drains within or adjacent to the site. In the event of any spoil, wastewater, spills and debris from construction works being deposited or any silt washed down to any area, then all such spoil, wastewater, spills debris or material and silt shall be immediately removed and the affected land and areas restored to their natural state by the Contractor to the satisfaction of the Employer.

## 53.0 CONTAINMENT OF NOISE AND VIBRATION

53.1 Construction often generates community noise/vibration complaints despite the limited time frame over which it takes place. Complaints typically arise from interface with people's activity, especially when community has no clear understanding of the extent or duration of construction.

53.2 This situation underscores the need for early identification and assessment of potential problem areas. An assessment of the potential for complaints can and should be made.

53.3 If done timely, such assessment can aid contractor in allowing changes in construction approach and reduce noise mitigation cost before the construction plans are finalised.

53.4 The contractor shall conform to ambient air quality standards/Baseline results with respect to noise.

53.5 The Employer will monitor noise level at site before the start of work and share the values with contractor. Thereafter, the contractor will employ necessary engineering control to ensure that noise lelves do not exceed preconstruction noise.

53.6 Where there are no ambient noise measurements, the noise levels from construction activities shall be limited to levels measured near the construction site as given in table below:

**Table 1.2.: Allowable Construction Noise**

| S. No | Land Use | Maximum Noise Levels (Leq- 5min) |
|---|---|---|
| 1 | Industrial | 75 |
| 2 | Residential and Other areas | 65 |

53.7 To the extent required to meet the noise limits, the Contractor shall use reasonable efforts to include noise reduction measures listed below to minimize construction noise emission levels. Noise reduction measures – include, but not limited to the following:

i. Acoustic barriers should be placed near construction sites. The properties of acoustic barrier are given in Table 1.1.

ii. Minimize the use of impact devices, such as jackhammers, and pavement breakers. Equip noise producing equipment such as jackhammers and pavement breakers with acoustically attenuating shields or shrouds recommended by the manufacturers thereof, to meet relevant noise limitations.

iii. Pneumatic impact tools and equipment used at the construction site shall have intake and exhaust mufflers recommended by the manufacturers thereof, to meet relevant noise limitations.

iv. Provide mufflers or shield panelling for other equipment, including internal combustion engines, recommended by manufacturers thereof.

v. Use construction equipment manufactured or modified to dampen noise and vibration emissions, such as:

1. Use hydraulic tools instead of pneumatic impact tools.
2. Maximize physical separation, as far as practicable, between noise generators and noise receptors such as locating stationary equipment so as to minimize noise and vibration impact on community.
3. Use of electric powered equipment instead of diesel-powered equipment.

vi. Schedule work to avoid simultaneous activities that generate high noise levels.

53.8 The contractor shall provide enclosures for stationary equipment and noise barriers around particularly noisy areas on site depending upon the land use.

53.9 To the extent feasible, configure the construction site in a manner that keeps noisier equipment and activities as far as possible from noise sensitive locations and nearby buildings. Plant and equipment known to emit noise in one direction should where possible, be oriented in a direction away from noise sensitive receptor and reduce the number of plant and equipment operating in critical areas close to noise sensitive receptors.

53.10 Schedule truck loading, unloading, and hauling operations so as to minimize noise impact near noise sensitive locations and surrounding communities.

53.11 Other measures that the contractor may adopt to mitigate noise include:

a) Minimize noise intrusive impacts during most noise sensitive hours.
b) Plan noisier operations during times of highest ambient noise levels
c) Keep noise levels relatively uniform; avoid excessive and impulse noises.
d) Equipment and plant should not to be kept idling when not in use.
e) Use only well-maintained plant & equipment at site, which should be serviced regularly.
f) Shall maintain equipment such that parts of vehicles and loads are secured against vibrations and rattling
g) Conduct truck loading, unloading and hauling operations in a manner such that noise and vibration are kept to a minimum.
h) Route construction equipment and vehicles carrying soil, concrete or other materials over streets that will cause least disturbance to residents in vicinity of work.
i) Avoid operating truck on streets that pass by schools during school hours
j) Select truck routes for muck disposal in such a way that noise from heavy-duty trucks will have minimal impact on sensitive land uses (e.g., residential) and submit the proposed routes to the Employer for approval.

53.12 If back-up alarms are used on construction equipment, their noise level near noise sensitive receptors such as residences, schools, hospitals and similar areas where silence is essential, should be regulated, especially at night time. Visual alarms shall preferably be used during night time operation.

53.13 The contractor shall make efforts to bring down the noise levels due to the DG set, outside his premises, within the ambient noise requirements by proper setting and control measures.

53.14 Installation of a DG set must be strictly in compliance with the recommendations of the DG set manufacturer. The contractor shall ensure that all necessary permissions/ approvals/consent is obtained from relevant authorities before installation and operation of Generator set.

53.15 A proper routine and preventive maintenance procedure for the DG set should be set and followed in consultation with the DG set manufacturer which would help prevent noise levels of the DG set from deteriorating with use.

53.16 The maximum permissible sound pressure level for new diesel generator (DG) sets (upto 1000 KVA) manufactured on or after the 1st July,2003 shall be 75 dB(A) at 1 metre from the enclosure surface. The diesel generator sets should be provided with integral acoustic enclosure at the manufacturing stage itself.

53.17 Noise limit for DG sets not covered by above paragraph shall be as follows:

a) Noise from DG set shall be controlled by providing an acoustic enclosure or by treating the room acoustically, at the user's end.

b) The acoustic enclosure or acoustic treatment of the room shall be designed for minimum 25 dB (A) insertion loss or for meeting the ambient noise standards, whichever is on the higher side (if the actual ambient noise is on the higher side, it may not be possible to check the performance of the acoustic enclosure/acoustic treatment. Under such circumstances the performance may be checked for noise reduction up to actual ambient noise level, preferably, in the night time). The measurement for Insertion Loss may be done at different points at 0.5 m from the acoustic enclosure/room, and then averaged.

c) The DG set shall be provided with proper exhaust muffler with insertion loss of minimum 25 dB(A)

53.18 If the measures to control noise pollution are found to be ineffective, the employer may issue stop work order till the time remedial measures are found to be effective to the satisfaction of employer.

53.19 Vibration consists of rapidly fluctuating motions with an average motion of zero. During vibration the oscillatory waves propagate from the source through the ground to adjacent buildings. Vibration from construction projects is caused by general equipment operations is usually highest during pile driving, soil compacting, jack hammering and construction related demolition activities.

53.20 The following steps may be taken by the contractor to reduce construction vibration:

**A.** Design considerations and project layout:

1. Route heavily loaded trucks away from residential streets.
2. If possible, select street with fewest homes, if no alternatives are available.
3. Operate earthmoving equipment on the construction lot as far away from vibration sensitive sites as possible.

**B.** Sequence of operations:

1. Phase demolition, earthmoving and ground-impacting operations so as not to occur the same time period. Unlike noise, the total vibration level produced could be significantly less when each vibration source operates separately.
2. Avoid night time activities. People are more aware of vibration in their homes during the night time hours.

**C.** Alternative construction methods:

1. Avoid impact pile driving where possible in vibration-sensitive areas.
2. Drilled piles or the use of a sonic or vibratory pile driver causes lower vibration levels where the geological conditions permit their use.
3. Select demolition methods not involving impact, where possible. For example, sawing bridge decks into sections that can be loaded onto trucks results in lower vibration levels than impact demolition by pavement breakers, and milling generates lower vibration levels than excavation using clam shell or chisel drops.
4. Avoid vibratory rollers and packers near sensitive areas.

## 54.0 WASTE MANAGEMENT

**54.1 General:** The following types of waste are most likely to be encountered during execution of contract:

1. General refuse
2. C&D waste
3. Hazardous waste
4. E-waste
5. Bio medical waste
6. Plastic waste
7. Batteries Waste

54.1.1 Disposal of waste as per legal requirement is found in the table below:

**Table 1.3: Construction Wastes – Type and Disposal**

| S.No | Waste Type | Legal requirement for handling, storage & disposal |
|---|---|---|
| 1. | General refuse | Solid Waste Management Rules, 2016 and its amendments |
| 2. | Vegetation / Timber etc. | The Maharashtra (Urban Areas) Preservation of Trees Act, 1975 and its amendments |
| 3. | Construction and Demolition (C&D) waste | Construction and Demolition Waste Management Rules, 2016 and its amendments and/or any suitable means acceptable to Maha-Metro/Engineers |
| 4. | Hazardous waste | Hazardous and Other Wastes (Management & Trans-boundary Movement) Rules, 2016 and its amendments |
| 5 | Electronic waste | E-waste (Management) Rules, 2016 and its amendments |
| 7. | Bio-medical waste | Bio-medical waste Management Rules, 2016 and its amendments |
| 8. | Chemical waste | Manufacture, Storage and handling of hazardous chemical rules 1989 and its amendments |
| 9. | Plastic Waste | Plastic Waste management Rules, 2016 and its amendments |

54.1.2 In addition to above, excavated earth and metal scrap is likely to be generated in large quantity. The excavated material comprises mainly soil and rock. Soil may be used for backfill at locations as directed by employer.

54.1.3 The contractor is required to develop, institute and maintain a Waste Management Programme (WMP) during the construction of the project for his works. This WMP shall be a part of Contractor's site Environmental Management Plan. Data sheet to be provided under WMP. However, the WMP should be prepared and submitted to the Engineer for approval. A Waste

Management Plan specific for handling and disposal of C&D waste shall be prepared separately by the contractor as per the provisions of C&D Waste Management Rules, 2016 or any other means acceptable to the engineers.

54.1.4 A mechanism is required to ensure that designated areas for the segregation and temporary storage of reusable, recyclable and waste materials are incorporated into the WMP.

54.1.5 The Contractor shall handle waste in a manner that ensures they are held securely without loss or leakage thus minimizing potential for pollution following all legal requirements for handling and storage. The Contractor shall maintain and clean waste storage areas regularly.

54.1.6 The contractor shall strictly manage transportation and disposal of all waste complying all legal/statuary requirements.

54.1.7 The contractor shall make available Material Supply Data Sheet (MSDS) for material/chemicals/substances used, for which these are available to the Employer when requested.

**54.2 General Refuse**

54.2.1 This category of waste is generated from living camps, offices, workshops, kitchen, and other work areas. Such type of waste includes food scraps (solids + liquids), Paper, Cardboard, Plastics (recyclable bottles, other), Glass (different colours), Aluminium and other cans, Wooden boxes, crates etc.

54.2.2 The Contractor shall provide at site, metal or heavy-duty plastic 'Refuse Containers' with tight fitting lids for disposal of all garbage or trash associated with food. The containers shall not have openings that allow access by rodents.

54.2.3 To keep the area free of litter and garbage, specific locations shall be designated for consuming food and snacks to prevent random disposal of waste. All waste shall be deposited in the refuse containers. Suitable all-weather signage shall be prominently displayed for compliance of these requirements.

54.2.4 The refuse containers shall be kept upright with their lids shut. These containers shall be emptied at least once daily by the Contractor to maintain site sanitation. There shall be different containers for each category of waste.

54.2.5 General refuse should be stored in enclosed bins or units separate from construction and chemical wastes. A waste collector should be employed by the contractor to remove general refuse from the site on a daily basis to minimise odour, pest and litter impacts.

54.2.6 Handling and disposal of general refuse should cope with the peak construction workforce during the construction period. The refuse should be stored and transported in accordance with good environment practice and disposed at licensed landfills.

54.2.7 Respective Waste with residual value is to be disposed off by selling to recyclers. The remaining can be disposed off through collection and disposal by local municipal agency.

54.2.8 Office waste can be reduced through recycling of paper if volumes are large enough to warrant collection.

54.2.9 Burning of refuse at construction site is not permitted. Dumping of any type of waste is strictly prohibited along any of the river bed.

54.2.10 Colour Coded Dustbin in suitable numbers at each working area shall be used for segregation of waste during collection. The waste management plan should clearly quantify and identify the number and locations of different types of dustbins that will be provided at each working site. Colour coding of dustbins shall be as per given Table:

**Table 1.4 - Colour Coding of Dust Bins**

| Type of Waste | Colour |
|---|---|
| Wet/Organic/ Bio-Degradable Waste | Green Bins with lids |
| Dry/Recyclable waste (excluding Bio-medical waste/ hazardous waste) | Blue |
| Bio-Medical waste | As per Bio-medical waste Management Rules, 2016 |
| E-Waste | Black |
| Hazardous Waste | Fluorescent yellow colour background wrien in RED words as 'HAZARDOUS WASTES' and 'HANDLE WITH CARE' in Hindi, English and vernacular language |
| COVID Waste | Yellow |

**54.3 Construction and Demolition Waste**

54.3.1 Construction and Demolition waste" means the waste comprising of building materials, debris and rubble resulting from construction, re- modelling, repair and demolition of any civil structure.

54.3.2 Construction & Demolition (C&D) waste shall be stored at a designated area.

54.3.3 The C&D waste shall be disposed off in a manner in compliance with the procedure given in the Construction & Demolition Waste Management Rules, 2016. or any other means with prior approval of Maha-Metro/Engineer.

54.3.4 The contractor shall be responsible for collection, segregation and storage of construction and demolition waste, as directed or notified by the concerned local authority in consonance with the Construction& Demolition Waste Management Rules, 2016.

54.3.5 The contractor shall ensure that other waste does not get mixed with this waste and is stored and disposed separately.

54.3.6 The contractor shall dispose C&D waste only at authorized processing facilities/pre approved dumping locations and ensure that there is no littering or deposition of construction and demolition waste so as to prevent obstruction to the traffic or the public or drains.

54.3.7 Disposal of C&D waste along the river bed, natural drainage and wet land is strictly prohibited and the contractor shall be fined for non compliance of this requirement.

54.3.8 The requirement of concrete/RCC/PCC waste disposal, generated from the entire contract shall be either when 15 Tonnes of C&D waste has been generated or such C&D waste has been stored for 15 days (irrespective of quantity), of the two whichever is earlier.

54.3.8 Proper record keeping has to be maintained for all disposed C&D waste. The contractor shall submit the C&D waste record through Monthly Environment Report.

**54.4 Hazardous Waste Management**

54.4.1 Generally, the hazardous waste from construction site includes used oil, grease, oil filters etc. A comprehensive list of hazardous waste is found in Hazardous waste management and handling rules 2016. If encountered or generated as a result of Contractor's activity, then waste classified as hazardous under the "Hazardous and Other Wastes (Management & Transboundary

Movement) Rules, 2016 shall be disposed off in a manner in compliance with the procedure given in the rules under the aforesaid act.

54.4.2 Chemicals classified as hazardous chemicals under "Manufacture, Storage and Import of Hazardous Chemical Rules, 1989 and amendments of Environment (Protection) Act, 1986 shall be disposed off in a manner in compliance with the procedure given in the rules under the aforesaid act.

54.4.3 The contractor shall identify the nature and quantity of hazardous waste generated as a result of his activities. The contractor shall obtain authorization for handling, storage of hazardous waste from the concerned pollution control board/committee. The contractor shall file annual return in prescribed format with the concerned pollution control board/ committee and forward a copy of receipt to employer.

54.4.4 The contractor shall provide and maintain a separate hazardous waste storage area for a) flammable, ignitable, reactive and b) Non- compatible wastes with suitable opening, Flame proof Electrical fittings should be at 15 m distance between the storage sheds. The storage yards should be provided with proper peripheral drainage system connected with the sump so as to collect any accidental spills.

54.4.5 The storage area for Hazardous waste shall:

a) Be clearly labelled and used solely for the storage of chemical waste;
b) Be enclosed on at least three sides;
c) Have an impermeable floor and bunding of capacity to accommodate 110% of the volume of the largest container or 20% by volume of the hazardous waste stored in that area, whichever is greater;
d) Have adequate ventilation;
e) Be covered to prevent rainfall entering and
f) Be arranged so that incompatible materials are adequately separated

54.4.6 Outside the storage area, the contractor shall place a 'display board', which will display quantity and nature of hazardous waste, on date. Hazardous Waste needs to be stored in a secure place.

54.4.7 It shall be the responsibility of the contractor to ensure that hazardous wastes are stored, based on the composition, in a manner suitable for handling, storage and transport. The labelling and packaging is required to be easily visible and be able to withstand physical conditions and climatic factors

54.4.8 Lubricants including oil and grease generated from operation of the TBM/other Machaneries/vehicles should be disposed off as a hazardous waste.

54.4.9 Drip pans of suitable size and numbers shall be used to collect oil leakages and spills. The area shall be cleaned after completion of maintenance /repair and generated waste disposed off in approved manner.

54.4.10 The contractor shall follow the manifest and approach only Authorised Recyclers of Hazardous Waste for disposal of Hazardous Waste, under intimation to the Employer.

**54.5 Chemical Waste**

54.5.1 The contractor should ascertain if some paints and solvents are classified as chemical waste and, if used on site, shall be subject to the stringent requirements of the Waste Disposal of Chemical Waste. Empty paint cans shall be recycled or collected as waste.

54.5.2 Any dry paint waste should be swept up (broomed / vacuumed) and collected in containers for disposal.

54.5.3 Containers used for the storage of chemical waste shall:

a) Be suitable for the substances they are holding, resistant to corrosion, maintained in good condition, and securely closed.

b) Be of adequate capacity and
c) Display a label in English and Hindi/Marathi as to the contents, quantity and safe method of disposal in accordance with instructions contained in Material Safety Data Sheet (MSDS).

54.5.4 The storage area for chemical waste shall:

a) Be clearly labelled and used solely for the storage of chemical waste;
b) Be enclosed on at least three sides;
c) Have an impermeable floor and bunding of capacity to accommodate 110% of the volume of the largest container or 20% by volume of the chemical waste stored in that area, whichever is greater;
d) Have adequate ventilation;
e) Be covered to prevent rainfall entering and
f) Be arranged so that incompatible materials are adequately separated.

54.5.5 Disposal of chemical waste shall be through a licensed waste collector duly authorized by the MoEF & CC or State Pollution Control Board as the case may be under intimation to the Employer.

54.5.6 No lubricants, oils, solvents or paint products shall be allowed to discharge into water courses, either by direct discharge, or as contaminants carried in surface water runoff from the construction site.

54.5.7 In sum, even though the exact quantities of chemical waste that will be generated per contract are expected to be small, still, because of the potential environmental and health & safety hazard that these chemicals pose, they must be handled, stored and disposed of appropriately, in accordance with the law.

**54.6 Metal Scrap**

54.6.1 Steel and other metals should be recovered from the construction waste and recycled as far as practical.

54.6.2 The contractor shall have a separate scrap yard with hard surface

54.6.3 Disposal of scrap shall be through a licensed waste collector/recycler under intimation to the Employer.

**54.7 Polymer Slurry**

54.7.1 Polymer slurries or other grouts used in diaphragm wall construction, piling and other concrete works should be collected in a separate slurry collection system.

54.7.2 If reuse is not practicable then it should be disposed off at nearest landfill site after obtaining permission from agency owning the landfill and under the conditions imposed by the agency concerned, or to a different disposal location as advised by the Employer.

54.7.3 Some Polymer slurry shall be used in diaphragm wall, bore-pile or to support the cutting face during maintenance of the TBM. This should be reconditioned and reused wherever practicable.

54.8.3 However, it may not be possible for re-use when it is extracted along with rock waste when tunnelling resumes following each intervention period. In this case the polymer will be mixed with rock and drained as usual before sending to the final disposal site.

**55.0 ENVIRONMENTAL MONITORING**

55.1 GENERAL

55.1.1 The Contractor shall carry out the monitoring of Air, DG stack, Noise, Vibration and ground water to assess the impact on environment during construction.

55.1.2 In addition, soil monitoring shall be carried out at underground station till no excavation is required. Representative sensitive receivers in the vicinity of the works shall be monitored for

noise and air quality impacts. Vibration monitoring shall be carried out as and when directed by the employer.

55.1.3 The Environmental monitoring shall be carried out by a MoEF recognised agency/lab with the prior approval of Maha Metro Environment Department. This approval can be withdrawn at any time if the quality of output of the laboratory/agency is found not satisfactory by Maha Metro Environment Department.

55.1.4 The contractor shall release the payment due to the monitoring agency within 2 months of the submission of bills failing which the Employer may deduct the payment from RA bills and directly pay to the engaged monitoring agency.

55.1.5 The contractor shall submit the method statement for the environmental monitoring with the prior approval of Maha Metro Environment Department.

**55.2 Air Monitoring**

55.2.1 For carrying out air monitoring the contractor shall appoint agency duly approved by Maha Metro Environment department with intimation to the employer. The contractor shall provide 220V AC power point, safety and security of monitoring equipment and suitable access at each monitoring point. Monitoring stations should be free from local obstructions or sheltering.

55.2.2 The monitoring shall be carried out till handing over of the site to the employer or as approved by Maha Metro Environment Department.

55.2.3 Ambient Air Quality Standards have been notified by the CPCB vide Gazette Notification dated 16th November 2009 and its amedments. These standards have to be referred by the Contractor for Limit Levels of PM10 and PM2.5 and other Parameters in ambient air which may be followed in estimating the pollution level caused by Contractor's activities.

55.2.4 Contractor will undertake baseline monitoring to establish background levels. Action Level of the Contractor shall be based on the results of baseline monitoring programme.

55.2.5 Where the Employer determines that the recorded PM10 & PM2.5 levels are significantly greater than the Limit levels, the Employer may direct the Contractor to take effective remedial measures including, but not limited to, reviewing dust sources and modifying working procedures.

55.2.6 Where the recorded baseline levels exceed the ambient air quality standards, then at such locations the limit level is the recorded baseline. Contractor shall take all effective remedial measures to contain the levels to their baseline value as a result of his activities. The action level may be varied by and at the sole discretion of the Maha Metro.

55.2.7 The Contractor should inform the Maha Metro of all steps taken to investigate cause of exceedance and immediate action taken to avoid further exceedance through written reports and proposals for action.

55.2.8 The contractor shall ensure calibration of monitoring instruments and their respective calibrators shall be carried out in accordance with the manufacturer's requirement to ensure they perform to the same level of accuracy as stated in the manufacturer's specifications.

55.2.9 The Contractor shall keep records of air quality monitoring (including location, date, time) and shall be available for review by the Employer. The Contractor shall submit a copy of monitoring results through the Monthly Environment Report (MER) to the Employer.

55.2.10 PM10 monitoring shall be done using Respirable Dust Sampler (RDS) and for PM2.5 either cyclone or impactor shall be used. Monitoring shall be done as per CPCB methodology

55.2.11 All the parameters as mentioned in Table 1.5 shall be monitored at following locations:

a) Depot, Batching Plant and Casting Yard

b) Elevated Stretch (Station and Viaduct)
c) Underground Station (at ground level)
d) Tunnel (only PM 2.5) Additionally, the contractor shall also carry out monitoring of PM2.5 at those locations where PM10 monitoring is carried out.

55.2.12 Followimng guidelines to be followed while monitoring, the RDS sampler to be placed such that:

a) The entry point of air should be at 2.5± 0.5 m above the ground.
b) The sampler to be placed near to the receptor at least 2.5-3.0 m away from barricades/obstruction.
c) Ensure flow rate of 1.15$m^3$/m.
d) The location will be finalized by environmental engineer at site in consultation with Maha Metro Environment deptt.
e) Elevated stretch: PM10 & 2.5 and other parameters monitoring to be carried out at every elevated station at a height of 2.5 ± 0.5 m. In the viaduct, monitoring to be performed at one location per 1 km in consultation with Maha Metro Environment department.
f) Underground Station: PM10& 2.5 and other parameters monitoring to be conducted at 2.5± 0.5 m above the ground. The specifications to be as per elevated stations

**55.3 Noise Monitoring**

55.3.1 Noise monitoring shall be carried out at ambient air monitoring locations in 15 days till site is handed over to the employer or The monitoring location shall be near to boundary of construction site and or as directed by the employer. Construction noise measurements shall coincide with daytime and night time periods of maximum noise generating construction activities.

55.3.2 Contractor will undertake baseline monitoring to establish background levels. Action Level of the Contractor shall be based on the results of baseline monitoring programme.

55.3.3 The Contractor shall submit a copy of monitoring results. The results should represent a comparison of data in form of bar charts for evaluation of trends and comparison with noise emission standards.

55.3.4 Where the Employer determines that the recorded Noise level is significantly greater than the acceptable levels, the Employer may direct the Contractor to take effective remedial measures including, but not limited to, reviewing noise sources and modifying working procedures.

55.3.5 Monitoring shall be carried out for day and night separately.

55.3.6 The noise monitoring parameters are Lmax, Lmin, Leq, L90, L50 & L10. All the parameters will be reported separately for day time and night time.

55.3.7 The contractor shall ensure calibration of noise monitoring instrument and its calibration shall be carried out in accordance with the manufacturer's requirement to ensure it perform to the same level of accuracy as stated in the manufacturer's specifications.

55.3.8 Type I/II integrating sound level meter with free -field microphone and tripod stand of 1 to 1.5 m height shall be used for noise monitoring. The microphone of the instrument shall be near the receptor.

55.3.9 The minimum requirements to the specifications of sound level meter are given in BIS: 9779-1981 and its latest amendment. Measurement frequency of 31.5 Hz to 8000 Hz. Noise measurements shall be reported ion dB(A). Sound Level Meter should be Type-I/II with A, C & Z weighing and measured sound values should also be suitably presented for quick comparison and interpretation.

**55.4 Vibration**

55.4.1 Steady State Vibration on any pre-identified site or building shall be measured on any foundation or intermediate storey of any building, as directed by the employer or his representative.

55.4.2 Vibration measurements shall be made preferably in velocity mode (PPV) or acceleration (dBv / vdB) in X-Y-Z directions with the help of a measurement system calibrated in an NABL accredited laboratory/equivalent. The transducer used for measurements should be firmly fixed on to the measurement surface as per internationally accepted measurement practices. Precautions should be taken to ensure that the mounting methods do not affect the accuracy of measurement results. The accelerometer shall be fixed firmly to the vibrating surface with the help of special wax or through magnetic mounts.

55.4.3 The measured vibration values should be accurate within an overall measurement uncertainty of ±10 % over the frequency range 1Hz – 100 Hz.

55.4.4 The data should be presented in suitable single number quantities like VdB or PPV values as per current international practices so that the final values are comparable directly with the accepted norms for structural integrity, human comfort etc.

**55.5 Ground Water**

55.5.1 The employer may require the contractor to monitor surface/ ground water/drinking water, for which requirements of IS 10500:2012 or its latest amendments shall be followed for sampling and testing (physical and chemical parameters).

55.5.2 Frequency of such monitoring at Stations, viaduct, batching plants, casting yard, Labour camps shall be once in 3 months.

**55.6 Soil**

55.6.1 The contractor shall carry out soil testing at all elevated, underground stations and working Sites. The frequency of testing shall be once in 3 months. The parameters of monitoring shall be Lead (Pb), Cadmium (Cd), Chromium (Cr6+), Mercury (Hg), Arsenic (As) and cyanide (CN). The sample collection, testing shall be as per relevant APHA standard.

**55.7 Environmental Monitoring Programme**

55.7.1 The various parameters, monitoring locations and Frequency of monitoring are presented in Table below:

**Table 1.5: Summary of contractor's Environmental Monitoring Programme**

| Parameters | Locations | Frequency |
|---|---|---|
| **Air** | | |
| PM2.5, PM10, Sox, Nox, Co, Pb, Ni, As, $O_3$ ($\mu/m^3$) | Station, Viaduct, depot, Batching plant,Casting yard Inside the Tunnel and in underground stations | Once in 15 days for 24hrs |
| PM10 Sox, Nox, Co, Pb, ($\mu/m^3$) | DG Sets | Once in 1 month |
| **Noise** | | |
| Day Time<br>(6 AM – 10PM)<br>Lmax, Lmin, Leq, L10, L90, L50<br><br>Night Time<br>(10PM –6AM)<br>Lmax, Lmin, Leq, L10, L90, L50 | Station, Viaduct, depot, Batching plant,Casting yard etc. | Once a 15 days for 24hrs (Separately for day time and night time) |
| **Ground Water/Drinking water** | | |

| Parameters | Locations | Frequency |
|---|---|---|
| Colour, odour, Taste, Turbidity, pH, toatad Hardness, Calcium, Ammonia, Residual Free Chlorine, Fluoride, Total Dissolved Solids, Magnesium (Mg), Copper (Cu), Sulphide ($H_2S$), Sodium, Potassium, Chloride, Nitrogen, Phosphorus, Organic Matter, Heavy Metals (Mercury, Cadmium, Arsenic, Cyanide, Lead, Chromium), Oil & Grease, Total Coliform, E.Coli, etc. | Station,Viaduct,Depot, Batching Plant and Casting Yard,Labour Camp | Once in 3 months |
| **Soil** | | |
| pH, Conductivity, Boron, Nitrogen, Calcium (Ca), Sodium (Na), Potassium (K), Zinc (Zn), Organic carbon, Magnesium (Mg), Phosphorus, iron (Fe), Lead (Pb), Cadmiun (Cd), Chromium (Cr6+), Mercury (Hg), Arsenic (As) and cyanide (CN). | At elevated & underground stations | Once in 3 months |
| **Vibration** | | |
| Vibration in mm/s or VdB. | At elevated & underground stations | During complaints or as directed by employer. |

## 56.0 ENVIRONMENTAL SANITATION

56.1 Environmental Sanitation refers to providing for a clean, hygienic, safe and aesthetically pleasing work area, as far as possible. It is also referred to as good housekeeping.

56.2 The Contractor shall constitute a special group of housekeeping personnel in charge of each work section. Contractor's Environment officer shall be responsible for Environmental sanitation/housekeeping at their respective site.

56.3 Housekeeping is the responsibility of all site personnel, and line management commitment shall be demonstrated by the continued efforts of supervising staff towards this activity.

56.4 General Housekeeping shall be the responsibility of site In-Charge and monitored by the housekeeping manager at all worksite, construction Depot, Batching Plant, Labour Camp, Stores, Offices and toilets / urinals. Towards this the contractor shall constitute a special group of housekeeping personnel. This group shall ensure daily cleaning at work sites and surrounding areas and maintain a register. Contractor's Environment officer shall be responsible for Environmental sanitation / housekeeping.

56.5 Each section of work site shall maintain the site reasonably clean, keep free from obstruction and properly store any construction equipment, tools, and materials. Any wreckage, rubbish shall be temporarily stored in wreckage and rubbish bins. These wreckage and rubbish bins shall be cleaned at frequent intervals. Special housekeeping group will ensure daily cleaning work at the site and its surrounding areas.

56.6 The Contractor's designated department will impart the necessary introduction/awareness and education to labours on housekeeping. This will be done through toolbox talks.

56.7 Every individual would be responsible for environmental sanitation in his area i.e.

A. **At Work Site:** All workers should clean their workplace after completion of their job. Supervisor should ensure good environmental sanitation of their respective work area through their workers. Environment Managers shall ensure sanitation in their area through their supervisors. Contractor's designate department will monitor this activity through environment manager as well as site supervisor.

B. **Labour Camp:** All workers should be responsible to maintain good sanitation and hygienic condition in their respective rooms/dormitories. The Contractor should ensure the availability of dustbins at required place and regular cleaning of rooms, kitchens, toilet blocks and dustbins. Safe disposal of all waste materials should also be ensured. Arrangement for regular fumigation should be made by the contractor.

C. **At Store:** Proper access and stacking shall be ensured at the Stores. A list will display daily stock of materials. All work material should be stored in clearly marked containers or at designated storage area.

D. **At Office:** Everyone is responsible to maintain sanitation of their work station. Disposal of waste materials (i.e. stationary, cigarette buds, tea bags etc.) must be in dustbin only.

56.8 Adequate Time shall be assigned to ensure that good housekeeping is maintained. This shall be carried out by team of housekeeping sqad.

56.9 The contractor shall be responsible to provide segregated containers for disposal of debris at required places and regular cleaning of the same.

56.10 Full height fence, barriers, barricade etc. shall be erected around the site in order to prevent the surrounding area from excavated soil, rubbish etc, which may cause inconvenience to and endanger the public. The barricade especially those exposed to public shall be aesthetically maintained by regular cleaning and painting as directed by the employer. These shall be maintained in one line and level. Measures shall be adopted to ensure that seepage from site shall not go on road / public areas.

56.11 The structure dimension of the barricade, material and composition, its colour scheme, Maha Metro Logo and other details shall be in accordance with specification laid down in tender document.

56.12 All surplus earth and debris are removed/disposed off from the working areas to officially designated dumpsites. Trucks carrying sand, earth and any pulverized materials etc. in order to avoid dust or odour impact shall be covered while moving. The tyres of the trucks leaving the site shall be cleaned with water, wherever the possibility of spillage on carriageways meant for regular road traffic exists.

56.13 No parking of trucks/trolleys, cranes and trailers etc. shall be allowed on roads, which may obstruct the traffic movement.

56.14 Roads shall be kept clear and material like: pipes, steel, sand boulders, concrete, chips and brick etc. shall not be allowed on the roads to obstruct free movement of road traffic.

56.15 Proper and safe stacking of material are of paramount importance at yards, stores and such locations where material would be unloaded for future use. The storage shall be well laid out with easy access and material stored/stacked in an orderly and safe manner.

56.16 Flammable chemicals / compressed gas cylinders shall be safely stored.

56.17 Unused/surplus cables, steel items and steel scrap lying scattered at different places within working areas shall be removed to identified locations.

56.18 All wooden scrap, empty wooden cable drums and other combustible packing material, shall be removed from workplace to identified locations.

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

56.20 The contractor shall ensure that all his sub-contractors maintain the site reasonably clean through provision related to housekeeping.

56.21 Debris shall be handled and disposed off in such a manner that it does not create any hazards to the site personnel. Debris shall not be accumulated to form a hazard and should be kept sufficiently moist to bring down the dust level within permissible limit.

56.22 Debris or other material shall not be thrown inside or outside the site premises from any height. The debris or waste material shall be disposed off at regular interval and as soon as the work has been completed.

**57.0 AVOIDANCE OF NUISANCE**

57.1 The Contractor shall take all precautions to avoid any nuisance arising from his operations. This shall be accomplished, wherever possible by suppression of nuisance at source rather than abatement of the nuisance once generated.

57.2 Following site clearing and before construction, the Contractor shall remove all trash, debris and other weeds.

57.3 The Contractor shall ensure that the workplace is free of trash, garbage, debris and weeds.

57.4 Light used for construction can illuminate adjacent areas in undesired ways. Such lighting and glare shall be prevented from striking adjacent areas, where feasible, through directional shielding.

57.5 The other measures include but not limited to:

a) Careful positioning of construction equipment.
b) Eliminating the possibility of stockpiles of material from being visible to public.
c) Strategically placing high visibility site markings at construction sites indicating facilities, offices and stores.
d) Adequate and properly managed parking of vehicles at construction depots and batching plants.

57.6 Measures shall be taken to prevent Mosquito breeding at site. The measures to be taken shall include, but not limited to, the following:

a) Construction run-off shall not be allowed to stagnate at work sites specially at construction depots and batching plant locations, by executing and efficient drainage system and / or levelling of low-lying areas.

b) Empty cans, oil drums, packing and other receptacles which may retain water shall be deposited at a central collection point and shall be removed from site regularly.

c) Still waters shall be treated at least once every week with eco-friendly chemical in order to prevent mosquito breeding; contractor's equipment and other items on the site, which may retain water, shall be stored, covered or treated in such a manner that water could not be retained.

d) All coolers should be scrubbed and cleaned once a week and mopped, dry before refilling and if cannot be emptied, put one tablespoon of temephos / petrol or Authority approved chemicals.

e) Collection of stagnant water should not be allowed inside or around construction sites / office premises/ project sites / parking area/ labour camps and if the same does not take place a little quantity of kerosene/ petrol/ diesel or chemical approved by local authorities may be put in such stagnant wastewater collection.

f) Ensure that over head and other water tanks / containers are kept closed properly with lid and overflow pipe/ air vent are covered with wire mesh.

g) Unused/ broken bottles, plastic cups, pots and tyres etc that can hold water should not be left in open in all contractor's premises.

h) Provision of access to roof tops and over head tanks in all contractor's offices to facilitate checking of mosquito breeding.

## 58.0 ARCHAEOLOGICAL AND HISTORICAL PRESERVATION

58.1 The contractor shall seek to accommodate archaeological and historical preservation concerns that may arise due to the construction of the project especially in close vicinity of such areas where such monuments may be located.

58.2 The contractor shall consult the Archaeological Survey of India (ASI) and other parties, on the advice of the Employer, to identify and assess construction effects and seek ways to avoid, minimize or mitigate adverse effects on such monuments.

58.3 Adverse effects may include reasonably foreseeable effects caused by the construction that may occur later in time, be farther removed in distance or those that alter, howsoever temporarily, the significance of the structure.

58.4 Where the alignment, runs within the prohibited/regulated zone of the monuments, Employer will apply for No Objection Certificate (NOC) from Director of Archaeology Archaeological Survey of India as per provision of National Monuments and Archaeological Sites and Remains (Amendment & Validation Act 2010).

## 59.0 LANDSCAPE AND GREENERY

59.1 As far as is reasonably practicable, the Contractor shall maintain ecological balance by preservation of trees and defacing of natural landscape.

59.2 The Contractor shall, so conduct his construction operations, as to prevent any avoidable destruction, scarring or defacing of natural surroundings in the vicinity of work.

59.3 Where destruction, scarring, damage or defacing may occur as a result of operations relating to Permanent or Temporary works, the same shall be repaired, replanted or otherwise corrected at Contractor's expense. All work areas shall be smoothened and graded in a manner to conform to natural appearance of the landscape as directed by the Employer.

59.4 Contractor shall clear the construction site of all scarp, dust, C&D waste and restore the site as per initial condition at the end of contract.

## 60.0 ENERGY MANAGEMENT

60.1 The Contractor shall use and maintain equipment so as to conserve energy and shall be able to produce demonstrable evidence of the same upon Employer's request.

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

1. Use of energy efficient motors and pumps
2. Use of energy efficient lighting, which uses energy efficient luminaries
3. Adequate and uniform illumination level at construction sites suitable for the task
4. Proper size and length of cables and wires to match the rating of equipment
5. Use of energy efficient air conditioners

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

## 61.0 ENVIRONMENTAL SITE INSPECTION

61.1 Site inspection shall be undertaken by the Contractor's Project Manager along with Environmental team to inspect the construction activities in order to ensure that appropriate environmental protection and pollution control measures are properly followed and implemented. The frequency of site inspection shall be at least once a week.

61.2 The Contractor shall, submit to the Employer a contract specific comprehensive Environment Inspection checklist as requirement of Site Environmental Plan.

61.3 The area of inspection shall not be limited to environmental compliance within the site but areas outside the site which are likely to be affected, directly or indirectly by activities at site.

61.4 Results of inspection shall be discussed with Employer and his recommendations on better environmental protection shall be notified to the Contractor for taking immediate action and rapid resolution of identified non-compliance.

61.5 If any significant environmental problems are identified or if there is an environmental complaint towards any activity performed by contractor, shall be investigated by the Engineer alog with the contractor and report on the same shall be submitted to the employer.

61.6 In addition, the Environment Department of Maha-Metro shall conduct surveillance audit of construction sites, in case of non compliance/violation of environmental conditions, penalties shall be levied in writing.

61.7 The results of monthly environmental inspection shall be discussed in monthly SHE committee meeting.

61.8 Reporting under the Environmental Management plan will contain the adopted mitigation measures for each potential activity and results of monitoring and inspection programmes.

61.9 In Site Environmental Plan, the Contractor shall prepare and submit monthly Environmental Management Reports in accordance with Employer's Requirements.

61.10 The Monthly Environment Management reports shall continue to be submitted till entire duration of contract and its extension.

**62.0 IGBC GREEN MRTS RATING REQUIREMENTS**

62.1 The Contractor shall, submit all the required documents/certificates/photographs to the Employer required for IGBC Green MRTS Rating which is broadly classified under following categories:

A. Site Selection and Planning
B. Water Efficiency
C. Energy Efficiency
D. Material Conservation
E. Indoor Environment and Comfort

62.2 An indicative list of documents required for IGBC green MRTS certification has been provided in the general instruction Maha-Metro/SHE/GI/13

# PART - V: PENALTY AND AWARDS

## 63.0 PENALTIES TO BE CHARGED/RECOVERED FROM THE CONTRACTOR

63.1 Maha-Metro is committed to provide and maintain Occupational Safety & Health in its all-project work activities, and intends to promote its image as a Safety Conscious Organisation. The unsafe conditions/acts at work place may cause accidents with serious injuries or fatalities to workmen and even to public, which will damage the reputation of Maha-Metro and hamper the project. Most of the accidents are avoidable and caused preliminarily due to Contractors' negligence. Hence Maha-Metro shall recover the cost of damages from the Contractors for every reportable incident (fatality / injury).

63.2 The work of metro construction is mostly executed on the right-of-way (movement of civil traffic) and densely populated business/residential areas. These work sites are more sensitive being in contact with public and may lead to serious accidents/damages. Any unsafe act / unsafe condition when observed by public/critics, attracts media adversely and further tarnishing on Maha-Metro's reputation. If such unsafe practices continue, and if not checked, and not penalised, may lead to serious irreversible damages/losses to the organisation. For the strict promotion of Occupational Safety & Health at the site of work and to avoid any safety violation with increased Safety Consciousness. Maha-Metro is empowered to levy penalties on any Safety violation.

63.4 The following table indicates the Safety, Health violation (unsafe act / unsafe condition) and charges/penalties to be recovered from contractors.

| SN | Topic | Unsafe Act/Unsafe condition | Range of Levels | Deductible Amount |
|---|---|---|---|---|
| 1 | SHE Policy & Plan | **i) SHE policy**.<br>a) non-compliance of clause 4.1 | L1→L2 | L1- Rs 5,000 per single violation, compounded to a maximum of Rs 25,000 at any single instance.<br><br>L2- Rs 10,000 per single violation, compounded to a maximum of Rs 50,000 at any single instance. |
| | | **ii) SHE plan** | L1→L2 | L1- Rs 50,000 per single violation, compounded to a maximum of Rs 1,00,000 at any single instance.<br><br>L2- Rs 1,00,000 per single violation, compounded to a maximum of Rs 2,00,000 at any single instance. |
| | | a) Not as per Employers' content and coverage (Clause 4.3,4.6) | | |
| | | b) Delay in submission (Clause 4.3, 4.5) | | |
| | | c) Not updated as per Employer's instruction as per Clause 4.8 | | |
| | | d) Copies not provided to all required supervisors/engineers | | |
| 2 | SHE Organisation | Not complying to the minimum manpower requirements as mentioned in General Instruction Maha-Metro/SHE/GI/001(Clause 6.1.1) | L1→L2 | L1- Rs 50,000 per month for first month and Rs 1,00,000 for subsequent months.<br>L2- Rs 1,50,000 per month for first month and Rs 3,00,000 for subsequent months. |
| | | Not filling up the vacancies created due to SHE personnel leaving the Contractor within 14 days. (Clause 6.7.2) | | L1- Rs 50,000 for first month and Rs 1,00,000 for subsequent months.<br><br>L2- Rs 1,50,000 for first month and Rs 3,00,000 for subsequent months. |

| | | | | |
|---|---|---|---|---|
| | | SHE organisation not provided with required Audiovisual and other equipments as per General Instruction.Maha-Metro /SHE/GI/09 | | L1- Rs 25000 for first violation and Rs 50000 for subsequent violations.<br><br>L2- Rs 75000 for first violation and Rs 150000 for subsequent violations. |
| | | Employing through outsourcing agencies and SHE personal are not in the payroll of the main Contractor. (Clause 6.5.1) | | |
| | | Disobedience / Improper conduct of any SHE personnel. (Clause 6.2) | | |
| | | Chief SHE Manager not reporting directly to CPM of Contractor. (Clause 6.6) | | |
| 3 | SHE committee | Failed to formulate or conduct SHE Committee meeting for any month (Clause 7.4) | L1→L2 | L1- Rs 50000 for the first violation and Rs 200000 for the subsequent violations.<br><br>L2- Rs 250000 for the first violation and Rs 500000 for the subsequent violations. |
| | | Contractor and Sub-contractor representatives not attending SHE Committee meetings (Clause 7.10) | | L1- Rs 5,000 to the contractor of the member who had not attended the meeting for first violation and Rs 25,000 for subsequent violations.<br><br>L2- Rs 10,000 to the contractor of the member who had not attended the meeting for first violation and Rs 50,000 for subsequent violations. |
| | | Failed to conduct Site inspection before conducting SHE Committee meeting (Clause 7.2.1 (xi)) | | L1-Rs 25,000 for first violation and Rs 50,000 for subsequent violations.<br><br>L2-Rs 50,000 for first violation and Rs 1,00,000 for subsequent violations. |
| | | Failed to send SHE Committee Meeting minutes or Agenda to Employer in time (Clause 7.8.1, 7.9.1) | | |
| | | Non-adherence of Clause 7.7.1 | | |
| | | Non-adherence of Clause 7.9 | | |
| 4 | ID card | Non-adherence of Clause 8.1, 8.2 and 8.3 | L1→L2 | L1- Rs 25,000 for first violation and Rs 50,000 for subsequent violations.<br><br>L2- Rs 1,00,000 for first violation and Rs 2,00,000 for subsequent violations. |
| 5 | SHE Training | Not complying to the requirements as mentioned in conditions of contract on SHE and project SHE manual with regard to: | | |
| | | a) Induction training not given (Clause 8.1) | L1→L2 | L1- Rs 50,000 for first violation on and Rs 1,00,000 for subsequent violations. |
| | | b) Supervisor / engineer / manager training not conducted as per Clause 9.6 | | |

| | | | | |
|---|---|---|---|---|
| | | c) Refresher training as per Clause 9.7 and 9.11 not conducted | | L2- Rs 1,00,000 for first violation on and Rs 2,00,000 for subsequent violations. |
| | | d) Tool-box talk not conducted as per Clause 9.8 | | |
| | | e) Skill development training not conducted as Clause 9.9 | | |
| | | f) Daily Safety Oath not conducted as per Clause 9.1 | | |
| | | g) Top management behaviour based SHE training conducted (Clause 9.4) | | |
| 6 | SHE Inspection | i) Not complying to the requirements as mentioned in conditions of contract on SHE and project SHE manual as per Clause 10.0 | L1→L2 | L1- Rs 50000 for first violation on and Rs 100000 for subsequent violations.<br><br>L2- Rs 1,00,000 for first violation on and Rs 2,00,000 for subsequent violations. |
| | | ii) Non-compliance of clause 10.3 & 10.4 | | |
| 7 | SHE audit | **`Internal Audit: MARS** | L1→L2 | |
| | | i) Not conducted as per SHE Plan (Clause 11.2.1) ii) Report not sent to Employer (Clause 11.2.6) iii) Action not taken for any month (Clause 11.2.4) | | L1- Rs 50,000 for first violation on and Rs 75,000 for subsequent violations.<br><br>L2- Rs 1,00,000 for first violation on and Rs 2,00,000 for subsequent violations. |
| | | **External Audit** | | |
| | | i) Not conducted as per SHE Plan (Clause 11.4.3 and 11.5.2.2) | | L1-Rs 1,00,000 for first violation and Rs 2,00,000 for subsequent violations.<br><br>L2-Rs 2,00,000 for first violation and Rs 4,00,000 for subsequent violations. |
| | | ii) Report not sent to Employer (Clause 11.4.7 and 11.5.2.8.1) | | |
| | | iii) Action not taken for any quarter (Clause 11.4.9.4 and 11.5.2.10.4) | | |
| 8 | SHE Communication | Important days to be observed for SHE awareness as furnished by Employer not observed (Clause 12.2) | L1→L2 | L1- Rs 10,000 for first violation and Rs 25,000 for subsequent violations.<br><br>L2- Rs 50,000 for first violation and Rs 1,00,000 for subsequent violations. |
| | | Posters as furnished by Employer not printed and displayed (Clause 12.2) | | L1- 50,000 per contract<br><br>L2- 1,00,000 per contract |

| | | | | |
|---|---|---|---|---|
| 9 | SHE Submittals | Non compliance of Clause 13.1 | L1→L2 | L1- Rs 50,000 for first violation on and Rs 1,00,000 for subsequent violations.<br><br>L2- Rs 1,00,000 for first violation on and Rs 2,00,000 for subsequent violations. |
| | | Non compliance of Clause 13.2 | | L1-Rs 25,000 for first violation and Rs 50,000 for subsequent violations.<br><br>L2-Rs 1,00,000 for first violation and Rs 2,00,000 for subsequent violations. |
| | | Non compliance of Clause 13.3 | | |
| 10 | Injury and Incidence reporting | Fatal accidents | L3 | L3- Rs 5,00,000 penalty and enforcement of embargo for first fatality, and Rs 10,00,000 penalty and enforcement of embargo for every subsequent fatality. |
| | | Injury accident | L2→L3 | L2- Rs 75,000 for first grievously injured person and Rs 1,50,000 for every subsequent grievously injured person (Grievous Injury as defined by Workmen Compensation Act).<br><br>L3- Rs 2,00,000 for first grievously injured person and Rs 4,00,000 for every subsequent grievously injured person |
| | | Abnormal delay in reporting accidents or wilful suppression of information about any accidents / dangerous occurrence as per Clause 14.1.4 | L2→L3 | L2-Rs 75,000 for first violation and Rs 1,50,000 for subsequent violations.<br><br>L3-Rs 2,00,000 for first violation and Rs 4,00,000 for subsequent violations. |
| | | Non-compliance of the Clause 14.4 The contractor shall create a fund to cater, from which in any case of fatal accident or permanent disability, payments will be made to the aggrieved party over and above the statutory requirements. | L2→L3 | L2- Rs 50,000 for first violation on and Rs 1,00,000 for subsequent violations.<br><br>L3- Rs 1,50,000 for first violation on and Rs 3,00,000 for subsequent violations. |

| | | | | |
|---|---|---|---|---|
| | | The contractor shall create a fund to cater, from which in any case of fatal accident or permanent disability, payments will be made to the aggrieved party over and above the statutory requirements. | | |
| 11 | Emergency preparedness Plan | Non-compliance of the Clause 15.1, 15.2, 15.3, 15.4, 15.5 and 15.6 | L2→L3 | L2- Rs 1,00,000 for non-compliance of any of the clauses.<br><br>L3- Rs 2,00,000 for non-compliance of any of the clauses. |
| 12 | Housekeeping | Housekeeping maintenance register not properly maintained up to date (Clause 17.4) | L1→L2 | L1- Rs 10,000 per single violation Compounded to a maximum of Rs 1,00,000 at any single instance.<br><br>L2- Rs 20,000 per single violation Compounded to a maximum of Rs 2,00,000 at any single instance. |
| | | Surrounding areas of drinking water tanks / taps not hygienically cleaned / maintained (Clause 17.4) | | |
| | | Office, stores, toilet / urinals not properly cleaned and maintained. (Clause 17.4) | | |
| | | Required dustbins at appropriate places not provided / not cleaned. (Clause 17.6) | | |
| | | Stairways, gangways, passageways blocked. (Clause 17.9) | | |
| | | Lumber with protruding nails left as such (Clause 17.10) | | |
| | | Openings unprotected (Clause 17.7) | | |
| | | Excavated earth not removed within a reasonable time.(Clause 17.15) | | |
| | | Truck carrying excavated earth not covered / tyres not cleaned. (Clause 17.11) | | |
| | | Vehicles / equipments parked / placed on roads obstructing free flow of traffic (Clause 17.13) | | |
| | | Unused surplus cables / steel scraps lying scattered (Clause 17.17) | | |
| | | Wooden scraps, empty wooden cable drums lying scattered (Clause 17.18) | | |
| | | Water stagnation leading to mosquito breeding (Clause 42.6.1) | | |
| 13 | Working at Height / Ladders and Scaffolds | Not using or anchoring Safety Belt (Clause 18.9) | L2→L3 | L1-Rs 10,000 per single violation Compounded to a maximum of Rs 1,00,000 at any single instance. |
| | | Not using Safety Net (Clause 18.18) | | |

| | | | | |
|---|---|---|---|---|
| | | Absence of life line or anchorage point to anchor safety belt (Clause 18.19) | | L2-Rs 20,000 per single violation Compounded to a maximum of Rs 2,00,000 at any single instance.<br><br>L3-Rs 30,000 per single violation Compounded to a maximum of Rs 3,00,000 at any single instance. |
| | | Non-compliance of Clause 18.17 | | |
| | | Using Bamboo ladders (Clause 18.20) | L1→L2 | |
| | | Painting of ladders | L1→L2 | |
| | | Improper usage (less than 1m extension above landing point, not maintaining 1:4 ratio) (Clause 18.20) | L2→L3 | |
| | | Aluminium ladders without base rubber bush (Clause 18.20) | | |
| | | Usage of broken / week ladders (Clause 18.20) | | |
| | | Usage of re-bar welded ladders (Clause 18.20) | | |
| | | Improper guardrail, toe board, barriers and other means of collective protection (Clause 18.16) | | |
| | | Improper working platform (Clause 18.17) | | |
| | | Working at unprotected fragile surface (Clause 18.9) | | |
| | | Working at unprotected edges (Clause 20.0) | | |
| 14 | Lifting appliances and gear | Non availability of fitness certificate as per Clause 21.3 | L2→L3 | L2-Rs 50,000 per single violation Compounded to a maximum of Rs 2,00,000 at any single instance.<br><br>L3-Rs 1,00,000 per single violation Compounded to a maximum of Rs 5,00,000 at any single instance. |
| | | Documents not displayed on the machine or not available with the operator as per Clause 21.4 | | |
| | | Maximum Safe Working Load not written on the machine as per Clause 21.5 | | |
| | | Non-compliance of Clause 21.6 | | |
| | | Non-compliance of Clause 21.7 | | |
| | | Automatic safe load indicator not provided or not in working condition as per Clause 21.8 | | |
| | | Age of the operator less than 21 years or without any licence and non-compliance of other item as per Clause 21.9 | | |
| | | Non-compliance of Clause 21.10 | | |
| | | Non-compliance of any of the items mentioned regarding rigging requirements as per Clause 21.11 | | |
| | | Failure to submit method statement in case of all critical lifting (Clause 21.3) | | |
| | | Person riding on crane. (Clause 23.4) | | |
| | | Creating more noise and smoke (Clause 43.1.1) | | |
| | | Absence of portable fire extinguisher in driver cabin (Clause 31.5) | | |
| | | Fail to guard hoist platform (Clause 24.0) | | |
| | | No fencing of hoist rope movement area (Clause 24.0) | | |

| | | | | |
|---|---|---|---|---|
| | | Hoist platform not in the horizontal position (Clause 21.2) | | |
| | | Usage of first Generation of Hydra Clause 21.11.11 and 21.11.12 | | |
| 15 | Launching operation | Non-adherence of any of the provisions mentioned in Clause 22.2 | L2→L3 | L2-Rs 50,000 for first violation and Rs 1,00,000 for subsequent violations.<br><br>L3-Rs 1,50,000 for first violation and Rs 3,00,000 for subsequent violations. |
| 16 | Site Electrical safety | Non-compliance of Clause 26.1.1 | L2→L3 | L2-Rs 10,000 per single violation Compounded to a maximum of Rs 1,00,000 at any single instance.<br><br>L3-Rs 20,000 per single violation Compounded to a maximum of Rs 2,00,000 at any single instance |
| | | Non-compliance of Clause 26.2.3, 26.2.4 & 26.2.5 | | |
| | | Non-compliance of Clause 26.3.1 | | |
| | | Non-compliance of Clause 26.7, 26.8 and 26.9.1 | | |
| | | Non-compliance of Clause 26.10 and 26.13 | | |
| | | Non-compliance of Clause 28.3.2 | | |
| | | Exposed electric lines (fermentative damage) and circuits in the workplace. (Clause 26.5.1) | | |
| | | Inserting of wires directly into the socket | | |
| | | Improper grounding for the electrical appliances Clause 26.7.1) | | |
| | | Electrical cables running on the ground (clause 26.8.5 & 26.8.6) | | |
| | | Non-compliance Clause 27.0 | | |
| 17 | Hand tools and Power tools | Non-compliance of Clause 28.0 | L2→L3 | L2-Rs 10,000 per single violation Compounded to a maximum of Rs 50,000 at any single instance.<br><br>L3-Rs 20,000 per single violation Compounded to a maximum of Rs 1,00,000 at any single instance. |
| 18 | Gas Cutting | Wrong colour coding of cylinder. | L2→L3 | L2-Rs 10,000 per single violation Compounded to a maximum of Rs 50,000 at any single instance.<br><br>L3-Rs 20,000 per single violation Compounded to a maximum of Rs 1,00,000 at any single instance. |
| | | Cylinders not stored in upright position. (Clause 29.1) Flash back arrester, non-return valve and regulator not present or not in working condition. (Clause 29.3 & 29.4) | | |
| | | Fail to put cylinders in a cylinder trolley. (Clause 29.1) | | |

| | | | | |
|---|---|---|---|---|
| | | Damaged hose and fail to use hose clamps (Clause 29.2) | | |
| | | Using domestic LPG cylinders (Clause 29.5) | | |
| | | Fail to store cylinder 6.6m away from fire prone materials (Clause 29.8) | | |
| | | Fire extinguisher not placed in the vicinity during operation (Clause 29.6) | | |
| 19 | Welding | Voltmeter and Ammeter not working (Clause 29.9) | L2→L3 | L2-Rs 10,000 per first violation and Rs 50,000 for subsequent violations.<br><br>L3-Rs 75,000 per first violation and Rs 1,50,000 for subsequent violations. |
| | | Non-availability of separate switch in the transformer (Clause 29.9) | | |
| | | Improper grounding and return path. (Clause 29.10) | | |
| | | Damaged and bare openings in the welding cable. (Clause 29.10) | | |
| | | Damaged holder (Clause 29.10) | | |
| | | Fire extinguisher not placed in the vicinity during operation (Clause 29.6) | | |
| 20 | Fire precaution | Smoking and open flames in fire prone area (Clause 31.6) | L2→L3 | L2-Rs 5,000 per single violation Compounded to a maximum of Rs 25,000 at any single instance.<br><br>L3-Rs 10,000 per single violation Compounded to a maximum of Rs 1,00,000 at any single instance. |
| | | Using more than 24V portable electrical appliances in the fire prone area (Clause 34.2.3) | | |
| | | Not proper ventilation in cylinder storage area. (Clause 29.8) | | |
| | | Absence of fire extinguishers (Clause 31.1) | | |
| | | Fire extinguishers not refilled once in a year. (Clause 31.2) | | |
| | | Fire extinguisher placed in a not easily accessible location | | |
| 21 | Excavation, Tunnelling and confined space | Non-compliance of Clause 34.1.1 | L2→L3 | L2-Rs 10,000 per single violation Compounded to a maximum of Rs 50,000 at any single instance.<br><br>L3-Rs 20,000 per single violation Compounded to a maximum of Rs 1,00,000 at any single instance. |
| | | Non-compliance of Clause 34.2.3 | | |
| | | Non-compliance of Clause 34.4 | | L2-Rs 10,000 per first violation and Rs 50,000 for subsequent violations.<br><br>L3-Rs 75,000 per first violation and Rs 1,50,000 for subsequent violations. |
| 22 | Work permit system | Non-compliance of Clause 35.2 | L2→L3 | L2- Rs 50,000 per first violation and Rs 1,00,000 for subsequent violations.<br><br>L3- Rs 1,00,000 per first violation and Rs 2,00,000 for subsequent violations. |
| | | Non-compliance of Clause 21.11.9 | | |
| 23 | Traffic Management | Non-compliance of Clause 36.4.1 | L2→L3 | |

| | | | | |
|---|---|---|---|---|
| | | Non-compliance of Clause 36.8.3 | | L2-Rs 50,000 per first violation and Rs 1,00,000 for subsequent violations.<br><br>L3-Rs 1,50,000 per first violation and Rs 3,00,000 for subsequent violations. |
| | | Non-compliance of Clause 36.9.2 | | |
| | | Non-compliance of Clause 36.9.3 | | |
| | | Non-compliance of Clause 36.9.7 | | |
| | | Non-compliance of Clause 36.9.8 | | |
| | | **Barricades (Clause 36.9.4)** | | |
| | | Not Cleaned | L2 | Rs 15,000 per single violation Compounded to a maximum of Rs 25,000 at any single instance |
| | | Not in alignment | | |
| | | Not numbered | | |
| | | Not painted | | |
| | | Red ights /reflectros not working | | |
| | | Damages not repaired | | |
| | | Not secured properly | | |
| | | Barricade inspector not employed | | |
| | | Protruding parts / portions repaired | | |
| | | Barricades maintaining register not properly maintained up to date | | |
| | | | | |
| | | **Contractor Vehicles (Clause 36.9.5 & 36.9.6)** | | |
| | | i) Over loading of vehicles<br>ii) Unfit drivers or operators<br>iii) Unlicensed vehicles<br>iv) Absence of traffic marshals<br>v) Absence of reversing alarm<br>vi) Absence of fog light (at winter)<br>vii) Power / hand brakes not in working condition. | L2 | Rs 15,000 per single violation Compounded to a maximum of Rs 1,00,000 at any single instance |
| | | | | |
| | | **Splashing of Bentonite on roads / non-cleaning of tyres of dumpers and transit mixers (Clause 17.11 & 17.14)** | | |
| | | i) Mishandling of bentonite like splashing of bentonite outside specified width of barricading.<br>ii) Non-cleaning of tyres of dumpers and transit mixers before leaving the site and thereby creating a traffic safety hazard to road users. | L2 | a) Rs 50,000 on first observation.<br>b) Rs 1,00,000 on second observation c) Rs 2,00,000 on third and subsequent observations |
| 24 | Batching plant / Casting yard | Non-adherence of any of the provisions mentioned in Clause 38.0. | L2 | Rs 10000 for single violation compounded to a maximum of Rs 1,00,000 at any single instant. |
| 25 | PPE (Personal Protective Equipment) | Not having (Clause 39.1) | L2→L3 | L2-Rs 200 per single violation.<br><br>L3-Rs 400 per single violation. |
| | | Not wearing (or) using and kept it elsewhere (Clause 39.1) | L2→L3 | |
| | | Using damaged one (Clause 39.2) | L2→L3 | |

| | | | | |
|---|---|---|---|---|
| | | Using wrong type (Clause 39.5) | L2→L3 | |
| | | Using wrong colour helmet or helmet without logo (Clause 39.4.1) | L1→L2 | |
| | | Using for other operation (e.g. Using safety helmet for storing materials or carrying water from one place to other) (Clause 39.5) | L2→L3 | |
| | | Not conforming to BIS standard (Clause 39.2) | L2→L3 | L2-Rs 10,000 for first violation and Rs 40,000 for subsequent violations.<br><br>L3-Rs 75,000 for first violation and Rs 1,50,000 for subsequent violations. |
| | | Non-compliance of Clause 39.6, 39.7 and 39.8 | L2→L3 | L2-Rs 10,000 for first violation and Rs 40,000 for subsequent violations.<br><br>L3-Rs 75,000 for first violation and Rs 1,50,000 for subsequent violations. |
| 26 | Occupational Health | Fail to conduct Medical examination to workers (Clause 42.1) | L1→L2 | L1-Rs 5,000 per single violation Compounded to a maximum of Rs 50,000 at any single instance.<br><br>L2-Rs 10,000 per single violation Compounded to a maximum of Rs 1,00,000 at any single instance.<br><br>L3-Rs 15,000 per single violation Compounded to a maximum of Rs 1,50,000 at any single instance. |
| | | Absence of ambulance van & room (Clause 42.3) | | |
| | | Workers not having ID card (Clause 8.2) | | |
| | | Absence of first-aid person in work site (Clause 42.4) | L2→L3 | |
| | | Absence or inadequacy of first-aid box (Clause 42.4) | | |
| | | Misuse of first-aid box (Clause 42.4) | L1→L2 | |
| | | First-aid box not satisfy the minimum Indian standard. (Clause 42.4) | | |
| | | Smoking inside the construction site (Clause 42.7.2) | | |
| | | Drink and drive or work (Clause 42.7.1) | | |
| | | Fumigation / insecticides not sprayed to prevent Mosquito breeding (Clause 42.6.3) | | |
| | | Non-compliance of Clause 44.1 and 44.2 | | |
| 27 | Labour Welfare measures | Inadequate number of toilets (Clause 46.1.1) | L1→L2 | L1-Rs 10,000 per single violation Compounded to a maximum of Rs 50,000 at any single instance.<br><br>L2-Rs 20,000 per single violation Compounded to a maximum of Rs 1,00,000 at any single instance. |
| | | Toilets not cleaned properly (Clause 46.1.3) | | |
| | | Toilet placed more than 500m from the work site (Clause 46.1.3) | | |
| | | Absence of water facilities for toilets and washing places (Clause 46.1.3) | | |
| | | Accommodation not provided as per BOCWA (Clause 46.5.1) ) | | |
| | | Absence of drinking water (Clause 46.4) | | |
| | | Excessive noise and vibration (Clause 43.0) | | |
| | | Canteen not provided (Clause 46.2) | | |
| | | Food stuff not served on no loss no profit basis (Clause 46.3) | | |

| | | | | |
|---|---|---|---|---|
| | | Creche not provided (Clause 46.6) | | |
| | | Non adherence of Labour welfare provisions of BOCWA (Clause 3.3.1.2) | | |
| | | Fail to register establishment and display the registration certificate at workplace (Clause 3.3.1.2) | | |
| | | Absence of workers register and records (Clause 3.3.1.2) | | |
| | | Absence of muster roll and wages register (Clause 3.3.1.2) | | |
| | | Fail to display an abstract of BOCWA and BOCWR (Clause 3.3.1.2) | | |

63.5 Without limiting to the unsafe acts and or conditions mentioned above in Clause 63.4 the Employer 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 Clause 63.4.

63.6 Non-conformities detected during inspections carried out by the Engineer are subject to a process adapted to the severity of the situation. Non-conformities are divided into 4 categories as follows:

63.6.1 Notification of observation of minor non-conformities. The non-conformity results in a notification to the on-site Contractor's representative, followed-up by a signed notification of observation prepared by the Engineer. The multiplication of notifications of observation at the Worksite, or absence of corrective actions by the Contractor, can result in the severity of the non-conformity being raised to that of level 1.

63.6.2 **Level 1 non conformity**: non-conformities, that do not represent a serious immediate risk for health and environment. The non-conformity is the subject of a report addressed to the Contractor and which shall be resolved within five (5) days. The Contractor addresses to the Engineer a report explaining how the non-conformity has been corrected. Further to an inspection and a favourable evaluation of effectiveness of the corrective action, the Engineer signs a close-out report for the non-conformity. In all cases where a non-conformity of level 1 is not resolved within one (1) month, the severity of the non-conformity is raised to level 2.

63.6.3 **Level 2 non-conformities**: Applies to all non-conformities that have resulted in damage to health or the environment or which represent a high risk to health and the environment. The same procedure as for level 1 non-conformities is applied. Corrective action shall be taken by the Contractor within three (3) days. The Contractor addresses a report explaining the corrective actions implemented. All level 2 non-conformities which are not resolved within one (1) month, are raised to level 3.

63.6.4 **Level 3 non-conformities**: applies to all non-conformities that represent a risk with major consequences to health and the environment. The highest levels of the Contractor's and Engineer's hierarchies present in the Employer's country are informed immediately and the Contractor has twenty-four (24) hours to bring the situation under control. Clause 14.7 of the Particular Conditions of Contract (PC), a level 3 non-conformity results in the suspension of interim payments until the non-conformity has been resolved. If the situation requires, and in pursuance to Clause 8.8 of the PC, the Engineer can order the suspension of work until the resolution of the non-conformity.

**63.7 Environmental Penalties:** Following penalties shall be recovered from contractors while dealing the Environmental Protection aspects/Management measures.

| SL. No. | Topic | Violation | Deductible Amount |
|---|---|---|---|
| 1. | Contractor's Environment Organization | Not engaging Environmental personnel for the entire duration of contract and its extension | Rs. 2,00,000/- for first month and Rs. 4, 00,000/- for subsequent months |

| | | | |
|---|---|---|---|
| 2. | ISO Certification | Not obtaining ISO 14001:2015 & ISO 45001:2018 certification within the stipulated time frame with the Maha-Metro approved agency | Rs. 1,00,000/- per single violation and Rs. 2,00,000 for subsequent violations. |
| 3. | External Environmental Audit | Not carrying out External Environmental Audit with the Maha-Metro approved agency | Rs. 1,00,000/-for first violation and Rs. 2,00,000/- subsequent violation |
| 4. | Environmental Training | Not carrying out Environmental Training with the Maha-Metro approved agency | Rs. 50,000/- for first violation and Rs. 1,00,000/- subsequent violation |
| 5. | Legal Requirements | Noncompliance of statutory requirements (CTE,CTO,Factory Act,CGWA Permission etc.) | Rs. 2,00,000/-for first violation and Rs. 4,00,000/- subsequent violation or as per regulatory Authority. |
| 6. | Environmental Sanitation | 1. Environment Sanitation maintenance register not properly maintained up to date<br>2. Surrounding areas of drinking water tanks/ taps not hygienically cleaned / maintained<br>3. Office, stores, toilet/ urinals not properly cleaned and maintained<br>4. Required dustbins at appropriate places not provided / not cleaned<br>5. Water stagnation leading to mosquito breeding<br>6. Not practicing any other Environmental Sanitation measures mentioned in this document | Rs. 50,000/- for violation of any single item compounded to a maximum of Rs. 1,00,000/- at any single instance |
| 7. | Felling of Trees & Tree Preservation | Felling of trees without obtaining requisite permission from Maha Metro /Statutory Authority | Rs. 1,00,000/- on single violation for item a) |
| 8. | Top Soil Preservation | Top soil preservation not practiced | Rs. 25,000/- on each violation/ per instance |
| 9. | Containment of Air Pollution | 1. Wheel washing facility not provided at exit gates of casting yard, batching plant and underground station sites<br>2. Soil, sand, aggregate, debris of any kind and all dust prone materials stored without proper tarpaulin coverage<br>3. Sprinkling or mist-based dust suppression methods not practiced at site<br>4. Casting yard and batching plant not provided with hard surface and access roads and internal circulation roads not maintained properly<br>5. Not maintaining required DG Stack height as prescribed in the standard<br>6. Conveyor belt used for carrying aggregate not covered<br>7. Carrying out construction work without erecting proper barricades<br>8. Storage facility for dust generating materials/debris not provided<br>9. Storing material/debris/soil outside barricaded area<br>10. Storing aggregates and sand in open area | Rs. 50,000/- on single violation compounded to a maximum of Rs. 2,00,000/- at any single instance |

| | | | |
|---|---|---|---|
| | | 11. Over speeding of construction vehicles<br>12. Operating vehicles, machineries and other equipments without valid PUC<br>13. Truck carrying Material/ muck/ soil/ C&D waste (debris) not covered / tyre not cleaned/washed while leaving site<br>14. Deposition of material/muck/soil on public streets<br>15. Dumping sites not barricaded<br>16. Toe dust along the barricade not cleaned regularly<br>17. Not practicing any other Air Pollution & dust control measures mentioned in this document | |
| 10. | Containment of Water Pollution and Conservation of Water | 1. Transit Mixer (TM) washing facility not provided at casting yard/batching plant<br>2. Drainage system not maintained at casting yard or and batching plant<br>3. Not providing treatment facility before discharge of muck slurry into drainage system<br>4. Washout of construction or excavated materials directly diverted to drainage system<br>5. Spillage or dumping of Bentonite slurry/Poly-mud slurry or other grouts onto public road or any other ecologically sensitive location<br>6. Discharge water from the site without the approval of the Employer<br>7. Discharge of de-watered water from underground construction work to drains without prior approval of the Employer<br>8. Not practicing any other Water Pollution control measures mentioned in this document. | Rs. 5 0 ,000/- for violation of any single item compounded to a maximum of Rs. 2,00,000/- at any single instance |
| 11. | Containment of Noise | 1. Not providing noise barrier of required height near noise sensitive receptors such as residences, schools, hospitals and similar areas<br>2. Not providing acoustic enclosure or acoustic treatment for DG sets for meeting the ambient noise standards<br>3. Breaching allowable noise limits given in this document<br>4. Not adhering to noise limits for DG sets<br>5. Not providing PPE to workers against occupational noise | Rs. 5 0 ,000/- for violation of any single item from a) to b) compounded to a maximum of Rs. 2,00,000/- at any single instance |
| 12. | Containment of Waste | 1. Waste Management Plan not submitted along with Environment Plan<br>2. Leakage of waste during handling, storage and transportation of waste causing pollution | Rs. 5 0 ,000/- for violation of any single item from a) to n) compounded to a maximum of Rs. 2,00,000/- at any single instance |

| | | | |
|---|---|---|---|
| | | 3. Material Safety Data Sheet for material/ chemicals/ substances used not provided<br>4. Not following waste disposal mechanism in accordance with this document<br>5. Discharging of Bentonite slurry/Poly- mud slurry or other grouts drainage directly in to drainage system<br>6. Delay in disposal of waste items<br>7. Burning of refuse at construction site<br>8. Required number of colour coded dust bins not provided<br>9. Not disposing C&D waste by authorized means<br>10. Disposal of C&D waste along the river bed, natural drainage and wet land<br>11. Separate hazardous waste storage area not provided<br>12. Drip pans of suitable size not provided<br>13. Not maintaining separate scrap yard with hard surface<br>14. Not practicing any other waste management measures mentioned in this document. | |
| 13. | Environmental Monitoring | 1. Air monitoring not implemented as per requirement given in this document<br>2. DG set stack monitoring is not implemented as per requirement given in this document<br>3. Noise monitoring not implemented as per requirement given in this document<br>4. Soil testing not implemented as per requirement given in this document<br>5. Groundwater testing not implemented as per requirement given in this document<br>6. Carrying out monitoring through un- approved laboratories<br>7. Not keeping records of monitoring<br>8. Not maintaining check on the quality of monitoring agency while carrying out monitoring work at site<br>9. Not verifying the correctness of monitoring data submitted by monitoring lab<br>10. Not ensuring calibration of air monitoring instruments used by monitoring agency<br>11. Not ensuring calibration of noise monitoring instrument used by monitoring agency | Rs. 5 0 ,000/- for violation of any single item compounded to a maximum of Rs. 2,00,000/- at any single instance |
| 14. | Green Building Requirements | 1. Green Building measures not implemented as per requirement given in Green Mass Rapid Transit System (MRTS) Rating (latest revision). | Rs. 1 , 0 0 ,000/- for violation of any single item compounded to a maximum of Rs. 2,00,000/- at any single instance. |

| | | | |
|---|---|---|---|
| | | 2. Non-Submission of required documents under Green Mass Rapid Transit System (MRTS) Rating.<br>3. Not practicing any other Green Building requirements mentioned in this document | |

63.8 Without limiting to the environmental management measures mentioned above in Clause 63.7 the Employer shall have the right to deduct charges for any other Environmental management noncompliance 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 Clause 63.4.

## 64.0 STOPPAGE OF WORK

64.1 The Employer shall have the right to stop the work at his sole discretion, if in his opinion the work is being carried out in such a way that it may cause accidents and endanger the safety of the persons and / or property, and / or equipments. In such cases, the Contractor shall be informed in writing about the nature of hazards and possible injury / accident.

64.2 The Contractor shall not proceed with the work until he has complied with each direction to the satisfaction of Employer.

64.3 The Contractor shall not be entitled for any damages / compensation for stoppage of work, due to safety reasons and the period of such stoppage 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.

## 65.0 OCCUPATIONAL HEALTH AND SAFETY AWARDS

65.1 The following categories will be considered for awards as per the scheme in practice of Employer:

(i) For every safe million-man hour working without any reportable incidents
(ii) Zero fatality contracts
(iii) 100% adherence to voluntary reporting of all accidents throughout the currency of contract
(iv) Safest project team of the year.
(v) Best SHE team of the year.
(vi) Safest Contractor of the year.

## 66.0 ENVIRONMENTAL AWARDS

66.1 The following categories will be considered for awards as per the scheme in practice of Employer

(i) Best Environmentally managed Underground contract
(ii) Best Environmentally managed Elevated contract
(iii) Best Environmentally managed Batching plant
(iv) Best Environmentally managed Casting yard
(v) Best Condition of Contract compliant contractor

66.2 The above categories may increase or decrease at the sole discretion of the employer.

# PART - VI: APPENDIX, FORMS AND GENERAL INSTRUCTION

| | |
|---|---|
| | **MAHARASHTRA METRO RAIL CORPORATION LIMITED** |
| **Appendix No.1: MoU between Maha-Metro and the Contractor for safe execution of contract work** | |

This Memorandum of Understanding is made and executed by and between **Maharashtra Metro Rail Corporation Limited (Maha-Metro).**, a Company registered under the Companies Act 1956 and having its registered office at XXXXor their authorized representative(s), hereinafter referred to as "**EMPLOYER**" (which expression shall wherever the context so requires or admits be deemed to mean and include its successors in business yhs and assigns) of the one party

AND

M/s _____ having its registered office ` _____
hereinafter referred to as the "**CONTRACTOR**" (which expression shall wherever the context so requires or admits be deemed to mean and include its successors in business and assigns) of the other party

WITNESSETH THAT

WHEREAS the EMPLOYER gives highest importance to the occupational safety, health and environment during execution of work, seeks cooperation from the CONTRACTOR in this endeavour.

Thus, this Memorandum of Understanding is for promoting the safety, health and environment aspects required to be followed at workplace/site and will be applicable to any site job to be done by the CONTRACTOR

AND

WHEREAS the CONTRACTOR has read all the terms and conditions of the EMPLOYER and whereas the CONTRACTOR has studied the following documents:

(i) Tender Documents, including Notice Inviting Tender, General Conditions, Special Conditions;
(ii) Conditions of Contract on Safety, Health and Environment and Project Safety, Health, and Environment Manual;
(iii) Building and Other Construction Workers (Regulations of Employment and Conditions of Service) Act 1996, Central Rules 1998 and subsequent MaharashtraBOCW Rules 2003, Building and Other Construction Workers Welfare Cess Act 1996 and Rules 1998 and notification [Central & State] Collection of cesses.
(iv) Indian Electricity Act 2003 and Rules 1956;
(v) Corresponding International / Bureau of Indian Standard Codes.

Including the amendments to any of the above rules and any other rules & regulations or procedures, circulars, notices & advices laid down by the EMPLOYER from time to time.

Now it is hereby AGREED AND DECLARED by and between the EMPLOYER and the CONTRACTOR as follows:

Clause - I The CONTRACTOR shall abide by the terms and conditions stipulated in Condition of Contract on Safety, Health & Environment and Project Safety, Health & Environment Manual.

Clause - II The CONTRACTOR shall undertake full responsibility for safe execution of job at work place/site and safety of his personnel and adjoining road users during work.

| | |
|---|---|
| Clause - III | Without giving any prior notice, the EMPLOYER shall from time to time be entitled to add/or amend any or all terms and conditions with a view to improving safety and occupational health of personnel and safety of work, with immediate effect and the same shall be binding on the CONTRACTOR. The Contractor agrees to implement all such amendments, which shall be laid down by the EMPLOYER. |
| Clause - IV | Besides following the guidelines, safety rules and regulations, safety codes given in various safety procedures/documents mentioned above, the CONTRACTOR shall also prepare detailed method statement which includes job safety analysis wherever there are complicated and hazardous/high risk working involved and get it approved from Employer before execution of work. |
| Clause - V | Any negligence or violation in implementing any of the provision of the conditions of contract on Safety, Health & Environment and Maha-Metro project Safety, Health & Environment Manual shall be viewed seriously and the Contractor is liable to compensate the Employer for the loss of reputation. The cost of damage shall be fixed on case-to-case basis. |

In witness thereof the Parties hereto by representatives duly authorised have executed this Memorandum of Understanding on _____ day of _____ 20____.

| | |
|---|---|
| Signed on | Signed on |
| For and on behalf of Maha-Metro | For and on behalf of (Contractor) |
| _____ | _____ |
| Signature: | Signature: |
| Name: | Name: |
| Title: | Title: |

| | |
|---|---|
| | **MAHARASHTRA METRO RAIL CORPORATION LIMITED** |

**Appendix no.: 2: OHS and Welfare requirements as per BOCW Act 1996 and Rules 1998**

(This list has been prepared in chronological order with primary importance to Section of Act and secondary importance to Rules)

S - Refers relevant Sections in BOCWA
R - Refers relevant Rules in BOCWR
C - Refers relevant Chapter No. in BOCWR
P - Refers to relevant rules in BOCWWCR 1998
G - Refers to relevant rules in Maharashtra BOCWR 2003

| SN | Items | Relevant Sections / Rules in BOCWA and BOCWR and MBOCWR 2003 |
|---|---|---|
| 1. | Registration of establishment | S – 7,<br>R – 23 to 27 |
| 2. | Display of registration certification at workplace | R – 26 (5) |
| 3. | Hours of work | S – 28<br>R – 234 to 237 |
| 4. | Register of overtime | S – 28; S – 29<br>R – 241(1) Form XXII |
| 5. | Weekly rest and payment at rest | R – 235 |
| 6. | Night shift | R – 236 |
| 7. | Maintenance of workers registers and records | S – 30<br>R – 238 |
| 8. | Notice of commencement and completion | S – 46<br>R – 239 |
| 9. | Register of persons employed as building workers | R – 240 |
| 10. | Muster roll and wages register | R – 241(1) (a); Form XVI and XVII |
| 11. | Payment of wages | R – 248 |
| 12. | Display of notice of wages regarding | R – 249 |
| 13. | Register of damage or loss | R – 241(1)(a); Form XIX, XX, XXI |
| 14. | Issue of wages book | R – 241(2)(a); Form XXIII |
| 15. | Service certificate for each workers | R – 241(2)(b); Form XXIV |
| 16. | Display an abstract of BOCWA and BOCWR | R – 241(5) |
| 17. | Deduction of welfare cess by the government agencies | P – 4(3) |
| 18. | Annual return | R – 242; Form XXV |
| 19. | Drinking water | S – 32 |
| 20. | Latrines and Urinals | S – 33<br>R – 243 |
| 21. | Accommodation | S – 34 |
| 22. | Creches | S – 35 |
| 23. | First-aid boxes | S – 36<br>R – 231 and Schedule III |
| 24. | Canteens | S – 37<br>R – 244 |
| 25. | Food stuff and other items served in the canteens | R – 245 |
| 26. | Supply of tea and snacks in work place | R – 246 |
| 27. | Food charges on no loss no profit basis | R – 247 |
| 28. | BOCWR 2003 welfare Board Rules | |
| 29. | Safety committee | S – 38<br>R – 208 |

| SN | Items | Relevant Sections / Rules in BOCWA and BOCWR and MBOCWR 2003 |
|---|---|---|
| 30. | Safety officer | S – 38<br>R – 209 and Schedule VII |
| 31. | Reporting of accidents and dangerous occurrences | S – 39<br>R – 210 |
| 32. | Procedure for inquiry in to the causes of accidents | R – 211 |
| 33. | Responsibility of employer | S - 44<br>R – 5 |
| 34. | Responsibility of Architects, Project engineer and Designers | R – 6 |
| 35. | Responsibility of workmen | R – 8 |
| 36. | Responsibility for payment of wages and compensation | S – 45 |
| 37. | Penalties and Procedures | S – 47; S – 55 |
| 38. | Excessive noise, vibration etc | R – 34 |
| 39. | Fire Protection | R – 35 |
| 40. | Emergency action plan | R – 36 |
| 41. | Fencing of motors | R – 37 |
| 42. | Lifting of carrying of excessive weight | R – 38 |
| 43. | Health, Safety and Environmental Policy | R – 39 |
| 44. | Dangerous and Harmful Environment | R – 40 |
| 45. | Overhead protection | R – 41 |
| 46. | Slipping, Tripping, Cutting, Drowning and Falling Hazards | R – 42 |
| 47. | Dust, Gases, Fumes, etc | R – 43 |
| 48. | Corrosive substance | R – 49 |
| 49. | Eye Protection | R – 45 |
| 50. | Head Protection and other protection apparel | R – 46; R – 54 |
| 51. | Electrical Hazards | R – 47 |
| 52. | Vehicular traffic | R – 48 |
| 53. | Stability of structure | R – 49 |
| 54. | Illumination | R – 50; R – 124 |
| 55. | Stacking of materials | R – 51 |
| 56. | Disposal of debris | R – 52 |
| 57. | Numbering and marking of floors | R – 53 |
| 58. | Lifting appliances and gears | C – VII; R – 55 to 81 |
| 59. | Runways and Ramps | C – VIII; R – 82 to 85 |
| 60. | Working on or adjacent to water | C – IX; R – 86 & 87 |
| 61. | Transport and earthmoving equipments | C – X; R – 88 to 95 |
| 62. | Concrete work | C – XI; R – 96 to 107 |
| 63. | Demolition | C – XII; R – 108 to 118 |
| 64. | Excavation and Tunnelling works | C – XIII; R – 119 to 168 |
| 65. | Ventilation | R – 153 |
| 66. | Construction, repair and maintenance of step roof | C – XIV; R – 169 to 171 |
| 67. | Ladders and Step ladders | C – XV; R – 172 to 174 |
| 68. | Catch platform and hoardings, chutes, safety belts and nets | C – XVI; R – 175 to 180 |
| 69. | Structural frame and formworks | C – XVII; R – 181 to 185 |
| 70. | Stacking and unstacking | C – XVIII; R – 186 & 187 |
| 71. | Scaffold | C – XIX; R – 188 to 205 |
| 72. | Cofferdams and Caissons | C – XX; R – 206 to 211 |
| 73. | Explosives | C – XXI; R – 212 & 213 |
| 74. | Piling | C – XXII; R – 214 to 222 |
| 75. | Medical Examination for building and other construction worker, Crane operator an Transport vehicle drivers | R – 81; R – 223(a)(iii) and Schedule XII |

| SN | Items | Relevant Sections / Rules in BOCWA and BOCWR and MBOCWR 2003 |
|---|---|---|
| 76. | Medical examination for occupational health hazards | R – 223(a)(iv) |
| 77. | Charging of workers for Medical Examination | R – 223(b) |
| 78. | Occupational health centres and medical officers | R – 225 and Schedule X &XI |
| 79. | Ambulance van & room | R – 226 & 227 and Schedule IV & V |
| 80. | Stretchers | R – 228 |
| 81. | Occupational health service for building workers | R – 229 |
| 82. | Medical examination for occupational health hazards | R – 223(a)(iv) |
| 83. | Emergency care services and emergency treatment | R – 232 |
| 84. | Panel of experts and agencies | Central Rule 250 |
| 85. | Power of inspectors | Central rule 251<br>MaharashtraState Rules |

| | |
|---|---|
| | **MAHARASHTRA METRO RAIL CORPORATION LIMITED** |
| **Appendix no. : 3 Site Safety,Health and Environmental Plan** | |

| | |
|---|---|
| **Contract No** | |
| **Contractor Name** | |
| **Project Name** | |

| | |
|---|---|
| 1. | **Project Highlights**<br><br>i) Title of the content<br>ii) Contractor Number<br>iii) Brief scope of work<br>iv) Location map/ key plan<br>v) Period of the project |
| 2. | **SHE Policy** |
| 3. | **Site Organisation Chart**<br><br>Chart indicating reporting of SHE personnel |
| 4. | **Roles & Responsibility**<br><br>Individual responsibility of the:<br><br>i) Project Manager<br>ii) Construction Manager<br>iii) Construction Supervisors<br>iv) SHE Committee Members<br>v) SHE In charge<br>vi) Environmental Manager<br>vii) Site Engineers<br>viii) First Line Supervisors<br>ix) Sub-contractors |
| 5. | **SHE Committee**<br><br>i) Details - Chairman, Members, Secretary and Employer's representative<br>ii) Procedures for effective conduct of meeting |
| 6. | **SHE Training** |
| 7. | **Subcontractor Evaluation, Selection and Control** |
| 8. | **SHE Inspection** |
| 9. | **SHE Audit** |
| 10. | **Accident Investigation and Reporting Procedures** |
| 11. | **Occupational Health Measures** |
| 12. | **Labour Welfare Measures** |
| 13. | **Risk assessment and mitigation procedures** |

| | |
|---|---|
| 14. | **Safe Work Procedures**<br><br>i) Work at Height<br>ii) Structural Steel Erection<br>iii) Launching of segments<br>iv) Floor, Wall Openings and Stairways<br>v) Welding, Cutting and Bracing<br>vi) Lifting appliances<br>vii) Work Permit Systems<br>viii) Electrical Equipments<br>ix) Mechanical Equipments<br>x) Excavation<br>xi) Fire Prevention<br>xii) Hazardous Chemicals and Solvents<br>xiii) Ionising Radiation<br>xiv) Lighting<br>xv) Abrasive Blasting |
| 15. | **Work Permit System** |
| 16. | **List of standard job specific PPEs to be used in the site** |
| 17. | **Maintenance of Regime for construction Equipment and Machinery** |
| 18. | **Traffic management** |
| 19. | **Housekeeping** |
| 20. | **Environmental Management** |
| 21. | **Emergency Management** |
| 22. | **Visitors and Security arrangement** |

| | |
|---|---|
| | **MAHARASHTRA METRO RAIL CORPORATION LIMITED** |

**Appendix No.4: Workplace Policy on HIV Prevention & Control for Workmen**

"Being mobile in and of itself is not a risk factor for HIV infection. It is the situations encountered and the behaviours possibly engaged in during mobility or migration that increase vulnerability and risk regarding HIV / AIDS."

*UNAIDS, Technical update on 'Population, Mobility and AIDS', February 2001, p.5*

Maha-Metro recognizes HIV / AIDS as a developmental challenge and realizes the need to respond to it by implementing regular HIV / AIDS prevention programmes and creating a non-discriminatory work environment for HIV infected workmen engaged by contractors. For the purpose of making conscientious, sensitive and compassionate decision in addressing the realities of HIV / AIDS, Maha-Metro has established these guidelines based on ILO code of practice on HIV / AIDS.

- Creating awareness through professional agency using IEC (Information, Education and Communication) package specially designed for migrant workers.
- Institutional capacity building by training the project implementation team, Safety, Health & Environment (SHE) Managers, establishing linkages for efficient diagnosis and treatment of the affected workers, effective monitoring of implementation and documentation for further learning.
- Establishing peer educators by selecting them in consultation with Contractors and training them through professional agencies so that they become focal point for any information, education and awareness campaigns among the workmen throughout the contract period.
- Promotion of social marketing of condoms through State Aids Control Society

**MAHARASHTRA METRO RAIL CORPORATION LIMITED**

**General Instruction: Maha-Metro/SHE/GI/001: Minimum Manpower Requirements of SHE Org.**

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Awarded Contract value (in Rs Cr.)** | **Chief SHE Manager** | **Senior SHE Manager** | **Junior SHE Manager** | **Safety Steward** | **Senior SHE (Electrical Engineer)** | **Junior SHE (Electrical Engineer)** | **Senior SHE (Fire) Manager** | **Occupational Health officer** with Necessary Male Nursing Assistants | **Senior Environmental Manager** | **Senior SHE (Traffic) Engineer** | **House Keeping Cum Barricade Maintenance Manager** | **Labour Welfare Officer** |
| **Up to 2** | - | - | 1 | - | - | 1 | - | - | - | - | - | - |
| **Up to 10** | - | 1 | - | 1 | - | 1 | - | 1 (PT) | 1 | 1 | **Refer Note 4** | 1 |
| **Up to 25** | 1 | - | 1 | - | 1 | - | 1 | 1 (PT) | 1 | 1 | | 1 |
| **Up to 100** | 1 | 1 | - | 1 | 1 | 1 | 1 | 1 (FT) | 1 | 1 | | 1 |
| **Up to 200** | 1 | 2 | 2 | 2 | 1 | 2 | 1 | 2 (FT) | 1 | 1 | | **1 with support staff** |
| **More than 200** | 1 | 2 | 5 | 5 | 1 | 2 | 1 | 2 (FT) | **1 with Env. Steward** | 1 | | |

**Note 1**: The above deployment of SHE professionals can be varied as per the progress of work with approval of Engineer In-charge. Nothing extra shall be paid on this account.

**Note 2**: (PT) means Part-Time and (FT) means Full-time.

**Note 3**: Senior SHE (Traffic) Engineer Post and Barricade Manager (including the staff) Posts are applicable to contracts where the work has to be executed either below or over the right-of-way like Viaduct, Tunnel Contracts wherein erection and maintenance of barricades are paramount important.

**Note 4**: One Housekeeping cum Barricade Manager supported by **Minimum 02** (**Two) Supervisors** and **10 (Ten) workmen**

**Note 5:** Minimum requirement of the SHE organisation given as above (SHE Condition of Tender Documents) with deployment schedule **shall prevail,** in case of any variation/conflict in provisions given in MAHA Metro SHE Manual or elsewhere.

## Deployment Schedule of SHE Professionals

| SHE Professionals | DEPLOYMENT ** |
|---|---|
| Chief SHE Manager | Within 30 Days from the date of issuance of LOA |
| Senior SHE Manager | 50% Within 30 Days from the date of issuance of LOA and balance 50 % Within 90 Days from the date of issuance of LOA |
| Junior SHE Manager | 50% Within 30 Days from the date of issuance of LOA and balance 50 % Within 90 Days from the date of issuance of LOA |
| Safety Steward | 50% Within 30 Days from the date of issuance of LOA and balance 50 % Within 90 Days from the date of issuance of LOA |
| Sr SHE (Ele Engineer) | Within 30 Days from the date of issuance of LOA |
| Jr SHE (Ele Engineer) | 50% Within 30 Days from the date of issuance of LOA and balance 50 % Within 90 Days from the date of issuance of LOA |
| Sr SHE (Fire) Manager | Within 90 Days from the date of issuance of LOA |
| Occupational Health Officer | Within 60 Days from the date of issuance of LOA |
| Environmental Manager | Within 60 Days from the date of issuance of LOA |
| Sr SHE (Traffic) Engineer | Within 30 Days from the date of issuance of LOA. |
| House Keeping Cum Barricade Maintenance Manager with Team | Within 30 Days from the date of issuance of LOA. |
| Labour Welfare Officer | Within 60 Days from the date of issuance of LOA. |
| **Note:** ** **Deployment to continue till completion of the project work.** | |

**Note 1:** Minimum requirement of the SHE organisation given as above (SHE Condition of Tender Documents) with deployment schedule **shall prevail,** in case of any variation/conflict in provisions given in MAHA Metro SHE Manual or elsewhere.

| | |
|---|---|
| | **MAHARASHTRA METRO RAIL CORPORATION LIMITED** |

**General Instruction: Maha-Metro/SHE/GI/002: Minimum Qualification and exp. for SHE Professionals**

| SN | Designation | Qualification | Experience (in years) |
|---|---|---|---|
| 1. | Chief SHE Manager | The Chief SHE Manager shall have qualified in any of the following degree/diploma:<br>i) Post Graduate Diploma in Industrial Safety & Environmental Management (PGDISEM) from National Institute of Industrial Engineering, Mumbai<br>ii) M.E. in Industrial Safety from NIT, Trichy, Tamil Nadu<br>iii) M.E. in Industrial Safety from MepcoSchlenk Engineering College, Sivakasi, Tamil Nadu<br>iv) B.E. in Fire and Safety Engg. From Cochin University of Science and Engg. Cochin, Kerala<br>v) B.E. with advanced Safety Management Diploma from CLI / RLI Mumbai / Chennai / Kolkata and Kanpur.<br>vi) B.E / B.Arch., with one-year Full Time advanced Safety diploma from NICMAR, Hyderabad.<br>vii) B.E / B.Tech with any other equivalent State and Central Govt. recognized full time Degree / Diploma in Safety.<br>viii) International qualifications like CSP (Certified Safety Professional), NEBOSH, MIOSH, MSISO etc. | 12 years for Diploma holders and 10 years for Degree holders<br>2 {for all category except (iv) and 5yrs for category (iv) |
| 2. | Senior SHE Manager | As stated in SN1 and in addition the following categories:<br>i) B.Sc. (Physics/Chemistry/Maths) with one-year Full Time advanced Safety diploma from NICMAR, Hyderabad<br>ii) B.Sc. / Diploma in Engg with advanced Safety Management Diploma from CLI / RLI / Mumbai / Chennai / Kolkata and Kanpur.<br>iii) B.Sc. (Physics/Chemistry/Maths) with One-year Full Time diploma in Safety Engineering offered by West Bengal State Technical Education Departments and similar courses by other states.<br>iv) Any Graduate or diploma holder with 7 years of work experience in full fledged SHE department of any Public Sector / Leading Private Sector / MNC / with prior approval of employer on a case-to-case basis | 05 years for Diploma holders and 03 years for Degree holders<br>2 {for category (i), (ii) and (iii) only} |
| 3. | Senior Environment Manager | Govt. recognized B. Tech/ M.Sc./M.Tech. in Environmental Science/Engineering with experience in Metro Rail Project/Construction sector | 5 Years |
| 4. | Junior SHE Manager | i) Degree in Science / Diploma in Engineering with Govt. recognized safety diplomas from Correspondence course of NICMAR, Annamalai University, National and State Productivity Councils, Other State Technical Education Boards etc.<br>ii) Any Graduate or diploma holder with 5 years of work experience in full fledged SHE department of any Public Sector / Leading Private Sector / MNC / with prior approval of employer on a case-to-case basis | 2 (for category (i) only) |

| SN | Designation | Qualification | Experience (in years) |
|---|---|---|---|
| 5. | Safety Steward | Any basic qualification with any SHE related certificate courses. | 2 |
| 6. | Environment Steward | Any basic qualification with Environment Management certificate courses. | 2 |
| 7. | Senior SHE (Electrical) Manager | Degree in Electrical Engineering + Govt. recognized Electrical Licence holder | 2 |
| 9. | Junior SHE (Electrical) Manager | Diploma in Electrical Engineering + Govt. recognized Electrical Licence holder | 1 |
| 10. | Senior SHE (Fire) Manager | i) B.E. (Fire) from National Fire Service College, Pune<br>ii) B.E (Fire & Safety) from Cochin University<br>iii) Graduate with any Govt. recognized diploma in Fire Safety with 5 years of experience | 2 (for category (i) and (ii) only) |
| 11. | Junior SHE (Fire) Manager | Any Diploma holder with any Govt. recognized diploma in Industrial Fire Safety. | 1 |
| 12. | Occupational Health Officer | MBBS with Govt. recognized degree/diploma in Industrial/ occupational health | 1 |
| 13. | Senior SHE (Traffic) Engineer | Govt. recognized PG Degree / Degree / Diploma in Traffic/Transportation Engineering or Planning | 1 |
| 14. | House Keeping Cum Barricade Manager | Any Diploma in Engineering | 1 |
| 15. | Labour Welfare Officer | Any Degree with Govt. Recognized Degree / Diploma / P G Diploma in Labour Welfare related fields like Law, Personnel / Industrial Relations etc. | 2 |

**Note 1:** In some extraordinary cases where the candidate had earlier worked in any metro projects in India, they can be considered for the following posts:

- Senior SHE Manager
- Junior SHE Manager
- Safety Steward

depending upon the qualification and number of years of experience on a case-to-case basis even if they do not possess the prescribed qualification as listed above.

**Note 2:** In all other cases other than listed under Note 1 irrespective their earlier experience with metro projects in India the candidates shall qualify as specified above.

| | |
|---|---|
| | **MAHARASHTRA METRO RAIL CORPORATION LIMITED** |

**General Instruction: Maha-Metro/SHE/GI/003: Min. Requirements of SHE Monitoring and A.V. Equip.**

1. For the purpose of minimum requirements of Audio-visual and Other equipment the contracts are categorized into the following groups:

| Contract Value (Initial awarded value of contract) | Group |
|---|---|
| Upto 25 Cr | A |
| Upto 100 Cr | B |
| Upto 250 Cr | C |
| More than 250 Cr | D |

2. Every contractor falling into the above groups shall provide the following minimum required audio-visual aids for conducting weekly review, monthly safety committee and other post review meeting of all fatal and major incidences effectively. These audio-visual equipments are a must for conducting periodical in-house safety presentations in the training programmes.

3. In addition to the above portable hand-held digital sound level meter (SLM) and portable hand-held digital lux meter are also to be provided.

| SN | SHE monitoring and Audio-Visual Equipment details | SHE monitoring and Audio-Visual equipment required for | | | |
|---|---|---|---|---|---|
| | | Group A Contract | Group B Contract | Group C Contract | Group D Contract |
| 1. | Portable hand-held Digital Sound Level Meter (SLM) Noise Monitoring deleted | 1 | 1 | 1 | 1 |
| 2. | Portable hand-held Digital Lux Meter | 1 | 1 | 1 | 1 |
| 3. | Laptop Computer with standard configuration including multimedia facilities | 1 | 1 | 1 | 1 |
| 4. | Colour Printer | 1 | 1 | 1 | 1 |
| 5. | Computer projector with screen | - | 1 | 1 | 1 |
| 6. | Overhead projector | 1 | | | |
| 7. | 35mm Camera (For taking accident investigation photos in which case the images cannot be easily altered) | 1 | 1 | 1 | 1 |
| 8. | Digital camera with flash of minimum 4 mega pixel and video facility | 1 | 1 | 1 | 2 |
| 9. | Digital still camera with flash of minimum 4 mega pixel | 1 | 2 | 4 | 6 |
| 10. | Portable loudspeaker (for tool-box talk and emergency purpose) | 1 | 1 | 2 | 6 |
| 11. | Communication facility like mobile phone, walky-talky etc | For all supervisors and managers/engineers working in Safety, Health & Environment | | | |
| 12. | Accident investigation Kit containing the following: | 1 | 1 | 1 | 2 |
| a) | Chalk piece for marking | | | | |
| b) | Measuring tape for measuring Flexible tape – 2m length Metal Foot long scale and Metal tape – 30m | | | | |

| SN | SHE monitoring and Audio-Visual Equipment details | SHE monitoring and Audio-Visual equipment required for | | | |
|---|---|---|---|---|---|
| | | Group A Contract | Group B Contract | Group C Contract | Group D Contract |
| c) | Equipment tags | | | | |
| d) | Multipurpose Flash light | | | | |
| e) | Barrier tape of 20m length | | | | |
| f) | Accident investigation Forms and checklists | | | | |
| g) | Enough Paper for witness recording and other noting | | | | |
| h) | Emergency Phone Numbers list | | | | |

| | |
|---|---|
| | **MAHARASHTRA METRO RAIL CORPORATION LIMITED** |
| **General Instruction: Maha-Metro/SHE/GI/004:SHE Induction Training** | |

**A) Safety and Health induction training Topic**

**1. Hazard Identification Procedure**

Hazards on site:

- Falls
- Earthing work
- Electricity
- Machinery
- Handling materials
- Transport
- Site housekeeping
- Fire

**2. Personal Protective Equipment**

- What is available?
- How to obtain it?
- Correct use and care

**3. Health**

- Site welfare facilities
- Potential health hazards
- First Aid/Cardio-Pulmonary Resuscitation (CPR)

**4. Duties of the Contractor**

- Brief outline of the responsibilities of the Contractor by law
- Details of Contractor's accident prevention policy
- Maha-Metro's SHE manual
- Building and other Constructions Welfare Law

**5. Employee's Duties**

- Brief outline of responsibilities of employee under law
- Explanation of how new employees fit into the Contractor's plan for accident prevention. (Induction and orientation).

**B) Environment induction training Topic**

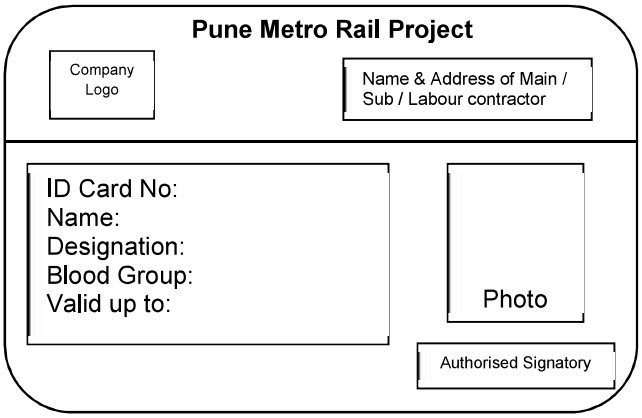
- Contractor's Environment Policy
- Avoidance of Nuisance
- Environmental Sanitation
- Dust Control Measures
- Water Pollution and Control
- Occupational noise mitigation
- Waste Management and Disposal
- Key legal requirements

**Note: This is a sample list; other topic can also be included in first day induction training**

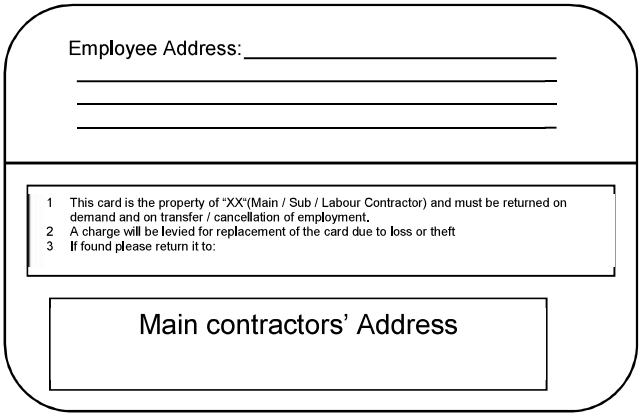
| | |
|---|---|
| | **MAHARASHTRA METRO RAIL CORPORATION LIMITED** |
| **General Instruction: Maha-Metro/SHE/GI/005: ID Card Format** | |

(85 mm x 55mm)

Front side of ID card:




Backside of ID card:



| | |
|---|---|
| | **MAHARASHTRA METRO RAIL CORPORATION LIMITED** |
| **General Instruction: Maha-Metro/SHE/GI/006: SHE Training details for Managers and Supervisors** | |

| **1. The Law and Safety** | **2. Policy and Administration** |
|---|---|
| Statutory requirement<br>Appropriate regulations<br>Duties of employer and employee | Effect of incentive on accident prevention<br>Human relations<br>Consultation<br>Safety Officer: duties, aims, objectives |
| **3. Safety and the Supervisor** | **4. Principles of Accident Prevention** |
| Safety and efficient production go together<br>Accidents affect morale and public relations | Attitudes of management, supervision, and operations<br>Methods of achieving safe operations<br>Accident and injury causes |
| **5. Site Inspection** | **6. Human Behaviour** |
| The role of management<br>Hazard Identification Procedure<br>Records results<br>Follow-up procedures<br>Feedback | Motivating agencies<br>Individual behaviour<br>Environmental effects<br>Techniques of persuasion |
| **7. Site housekeeping** | **8. Health** |
| Site organization<br>Relationship of site housekeeping to accident occurrence<br>Site access<br>Equipment storage<br>Material stacking<br>Materials handling | Medical examination<br>Hazard to health on site<br>Sanitation and welfare<br>Protective clothing<br>First Aid/CPR |
| **9. Personal Protective Equipment** | **10. Electricity** |
| Eye, face, hands, feet and legs<br>Respiratory protective equipment<br>Protection against ionizing radiation | Appreciation of electrical hazards<br>Power tools<br>Arc welding<br>Low voltage system<br>Lighting and power system on sites<br>ELCB, RRCB, Grounding/Ground fault circuit interrupters (GFCIs) |
| **11. Oxygen and Acetylene Equipment** | **12. Equipment** |
| Cylinder storage and maintenance<br>Condition and maintenance of valves, regulators, and gauges<br>Condition and maintenance of hoses and fittings<br>Pressures | Accidents related to moving parts of machinery<br>Appreciation of principles of guarding<br>Importance of regular maintenance |
| **13. Transportation** | **14. Excavations** |
| Transport to and from site<br>Hazard connected with site transport<br>Competent drivers<br>Dumpers<br>Tipping trucks<br>Movement near excavations | Method of shoring<br>Precautions while shoring<br>Precautions at edge of excavations<br>Removal of shoring<br>Sheet steel piling |
| **15. Working platforms, Ladders, and Scaffolding** | **16. Cranes and other Lifting Machines** |
| Hazards connected with the use of ladders<br>Maintenance and inspection<br>Type of scaffold<br>Overloading<br>Work on roofs<br>Fragile material | Licensing, certification, and training required for operation of cranes<br>Slinging methods<br>Signalling<br>Access to crane(s)<br>Maintenance and examination |

| | |
|---|---|
| Openings in walls and floors<br>Use of safety belts and nets | Ground conditions<br>Hazards and accident prevention methods connected with the use of different types of cranes/heavy equipment<br>Crane Lift Plan for all lifts |
| **17. Lifting Tackle** | **18. Fire Prevention and Control** |
| Slings - single and multi-legged<br>Safe working loads (SWLs)<br>Safety hooks and eyebolts<br>Cause of failure<br>Maintenance and examination | Principle causes determining fire<br>Understanding fire chemistry<br>Fire fighting equipment<br>Fire fighting training |
| **19. Communications** | **20. Manual Handling** |
| Effective methods of communication (particular interest to non-English speaking workers)<br>Method and preparation of reports<br>Safety committees<br>Safety meeting | Body posture and procedure for lifting, pushing, pulling, dragging, sitting and walking<br>Ergonomics<br>Stretching exercises |

## CONTENTS OF ENVIRONMENTAL TRAINING PROGRAMME

1. Environment Policy
2. Regulatory requirements i.e. Central, State and Environmental requirement of funding agency
3. Overview of Environmental issues at construction sites and funding agency's requirements.
4. Avoidance of nuisance
5. Environmental sanitation
6. Dust control measures
7. Contractual requirements to reduce construction related impacts
8. Monitoring of environmental parameters and their significance
9. Waste Management
10. Occupational Noise and its mitigation
11. Health impacts of construction industry
12. Green Buildings certifications (IGBC)
13. Resource minimization
14. ISO requirement (as applicable)

**MAHARASHTRA METRO RAIL CORPORATION LIMITED**

**General Instruction: Maha-Metro/SHE/GI/007: SHE Training Matrix**

| Types of training | Management | | | | | | | | | | | | | | | | | | Supervisor | | | | | | | | | | Specific | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Safety & Health Orientation | safety & Health Leadership | Safety & Health Plan | safety & Health Improvement Plan | Management of Change | Safety & Health Audit & Inspection | Safety & Health Emergency Response & | Incident/Accident Investigation & | Safety & Health Communication | Safety & Health Promotion & Incentives | Traffic Management | Hazard Identification & Risk Analysis | Permit to work system | Confined space entry | scaffolding | Labour welfare measures | Behavioral Based Safety Management | Job/Task Safety Analysis (JSA) | Safety Training Observation Programme (STOP) | Industrial First Aid & CPR | Incident / Accident Investigation & | Fire fighting | Confined Space Testing & Certification | Scaffold Erection & Inspection | Rigging | Wire Rope Inspection | Crane Inspection | Electrical/Mechanical Isolation | Permit to Work System | Confined Space Working | Explosive Handling & Control | Heavy Lifting Operation | Radiography (X-Ray) | HAZMAT Handling & Control | Welding, Cutting & Bracing | Power Actuated Hand Tool | Electrical/Mechanical Isolation | Roofing Work | Steel erection work | Scaffold Erection/Dismantling | False-work Erection / Dismantling | Painting in Confined Area |
| Project Manager | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | | • | | | | | | | | | | | | | | | | | | | | | |
| Sr. Construction Managers | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | | • | | | | | • | | | | | | | • | | | | | | | | | |
| Quality Manager | • | • | • | • | • | | • | • | • | | • | • | • | • | • | • | • | • | • | • | | | | | | | | | | | | | | | | | | | | | |
| Planning engineer | • | • | • | | • | • | • | • | • | | | • | | • | | | | | | • | | | | | | | | | | | | | | | | | | | | | |
| Construction Managers | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | | | | • | • | • | • | • | | | | | | | | | | | | |
| Construction Supervisors | • | | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • |
| Construction Foreman | • | | • | | | | • | | • | | | • | • | | | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • |
| Machinery Operators | • | | | | | | • | | | | • | | | | | | | | | • | | • | | | • | | | | | | | | | | | | | | | | |
| Material Handlers | • | | | | | | • | | | | | • | • | | • | | | | | • | • | • | | | • | | | | | | | | | | | | | | | | |
| Station Building Workers | • | | | | | | • | | | | | | • | | • | | | | | • | | • | | | | | | | • | | • | | • | | • | | | • | • | • | • |
| Steel workers | • | | | | | | • | | | | | | • | | • | | | | | • | | • | | | • | | | | • | | • | | • | • | | • | • | • | • | | |
| Mechanical workers | • | | | | | | • | | | | | | | | | | | | | • | | • | | | • | | | | • | • | • | | • | | | • | • | | • | | • |
| Other Civil workers | • | | | | | | • | | | | | | | | | | | | | • | | • | | | • | | | | • | • | • | • | • | | | • | • | | • | • | • |
| Electrical workers | • | | | | | | • | | | | | | | | | | | | | • | | • | | | • | | | | • | • | | • | • | | | • | • | | • | | • |
| Radiographers | • | | | | | | • | | | | | | | | | | | | | • | | • | | | | | | | • | • | | | • | | | | | | • | | |
| Transportation Drivers | • | | | | | | • | | | | • | | | | | | | | | • | | • | | | | | | | | | | | | | | | | | | | |
| Security Officers | • | | | | | | • | • | | | • | • | • | | • | | | | | • | • | • | | | | | | | | | | | | | | | | | | | |
| Clerical Staff | • | | | | | | • | | | | | | | | | | | | | • | | • | | | | | | | | | | | | | | | | | | | |
| Medical Doctor | • | • | • | | | | • | • | | | | | | | | • | | | | • | | | | | | | | | | | | | | | | | | | | | |
| Sr. Safety & Health Managers | | • | | | | | • | | | | | | | | | | | | | • | | | | | | | | | | | | | | | | | | | | | |
| Jr. Safety & Health Managers | • | | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • |
| Safety & Health Supervisors | • | | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • |

| | |
|---|---|
| | **MAHARASHTRA METRO RAIL CORPORATION LIMITED** |

**General Instruction: Maha-Metro/SHE/GI/008: Days to Be Observed for Creating SHE Awareness**

| | |
|---|---|
| 1st Monday to Sunday of January | Road Safety Week (Subjected to confirmation from Ministry of Road Transport, Govt. of India every year.) |
| 16th February | Kyoto Protocol Day |
| March | Red Cross Month |
| 4th March | National Safety Day |
| 7th April | World Health Day |
| 14th April | Fire Safety Day |
| April 18 to 22 | Earth Week |
| 20th April | Earth Day |
| 20th April | Noise Awareness Day |
| 28th April | ILO World Day for Safety and Health at Work |
| May 1 to 7 | Emergency Preparedness Week |
| 5th June | World Environmental Day |
| 12th June | World Day against Child Labours |
| 9th July | Occupational Health Day |
| 17th October | World Trauma Day |
| 1stDecember | World AIDS Day |

**MAHARASHTRA METRO RAIL CORPORATION LIMITED**

**General Instruction: Maha-Metro/SHE/GI/009: Minimum Requirements of SHE Communications**

1. For the purpose of Minimum requirements of SHE Communication Posters / Signages / Video the contracts are categorized into the following groups:

| Contract Value (Initial awarded value of contract) | Group |
|---|---|
| Upto 25 Cr | A |
| Upto 100 Cr | B |
| Upto 250 Cr | C |
| More than 250 Cr | D |

2. Every contractor falling into the above groups shall prepare a SHE Communication Plan as a part of site specific SHE Plan and shall include the following minimum requirement of Posters / Signages / Video as applicable. In case readymade posters are available in any of the category from National Safety Council, Loss Prevention Association of India or any other safety related organisations they may procure the same and display it. In case the same is not available then the contractors shall make necessary arrangements to get the posters designed and printed on their own.

   All the above are to be detailed in the Site SHE Plan and get an approval from the Employer before displaying the posters.

**Table 1:** Minimum number of Posters

| SN | SHE Poster Title | Min No. of concepts in each title | No. of Posters / Signage / Video | | | |
|---|---|---|---|---|---|---|
| | | | Group A Contract | Group B Contract | Group C Contract | Group D Contract |
| 1. | Safety Culture | 5 | Each 10 | Each 50 | Each 75 | Each 100 |
| 2. | Daily Safety Oath | 1 English, 1 Hindi | Each 100 | Each 200 | Each 500 | Each 1000 |
| 3. | Mandatory PPE Usage | | | | | |
| a) | Signages to display the messages like PPE ZONE, NO PPE ZONE, HARD HAT AREA etc. | 2 types of sizes made up of metal sheet to be mounted at different locations | Each 25 | Each 50 | Each 75 | Each 200 |
| b) | Helmet | 5 | Each 25 | Each 50 | Each 75 | Each 200 |
| c) | Shoe | 5 | Each 25 | Each 50 | Each 75 | Each 200 |
| d) | Goggles & Ear Protection | 5 | Each 25 | Each 50 | Each 75 | Each 200 |
| e) | Full Body Harness | 5 | Each 25 | Each 50 | Each 75 | Each 200 |
| f) | Hi-Vi Jacket | 5 | Each 25 | Each 50 | Each 75 | Each 200 |
| 4. | Emergency Management Plan | 5 | Each 25 | Each 50 | Each 75 | Each 200 |
| 5. | Working at Heights | 10 | Each 25 | Each 50 | Each 75 | Each 200 |
| a) | Ladder, Stairway, Scaffold - Signages to display the messages like SAFE, UNSAFE, FIT FOR USE, AVOID USE etc. | 5 types of sizes made up of metal sheet to be mounted at different locations | Each 25 | Each 50 | Each 75 | Each 200 |
| 6. | Site Electricity | 5 | Each 25 | Each 50 | Each 75 | Each 200 |
| 7. | Fire and Explosion | 5 | Each 25 | Each 50 | Each 75 | Each 200 |
| 8. | Crane Safety | 5 | Each 25 | Each 50 | Each 75 | Each 200 |
| 9. | Slings | 5 | Each 25 | Each 50 | Each 75 | Each 200 |
| 10. | Rigging Procedures | 5 | Each 25 | Each 50 | Each 75 | Each 200 |
| 11. | Excavation | 5 | Each 25 | Each 50 | Each 75 | Each 200 |

| SN | SHE Poster Title | Min No. of concepts in each title | No. of Posters / Signage / Video | | | |
|---|---|---|---|---|---|---|
| | | | Group A Contract | Group B Contract | Group C Contract | Group D Contract |
| 12. | Occupational Health (Mosquito Control, HIV/AIDS awareness, Dust Control, Noise Control, No Smoking/Spitting, etc.) | 10 | Each 25 | Each 50 | Each 75 | Each 200 |
| 13. | First – Aid | 3 | Each 25 | Each 50 | Each 75 | Each 200 |
| 14. | Labour Welfare Measures (Payment of Minimum Wages, Avoidance of Child labour, signing in the Muster Roll, In case of accidents-what to do? etc | 5 | Each 25 | Each 50 | Each 75 | Each 200 |
| 15. | Importance of "Safety Handbook" | 1 | 25 | 50 | 75 | 200 |
| 16. | Traffic Safety (Speed limi safe crossing and workin within barricaded area etc.) | 5 | Each 25 | Each 50 | Each 75 | Each 200 |
| 17. | Environmental Sanitation, Dust Control, Waste Management, Water Conservation, Tree Protection, General Environmental Awareness Measures against noise pollution etc | 5 | Each 25 | Each 50 | Each 75 | Each 200 |
| 18. | Video in Hindi on PPE usage – 15 minutes duration | 1 | - | - | - | 1 |

**Note 1:** Items mentioned under 17 is video. Items under 3 (a) and 5 (a) are metal signage boards and all other items are posters.

**Table 2:** Size of Posters / Signages

| SN | Item | Size |
|---|---|---|
| 1. | Posters – Standard | 17"x22" –135 GSM 4 Colour Printing |
| 2. | Posters – Special (Wherever required) | 17"x22" card laminated FA Poster |
| 3. | Posters - Mega size (Wherever required) | 32"x40" Flex FA Poster |
| 4. | First-Aid Booklet | 6"x4" |
| 5. | SHE Handbook | 6"x4" |
| 6. | Signages | Small: 12"x6"<br>Big : 24"x12" |
| 7. | Road Traffic Sign Boards | Strictly as per Indian Road Congress (IRC) specifications |

**Table 3:** Safety Signage Colour (as per IS 9457)

| SN | Type of signage | Colour |
|---|---|---|
| 1 | Mandatory | Blue |
| 2 | Danger | Yellow |
| 3 | Prohibit | Red |
| 4 | Safe conditions | Green |

**MAHARASHTRA METRO RAIL CORPORATION LIMITED**

**General Instruction: Maha-Metro/SHE/GI/010: Experts / Agencies for SHE Services**

| SN | Organisation | Services |
|---|---|---|
| 1. | Bureau Veritas Industrial Services (India) Pvt. Ltd.,<br>B-21 & 22, First Floor, Sector-16,<br>NOIDA-201 301 (U.P.)<br>Phone: 0120 - 2515055<br>Fax: 0120 - 2515248<br>E-mail: enp.delhi@in.bureauveritas.com | • External SHE Audit<br>• SHE Management / Technical Training |
| 2. | Central Labour Institute<br>Post box no: 17851, NSMonkikarMarg<br>Sion, Mumbai- 400 022<br>Tel.: 022- 4092203<br>Fax: 022 – 4071986<br>E-mail: cli@dgfasli.nic.in | SHE Management / Technical Training |
| 3. | Construction Industry Development Council<br>801, 8th Floor,<br>Hemkunt Chambers,<br>89, Nehru Place,<br>New Delhi – 110 019<br>E-mail: cidc@vsnl.com | SHE Management / Technical Training |
| 4. | Delhi Productivity Council<br>1E/10, Swami Ramtirath Nagar<br>New Delhi – 110 055<br>Tel.: 23522835 | SHE Management / Technical Training |
| 5. | Det Norske Veritas AS,<br>203, SavitriSadan 1,<br>11 PreetVihar Community Centre,<br>New Delhi-110 092<br>Phone: 011-22531502/2253/1503,<br>22427688/22531278<br>Fax: 011-2253 0247<br>Website: www.dnv.com | • External SHE Audit<br>• SHE Management / Technical Training |
| 6. | Dr AV Baliga Memorial trust<br>Link House, Bagadur Shah ZafarMarg<br>Press Area<br>New Delhi – 110 002<br>Phone: 011 – 23311119 | HIV / AIDS awareness |
| 7. | Dr. Cris Research Centre for Occupational Health & Safety<br>306, Guru ArjunaDevBhawan,<br>Ranjit Nagar Complex, New Delhi – 110 008<br>Phone: 9810040406<br>Fax: 011 – 25702929<br>E-mail: team@drcris.com<br>Website: www.drcris.com | • Ambulance Room & Van<br>• Communication Materials<br>• First-aid box<br>• First-aid Training<br>• HIV / AIDS awareness<br>• ID Card<br>• Medical Facilities<br>• SHE Orientation Training |
| 8. | DuPont Safety Resources,<br>E.I. DuPont India Private Limited,<br>ArihantNitco Park 6th Floor,<br>90, Dr. Radhakrishnan Salai,<br>Mylapore, Chennai-600 004<br>Phone: 044-2847 2800, 2847 3752<br>Fax: 044-2847 3800<br>Mobile: 9381201040<br>Website: in.dupont.com | SHE Management Training |

| SN | Organisation | Services |
|---|---|---|
| 9. | Automech Engineering India Pvt. Ltd,<br>L-1, Shivalay, Deenanath Mangeshkar Road,<br>Pune-411004, Phone: 09423732672<br>E-Mail: info@automechengineering.in | ISO certification services<br>SHE Trainings<br>External SHE audits<br>T&P testing and certifications |
| 10. | Green Cross Consultants<br>59, 7th Cross, 1st Floor,<br>Jai Bharath Nagar, Banglore-560 033<br>Phone: 080-2549 6782<br>E-mail: etgrangan@yahoo.com | SHE Management / Technical Training |
| 11. | HSRTC, PENTASAFE,<br>201, 2nd Floor, Town Centre,<br>AndheriKurla Road, Marol,<br>Andheri (East), Mumbai-400 059<br>Phone: 022-2850 2210/20/50<br>Fax: 022-2850 2260<br>E-mail: training@penta-safe.com | SHE Practical Field Training for Height Safety |
| 12. | Institute of Driving Training & Research,<br>Wazirabad Road,<br>Adjoining Loni Road flyover.<br>New Delhi – 110 094<br>Phone: 011 – 22813474, 22815833<br>Fax: 011 - 22811131 | SHE Technical Training for Vehicle Drivers. |
| 13. | Institute for Research, Development & Training of Construction Trades & Management,<br>An Educational Institute, Society and Trust,<br>1st Floor, UVCE Alumni Association Building,<br>K.R. Circle, Bangalore-560 001<br>Phone: 080-22294291/22243257<br>Fax: 080-22243257<br>E-mail: ubrco@vsnl.com<br>Website: www.instructindia.org | SHE Technical /Field Training |
| 14. | International Engineering Company<br>K – 10, South Extension,<br>Part – 2, New Delhi – 110 049<br>Phone: 011 – 26254761, 26258130<br>Mobile: 9312260130<br>E-mail: ashok@intenco.net | • Crane and Lifting appliances and Gears Certification<br>• SHE Practical Field Training for Crane Safety |
| 15. | L & T Eutectic<br>32, SivajiMarg, New Delhi – 110 015<br>Phone: 011 - 51419538, 51419539<br>Fax: 011 - 51419600<br>Website: www.lnteutecticwelding.com | SHE Practical Field Training for Welding Safety |
| 16. | Loss Prevention Association of India Ltd.<br>Warden House,<br>Sir P.M. Road,<br>Mumbai – 400 001<br>Website: www.lpaindia.org | SHE Management / Technical Training |
| 17. | MFA Crucial Moments Healthcare Pvt. Ltd.,<br>42, Okhla Industrial Estate, Phase – II<br>New Delhi – 110 020<br>Phone: 011 – 55624000<br>Fax: 011 – 55624010<br>E-mail: contact@crucialmoments.net | First-aid Training |
| 18. | Modicare Foundation<br>4 Community Centre, New Friends Colony,<br>New Delhi – 110 065<br>Phone: 011 – 5167235059<br>Fax: 011 – 26915469<br>E-mail: nivedita@modi.com<br>nivedita@gmavil.com<br>Website: www.modicarefoundation.org | HIV / AIDS awareness |

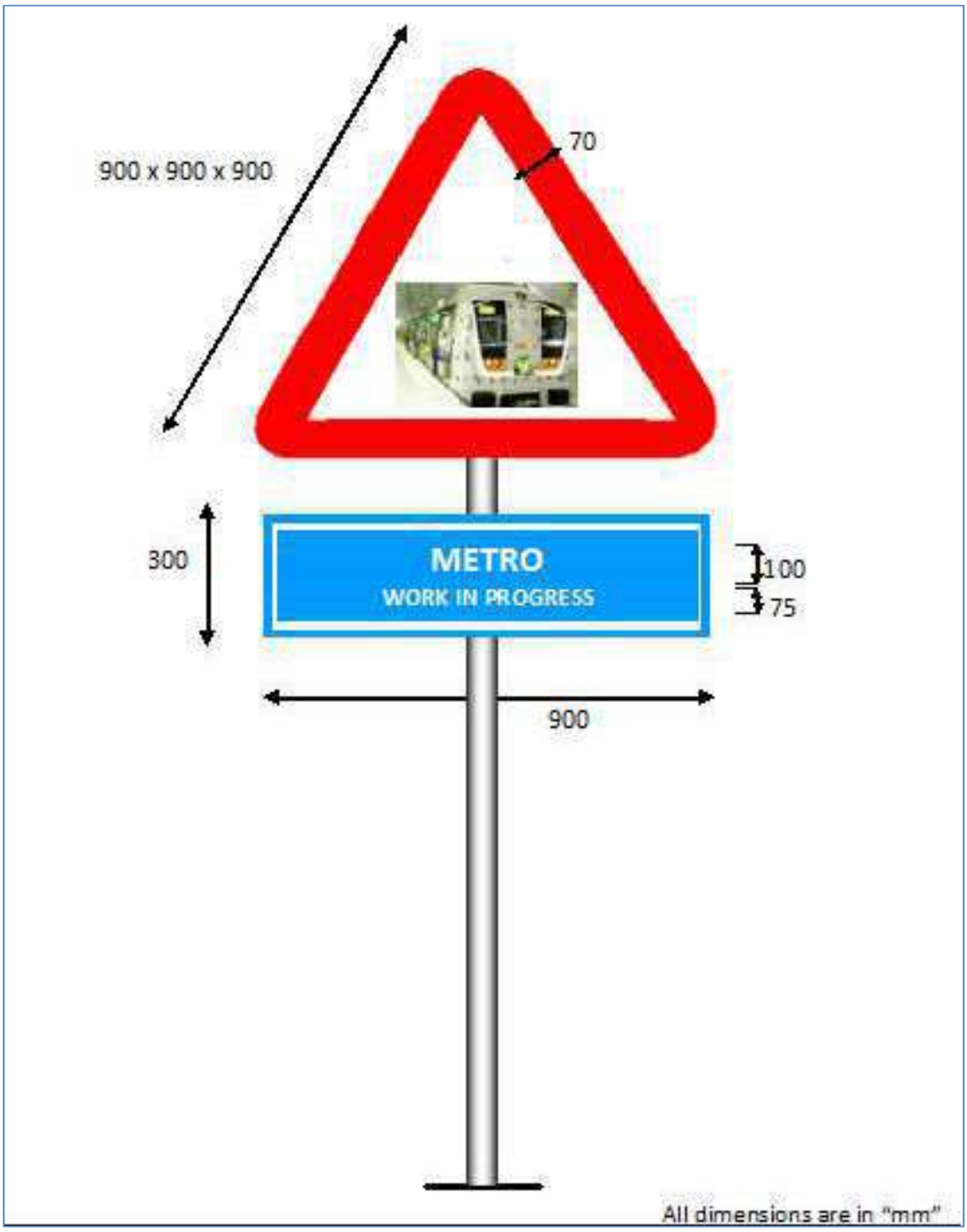
| SN | Organisation | Services |
|---|---|---|
| 19. | National Safety Council<br>HQ and Institute Building<br>98A, Sector 15, industrial Area<br>C.B.D Belapur, Navi Mumbai – 400614<br>Phone: 27579924 | SHE Management / Technical Training |
| 20. | NICMAR (National Institute of Construction Management and Research)<br>910,9th Floor, Hemkunt Chambers,<br>89, Nehru Place,<br>New Delhi – 110 019<br>Phone: 011 – 51618415, 51618417, 51618418<br>Fax: 011 – 51618416 | SHE Management / Technical Training |
| 21. | Quality Growth Services Pvt. Ltd.<br>H-13, Kirti Nagar,<br>New Delhi – 110 015<br>Fax: 011 – 25431737 / 25438598 / 25918332<br>E-mail: qgs@qgspl.com<br>Website: www.qgspl.com | ISO Certification |
| 22. | Safety Engineers Association / Safety Educational Trust – India<br>2/257, First Floor, Dr.Ambedkar Nagar,<br>Manapakkam, Chennai – 600 116<br>Phone: 044 – 22523461<br>E-mail: safetrustindia@rediffmail.com | SHE Management / Technical Training |
| 23. | SHE Management Consultancy & Support Services,<br>145 A, Pocket-VI, (DDA Flats),<br>KondliGharoli, MayurVihar-II,<br>Delhi-110 096<br>Fax: 011-2262 5015<br>Mobile: 9811153873<br>E-mail: r_k_p@vsnl.net | SHE Management / Technical Training |
| 24. | St. Johns' Ambulance<br>Red Cross Road<br>New Delhi – 110 001 | First-aid Training |
| 25. | Vexil Business Process Services Pvt. Ltd.<br>208, A/4, Savitri Nagar,<br>New Delhi – 110 017<br>Mobile: 9350232714, 98102832201, 9350232716<br>E-mail: info@vexilbps.com<br>Website: www.vexilbps.com | • Emergency Preparedness Mock drill<br>• SHE Management / Technical Training |
| 26. | Welding Research Institute<br>Bharat Heavy Electricals Ltd. (BHEL)<br>Trichirappalli,<br>Tamil Nadu – 620 014<br>Phone: 0431 – 2577029, 2577283<br>Fax: 0431 – 2520770<br>E-mail: wri@bheltry.co.in | SHE Practical Field Training for Welding Safety |

**General Instruction: Maha-Metro/SHE/GI/011: Minimum Lighting Requirements**

| SN | Facility or Function | Luminance – lx (lm/ft2) |
|---|---|---|
| 1. | Administrative areas (offices, drafting and meeting rooms, etc.) | 540 (50) |
| 2. | **Construction areas**<br><br>• general indoor<br>• general outdoor<br>• tunnel and general underground work areas (minimum 110 lux required at tunnel and shaft heading during drilling, mucking and scaling) | <br><br>55 (5)<br>33 (3)<br>55 (5) |
| 3. | **Access ways**<br><br>• exit ways, walkways, ladders, stairs | <br><br>110 (10) |
| 4. | **Maintenance / Operating areas / shops**<br><br>• vehicle maintenance shop<br>• carpentry shop<br>• outdoors field maintenance area<br>• refueling area, outdoors<br>• shops, fine details work<br>• shops, medium detail work<br>• welding shop | <br><br>325 (30)<br>110 (10)<br>55 (5)<br>55 (5)<br>540 (50)<br>325 (30)<br>325 (30) |
| 5. | Mechanical/electrical equipment rooms | 110 (10) |
| 6. | Hoists, Elevators, freight and passenger | 215 (20) |
| 7. | **Warehouses and storage rooms/area**<br><br>• indoor stockroom, active/bulk storage<br>• indoor rack storage<br>• outdoor storage | <br><br>110 (10)<br>270 (25)<br>33 (3) |
| 8. | Health Centers and First aid stations and infirmaries | 325 (30) |
| 9. | Toilets, wash and dressing rooms | 110 (10) |
| 10. | Work areas – general (not listed above) | 325 (30) |
| 11. | Parking areas | 33 (3) |
| 12. | Visitor areas | 215 (20) |
| 13. | Laboratories | 540 (50) |

| | |
|---|---|
| | **MAHARASHTRA METRO RAIL CORPORATION LIMITED** |

**General Instruction: Maha-Metro/SHE/GI/012: Warning Traffic Sign**



| | |
|---|---|
| | **MAHARASHTRA METRO RAIL CORPORATION LIMITED** |

**General Instruction: Maha-Metro/SHE/GI/013 :IGBC Document submission**

| **Credit-wise list of documents applicable to respective contractor of Elevated and Underground Station** | | |
|---|---|---|
| SSP MR1 | Site environment Management | 1. Emergency excavation plans / Site Management Plan (DWG) with photograph of site barricading and stacking of fresh material yard with signange |
| | | 2. Photograph of Wheel Wash Facility/ Grating/Manual cleaning |
| | | 3. Photograph of Water sprinkling |
| | | 4. Photograph of Covering excavated soil with tarpaulin or green net and tree protection at site |
| | | 5. Photograph of Diesel Storage area with drip tray |
| | | 6. Air & Noise test Reports at various locations in the station area along with photograph of monitoring measures during construction |
| | | 7. Environmental Management Plan |
| | | 8. Photograph of Waste Segregation with dust bins at the site |
| | | 9. Photograph of Electrical equipment covered at the site during civil construction and finishing |
| | | 10. Photograph of Covering of HVAC ducts |
| | | 11. Photograph of Scrap Material yard with signage |
| | | 12. Photograph of Good Housekeeping activities |
| | | 13. Photograph of Keep the Construction pathway free from interruption |
| | | 14. Photograph of DG Sets with proper exhaust (10m height from the breathing level) |
| | | 15. Photograph of Protect temporary area, and staircase using net or caution tape |
| | | 16. Traffic management permission and plan/policy along with photographs |
| | | 17. TopSoil test report showing porosity and percolation rate (Applicable only at grade station), also mentions the quantity and the process of preservation and uses and Photographs of Topsoil during excavation and preservation |
| SSP MR2 | Basic Facilities for Construction Workforce | 1. Welfare facilities and emergency excavation Plan for construction workforce for all stations (DWG) |
| | | 2. Photographs for basic facilities for the construction workforce<br>- PPE Kits<br>- First Aid & Medical Facilities<br>- Sanitation facilities<br>- Drinking-Water facilities |
| | | 3. Policy or contract documents and site layout for basic facilities for the construction workforce (Typical)<br>- PPE Kits, First Aid & Medical Facilities, Sanitation facilities, Drinking-Water facilities, Assembly Point, Wheel cleaning area, Dustbin / waste storage area, DG, Fire-point, worker restroom etc. |
| SSP CR5 | Preserve/Restor Tree | 1. Tree Survey Report |
| | | 2. Details Trees inventory |
| | | 3. Permission for tree cutting from the authority |
| | | 4. PO of new saplings and name of the saplings |
| | | 5. Trees Maintenance Clause |
| | | 6. Site plan indicating the location of existing trees, before construction (Kindly Provide the Survey drawing showing the location of trees) |

| | | |
|---|---|---|
| | | 7. Landscape plan (post-construction) highlighting the location of preserved/restored trees and newly planted saplings. In the landscape plan, please also provide a legend indicating the type of new plant species used (Kindly provide the landscape plan and also mention plant species) |
| | | 8. Photographs of Transplanted Trees with location |
| | | 9. Landscape plan and calculations demonstrating the percentage of the median area below the viaduct, covered with native/naturalized vegetation |
| | | 10. List of native / naturalized species planted in median area below the viaduct |
| | | 11. Photographs of landscape areas at various station locations |
| | | 12. Photographs of the median area below the viaduct tree plantation area |
| | | 13. Photographs during the tree plantation |
| | | 1. SRI Certificate for pavers from the manufacturer, also mention the distance from the manufacturer unit to the project location |
| | | 2. PO of the pavers block |
| | | 3. Photographs of Non Roof Areas, pavers blocks |
| SSP CR6.2 | Heat Island Mitigation, Roof | 1. PO and manufacturer specifications for SRI Paint (showing SRI Values) for exposed roof area |
| | | 2. Photographs of Exposed Roof Area |
| SSP CR8 | Green Education | 1. Any kind of Green Education Strategies, like<br>Green Signage Program<br>Environmental Awareness Program<br>Tree Plantation<br>Various Green Workshop, seminars or training programs for staff |
| | | 2. Photographs of the taken Green Education Strategies |
| | | |
| WE MR1 | Efficient Water Fixtures | 1. A list of all plumbing fixtures installed( make and model no.) in the project indicating their flow and flush rates. |
| | | 2. Manufacturer letters (addressed to the project) or test certificates indicating the flow rates (at design water pressure of 3 bar) and flush rates of plumbing fixtures installed. |
| | | 3. Photographs of Installed Water Fixtures |
| | | 4. PO of installed Water Fixtures |
| WE MR2 | Rainwater Harvesting, Station | 1. Site storm water layout and storm water drain typical section |
| | | 2. Rainwater harvesting system sizing calculations (if applicable) |
| | | 3. Rainwater harvesting system plan, section (pits, storage tanks, etc.,) (if applicable)<br>**If the ground Water table is less than 4m, such projects need not comply to the requirement.<br>For these, need to submit the soil test report or Geo-technical Investigation report indicating the water table level |
| | | 4.Photos of Rainwater Harvesting System (if applicable) during construction and after construction at all the station Locations |
| WE CR1 | Ultra Efficient Water Fixtures | Efficient Water Fixtures Details, PO, vendor certificate for Flow & Flush rate and photos |
| WE CR2 | Rainwater Harvesting, Station and Viaduct | 1. Total Length of Viaduct |
| | | 2. No of rainwater pits or tanks are provided throughout the viaduct |
| | | 3. Cross-sectional diagram for pits provided at viaduct area |
| WE CR3 | Water Monitoring | 1. Single line diagram (SLD) showing the installed water metering system (station wise, at least 2 locations in each station) (DWG) |
| | | 2. Photos of provided water meter |

| | | |
|---|---|---|
| | | 3. PO of water meter |
| | | |
| | | 1. Wall & Roof Construction Details (i.e., cross-section drawings in DWG) for all Air-Conditioned Spaces and fenestration details like a certificate from manufacturer mentioning the VLT, U-Value, SF, Make, and Model |
| | | 2. Lighting drawing layout (DWG) for all the proposed areas with fixture wattage and LPD level (station-wise) |
| | | 3. HVAC Layout (DWG) for all the stations |
| | | 4. List of HVAC Equipments space-wise for every station, Manufacturer Technical Specifications, PO and BOQ |
| | | 5. PO & BOQ of Lighting Fixtures |
| | | 6. Tender Document or Manufacturer test certificate for Escalator & Elevator, PO and VVVF technology Details |
| | | 7. Technical Specification of occupancy sensors in the toilet (if applicable) |
| | | 8. Technical Details and agreement/tender of BMS system if installed |
| | | 9. All office equipment such as printers, computers fax etc should be energy star-labeled. Please provide any contact agreement or policy regarding this. |
| | | 10. Pumps & Motors TDS, PO with VSD (Variable Speed Drive) systems. |
| | | 11. Photographs of All types of LED Lighting Fixtures |
| | | 12. Photographs of LED Signages inside stations |
| | | 13. Photographs of Occupancy Sensor (if applicable) |
| | | 14. Photographs of Escalator & Elevator VVVF control System |
| | | 15. Photographs of HVAC System |
| | | 16. Photographs of Pumps & Motors with VSDs system (Only of Under-Ground) |
| EE CR2 | Eco-Friendly Refrigerants and Halon-free System | 1. Technical specifications of installed fire suppression system |
| | | 2. A list of all Fire suppression systems used in the project |
| | | 3. A list of HVAC System and Technical details of refrigerants used in HVAC equipment & systems |
| | | 4. Photographs of installed Fire Suppression Systems |
| EE CR3 | On-Site Renewable Energy | *If any renewable energy system is installed:<br>1. Commissioning Report |
| | | 2. Capacity of the Installed Renewable Energy |
| | | 3. Technical Details of Installed Renewable Energy |
| | | **If the installing Renewable Energy is in progress |
| | | 1. Tender Documents or LoA with the Agency |
| | | 2. Tentative Calculation for each station |
| EE CR5 | Energy Monitoring | 1. Schematic drawing showing the location of energy meters in the project |
| | | 2. Energy (kwh) meter manufacturer specifications and PO |
| | | 3. Photographs of Electrical Panel |
| | | |
| MC CR1 | Handling of Waste Materials, During Construction | 1. Site logistic plan highlighting the construction waste segregation, storage, areas of topsoil storage, barricading, wheel washing area, labour facility (construction site management plan) |
| | | 2. A list of construction waste generated and diverted for reuse, recycle & land-fill within the project or outside the project |
| | | 3. Photographs taken at various stages of the project showing construction waste management yard and reuse of construction waste within site |

| | | |
|---|---|---|
| | | 4. Letters from scrap dealers (addressed to the project) / contractors stating the type and quantity of construction waste received/ reused from the project site, for recycling/ reuse |
| MC CR2 | Materials with Recycled Content | 1. Master material sheet (in excel format) listing all the civil and interior materials with quantities used in the project (BOQ will be accetable to calculate the quantity of all building civil and construction materials)Note: For quantities, specify the units (Sqm, no., tons, cum, liters etc.,) in line with bills/PO |
| | | 2. PO for all civil and interior material listed in master material sheet indicating the cost |
| | | 3. Manufacturers letters (addressed to the project) indicating the percentage of post consumer post-industrial recycled content of the major materials used in project |
| MC CR3 | Local Matrials | 1. Major civil and interior materials used in the project along with their cost. Clearly highlight the local materials and their corresponding cost along with approximate distance from the project site to the place of manufacturing unit. |
| | | 2. Manufacturer letters (addressed to the project) for local materials which are manufactured within a distance of 400km from project site. |
| | | |
| IEC CR1 | Indoor Air Quality (IAQ) Monitoring | 1. For all station types and tunnel submit Indoor Air Quality (IAQ) management plan would be provided by Contractor's representative describing the strategies implemented during construction and pre-occupancy phases for addressing measures such as scheduling, electrical and mechanical equipment & systems protection, housekeeping, isolating clean areas and source control (as applicable). |
| | | 2.Contractor's representative have to ensure and provide evidence indicating IAQ measures implemented at various development stages of the project such as construction, installation, commissioning and before occupancy phases of the project. |
| IEC CR4 | Low-Emitting Materials | **1. Paints & Coatings:**<br>a. A list of low or no VOC content paints & coatings (make & model) used in the project interiors, along with the VOC content (in g/L, less water). |
| | | b. Test certificate or manufacturer letters (addressed to the project) indicating the VOC content (in g/L, less water) of the paints & coatings sourced. |
| | | 2. Adhesives: |
| | | a. A list of low or no VOC content adhesives (make & model) used in the project interiors, along with the VOC content (in g/L, less water). |
| | | b. Test certificate or manufacturer letters (addressed to the project) indicating the VOC content (in g/L, less water) of the adhesives sourced. |
| | | 3. Sealants & Sealant Primers: |
| | | a. A list of low or no VOC content sealants & sealant primers (make & model) used in the project interiors, along with the VOC content (in g/L, less water). |
| | | b. Test certificate or manufacturer letters (addressed to the project) indicating the VOC content (in g/L, less water) of the sealants & sealant primers sourced. |
| | | ** Photographs of all the above mentioned materials |
| IEC CR6 | Daylighting | 1. Manufacturer cut-sheet / brochure / letter of the proposed glass showing the visual light transmittance (VLT) |

| | |
|---|---|
| | **MAHARASHTRA METRO RAIL CORPORATION LIMITED** |

**General Instruction: Maha-Metro/SHE/GI/014: Environmental Inspection Checklist**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Report No.:** | | **Inspection Date:** | | | **Inspected by :** | | |
| **Inspection Area:** | | | | | | | |
| **Participants:** | | | | | | | |
| **Sl. No** | **Item** | **Compliance** | | **Photograph** | **Observation & Recommendat ion** | **Action** | |
| | | **Yes** | **No** | | | **By whom** | **Target date** |
| **1.0** | **ENVIRONMENTAL SANITATION** | | | | | | |
| 1.1 | Regular housekeeping done at site | | | | | | |
| 1.2 | Materials are properly stored | | | | | | |
| 1.3 | Construction equipment's and tools are kept properly | | | | | | |
| 1.4 | Designated storage area for all materials as per requirement | | | | | | |
| **2.0** | **CONTAINMENT OF AIR POLLUTION** | | | | | | |
| 2.1 | Site is properly barricaded | | | | | | |
| 2.2 | Dust generating materials are stored properly as per requirement given in the contract document | | | | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 2.3 | construction equipment/ instruments/ construction material/debris/soil are not kept outside barricaded area | | | | | | |
| 2.4 | Nearby roadways are clean from dust/Muck/debris | | | | | | |
| 2.5 | Wheel washing facility is provided near the exit gate | | | | | | |
| 2.6 | Wheel washing facility is in working condition | | | | | | |
| 2.7 | Soil & debris stored in the site fully covered | | | | | | |
| 2.8 | Regular water sprinkling | | | | | | |
| 2.9 | Batching plant and / or casting yard area kept clean and neat | | | | | | |
| 2.10 | Sufficient number of openings with exhaust fans are provided at cement storage area | | | | | | |
| 2.11 | Proper PPEs are provided to workmen involved in manual cement handling | | | | | | |
| 2.12 | Conveyor belt used for carrying aggregate are fully covered | | | | | | |
| 2.13 | Access roads and internal circulation roads are well laid and maintained | | | | | | |
| 2.14 | Stack height of DG set is as per norms | | | | | | |
| 2.15 | Regular cleaning of toe dust | | | | | | |
| 2.16 | Vehicle carrying construction materials, debris, muck etc are properly cleaned and covered | | | | | | |
| **3.0** | **CONTAINMENT OF WATER POLLUTION** | | | | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 3.1 | Water meters are provided as per requirements and are functional | | | | | | |
| 3.2 | Waste water from site is not discharged into sewer without approval | | | | | | |
| 3.3 | Waste water from RO reject, curing etc is put to effective use | | | | | | |
| 3.4 | Transit Mixer washing facility /Beton washing provided at casting yard/batching plant | | | | | | |
| 3.5 | Transit Mixer washing facility provided at casting yard/batching plant is functional | | | | | | |
| 3.7 | Drainage system is functional | | | | | | |
| 3.8 | Refuse/ excavate muck are not stored near the drains | | | | | | |
| 3.9 | Site and adjacent areas are free from water logging | | | | | | |
| 3.10 | Water consumption is recorded regularly | | | | | | |
| **4.0** | **CONTAINMENT OF NOISE** | | | | | | |
| 4.1 | Construction plant & equipments are serviced regularly | | | | | | |
| 4.2 | Acoustic enclosures are provided for DG sets and maximum permissible sound pressure level is within 75dB(A) at one meter distance from the enclosure | | | | | | |
| **5** | **WASTE MANAGEMENT** | | | | | | |
| 5.1 | Adequate number of colour coded dust bins are available | | | | | | |
| 5.2 | All waste items are deposited in refuse containers | | | | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 5.3 | Bins are Emptied regularly | | | | | | |
| 5.4 | No refuse is burnt at site | | | | | | |
| 5.5 | Waste materials are properly stored at designated areas only | | | | | | |
| 5.6 | C&D waste is not disposed along river bed, drainage & wet land | | | | | | |
| 5.7 | Regular disposal of all types of waste as per law | | | | | | |
| 5.8 | Availability of drip pans to prevent leakage and spill. | | | | | | |
| 5.9 | No oil stains on ground | | | | | | |
| 5.10 | Spill absorption material available | | | | | | |

Senior Environment Manager Chief SHE Officer

| | |
|---|---|
| | **MAHARASHTRA METRO RAIL CORPORATION LIMITED** |

**Form No. SF/001: Formation of Site SHE Committee**

| | |
|---|---|
| **Contract No.** | |
| **Contractor Name** | |
| **Contract Title** | |

**CIRCULAR**

**Committee**

The following SHE Committee is constituted with immediate effect:

Chairman:
Members:

1.
2.
3.
4.
5.

**Secretary**

**Periodicity**

The committee will meet at least once in a month on the day (specify date)

**Agenda**

Secretary will circulate agenda of the meeting at least two days in advance of the schedule date of the meeting.

**Circulation**

Gist of the meeting will be minuted in the standard format and circulated to the following under the signature of the secretary

1. Chairman
2. Members
3. Maha-Metro Representatives
4. Others concerned

Date: Signed By: ----------

**CHAIRMAN**

| | |
|---|---|
| | **MAHARASHTRA METRO RAIL CORPORATION LIMITED** |

**Form No. SF/002: Minutes of SHE Committee Meeting**

| | | | |
|---|---|---|---|
| **Contract No.** | | | |
| **Contractor Name** | | | |
| **Contract Title** | | | |
| **Meeting No.** | | **Date of Meeting** | |
| **Location of Meeting** | | | |

| MEMBERS PRESENT | INVITEES | MEMBERS ABSENT |
|---|---|---|
| | | |

| REPORT SENT TO | | | | | |
|---|---|---|---|---|---|
| **No. of Copies** | **Name / Dept.** | **No. of Copies** | **Name / Dept.** | **No. of Copies** | **Name / Dept.** |
| | | | | | |

**Prepared by:** Location: Date:

**MINUTES OF SHE MEETING**

| Item No. | Description of Discussion | Action By | Target | Remarks |
|---|---|---|---|---|
| 1 | Complaints received from Clients and corrective and preventive action | | | |
| 2 | Review of MOM of previous meeting | | | |
| 3 | NCR's / Observation from third party | | | |
| 4 | First - Aid cases / Reportable accident cases | | | |
| 5 | Future jobs and specific requirement | | | |
| 6 | Status of implementation of Safety plan | | | |
| 7 | Sub-contractor performance | | | |
| 8 | Analysis of first-aid cases | | | |
| 9 | Need for any specific system / training / PPE's / resources | | | |
| 10 | Observation of SHE committee during last walk down | | | |
| | | | | |
| | | | | |

Next, SHE Meeting is scheduled on:

| | |
|---|---|
| **Date:** | **Chief SHE Manager (Signature & Name)** |
| **Date:** | **Project Manager (Signature & Name)** |

# Annexure-8:

Terms of Reference (ToR) for External Monitoring Agency

# Annexure 8 - Terms of Reference for Engaging External Monitoring Agency / Expert

## A. Background

**Project Description:** The proposed Project consists of extension of the PMRP Phase-I (Swargate to Katraj) with total length of around 5.9 km, which is entirely underground, with 5 stations.

**Project Category:** The Project is assigned as High Risk for Environment and Social Safeguards as the project is likely to have significant adverse environmental and social (E&S) impacts. MahaMetro will retain external monitor, if required, 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 Maharashtra (GoM), as well as the lenders' E&S policies;
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 MahaMetro 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 MahaMetro to manage and replicate third-party monitoring with rail users and stakeholders

## C. Scope of Services, Tasks and Expected Deliverables:

**Scope of Services:** Monitor the implementation of the Environmental Management Plan (EMP), Resettlement Plan (RP), 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.

**The Tasks** include, but are 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 RP / 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 MahaMetro to confirm appropriate methodologies being used and results correctly interpreted, and consult potentially affected people about the environmental nuisances;
vii. Randomly interview the labours 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 MahaMetro and provide recommendations to resolve any issues or problems on implementing EMP / RP / GAP and VCP / IPDP;

x. Prepare the external E&S monitoring reports, which should confirm the project's compliance with the EMP, RP, 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:

a. External SMP monitoring reports: a. Once upon payment of compensation and entitlements
b. Implementation of livelihood restoration and its efficacy: semi-annually during construction stage
c. Implementation of GAP and its efficacy: annually during first 2 years of operation and maintenance
d. 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:

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.

- Total estimated man-days for both experts during construction stage: (25 person × day / report) × (2 reports / year) × 4 years = 200 person × day.
- Total estimated man-days during O&M stage: (20 person × day / report) × (1 report / year) × 2 years = 40 person × day.

# Annexure-9:

Guidelines/Tasks for GC in implementation of ESMP and EMoP

# Annexure 9 - 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 MahaMetro in preparation of documents and taking necessary procedures in accordance with in the EIA Report for the Project, if any;
3. Assist MahaMetro in dissemination and explanation of additionally confirmed and identified environmental issues to public including holding public consultations;
4. Assist MahaMetro 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 MahaMetro 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 MahaMetro regarding any necessary amendments for its approval;
9. Assist MahaMetro 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 MahaMetro 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 MahaMetro 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 MahaMetro, 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 MahaMetro in preparation of the answer to the request from Funding Agencies for environmental considerations if necessary;
14. Assist MahaMetro 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 MahaMetro 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 MahaMetro in the capacity building of MahaMetro 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 project002E

# Annexure-10:

Annexure-10 A Guidelines for Site Selection and Management

Annexure-10 B Muck Handling Plan

# Annexure-10 A Guidelines for Site Selection and Management (Labour Camps & Construction Yards)

## 1. Purpose

Labour camps and construction plants represent the potentially most polluting locations during implementation of an infrastructure project. Air pollution may be caused by emissions from Crushers, Hot-Mix plants, Concrete Batching Plants and Casting Yards. Water pollution may be caused by discharge of sediment, oil & grease, and organics laden run-off from these plants and their ancillary facilities as well as workshops and residential quarters for the labour. Land may be polluted due to indiscriminate disposal of domestic waste or (accidental) release of hazardous liquids or solids from storage areas.

While the installation and operation of construction plants, in general, is regulated by the respective State Pollution Control Boards, detailed guidance on the environmental management aspects of the Contractor's campsites is often lacking. This guideline for site selection and management is designed to fill this gap.

## 2. Site Selection for Labour Camp and Construction Plant

The following guidelines are recommended to avoid any environmental issues while siting construction camps. Further specific guidance maybe taken from the relevant national / state regulations or conditions issued with the Consent to Establish:

- Labour camps, plant sites and debris disposal site are not located close to habitations, schools, hospitals, religious places and other community places. A minimum distance of 500 m must be maintained for setting up such facilities.
- Maintain a distance of about 1 km (or as per clearance conditions from forest department) from boundaries of designated Reserved Forests, Sanctuary or National Park area for locating any temporary or permanent camps.
- Maintain a distance of 1 km from any archaeological site.
- Maintain 500 m distance from river, stream, lake and ponds
- Maintain 200 m distance from the boundary of state and national highways.
- Locate facilities in areas not affected by flooding and clear of any natural or storm water courses.
- Locate facilities in the (most prevalent) downwind direction of nearest village(s). The boundary of the facilities should be at a suitable distance from the nearest habitation and in compliance with relevant national or state regulations such as the state pollution control board requirements so that the incoming labour does not stress the existing local civic facilities.
- The ground should have gentle slope to allow free drainage of the site.
- Recorded consultations should be held with residents of the nearest settlement and/or their representatives to understand and incorporate where possible, what they would like to see within their locality.
- While complying with the above, labour- and construction camps and muck and waste disposal sites must be located as close to the construction site as reasonably possible in order to minimize travelling distances.

## 3. Facilities at camps

During the construction stage of the project, the contractor will construct and maintain necessary (temporary) living accommodation, rest area and ancillary facilities for working staff & labour. Facilities required are listed and elaborated below.

- Site barricading
- Clean Water Facility
- Clean kitchen areas with provision of clean fuels like LPG, etc.
- Sanitation Facilities
- Waste Management Facilities

- Rest area for workers at construction site
- Adequate Illumination & ventilation
- Safe access road is required at camps
- Health Care Facilities
- Fire-fighting Facility
- Emergency Response Area

**Site barricading:** Site should be completely barricaded from all the sides to prevent entry of outsiders and animals into the site. Entry gate should be provided at each site, which should be guarded by security guard. All workers should be issued ID cards and entry of outsiders shall be maintained in the register at the gate. Board should be displayed at the site and the labour camp, the name of project, capacity of project, authority carrying out the project, restriction of entry without authorization, and no smoking zone and associated risks.

**Clean water facility:** Potable water shall be provided for working staff & construction labour for drinking & cooking purpose. Clean water shall be provided for bathing, cleaning and washing purpose. Water quality testing for water shall be carried out on quarterly basis.

**Clean kitchen area:** Provision of clean kitchen area for cooking and storage of eatables shall be provided. Clean fuels like LPG shall be provided for cooking purpose. Burning of firewood, garbage, paper and any other material for cooking or any other purpose shall strictly be prohibited at the site.

**Sanitation facilities:** Construction camps shall be provided with sanitary latrines and urinals. Toilets provided should have running water availability all the time. Bathing, washing & cleaning areas shall be provided at the site for construction labour. Washing and bathing places shall be kept in clean and drained condition. Workers shall be hired especially for cleaning of the toilets and bathing area. Septic tanks and soak pits shall be provided at site for disposal of the sewage generated.

**Waste management facilities:** Waste generated should be segregated at the site by providing the different colour bins for recyclable and non-recyclable waste. Recyclable waste shall be sold to authorized vendors and non-recyclable shall be handed over to authority responsible in area for waste management. Waste management for construction site shall be as per waste management plan proposed in EMP.

**Rest area:** A rest area / shelter shall be provided at the site for construction workers where they can rest after lunch time and shall not lay down at site anywhere. The height of shelter shall not be less than 3m from floor level to lowest part of the roof. Sheds shall be kept clean and the space provided shall be on the basis of at least 6×6 sq. feet per head.

**Illumination and ventilation:** Construction worker camps shall be electrified and adequately illuminated. Illumination level shall be maintained after 5.30 PM at the site to minimum 200 Lux. Labour camps shall be adequately ventilated. Fans shall be provided for ventilation purpose.

**Access road:** Temporary paved surface shall be constructed to approach the labour camp from the site. Movement shall not be hampered during monsoon season due to water logging and muddiness.

**Health care facilities:** First aid box, first aid room and personnel trained in first aid shall be available at labour camp and site all the time (24X7). A resident doctor shall be available at camp. Equipment in first-aid box shall be maintained as per State Factory's Law. Ambulance/ 4 wheeler motorized vehicle shall be available at the site for carrying injured to the nearby hospital. Tie-ups should be made with nearby hospital to handle emergency, if any. Nos. of ambulance, doctors and nearby hospital shall be displayed in first-aid room, site office & labour camps. Workers shall be made aware about the causes, symptoms and prevention from communicable diseases such as Covid-19 and HIV/AIDS through posters and awareness programs.

**Firefighting:** Fire-fighting facility such as sand filled buckets and potable fire-extinguishers shall be provided at labour camps and at site. Fire-extinguishers shall be provided as per NBC norms.

**Emergency response area:** Area shall be demarcated as emergency collection area near the gate where all the workers shall be guided to collect in case of any emergency like fire, flood and earthquake.

## 4. Activities prohibited at site

Activities which should be strictly prohibited at site shall include

- Open burning of wood, garbage and any other material at sit for cooking or any other purpose
- Disturbance to the local community.
- Operation of the plant and machinery between 10 pm to 6 am unless approved by team leader
- No animal (wild or domestic or bird) shall be harmed by any construction worker in any condition at site and nearby areas
- Cutting of tree without permission of team leader/authorized person
- No indigenous population shall be hurt or teased

## 5. Guidelines for night time working at the site.

No activity generating noise shall be carried out at the site after 10:00 PM. Night working protocol should be followed (if required) as per guidelines prepared by contractor and approved by the General Consultant (GC). Site should be well illuminated to maintain minimum illumination level of 200 Lux. Personnel working shall obtain permit to work from the team leader prior carrying out any work in night time and the record of such working shall be maintained in register. Any accidents, if occurs at site during night time working shall be immediately reported and recorded. Penalty shall be imposed on the contractor for the accident. Analysis shall be carried out to find the reason for such accidents for future learning.

## 6. Record keeping & Maintenance

Record of entry/exit of the people in the construction site and labour camp area shall be maintained in register at gate. Record of material coming in and going out from site also shall be maintained.

## 7. Auditing & Inspection

Conditions of labour camp and site shall be inspected and audit report shall be submitted to GC on monthly basis.

## 8. Establishment, Operation, and Closure of Camps and Plants

- The facilities within the camp and plant sites should be laid out so that the separation distances suggested in other guidelines are maintained.
- Topsoil from the area of the plant shall be stored separately for the duration of the operation of the camp and protected from being washed away, unless agreed otherwise in writing with the owner. If stored, it will be returned on to its original location at the time of closure of the site.
- The Contractor shall prepare, make widely available (especially to staff responsible for water and material management), and implement a Storm Water Management Plan (SWMP) for (all) the site(s) following approval of the same by the Engineer.
- The Contractor shall prepare an Emergency and Spill Response Plan to cover the spillage of fuel, oil, grease bitumen and/or chemicals like retarders, curing compounds, etc.
- The Contractor shall prepare a Waste Management Plan describing the types and quantities that are likely to be generated from within the camp site, with the period and duration during the construction schedule; methods to be adopted to minimize these; methods of removal, treatment and (on-site or off-site) disposal for each type; as well as location of final disposal site, if any.

- The Contractor shall provide safe ingress and egress for vehicles from the site and public roads and shall not impact existing through traffic.
- Water tankers with sprayers must be available at the camp site at all times to prevent dust generation.
- In case of stockpiles of stored material rising higher than wind-breaking perimeter fencing provided, sprinklers shall be available on site to prevent dusting from the piles during windy days.
- On completion of works, the Contractor shall restore the site to the condition it was in before the establishment of the campsite, unless agreed otherwise in writing with the owner(s) of the site(s). If such a written agreement has been made, the Contractor shall hand over the site to the owner(s) in accordance with such an agreement. Following measures are required to be taken during closure:
    - Septic tanks/soak pits should be dismantled
    - Any temporary/permanent structure constructed shall be dismantled
    - Construction/demolition waste, hazardous waste and municipal waste at site and labour camp site shall be disposed of as per waste management plan in EMP
    - The site shall be cleaned properly
    - Tree plantation to be carried out, if any required for stabilizing the area
    - Any pit excavated shall be filled back
    - Closure of the site and labour camp shall be approved by authorized person.
- Construction waste disposal should be disposed only at landfill facilities which are selected, designed, constructed and operated to ensure environmentally safe disposal, and these facilities have to be approved by the regulators.

**9. Workshop and Maintenance areas**

- These areas must have impervious flooring to prevent seepage of any leaked oil & grease into the ground. The area should be covered with a roof to prevent the entry of rainwater.
- The flooring shall be sloped towards from both directions to one corner where an oil-and-grease trap with sufficient capacity should be installed. All discharges from the workshop area must pass through the trap to remove the floating oil and grease before entering the drainage system of the site. The trap should be designed to provide a hydraulic residence time of about 20 minutes for the peak hourly discharge anticipated from the area (as per following figure).
- Alternatively, degreasing can also be carried out using mechanical spray type degreaser, with complete recycle using an enclosure with nozzles and two sieves, coarse above and fine below, may be used as shown in the adjacent photograph. This arrangement will require some initial investment and running cost for the pump, but the payback period, in terms of the use of diesel, under Indian conditions, has been reported to be less than 1 year.
- All the waste oil collected, from skimming of the oil trap as well as from the drip pans, or the mechanical degreaser shall be stored in accordance with the Environment Protection (Storage and Disposal of Hazardous Wastes) Rules, 1989. For this purpose, metallic drums should be used. These should be stored separately in sheds, preferably bunded. The advantage of this arrangement is that it allows for accurate accounting in case the waste material is sold to oil waste recyclers or other users like brick-kiln owners who can burn such inferior fuel.
- A separate vehicle washing ramp shall be constructed adjacent to the workshop for washing vehicles, including truck mounted concrete mixers, if any, after each day's construction is over, or as required. This ramp should have an impervious bottom and it should be sloped so that it drains into a separate chamber to remove the sediment from the wash water before discharge. The chamber should allow for a hydraulic residence time of about 10 minutes for discharge associated with the washing of each truck.

# ANNEXURE-10 B MUCK HANDLING PLAN

## 1. Introduction

This Muck Handling Plan describes the systematic approach to be adopted for the safe, environmentally compliant, and efficient handling of excavated material generated during the construction of the Swargate to Katraj (Phase-1 Extension) of the Pune Metro. The corridor, being entirely underground, involves significant tunnelling and underground station works that will generate large volumes of Construction & Demolition (C&D) waste or “muck.” The plan ensures that the entire process—from excavation to final disposal—is carried out in accordance with statutory regulations and contractual requirements.

The purpose of this document is to guide the Contractor in performing all activities related to muck generation, collection, transportation, reuse, and disposal in a safe and environmentally responsible manner. MahaMetro’s role is limited to oversight and verification through the GC; all operational, statutory, and compliance responsibilities rest solely with the Contractor.

## 2. Purpose and Objectives

The primary objective of this plan is to minimize the environmental and social impacts associated with muck generation during tunnelling and station construction. It establishes the procedures to be followed for collection, transportation, temporary storage, reuse, and scientific disposal of excavated materials.

Specifically, the plan aims to ensure that muck is managed as per the waste hierarchy of reduction, reuse, recycling, and safe disposal; handling and transport are done in compliance with environmental and safety regulations; reuse potential of excavated material is maximized for backfilling or levelling; and disposal activities do not result in air, water, or soil pollution.

## 3. Scope of Work

The scope of the plan covers all works that generate or manage muck, including excavation for tunnels, shafts, cross-passages, and underground stations. It also includes the lifting, loading, and transport of muck, segregation of reusable and non-reusable materials, and the final restoration of disposal sites as identified by the Contractor.

The plan applies to all contractors and subcontractors engaged in muck handling activities under this project. As per the Contract clauses, the Contractor is solely responsible for identifying the land, preparing and implementing site-specific disposal plans and obtaining all necessary permissions from local authorities, as and when needed.

## 4. Quantity and Characteristics of Muck

The Swargate–Katraj underground extension involves two parallel tunnels constructed using Tunnel Boring Machines (TBMs) and the New Austrian Tunnelling Method (NATM). Each tunnel has an internal diameter of approximately 6.7 meters and a cross-sectional area of around 35.24 $m^2$. This results in an excavation volume of around 208,000 $m^3$ per tunnel. Considering both tunnels, the cumulative excavation volume will be about 416,000 $m^3$, which corresponds to approximately 790,000 tonnes of muck, assuming an average soil/rock density of 1.9 $t/m^3$. In addition to tunnel excavation, cut-and-cover stations, shafts, and other underground structures are expected to generate additional muck, which could increase the total volume by approximately 10–15%, bringing the estimated overall excavation volume to around 460,000–480,000 $m^3$. This means that the project will create approximately 909,000 tonnes of muck (790,000 tonnes plus give and take 15%).

The muck will primarily comprise rock, silt, clay, and mixed soil. A small portion of this material will be reused for backfilling and levelling activities, while the remaining will be transported to approved disposal sites identified and managed by the Contractor.

## 5. Contractor's Obligations

As per the contract conditions, the excavated muck or spoil is treated as the property of the Contractor. The Contractor is solely responsible for its safe handling, transport, reuse, and disposal at his own cost. The GC or MahaMetro shall not provide any land or facilities for muck disposal.

As per the Contract clauses, the Contractor has to provide suitable muck disposal sites within 90 days of contract commencement for approval by the Engineer; ensure compliance with all applicable environmental, occupational health, and safety regulations; bear all costs associated with muck handling, transport, storage, and disposal, including taxes and statutory fees; obtain and maintain all necessary permissions and clearances for disposal operations; and submit monthly reports detailing the quantity, reuse, and disposal of muck.

## 6. Muck Handling Methodology

Muck generated from TBM and station excavation shall be collected at source and transported using covered dumpers to designated temporary storage yards within the project area. The storage yards shall be constructed with impervious flooring and adequate drainage to prevent leachate infiltration.

At each site, proper water sprinkling and dust suppression measures shall be carried out. Wheel wash facilities shall be provided at site exits to prevent spillage on public roads. The Contractor shall ensure that all loading and unloading operations are mechanized, minimizing manual handling.

Reusable material shall be segregated and stored separately after quality testing to ensure it meets engineering requirements for reuse in backfilling, sub-grade formation, or other approved purposes. Non-reusable material shall be disposed of at sites approved by Engineer.

## 7. Transportation of Muck

Transportation shall be carried out using well-maintained and covered vehicles equipped with tarpaulin sheets and functional tailgates. Vehicles must have valid PUC certificates and shall be operated only by trained drivers. Overloading is strictly prohibited, and each vehicle shall maintain a minimum of 300 mm freeboard.

Vehicle movements should preferably occur during non-peak hours (10 PM to 6 AM) along routes approved by the local traffic authorities. Wheel washing facilities shall be provided at all exit points, and haul roads shall be kept clean through regular sweeping and water sprinkling.

All vehicle trips shall be documented through a gate pass system indicating source, destination, and volume transported. A daily register of vehicle movement shall be maintained by the Contractor and verified by the site engineer.

## 8. Disposal of Muck

Disposal sites shall be selected by the Contractor based on land availability, environmental safety, and accessibility. Only sites approved by MahaMetro / GC shall be used. Prior to dumping, the disposal area shall be levelled and provided with adequate drainage to prevent runoff or flooding.

Muck shall be spread and compacted in layers to achieve the desired stability. Separate zones shall be maintained for soil and rock materials. The Contractor shall install wind barriers, drainage channels, and sedimentation pits to control dust and erosion. Dumping shall not be carried out during high-speed winds or heavy rainfall.

## 9. Environmental Management and Monitoring

The Contractor shall implement environmental protection measures as per the measures provided in the SHE manual, as a part of the Contract documents. These include air and noise monitoring, dust control, and prevention of water and soil contamination. Periodic monitoring of $PM_{10}$, $PM_{2.5}$, $SO_2$, NOx, and noise levels shall be conducted through NABL-accredited laboratories.

Results shall be recorded and reported monthly to GC / MahaMetro. Any exceedance shall be investigated, and corrective actions implemented immediately. The Contractor shall also ensure compliance with water quality, soil conservation, etc. as per the approved ESMP.

## 10. Safety and Health Provisions

The Contractor shall provide a safe working environment for all personnel involved in muck handling. Personal protective equipment (PPE) such as helmets, reflective vests, gloves, safety shoes, dust masks, and ear protection shall be mandatory.

Traffic marshals shall be deployed along haul routes, and clear signage shall be displayed at all sites. Regular toolbox meetings, safety inductions, and first-aid facilities shall be

maintained. Emergency response plans for spills, fire, or accidents must be implemented and periodically tested through mock drills.

## 11. Community Health and Safety

To minimize disturbance to nearby residents, the Contractor shall restrict haulage routes away from schools, hospitals, and residential colonies. Adequate barricading, signage, and dust control shall be maintained at all times.

Public information boards displaying project details, emergency contact numbers, and grievance mechanisms shall be installed at prominent locations. Any community complaints shall be recorded and addressed promptly through the established Grievance Redress Mechanism (GRM).

## 12. Site Restoration and Handover

Once muck disposal is complete, the Contractor shall restore the site to its original or improved condition. This includes final grading, slope stabilization, topsoil dressing, and plantation. A joint inspection shall be carried out with the Engineer, and the site shall be formally handed over after certification of satisfactory rehabilitation, in case of abandoned quarry or other government land being used as disposal site.

All restoration and plantation activities shall aim to ensure long-term stability, prevent erosion, and improve the ecological quality of the disposal sites. After completion of disposal, the site shall be graded and covered with topsoil, as per the requirement of the owners (in case of private property).

## 13. Conclusion

This Muck Handling Plan provides a structured framework for managing all excavation-related materials in compliance with environmental, safety, and contractual requirements. The Contractor shall be responsible for executing all related activities, including identification of land, handling and disposal of muck and that all activities are carried out scientifically, safely, and sustainably, without causing adverse impacts to the environment or surrounding communities.

Through adherence to this plan, the project will maintain environmental safeguards while meeting the operational and safety standards expected of an international metro infrastructure development.

# **Annexure-11:**

Vibration Modelling Report

# Annexure-11: Vibration Modelling Report

Feb -2025

## Vibration Modelling for Extension of Pune Metro, Corridors
### ( At 4 location on PMRP Phase-1 from Swargate to Katraj)




**Submitted to:**

*MITCON Consultancy & Engineering Services Ltd, Pune*

**Submitted by:**

***n-Dimensional GIS Solutions***
*Malad West,*
*Mumbai*
Ph: (040) 27122492
Mob: (+91) 9967970446

# 1. Introduction

Vibration is one of the major environmental threats to our health as well as to our surrounding environment. Nature provides its own vibration sources such as earthquakes, winds and ocean waves. With the advent of the technological era, vibration sources have multiplied and have become a threat to residents of buildings and also to the sensitive receptor and historical buildings.

Vibration effects on sensitive receptor are a more serious matter of concern especially in cities. In many Indian cities, buildings that are located close to the vibration sources are slowly deteriorating because of road traffic and train passing. As a matter of fact, one of the main reasons for this is the increase in traffic within a limited available space and also, the existence of business centers closes to the structures. This implies that restricted space is left to the transport planners for proposing alternative routes and means of conveyance.

One of the plausible means in such situations can be a commuters trains services either by elevated and above ground rail system. The detrimental effects of **vibration** due to elevated and above ground level activities and Train passage needs to be viewed in perspective and has to be investigated with improved methods and prediction models. This study therefore aims to address these very issues for elevated train service.

Vibration modelling was carried out at the **4** locations of proposed metro rail corridors extension PMRP Phase-1 ( from Swargate to Katraj ). In the vibration modelling, the peak vibration was calculated considering the maximum load and maximum speed with the futuristic data given in the DPR. The study of vibration modelling was carried out using empirical calculations and mapped using GIS software.

## 1.1 Scope of work

The following is the scope of work of the project.

1. GIS mapping of all 4 location along the proposed under ground metro rail corridors ( from Swargate to Katraj ).
2. Data compiling for vibration modelling
3. Vibration modelling of all 4 locations using GIS software.
4. Vibration modelling analysis and validation.
5. Report preparation and presentation.

## 1.2 Vibration

The vibration of an object is always caused by an excitation force. This force may be externally applied to the object, or it may originate inside the object. It will be seen later that the rate (frequency) and magnitude of the vibration of a given object is completely determined by the excitation force, direction, and frequency. This is the reason that vibration analysis can determine the excitation forces at work in a machine. Vibration is usually measured in units of inches per second or mm per second.

## 1.3 Vibration due to Rail Traffic

Vibration due to rail traffic depends on many factors such as height of elevated structure, soil condition, geological condition, type of train, train speed, type of loads etc. In case of elevated train operations, the major vibrations, that is vertical and radial vibrations passes through pier and foundation deep into the ground and it may not cause any serious damage to the nearby structures. Horizontal vibration passing through ground surface may cause some damage to nearby structures depend on frequency of train passing and distance of the structures from tracks. It is in this context; horizontal vibration is predicted with respective to the proposed alignment and location of sensitive receptors.

## 1.4 Effect of Vibration

After vibration is received by the building foundations, the vibrations are then propagated through other parts of the building and damage the building.

### 1.4.1 Effect on Humans

Human response to ground-borne vibration is influenced by many factors. Some of these factors are amplitude, duration and frequency content of vibration, while other factors relate to population type, age and gender. People may be more annoyed if they are exposed to both noise and vibration compared to when only vibration is felt.

### 1.4.2 Vibration Impact on Buildings

Continuous effect of vibration on the buildings can cause damage to buildings. Building subjected to the vibration effect with more than 150 VdB would receive structural damage. Historic buildings are more susceptible to vibration effects due to the type of building material and design. Old structures generally lose structural strength over a period of time. Therefore, it is more important to study the effects of vibration on the historical buildings, especially the structures that come under a heritage category.

# 2. Study area and Data Description

## 2.1 Study Area

Pune Metro Rail Project (PMRP) was planned to construct in two phases. The Phase-1 consisting two corridors- the North-South corridor (PCMC to Swargate) and the East-West corridor (Vanaj to Ramwadi) were already constructed and are in operation.

In Phase -II, extensions of both these corridors are planned to meet the connectivity to all congested, important and densely populated areas of the city mainly at stations. Vibration modelling and analysis was carried out at Swargate to Katraj (5.464 km)

The field vibration modelling at 4 locations, which are shown in figure 2.1

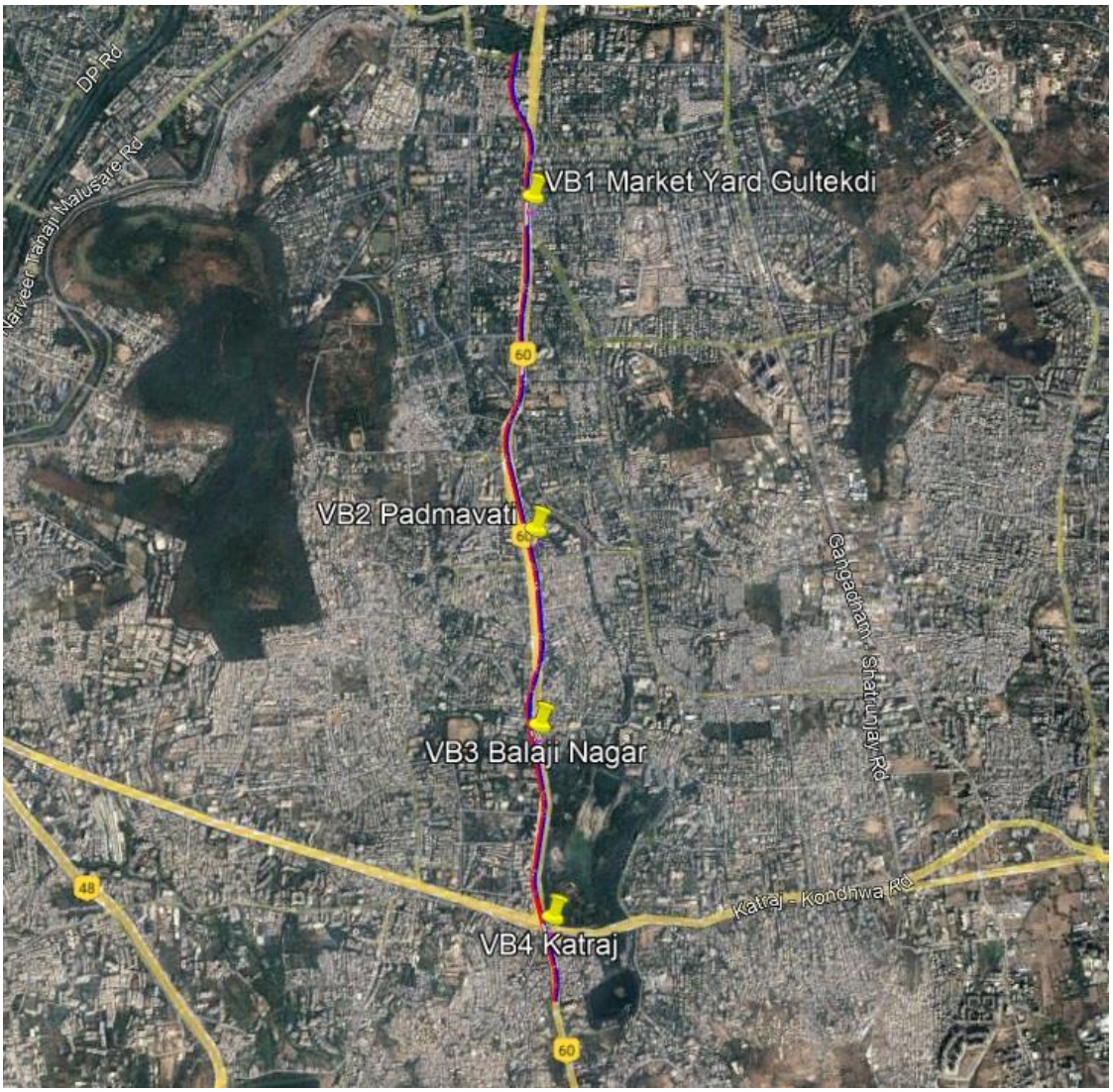



Figure 2. 1: Showing the location of Vibration modelling points on proposed extension of Swaragate to Katraj

The coordinates of the vibration monitoring points are given in table 2.1 below:

Table 2.1: Details of vibration modelling study locations.

| Sample code | Location | Latitude | Longitude | Chainage (m) |
|---|---|---|---|---|
| VB1 | Station 1 (Market Yard, Gultekdi) | 18°29'16.95"N | 73°51'27.29"E | 17483.933 |
| VB2 | Station 2 (Padmavati) | 20°55'43.79"N | 73°51'27.96"E | 19594.224 |
| VB3 | Station 3 (Balaji Nagar) | 18°27'30.10"N | 73°51'28.82"E | 20824.954 |
| VB4 | Station 4 (Katraj) | 18°26'51.56"N | 73°51'31.59"E | 22030.539 |

## 2.2 Soil Condition at Study Area

The area under study is part of the Gangetic alluvial plain consisting of fine to medium sand, silts, clay, occasionally mixed with gravel and kankar. The terrain of Pune city area is generally flat and the area / corridor under study / investigation consists mainly of newer alluvium, made-up of fine to medium sand, silts, clay, occasionally mixed with gravel and kankar up to the depth of investigation. Deep, Moderately Well drained, strongly calcareous, fine soils on gently sloping plains and valleys with moderate erosion. Slightly deep, well drained, fine, calcareous soils on very gently sloping lands with mesas and buttes with moderate erosion.

## 2.3 Section details

### Underground sections

Rail level at midsection in tunneling portion shall be kept at least 15.0 m below the ground level. At stations, the desirable depth of rail below ground level is 25 m, so that station concourse can be located above the platforms.

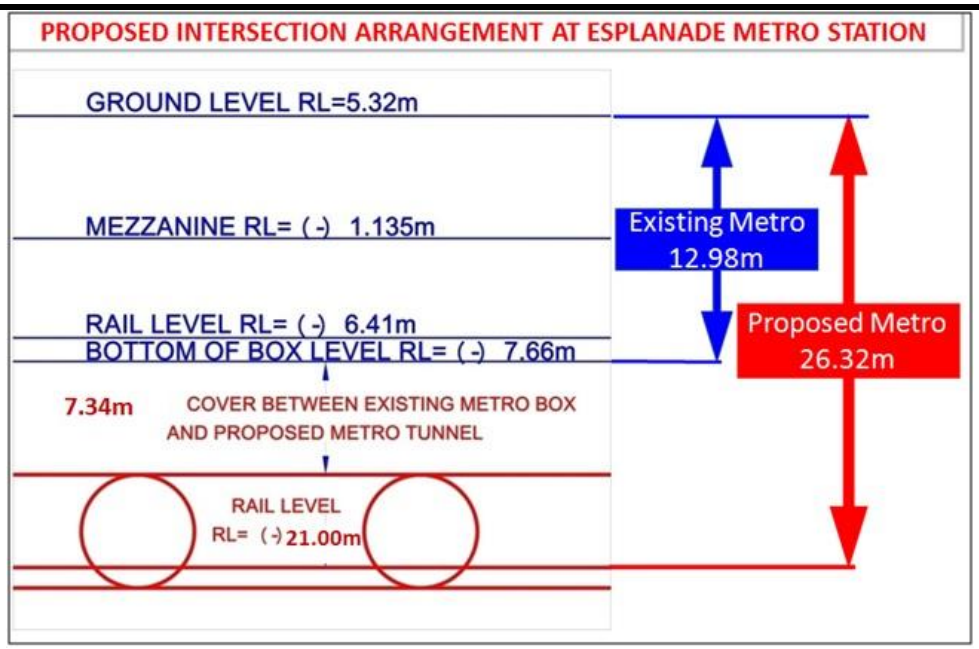



Figure 2.2: showing the cross-section of underground track levels Section

## 2.4 Use of GIS for Vibration study

The base map for the study of vibration impact assessment is prepared using a Geographical Information System (GIS). GIS provides a powerful set of tools for storing, retrieving, transforming and displaying spatial data from the real world for a particular set of purposes. Therefore, GIS is increasingly important in the study on possible effects of vibration. GIS facilitates the visual presentation of the vibration effects and is an additional tool for analyzing the results. The integration of GIS with vibration prediction models provides fast and accurate assessment of the environmental impact of vibration.

# 3. Ground Borne Vibration

## 3.1 Requirement of Ground Borne Vibration prediction

Ground-borne vibration can be a major concern for nearby neighbors of a transit system route or maintenance facility, causing buildings to shake and rumbling sounds to be heard. In contrast to airborne noise, ground-borne vibration is not a common environmental problem. Some common sources of ground-borne vibration are trains, buses on rough Rails, and construction activities such as jack hammer, earth driving equipments, operation of earth moving equipment.

The effects of ground-borne vibration include perceivable movement of the building floors, rattling of windows, shaking of items on shelves or hanging on walls, and rumbling sounds. In extreme cases, the vibration can cause damage to buildings, though it is an uncommon phenomenon as a result of regular train operations, with the occasional exception of earth drilling, train passing and pile-driving during construction. Annoyance from vibration often occurs when the vibration exceeds the threshold of perception by only a small margin. A vibration level that causes annoyance will be well below the damage threshold for normal buildings.

A model capable of predicting excessive ground-borne vibration due to train traffic would be a powerful tool for Railway designers in order to avoid the problem at early stages of the project. In this vibration modelling study, empirical calculation was used to predict the vibration due to train operation.

The mathematical form in the equation below:

$$A(f) = F[S(f), P(f), R(f)]$$

where

$S(f)$ is Source related term as a function of frequency
$P(f)$ is Path related term as a function of frequency
$R(f)$ is Receiver related term as a function of frequency

The US Department of Transport has suggested a prediction called DOT-T95-16 which is widely used in US for prediction of ground–borne vibration from the train traffic. The model is based on the Root Mean Square (r.m.s) method. The r.m.s vibration velocity level in 1/3 octave band according to the method is given by the equation below:

$$L_v = L_F + TM_{line} + C_{build}$$

where, $L_v$ is the r.m.s. vibration velocity level in 1/3 octave band, $L_F$ is the force density for line vibration source, $TM_{line}$ is the line source transfer mobility from the track to a point on the ground close to the building, and $C_{build}$is the adjustment to account for ground-building foundation interaction and attenuation of vibration amplitudes as vibration propagates through the building. The generalized ground-borne vibration curve is given in figure 3.1

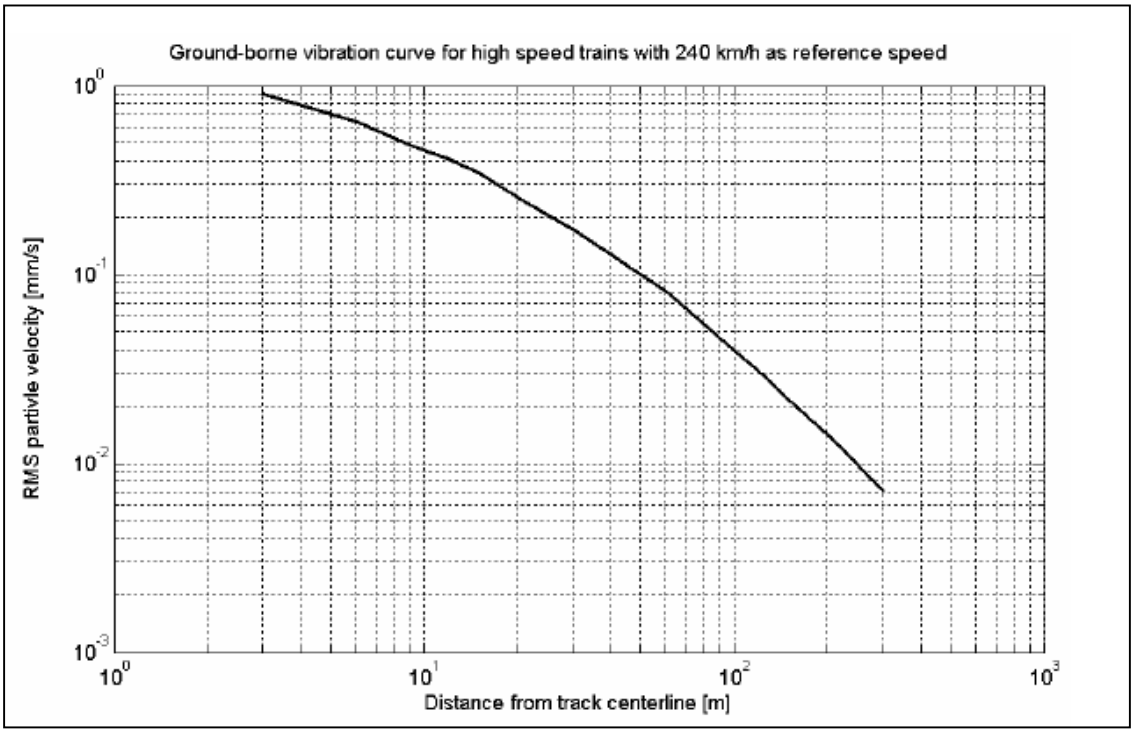



Figure 3.1: Generalized ground-borne vibration curve (DOT-293630-1, 1989).

## 3.2 Calculation of Vibration due to Tunnel Boring Machine (TBM)

Ground borne vibration caused by tunneling machinery can result in significant community annoyance. Vibration due to TBM can also cause noise in the buildings. It is generated by ground vibrations that are initiated by the cutting blades of tunneling equipment imparting the ground materials. The prediction of potential ground borne vibration impacts can allow for better planning of construction activities by,

- Predicting the cost of relocating imparted residents
- Informing the community consultation process
- Scheduling activities to minimize noise impact or duration of impact
- Initiating mitigation measures, where practicable, prior to construction.

TBM typically consist a large rotating cutting wheel in front of large metal cylinder(s) known as shields as well as trailing control and ancillary mechanisms. Behind the cutting wheel is a chamber where the spoil is removed using conveyors to the rear of the machine.

The cutting wheel is moved forward by hydraulic jacks supported off the finished tunnel walls. When the cutting wheel has reached maximum extension the TBM head is braced against the tunnel walls and the rear section of the TBM is dragged forward. Figure 3.3 shows the Herrenknecht Earth Pressure Balance of a TBM. The TBM will travel approximately 20m per day



Source: Herrenknecht

Figure 3.2 Herrenknecht tunnel boring machine

The vibration propagation caused due to the TBM will depend largely upon the source frequency and the local ground properties. The propagation equation of the vibration form is given below:

$$PPV = \frac{K}{d} e^{-\alpha d}$$

| | |
|---|---|
| $PPV$ | Peak particle velocity |
| $d$ | Distance in metres from the source |
| $K$ & $\alpha$ | Site / machine specific operators |

The equations are based on the peak particle velocity (PPV) at the dominant vibration frequency for a given machine. If the machine vibration is measured at a number of locations at varying distance from the source then the site specific operators can be determined as shown below.

$$\alpha = -\frac{\ln(V_2 d_2 / V_1 d_1)}{(d_2 - d_1)}$$

$$K = \frac{V_1 d_1}{e^{-\alpha d_1}}$$

*Where $V_1$and $V_2$*are measured for PPV at distance $d_1$ and $d_2$ respectively.

Figure 3.3 shows the typical vibration propagation curve for TBM vibration at the dominant frequencies.

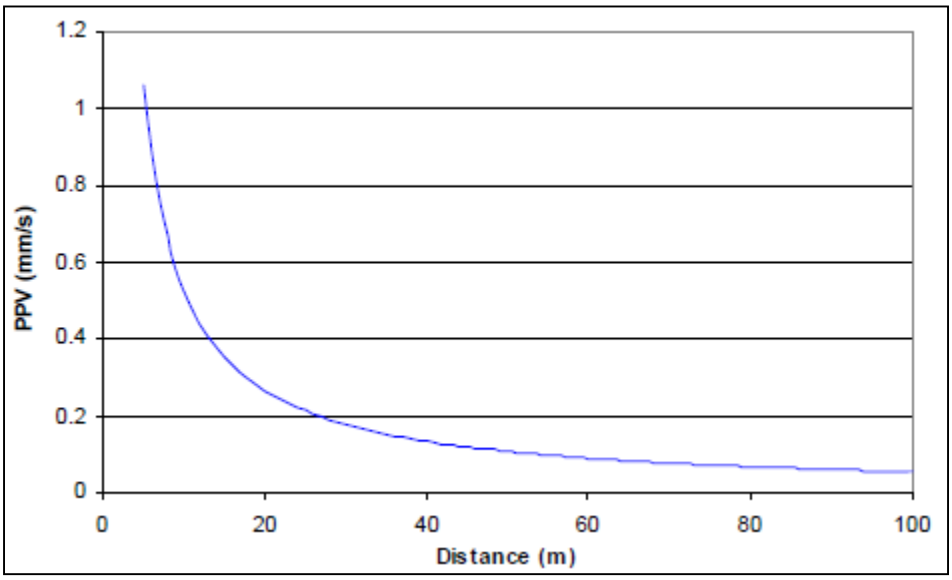



Figure 3.3: Typical vibration propagation curve for tunnel boring machine

# 4. Vibration Monitoring and Analysis

Vibration modelling was carried out using GIS software and empirical formula mentioned in this report. Vibration modelling was conducted at the proposed stations along the expansion of Swargate to Katraj alignment. The maps of the vibration modelling show the lines with different color representing vibration levels during operation of train. Though vibration is calculated in logarithmic scale, the results is converted into equidistance isopters.:

## 4.1 Station 1 : Market Yard Gultekdi,

Market Yard Gultekdi which is along the proposed Swargate to Katraj. The station is exactly on the center line of proposed metro rail alignment. Vibration modelling was conducted at this station in two cases: 1) during construction and during operation. 2) Vibration due to train operation.

### 4.1.1 Prediction of Vibration due to TBM and other construction activities

The prediction of vibration due to Tunnel Boring Machine (TBM), and also other construction activities has been modeled with the standard finite element method. All the parameters concerned with the TBM have been taken into account while considering the vibration prediction. The speed of the tunneling work with TBM is considered to be 10m per day. The minimum soil cover of the proposed tunnel is considered as 15 m from the ground surface and the soil is taken as soft silty –sand with clay and kankar

The results of predicted vibration due to TBM at Market yard Gultekdi station is shown in figure 4.1.

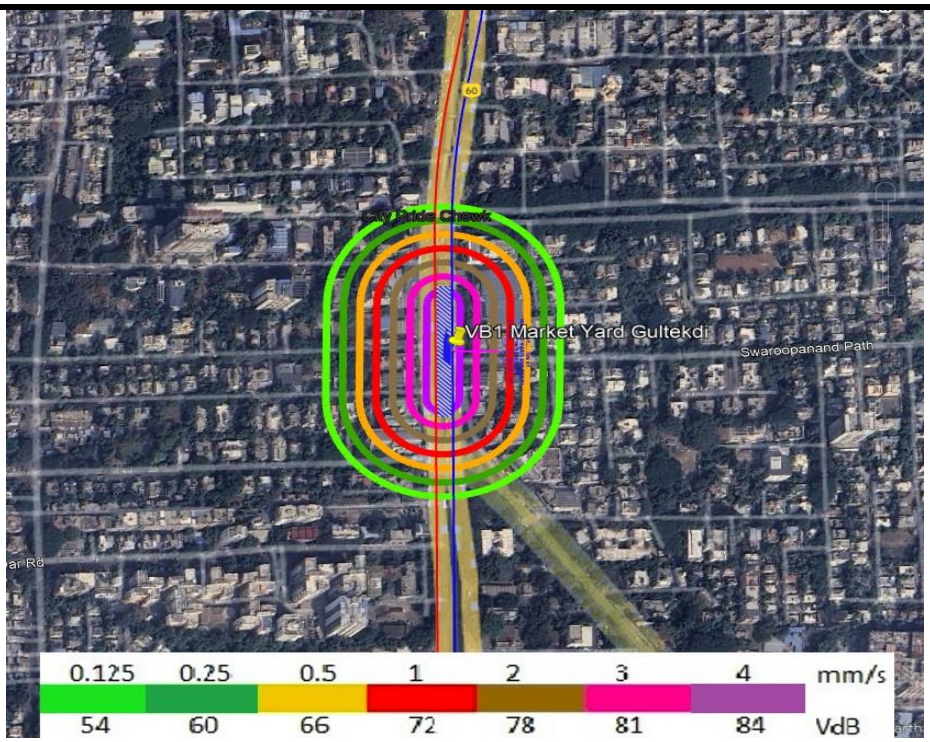



Figure 4.1: Predicted vibration contour due to TBM operation along Market yard Gultekdi

The proposed tunnel passes under the building and houses at Market Yard station Gultekdi. The vibration contours show that the least vibration caused by the TBM is about 3.5 mm/s (48VdB) which is at a centerline distance of about 1m from the Market yard station. The vibration due to drilling operation at station would not cause any damage to nearby buildings. However care should be taken during tunneling.

### 4.1.2 Prediction of Vibration due to Metro train operation at Market Yard Gultekdi

The vibration that can arise due to the passage of the metro train through the underground tunnel has been modeled and calculated using the Pipe-in-Pipe (PiP) model. The PiP model has been developed by a team of experts and scientist from Nottingham University, UK. It is commonly used to simulate the vibration that is generated in the tunnels due to train passage. The vibration is calculated in Power Spectral Density in VdB.

The graph shows that the vertical Power Spectral Density (PSD) increases with the frequency and became constant between 30 Hz to 80 Hz. The figure also shows the assumptions made for the prediction of vibrations. The velocity of the train is considered to be 80 km/hr. The vibration contours were then plotted which gives a clear picture of the vibration effect. The vibration graph is shown in figure 4.2.

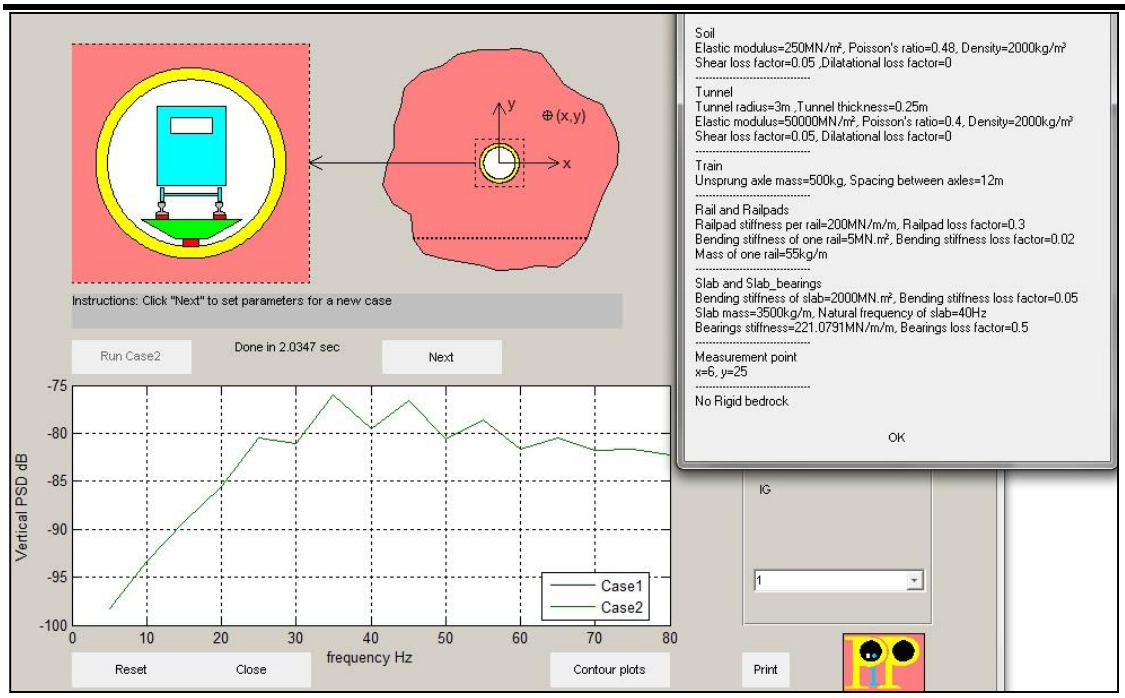



Figure 4.2: Vertical vibration level at "Market Yards station " due to the proposed metro-rail operation

The maximum vertical vibration that could occur due to train passing would be between 75 to 96 VDB, which has very minimum effect on the buildings at ground surface.

## 4.2 Station 2 : Padmavati Station

Padmavati station which is along the proposed Swargate to Katraj. The station is exactly on the center line of proposed metro rail alignment. Vibration modelling was conducted at this station in two cases: 1) during construction and during operation. 2) Vibration due to train operation.

### 4.2.1 Prediction of Vibration due to TBM and other construction activities

The prediction of vibration due to Tunnel Boring Machine (TBM) and also other construction activities has been modeled with the standard finite element method. All the parameters concerned with the TBM have been taken into account while considering the vibration prediction. The speed of the tunneling work with TBM is considered to be 10m per day. The minimum soil cover of the proposed tunnel is considered as 15 m from the ground surface and the soil is taken as soft silty –sand with clay and kankar

The results of predicted vibration due to TBM at Padmavati station is shown in figure 4.3.

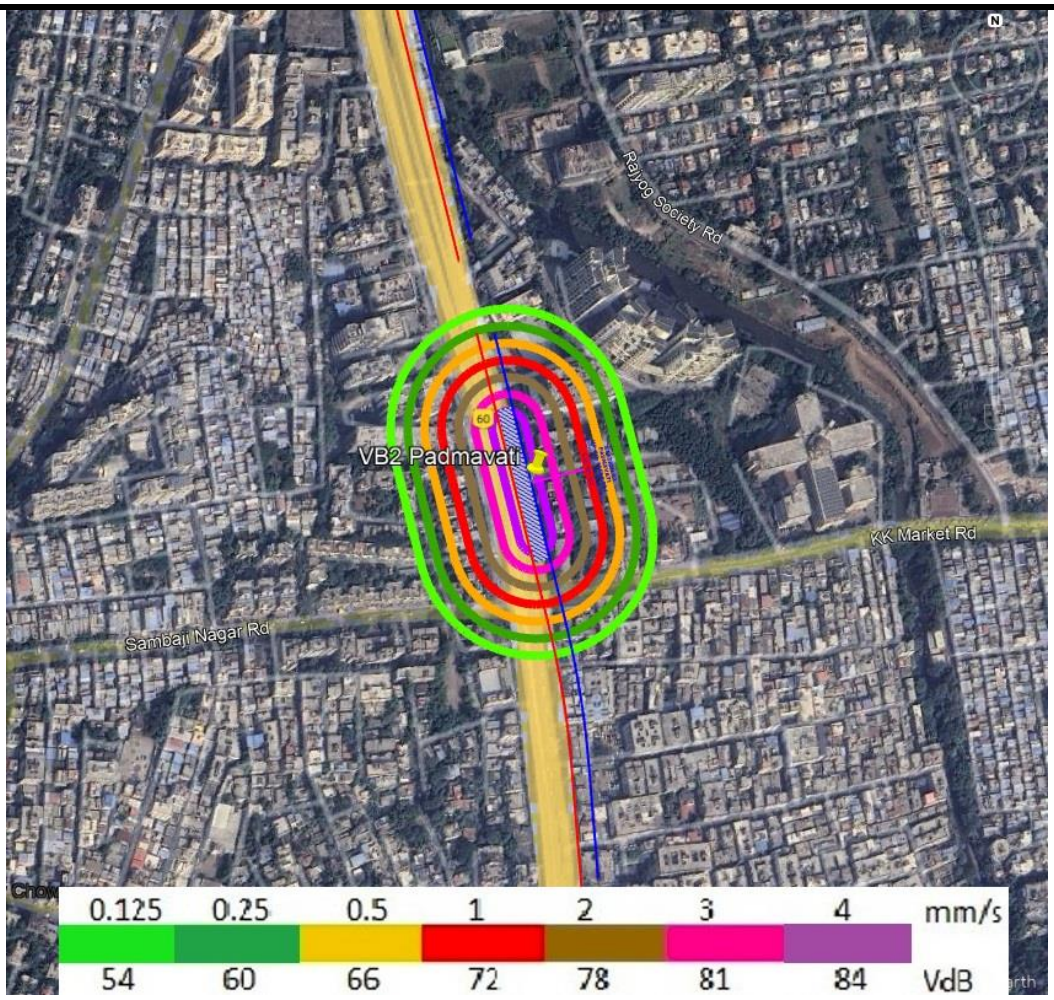



Figure 4.3: Predicted vibration contour due to TBM operation along Padmavati station

The proposed tunnel passes under the building and houses at Padmavati station. The vibration contours show that the least vibration caused by the TBM is about 4 mm/s (84VdB) which is at center line distance of about 1m from the Padmavati station. The vibration due to drilling operation at station would not cause any damage to nearby buildings. However, care should be taken during tunneling.

### 4.2.2 Prediction of Vibration due to Metro train operation at Padmavati Station

The graph shows that the vertical Power Spectral Density (PSD) increases with the frequency and became constant between 30 Hz to 80 Hz. The figure also shows the assumptions made for the prediction of vibrations. The velocity of the train is considered to be 80 km/hr. The vibration contours were then plotted which gives a clear picture of the vibration effect. The vibration graph is shown in figure 4.4.

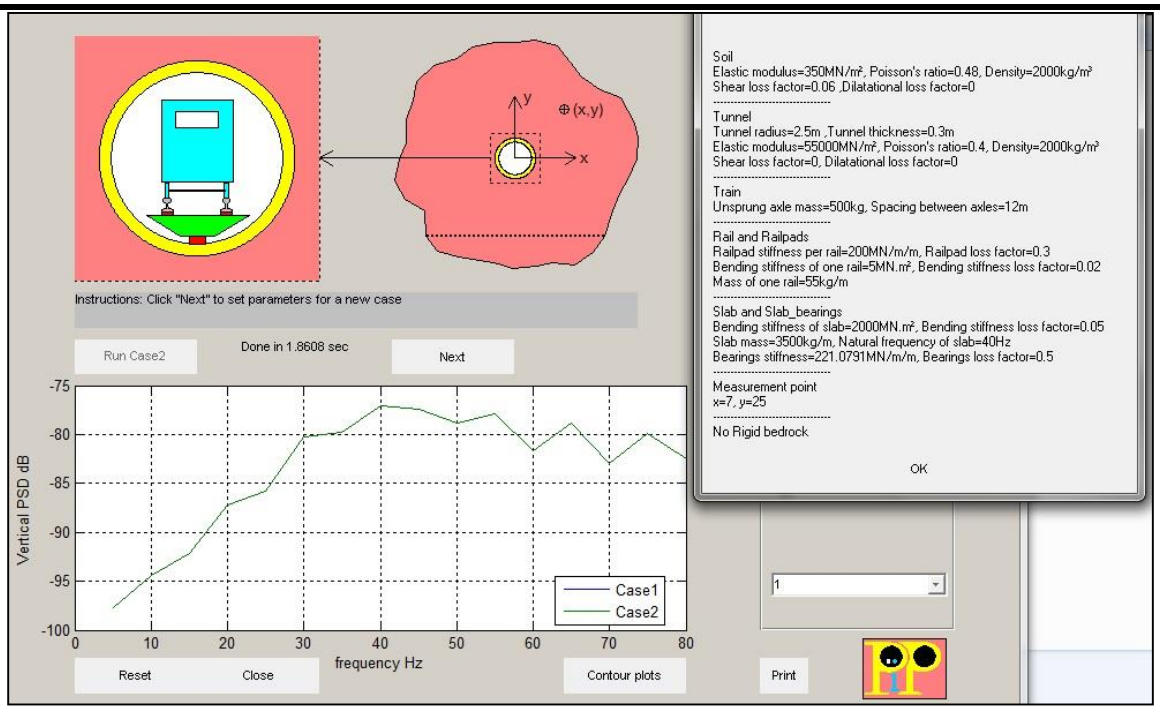



Figure 4.4: showing the predicted vibration contours due to train operation at Padmavati station

The above figure shows that maximum vibration is about 75 to 95 VdB at the ground surface and above the metro rail alignment. This reduces with distance, and at "Padmavati station", the vibration due to train passage would be well below the permissible limits and there would not be any vibration effects to the structure.

## 4.3 Station 3: Balaji Nagar station

Balaji Nagar Station is along the proposed Swargate to Katraj. The station is exactly on the center line of proposed metro rail alignment. Vibration modelling was conducted at this station in two cases: 1) during construction and during operation. 2) Vibration due to train operation.

### 4.3.1 Prediction of Vibration due to TBM and other construction activities

The prediction of vibration due to Tunnel Boring Machine (TBM) and also other construction activities has been modeled with the standard finite element method. All the parameters concerned with the TBM have been taken into account while considering the vibration prediction. The speed of the tunneling work with TBM is considered to be 10m per day. The minimum soil cover of the proposed tunnel is considered as 15 m from the ground surface and the soil is taken as soft silty –sand with clay and kankar

The results of predicted vibration due to TBM at Balaji nagar station is shown in figure 4.5.

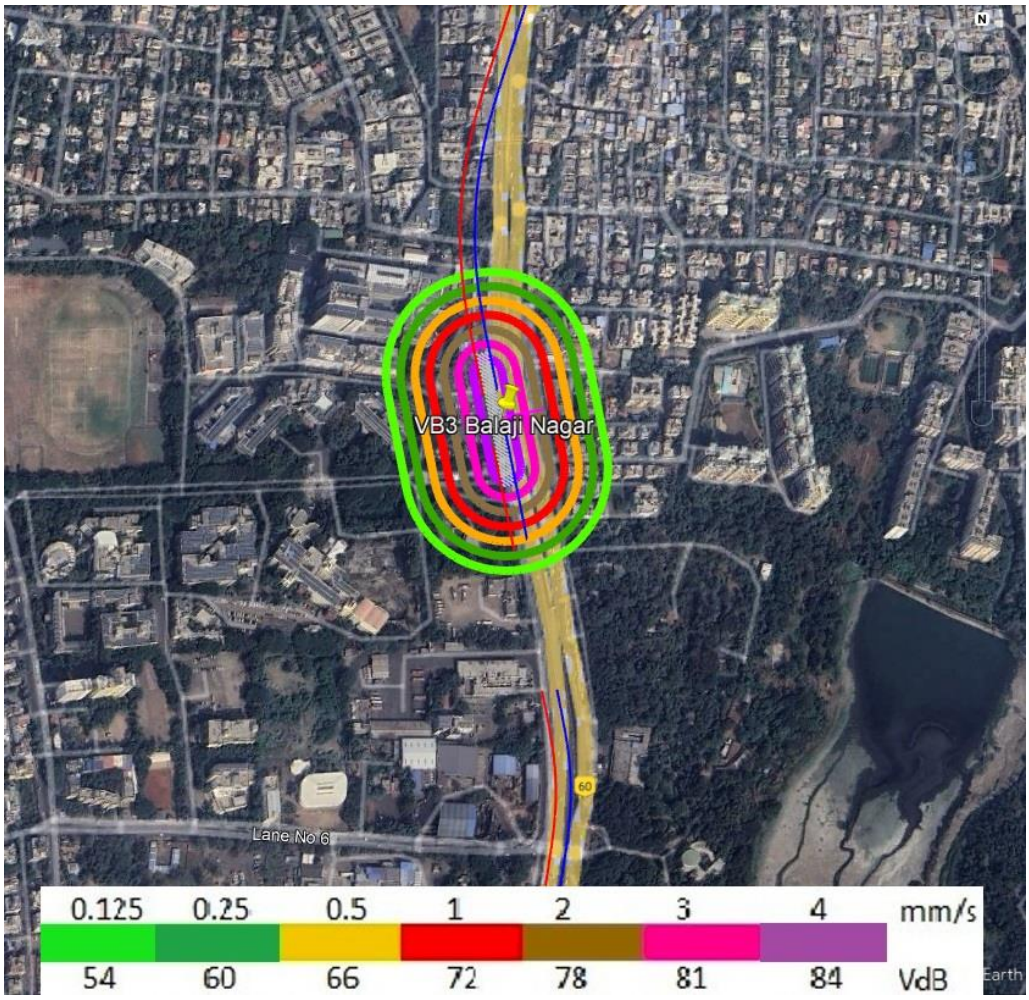



Figure 4.5: Predicted vibration contour due to TBM operation along Balaji Nagar

The proposed tunnel passes under the building and houses at Balaji Nagar station. The vibration contours show that the least vibration caused by the TBM is about 3.6 mm/s (82VdB) which is at center line distance of about 1m from the Balaji Nagar station. The vibration due to drilling operation at station would not cause any damage to nearby buildings. However, care should be taken during tunneling.

### 4.3.2 Prediction of Vibration due to Metro train operation at Balaji Nagar Station

The graph shows that the vertical Power Spectral Density (PSD) increases with the frequency and became constant between 30 Hz to 80 Hz. The figure also shows the assumptions made for the prediction of vibrations. The velocity of the train is considered to be 80 km/hr. The vibration contours were then plotted which gives a clear picture of the vibration effect. The vibration graph is shown in figure 4.6.

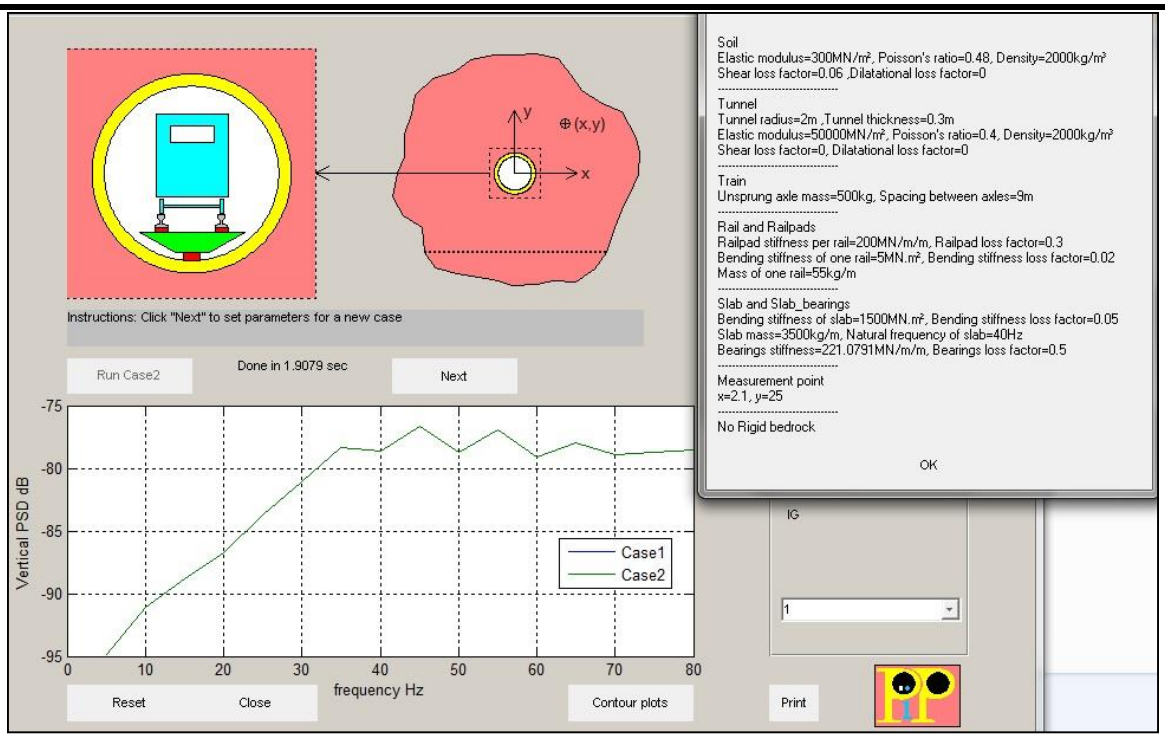



Figure 4.6: showing the predicted vibration contours due to train operation at Balaji Nagar station

The above figure shows that maximum vibration is about 75 to 95 VdB at the ground surface and above the metro rail alignment. This reduces with distance, and at "Balaji nagar station", the vibration due to train passage would be well below the permissible limits and there would not be any vibration effects to the structure.

## 4.4 Location 4: Katraj Station

Katraj Station is along the proposed Swargate to Katraj. The station is exactly on the center line of proposed metro rail alignment. Vibration modelling was conducted at this station in two cases: 1) during construction and during operation. 2) Vibration due to train operation.

### 4.4.1 Prediction of Vibration due to TBM and other construction activities

The prediction of vibration due to Tunnel Boring Machine (TBM) and also other construction activities has been modeled with the standard finite element method. All the parameters concerned with the TBM have been taken into account while considering the vibration prediction. The speed of the tunneling work with TBM is considered to be 10m per day. The minimum soil cover of the proposed tunnel is considered as 15 m from the ground surface and the soil is taken as soft silty –sand with clay and kankar

The results of predicted vibration due to TBM at Katraj station is shown in figure 4.7.

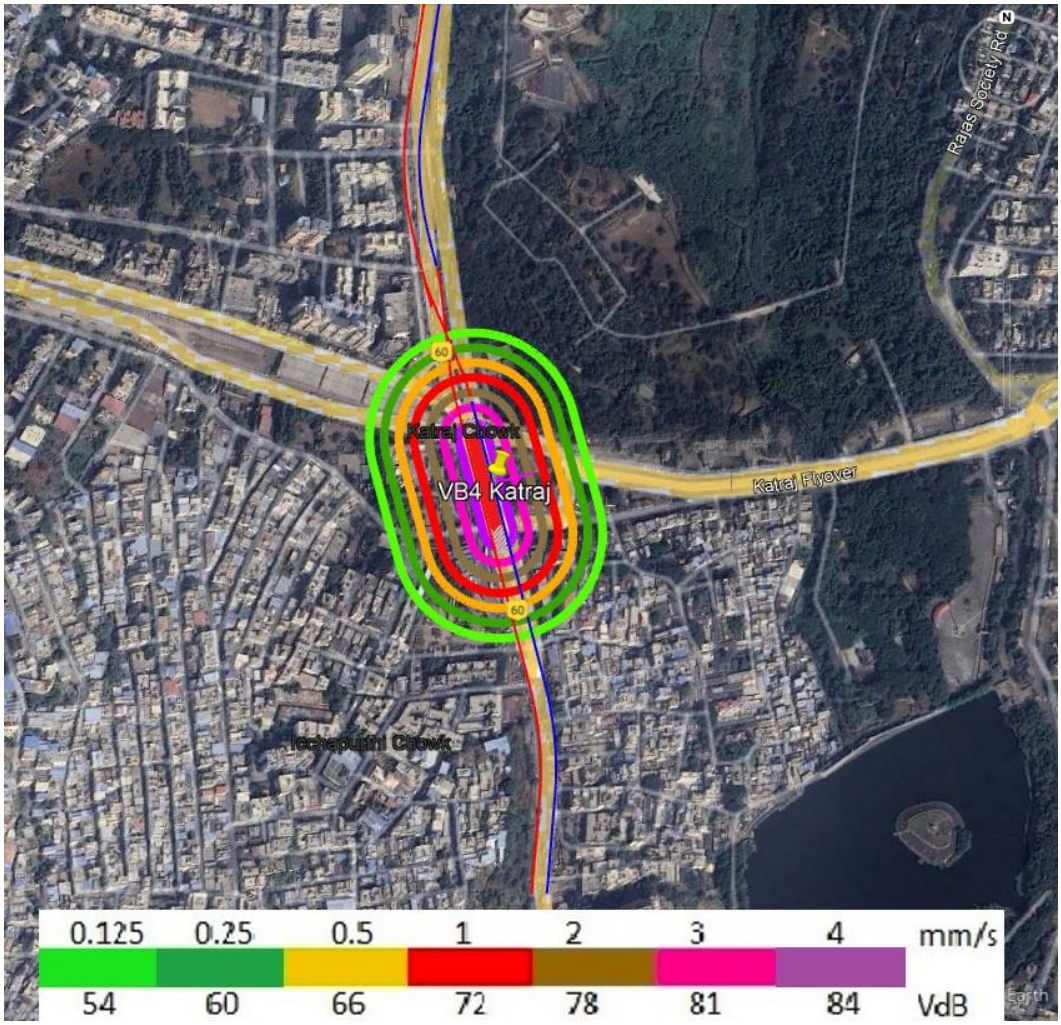



Figure 4.7: Predicted vibration contour due to TBM operation along Katraj Nagar

The proposed tunnel passes under the building and houses at Katraj station. The vibration contours show that the least vibration caused by the TBM is about 3.4 mm/s (82VdB) which is at center line distance of about 1m from the Katraj station. The vibration due to drilling operation at station would not cause any damage to nearby buildings. However, care should be taken during tunneling.

### 4.4.2 Prediction of Vibration due to Metro train operation at Katraj Station

The graph shows that the vertical Power Spectral Density (PSD) increases with the frequency and became constant between 30 Hz to 80 Hz. The figure also shows the assumptions made for the prediction of vibrations. The velocity of the train is considered to be 80 km/hr. The vibration contours were then plotted which gives a clear picture of the vibration effect. The vibration graph is shown in figure 4.8.

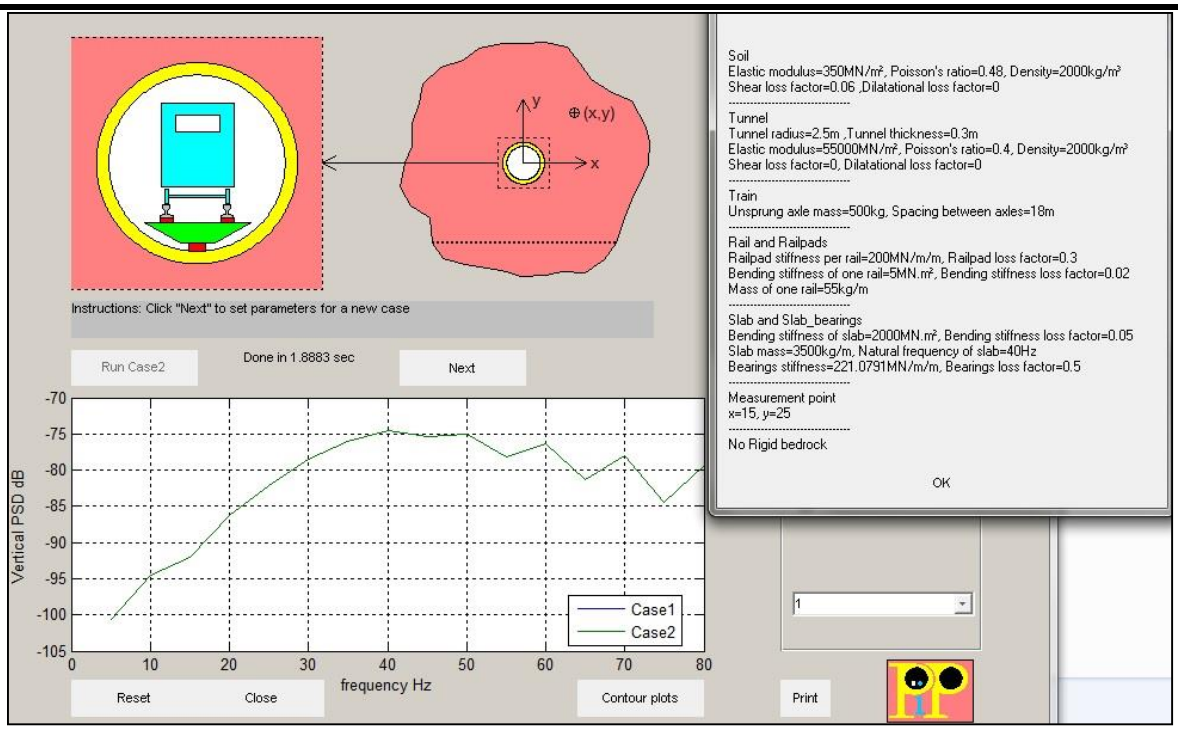



Figure 4.8: showing the predicted vibration contours due to train operation at Katraj station

The above figure shows that maximum vibration is about 75 to 100 VdB at the ground surface and above the metro rail alignment. This reduces with distance, and at "Katraj station", the vibration due to train passage would be well below the permissible limits and there would not be any vibration effects to the structure.

# 5 Conclusion

## 5.1 Vibration comparison with criteria mentioned in DGMS standards

Directorate General of Mines and Safety (DGMS), has published the limits for ground vibration for various type of structures. The following table describes the prescribed permissible limits of ground vibration in India, according to the Directorate General of Mines and Safety (DGMS).

**Table 5.1: Directorate General of Mines and Safety (DGMS) prescribed permissible limit of ground vibration (INDIA).**

| Type of Structures | Dominant excitation frequency (Hz) | | |
|---|---|---|---|
| | < 8Hz | 8-25 Hz | >25hz |
| ***(A)Buildings/Structures not belong to the owner*** | | | |
| (i) Domestic houses/structure (Kuchcha, bricks & cement) | 5 mm/s | 10mm/s | 15 mm/s |
| (ii) Industrial Buildings (RCC & Framed structures) | 10 mm/s | 20 mm/s | 25 mm/s |
| (iii) Objects of historical importance & sensitive structures | 2 mm/s | 5 mm/s | 10 mm/s |
| ***(B)Buildings belonging to owner with limited span of life*** | | | |
| (i) Domestic house/structures (kuchcha, brick & cement) | 10 mm/s | 15 mm/s | 25 mm/s |
| (ii) Industrial buildings (RCC & framed structures) | 15 mm/s | 25 mm/s | 50 mm/s |

The results of the predicted vibration was compared with the DGMS standards as shown in table 5.2:

Table 5.2: Vibration modelling results compared with standards

| Location code. | Location | During Construction vibration modelling (mm/s) | During operation vibration modelling (VdB) | Vibration standard in (mm/s) | Vibration standard in (VdB) |
|---|---|---|---|---|---|
| VB1 | Station 1 (Market Yard, Gultekdi) | 3.5 | 96 | 5 | 134 |
| VB2 | Station 2 (Padmavati) | 4 | 95 | 5 | 134 |
| VB3 | Station 3 (Balaji Nagar) | 3.6 | 95 | 5 | 134 |

| | | | | | |
|---|---|---|---|---|---|
| VB4 | Station 4 (Katraj) | 3.4 | 100 | 5 | 134 |

The table 5.2 shows that the vibration levels monitored at various locations are within the DGMS limits. Thus, there would be any significant impact on the structures due to the operation of metro rail.

# Annexure-12:

List of Sensitive Receptors

# Annexure – 12: List of Sensitive Receptors (Religious, Cultural, Community Resources)

**along Swargate to Katraj (PMRP Phase 1 extension)**

| Sr. | Description | Type | Nearest Distance from alignment (m) | Direction | Latitude | Longitude |
|---|---|---|---|---|---|---|
| 1 | Kidzee Pre School, Primary School & Day Care | Education | 156.7 | W | 18°27'6.96"N | 73°51'23.72"E |
| 2 | Shree Balaji English Medium School | Education | 139 | W | 18°27'57.09"N | 73°51'24.44"E |
| 3 | Angels day care Bibvewadi | Education | 66 | W | 18°28'47.93"N | 73°51'23.40"E |
| 4 | Taal Tarangini School of Performing Arts | Education | 30.5 | ENE | 18°30'2.38"N | 73°51'29.03"E |
| 5 | Prakash Pawar Primary School (40G PMC school) | Education | 95.13 | NW | 18°29'38.51"N | 73°51'20.44"E |
| 6 | City International School, Maharshi Nagar | Education | 68.24 | E | 18°27'42.79"N | 73°51'32.99"E |
| 7 | Bharati Vidyapeeth Deemed University Pune | Education | 21.89 | WNW | 18°27'28.54"N | 73°51'27.86"E |
| 8 | ICE College of Hotel Management & Catering Technology, Pune | Education | 65.5 | WNW | 18°27'57.20"N | 73°51'26.96"E |
| 9 | Vishwas Institute of Paramedical Science | Education | 25.25 | W | 18°27'58.35"N | 73°51'27.94"E |
| 10 | Pushpa Devi Dugad Jr College | Education | 6.37 | SW | 18°29'32.02"N | 73°51'26.11"E |
| 11 | YCI College of CNC Technology | Education | 0 (Lies on alignment) | | 18°27'51.49"N | 73°51'30.42"E |
| 12 | Swaraj College of Arts, Commerce and Science | Education | 84.67 | ESE | 18°27'42.79"N | 73°51'32.99"E |
| 13 | Olive Clinic (Childrens Hospital), Katraj | Health/Hospital | 83.47 | WSW | 18°26'57.99"N | 73°51'26.59"E |
| 14 | Royal Hospital, Dhankawadi | Health/Hospital | 19.74 | W | 18°27'4.16"N | 73°51'27.39"E |
| 15 | Bharati Hospital, Bharati Vidyapeeth Campus, Dhankawadi | Health/Hospital | 61.14 | WNW | 18°27'33.55"N | 73°51'26.17"E |
| 16 | Asha Nursing Home - Dr. Modi Children's Clinic | Health/Hospital | 104 | WSW | 18°28'26.28"N | 73°51'19.64"E |
| 17 | Shivshankar Pote Hospital, Parvati Paytha, Pune | Health/Hospital | 52 | WNW | 18°28'35.43"N | 73°51'21.72"E |
| 18 | Siddhant Maternity Home, Parvati Paytha, Pune | Health/Hospital | 16.5 | W | 18°28'45.21"N | 73°51'24.00"E |
| 19 | Lalwani Mother and Child Care Hospital, Parvati Paytha, Pune | Health/Hospital | 14 | WSW | 18°28'58.53"N | 73°51'25.28"E |

| | | | | | | |
|---|---|---|---|---|---|---|
| 20 | Mahajan Multispeciality Hospital, Parvati Darshan, Pune | Health/Hospital | 44 | WNW | 18°29'2.21"N | 73°51'25.14"E |
| 21 | Madhavbaug - Aranyeshwar, Pune Satara road, Pune. | Health/Hospital | 75 | NW | 18°29'7.68"N | 73°51'23.85"E |
| 22 | Kothari Orthopaedic Hospital, Parvati Paytha, Pune | Health/Hospital | 11.55 | NW | 18°29'20.84"N | 73°51'25.94"E |
| 23 | Sampadan Hospital | Health/Hospital | 36 | SW | 18°29'30.42"N | 73°51'26.48"E |
| 24 | Shanikrupa, near Laxmi Narayan Theatre, Swargate | Health/Hospital | 41.8 | NE | 18°29'39.64"N | 73°51'26.99"E |
| 25 | Sanrang Pani Hospital | Health/Hospital | 26 | ENE | 18°29'17.39"N | 73°51'28.32"E |
| 26 | Vimal Nursing Home Multispeciality Hospital and Criticare Center, Dhankawadi, Pune | Health/Hospital | 0 (Lies on alignment) | | 18°28'2.83"N | 73°51'29.25"E |
| 27 | Sangam Hospital - Bibwewadi IVF & Maternity Centre, Padmavati Nagar Pune | Health/Hospital | 142 | ESE | 18°28'32.64"N | 73°51'28.23"E |
| 28 | Shri Sai Temple, Katraj, Pune | Religious | 91 | WNW | 18°27'14.55"N | 73°51'27.43"E |
| 29 | Rudra Math | Religious | 65 | NW | 18°27'41.00"N | 73°51'26.78"E |
| 30 | Balaji Temple | Religious | 74 | WNW | 18°27'42.48"N | 73°51'26.75"E |
| 31 | Gagangiri Maharaj Matth | Religious | 33 | WSW | 18°27'49.69"N | 73°51'28.27"E |
| 32 | Durga Mata Mandir, Pune | Religious | 161 | WSW | 18°28'23.38"N | 73°51'18.14"E |
| 33 | Shree Kalubai Mata Mandir, Parvati Paytha, Pune | Religious | 66 | SW | 18°28'28.29"N | 73°51'20.60"E |
| 34 | Shri Sadguru Bhagwan Shridhar Swamiji Ashram | Religious | 117 | WNW | 18°28'34.95"N | 73°51'19.09"E |
| 35 | Adinath Society Shwetamber Jain Temple | Religious | 102 | ENE | 18°29'26.43"N | 73°51'31.97"E |
| 36 | Shree Saptashrungi Mahalaxmi Mandir | Religious | 146 | E | 18°29'5.60"N | 73°51'32.80"E |
| 37 | Shri Vasupujya Swami Bhagwan Shwetamber Jain temple | Religious | 57 | E | 18°28'16.50"N | 73°51'28.53"E |
| 38 | Shree Sadguru Shankar Maharaj Samadhi Math | Religious | 0 (Lies on alignment) | | 18°28'13.08"N | 73°51'26.80"E |
| 39 | Inamiya Masjid, Balaji Nagar, Pune | Religious | 153 | E | 18°28'4.16"N | 73°51'34.42"E |
| 40 | Church of Christ, Dhankawadi, Pune | Religious | 81 | ENE | 18°27'43.16"N | 73°51'32.88"E |
| 41 | Pune City Vipassana Centre, Saras Baug Rd, Dadawadi, Pune | Religious | 119 | WNW | 18°29'59.35"N | 73°51'18.80"E |
| 42 | Parvati Post Office | PCR | 14 | W | 18°29'30.35"N | 73°51'26.82"E |
| 43 | India post Pune City H.O, Parsanees Colony, Maharshi Nagar, Pune | PCR | 28 | E | 18°29'23.01"N | 73°51'28.29"E |

| | | | | | | |
|---|---|---|---|---|---|---|
| 44 | Jawaharlal Nehru Stadium, Dadawadi, Pune | PCR | 146 | WSW | 18°30'6.66"N | 73°51'19.80"E |
| 45 | Sarasbaug - Garden | PCR | 400 | W | 18°30'2.92"N | 73°51'10.90"E |
| 46 | Rajiv Gandhi Zoological Park and Wildlife Research Centre,Katraj | PCR | 70 | ESE | 18°27'8.77"N | 73°51'38.78"E |
| 47 | Anna Bhau Sathe Auditorium | PCR | 61 | SE | | |
| 48 | Nityanand Hall, Dhankawadi, Pune | PCR | 142 | WNE | 18°28'0.06"N | 73°51'24.05"E |
| 49 | Walvekar Lawns, Katraj | PCR | 25 | WNW | 18°28'55.03"N | 73°51'24.38"E |
| 50 | Shreyas Siddhi Banquet Hall, Swargate | PCR | 8.8 | WSW | 18°29'32.07"N | 73°51'26.25"E |
| 51 | Lakake Hall, MCCIA, Tilak Road | PCR | 0 (Lies on alignment) | | 18°30'5.11"N | 73°51'28.61"E |
| 52 | Mini Dhamma Hall - Dhamma Punna, Dadawadi | PCR | 120 | W | 18°29'57.68"N | 73°51'22.09"E |
| 53 | Swayamvar Mangal Karyalay, Parsanees Colony, Maharshi Nagar | PCR | 34 | E | 18°29'26.09"N | 73°51'28.77"E |
| 54 | Pushp Mangal Karyalaya, Satara Rd, Maharshi Nagar | PCR | 77 | E | 18°29'11.57"N | 73°51'30.10"E |
| 55 | Sangam Hall & Banquets, Bibwewadi, Pune | PCR | 38 | SE | 18°28'34.37"N | 73°51'25.61"E |

# Annexure-13:

Public Consultation Report

## Public Consultation
## for
## Swargate to Katraj (Phase-1 Extension) of the Pune Metro Rail Project (PMRP)

- The Swargate to Katraj (Phase-1 Extension) of the Pune Metro Rail Project (PMRP) is a significant infrastructure initiative aimed at improving urban mobility in the rapidly growing Pimpri-Chinchwad region.
- This extension is completely underground continuing from the existing underground alignment and covers five underground stations namely Market Yard (Gultekdi), Bibwewadi, Padmavati, Balajinagar and Katraj.
- The project, financed by the European Investment Bank (EIB), addresses the increasing demand for an efficient and sustainable public transport system, helping reduce traffic congestion, air pollution, and reliance on private vehicles.
- The Environmental and Social Impact Assessment (ESIA) and Environmental and Social Management Plan (ESMP) have been prepared in accordance with national regulations and the environmental and social standards of the EIB.

As per EIB Environmental & Social Standards (ESS) 2022,

*"In order to ensure the effective participation of the identified stakeholders, the promoter shall make available to the public the following information in the most accessible way and as soon as it can reasonably be provided:*

a. *The purpose, nature and scale of the project, including the duration of proposed project activities;*
b. *The description of the likely project impacts and risks for local communities, as well as the proposed mitigation and/or compensatory/remedial measures as defined in Standard 1;*
c. *As and where applicable, the description of potential impacts and risks that might disproportionately affect vulnerable, marginalised, and/or discriminated-against groups and an overview of the different measures proposed to avoid and minimise these;*
d. *The proposed stakeholder engagement process and opportunities for public participation, including locations and dates of any envisaged public consultation meetings, and the process by which meetings are notified and reported, as described in the SEP and its revisions/updates where applicable;*
e. *The available project-level grievance or feedback mechanism, the EIB Group's Complaints Mechanism20 and how stakeholders can access them; and*
f. *Any opportunities for benefit-sharing and added value for affected communities, where applicable."*

Accordingly, Maha-Metro (PMRP) with the help of MITCON (the environmental consultant engaged for preparation of the ESIA) organised Public Consultations at following two locations along the PMRP South extension (Swargate to Katraj) alignment:

- Location 1: ..... Proposed Metro Station → Katraj .....
- Location 2: ..... D.Mart - Bibewadi .....

Notice for the same was given in the identified areas one week in advance (i.e. on 1st April, 2025) in the form of posters put up at bus stations and other locations along the alignment, frequented by general public. Following persons attended the Public Consultations and were informed about all relevant details of the project as mentioned above:

## Attendance Sheet

**Date** : 09/04/2025
**Location 1** : Proposed Katraj Metro Station
**Start Time** : 03:30 pm
**End Time** : 4:10 pm

| Sr. No. | Name of Stakeholder | Contact No. | Occupation | Signature |
|---|---|---|---|---|
| 1) | Sunny Laxman Gaikwad | 8121186140 | Auto Driver | |
| 2) | Suraj jon Mhaske | | -11- | |
| 3) | Pravin Sonawane | | -11- | |
| 4) | Bajrang Yadav | | -11- | |
| 5) | Shekhar Pujari | 9860820247 | -11- | |
| 6) | Vinod Yadav | | -11- | |
| 7) | Shilpa kedari | | Service | |
| 8) | Neha joshi | | student | |
| 9) | Pramila Naik | | Teacher | |
| 10) | Dipti Kakad | | Service | |
| 11) | Mayuri more | | student | |
| 12) | Sanjay Payagude | 9850107055 | Auto driver | |
| 13) | Shekar kudale | 7276938891 | Auto driver | |
| 14 | Suresh Aikude, | 7218142450 | -11- | |
| 15 | Harshubhau Doijode | | -11- | |
| 16) | Jagat Kote | — | -11- | |
| 17) | Paasad Patil | - | Service | |
| 18) | Sheela Patil | | Housewife | |
| 19) | Pramod Shirke | | service | |
| 20) | Nityanand Sinha | | -11- | |
| 21) | Tukaram Kadam | | -11- | |
| 22) | Vishvesh Patil. | | -11- | |
| 23) | Rohit Kamble | | Student | |

## Attendance Sheet

**Date** : 09/04/2025
**Location 2** : D Mart - Bibewadi
**Start Time** : ~~5:00 pm to 5:45 pm~~
**End Time** : 5.45 pm

| Sr. No. | Name of Stakeholder | Contact No. | Occupation | Signature |
|---|---|---|---|---|
| 1) | Dinesh Shetty | 9890508335 | Pan stall owner | |
| 2) | Sachin Bora | | Tours shop | Sachin |
| 3) | Namrata Ubhe | | Shop owner | |
| 4) | Lalit Pawar | | student | |
| 5) | Shree More | | Student | |
| 6) | Saurabh Joshi | | service | |
| 7) | Naman Bhatia | | Teacher | |
| 8) | Pratik Shinde | | Student | |
| 9) | Vinayak Paruijne | | Retired | |
| 10) | Aditya Desai | | Service | |
| 11) | Vaibhav S. Koli | 7972066693 | Service | |
| 12) | Tajdeep Shirole | 7756007935 | Banker | |
| 13) | Tushar Vaz | 7199600041 | Banker | |

**Some Photographs taken during Formal Public Consultations undertaken at the Proposed Metro Station (Katraj) and at D-Mart (Bibwewadi) along the Swargate to Katraj (PMRP Phase 1 Extension)**













# ENVIRONMENTAL & SOCIAL IMPACT ASSESSMENT (ESIA)

# AND

# ENVIRONMENTAL & SOCIAL MANAGEMENT PLAN (ESMP)

# FOR

# PUNE METRO RAIL PROJECT PHASE-1 EXTENSION

# (SWARGATE TO KATRAJ ALIGNMENT)

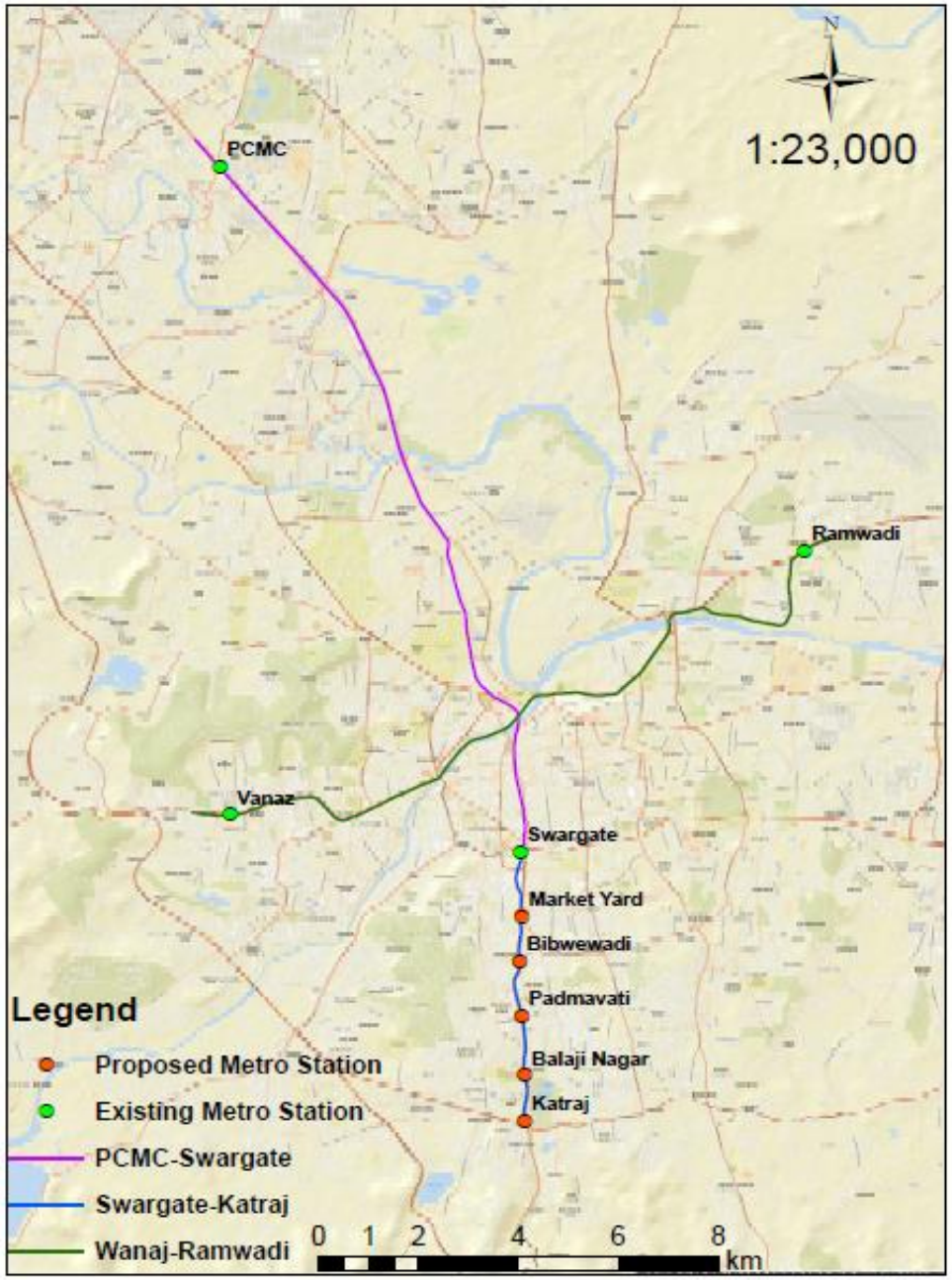
# Project Brief

The Swargate to Katraj (Phase-1 Extension) is a vital part of Pune's urban transit expansion, aimed at providing efficient, safe, and environmentally friendly transport options. This extension will integrate seamlessly with existing metro infrastructure and enhance commuter convenience.

- **Project Name:** Swargate to Katraj Metro (Phase-1 Extension).
- **Corridor Type:** Fully underground**.**
- **Total Length:** 5.9 km.
- **Funding Agency:** European Investment Bank (EIB).
- **Implementation Agency:** Maharashtra Metro Rail Corporation (Maha Metro).
- **Associated Infrastructure:** Stations, ventilation shafts, emergency exits, electrical substations.
- **Stations Covered:** Station 1 (Market Yard, Gultekdi), Station 2 (Bibwewadi), Station 3 (Padamavati), Station 4 (Balajinagar), Station 5 (Katraj)

| Corridor | Stations | | | Length (in Km) | | |
|---|---|---|---|---|---|---|
| | Underground | At Grade | Total | Elevated | Underground | Total |
| Swargate to Katraj (Phase-1 Extension) | 5 | 0 | 5 | 0 | 5.9 | 5.9 |
| **Total** | **5** | **0** | **5** | **0** | **5.9** | **5.9** |

# Alignment Map Showing Station Locations






# **Legal Framework (**Applicable Legal Framework for the Project as per GOI Guidelines**)**

| | |
|---|---|
| Environment (Protection) Act (1986) and Rules (1986) | National Conservation Strategy and Policy Statement on Environment and Development of 1992 |
| National Environment Policy of 2006 | Environmental impact assessment (EIA) under EIB's Environmental and Social Standards (updated in February 2022) |
| The Noise Pollution (Regulation and Control) Rules, 2000 (Amended 2002) | The Water (Prevention and Control of Pollution) Act 1972 (Amended 1988) and Rules 1974 |
| Metro Rail Transit System, Guidelines for Noise and Vibrations, RDSO, Ministry of Railways, September 2015 | The Maharashtra Prevention of Water Pollution Act, 1969 (Amended 1981) |
| The Air (Prevention and Control of Pollution) Act, 1981(Amended 1987) and Rules 1982 | Policy Statement for Abatement of Pollution of 1992 |
| Municipal Solid Waste (MSW) Rules, 2000 | Solid Waste Management Rules, 2016 |
| Hazardous and Other Wastes (Management and Transboundary Movement) Amendment Rules 2019 | Construction and Demolition Waste Management Rules, 2016 |
| Guidelines on Environmental Management of Construction and Demolition (C&D) Waste, March 2017 | The Mines and Minerals (Development and Regulation) Act, 1957 |
| Central Motor Vehicle Act (1988) and Rules (1988 | Indian Treasure Trove Act, 1878 (as modified up to September 1949); Ancient Monuments and Archaeological Sites and Remains Act (1958) |
| Interstate Migrant Workmen (Regulation of Employment and conditions of Service) Act 1979 | Child and Adolescent Labour (Prohibition and Regulation) Act, 1986 |
| Occupational Safety, Health and Working Conditions Code, 2020 (OHSWC Code) | Maharashtra Building and Other Construction Workers (Regulation of Employment and Conditions of Service) Rules, 2007 |
| Employees State Insurance Act, 1948 (ESI) | Workmen's Compensation Act, 1923 |

# Baseline / Findings

## Methodology:

- **Primary data collection:** Air, water, soil, noise, vibration monitoring.
- **Secondary data sources:** Meteorology, biodiversity, socio-economics, hydrogeology, traffic study.
- Field surveys and interactions with stakeholders.

**Physical Environment & Geology**

**Physiography:**

The region is part of the Western Ghats and Deccan Plateau, characterized by hills, valleys, and plains.

**Three distinct topographical belts:** western (rugged terrain), central (hills and plateaus), eastern (gradual slopes and plains).

**Major drainage systems:** Bhima-Ghod, Mula-Mutha, and Nira Rivers, contributing to the hydrogeological framework.

**Geology:**

Dominated by Deccan Volcanic Basalts of Upper Cretaceous to Eocene age.

Composed of simple and compound lava flows with varied porosity and water retention capacities.

Presence of dykes and fractures, which influence groundwater movement and availability.

**Hydrogeology:**

**Two major aquifer systems:** Shallow (9-30m) and Deep (48-175m) basalt formations.

Groundwater occurs in phreatic to semi-confined conditions, with variable yield potential.

# Baseline / Findings

## Ambient Air Quality (6 Locations Monitored)

| Pollutant | NAAQS Limit | WHO Guideline | Range Found | Observation |
|---|---|---|---|---|
| PM2.5 (µg/m³) | 60 | 15 | 21.74 – 37.85 | Air quality is **within NAAQS limits** but exceeds WHO guidelines for **PM10, PM2.5, NOx, and SO2**. |
| PM10 (µg/m³) | 100 | 45 | 47.14 – 87.41 | |
| SO2 (µg/m³) | 80 | 40 | <10 – 25.74 | |
| NOx (µg/m³) | 80 | 25 | 15.54 – 34.85 | |
| CO (mg/m³) | 2 | 4 | 0.08 – 1.85 | |

## Noise Level (6 Locations Monitored)

| Location | Zone | Day Time (dB) | Night Time (dB) | CPCB Limit (dB) | Observation |
|---|---|---|---|---|---|
| Swargate Metro Station | Commercial | 64.2 | 53.7 | 65/55 | Noise levels are **within CPCB limits** |
| Parvati Post Office | Commercial | 46.8 | 42.1 | 65/55 | |
| Market Yard Gultekdi Metro Station | Commercial | 64.7 | 54.2 | 65/55 | |
| Padmavati Metro Station | Commercial | 63.5 | 54.3 | 65/55 | |
| YCI College of CNC Technology | Silent | 52.7 | 45.2 | 50/40 | |
| Katraj Metro Station | Commercial | 64.1 | 53.5 | 65/55 | |

# Baseline / Findings

## Water Quality (4 Groundwater & 4 Surface Water Locations)

| Parameter | IS 10500 Limit | Groundwater (Range) | Surface Water (Range) | Observation |
|---|---|---|---|---|
| pH | 6.5 - 8.5 | 7.19 – 7.39 | 7.18 – 7.32 | ▪ Groundwater is **safe for drinking** but **hardness is slightly high**.<br>▪ Surface water is **contaminated with coliform bacteria**, requiring **treatment before use**. |
| Total Dissolved Solids (mg/l) | ≤ 500 | 142 – 267 | 185 – 224 | |
| Total Hardness (mg/l) | ≤ 200 | 82.52 – 137.15 | 92.16 – 116.45 | |
| Chloride (mg/l) | ≤ 250 | 38.7 – 42.16 | 13.02 – 23.25 | |
| Fluoride (mg/l) | ≤ 1.0 | <0.1 | <0.1 | |
| BOD (mg/l) | ≤ 3 | - | 4 – 13 | |
| DO (mg/l) | ≥ 4 | - | 3.2 – 5.1 | |
| Total Coliform (MPN/100ml) | 0 | Absent | Present | |

# Baseline / Findings

## Soil Analysis Results (5 Locations):

| Parameter | Range Found | Standard Classification | Observation |
|---|---|---|---|
| Soil Moisture (%) | 13.15 – 18.12 | Low to moderate | ▪ Soil quality is **poor for agriculture** in the project area. |
| Water Holding Capacity (%) | 31.15 – 61.45 | Moderate | |
| Organic Carbon (%) | 0.16 – 0.18 | Low | |
| Nitrogen (kg/ha) | 90.16 – 114.53 | Very Low | |
| Phosphorus (kg/ha) | 5.23 – 8.92 | Poor | |
| Potassium (kg/ha) | 102.18 – 135.78 | Moderate | |

## Biological Aspects-Vegetation:

- 175 trees impacted due to metro alignment.
- Most affected trees are near Rajiv Gandhi Zoological Park.

## Total Species Identified:

- 310 plant species (211 trees, 32 herbs, 27 shrubs, 40 climbers).
- Several near-threatened and vulnerable species recorded.

## Faunal Survey (10 km radius):

- Presence of mammals, birds, reptiles, and butterflies documented.
- Fish species identified through market surveys & local consultations.

# Impact & Mitigation

## Significance of the Project:

| Impact Category | Significance | Nature of Impact |
|---|---|---|
| Public Transport | High – Enhances connectivity and accessibility. | Permanent Positive Impact |
| Traffic Congestion | High – Reduces dependency on private vehicles. | Permanent Positive Impact |
| Economic Growth | Medium – Boosts local business opportunities. | Permanent Positive Impact |
| Environmental Impact | Moderate – Air & noise pollution during construction. | Temporary Negative Impact |
| Social Impact | Moderate – Disruptions to local businesses & traffic. | Temporary Negative Impact |

## Environmental & Social Impact:

| Impact Area | Potential Impact | Duration | Severity |
|---|---|---|---|
| Air Quality | Increased dust & emissions. | Temporary | Moderate |
| Noise & Vibration | Higher levels near sensitive areas. | Temporary | Moderate |
| Water Resources | Risk of groundwater contamination. | Temporary | Low |
| Biodiversity | Some tree cutting; minimal wildlife impact. | Permanent | Low |
| Traffic Disruption | Increased congestion during construction. | Temporary | High |
| Community Impact | Restricted access to businesses & public services. | Temporary | Moderate |

# Impact & Mitigation

## Mitigation Measures:

| Impact Category | Mitigation Strategy | Implementation Stage |
|---|---|---|
| Air Pollution | Dust suppression, emission control on machinery. | Construction |
| Noise Control | Noise barriers, low-noise equipment. | Construction |
| Water Protection | Proper wastewater disposal, groundwater monitoring. | Construction |
| Waste Management | Safe disposal of hazardous and construction waste. | Construction |
| Traffic Control | Diversion plans, traffic marshals, road safety measures. | Construction |
| Social Measures | Compensation, local employment (50%), grievance redressal. | Pre & Construction |

## Residual Impact After Mitigation:

| Stage | Expected Residual Impact | Impact Level |
|---|---|---|
| Construction | Moderate – Some air, noise, and traffic issues will remain. | Medium |
| Operation | Minimal – Improved transportation reduces long-term pollution. | Low |

# Institutional Framework for ESMP Monitoring

| Particulars | Frequency of reporting | Reporting by / Reporting to | Review by / Monitoring by |
|---|---|---|---|
| Implementation of ESMP:<br>• Start of the construction & during construction. (Monthly Environmental Monitoring Report) | Monthly till completion of construction | Contractor to GC | Maha-Metro |
| Submission of ESMP & EMoP Progress report to MDBs | Half Yearly | GC to MDBs | Maha-Metro |
| Submission of External E&S progress report by third party (If required) | • Semi-annually for the three years of construction phase<br>• Yearly during first 2 years of Operation & Maintenance. | GC to MDBs | Maha-Metro |

# Grievance Redress Mechanism (GRM)

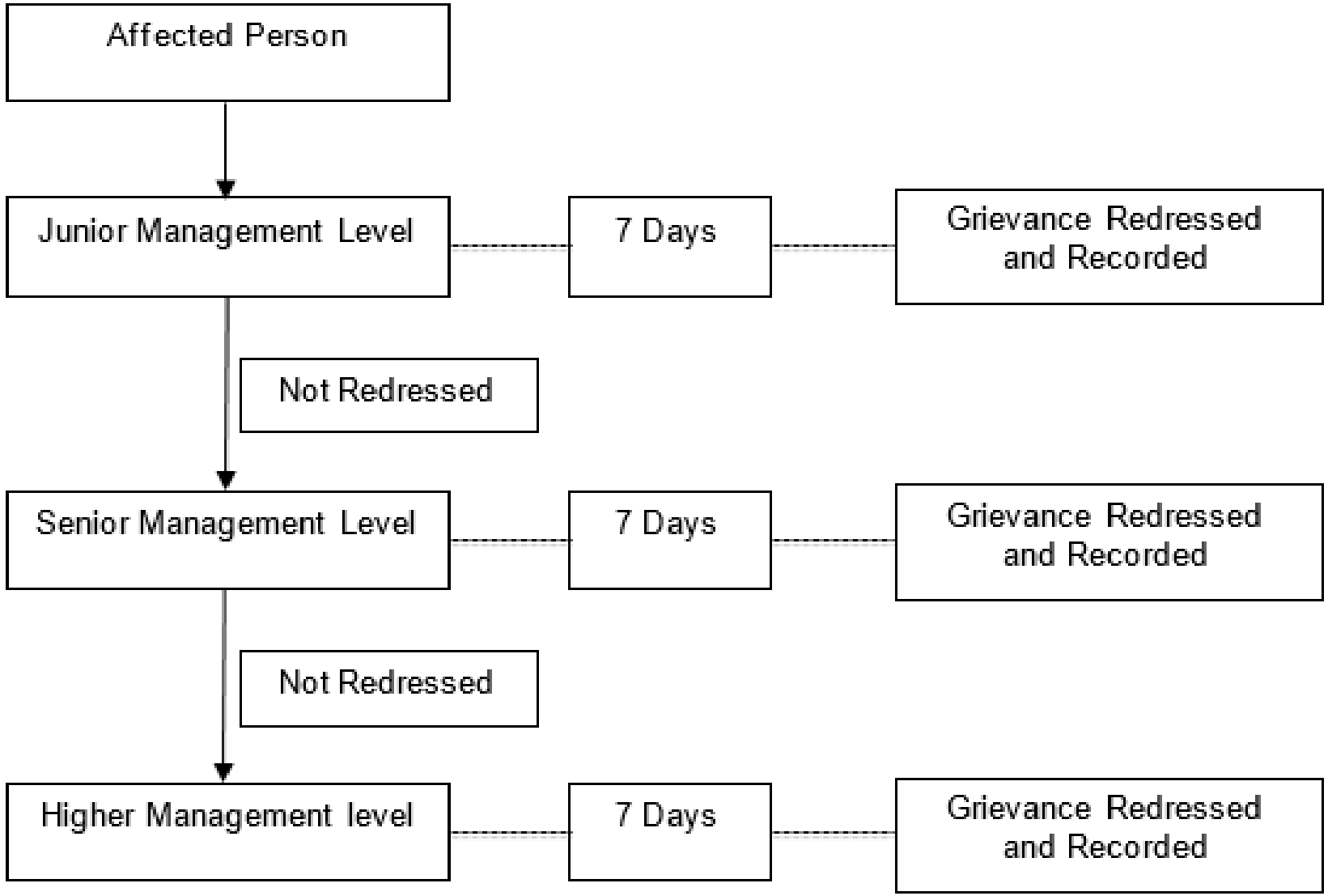
## Purpose of GRM:

- Provide a structured, transparent system for addressing grievances from Project-Affected Persons (PAPs), workers, and local communities.
- Minimize disputes and conflicts related to land acquisition, displacement, compensation, and environmental/social concerns.
- Ensure compliance with national and international standards, including EIB's Environmental and Social Standards.
- Promote stakeholder engagement by facilitating dialogue and timely dispute resolution.

## Types of Grievances Covered:

- ✔ Land acquisition and compensation disputes.
- ✔ Impact on livelihoods (businesses, employment loss).
- ✔ Environmental concerns (noise, dust, water contamination).
- ✔ Safety concerns related to construction activities.
- ✔ Worker grievances on wages, working conditions, and safety.

# Grievance Redress Mechanism (GRM)




**Grievance Redressal Mechanism**

# ESMP Budget

| Sr. No. | Item | Estimated Total Cost (₹) |
|---|---|---|
| **1.** | Compensatory Plantation of 1750 trees in lieu of 175 affected trees (as per the PMC Tree Authority guidelines rate in 1:10 ratio) | 1,75,00,000 |
| **2.** | Rainwater Harvesting | 50,00,000 |
| **3.** | Environmental Monitoring | 2,20,45,000 |
| **4.** | Training and Capacity building | 15,00,000 |
| **5.** | R&R and RP | 32,90,00,000 |
| **6.** | Public Consultation | 10,00,000 |
| **Total ESMP Cost for Swargate to Katraj (Phase-1 Extension)** | | **37,60,45,000** |

# THANK YOU!!!

# **Annexure-14:**

Noise Modelling Report

## ABBREVIATIONS

| | |
|---|---|
| EIB | European Investment Bank |
| CPCB | Central Pollution Control Board |
| EIA | Environmental Impact Assessment |
| FTA | Federal Transit Administration |
| MMRCL | Maharashtra Metro Rail Corporation Limited |
| PMRP | Pune Metro Rail Project |
| RoW | Right of Way |
| SPL | Sound Pressure Level |

## TABLE OF CONTENTS


ABBREVIATIONS ..... 2
TABLE OF CONTENTS ..... 2
LIST OF TABLES ..... 2
LIST OF FIGURES ..... 2
A. INTRODUCTION ..... 3
B. PROJECT DESCRIPTION ..... 3
C. BASELINE NOISE LEVELS AT SENSITIVE RECEPTORS ..... 4
D. OPERATION PHASE NOISE LEVEL PREDICTION ..... 4
E. ASSESSMENT FINDINGS ..... 8
F. CONCLUSION AND RECOMMENDATIONS ..... 8


## LIST OF TABLES


Table 1: Description of Swargate to Katraj (Phase-1 Extension) ..... 3
Table 2: Baseline Noise Levels along Swargate to Katraj alignment ..... 4
Table 3: Levels of Impact ..... 6
Table 4: Land use Category and Metrics for Transit Noise Impact Criteria ..... 6
Table 5: Features of Rolling Stock and Track ..... 7
Table 6: Predicted Noise levels due to Metro Operation ..... 8


## LIST OF FIGURES


Figure 1: Pune Metro Phase 1 Extension project (Swargate to Katraj Alignment) ..... 3
Figure 2: Predicted Noise level contours along Metro line Phase-1 Extension – Swargate to Katraj Alignment ..... 10

## A. INTRODUCTION

1. This is the noise assessment report prepared for the Phase-1 of the proposed Pune Metro Rail Project (PMRP) located in Pune City of Maharashtra State in India. The project will be implemented by the Maharashtra Metro Rail Corporation Ltd. (Maha Metro) and it is proposed for financing from the European Investment Bank (EIB).

2. An environmental & social impact assessment (ESIA) has been carried out for the project in line with EIB's E&S Guidelines (Feb. 2022) requirements. Considering the nature and the location of project, additional assessments are required to ensure that the noise impacts from the project are analysed and mitigated. Accordingly, this noise assessment report has been carried out as a supplementary assessment to comply with EIB's E&S Guidelines (2022) requirements. This report will be annexed to the ESIA report.

## B. PROJECT DESCRIPTION[1]

3. With a view of developing effective and efficient mass transit system in addition to existing public transportation, the Maharashtra Metro Rail Corporation Ltd. intends to develop the proposed Pune Metro Rail Project (Phase 1 Extension project) having North & South Extension Corridors. This report is prepared for the South extension corridor (Swargate to Katraj alignment), details of which are given in **Table 1**. The proposed metro corridor in Pune city are shown in **Figure 1**.

*Table 1: Description of Swargate to Katraj (Phase-1 Extension)*

| Corridor | Stations | | | Length (in Km) As per DPR | | |
|---|---|---|---|---|---|---|
| | Underground | At Grade | Total | Elevated | Underground | Total |
| Swargate to Katraj (Phase-1 Extension) | 5 | **0** | **5** | 0 | 5.9 | 5.9 |
| **Total** | **5** | **0** | **5** | **0** | **5.9** | **5.9** |

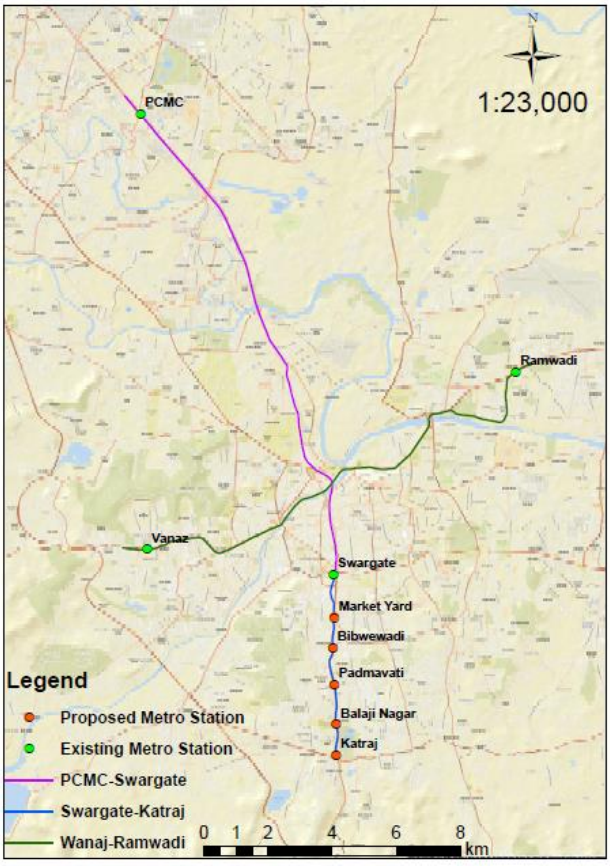



*Figure 1: Pune Metro Phase 1 Extension project (Swargate to Katraj Alignment)*

[1] *Source: Revised Final Detailed Project Report (Swargate to Katraj dated Dec 2022)*

## C. BASELINE NOISE LEVELS AT SENSITIVE RECEPTORS

4. The baseline noise levels at monitored locations along the Swargate to Katraj alignment are presented in **Table 2** below. 1 sensitive receptor i.e. YCI College of CNC Technology has been found to be located within 100 m on either side of the project alignment.

*Table 2: Baseline Noise Levels along Swargate to Katraj alignment*

| Sample No. | Locations (Village) | Significance/ Category of Area / Zone | 24 hourly Average Noise Level Values [in $L_{eq}$ dB (A)] | |
|---|---|---|---|---|
| | | | Day | Night |
| NQ1 | Swargate Metro Station | Commercial | 64.2 | 53.7 |
| NQ2 | Parvati Post Office | Commercial | 46.8 | 42.1 |
| NQ3 | Market Yard Gultekdi Metro Station | Commercial | 64.7 | 54.2 |
| NQ4 | Padmavati Metro Station | Commercial | 63.5 | 54.3 |
| NQ5 | YCI College of CNC Technology | Silent | **52.7** | **45.2** |
| NQ6 | Katraj Metro Station | Commercial | 64.1 | 53.5 |

## D. OPERATION PHASE NOISE LEVEL PREDICTION

5. To estimate the operational noise level, the internationally recognized noise modelling software 'SoundPLAN' version 9.0 has been utilized. The Environmental noise propagation methodology adopted, and the equations used within the SoundPLAN model are based on the ISO 9613 'Acoustics – Attenuation of Sound during Propagation Outdoors' (ISO, 1996) and Railway noise using FTA/FRA-HSGT:2005.

6. SoundPLAN has been developed by Braunstein & Berndt GmbH in Germany, and belongs to the class of sophisticated provisional models, based on the technique of the Ray Tracing Inverted (from the receivers), that allows to simulate the propagation of noise in complex source situations and orography. The model allows calculating the sound levels due to various types of sources and introduces its own algorithms for the calculation of the ground effect, the absorption and the other phenomena involved.

7. The equations used to estimate the propagation of the sound waves, for sources type, are those described in the International Standard ISO 9613. The sound pressure level at the receiver is the sum of all contributing frequencies, and the fundamental equation is the following:

$$SPL = PWL + Di - (Ad + Aa + Ag + Ab + An + Av)$$

where:

- SPL=Sound Pressure Level at the receiver
- PWL=Sound Power Level of noise source
- Di=directivity of the source
- Ad=attenuation of sound wave due to geometric divergence
- Aa=attenuation of sound wave due to air absorption
- Ag=attenuation of sound wave due to ground absorption and reflection
- Ab=attenuation of sound wave due to diffraction
- An=attenuation of sound wave due to variations of the vertical gradient of the temperature, of the wind speed and of the atmospheric turbulence
- Av=attenuation of sound wave due to vegetation

- The directivity correction Di describes the extent by which the equivalent continuous Sound Pressure Level deviates from the point source in a specified direction from the level of an Omni directional point source.
- The geometrical divergence Ad accounts for spherical spreading in the free field from a point sound source, making an attenuation in decibels.
- The law of spreading is different for point, line, and area sources.
- The attenuation due to atmospheric absorption Aa, in decibels, during the propagation through a distance "d", in meters, is equal to Aa = d/1000, where is the atmospheric attenuation coefficient for each octave band. It depends strongly on the frequency of the sound, the ambient temperature, and the relative humidity.

- The attenuation of sound wave due to ground absorption and reflection “Ag” and that one due to the meteorological conditions “An” depend on the average height of the line of sight above the terrain and the distance from source to receiver. The absorption of sound waves by terrain is expressed by the model using a coefficient G (dimensionless), between 0 (hard ground, such as paving, water, ice and other surface having a low porosity) and 1 (porous ground, such as ground covered by grass, trees or other vegetation); for intermediate terrains (0<G<1), G represents the percentage of porous terrain.

## 1. Methodology

8. As per the Federal Transit Administration (FTA) manual, the transit project category includes projects where the project noise is exclusively due to new transit sources, no changes are made to the highway or to existing noise barriers, and the existing noise levels generated by sources will not change because of the project.

9. As a part of the project a general screening assessment was performed. The General Noise Assessment is used to examine potentially impacted areas identified in the screening step by examining the location and estimated severity of noise impacts. This procedure considers noise source and land use information likely to be available at an early stage in the project development process. Estimates are made of project noise levels and of existing noise conditions to model the location of a noise impact contour that defines the outer limit of an impact corridor or area. This modelling method uses transit-specific noise and adjustment data (in tabular and graphical form) for the noise computations. Major steps in the General Noise Assessment procedure is listed below:

- **Step 1: Identify Noise-Sensitive Receivers –** Identify noise-sensitive receivers and their proximity to the project and major noise sources.
- **Step 2: Determine Project Noise Source Reference Levels –** Determine the project noise sources and reference levels. Then, estimate the project noise exposure at the reference distance of 50 ft considering operational characteristics with preliminary estimations of the effect of mitigation.
- **Step 3: Estimate Project Noise Exposure by Distance –** Estimate project noise exposure at distances beyond 50 ft considering propagation characteristics using a simplified procedure.
- **Step 4: Combine Noise Exposure from All Sources –** Combine all sources associated with the project to predict the total project noise at the receivers.
- **Step 5: Measure Existing Noise Exposure –** Measure the existing noise or estimate the existing noise exposure using a simplified procedure.
- **Step 6: Inventory Impacts**
  a) **Option A:** Tabulate the change in noise (existing vs. estimated project noise) at each noise-sensitive receiver or cluster, identifying all moderate and severe impacts.
  b) **Option B:** Take inventory of noise-sensitive receivers that fall within the moderate and severe noise contours
- **Step 7: Determine Noise Mitigation Needs –** Evaluate the need for mitigation and repeat the General Noise Assessment with proposed mitigation.

10. At an early project stage, the information available for a General Noise Assessment includes:

- Candidate transit mode
- Guideway options – design conditions
- Operational headways – will be single or double
- Design speed – maximum and average speed
- Alternative alignments

11. **Evaluate Path Treatments –** When noise mitigation treatments cannot be applied at the noise source or additional mitigation is required after treating the source, the next preferred placement of noise mitigation is along the noise propagation path between the source and receiver.

12. **Noise Barriers –** Noise barriers are effective in mitigating noise when they break the line-of-sight between source and receiver. The necessary height of a barrier depends on the source height and the distance from the source to the barrier.

- **Noise barriers close to vehicles** – Barriers located very close to a rapid transit train, for example, may only need to be approximately 2 to 3 m above the top of rail to be effective. Standard barriers close to vehicles can provide noise reductions of 6 to 10 dB.
- **Noise barriers at Right of Way (ROW) line** – Barriers on the ROW line or for trains on the far track, the height must be increased to provide equivalent effectiveness to barriers located

close to the vehicles. Otherwise, the effectiveness can drop to 3 dB or less, even if the barrier breaks the line-of-sight.

13. All barrier effectiveness can be increased by as much as 5 dB by applying sound-absorbing material to the inner surface of the barrier. The length of the barrier wall is also important to its effectiveness. The barrier must be long enough to block noise from a moving train along most of its visible path. This is necessary so that train noise from beyond the ends of the barrier will not severely compromise noise-barrier performance at noise-sensitive locations. The barrier length can be refined in the engineering phase, closely examining the predicted sound level exceedances at specific receivers, site geometries, and the contribution of barrier flanking noise, then adjusting the length as appropriate.

14. The noise modelling simulation of the project requires noise input data for all significantly noisy equipment in the project area with following input:

- Sound Pressure Level (SPL) of noise source at a distance of 1 m from the edge of the source·
- Source type estimation of the wave-front of the source, modelled as either a point, line or area source.
- Other data types which improve source accuracy include operational duty cycles (as a conservative assessment, all equipment's are operating continuously at maximum operating conditions)

15. FTA criteria for noise impact were developed specifically for transit noise sources operating on fixed-guideways in urban areas. These criteria are based on well-documented research on human response to community noise and represent a reasonable balance between community benefit and project costs. These criteria do not reflect specific community attitudinal factors. The levels of impact are described in **Table 3** below. The criteria at which the levels of impact occur are presented in two ways depending on the relationship of project and existing noise sources.

16. If the project noise source is a new source of transit noise in the community, such as a new project in an area currently without transit, use the criteria as presented in **Table 4** for analysing the Project Noise Impact criteria presentation.

*Table 3: Levels of Impact*

| Level of Impact | Description |
|---|---|
| No Impact | Project-generated noise is not likely to cause community annoyance. Noise projections in this range are considered acceptable by FTA and mitigation is not required |
| Moderate Impact | Project-generated noise in this range is considered to cause impact at the threshold of measurable annoyance.<br>Moderate impacts serve as an alert to project planners for potential adverse impacts and complaints from the community. Mitigation should be considered at this level of impact based on project specifics and details concerning the affected properties |
| Severe Impact | Project-generated noise in this range is likely to cause a high level of community annoyance. The project sponsor should first evaluate alternative locations / alignments to determine whether it is feasible to avoid severe impacts altogether. In densely populated urban areas, evaluation of alternative locations may reveal a trade-off of affected groups, particularly for surface rail alignments. Projects that are characterized as point sources rather than line sources often present greater opportunity for selecting alternative sites. This guidance manual and FTA's environmental impact regulations both encourage project sites which are compatible with surrounding development when possible. If it is not practical to avoid severe impacts by changing the location of the project, mitigation measures must be considered |

*Table 4: Land use Category and Metrics for Transit Noise Impact Criteria*

| Land Use Category No. | Land Use Type | Noise Metric, dBA | Description of Land Use Category |
|---|---|---|---|
| **1** | High Sensitivity | Outdoor Leq (1hr)* | Land where quiet is an essential element of its intended purpose. Example land uses include preserved land for serenity and quiet, outdoor amphitheatres and concert pavilions, and national historic landmarks with |

| | | | |
|---|---|---|---|
| | | | considerable outdoor use. Recording studios and concert halls are also included in this category. |
| **2** | Residential | Outdoor Ldn | This category is applicable all residential land use and buildings where people normally sleep, such as hotels and hospitals. |
| **3** | Institutional | Outdoor Leq(1hr)* | This category is applicable to institutional land uses with primarily daytime and evening use. Example land uses include schools, libraries, theatres, and places of worship where it is important to avoid interference with such activities as speech, meditation, and concentration on reading material. Places for meditation or study associated with cemeteries, monuments, museums, campgrounds, and recreational facilities are also included in this category. |

** Leq(1hr) for the loudest hour of project-related activity during hours of noise sensitivity.*

## 2. Noise Model

17. Using SoundPlan 9.0, the calculation options that were selected for this project provided a balance between accuracy of noise assessment and time to complete the computation. The required inputs for modeling of Noise were collected from Maharashtra Metro Rail Corporation Limited (MMRCL) and presented in below **Table 5**. As mentioned earlier, in addition to the FTA/FRA-HSGT (2005) standards that were applied, the following options were adopted:

- The maximum distance between any two stations is 1km, respectively.
- The metro train service timing for all routes is 6:00 AM till midnight, 18 hours per day.
- The scheduled speed on all the routes is 34 kmph
- The maximum acceleration and deceleration shall be 1.0 m/s2 and 1.1 m/s2
- Assessment: Day, Night, Ldn
- Emission time slices: 6-22, 22-6
- Reflection order: 3

*Table 5: Features of Rolling Stock and Track*

| **Parameter** | **Details** |
|---|---|
| Unit | 3 car basic unit DMC+TMC+DMC |
| DMC dimension | 21.64 × 2.9 × 3.9 (L×B×H) |
| TMC dimension | 21.34 × 2.9 × 3.9 (L×B×H) |
| Maximum coach length | 22.6m |
| Axle Load | ≤ 16T or 157kN |
| Number of axles | 4 |
| Normal braking system | Regenerative |
| Braking type | Disc Brakes |
| Wheel diameter | 860mm (assumption) |
| Track Gauge | 1435mm |
| Track base | Ballast-less track with elastic and absorbent fittings |
| Rail joints | Minimum spacing (assumption) |

### 2.1. Noise Emission Sources

18. Noise radiated from train operations and track structures generally constitute the major noise sources. Airborne noise is radiated from at-grade and elevated structures, while ground- borne noise are of primary concern in underground operations. Basic sources of wayside airborne noise are:

- Wheel / Rail Noise: Due to wheel /rail roughness
- Propulsion Equipment: Traction motors, cooling fans for Traction Motor, reduction gears etc.
- Auxiliary Equipment: Compressors, motor generators, brakes, ventilation systems, other car mounted equipment

19. Predicted noise levels for the project area were modelled in accordance with the FTA guidelines. Predicted future noise levels in the project area were based on existing measured sound levels and future daily transit operations.

### 2.2. Ground Elevation and Digital Ground Model

20. The ground elevation data was taken from Google Earth to generate Digital Ground Model.

### 2.3. Superstructure

21. The viaduct has pre-stressed concrete “Box” shaped Girders/Double U-Girder on a Single pier with pile / Open foundations. It is assumed that the viaduct side wall height is 750mm and will act as a noise wall. For elevated viaducts, the rail level is 11.16m AGL.

### 2.4. Rail Elevation

22. The rail elevations from the engineering vertical profiles were used to establish the absolute and relative height of the railway every 11.16 meters.

### 2.5. Building Location and Heights

23. Building locations were taken from Open Street Map and Google Maps while the building heights were extrapolated from the number of floors as observed from field survey.

## E. ASSESSMENT FINDINGS

24. The baseline noise levels at sensitive receptors along the proposed Swargate to Katraj underground alignment, along with the modelled noise levels from metro operations, are presented in **Table 6**. The findings are summarized below.

25. Noise generated from the operation of the underground metro remains within the permissible limits prescribed by CPCB and does not exceed +3 dB(A) above the existing ambient noise levels at any of the identified receptors, including residential and institutional areas. Due to the underground nature of the alignment, noise transmission to the surface is significantly attenuated. No exceedances were observed, even during night-time conditions. Therefore, no additional noise mitigation measures are required along this corridor during the operation phase.

*Table 6: Predicted Noise levels due to Metro Operation*

| Name of Receptor | Land use Category as per CPCB | Baseline Noise Levels, dB(A) | | CPCB Noise Standards (dBA) | Projected Noise Levels, dB(A) | | Increase over Baseline Noise Levels, dB(A) | | Noise Levels after installation of Noise Barriers, dB(A) | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Day | Night | | Day | Night | Day | Night | Day | Night |
| Swargate Metro Station | Proposed Station / Commercial | 64.2 | 53.7 | Day: 65 Night: 55 | 64.8 | 54.1 | 0.6 | 0.4 | No Mitigation Required | |
| Parvati Post Office | Commercial | 46.8 | 42.1 | Day: 65 Night: 55 | 48.1 | 43.2 | 1.3 | 1.1 | No Mitigation Required | |
| Market Yard Gultekdi Metro Station | Proposed Station / Commercial | 64.7 | 54.2 | Day: 65 Night: 55 | **65.1** | 54.5 | 0.4 | 0.3 | 63.2 | 53.1 |
| Padmavati Metro Station | Proposed Station/ Commercial | 63.5 | 54.3 | Day: 65 Night: 55 | 64.6 | **55.1** | 1.1 | 0.8 | 63.8 | 54.6 |
| YCI College of CNC Technology | Educational / Silent | 52.7 | 45.2 | Day: 50 Night: 40 | **53.5** | **45.9** | 0.8 | 0.7 | 49.8 | 39.7 |
| Katraj Metro Station | Proposed Station / Commercial | 64.1 | 53.5 | Day: 65 Night: 55 | 64.6 | 53.9 | 0.5 | 0.4 | No Mitigation Required | |

## F. CONCLUSION AND RECOMMENDATIONS

26. The noise assessment for the proposed Swargate-Katraj underground metro line shows that projected noise levels at most sensitive receptors—including Swargate Metro Station, Parvati Post Office, and Katraj Metro Station—are within CPCB permissible limits for both day and night periods, with minimal increases over baseline levels. Therefore, no control / mitigation measures are needed at this stage. It is highly recommended that the metro tracks be maintained throughout the project life following ISO 3095:2013 for the smooth movement of metro trains and low noise generation.

27. Slight exceedances are seen to occur in daytime noise at Market Yard Gultekdi station and in night-time noise at Padmavati stations. However, these are marginally exceeding CPCB limits by less than 1 dB(A). Traditional noise barriers are generally not feasible or effective in underground metro projects. Instead, noise control will rely on vibration isolation measures, acoustic treatments within tunnels and stations, and noise attenuation at ventilation shafts & station access points. Targeted surface-level noise barriers or acoustic enclosures may also be implemented at Market Yard Gultekdi and Padmavati.

28. At YCI College of CNC Technology, baseline and projected noise levels exceed CPCB standards, indicating an existing high-noise environment. In this case, the focus is on ensuring that the metro project does not cause any significant increase over baseline levels. Noise control measures such as vibration isolation and acoustic treatments will be implemented to minimize additional noise contribution. Regular monitoring and stakeholder engagement are recommended to manage the overall noise environment effectively.

29. Predicted Noise level contours along Metro line Phase-1 Extension – Swargate to Katraj Alignment are shown in **Figure 2**.

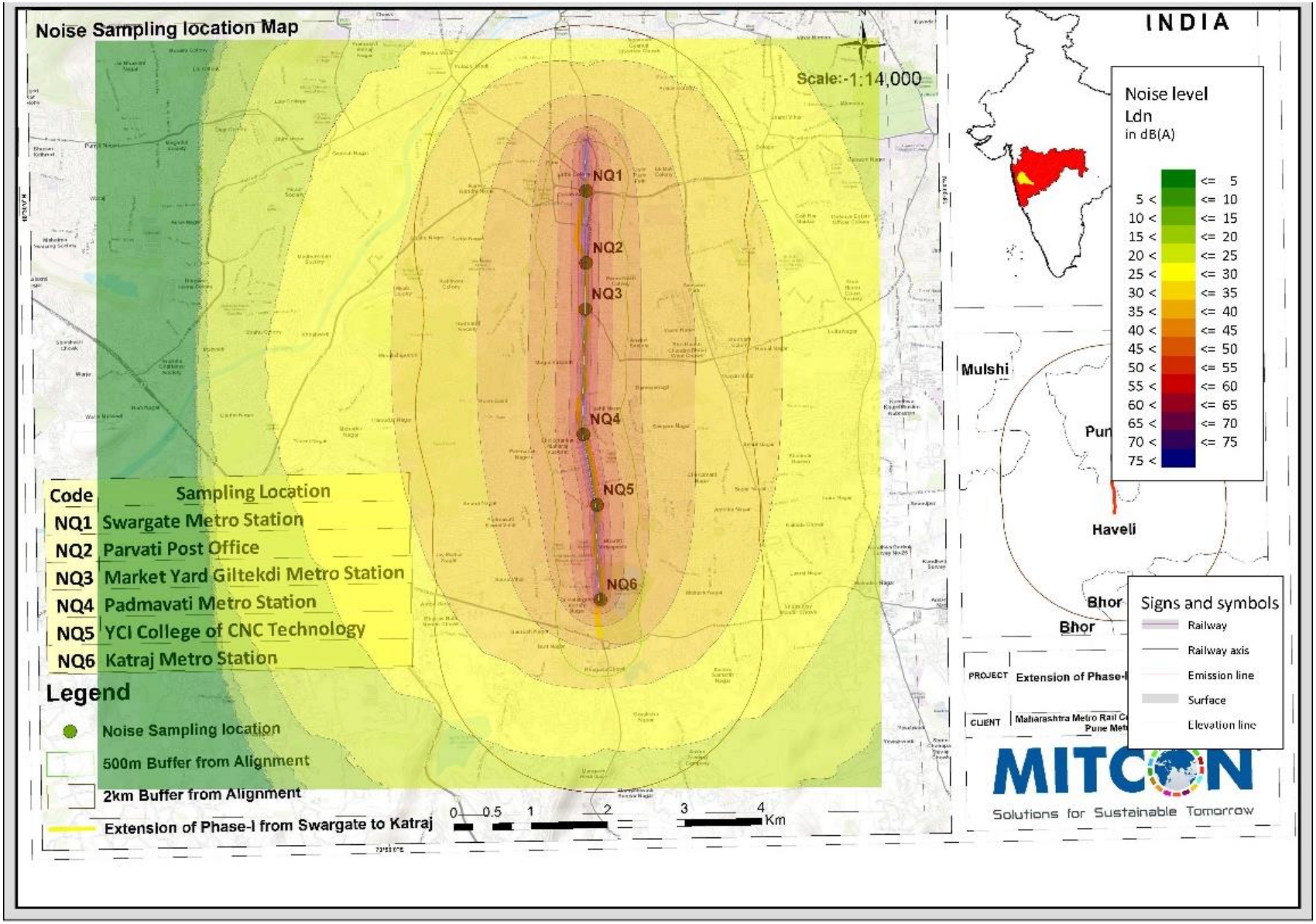



*Figure 2: Predicted Noise level contours along Metro line Phase-1 Extension – Swargate to Katraj Alignment*

# Annexure-15:

Tunnel Worker Safety Assessment and Mitigation Plan

# Tunnel Worker Safety Assessment and Mitigation Plan

## 1. Background

The Swargate to Katraj (Phase-1 Extension) of Pune Metro comprises a 5.9 km fully underground corridor, with Swargate already an underground station and the extension continuing underground up to Katraj. The section is designed as a twin-tunnel arrangement, each with an excavation width of approximately 6.7 meters and a cross-sectional area of about 35.24 $m^2$.

Tunnelling operations will generate a substantial quantity of excavated soil and rock, necessitating careful planning for worker safety, ventilation, muck handling, and equipment movement within confined spaces. The underground working environment presents specific safety and health challenges such as confined space hazards, dust exposure, noise, vibration, and fire risks.

To address these, Maha Metro has adopted a comprehensive Safety, Health and Environment (SHE) framework, aligned with national regulations and EIB Environmental and Social Standards. This framework forms an integral part of the contract documents and its implementation is mandatory for all contractors and subcontractors.

This preliminary Tunnel Worker Safety Management Plan ensures systematic identification of risks, implementation of preventive and mitigation measures, and continuous monitoring of safety performance during construction. It aims to safeguard workers through proper training, supervision, and emergency preparedness, ensuring safe and compliant tunnel operations. Additionally, the contractor shall prepare a detailed Tunnel Safety Implementation Plan based on this framework, defining site-specific procedures, responsibilities, and monitoring mechanisms for effective execution.

## 2. Purpose

The purpose of this plan is to establish comprehensive occupational health, safety, and environmental (HSE) guidelines for all activities involved in the construction of underground tunnels and associated structures under the Swargate–Katraj Metro section. The document aims to prevent accidents, ensure safe working practices, and provide a structured approach to identifying, mitigating, and managing potential risks during tunnelling operations. The plan is a live document and shall be reviewed periodically to ensure continual improvement in safety performance.

## 3. Scope

This plan applies to all tunnelling works executed by the Contractor, including excavation, lining, structural works, and TBM related underground activities. The provisions cover worker safety, environmental protection, and emergency response within the tunnel system. Tunnel cross-section, dimensions, and design profiles shall conform to the approved project drawings and specifications as verified by GC / MahaMetro.

## 4. Risk Assessment and Control

Prior to commencement of tunnelling, a detailed risk assessment shall be conducted by the Contactor to identify potential hazards and establish mitigation measures. The key categories of risk are summarized below.

| Category | Potential Risks / Hazards |
|---|---|
| **Geotechnical Risks** | Collapse of tunnel face or roof, ground settlement, rock falls, unstable geological strata. |
| **Water Ingress** | Sudden inflow of groundwater or pressurized water, leading to flooding. |
| **Fire & Explosion** | Combustible gases, diesel equipment fires, welding sparks, and short circuits. |
| **Air Quality & Ventilation** | Accumulation of dust, fumes, CO, NOx, or low oxygen concentration. |
| **Machinery & Equipment Hazards** | TBM (Tunnel Boring Machine) entrapment, moving machinery, electrical hazards. |
| **Ergonomic / Physical Hazards** | Working in confined spaces, high noise, vibration, and temperature. |
| **Blasting and Vibration** | Flying debris, overpressure, structural damage, and worker exposure. |
| **Slip, Trip, Fall** | Wet/slippery floors, poor illumination, uneven surfaces. |
| **Emergency Situations** | Fire, flooding, gas leakage, collapse, or equipment failure. |

Mitigation measures suggested for each of the above mention Risk categories as summarized below:

**Geotechnical Risks:** Potential hazards such as tunnel collapse, ground settlement, or rock falls will be managed through detailed geotechnical investigations, face monitoring, and appropriate support systems like rock bolts, ribs, and shotcrete.

**Water Ingress:** Sudden inflow of groundwater or high-pressure seepage can cause flooding. Continuous dewatering, pressure relief holes, and waterproof lining will be maintained to mitigate this risk.

**Fire and Explosion:** Combustible gases and diesel exhaust present fire hazards. Flame-proof equipment, fire detection systems, and CO/$CH_4$ sensors will be installed, supported by regular firefighting drills and training.

**Air Quality:** Ventilation will be designed to maintain air velocity of at least 0.5 m/s at the face and ensure that CO levels remain below 50 ppm. Oxygen levels will be continuously monitored.

**Machinery and Equipment Hazards:** All mechanical and electrical equipment shall have proper guarding and grounding. Lockout–Tagout (LOTO) procedures will be implemented during maintenance.

**Physical and Ergonomic Hazards:** Working in confined, hot, or noisy environments shall be managed by providing PPE, rest breaks, and rotational shifts.

**Emergency Situations:** Emergency scenarios such as flooding, fire, or collapse shall be addressed through pre-defined response plans, regular mock drills, and availability of refuge chambers.

## 5. Safety & Training Management

The Contractor shall execute all works in a manner that safeguards human health and minimizes environmental impact. The primary objective is to maintain zero fatalities, zero lost-time injuries, and minimal disruption to nearby communities. The Contractor's management team will ensure that all work activities, including those by subcontractors, comply with the approved Safety, Health, and Environment (SHE) Manual, which will be included in the Contract documents, and the Environmental and Social Management Plan (ESMP). Safety performance will be monitored continuously through regular site inspections, structured training programs, and systematic reporting mechanisms. Training plays a vital role in ensuring that all site personnel are competent, aware, and equipped to maintain safe working conditions throughout tunnel construction activities. The following training initiatives will be implemented:

- **Induction Training:** Conducted for all new workers before entering the site. It covers project-specific safety rules, hazard identification, emergency procedures, PPE usage, and reporting of unsafe conditions.
- **Job-Specific Training:** Provided to workers based on their roles (e.g., tunnelling crew, electricians, equipment operators). It focuses on safe work procedures, equipment handling, confined space safety, and emergency response.
- **Refresher Training:** Periodic sessions conducted every 6 months to reinforce safe practices, highlight lessons learned from incidents, and introduce updates in safety standards or work procedures.
- **Emergency and Fire Safety Drills:** Practical simulations of evacuation, fire response, and rescue operations are organized quarterly to enhance preparedness for tunnel emergencies.
- **First Aid and Health Awareness Training:** Conducted by qualified health professionals to ensure designated personnel are trained in basic first aid, injury management, and workplace hygiene.
- **Supervisor and Safety Officer Training:** Focused on leadership in safety, risk assessment, incident reporting, and communication. Supervisors will undergo these sessions bi-annually to strengthen the overall SHE culture.

All training sessions will be documented, and attendance records maintained. Evaluation of worker understanding and competency will be conducted after each training to ensure effective implementation at the site.

## 6. Mandatory Provisions for Worker Safety

All tunnel personnel shall undergo comprehensive safety induction and task-specific training before starting work. Use of Personal Protective Equipment (PPE)—including helmets, reflective jackets, gloves, safety shoes, eye protection, ear plugs, and self-rescue respirators—shall be mandatory at all times. For confined space activities, entry shall be allowed only through a written permit system after confirming oxygen concentration above 19.5%. Adequate lighting (minimum 50 lux at the work face), effective communication, and availability of first aid, drinking water, sanitation, and ambulance facilities shall be ensured at each portal.

The Contractor shall provide, maintain, and enforce use of PPE conforming to relevant IS/EN standards, replacing items as per manufacturer's recommendations. Supervisors shall monitor correct usage, upkeep, and periodic inspection of all safety gear. Non-compliance shall invite disciplinary action under the site SHE policy. Regular health check-ups and medical fitness certification shall be mandatory for all tunnel personnel.

## 7. Emergency and Evacuation Procedures

An Emergency Control Room shall function round the clock to coordinate response and communication during incidents. Refuge chambers shall be provided at intervals not exceeding 250m, equipped with oxygen supply, first-aid kits, and communication links. Evacuation routes shall be clearly marked and illuminated, and emergency lighting shall automatically activate during power failure. Firefighting equipment including $CO_2$, DCP, and foam extinguishers shall be positioned every 50m along the tunnel and near machinery areas. The Contractor shall coordinate with the local fire brigade, police, and hospital authorities for emergency support and conduct joint evacuation drills at least once a month.

## 8. Monitoring and Reporting

The Contractor's Safety Officer shall carry out daily safety inspections and toolbox talks with workers at the start of each shift. Fortnightly safety audits shall be conducted and findings submitted to the Engineer for review. All incidents, near misses, and corrective actions shall be recorded in the site SHE Register. Monthly trend analysis will be used to identify recurring issues, if any, and preventive measures.

## 9. Site Safety and Housekeeping

Good housekeeping and safe access are essential to prevent accidents. The Contractor shall maintain clean and illuminated walkways, ensure that materials are stored properly, and promptly remove debris. Electrical connections and lighting systems shall be checked regularly to avoid hazards. Emergency contact numbers, signage, and SHE information shall be displayed prominently at each access point.

## 10. Health, Safety, and Environment for Visitors

Visitors shall not enter the tunnel without completing a safety induction specific to tunnel works. They shall be accompanied at all times by authorized tunnel staff and provided with essential PPE including a helmet, high-visibility jacket, and safety footwear. Access shall be restricted to designated safe zones only.

## 11. Review and Continuous Improvement

The Tunnel Worker Safety Plan prepared by Contractor shall be reviewed every six months or following any major incident or change in work methodology, by GC / MahaMetro. Lessons learned will be incorporated into revised procedures to ensure continual enhancement of health and safety performance.